APPENDIX A: Works Cited

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APPENDIX B: Previous Studies and Summaries

Historical Reports

For a historical perspective on water quality in the Cass River, reports were gleaned from the Michigan Water Resources Commission of the Department of Natural Resources from 1960 – 1974 and are summarized below. A cross comparison of scientific data collected during this time period and the 1990's is not possible due to a change in the State's monitoring procedures between the two time periods.

A Report of Investigation on Fish Mortality in the Cass River was completed on April 25, 1960. A citizen complaint was filed to the Michigan State Police about fish kills in the Cass River near the vicinity of Caro. The investigation concluded that the fish mortality was due to sugar beet waste being discharged into the Cass River in Caro. The waste was discharge from a project that was to repair a pipe in a holding pond owned by Michigan Sugar Company. The company dug channel from the holding pond to the Cass River to drain the pond and fix the dyke and pipe. (Fetterolf Jr 1960)

A Cass River Study from Caro to Vassar was completed by the Michigan Water Resources Commission, DNR. A water quality survey was conducted at twelve locations including three major dischargers: Caro Waste Water Treatment Plant (WWTP), Caro Regional Center, and Michigan Sugar Company. Wastewater survey results indicated the phosphorous levels in discharge effluent from the Caro WWTP were in exceedence of water quality standards. Effluent from Michigan Sugar Company and the Caro WWTP are thought to be adversely affecting the aquatic ecosystem of the Cass River. Water Quality Index values rated water quality "medium" to "good". Additional impacts were thought to occur when Michigan Sugar Company is discharging at normal volume and in the impounded section behind the Michigan Sugar Company dam. At the time of the study, Michigan Sugar Company was discharging below normal volumes. (Heckathorn 1974)

A Cass River Survey from Cass City to Caro was completed by the Michigan Water Resources Commission, DNR. A water quality summary was conducted at seven locations of this stretch showing no major water quality problems. The Cass River had "medium" to "good" water quality per the Water Quality Index. During drought conditions, the river exceeded acceptable standards of total dissolved solids. (Rymph and Boersen 1974)

A Cass River Study from Vassar to Mouth was completed by the Michigan Water Resources Commission, DNR. The water quality study determined that water quality was "medium" to "good" during the survey. It was determined that toxic materials from effluent from the Bridgeport Township and Frankenmuth WWTP's would result in the deaths of fish and other aquatic organisms at drought flow. During the sampling period, Dissolved Oxygen (DO) levels were below standards and pH values could also exceed standards. Impacts from algal respiration at the Frankenmuth dam were causing DO concentrations to dip. Compared to a

study conducted in 1960, water quality had improved significantly in part due to regulations that improved the Frankenmuth WWTP. (Eldredge 1974)

United States Geologic Survey Water Quality Sampling

The United States Geologic Survey (USGS) collects data on the Cass River in Frankenmuth (Station ID 04151500) on suspended sediment concentration in milligrams/liter and suspended sediment discharge in tons/day.

Figures 3.1 and 3.2 show the results from the USGS's sediment data for the Cass River station in Frankenmuth:

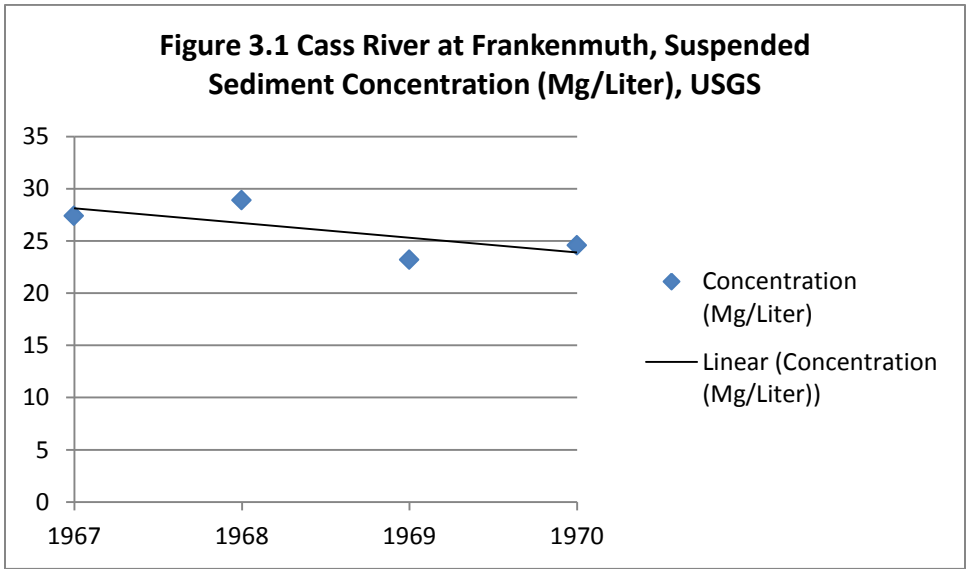


Figure 3.1 Caption: Suspended sediment concentration is available from 1967 – 1970. The above Figure shows a range from 23.2 milligrams per liter to 28.9 milligrams per liter. A trendline was added to show a general decline in suspended sediment concentration over the 4-year period.

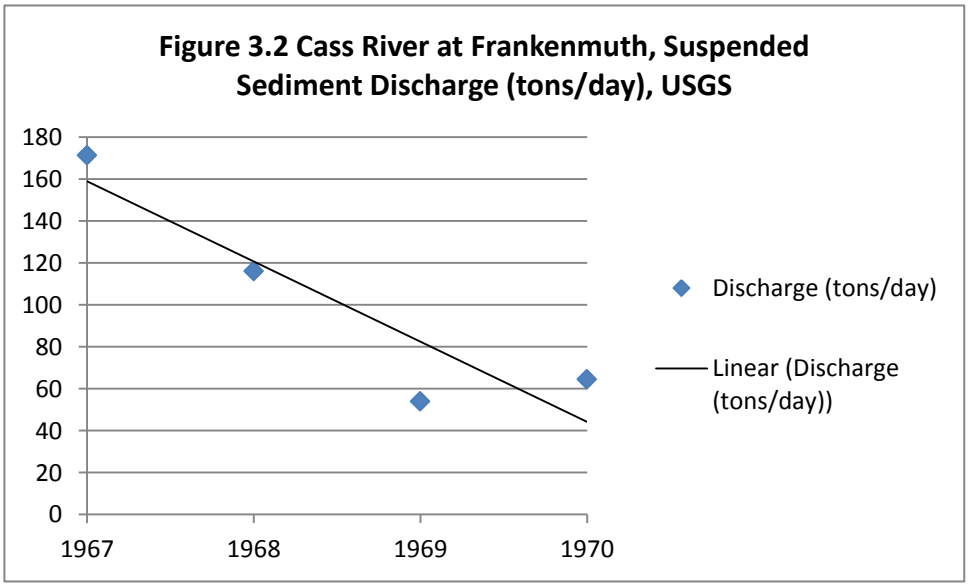


Figure 3.2 Caption: Suspended discharge data was available for the Cass River in Frankenmuth from 1967 to 1970 showing a range from 54 to 171 tons/day being discharged. A trendline was added to show a significant reduction in sediment discharge over the 4-year period.

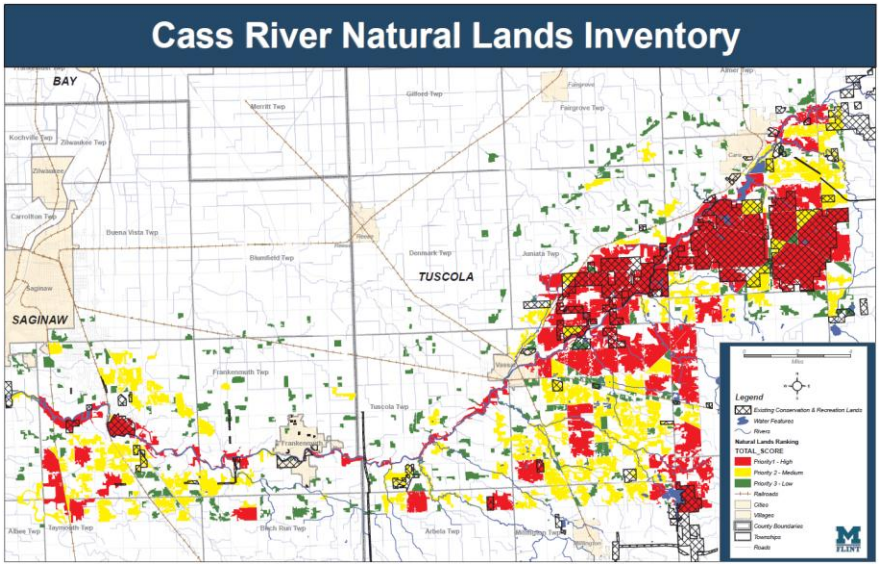
Natural Lands Inventory, Lower Cass River Greenway 2010-2011 (Cass River Greenway and University Outreach, University of Michigan - Flint, 2011)

An inventory of natural lands was created to identify and rank natural lands in Bridgeport, Frankenmuth, Tuscola, Vassar, Juniata, and Indian Fields Townships in Saginaw and Tuscola counties along the mainstem of the Cass River corridor per the request of the Cass River Greenway committee in 2010 – 2011.

Natural lands are defined as places on the landscape dominated by native vegetation that have various levels of potential for harboring high quality natural areas and unique natural features. In addition these areas may provide critical ecological services such as maintaining water quality and quantity, soil development and stabilization, pollination of cropland, corridors for wildlife travel, stopover sites for migratory birds, sources of genetic diversity, and floodwater retention. However, the actual ecological value of these natural lands can only be truly determined through on the ground surveys.

A total of 511 natural areas were identified and evaluated against a set of nine criteria and scored based on methodology developed by the Michigan Natural Features Inventory (MNFI). The ranking scheme produced a total of 41 possible points while actual scores ranged from 1 – 33 points. Tables are displayed from the report showing…

Figure 3.x Lower Cass River Natural Lands Inventory



Source: Cass River Greenway and University Outreach, University of Michigan - Flint, 2011

Saginaw Bay Watershed Wildlife Habitat Conservation Framework (Nelson, 2000)

"This report identifies the Cass River as a valuable corridor for wildlife travel, and recommends that it be evaluated for designation under the Michigan Natural Rivers program from Vassar upstream in order to protect the watershed. The report also recommends safeguarding the corridor through expansion of the five existing game areas in the watershed (Vassar, Deford, Tuscola, Sanilac, and Cass City). (*Saginaw Bay RC&D*, 2008) "

A Vision of Green Report (2005)

"The Saginaw Bay Greenways Collaborative (the Collaborative) formed in 1999 to develop the Saginaw Bay Greenways plan "to connect communities to the area's natural and cultural amenities for the benefits of recreation, transportation, education, health and well being of its citizens. "The Collaborative's report, "A Vision of Green", summarizing the green infrastructure plan for the tri-county (Midland/Bay/Saginaw) area and outlining suggested implementation steps was released in early 2005. The plan put forth capitalizes on the large tracts of land already protected in the area. The Shiawassee National Wildlife Refuge and the adjoining Shiawassee River State Game Area form a major hub for the region. Most of the green infrastructure corridors identified by the Saginaw Bay Greenways Plan follow the network of rivers that flows into the bay. The Cass River system is one of the key rivers identified in the plan. (*Saginaw Bay RC&D*, 2008)"

Shiawassee National Wildlife Refuge Additions Final Environmental Assessment, 1995
"In 1995, the U.S. Fish and Wildlife Service considered alternative ways to better protect the Refuge resources at Shiawassee National Wildlife Refuge. After evaluating the alternatives, the Service decided to pursue the addition of approximately 7,500 acres to the existing Refuge (Shiawassee National Wildlife Refuge Additions Final Environmental Assessment,1995). If all authorized acres are eventually acquired, the Refuge will include approximately 16,600 acres. The additions will be primarily along the Tittabawassee and Cass River corridors. These waterways are two of the four rivers that converge on the Refuge and make up Michigan's largest *watershed*, and their environmental integrity is vital to the health of the Refuge's core. (*Saginaw Bay RC&D*, 2008)"

Enhancing Fish Passage over Low-head Barrier Dams in the Saginaw River Watershed (Public Sector Consultants, 2005)

"This report recommended fish passage over the Frankenmuth Dam to open up roughly 73 miles of river and tributary habitat up to the dam in the City of Caro. Approximately 24 miles of this habitat occurs on the mainstream. The fish passage alternative explored in this report would pass walleye, sturgeon, and other species of fish. (*Saginaw Bay RC&D*, 2008)"

Fisheries Scoping Study (The Conservation Fund, 1999)

"This report identified the fish passage over the Frankenmuth Dam as an important step to improve fish habitat. It also noted that the Cass River has not been cultivated as a fishing resource. In addition, the Cass River was identified as a good candidate for a water trail, and it was suggested that it could be promoted as part of a 'Canoe Saginaw Bay' package. One of the critical challenges noted was the lack of significant public access sites and canoe launches in the watershed. (*Saginaw Bay RC&D*, 2008)"

Saginaw County Vision 2020 River Corridor Project – Cass R Field Check (Hoover, 2005)

"This report identifies current limitations for boating in the Cass River (boat access, easy stops for food, easy stops for restroom facilities, easy stops for supplies, easy stops for historic sites), and evaluates possible locations to be included in a water trail. (*Saginaw Bay RC&D*, 2008)"

Feedlot Pollution Reduction Calculator - Section 319 (MDEQ)

Contributing Area (CA) =	12			NOTE calcs not sensitive to area
25yr - 24 hr Rainfall ® per day =	0.2848	inches		
CN =	74			
Slaughter Beef				
Number of animals =	20			
BOD Ratio =	1	**EAU =**	20	
P Ratio =	1	**EAU =**	20	
N Ratio =	1	**EAU =**	20	
Dairy Cattle				
Number of animals =	0			
BOD Ratio =	1.4	**EAU =**	0	
P Ratio =	0.92	**EAU =**	0	
N Ratio =	1.91	**EAU =**	0	
Horse				
Number of animals =	1			
BOD Ratio =	1.063	**EAU =**	1.063	
P Ratio =	0.42	**EAU =**	0.42	
N Ratio =	0.85	**EAU =**	0.85	
Feeder Pig				
Number of animals =	0			
BOD Ratio =	0.097	**EAU =**	0	
P Ratio =	0.07	**EAU =**	0	
N Ratio =	0.06	**EAU =**	0	
Sheep				
Number of animals =	0			
BOD Ratio =	0.075	**EAU =**	0	
P Ratio =	0.06	**EAU =**	0	
N Ratio =	0.14	**EAU =**	0	

S = an emp
CN = curve number
Q = runoff in inches
R = design rainfall in inches
V = runoff volume in acre-inches
CA = contributing area of acres

S = ((1000/CN)-10
S = 3.514

$Q = (R-0.2S)^2 / (R+0.8S)$
Q = 0.06 inches

V= Q x CA
V= 0.68 acre-inches

AUD = EAU / CA

AUD (BOD) =	1.75525
AUD (P) =	1.701666667
AUD (N) =	1.7375

manure pack (BOD) =	1.75525	%	If AUD < 100, percent manure pack = AUD
manure pack (P) =	1.701666667	%	If AUD > 100, percent manure pack = 100%
manure pack (N) =	1.7375		

BOD Constant =	2000	**mg/L**	**BOD =**	35.105 mg/L
P Constant =	300	**mg/L**	**P =**	5.105 mg/L
N Constant =	1500	**mg/L**	**N =**	26.0625 mg/L

Mass Load of pollutants in Runoff	**BOD =**	**5**	Lbs of BOD
Mass Load of pollutants in Runoff	**P =**	**1**	Lbs of P
Mass Load of pollutants in Runoff	**N =**	**4**	Lbs of N

Annual BOD Load in Runoff	**360**	Lbs of BOD/ Yr	
Annual P Load in Runoff	**54**	Lbs of P / Yr	
Annual N Load in Runoff	**270**	Lbs of N / Yr	

		BMP Factor	factor	Removal
Annual Load Reduction BOD	0	0	0	0
Annual Load Reduction P	46	0.85	810	0.6	486
Annual Load Reduction N	0	0	4049	0.65	2631.85

TABLE 2

Animal Type	Design Weight (lbs)	BOD Ratio	P Ratio	N Ratio
Slaughter Beef	1000	1	1	1
Young Beef	500	0.5	0.51	0.45
Dairy Cow	1400	1.4	0.92	1.91
Young Dairy stock	500	0.5	0.33	0.55
Horse	1000	1.063	0.42	0.85
Swine	200	0.388	0.27	0.25
Feeder pig	50	0.097	0.07	0.06
Sheep	100	0.075	0.06	0.14
Turkey	10	0.013	0.03	0.02
Chicken	4	0.008	0.01	0.01
Duck	4	0.0011	0.01	0.01

TABLE 1

Percent Paved =	**0 - 24%**	**25 - 49%**	**50 - 74%**	**75 - 100%**
CN =	91	92	93	94

Pasture =	74
Unvegetated =	86

BRIDGEPORT SURVEY SUMMARY

Date:

Inspected by (init.) MWC

# of Sites Surveyed: 92

Bridgeport TWP

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Average % Impervious = 69.5

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

NOTES:

Structure

Collection Systems:	**#**	**Percent**	
Catch basins with sumps	42	46%	
Grading of impervious areas	87	95%	
Grading to swales	19	21%	
Grading to ditches	10	11%	
Vegetation present	47	51%	In the swale or ditch (could filter runoff)
Inlet grates marked	1	1%	Means with "Dump No Waste" or similar verbage
Curb Inlets	8	9%	
Erosion protection	32	35%	

Storm Water Storage Systems:

	#	**No**
Detention Basin	9	10%
Retention Basin	0	0%
Bio swale	0	0%
Rain garden	1	1%

Size estimate =

length	**Width**	**Depth**

Total Volume = 58,000 **ft^3**

Storm Water Filters:

	#	**No**
Stone filter	2	2%
Infiltration strips	1	1%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
BRIDGEPORT CHARTER TOWNSHIP

Urban Area Storm Water Management (SWM) Survey

Bridgeport Business Storm Water Survey Results

Detention Basin

- SWM w/ Detention
- SWM w/o Detention

Spicer group

CARO SURVEY SUMMARY

Date:

Inspected by (init.) RAB

# of Sites Surveyed: 43

Caro

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

Aveerage % Impervious = 68.7%

NOTES:

Structure

Collection Systems:	**#**	**Percent**	
Catch basins with sumps	31	72%	
Grading of impervious areas	42	98%	
Grading to swales	23	53%	
Grading to ditches	6	14%	
Vegetation present	30	70%	In the swale or ditch (could filter runoff)
Inlet grates marked	5	12%	Means with "Dump No Waste" or similar verbage
Curb Inlets	5	12%	
Erosion protection	28	65%	

Storm Water Storage Systems:

	#	**Percent**
Detention Basin	22	51%
Retention Basin	2	5%
Bio swale	0	0%
Rain garden	0	0%

	length	**Width**	**Depth**
Size estimate =			
Total Volume =	263,600		**ft^3**

Storm Water Filters:	**#**	**Percent**
Stone filter	0	0%
Infiltration strips	4	9%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
CITY OF CARO

Urban Area Storm Water Management (SWM) Survey

Caro Business Storm Water Survey Results

Detention Basin

- SWM w/ Detention
- SWM w/o Detention
- City Limit
- Downtown (Catch Basins Only)

Spicer group

CASS CITY SURVEY SUMMARY

Date:

Inspected by (init.) RAB

# of Sites Surveyed: 29 — Cass City

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Aveerage % Impervious = 51.4%

NOTES:

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

Structure

Collection Systems:	**#**	**Percent**	
Catch basins with sumps	21	72%	
Grading of impervious areas	29	100%	
Grading to swales	15	52%	
Grading to ditches	3	10%	
Vegetation present	11	38%	In the swale or ditch (could filter runoff)
Inlet grates marked	1	3%	Means with "Dump No Waste" or similar verbage
Curb Inlets	2	7%	
Erosion protection	8	28%	

Storm Water Storage Systems:

	#	**Percent**
Detention Basin	7	24%
Retention Basin	0	0%
Bio swale	0	0%
Rain garden	0	0%

Size estimate =

length	**Width**	**Depth**

Total Volume = 752,300 **ft^3**

Storm Water Filters:	**#**	**Percent**
Stone filter	0	0%
Infiltration strips	0	0%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
CITY OF CASS CITY

Urban Area Storm Water Management (SWM) Survey

Cass City Business Storm Water Survey Results

Detention Basin

- SWM w/ Detention
- SWM w/o Detention
- City Limit
- Downtown (Catch Basins Only)

Spicer group

FRANKENMUTH SURVEY SUMMARY

Date:

Inspected by (init.) RAB

# of Sites Surveyed: 79 — Frankenmuth

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Average % Impervious = 76.6

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

NOTES:

Structure

Collection Systems:	**#**	**Percent**	
Catch basins with sumps	79	100%	
Grading of impervious areas	78	99%	
Grading to swales	15	19%	
Grading to ditches	2	3%	
Vegetation present	14	18%	In the swale or ditch (could filter runoff)
Inlet grates marked	14	18%	Means with "Dump No Waste" or similar verbage
Curb Inlets	13	16%	
Erosion protection	69	87%	

Storm Water Storage Systems:

	#	**No**
Detention Basin	45	57%
Retention Basin	0	0%
Bio swale	0	0%
Rain garden	0	0%

Size estimate =

length	**Width**	**Depth**

Total Volume = 349,300 **ft^3**

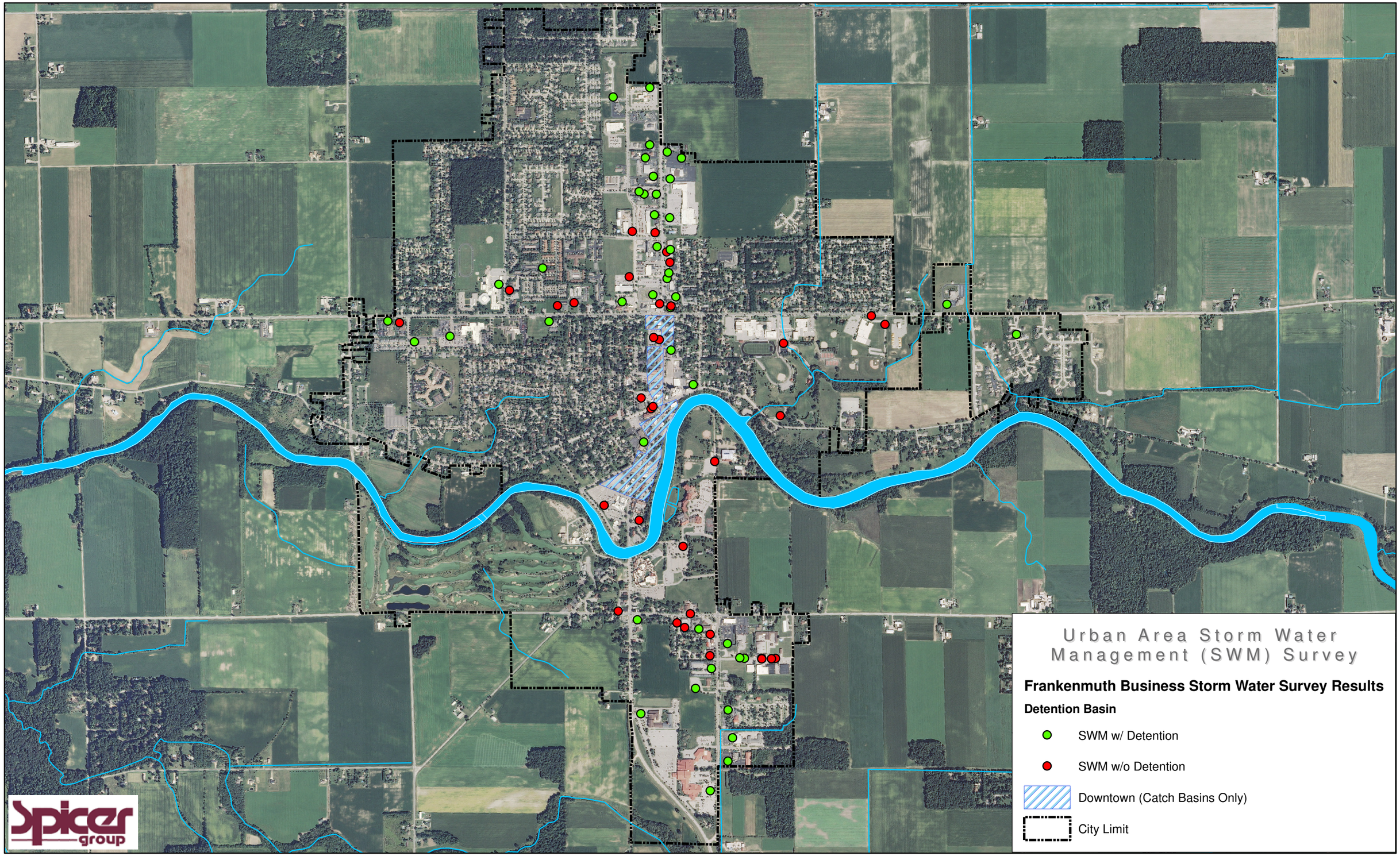
Storm Water Filters:

	#	**No**
Stone filter	0	0%
Infiltration strips	0	0%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
CITY OF FRANKENMUTH



MARLETTE SURVEY SUMMARY

Date:

Inspected by (init.) RAB

# of Sites Surveyed: 26

Marlette

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

Aveerage % Impervious = 74.2%

NOTES:

Structure

Collection Systems:	**#**	**Percent**	
Catch basins with sumps	21	81%	
Grading of impervious areas	25	96%	
Grading to swales	10	38%	
Grading to ditches	2	8%	
Vegetation present	11	42%	In the swale or ditch (could filter runoff)
Inlet grates marked	6	23%	Means with "Dump No Waste" or similar verbage
Curb Inlets	2	8%	
Erosion protection	4	15%	

Storm Water Storage Systems:

	#	**Percent**
Detention Basin	9	35%
Retention Basin	0	0%
Bio swale	0	0%
Rain garden	0	0%

Size estimate =

length	**Width**	**Depth**

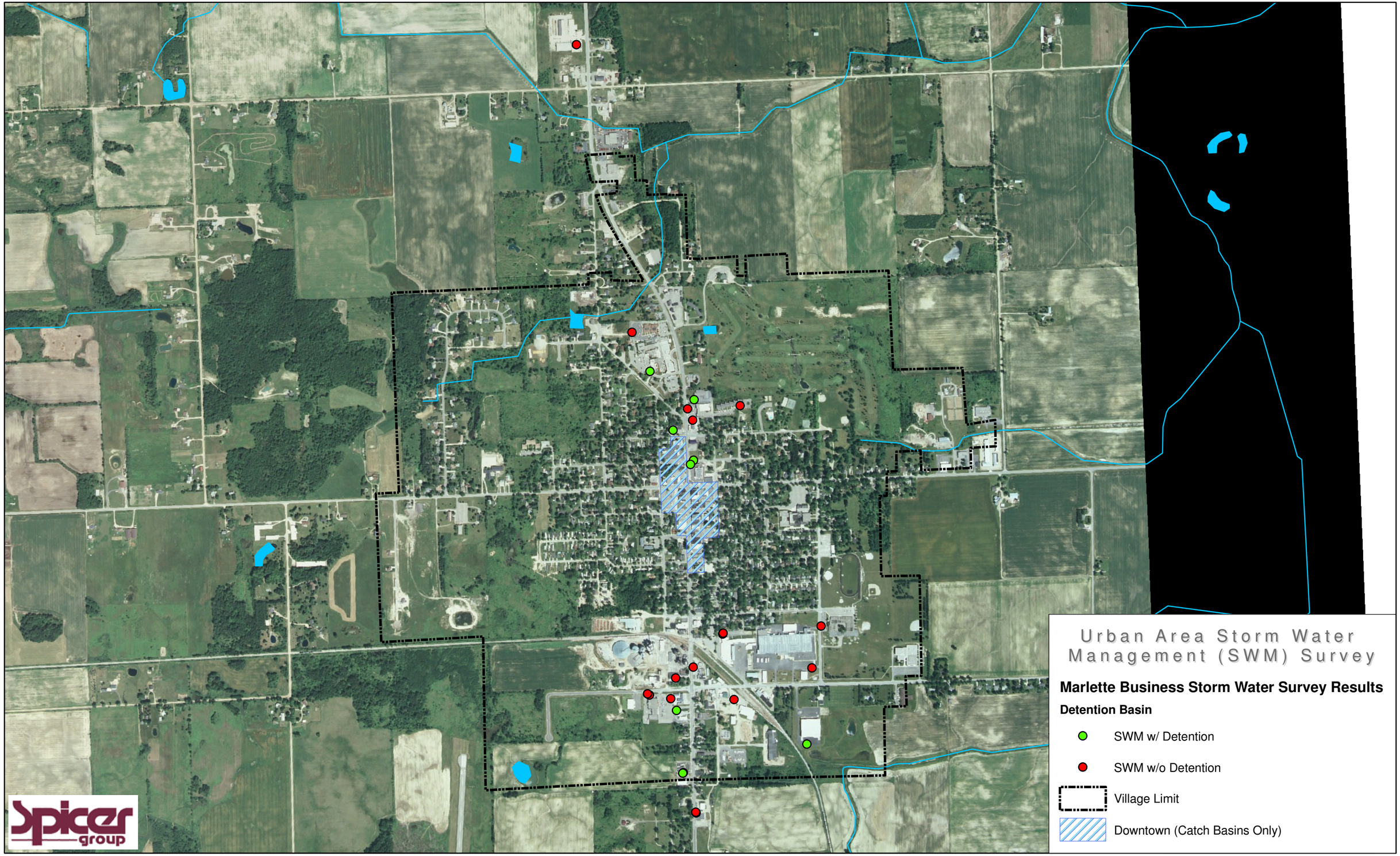
Total Volume = 101,900 **ft^3**

Storm Water Filters:	**#**	**Percent**
Stone filter	0	0%
Infiltration strips	0	0%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
VILLAGE OF MARLETTE



MILLINGTON SURVEY SUMMARY

Date:

Inspected by (init.) RAB

# of Sites Surveyed: 14 — Millington

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Average % Impervious = 72.3%

NOTES:

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

Structure

Collection Systems:	**Yes**	**Percent**	
Catch basins with sumps	8	57%	
Grading of impervious areas	12	86%	
Grading to swales	9	64%	
Grading to ditches	0	0%	
Vegetation present	9	64%	In the swale or ditch (could filter runoff)
Inlet grates marked	0	0%	Means with "Dump No Waste" or similar verbage
Curb Inlets	0	0%	
Erosion protection	2	14%	

Storm Water Storage Systems:

	Yes	**No**
Detention Basin	4	29%
Retention Basin	0	0%
Bio swale	0	0%
Rain garden	0	0%

Size estimate =

length	**Width**	**Depth**

Total Volume = 80,000 **ft^3**

Storm Water Filters:

	Yes	**No**
Stone filter	0	0%
Infiltration strips	1	7%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
VILLAGE OF MILLINGTON

Urban Area Storm Water Management (SWM) Survey

Millington Business Storm Water Survey Results

Detention Basin

- SWM w/ Detention
- SWM w/o Detention
- Village Limit
- Downtown (Catch Basins Only)

Spicer group

VASSAR SURVEY SUMMARY

Date:	11/1/2011	Inspected by (init.)	RAB

# of Sites Surveyed: 54 — Millington

Site Location (coordinates), Lat. **N** Long. **W**

TYPE OF LANDUSE (check all that apply)

Commercial	
Industrial	
Church	
Educational Institution	
Governmental	
Residential	
Condo/Apt.	
Mobile / Manufactured	

Average % Impervious = 72.9%

NOTES:

Structure

Collection Systems:	**Yes**	**Percent**	
Catch basins with sumps	20	38%	
Grading of impervious areas	52	98%	
Grading to swales	34	64%	
Grading to ditches	5	9%	
Vegetation present	26	49%	In the swale or ditch (could filter runoff)
Inlet grates marked	6	11%	Means with "Dump No Waste" or similar verbage
Curb Inlets	5	9%	
Erosion protection	17	32%	

Storm Water Storage Systems:

	Yes	**No**
Detention Basin	9	17%
Retention Basin	0	0%
Bio swale	0	0%
Rain garden	0	0%

	length	**Width**	**Depth**
Size estimate =			
Total Volume =		51,000	**ft^3**

Storm Water Filters:

	Yes	**No**
Stone filter	0	0%
Infiltration strips	0	0%

Other:

Other BMPs e.g. Pavers, porous paving,

CASS RIVER WATERSHED MANAGEMENT PLAN
CITY OF VASSAR

Urban Area Storm Water Management (SWM) Survey

Vassar Business Storm Water Survey Results

Detention Basin

- SWM w/ Detention
- SWM w/o Detention
- City Limit
- Downtown (Catch Basins Only)

Spicer group

POST CONSTRUCTION CONTROL

STORMWATER MANAGEMENT DESIGN

<municipality> or City of

GENERAL COMPLIANCE STANDARDS AND REQUIREMENTS
FOR POST CONSTRUCTION CONTROL DESIGN
FOR DEVELOPMENT AND REDEVELOPMENT PROJECTS
WITHIN THE <<MUNICIPALITY TYPE> > <CITY>OF XXXXXXXXX

Prepared By:

Spicer group

TABLE OF CONTENTS

I. INTRODUCTION

A. Objective of the Post Construction Controls (Storm Water Management Plan)

The purpose of developing this plan is to aid developers and <municipality name> in the design of their storm water runoff collection and detention systems. The Post Construction Controls are developed for compliance with site planning efforts by the <municipality name>.

This Storm Water Management Plan establishes the framework through which detention measures and the design of storm water collection systems will be implemented and details the process that must be followed to gain approval for new developments or redevelopment projects. The plan requires storm water management design practices, which will help to minimize the impacts of proposed development or redevelopment projects on the existing drainage system. In addition, these guidelines will help to insure adequate drainage systems are being constructed for future development in the <municipality type>.

The Post Construction Controls provide detailed information about the< municipality>'s storm drainage system and explains the <municipality's type> approach to managing storm water.

The Post Construction Control Plan includes:

1. A summary of the administrative procedures to be followed to comply with the plan, including meeting requirements, review procedures, inspection requirements, fee schedule, issuance of the storm water discharge permit, penalties and enforcement, and other agency requirements.

2. A summary of existing drainage conditions within the <municipality type>.

3. A description of design calculations.

4. A description of design standards and guidelines.

5. The <municipality type> Storm Water Management Procedure.

B. Administration of the Post Construction Controls

The Post Construction Control Plan will be implemented and operated by the <municipality type>. The <municipality type> will be responsible for the review of new development and redevelopment plans and for the installation and maintenance of measures within the <municipality type> to accomplish the plan. The Department will work in conjunction with <municipality type> Administration, Planning Commission, architectural and engineering consultants, landowners, and developers within the <municipality type> . Additionally, as needed or necessary, the <municipality type> will coordinate with the _____ County Drain Commissioner and the _____ County Road Commission.

C. Review/Design Criteria for Existing and Proposed Storm Water Collection

Proper sizing of storm sewers and open drains is accomplished by examining past rainfall data and projecting the amount of surface water runoff that can be expected from a rain storm. In this study, the design rainstorm was chosen with a recurrence frequency of 100 yr (1% recurrence interval, 50yr (2% recurrence interval), 25 yr (4% recurrence interval),10 years (10% recurrence interval) (PICK ONE). The amount of surface water runoff to be collected in storm sewers and open drains will be estimated using the Modified Rational Method.

The plan also requires there will best management practices (BMPs) implemented to address water

quality for any storm water discharges that will enter into the <municipality type> storm water system or the small drainage streams or other storm water systems within the jurisdictional boundary of the <municipality type> that ultimately discharge to the Cass River. Examples of BMPs are capture and slow discharge of the "First Flush" volume on site projects or retrofitting existing sites to address first flush. It should be noted that discharges directly to a storm sewer (pipe system only) will not be required to deal with "Bankfull" discharge conditions. However, if stormwater discharge is into an existing stream that has bank and stream bed erosion situations then "Bankfull" discharge criteria will have to be used to achieve water quality standards.

D. NPDES Phase II Requirements for Storm Water

There is only one community in the Cass River Watershed that must maintain compliance with the National Pollutant Discharge Elimination System (NPDES) Phase II requirements as they relate to storm water discharge in their jurisdictional area. However, in the future these practices may become a requirement. With the implementation of the Post Construction Controls there will be specific best management practices (BMPs) that developers may be required to implement to assure the storm water discharged from a site is clean to the maximum extent practicable. This is already done in NPDES Phase II areas in Michigan and the rest of the United States. Developers are already familiar with these requirements or should be.

To accomplish this goal of clean storm water discharges BMPs such as bio-swales, rain gardens, bio-infiltration, sediment forebays, catch basin inserts and other BMPs may be required on specific sites. The design engineers must make every attempt to use appropriate BMPs to clean the storm water runoff as it is collected by the storm sewer system, properly detained, and ultimately discharged into an established storm drain, county drain, road commission drain, or natural waterway.

Furthermore, it is the responsibility of the owners of private storm sewer systems to maintain these systems properly to assure they are discharging storm water runoff as clean and pollutant free as possible and only storm water or other authorized discharges are discharged by the private on-site storm sewer system. Storm sewer outfalls into public systems are subject to inspection and if pollutants are being discharged from a private site into a public system or waters of the state of Michigan it is the responsibility of the owner of the private system to clean up any spill or discharge from their site into a public system.

E. Tampering or Removal of Storm Water Controls or Best Management Practices

No property owner or other party shall remove or modify any storm water device or best management practice designed to restrict the flow of storm water into a storm water conveyance system or waters of the State. The removal or modification of a device or best management practice to restrict flows of storm water can only be performed if the party responsible for the removal has had a detailed hydrology & hydraulic study done that provides proof of no significant impact on neighboring properties upstream or downstream of the site. The <municipal> Engineer must approve this study. The party removing such a restrictor will be held liable for any water damage incurred on neighboring properties.

No property owner or other party shall remove or modify a best management practice that protects, preserves, or improves storm water quality. The owner or their designee must obtain permission from the <municipality type> to remove or modify a best management practice. If permission is not received in writing from the <municipality type> , the owner or other party must replace the best management practice at their expense. It is the responsibility of every parcel owner to discharge the cleanest possible storm water from their site as this water drains to the Great Lakes, and we all must take care to protect this water resource to the maximum extent possible.

II. DEFINITIONS

For the purpose of this Storm Water Management Plan, the following definitions are adopted:

1. *Allowable Discharge*: The maximum flow rate that can be discharged from a site, as calculated for design criteria in accordance with this Storm Water Management Plan.

2. *Base Flood Elevation*: The 100-year flood elevation as determined from Flood Insurance Rate Maps (FIRMs) or the best available information.

3. *Best Management Practices (BMPs)*: Structural, vegetative or managerial practices used to protect and improve the quality of surface water and groundwater.

4. *Bio-filtration*: a system comprised of native plants and amended soils with an underdrain that goes to a detention area. The system is designed to receive storm water runoff and clean it via a filtration process and slow the runoff by letting it percolate through the amended soils to reach an underdrain, which then conveys it to a detention area. The system is designed to remove sediment and pollutants from storm water before discharge.

5. *Bio-swales:* vegetated swales with specified native species and amended soils that is sloped and graded to provide conveyance of storm water runoff on a site. The system is designed to remove sediment and pollutants from storm water before discharge.

6. *Conduit*: Any channel, pipe, sewer or culvert used for the conveyance or movement of water, whether open or closed.

7. *Control Elevation*: Contour lines and points of predetermined elevation used to denote a detention storm area on a plat or site drawing.

8. *Detention Facility*: A facility constructed to provide detention storage.

9. *Detention Storage*: The temporary detaining or storage of storm water in a storage basin, on rooftops, in streets, parking lots, school yards, parks, open space, or other areas under predetermined and controlled conditions, with the rate of drainage regulated to the allowable discharge by appropriately installed devices. These detention storage areas shall not be considered regulated wetlands.

10. *Developer/Owner Engineer*: The engineering company formally designated by the Developer/Owner to act as their Engineer.

11. *Development*: The construction of a building, parking lot, structure, etc. on a piece of land or otherwise changing the use of a piece of land.

12. *Discharge*: The release or outflow of water from any source.

13. *Drainage Area*: The area from which storm water runoff is conveyed to a single outlet (i.e. a watershed or catchment area).

14. *Easement*: A parcel of land on which the owner has granted rights-of-way to make surveys, construct, maintain, operate, alter, replace, repair, and remove at any time that part of the storm drainage system located within the easement. The landowner will not be allowed to construct

buildings or other structures on said easement without the written consent of the easement grantee.

15. *Engineer:* A civil engineer that is licensed to work in the state of Michigan or a person who is working under the direct supervision of a civil engineer licensed to work in Michigan.

16. *Excess Storm Water Runoff*: The volume and rate of flow of storm water discharged from a drainage area, which is in excess of the allowable discharge.

17. *Floodplain*: The special flood hazard lands adjoining a watercourse, the surface elevation of which is lower than the Base Flood Elevation and is subject to periodic inundations determined from Flood Insurance Rate Maps (FIRMs) or the best available information. A parcel of land can be located within a floodplain without being shown on a FIRM map.

18. *First Flush*: Is the volume of 0.5 inch of rain over the area of a site. The first flush of a rain event typically carries the most pollutants to our storm sewer system and ultimately to our rivers, lakes and streams. The first flush volume must be discharge over a 24-hour period of time to settle out pollutant loads. Required by MDEQ before discharge into any waters of the State.

19. *Impervious Factor* (**IF**): The percentage of impervious surface specific to a site that the existing storm drain outlet has been historically designed to convey. The **IF** is used to calculate the allowable discharge from a site. Proposed developments or redevelopments will not be allowed to discharge storm water at a rate, which is greater than the runoff that would occur from the site with the percentage of impervious surfaces defined by the impervious factor. **IF's** have been established for the existing drains and storm sewer systems located within the <municipality type> (See Table I, Page 23).

20. *Impervious Surface*: A surface that does not easily allow the infiltration or penetration of water. During rainstorm events, a large percentage of water will runoff. (Typically considered as rooftops, paved walks, roadways, driveways, sidewalks, parking lots, etc.)

21. *Low Impact Development:* Implementation of developmental strategies or best management practices in a manner that maintains predevelopment hydrology, or decreases runoff quantity, and improves runoff quality. It is recommended that the *Low Impact Development Manual of Michigan* be used as a design standard. This document is available for download from the following website: http://www.semcog.org/LowImpactDevelopment.aspx

22. *NPDES*: National Pollutant Discharge Elimination System. In 1987 the Clean Water Act was amended and required to implement a program that would address pollutants being discharged to the nation's waters. This now includes storm water discharges into waters of the nation/state.

23. *Peak Flow*: The maximum rate of flow of storm water runoff at a given location.

24. *Percent Imperviousness* (**IMP**): The actual proposed percentage of impervious surface for a proposed development or redevelopment. The **IMP** is used to calculate the design discharge ($\mathbf{Q_d}$). The design discharge is used to determine storm sewer sizes and required detention volumes. Minimum impervious factors have been established for various zoned land uses (See Table II, Page 16).

25. *Pervious Surface*: A surface that allows infiltration or penetration of water. During rainstorm events, a percentage of water will infiltrate into the surface with the remaining storm water running off. The percentage of runoff is dependent on the type, slope, percent saturation, etc. of the surface. (i.e. lawns, farm fields, parks, wooded areas, golf courses, etc.). Design personnel should attempt to maximize these surfaces as much as possible.

26. *Rain Gardens*: A depressed area of a size that is determined by specified engineering guidelines with amended soils and specific plants, shrubs, and trees that have a specific volume to store storm water runoff. The site can be underdrained to increase performance.

27. *Rear lot drainage*: A storm water system designed to provide drainage in rear lot areas to prevent water from ponding for extended periods of time. It must be noted that these systems are not designed to convey storm water in a rapid manner. It is a deliberately designed system that can provide additional detention capabilities during severe runoff conditions. It is a system that in condos or subdivisions is the responsibility of the owner to maintain. It is not the <municipality type> s responsibility. The <municipality type> may repair the system if necessary to prevent damage to neighboring properties, but all associated repair costs, plus a 20% administrative fee will be passed on to the owner.

28. *Redevelopment*: Altering, improving, reconstructing or otherwise changing the use of an existing developed property. A site will be considered a redevelopment for this Storm Water Management Plan when an area greater than or equal to 5% of the existing developed portion of the site (i.e. roof, gravel, & paved surfaces) or, an area greater than 20,000 square feet is increased or reconstructed with roof, pavement, or any other impervious surface. NOTE: this percentage is cumulative. If redevelopment is 2% one year and 3% at another time, this will meet the 5% rule. Also, at times, less than 5% can create drainage problems, and the <municipality type> Engineer may require additional detention or storage based on historical or anecdotal problems on a site.

29. *Retention Storage*: The permanent retaining or storage of storm water in a storage basin, on rooftops, in streets, parking lots, schoolyards, parks, open space, or other areas under predetermined and controlled conditions. The only discharge of storm water from the retention storage area is by ground infiltration, evaporation, etc. An emergency overflow must be provided in the event the capacity of the retention facility is exceeded. These retention storage areas shall not be considered regulated wetlands.

30. *Storm Water Management Plan (SWMP)*: Also known as post construction controls, this is a site specific storm water runoff drainage plan developed specifically for individual sites. The plan includes calculation of allowable and restricted discharge rates, detention/retention volume, restrictor sizing, size of pipes or conveyance devices. A train of best management practices to provide for discharge of clean storm water runoff from a site.

31. *Storm Water Runoff*: The water from a rainstorm or snowmelt, which flows over the surface of the ground or is collected in a drainage system.

32. *Ten-Year Design Storm*: A precipitation event with a duration equal to the time of concentration, having a ten percent probability of occurring in any given year or occurring once every 10 years on average. This amounts to approximately 3.05 inches of rain in 24 hours. But, brief, intense storms of 10-year design can range from 1.5 inches in 1 hour to 2.87 inches in 18 hours. (Source: Bulletin 71, Rainfall Frequency Atlas of the Midwest, F.A. Huff & J.R. Angel, 1992).

33. *Time of Concentration (T_c)*: The elapsed time for storm water runoff to flow from the most hydraulically distant point in a drainage area to the outlet or other predetermined point.

34. *<municipality type> Engineer*: The civil engineer or civil engineering firm formally designated by the <municipality type> of <municipality name> to act as their Engineer. This person or firm must have qualifications suitable for review of stormwater management plans and knowledgeable with NPDES Phase II regulations in the State of Michigan.

35. *Upland Area*: Land located in the upper portion of a watershed whose surface drainage flows toward the area being considered for development.

36. *Urbanization*: The development, change, or improvement of any parcel of land consisting of one or more lots for residential, commercial, industrial, institutional, recreational, or public utility purposes.

37. *Urbanized Area*: An area designated by the US Census Bureau, which has specific rules and regulations concerning storm water under the NPDES Phase II regulations. This regulated area may require adherence to specific water quality standards.

38. *Watercourse*: Any natural or artificial stream, river, creek, channel, ditch, canal, conduit, culvert, drain, waterway, gully, ravine, street, roadway, swale, or wash in which water flows in a definite direction, either continuously or intermittently.

39. *Waters of the State***:** Means any of the following: The Great Lakes bordering the State and their connecting waters, all inland lakes, rivers, streams, impoundments, open drains, and other surface bodies of water within the jurisdiction of the state, including wetlands as defined by Part 303 of PA 451 of 1994. In <municipality name>, that would include streams that have a defined bed and bank, and established flow, established county drains, and the Cass River.

III. REVIEW PROCESS AND PROCEDURES

A. Review Procedures

<municipality name> shall review all plans for development of subdivisions, multiple family projects, commercial, and industrial sites for compliance with the <municipality type> 's regulations for storm water management, as recommended in the Storm Water Management Plan and required by adoption of the Storm Water Runoff Regulation and Control Ordinance.

The Planning Commission shall designate a review Engineer who will provide the services required to assure the <municipality type> that all the requirements of the plan and the ordinance are being met. The Engineer shall review the Developer's plan and submit a report to the <municipality type> showing the acceptance or rejection of the proposed site drainage plans, calculations and best management practices for discharge of clean storm water.

A site will be considered in compliance with the Storm Water Regulations and guidelines when an approval of the site's Storm Water Management Plan has been completed. The <municipality type> will not accept runoff into drainage systems located within the <municipality type> from newly developed or redeveloped sites without compliance with the Post Construction Controls guidelines.

To comply with the Storm Water Management Plan and Storm Water Runoff Regulation and Control Ordinance, complete the following process and deliver or mail all submittals to the <municipality type> of <MUNICIPALITY NAME>, Planning Commission,

A complete submittal package for a storm water review consists of:

- A completed Drainage Checklist
- 3 sets of Site Plans
- 2 sets of calculations

1. Pre-design Meeting/ Conceptual Review

This meeting, at a minimum, shall consist of the Developer's Engineer and the <municipality type> 's Engineer. The purpose of the meeting is to address the various storm water management proposals of the developer. Conceptual storm water management alternatives can be discussed and potential problems addressed prior to the design phase of the project. The goal of the meeting is to eliminate potential problems up front and reduce the time and costs needed for the design and review of the project.

This meeting will be required for all platted developments, condominium projects, and site developments larger than five (5) acres. It is recommended other site development projects have this meeting or at a minimum correspond with the <municipality type> 's Engineer by phone, e-mail, and/or facsimile regarding conceptual design alternatives prior to submitting for formal review.

The Developer's Engineer and/or <municipality type> 's Engineers should have in his/her possession or have an understanding of the following information prior to attending the pre-design meeting.

a. The drainage district or area in which the proposed development is located and the outlet condition for the proposed development. This information can be obtained from the <municipality type> Engineer or public works staff.

b. Small location map showing where the site is situated.

c. Location and description of activities that may impact or be impacted by the proposed development or redevelopment both on and off the site.

d. Acreage of the total site and an estimate of the area tributary to the proposed storm drainage system, including offsite runoff.

e. The size and location of the proposed storm drainage outlet and information on contributing area.

f. If known, a conceptual layout of the proposed storm drainage system for the development or redevelopment.

If required, the Owner/Developer and his/her technical consultant shall attend a land development advisory committee meeting. The intention of this meeting is to obtain uniform direction and communication to minimize misdirection of early construction and minimize financial losses to proprietors, developers, and consultants.

If the conceptual layout of the storm drainage system is agreed upon by the <municipality type> 's Engineer and the Developer's Engineer, the Owner/Developer shall begin completing plans and calculations for formal review by the <municipality type> .

2. Formal Review

a. The Owner/Developer or representative shall submit three sets of plans, three sets of calculations, a copy of the completed checklist (Appendix A), and any other supporting information for the site to the <municipality type> Engineer. The plans and calculations shall comply with the requirements of this Storm Water Management Plan. The checklist, design calculations, and design standards that will be used during the formal review process are established by this Storm Water Management Plan.

b. Submit deposit/fee for storm water management plan review and inspection to the Planning Commission in accordance with the current fee schedule established by the <municipality type> .

c. Formal review and approval will not begin until all items required for application have been received. The proposed drainage system will be either approved or rejected with reason and returned to the owner/ developer.

d. The <municipality type> Engineer will review all plans, calculations, and other information for compliance with the <municipality type> 's design guidelines. All materials will be reviewed for completeness. Calculations will be checked. The minimum design calculations and design standards outlined in this document will be used for review. The drainage plan checklist will be reviewed.

e. A typical review will take approximately two (2) weeks to complete from the date the plan is submitted in complete form.

f. If the proposed drainage system is rejected, three (3) sets of plans and calculations will need to be resubmitted with the appropriate revisions. A completed checklist will also have to be resubmitted.

B. Plan Approval

Once the storm water management plan has been recommended for approval by the <municipality type>

Engineer a recommendation for approval letter will be sent to the <municipality type> . A copy of the letter will be forwarded to the Developer. Three sets of plans will be stamped approved: one set will be forwarded each to the <municipality type> and the applicant, and one set will be kept on file with the <municipality type> Engineer. The approval letter will include, if necessary, inspection and compliance requirements.

C. Changes to Plan after Approval

1. Any changes made to the approved plan after issuance of the storm water permit shall require three sets of plans are submitted to the <municipality type> for review and approval.

2. Upon receipt of this information, it will be determined if additional information, such as calculations, revised checklist, etc. will be required.

3. The fee for review of any changes to the plan after approval will be billed on an hourly basis. An occupancy permit will not be issued until all changes have been approved and the <municipality type> has received all review fees.

D. Inspection/Letter of Certification Requirements

Inspection of storm sewer systems and/or detention facilities will be required on all development and redevelopment projects. The extent of the inspection will depend on the size and type of the development or redevelopment. Descriptions of these inspection requirements are outlined below. Specific inspection requirements, including the frequency of inspections, will be outlined on the approval letter. The fees associated with this inspection are included in the original deposit.

1. Small Developments/ Redevelopments (Less than 3 acres) – A general site inspection of the restrictor and the detention storage areas by the <municipality type> Engineer will be required. This one-time inspection will be performed at the completion of the project. Subsequent inspections may be required if deficiencies exist. The fees for subsequent inspections will be based on an hourly basis.

   A letter of certification will have to be completed by the developer's engineer indicating the storm drainage system has been constructed as shown on the approved storm water management plans. An occupancy permit will not be issued until a letter of certification has been received by the <municipality type> and the final approved inspection of the site has been completed by the <municipality type> Engineer or designee.

2. Large Developments/ Redevelopments (3 acres and greater) - Periodic Site inspections of the storm sewer, outlet, restrictors, and detention storage areas may be required by the <municipality type> Engineer. Specific items needing inspection prior to the completion of the project will be identified in the approval letter (i.e. installation of restrictors, restricting pipes, etc.). The <municipality type> Engineer or designee shall be informed 24 hours in advance of the placement of items requiring inspection as outlined on the storm water management permit.

   A final inspection of the restrictor and the detention storage areas by the <municipality type> Engineer or designee will be required. This one-time inspection will be performed at the completion of the project. Subsequent inspections may be required if deficiencies exist.

   A letter of certification will have to be completed by the developer's engineer indicating the storm drainage system has been inspected during construction and the drainage system was constructed as shown on the approved storm water management plans. An occupancy permit will not be issued until the <municipality type> has received a letter of certification and the <municipality type> Engineer or designee has completed the final approved inspection of the

site.

3. Any Single Family, Two Family, or Multi-family Development Projects -Daily inspections of the storm sewer and drainage system construction will be required. This inspection shall be performed by the Owner/Developers Engineer or by the <municipality type> Engineer or designee. Daily Inspection reports shall be completed for all days on which construction of the storm drainage system occurs. At a minimum, the daily inspection reports shall include the information shown on the sample daily inspection report included in Appendix A. These daily inspection reports do not have to be submitted to the <municipality type> . However, they should be on file with the design engineer and made available upon request.

   A final inspection of the restrictor and the detention storage areas by the <municipality type> Engineer or designee will be required. This one-time inspection will be performed at the completion of the project. Subsequent inspections may be required if deficiencies exist.

   A letter of certification will have to be completed by the developer's engineer indicating the storm drainage system has been constructed as shown on the approved storm water management plans. An occupancy permit will not be issued until the <municipality type> has received a letter of certification and the <municipality type> Engineer or designee has completed the final approved inspection of the site.

E. Fee Schedule

The fee schedule for reviewing storm drainage submittals and performing inspections of drainage system construction shall conform to the current <municipality type> Resolution Regarding Fees. This resolution will be reviewed on an annual basis and fees may be adjusted if determined necessary.

IV. STORM DRAINAGE SYSTEMS WITHIN <MUNICIPALITY NAME>

Within the <municipality type> , there are drains that fall under several different agencies' jurisdictions. These include the following:

A. Established County Drains - Work done directly on or connected to these drains falls under the jurisdiction of the County Drain Commissioner. Preliminary and final plat approval requires a signature and review from the Drain Commissioner. However, many site plan developments, condominiums, etc. that impact established county drains are not submitted for review to the Drain Commissioner. There are no established county drains within the jurisdiction of the <municipality type> of <municipality name>.

B. County Roadside Drains - There are many drains that fall under the jurisdiction of the County Road Commission. When a crossing is installed over a county roadside drain, a permit or permission must be obtained from the County Road Commission.

C. Michigan Department of Transportation (MDOT) - There are several drains that are located along M-25 and M-90 that fall under the jurisdiction of MDOT. Any development that proposes to use these drains for a storm water outlet must get a permit from MDOT. As part of this permit, storm water detention may be required. A copy of this permit application is available at the website address located in Appendix B of this document.

D. Michigan Department of Environmental Quality (MDEQ) - The MDEQ regulates any work done within the 100-year floodplain and/or any inland lakes or streams. There are several wetland areas within the <municipality type> that are regulated by the MDEQ. A copy of the Joint Permit application for a site to discharge to Lake Huron or within 500 feet of inland lakes or streams, as well as wetlands, is provided from a website address that can be found in Appendix B.

E. <municipality type> Drains - There are several areas within the <municipality type> that have drainage swales, open channel drains and/or tile drains that are not regulated by any of the above referenced agencies. In these areas, it is the sole responsibility of the <municipality type> to manage the storm water. This storm water management plan will provide for the management of those areas. Proposed storm water management in these areas is explained in more detail later in this section.

Each of the agencies listed previously have their own design criteria for reviewing proposed developments and drainage improvements. These criteria are not always consistent with the storm water requirements of the <municipality type> as a whole. For example, the MDOT is concerned about the proper drainage of the roadway and sub-base of the road; a permit may be obtained to discharge a large quantity of water to a road side drain not causing a problem now but may not leave any additional storm water outlet capacity for future development upstream. For these reasons, it is very important that the <municipality type> review all proposed developments/ improvements to assure that the proposed storm water management is consistent with the future plans of the <municipality type> .

V. DESIGN CALCULATIONS

A. Allowable Discharge Rate (Qa) and 10-Year Design Discharge (Qd_{10})

The storm water discharge rate from any proposed development or redevelopment site shall be restricted to an allowable discharge (**Qa**). This allowable discharge shall be the most restrictive discharge (smallest discharge) from the site as determined by one of the following three (3) design approaches. The 10 Year design discharge ($\mathbf{Qd_{10}}$) for the proposed site development or redevelopment to be used for storm sewer sizing shall include the discharge from all development upstream of the proposed site fully developed to current zoning requirements.

1. Rational Method using predetermined Impervious Factors (**IF**) and actual percent imperviousness (**IMP**).

   The allowable discharge rate and 10 Year design discharge for a site is calculated using the Rational Method.

   Q = (C)(I)(A)

   Q is the runoff rate in cubic feet per second (cfs).
   C is the coefficient of runoff.
   I is the intensity of rainfall in inches per hour (in/hr).
   A is the area of the site in acres (ac).

   The rational method will be used to calculate allowable discharge **(Qa)** and 10-year design discharge **($\mathbf{Qd_{10}}$)**. The allowable discharge (**Qa**) is calculated using the impervious factor **(IF)** for the site. The **IF** for the proposed site development or redevelopment can be obtained from the <municipality type> Engineer or from within this document.

   The 10-year design discharge ($\mathbf{Qd_{10}}$) is calculated using the actual percentage of imperviousness **(IMP)** for the entire drainage district when fully developed to the zoned land usage. The **IMP** for the <municipality type> 's zoned land uses can be obtained from the <municipality type> Engineer or from within this document. The actual proposed and/or existing amount of impervious surface shall be used when designing the storm sewer system. The minimum **IMP** shall not be less than the values defined in Table II of this document. If an **IMP** lower than the minimum values is used, the basis for determining the proposed and/or existing amount of impervious surface shall be submitted with calculations.

   All of the contributing area to the site shall be considered when determining the 10 Year design discharge ($\mathbf{Qd_{10}}$), including any existing offsite drainage coming onto the site. Sizing the proposed drainage system based on the entire contributing drainage area will minimizes potential impacts to upstream property owners.

The actual area of the site development, excluding runoff from surrounding lands, shall be used when determining the allowable discharge from the site **(Qa)**. Using only the runoff from within the proposed site development to determine the allowable discharge minimizes impacts to the existing downstream outlet.

The allowable discharge or 10 year design discharge will be determined by summing the calculated runoff from impervious surfaces and pervious surfaces based on the required **IF**. **Qi** is the runoff rate from the impervious surfaces of a site and **Qp** is the runoff rate from the pervious surfaces of a site. The total runoff rate for a site is the sum of **Qi** and **Qp**.

Q = Qi + Qp = (Ci)(Ai)(I) + (Cp)(Ap)(I)
Qa = (Ci)(I)[(IF)/100](A) + (Cp)(I)[(100-IF)/100](A)
Qd = (Ci)(I)[(IMP)/100](A) + (Cp)(I)[(100-IMP)/100](A)

To calculate **Qa** or **Qd** the values for **Ci**, **Cp**, **I**, **IMP**, **IF**, and A must be determined. The percent impervious (**IMP**) are obtained from the <municipality type> , <municipality type> Engineer, from within this document, or measured from the site plan. The impervious factor (**IF**) is a design value obtained from the <municipality type> Engineer or from within this document. The Area (**A**) is determined based on measurements of the entire area contributing to the storm sewer or detention area. The impervious area runoff coefficient **(Ci),** the pervious area runoff coefficient **(Cp),** and the rainfall intensity (**I**) are calculated values based on the time of concentration **(t_C)**.

Time of concentration (**t_C**) is the time it will take for runoff from the most hydraulically distance point (i.e. high elevation) to reach the design point (i.e. low elevation such as a catch basin or an outlet sewer). The following can be used to calculate time of concentration:

t_C (min) = length (ft) of runoff / avg. vel. (fps) * 60 (sec/min) + lag time (min)

The average velocity for overland drainage in <municipality name> will range between 1.0 fps and 2.5 fps based on overland slope and land use. Lag time will range between 15 min and 20 min. When calculating time of concentration (**t_C**), include all assumptions with calculations.

When the time of concentration (**t_C**) is found to be greater than 30 minutes calculate the runoff coefficients (**Ci, Cp**) and rainfall intensities (**I**) according to the following equations:

impervious area (Ci) = 0.80
pervious area (Cp)= 0.20
$I_{10} = 175 / (25 + t_c)$ **NOTE: $I_{100} = 275/ (25 + t_c)$**

When the time of concentration (t_c) is found to be less than 30 minutes calculate the runoff coefficients (**Ci, Cp**) and rainfall intensities (**I**) according to the following equations. If t_C is calculated to be less than 15 minutes, use t_C equal to 15 minutes.

impervious area (Ci) = t_C / (8 +t_C)
pervious area (Cp) =t_C / (80 + 4 t_C)
I = 175/ (25 + t_C)

2. The allowable discharge may need to be restricted further based on the capacity of the downstream storm sewer or drainage system. To minimize impacts downstream, the maximum capacity of the existing storm sewer or drain without surcharging or flooding shall be determined at the controlling downstream restriction. The drainage area contributing at this restriction shall be determined. Based on the area of the proposed development, the area upstream of the restriction, and the outlet capacity at the restriction, an allowable discharge shall be determined by the following method.

Qa = Qr(Ad/Ac)

Qa = Allowable discharge from proposed development or redevelopment.
Qr = Maximum capacity of downstream storm sewer/drain at the controlling restriction.
Ad = Area of the proposed site development or redevelopment.
Ac = Total area of watershed contributing upstream of the restriction.

3. If it is determined the existing runoff from the drainage district is at or exceeding the capacity of the downstream storm sewer or drain the proposed development or redevelopment will, at a minimum, have to be restricted to existing conditions. The allowable discharge from the site shall not exceed the runoff from the site during the 10-year storm event under existing conditions. This discharge can be determined using the rational method previously identified and the existing percentage of impervious surface on the site.

B. Storm Water Detention Requirements

The storm water detention storage required for a site is calculated as follows:

Calculate the maximum flow rate per acre of impervious surfaces, **Qo**.

Qo = Qa / C_wA

A = Area of the site in acres.
C_w = Weighted Coefficient for runoff for the proposed development.

Calculate the storage time (**T**) in minutes at which the maximum volume of storage will occur on site for the 10-year design storm.

$T = (4080/Qo)^{1/2}-20$

Calculate the maximum volume of storage per acre of impervious surfaces, **Vs**. The units of **Vs** are cubic feet per acre of impervious surface (cu. ft / ac).

Vs = [(8160)(T) / (T + 20)] – (40)(Qo)(T)

Finally, calculate the **total volume of storage required** for the site, **Vt.** The units of **Vt** are cubic feet.

$$V_t = (V_s)\ (A*C_w)$$

Discharge Restrictor Requirements

Restrictors are required to regulate the discharge of storm water to the allowable discharge rate established for a site. The circular in-line restrictor is sized based on the orifice formula.

$$a = Qa/[\ 0.62\ (64.4(\Delta h))^{1/2}]$$

a = area of orifice (sq. ft.)
Δ**h** = head differential from center of orifice to Hydraulic Grade Line of detention pond at maximum capacity, (ft).

First Flush requirements

All construction projects are required to detain the first flush volume, which is defined as 0.5 inch of runoff over the entire parcel being developed or re-developed. This volume will be calculated as:

$$1815 \times A \times Cw = FF \text{ volume}$$

This volume must be held for more than 18 hours but not more than 24 hours. The average allowable release rate for runoff resulting from 0.5" of rain in 24 hours is calculated as follows:

$$Q_{ff} = \frac{\text{Volume}}{(24hr)*\left(3600sec/1hour\right)} = \frac{V}{86{,}400sec}$$

Determine Area of Orifice

The first flush discharge controls the required total area of orifice (number of holes needed).

$$A_{ff} = \frac{Q_{ff}}{(0.62)*\sqrt{2gh_{ave}}}$$

Where h_{ave} is defined as, $h_{ave} = (2/3) \times (elev._{\text{first flush}} - elev._{\text{bottom}})$

The number of holes needed is calculated as follows:

$$\text{Number of holes} = \frac{A_{ff}}{\text{Area of orifice}}$$

Detention Time for Given Orifice Area (Calculated above)

$$Q_{ff\ New} = A_{ff\ New} * 0.62 * \sqrt{2gh_{ave}}$$

New Holding Time ($T_{ff\ New}$)

$$T_{ff\ New} = \frac{V_{ff}}{Q_{ff\ New}}$$

The new holding time must be within the time frame listed above (18 to 24 hours).

Bank Full Flood requirements

All construction projects are required to detain the bank full (BF) volume, which is defined as the 24 hour, 2-year storm event (2.14 inches). This volume will be calculated as:

$$V_{bf} = (2.14") * \left(\frac{1'}{12"}\right) * \left(\frac{43560\, ft^2}{1ac}\right) * (Area) * C_W$$

Or

7768 x A x Cw = BF volume

This volume must be held for more than 36 hours but not more than 48 hours. The average allowable release rate for runoff resulting from 0.5" of rain in 24 hours is calculated as follows:

Determine Area of Orifice

Check the discharge through the first flush orifice to see if additional holes are necessary.

$$h_{ave} = (2/3) \text{ x } (\text{elev.}_{\text{bank full}} - \text{elev.}_{\text{bottom}})$$

$$Q = A_{bf} * (\#orifices) * 0.62 * \sqrt{2gh_{ave}}$$

$$T_{bf} = \frac{V_{bf}}{Q}$$

If T_{bf} is greater than 48 hours, more orifice area will be needed.

Choose a target detention time (T_{total}) to find the remaining volume which needs to be released so that detention time is between 36 to 48 hours.

$$V_{rem} = V_{bf} - V_{ff}$$

$$T_{rem} = T_{total} - T_{ff\ New}$$

Find Q_1, which is defined as the discharge through the First Flush orifice when both the FF and the bank full volumes are contributing.

$$Q_1 = A_{ff} * (\#orifices) * \sqrt{2gh_{ave}}$$

$$V_1 = T_{rem} * Q_1$$

Leftover volume will be released by the Bank Full orifice. V_2 will be defined as the amount of water to be discharged

$$V_2 = V_{rem} - V_1$$

$$Q_2 = \frac{V_2}{T_{rem}}$$

$$A_2 = \frac{Q_2}{0.62 * \sqrt{2gh_{ave,bf}}}$$

The number of holes needed is calculated as follows:

$$\text{Number of holes} = \frac{A_{ff}}{\text{Area of orifice}}$$

DESIGN STANDARDS

A. Requirements

1. General Requirements

a. Storm water detention requirements for any new construction development, redevelopment, or land use change occurring within <municipality type> will be determined according to this storm water management plan.

b. The peak runoff rate during a 10-year storm event from a developed or improved site shall not exceed the allowable discharge rate **(Qa).** This rate is determined as outlined in the design calculations section of this plan.

c. There shall be no detrimental effect on the floodway or the floodplain elevation during a 10-year design storm upstream or downstream of the proposed development area as a result of the proposed development.

d. Engineering calculations must be submitted with the proposed storm drainage system plans. The calculations shall follow the procedures outlined in this document.

e. Roof drains may be connected to a storm sewer system if the flow through the outlet to the <municipality type> system is properly restricted. Unrestricted runoff from a roof drain will not be accepted, there are no exemptions.

f. The developer, <municipality type> Engineer and/or <municipality type> DPW staff shall make a determination as to whether any or all of the facilities proposed are to become private or part of the <municipality type> Drainage system or part of any other regulating agencies storm sewer system.

g. The <municipality type> Engineer shall in the case of a proposed subdivision, make a determination as to those control elevations that shall be entered on the final plat or make a determination as to the necessity for deed restrictions on any particular lot in said subdivision requiring the preservation of mandatory drainage facilities. Where a non-subdivided parcel of land is proposed for development, the <municipality type> Engineer shall make a determination as to the need for covenants to maintain responsibility for mandatory drainage facilities. All the said facilities shall be located in easements dedicated to the public, and shall be subject to continual inspection during the construction period.

h. Proposed storm sewer enclosures must be designed so they will not adversely impact any adjacent properties, upstream or downstream, and must be designed to the impervious factors of the lands based upon zoning, not necessarily existing conditions.

i. Soil erosion and sedimentation control measures must be implemented per Part 91 of Public Act 451 of 1994 (NREPA).

2. Storm Sewer Piping Requirements

a. Proposed storm sewer shall be designed to have capacity to pass 10-year design storm runoff rate **(Qd)** Refer to Design Calculations section of this document.

b. Class III or IV concrete pipe must be used for the following:

i. Storm Sewers within <municipality type> , county, and state right-of-way
ii. INSERT OTHER ACCEPTABLE MATERIALS

c. Provide 2' Minimum cover with minimum 5' cover in M.D.O.T. R.O.W.

d. Provide 18" Vertical separation between all other utilities including, sanitary sewers and water mains. Provide 10' Horizontal separation from other utilities.

e. A minimum of four inches of sand bedding is required beneath the pipe and a minimum of 6 inches of sand backfill is required above the pipe.

f. Manhole/catch basin shall be placed at a maximum distance of 300' from any other manhole/catch basin for access/maintenance purposes.

g. Provide a sump discharge outlet for each individual property/lot in all developments. Sump leads shall not be connected to rear lot drainage systems. This outlet shall be a catch basin (minimum 3' diameter) or a storm sewer lead extended to the Right-of-Way/Property line of each lot (minimum 6").

h. Place a catch basin (minimum 3' diameter) between each pair of driveways, if curb and gutter, driveway culverts, and/or valley shaped ditches are not proposed.

i. Minimum pipe grades must be such to produce minimum scouring velocity of 2.5 ft/sec when pipe is flowing full without surcharging.

j. Concrete pipe (C-76-III, IV) shall have fabric wrapped joints.

k. For private storm sewer systems Plastic pipe may be used. This plastic pipe shall be either smooth walled HDPE or SDR 35 P.V.C. Pipe. If pipe is perforated a manufacturer's "Sock" shall be used over the pipe.

l. Minimum pipe diameter for catch basin leads is 10".

m. Minimum pipe size for sewer main is 12".

n. When two pipes or more of different sizes come into a structure, the 8/10th flow lines shall match when possible.

o. Catch basins should have a minimum sump depth of 18". It should be noted that some new systems using "end of pipe" BMPs may require systems with no sumps. This type of system requires less maintenance of each individual catch basin, but requires routine

maintenance of the BMP.

3. Detention Requirements

a. If a separate lot or parcel is used for detention or retention the outer limits shall be delineated on the Exhibit B drawings of a Condominium Development or on the Final Plat.

i. Condominium Developments - Detention or Retention areas shall be designated as general common areas.

ii. Platted Developments - Detention or Retention areas shall be designated as a storm water detention/retention area. (See State Requirements)

b. Requirements for all Detention/ Retention Areas

i. Proposed storm water detention facilities shall be designed to detain the 10-year design storm runoff volume from the entire contributing area in excess of the allowable discharge from the site (See Design Calculations, Section IV).

ii. The maximum design storage elevation in a detention area must be a minimum of one (1) foot below the lowest ground elevation adjacent to the detention area.

iii. The design maximum storage elevation in a detention area must not exceed a depth of nine (9) inches above any paved surfaced in non-residential developments. In residential developments the maximum ponding elevation in the detention pond shall not exceed the lowest rim elevation in the development.

iv. If parking lot detention is used the owner or lessee must be aware of this detention and sign a letter of understanding that the parking lot will flood during design storms and be flooded for periods of time.

v. The design maximum storage elevation in a detention area must not be closer than one (1) foot below the minimum finish floor elevation of the proposed structure(s) or existing facilities.

vi. An emergency overflow shall be provided at the detention basin to insure the maximum ponding elevation does not exceed the depths outlined in items iii and iv above. This overflow shall be able to allow drainage from the site in the event the 10-year storm is exceeded or the restricted outlet is obstructed.

vii. Designs of detention facilities shall incorporate safety features, particularly at inlets, outlets, on steep slopes, and at any attractive nuisances. These features may include, but not be limited to, landscaping, fencing, handrails, lighting, steps, grills, signs, and other protective or warning devices so as to restrict access as required by the <municipality type> .

viii. Side slopes and the bottom of detention basins shall be top soiled, to a minimum of 3 inches, and seeded.

ix. The side slopes and bottom of the basins shall be shaped with maximum slopes of 1 vertical to 4 horizontal to allow mowing of these surfaces.

x. Detention basins with bottom slopes less than 1% shall be underdrained.

xi. Detention basins shall be constructed with the top of banks a minimum of 5 feet from any pedestrian walkway (i.e. public and private sidewalks/ bike paths).

xii. If a "Wet" detention pond is proposed the bottom of the pond shall be a minimum of 5 feet below the proposed pond's outlet elevation. Item ix shall not apply to "Wet" detention facilities.

4. Rear Lot Drainage Requirements

a. Minimum rear lot tile drain sizes and slopes have been determined assuming ponding will occur in rear yards for a duration 4 times the duration of a given 10-year design storm event. This time may range from 4 to 24 hours depending on drainage conditions. The following minimum pipe sizes and slopes apply:

i. Rear lot tile drains with contributing drainage areas up to 2 acres will have a minimum diameter of 6 inches and a minimum slope of 0.5 %.

ii. Rear lot tile drains with contributing drainage areas greater than 2 and less than 3 acres shall have a minimum diameter of 8 inches and a minimum slope of 0.4%.

iii. Rear lot tile drains with contributing drainage areas greater than 3 and less than 4 acres shall have a minimum diameter of 10 inches and a minimum slope of 0.32%.

b. Rear lot tile drains with a contributing area greater than 4 acres shall be considered main line storm sewer and shall be designed according to corresponding storm sewer requirements (See design calculations section of this report). Calculations shall be submitted to verify that rear lot drains have the capacity to pass the 10-year design storm event. Plastic pipe is acceptable for rear lot drainage systems draining more than 4 acres provided it is installed in landscaped/ lawn areas.

c. Rear lot tile drains cannot connect to road underdrains.

d. Rear lot drainage tiles shall have a minimum cover of 2 feet. A minimum of four inches of sand bedding is required beneath the pipe and a minimum of 6 inches of sand backfill is required above the pipe.

e. Rear lot catch basins shall have a minimum diameter of 2 feet. Plastic structures may be used for rear lot drainage systems. Concrete structures are required for storm sewer systems. The catch basins shall not be placed at spacing greater than 300 feet. Any bends, turns, or dead ends shall require a structure.

f. If pipe is perforated, a manufacturer's "Sock" may be used over the pipe, but is not required.

g. A 20-foot easement will be required for all rear lot drainage systems. This easement should be centered along lot lines to allow for a 10-foot easement along adjacent lots and to provide access to the rear lot drainage system from either adjacent property owners. Said easements shall be written as to permit neighboring property and/or condominium owners to maintain the rear lot drainage system as it may affect their property.

h. Rear lot drainage shall be large enough to convey all contributing area to the rear lot system, including off site drainage if it is not diverted around the development.

i. Existing rear lot drainage systems abutting a proposed development may be used for the new development provided:

i. The existing rear lot drainage system has the capacity to convey storm water runoff from the proposed rear lot drainage areas.

ii. A signed agreement is obtained from property owners located within the existing subdivision allowing the proposed subdivision's rear lot storm water runoff to pass through their existing system.

j. Phased developments owned by the same proprietor may utilize proposed rear lot drainage for a current development phase on future phases of the development provided:

i. Covenants shall be recorded into the deeds of the property owners affected in the current phase allowing for future phases of the development to drain into the current phase's rear lot drainage system.

ii. If covenants are not made as outlined above, future phases will require separate rear lot drainage systems or agreements from the current land owners allowing for the use of their rear lot drainage system.

iii. The rear lot drainage system shall be constructed to convey rear lot drainage from both the existing and proposed rear lot drainage areas.

iv. Easements shall be provided allowing for maintenance by both abutting landowners in current and proposed phases of development.

k. Rear lot drainage shall be shown on the preliminary plat (subdivisions) or site plan (condominiums).

l. All rear lot drains shall connect to an approved storm water drainage system.

B. General Compliance Guidelines

The following guidelines are recommended, but are not a requirement of this plan. These guidelines are provided for reference.

1. The minimum surface slopes for overland drainage are as follows:

a. For bituminous paved surfaces, 1%.
b. For concrete paved surfaces, 0.5%.
c. For concrete curb and gutter, 0.32%.
d. For drainage swales and valley shaped ditches, 0.5%.
e. For rear lot drainage swales and valley shaped ditches, 0.5%.
f. Landscape grading, 2%.

2. The maximum surface slopes for overland drainage are as follows:

a. For bituminous, concrete paved surfaces, 5%.
b. For concrete curb and gutter, 5%.
c. For drainage swales and valley shaped ditches, 5%.
d. For rear lot drainage swales and valley shaped ditches, 5%.

e. Drainage swales and valley shaped ditches shall have maximum side slopes of 3 horizontal to 1 vertical.
f. Landscape grading, 4 horizontal to 1 vertical.

C. Variances from Requirements

The <municipality type> may waive allowable discharge requirements and or detention requirements. All variances will be reviewed under the appeal procedures established in the current storm water management ordinance. Variances from these requirements shall require the approval of <municipality type> whose actions shall be conditioned upon the following:

1. A petition shall be submitted describing in detail the rationale for the proposed design changes including hydraulic and or hydrologic computations.

2. Special circumstances or conditions exist which will affect the property under consideration such that strict compliance with the provisions of the storm water discharge permit would deprive the applicant of the reasonable use of their land.

3. A variance is necessary for the preservation and enjoyment of a substantial property right of the proprietor.

4. Granting of the variance will not be detrimental to the public health, safety or welfare, or injurious to other property in the territory in which said property is located.

5. An affirmative recommendation must be received from the <municipality type> Engineer supporting such variance. In the event that the <municipality type> Engineer does not submit an affirmative recommendation, a recommendation shall be received from <municipality name>.

APPENDIX A

1. <MUNICIPALITY NAME> DRAINAGE PLAN APPLICATION & CHECKLIST

2. <MUNICIPALITY NAME> STORM WATER MANAGEMENT SITE REVIEW AGREEMENT PROCEDURE & FORM

3. TYPICAL DAILY INSPECTION REPORT FORM

4. SOIL EROSION AND SEDIMENT CONTROL FOR CONSTRUCTION SITES PROCEDURE

5. <municipality type> ENGINEER FINAL INSPECTION FORM

6. SITE VISIT AND INSPECTION REPORT PROCEDURE

7. STORM WATER MANAGEMENT SITE REVIEW AGREEMENT

<municipality type> of <MUNICIPALITY NAME>
STORM WATER DISCHARGE PERMIT APPLICATION

PROJECT NAME:	
Property Tax Identification #:	
Site Plan Review Date:	
Date Applied:	
Deposit Amount Submitted:	
NAME OF DEVELOPER/OWNER:	**ENGINEER/ARCHITECT:**
Contact Person:	Contact Person:
Street Address:	Street Address:
City, State, Zip:	City, State, Zip:
Telephone:	Telephone:
Email:	Email:
Fax:	Fax:
PROJECT LOCATION:	
Street Address:	
Name of Subdivision/Plat:	
Drainage District:	
STORM WATER DESIGN INFORMATION (*Calculation must be submitted for verification. Calculations must have clearly labeled headings, clearly labeled formulas, and clearly labeled units.)	
Type of Development (Circle): *COMMERCIAL SITE, INDUSTRIAL SITE, RESIDENTIAL PLATTED, RESIDENTIAL CONDOMINIUM, OTHER*	
*AREA OF DEVELOPMENT (acres):	
*AREA OF CONTRIBUTING DRAINAGE DISTRICT (acres):	
*AREA OF EXISTING IMPERVIOUS SURFACE (acres):	
*AREA OF PROPOSED IMPERVIOUS SURFACE (acres):	
*ALLOWABLE DISCHARGE RATE (Q_a) (cfs):	
*TOTAL VOLUME OF STORAGE REQUIRED (cu. ft.)	
*TOTAL VOLUME OF STORAGE DESIGNED (cu. ft.)	
10 YR DESIGN STORM WATER DETENTION STORAGE ELEVATION:	
EMERGENCY OVERFLOW/MAXIMUM STORAGE ELEVATION:	
LOWEST FINISHED FLOOR ELEVATION:	
OUTLET DRAIN SIZE AND DESIGN FLOW CAPACITY:	
OUTLET DRAIN INVERT ELEVATION:	
DESIGN IMPERVIOUS FACTOR (IMP):	
*10 YEAR DESIGN DISCHARGE (cfs):	
*HEAD DIFFERENTIAL THROUGH RESTRICTOR (ft.):	
*DIAMETER OF PROPOSED RESTRICTOR (in):	
*ACTUAL RESTRICTED DISCHARGE (cfs):	
AUTHORIZED SIGNATURE DATE	PLEASE DRAINAGE PLAN CHECKLIST TO ASSURE ALL INFORMATION IS PRESENT FOR REVIEW

DRAINAGE PLAN CHECKLIST

In order for the Owner, Developer, or Builder to be in compliance with these guidelines he/she shall for review by the <municipality type> Engineer, three complete sets of the site drainage and grading plan, and one copy of the calculations for allowable discharge and on-site storage requirements, as prepared by a Registered Professional Engineer or Architect. A copy of the completed checklist will be sent with all submittals.

Each of the following items shall be included on the plan:

_____ Total acres of site.

_____ Total acres of watershed draining through the site outlet

_____ Drainage district lines including sub-district lines contributing to individual storm sewers and rear lot drainage systems.

_____ Location of site including dimension to nearest intersection road or section line.

_____ Existing ground elevations at maximum 50' centers, including shots on perimeter of site and 50' beyond or contour lines at 1 foot intervals extending 50 feet beyond the site limits.

_____ Elevations of ground, edge of pavement, and buildings within 50' of site.

_____ Top of curb, gutter, ditch line, and centerline of road elevation at maximum 50' intervals.

_____ Existing storm catch basins, manholes, sewers, and culverts showing rim and invert elevation(s).

_____ Proposed elevations showing parking lot grades and control and building elevations.

_____ Lawn/landscape areas.

_____ Location, size, length, slope, and type of proposed storm sewer and rear lot drains.

_____ Rim and invert elevation(s) of proposed manholes and catch basins, including rear lot drainage.

_____ Location of on-site storage showing contour line for the top of storage elevation.

_____ Provide sufficient dimensions, cross-sections, profiles, tie downs, etc. to determine the location and size of proposed storm sewers and detention areas. This information will be used for verifying proposed detention volume calculations in grassed and paved areas.

_____ Location of restrictor and proposed restrictor detail(s).

_____ Location and elevation of the Emergency Overflow.

DRAINAGE PLAN - CHECKLIST (Continued)

Each of the following items shall be included in the submitted calculations:

_____ Drainage District and impervious factor.

_____ Calculation of maximum allowable discharge (Obtain impervious factor from the <municipality type> Engineer).

_____ Calculation of on-site storage required.

_____ Calculation of storage volume provided.

_____ Calculation of restrictor size.

_____ Hydrologic & Hydraulic Calculations for sizing storm sewer systems, which will be maintained by a public agency.

_____ Hydrologic and Hydraulic calculations showing there will be no adverse impacts upstream or downstream of the proposed development.

Beyond the <municipality type> of <municipality name> requirements, the Developer must submit applications for permit with all agencies that regulate storm water within the area of development. These may include Michigan Department of Transportation, Michigan Department of Environmental Quality, _____ County Drain Commissioner, or the _____ County Road Commission.

Developed February, 2012

DAILY INSPECTION REPORT FORM

PROJECT NAME:			WORK ORDER NO.:	
CONTRACTOR:			REPORT NO.:	
SUPERINTENDENT:			DATE:	
WEATHER (CLEAR, CLOUDY, RAIN, SNOW):			TEMPERATURE:	INSPECTOR:
WORK FORCE ON SITE:	NUMBER:	TRADE:	NUMBER:	TRADE:
EQUIPMENT IN USE (Number and Type):				
WORK DONE (Location, Amount, and Type): (Be Specific)				
TYPE OF UTILITY INSTALLED (Water, Sewer, Pavement, size, Class, Description, Source):				
GROUND CONDITIONS ENCOUNTERED (Clay, Sand, Wet, Dry, Good Poor, or Other & Detail Further):				
BACKFILL INSTALLED:				
EXISTING UTILITIES ENCOUNTERED:				
RELOCATION OF PROPOSED UTILITIES AND REASON NECESSARY:				
MATERIAL DELIVERED TO SITE (Size, Class, Description, Source):				
VISITORS TO WORK SITE (Name, Affiliation):				
REMARKS:				

NOTE: Complete in ink each day. Use reverse side if necessary.

By: _____ Date: _____

A general procedure for Soil Erosion and Sediment Control (SESC) and NPDES permits to discharge storm water from construction sites:

There have been changes in the permitting for construction sites for contractors, developers, municipalities, and other public agencies. These rules took effect at the date listed below; everyone must adhere to these changes and be aware of them.

EFFECTIVE DATE – MARCH 10, 2003

General procedure to follow:

Site has a soil disturbance of 1 to <5 acres:

Apply for Soil Erosion Sediment Control permit from either the county enforcement agency (CEA) or municipal enforcement agency (MEA).
The NPDES discharge permit for this site is covered by the "permit by rule"; no permit or application needs to be filled out for the state.

Note: If client is an APA (authorized public agency for soil erosion and sediment control) they still must follow the permit by rule, they do not need a SESC Permit as they have procedures approved by MDEQ. The rules are at the following site:

http://www.deq.state.mi.us/documents/deq-swq-stormwater-nocrules.doc.

Site has a soil disturbance of 5 or more acres:

Apply for Soil Erosion Sediment Control permit from either the county enforcement agency (CEA) or municipal agency (MEA) first.
Then fill out the NPDES Notice of Coverage form for discharges from the construction site, attached the proper fee, and send it to the State at the address listed on the form.
Once the state receives the form, the site is covered.

Note: If client is an APA (authorized public agency for soil erosion and sediment control) they still must obtain and fill out the NPDES Notice of Coverage to discharge storm water from a construction site; they do not need SESC Permit as they have procedures approved by MDEQ.

http://www.deq.state.mi.us/documents/deq-swq-nocform.doc.
Once the project site is stabilized and has good vegetative cover, remember to fill out a project termination form, this can be found at:

http://www.deq.state.mi.us/documents/deq-swq-notform.doc.

Determine inspection responsibilities:

Make sure that SESC issues are an agenda item at the pre-bid meeting and at the pre-construction meeting. Do not just put a note on the plans that SESC is the contractor's responsibility; make sure they are fully aware of their site responsibilities. Remember that the owner of the project is ultimately the responsible party, the DEQ or enforcing agency will be fining them. If the owner is a municipality that we are doing a service for, we must protect them as best we can.

<MUNICIPALITY NAME>
DETENTION AND RESTRICTION
FINAL INSPECTION REPORT FORM

Name of Site Development:	
Planning Commission Approval Number:	
Location:	
Type of Development:*	
Size of Restrictor:	
Type of Restrictor:**	
Location of Restrictor:	
Required Detention (ft^3):	
Type of Detention:***	
Location of Detention:	
Do As-builts Conform To Present Site Conditions?	
Inspection Comments:	
Date of Inspection:	
Inspector's Name and Affiliation:	

* - Residential, Commercial, Subdivision, Etc.
** - Orifice in Outlet Pipe, Metering Outlet Pipe, Square Orifice, Etc.
*** - Parking Lot Ponding, Detention Basin, Etc.

Maintenance:

A. All stormwater runoff control structures, measures, systems and facilities shall be maintained by the property owner or homeowners association. (For example, property owners will be individually responsible for rear lot drainage structures or best management practices (BMPs) on their parcels. Associations will be responsible for common use facilities, measures, systems and structures.)

B. The person or association responsible for maintenance of storm water systems shall be designated in the Stormwater Maintenance Plan for a subdivision, condominium, commercial property, et cetera must be communicated to the <municipality type> 's Planning Commission or their designee. Options include:

- Name of property owner
- Property owners association or other nonprofit organization provided that provisions for financing necessary maintenance are included in deed restrictions or other contractual agreements.
- XXXXX County Drain Commissioner in accordance with provisions of the Michigan Drain Code (Public Act 40 of 1956, as amended).

C. Maintenance agreements shall specify responsibilities for financing maintenance and emergency repairs, including but not limited to the maintenance and repair of:

- Detention / Retention basins (wet or dry)
- Best Management Practices implemented on the site to address water quality.
- Flow restriction structures
- Rear Lot drainage systems
- Storm sewer structures, pipes as required by type of system and ownership of such a system. (For example if the system is under control of the MDOT, they will maintain the system, if a private owner or association, then they have responsibility.)

D. If necessary to protect public health, safety, welfare, or water resources, including lakes, rivers, streams, protected wetlands, county drains or other receiving bodies of water, the <municipality type> may initiate emergency action to abate imminent and substantial danger and risk. Any costs incurred will be the responsibility of the owner or association responsible for maintenance of the storm water system.

<MUNICIPALITY NAME>
STORM WATER MANAGEMENT SITE REVIEW AGREEMENT

DEVELOPER'S/CONTRACTOR'S SITE REVIEW AGREEMENT for STORM WATER MANAGEMENT

PROJECT NAME: _____

SITE ADDRESS / LOCATION: _____

CONTACT PERSON: _____

COMPANY: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP CODE: _____

For **Subdivision, Condominium, & Manufactured Home Sites** the following procedure will be in place for site inspections and deposit. The site must conform to the original plans reviewed and stamped "Approved" by the <municipality type> engineer. Any changes that are necessary based on field conditions during construction that change the approved plan must be documented in a letter and a copy provided to the <municipality type> and the <municipality type> 's engineer.

The site will be inspected to assure compliance with the approved storm water management plan. All costs associated with re-inspections or repair, replacement, deficiency reconciliation above the fee paid will be invoiced to the owner/developer and must be paid by them. No refunds will be given from unused fees paid.

A unit is defined as a dwelling or residential apartment, condo or site for mobile/manufactured home. For example a parcel may contain a condominium that can house 4 individual families, which will be construed as 4 units, a duplex will be two units, et cetera.

To assure compliance with design guidelines there will be **two inspections.**

<MUNICIPALITY NAME>
STORM WATER MANAGEMENT SITE REVIEW AGREEMENT

I hereby certify that to the best of my knowledge, information and belief, the storm water system will be constructed in general conformance to the approved plans and specifications delivered to me by the design engineer. I accept the responsibility that the storm water system will be in compliance with the design guidelines of <municipality name>'s Storm Water Management Plan. I understand that if deficiencies are discovered during inspections that I am responsible for correction of those deficiencies within a prescribed time frame.

_____ _____

Printed Name Signature

_____

Date

Items to cover:

_____ Review of SWMP inspection procedure and copy to developer / contractor

_____ Deposit of funds for inspections of storm water system

_____ Developer / Contractor to notify <municipality type> Planner (or Engineer) for first inspection

_____ Developer / Contractor to notify <municipality type> Planner (or Engineer) for second inspection

_____ Developer / Contractor has a set of plans marked "Approved" by the <municipality type> engineer from the storm water review process

_____ Storm Water System maintenance plan submitted

_____ Developer / Contractor provides documentation that homeowners association, condo association, or property owners have a copy of maintenance plan, easements, plat layout, and property owner's responsibility for rear lot drainage.

APPENDIX B

To assure that all agency forms are as up to date as possible <municipality name> has provided the following web site addresses that various forms may be attained at for use by developers and design engineers.

1. MICHIGAN DEPARTMENT OF TRANSPORTATION PERMIT APPLICATION FOR USE OF RIGHT-OF-WAY, is available at

http://mdotwas1.mdot.state.mi.us/public/webforms/detail.cfm?ALLFORMS__FormNumber=2205

2. MICHIGAN DEPARTMENT OF TRANSPORTATION STORM WATER DISCHARGE PERMIT APPLICATION, is available at:

http://mdotwas1.mdot.state.mi.us/public/webforms/detail.cfm?ALLFORMS__FormNumber=2484

3. MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY JOINT PERMIT APPLICATION is available at:

http://www.michigan.gov/deq/0,1607,7-135-3307_29692_24403---,00.html

MDEQ Notice of Coverage and Notice of Termination forms for Construction sites of 5 acres or more in size**.**

http://www.deq.state.mi.us/documents/deq-swq-nocform.doc

http://www.deq.state.mi.us/documents/deq-swq-notform.doc

APPENDIX C

Appendix D

Runoff Coefficients

Table 1

TABLE 1. Runoff Coefficients

Urban areas The use of average coefficients for various surface types, which are assumed not to vary through the duration of the storm, is common. The range of coefficients, classified with respect to the general character of the tributary reported in use is:

Description of area	Runoff coefficients
Business	
Downtown areas	0.70 to 0.95
Neighborhood areas	0.50 to 0.70
Residential	
Single-family areas	0.30 to 0.50
Multi-units, detached	0.40 to 0.60
Multi-units, attached	0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment dwelling areas	0.50 to 0.70
Industrial	
Light areas	0.50 to 0.80
Heavy areas	0.60 to 0.90
Parks, cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad yard areas	0.20 to 0.35
Unimproved areas	0.10 to 0.30

Note: It is often desirable to develop a composite runoff coefficient based on the percentage of different types of surface in the drainage area. This procedure is often applied to typical 'sample' blocks as a guide to selection of reasonable values of the coefficient for an entire area. Coefficients with respect to surface type currently in use are:

Character of surface	Runoff coefficients
Streets	
Asphaltic and concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, sandy soil	
Flat, 2%	0.05 to 0.10
Average, 2 to 7%	0.10 to 0.15
Steep, 7%	0.15 to 0.20
Lawns, heavy soil	
Flat, 2%	0.13 to 0.17
Average, 2 to 7%	0.18 to 0.22

Steep, 7%	0.25 to 0.35

Note: The coefficients in these two tabulations are applicable for storms of 5-year to 10-year frequencies. Less frequent higher intensity storms will require the use of higher coefficients because infiltration and other losses have a proportionally smaller effect on runoff. The coefficients are based on the assumption that the design storm does not occur when the ground surface is frozen.

Rural areas

	Soil texture		
Topography and Vegetation	**Open sandy loam**	**Clay and silt loam**	**Tight clay**
Woodland			
Flat 0-5% slope	0.10	0.30	0.40
Rolling 5-10% slope	0.25	0.35	0.50
Hilly 10-30% slope	0.30	0.50	0.60
Pasture			
Flat	0.10	0.30	0.40
Rolling	0.16	0.36	0.55
Hilly	0.22	0.42	0.60
Cultivated			
Flat	0.30	0.50	0.60
Rolling	0.40	0.60	0.70
Hilly	0.52	0.72	0.82

Source: C.T. Haan, B.J. Barfield, J.C. Hayes, *Design Hydrology and Sedimentology for Small Catchments*, Academic Press, Inc. (1994).

PROJECT: Cass River Watershed
ITEM: Local government capacity assessment for implementing new policies
RECIPIENTS: Municipal Clerks in the Cass River Watershed (47)
METHOD: Phone Survey
TIMEFRAME: December 2011 – January 2012 (negotiable)

Hello, My name is _____ and I would like to schedule a 1-hour phone call with you for an interview. I work for University Outreach at the University of Michigan – Flint and am conducting a study with all the townships, villages, and cities that are connected to the Cass River. The survey asks some basic questions about your jurisdiction, the staffing and volunteer resources it has, and use of technology.

I am conducting the study as a part of the Cass River Watershed Management Plan. A watershed management plan is, in essence, an action plan that details our community's water quality concerns and the most cost-effective strategies to pay for education and installation costs to improve and protect water quality. This study will be used to help determine which local governments are most interested and able to make policy changes to improve and protect water quality in the Cass River Watershed.

Once the watershed management plan is completed, any local government, non-profit, or school can apply for grant funds through the State of Michigan to implement the plan. The watershed management plan will be completed in December of 2012, it belongs to everyone though typically Conservation Districts take the lead on implementing the final plan.

(if they ask the Watershed Management plan and this study are being funded through a state grant to the Saginaw Bay Resource Conservation and Development Council)

Interview Date:
Township/Village/City:
Person Being Interviewed and Position:
Interviewed By:

Local Capacity Survey Questions

1. What is the population of your jurisdiction?

STAFFING

The following questions ask about the types of staff positions and number of hours worked.

2. Does your jurisdiction have a city, village or township manager?
    a. Yes
        i. Is the position full time or part time? (hrs / wk) (SKIP TO QUESTION 3)
    b. No (SKIP TO QUESTION 3)

3. Does your jurisdiction have a building inspector?
    a. Yes
        i. Is the position full time or part time? (hrs / wk) (SKIP TO QUESTION 4)
    b. No, is building inspection handled by the County?
        i. Yes (SKIP TO QUESTION 4)
        ii. No
    c. No, is building inspection handled by the state?
        i. Yes (SKIP TO QUESTION 4)
        ii. No (SKIP TO QUESTION 4)

4. Does your jurisdiction have a **zoning administrator** as a separate position?
    a. Yes
        i. Is the zoning administrator position full time or part time? (hrs/wk) (SKIP TO QUESTION 5)
    b. No
        i. If no, who is responsible for zoning administration?
            1. City or township manager
            2. Supervisor or mayor
            3. Member of township board or city or village council
            4. Professional planner (on staff or consultant)
            5. Someone else, please specify_____
            6. No one

5. Does your jurisdiction have an official **municipal attorney**?
    a. Yes
        i. Is the person, employed directly by the city, village or township?
            1. Yes (SKIP TO QUESTION 6)
            2. No (SKIP TO 5. a. ii.)
        ii. Is the person self-employed or with a law firm?
            1. Yes
            2. No
    b. No

6. What other staff positions are there within the city, village or township?
    a. Chief of Police
        i. Yes (full time or part time) (SKIP TO PART b)
        ii. No
            1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
                a. Yes; who: _____
                b. No
    b. Fire Chief
        i. Yes (full time or part time) (SKIP TO PART c)
        ii. No
            1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
                a. Yes; who: _____
                b. No
    c. Assessing
        i. Yes (full time or part time) (SKIP TO PART d)
        ii. No
            1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
                a. Yes; who: _____
                b. No
    d. Clerk
        i. Yes (full time or part time) (SKIP TO PART e)
        ii. No
            1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
                a. Yes; who: _____
                b. No

e. Public Works/Transportation
    i. Yes (full time or part time) (SKIP TO PART f)
    ii. No
        1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
            a. Yes; who: _____
            b. No

f. Finance/Budget/Treasurer
    i. Yes (full time or part time) (SKIP TO PART g)
    ii. No
        1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
            a. Yes; who: _____
            b. No

g. Parks and Recreation
    i. Yes (full time or part time) (SKIP TO PART h)
    ii. No
        1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
            a. Yes; who: _____
            b. No

h. Community Planner
    i. Yes (full time or part time) (SKIP TO PART i)
    ii. No
        1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
            a. Yes; who: _____
            b. No

i. Engineer
    i. Yes (full time or part time) (SKIP TO PART j)
    ii. No
        1. Does the community have a contract with an outside individual, municipality, or firm to perform this service?
            a. Yes; who: _____
            b. No

j. Other please specify (Is this a full time or part time position?)

VOLUNTEERS

The following questions ask how many hours of volunteer time are donated to the jurisdiction for various services.

7. Within each of the following services how many hours of volunteer time do you estimate each **week**?
    a. City, village, township management?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    b. Building permit administration?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    c. Planning administration?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    d. Zoning administration?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    e. Police services?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    f. Fire services?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    g. Public works/Transportation?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    h. Assessing?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30
    i. Finance/Budgeting/Treasurer?
        i. Less than 10
        ii. 10-30
        iii. Greater than 30

j. Clerk?
    i. Less than 10
    ii. 10-30
    iii. Greater than 30
k. Other, please specify?

PLANNING COMMISSION AND ZONING BOARD OF APPEALS (ZBA)

The next set of questions asks about the jurisdiction's planning commission and zoning board of appeals.

8. How many members are on the planning commission?

9. Does the planning commission have a budget?
    a. Yes
        i. If yes, how much is it?
        ii. How much is available annually for training purposes? (SKIP TO QUESTION 10)

    b. No
        i. If not, can the planning commission receive municipal funds to attend training programs?

10. How many planning commissioners have attended the MSU Citizen Planner Training Program?

11. Has the zoning administrator been certified through the MSU Zoning Administrator Certificate training program?

12. Have either the planning commission or zoning administrator been trained through other means? If yes, how?

13. How many members are on the zoning board of appeals (ZBA)?

14. Does the ZBA have a budget?
    a. Yes
        i. If yes, how much is it?
        ii. How much is available annually for training purposes? (SKIP TO QUESTION 15)
    b. No
        i. If not, can the ZBA receive municipal funds to attend training programs?

15. How many ZBA members have attended the MSU Citizen Planner Training Program?

16. Have any ZBA members been trained through other means? If yes, how was this done?

COMPUTER CAPABILITIES

This final set of questions asks about the use of technology in your jurisdiction.

17. Does the community track applications for building permits and zoning approvals electronically?
    a. Yes
    b. No

18. Does your community track code enforcement issues electronically (i.e. using a spreadsheet or database)?
    a. Yes
    b. No

19. Does the main community office have internet access?
    a. Yes
        i. If yes, is it high speed internet or dial up?
    b. No

20. Does the office have access and use mapping software?
    a. Yes
    b. No

21. Does the township/city/village have a website?
    a. Yes
        i. If yes, are the Master Plan and zoning ordinance available on the website?
        ii. Does the township routinely post meeting minutes of the governing body and planning commission, on the local government website?

    b. No

22. Do you use email regularly for conducting standard business communication?
    a. Yes
    b. No
        i. If not, what method is used? (phone, mail, etc)

Thank you for your time for participating in the study. Are you interested in being placed on our mailing list to be notified when the watershed management plan is finalized? Are you interested in being involved in the watershed management planning process?

Excerpts from survey work completed by MSU Planning and Zoning Center

Blue Form: Describe how township evaluated itself

Elkland Township's Master Plan (MP) and Zoning Ordinance (ZO) were evaluated to determine what needed to be added to each. Specifically the following areas were evaluated: Goals and Objectives for Water Quality, Environmental Inventory, Coordinated Permitting (with local, county, and state agencies as appropriate for actions such as, parcel splits, subdivision review, condominium review and zoning review), Coordinated Site Plan Review (under the zoning ordinance), Earth Change Activity as Regulated under Soil Erosion and Sedimentation Control Act, and Accumulation and Disposal of Waste (junk and yard waste) and Other Material. Best Management Practices, Resource Protection Techniques, Implementation Techniques, and Public Education strategies were also evaluated using the "Good, Better, Best" checklist.

Categories evaluated for Best Management Practices included: Parcel Splits for Buildable Area, Land Division Alternatives, Stormwater Management (MP), Stormwater Management (ZO), Stormwater Management: *Buffer strips site plan review standards*, Stormwater Management: *Other site plan review standards*, Impervious Surface Reduction, Protecting Groudwater, Impervious Surface Reduction, Natural Feature and Drain Setbacks.

Resource Protection Techniques that were evaluated included: Resource Protection Overlay Districts (MP), Resource Protection Overlay Districts (ZO), Floodplains, Woodland Protection and Reforestation (MP), Woodland Protection and Reforestation (ZO), and Wetland Protection/Restoration/Creation.

Implementation Techniques evaluated were Conservation Easements and Green Streets Bio-Retention.

.Finally, Public Education strategies were assessed using the following categories: Agricultural BMPs, Open Lands Vegetation Management, Water Quality Monitoring, Drain Clearing, and Road and Bridge Repair and Stream Crossings.

Green Form – ideal examples for each BMP type (Good, Better, Best)

Goals and Objectives for Water Quality that needed to be added after evaluation was that the Master Plan should identify goals and objects relative to water quality protection. The following was added to Environmental Inventory: The Master Plan indentifies existing conditions and issues for major water courses, minor and major drains, and hydrologic soils. Nothing was added for Coordinated Permitting (With local, county, and state agencies as appropriate for actions such as, parcel splits, subdivision review, condominium review and zoning review) and Coordinated Site Plan Review (Under the Zoning Ordinance) categories. Under Earth Change Activity as Regulated under Soil Erosion and Sedimentation Control Act the following was added: "Earth change" means a human-made change in the natural cover or topography of land, including cut and fill activities, which may result in or contribute to soil erosion or sedimentation of the waters of the state. Earth change does not include the practice of plowing and tilling soil for the purpose of crop production. Finally, Accumulation & Disposal of Waste (Junk & Yard Waste) and Other Materials added that the Master Plan should identify junk and yard waste disposal and storage as a problem and includes a goal and objective for the elimination of blight. The Zoning Ordinance should prohibit the storage of waste and other materials unless the amount is small, and for yard waste, in approved composting devices.

The following are Best Management Practices, Resource Protection Techniques, Implementation Techniques, and Public Education strategies. "Good, Better, and Best" examples are given for each category that was previously mentioned.

Best Management Practices

Parcel Splits for Buildable Area: Good: The local community should review every parcel split to ensure buildable sites. Better: In addition to the "Good" category, the community should identify where unbuildable sites exist and notify the property owner upon inquiry. Best: All of the previous elements and maps should be published of the unbuildable sites.

Land Division Alternatives (MP and ZO): Good: Subdivision and site condominium projects. Better: All of the previous elements and conservation open space projects. Best: All of the previous elements in the "Better" category and Planned Unit Developments (PUDs). Stormwater Management (MP): Good: MP must have goals and objectives to protect water quality. MP must have an inventory of waterbodies and their respective water quality. ZP must identify elements to be included in the Zoning Ordinance. Better: All previous elements and ZP specifies stormwater retention for longer periods (or 50 year storm event). Best: All previous elements and ZP must specify stormwater ordinance for 100 year storm event. Stormwater Management (ZO): Good: Locally adopted stormwater ordinances require stormwater plans for disturbances to be in agreement with State minimum standards. Two year, 24 hour retention standard applied to review of engineered stormwater plans. Better: All of the previous elements and the use of Stormwater BMP Credits to encourage the use of additional BMPs to reduce runoff. Ten year, 72 hour retention standards are to be applied to review of engineered stormwater plans. Retention standards should be increased over time. Best: All previous elements and 100 year, 72 hour retention standards to be applied to review of engineered stormwater plans. Retention standards should be increased over time. Stormwater Management: *Buffer Strips Site Plan Review Standards*: Good: All new development that requires Site Plan Review must have a vegetated buffer strip at a minimum of 25' and naturally occurring riparian vegetation should not be cleared within 25' of the waterbody or drain. Better: All of the previous elements and a vegetation buffer strip of 60' for slopes<10% or 90' for slopes>10%. Best: All of the previous elements and waterbodies and drains are to have vegetated buffer strips minimum 90' for slopes<10% and 100' for slopes>10%. Stormwater Management: *Other Site Plan Review Standards*: Good: Any of the conditions under "Better" if they are required by federal Stormwater Phase II rules. Better: Ordinance Site Plan Review Standards must include a list of potential stormwater management BMPs. Best: All of the previous elements and engineered designs are required where appropriate. Impervious Surface Reduction: *Plan*: Good: Impervious surfaces in the area of the subwatershed are 15% of the development at maximum. Development areas should be at a maximum distance from waterbodies and large parcels. Better: All of the previous elements and public facilities should

install pervious pavement where feasible. Best: All of the previous elements and new construction should have green roofs. Impervious Surface Reduction (ZO): Good: Ordinance requirements should specify large minimum lot size and limit lot area coverage in suburban areas. Ordinance also provides for clustering of residential lots and should surround built-up areas with natural spaces. Better: All of the previous elements and requirements for pervious pavement on new development and pervious pavement maintenance protocols to be implemented. Downspouts are to be disconnected in communities where stormwater systems exist. Best: All of the previous elements and industrial and commercial buildings (of a certain size TBD) are required to install green roofs. Natural Feature and Drain Setbacks: Good: Site Plan Review Standards in the ZO should include setbacks from natural features and water courses. Better: All of the previous elements and a Natural Features Ordinance that requires the setback of structures and impervious surfaces from wetlands, watercourses, and 100-year floodplains should be adopted. LID of certain types will be permitted within setback. Best: All of the previous elements and the NFO should require setbacks from endangered species habitat, landmark tress, steep slopes, and woodlands. Limited LID will be allowed. Protecting Groundwater: Good: Local MP should include goals to protect groundwater and all new development projects provided for on-site stormwater retention. Better: All of the previous elements and site plan review standards that address secondary containment, drain discharge location, and setback from wells. Best: All previous elements and the Health Department should be assisted in monitoring chemicals in groundwater and educating citizens on outcome.

Resource Protection Techniques

Resource Protection Overlay Districts (MP): Good: MP includes objective of creation of overlay ZO for waterbodies, wetlands, floodplains, significant habitat areas, and highly erodible soils. Areas should be mapped where overlay zones should be created in the ZO. Better: All of the previous elements and the MP contains language to include county drains in overlays zones. Best: Everything previously mentioned and the MP adds language to include groundwater recharge in overlay zones where surface geology warrants such. Resource Protection Overlay Districts *Ordinance*: Good: Overlay zones should be created for waterbodies, wetlands,

floodplains, and highly erodible soils. Also, an overlay zone should be adopted for a natural resource targeted for protection. Development within the overlay zone should require a permit that may include buffer or other BMPs. Better: All of the previous elements and overlay zones should be adopted for county drains. Best: Everything previous and overlay zones adopted for groundwater recharge areas where needed. Floodplains: Good: Maps of floodplains should be included in the MP. The local government should connect permit applicants to entities doing permitting for floodplains. Better: All of the previous elements and the ZO should include provisions for activities in floodplains and the creation of a floodplain overlay district. Best: No recommendations. Woodland Protection and Reforestation *Plan*: Good: Locate places in the MP where woodland protection, restoration, or development of a Woodland Management Plan should take place. Better: All previous elements and the local unit should include the protection of landmark trees and woodlands as a goal in its plan. Best: Everything previous and the local unit should add the reforestation of undeveloped land as a goal in the MP. It should also engage in tree planting on publically owned lands with other organizations with a goal to reforest all undeveloped public and private lands. Woodland Protection and Reforestation: *Ordinance*: Good: No recommendations. Better: The ZO should include a woodland protection and reforestation overlay district. The woodland protection ordinance should require that a permit is needed to cut landmark trees and tree stands. The local government should work with developers of open space developments to cluster built elements and site disturbances away from existing wooded portions of the site. Best: No recommendations. Wetland Protection/ Restoration/ Creation: Good: Michigan Natural Features Inventory maps should be included in the MP. Better: The previous element and the local unit of government adopts a wetland or natural feature ordinance that requires a permit for disturbances in a wetland and a buffer of undisturbed vegetation around the wetland for wetlands ¼ acre or larger and within 500 feet of a waterbody. The ordinance requires the creation of 2 acres of constructed wetland for every acre of destroyed wetland. The ZO includes a wetland overlay district. Best: All of the previous elements and the local government should map all wetlands and provide Rapid Wetland Assessment data on each.

Implementation Techniques

Conservation Easements: Good: Property owners of lands indentified in the MP as having important water protection features to conservancies. Better: Previous elements and the local government should apply for Natural Resources Trust Fund dollars to acquire easements from willing sellers lands indentified in the MP. Best: All of the previous elements and a millage for acquisition of conservation easements should be passed. Green Streets Bio-Retention: Good: The local government should include an analysis of the most effective places to implement bio-retention BMPs. Better: New town and village street construction incorporates bio-retention facilities (bio-retention planter boxes, bio-swales and rain gardens) in the ROW where slope and soil conditions permit. Bio-retention retrofits constructed with stormwater separation projects and major street upgrade, plus grant funding obtained for location of retrofit bio-retention facilities on private property where public ROW is inadequate. Best: All of the previous elements and a stormwater fee should be established for stormwater management infrastructure. Private, onsite management of stormwater should be encouraged. Bio-retention should be adopted as a standard for new development where appropriate.

Public Education

Agricultural BMPs: Good: The local unit of government should provide published literature on Right-to-Farm Act and Agricultural BMPs. Better: No recommendations. Best: No recommendations. Open Lands Vegetation Management: Good: Information on water quality benefits of different vegetation types and management regimens for parcels with large, non-agricultural vegetated areas should be provided. Better: No recommendations. Best: No recommendations. Water Quality Monitoring: Pamphlets and lists of websites with information on relevant BMPs should be provided. Information on site plan review standards should be available at little or no cost. Better: All of the previous elements and public education sessions should be hosted that pertain to water assets, quality assessments, and water quality protection. The local government should provide information on BMPs implemented on public properties. Best: Everything previous and local schools should host experts in water quality protection and K-12 students should be involved in analysis of water quality and

implementation of BMPs. Drain Clearing: Best: Residents should be aware of who is responsible for water quality protection during these activities. Better: No recommendations. Best: No recommendations. Road and Bridge Repair and Stream Crossings: Good: Residents should be aware of who is responsible for water quality protection during these activities. Better: No recommendations. Best: No recommendations.

Master Plan Amendments

Several amendments were added to the Master Plan with the intention of improving water quality protection. Goals were developed that fit in with natural resources and environmental protection; other goals fit in with land use regulations (or zoning).

Goals that relate to natural resources and environmental protections are the following: Low Impact Development (LID) approaches should be used by new development and redevelopment projects. Using a LID approach, vegetation would be used to filter runoff from developed areas and natural swales would be used instead of a constructed system. The quality of surface and ground water of Elkland Township must be preserved and protected against non-point source pollutions and must enhanced for current and future residents. The accumulation of waste that could result in health risks should be prevented. Developers and land owners should be educated about the importance of environmental conservation practices including LID. Water quality should be monitored and minimum standards for stormwater management should be established. LID standards should be included in the Zoning Ordinance. Techniques and programs should be implemented to protect and improve the natural resources of the township. Possibilities include implementing adequate natural feature setback into the Zoning Ordinance of buildings and impervious surfaces from watercourses, drains, and sensitive natural features. LID approaches should be implemented into the Zoning Ordinance. Land use and construction should not contaminate ground water by ensuring that hazardous materials are not used near water sources. Overlay zone provisions should be created to protect natural features that have been identified as helping to protect water quality. Encourage the Federal Management Agency to use a maximum of 2’ contours when completing future floodplain mapping for the community. Site Plan Review regulations for protection of natural features

should be developed and adopted. Density bonuses should be available for development that voluntarily conserves the surrounding environment. The State of Michigan's purchase and leasing of development rights program (P.A. 116) and transfer of development rights should be supported. Open space should be encouraged to preserve the natural character of the County. The Planning Commission and Zoning Administrator will educate citizens, property owners, and government officials about the status and benefits of water quality protection. Soil Erosion & Sedimentation Control Officer, the County Drain Commissioner/Road Commission should be worked with to promote education about drain maintenance, bridge repair, and stream crossing construction activities with public and private landowners. Best Management Practices should be implemented to reduce soil erosion and sedimentation of drains and other water bodies.

The following goals relate to land use regulations (or zoning). Permits from other agencies will be received before the Zoning Administrator or Building Administrator issue zoning or building permits. Prevent the creation of unbuildable lots on vacant land; this includes land as part of a lot split, subdivision, site condominium project, or planned unit development. All new parcels and lots that are to be created should meet the requirements of the Land Division Act and minimum Zoning Ordinance requirements. Minimum Zoning Ordinance requirements that need to be met include lot frontage, depth and area, and must be outside of a floodplain, wetland, or sensitive groundwater recharge area. Site Plan Review, Open Space provisions, and Planned Unit Development should be utilized by landowners and encouraged by the Zoning Administrator and Planning Commission in order to minimize negative impacts on identified natural features. Best Management Practices should be supported and encouraged for agriculture to preserve the environment and protect water quality.

ZONING ORDINANCE TEXT AMENDMENTS

The Zoning Ordinance is intended to conserve the expenditure of funds for public improvements and services to conform to the most advantageous uses of land, resources, and properties. In order to do so, the following must be accomplished. Zoning districts and uniform

regulations must be established regarding use of land and dimensions for building and site development. Land uses that are compatible with the Township's character should be promoted. Property values and stability of prime farmlands, rural residential areas, residential neighborhoods, conservation/recreation areas, and general business districts should be conserved. The Ordinance acknowledges the importance of identified natural features for the long-term economic climate of all uses and for the overall quality of life for the Township residents. Improper use of land should be prohibited, and hazards to life and property should be reduced. The right of the Township to compatible and quality development should be balanced with the rights of property owners. Property owners are to be provided with reasonable access to property. Controls over potential conflicting land uses should be established. Uses, buildings, and structures that do not conform to the Zoning Ordinance should be eliminated. Any matters regarding what is authorized by the Zoning Enabling Act should be provided for. Natural features, ground, and surface water should be protected from pollution.

LID was included in the definition section as follows: Low Impact Development (LID): An approach to land development that uses various land planning and design practices and technologies to simultaneously conserve and protect natural resource systems, water quality and reduce infrastructure costs. Consult Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers; http://www.mi.gov/deq/0,1607,7-135--207334--,00.html, or http://www.mi.gov/deq/0,1607,7-135--207334--,00.html. Significant Natural Feature was also included in the definitions section of the Zoning Ordinance as follows: Significant Natural Feature: A natural area as designated by the Planning Commission or the Michigan Department of Environmental Quality which exhibits unique topographic, ecological, hydrological, or historical characteristics such as a wetland, flood plain, water features, or other unique natural features.

The subsequent amendments were added to the General Provisions Article, under Section 306 Performance Standards in this order. Soil Erosion: To prevent soil erosion and sedimentation

during and after construction all development within 500 feet of an inland lake or stream, or development that exposes more than an acre or soil must obtain a Soil Erosion and Sedimentation Control Permit unless the activity is exempt under the Natural Resources and Environmental Protection Act. Surface Water Drainage: Removal of surface waters will be removed properly so they do not affect neighboring properties or the public storm drainage system. Stormwater removal must not obstruct the flow of vehicular or pedestrian traffic. Erosion will be prevented by detaining or retaining run-off water. LID standards should be applied where possible. Setbacks from Significant Natural Features: A building setback minimum of 25' should be planted with sod-forming vegetation or naturally occurring vegetation along all watercourses, drains, waterbodies, and wetlands. The building setback is required to be maintained if any land use is receiving Site Plan approval in accordance with Section 801. The vegetation within the setback (buffer strip) may not be clear cut, plowed or graded, unless it is part of an official drain cleaning project.

The following is to be added to the Site Plan Review after Section 803 Standards for Site Plan Approval. Section 804 Groundwater Protection Standards: The project and related improvements must be designed to protect the natural environment. The following site plan review is designed for facilities that use or store hazardous substances in amounts greater than 100 kilograms per month regarding the location and size of interior and exterior areas and structures to be used for storage, use, loading/ unloading, recycling, or disposal of hazardous substances. Location of all underground and above ground storage tanks for such uses as fuel storage, waste oil holding tanks, chemical storage, hazardous waste storage, collection of contaminated storm water or wash water, and all similar uses. Location of exterior drains, dry wells, catch basins, retention/detention areas, sumps and other facilities designed to collect, store or transport stormwater or wastewater. The point of discharge for all drains and pipes shall be specified on the site plan. Delineation of areas on the site which are known as suspected to be contaminated, together with a report on the status of site cleanup. The following site plan review standards are for facilities that use, store, or generate hazardous substances. Sites where hazardous materials are present, either used or generated, must be

designed to prevent materials from entering the environment. Secondary containment must be used for above ground areas and be sufficient to store the substance for the amount of time necessary to recover any of it that was released. General purpose drains are only allowed if they are approved by the responsible agency. Requirements for storage, spill prevention, record keeping, emergency response, transport and disposal of hazardous materials must be met. Discharges are only allowed with required permits and approvals.

The following is to be added to Article 9 Administration in Section 902 Duties of the Zoning Administrator. All land uses and construction activities must conform to the provisions of this Ordinance and to all local, county, state, and federal regulations that are applicable. Approved permits must be submitted to the Zoning Administrator before the following will be issued: Building Permit, Zoning Permit, or a Special Approval Use Permit (a Zoning Permit must be obtained from the Zoning Administrator before a Building Permit can be issued). The approved permits include: driveway permit, septic system permit, soil erosion and sedimentation control permit, floodplain permit, wetland permit, other permits from authorities as pertinent to transport, storage, use, and/or disposal of hazardous waste.

Appendix F: Social Monitoring

Methods	Goals, Intended Outcomes, and Core Social Indicators for NPS Management	Timing
Surveys and focus groups before and after implementation (including education) projects	**Goal: Increased Awareness Among a Target Audience**	During 319 funding applications. Include results in next watershed plan update.
	Intended Outcome: Awareness gained regarding the relevant technical issues and/or recommended practices of the target audience in the critical area	
	Indicator 1: Awareness of pollutants impairing waterways	
	Indicator 2: Awareness of consequences of pollutants to water quality	
	Indicator 3: Awareness of appropriate practices to improve water quality	
Surveys and focus groups before and after implementation (including education) projects	**Goal: Attitude Among Target Audience Supportive of NPS Management Actions**	During 319 funding applications. Include results in next watershed plan update.
	Intended Outcome: Attitudes changed in a way that is expected to facilitate desired behavior change of target audiences in critical areas	
	Indicator 1: General water-quality-related attitudes	
	Indicator 2: Willingness to take action to improve water quality	
Surveys and focus groups before and after implementation (including education) projects	**Goal: Reduced Constraints for Using Appropriate Practices**	During 319 funding applications. Include results in next watershed plan update.
	Intended Outcome: Constraints to behavior change will be reduced	
	Indicator 1: Constraints to behavior change	
Tracking of resources leveraged during implementation via landowner surveys or forms. Tracking of funding sources and	**Goal: Increased Capacity to Address NPS Management Issues in the Project Area**	During implementation projects, detail in final project reports and next watershed plan update.
	Intended Outcome 1: The project improved the recipient's capacity to leverage resources in the watershed	
	Indicator 1: Resources leveraged by grant recipient in the watershed as a result of project funding (including cash and in-kind resources)	

technical assistance avialable over implementation period. Tracking of monitoring programs duration and frequency.	Intended Outcome 2: Increased capacity to support appropriate practices by target audiences in critical areas	
	Indicator 1: Funding available to support NPS practices in critical areas	
	Indicator 2: Technical support available for NPS practices in critical areas	
	Indicator 3: Ability to monitor practices in critical areas	
Tracking (via survey or form) the percentage of critical areas receiving treatment, percentage of target audience implementing practices, and the number of ordinances adopted.	**Goal: Increased Adoption of NPS Management Practices by a Target Audience**	During implementation projects, detail in final project reports and next watershed plan update.
	Intended Outcome: This project resulted in changes in behavior and/or adoption of practices to prevent new problems and improve or maintain water quality in the critical area by the target audience	
	Indicator 1: Percentage of critical area receiving treatment	
	Indicator 2: Percentage of target audience implementing practices in critical areas	
	Indicator 3: Ordinances in place that will reduce nonpoint source stressors	

Social Indicators Data Management and Analysis Tool
Social Indicator Planning and Evaluation System

Step 1: Review Project Plan
1. What are the specific NPS problem(s) the Cass River project is trying to address?

Bacteria from agriculture, illicit connections / hook-ups to storm sewers, and on-site treatment systems (septic systems, etc)
Nutrients and eutrophication from agricultural land uses
Sedimentation due to channelization and dredging

2. What are the critical area(s) that contribute to the problem?

Impaired Areas:

HUC Name	HUC 12-Code	Use Description	Cause Name	Miles	Source
Spring Drain-South	040802050101	Total and Partial body contact	Escherichia coli	72	Agriculture
					Illicit Connections/Hook-

Branch Cass River		recreation			ups to Storm Sewers
					Municipal Point Source Discharges
Duff Creek-South Branch Cass River	040802050102	Total and Partial body contact recreation	Escherichia coli	62	Agriculture
					Illicit Connections/Hook-ups to Storm Sewers
					Municipal Point Source Discharges
Stony Creek-South Branch Cass Rive	040802050106	Total and Partial body contact recreation	Escherichia coli	13	On-site Treatment Systems (Septic Systems and Similar Decentralized System
					Unpermitted Discharge (Domestic Wastes)
		Other Indigenous Aquatic Life and Wildlife	Organic Enrichment (Sewage) Biological Indicators	13	Source Unknown
			Other anthropogenic substrate alterations	13	Channelization
			Other flow regime alterations		
Butternut Creek-White Creek	040802050207	Warm Water Fishery	Aquatic Plants (Macrophytes)	3	Agriculture
			Oxygen, Dissolved	3	Agriculture
Moore Drain-White Creek	040802050209	Other Indigenous Aquatic Life and Wildlife	Direct Habitat Alterations	25	Channelization
			Other flow regime alterations	25	Channelization
					Source Unknown

Dead Creek	040802050304	Other Indigenous Aquatic Life and Wildlife	Other anthropogenic substrate alterations	6	Channelization
			Other flow regime alterations		
Cole Creek-Cass River	040802050305	Total and Partial body contact recreation	Escherichia coli	1	Source Unknown
Cass River	040802050306	Total and Partial body contact recreation	Escherichia coli	1	Source Unknown

Critical Areas coincide with those identified in the Integrated Water Quality Report, 2010 by MDEQ.

3. Who are the target audience(s) for the NPS problem(s) the Cass River project will address?

Local growers
Town Residents
Large landowners
Septic system owners
Riparian landowners
Livestock producers
Angler/paddlers/sportsmen

4. What actions do we want the target audience(s) to take regarding the NPS problems?

Varies by target audience

- Local growers: Install grassed waterways, conservation tillage, cover crops where feasible
- Town Residents: Identify with the watershed, treat stormdrains headwaters to the Great Lakes
- Large landowners: Permanent land protection in high quality natural areas, where economically feasible
- Septic system owners: Properly maintain septic systems
- Riparian landowners: Stabilize streambanks where feasible and manage property in a manner that minimizes streambank erosion

- Livestock producers: Keep livestock out of waterways, minimize runoff

Step 2: Collect and enter pre-project survey data

- Choose method
  - Mail Surveys
  - Telephone Surveys
  - In-person Surveys
  - E-mail Surveys
  - Group Surveys
  - Hybrid Approaches

- Compile contact list(s) for the target audience(s)
- Determine sample size
- Select sample
- Create questionnaire