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Stormwater Educational Handbook

Annis Water Resources Institute

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Stormwater management project

STORMWATER EDUCATIONAL HANDBOOK

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Introduction

Why do we need stormwater education?

Stormwater has a direct effect on all our lives. It is a major source of pollution in our local groundwater and surface waters, which are part of the larger Great Lakes system. The water that runs off our urban and suburban landscapes contains lawn chemicals and clippings, silt from constructions sites, oil and tars from roads and driveways, pet wastes, salt and much more. All these contaminants, all this pollution goes swirling down our storm drains.

Stormwater runoff can carry with it pollutants such as lawn chemicals and clippings, silt from construction sites, oils and tars from roads and driveways, pet wastes, and much more. This runoff is directed to storm drains, which dump into streams, rivers, and lakes in which we swim, fish and drink.

But that doesn't mean that it just goes away. The storm drains dump it into streams, rivers and lakes. It's there waiting for us when we go swimming, fishing and boating. It's there when we turn on our taps for drinking water.

In order to maintain our water resources and our quality of life, we need to take steps to protect and manage stormwater. We also need to educate the general public, so that people understand how their actions affect the quality of our waters. The Kent County Stormwater Task Force feels that an informed public and concerned local governments can make stormwater decisions that will support those goals for everyone in West Michigan.

The goal of the Kent County Stormwater Management Program is to improve and protect the region's quality of life by preventing and minimizing any impacts of stormwater runoff into a valuable resource.

One action that has great impact is the adoption of stormwater protection ordinances by townships and municipalities. The informed support of local citizens is critical to that process. The Kent County Stormwater Task Force has prepared a Model Stormwater Ordinance for Kent County Townships and Municipalities (Appendix A) which is intended as a model for local governments in Kent County. The primary aim of this manual is to clarify and expand on the suggested ordinance. A secondary purpose is to start the process of self-education necessary to obtain citizens' support.

The Task Force hopes that this handbook will be useful whether the reader is new to the subject of stormwater or has questions of the most technical nature. For instance, Part 5 refers the reader to a wealth of additional information available in printed documents or through the Internet. For ease of use, each section has a separate divider with a number on the tab extension. A history of the model ordinance and management tools is provided in Appendix B for those interested in the background of the present effort.

Part 1: The Stormwater Resource

1.1 The Effects of Stormwater

In a natural landscape, rain water is not normally a problem. Much of it is absorbed by the soil. Some of the absorbed water is taken up by plant roots and the rest seeps down to become part of the ground water. Along the way it is naturally filtered as it percolates through the different soil layers. What isn't absorbed runs over the soil surface to nearby streams or **wetlands** or stays as temporary **pools**.

As a consequence of development and sprawl, many communities are experiencing degradation of their water resources. **Stormwater runoff** can carry contaminants that can pollute lakes and streams, and pose a threat to the health of people exposed to these degraded resources.

Growing communities across the country are experiencing degradation of their water resources as a consequence of development and sprawl. Many people do not make the connection between **stormwater runoff** from development and the pollution of water resources. When land is developed, landscapes are turned into cityscapes, vegetation disappears and the soil is covered with rooftops, roads, parking lots, driveways, sidewalks, and lawns. These impermeable surfaces, collectively known as **impervious cover**, do not allow rain to soak into the ground. Natural systems are replaced by engineered systems in a cityscape; water running off the impervious surfaces is channeled into storm drains and directed through pipes to the nearest body of water. An increase in **impervious cover** increases the volume of **stormwater runoff**, effects the natural **infiltration** process, and increases the amount of pollutants carried to nearby streams.

<u>Volume of Stormwater Runoff</u>

As development occurs within a watershed, the volume of runoff increases, potentially increasing flood volumes and river heights. Government officials and other watershed decision makers are generally well aware of these effects and have often passed ordinances intended to control and limit these flood flows. The motivation for these ordinances is primarily the protection of life and property.

Unless appropriate stormwater management controls are incorporated, peak runoff flows from a developed area will reach the receiving water much more quickly and at higher volumes than under natural conditions. The result is an unstable stream system with higher peak flows and more streambed and bank erosion.

Natural Infiltration

When stormwater runoff is collected and conveyed from a developed area, rather than staying on site, the natural infiltration process is interrupted. Land use changes that increase the volume of runoff cause a corresponding decrease in infiltration to groundwater, leading to reduced **base flows** in smaller streams. Under low flow conditions, which typically occur in the summer, streams can become intermittent, eliminating suitable habitat for aquatic life.

Parking lots, roads, and rooftops are impervious surfaces that do not allow rain to soak into the ground. Rain that was once absorbed by the soil is now channeled into storm drains and directed through pipes to the nearest body of water.

The loss of the cooler **groundwater** flowing into the stream can also raise a stream's mean summer stream temperature by two to 10 degrees Fahrenheit. This seemingly slight increase can have a devastating effect on cold water trout streams, by altering the ecosystem enough to change the population structure of the aquatic system. An elevated water temperature in warm water streams also stresses fish and aquatic insects.

Pollutants to Surface Water Bodies

Surface water bodies provide a number of benefits, including:

- resources that support industries such as shipping, commercial fishing, and tourism;
- use for utilities and industry;
- recreational opportunities such as swimming, boating, and fishing;
- fresh drinking water;
- habitat for a diversity of species, some of which are threatened or endangered;
- aesthetic experiences;
- irrigation and drainage for agricultural production.

All of these are affected to a greater or lesser degree by stormwater. Pollutants in **stormwater runoff** can impact lakes and streams, and pose a threat to the health of people exposed to these degraded resources. These pollutants can include oil and grease, fertilizers, and animal waste.

- Oil and Grease

Rainfall transports petroleum and petroleum byproducts (oil and grease) from roads, parking lots, and storm drains to rivers, lakes, and streams. These toxic substances contaminate the waters and are expensive and difficult to remove.

- Fertilizers

Nutrients from fertilized lawns, golf courses, and other landscaped areas also are transported in stormwater. **Phosphorus** and **nitrogen** are necessary nutrients in aquatic ecosystems, but excess amount of nutrients to a water body increases algae and aquatic plant growth, also known as **eutrophication**. This overgrowth impairs recreation and aesthetic enjoyment of water resources

through reduced water clarity, unpleasant swimming conditions, offensive odor, blooms of toxic and nontoxic organisms, and boating interference.

Surface water contamination with human or livestock waste is responsible for the spread of many contagious diseases. Greater attention to the management of stormwater in general can result in decreased instances of this type of contamination.

- Animal Waste

Surface water contaminated with human waste, livestock manure, or other mammal waste is responsible for the spread of many contagious diseases. The presence of ***E. coli*** bacteria indicates that human waste or manure is present in the water. Peak ***E. coli*** concentrations occur after high flow periods when floodwater is importing contaminants such as livestock waste from along the stream bank. Greater attention to the management of stormwater can result in decreased instances of this type of contamination.

Stormwater can be a liability or an asset, depending on how we care for it. If we allow it to become polluted, it will lower the quality of our lakes, rivers, and streams, affecting the quality of our lives and even our health in many ways. If we protect its quality, it will become a valuable resource.

The quality of our lakes, rivers, and streams can be protected through stormwater management.

1.2 The Control of Stormwater

Enactment of stormwater ordinances and regulations helps a local government to meet its goals in several ways. For example:

- communications concerning stormwater will be consistent and all stakeholders will have the same expectations;
- discussions with developers can be undertaken using the ordinances, along with design and performance standards as educational tools;
- local planning can be coordinated and given authoritative weight;
- discussions among adjacent and subregional governmental units can be facilitated.

In the Kent County area, officials at many levels are studying a variety of stormwater management approaches that include the following:

- flood control
- control of pollution at its sources;
- runoff diversion into vegetated areas for storage and filtering; and
- creation, adoption and enforcement of management strategies that promote “smart” development.

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Part 2: The Science of Stormwater Management

2.1 Importance of Stormwater Management

Stormwater is not waste water; it is a resource. Many different agencies currently manage **stormwater runoff** and often these agencies have different objectives for that resource. Furthermore, upstream and downstream communities sometimes differ on stormwater management issues. It is important that all involved parties share common goals if we are to manage stormwater effectively for the good of the entire region.

Stormwater management has traditionally addressed water quantity issues, primarily flooding. When quality issues have been considered, it has typically been in the form of **point source** pollution. Today, water quality issues such as pollution from increased runoff are included as priorities, but further progress must come through reduction of **stormwater runoff** and control of **nonpoint sources of pollution**.

The primary goals of stormwater management are resource protection and the reduction of runoff volume at its sources. Techniques for meeting these goals include protecting natural areas, decreasing impervious surfaces, and using as many natural zones as possible to manage stormwater. The next step is to mitigate negative impacts and use structural site controls by maximizing **infiltration** techniques and designing retention/detention facilities to address resource concerns and pollutants.

Using natural zones to manage stormwater allows for more **infiltration** and results in less runoff and greater **groundwater** protection. Creating **buffers** along watercourses reduces the impacts of pollution.

Using natural zones to manage stormwater allows for more **infiltration** and results in less runoff and greater **groundwater** protection. Maintaining **open spaces** and creating **buffers** along watercourses will reduce the impacts of pollution and increase **groundwater recharge**. Future development and the long-term sustainability of the region's resources require a thorough understanding, on the part of residents and decision-makers in the region, of the relationship between land use activities and water quality.

In construction areas, staging and scheduling the construction project will minimize runoff and limit the severity of erosion problems. Staging a project is dividing the construction area into smaller work zones, thereby minimizing the amount of soil exposed at any given time. Scheduling involves implementing **Best Management Practices (BMPs)** in a timely and logical fashion, ensuring that the appropriate **BMPs** are being implemented at the appropriate time. Strict enforcement of **soil erosion and sediment control ordinances** is critical. Controlling erosion before and during construction is much more cost effective than removing sediment after construction.

Utilizing a series of **Best Management Practices** is important to minimize runoff. In the picture above, a silt fence and buffer strip are used together to minimize the amount of sediment being swept off the site during a rain event.

It is crucial to minimize the amount of impervious surfaces and to optimize the use of those impervious surfaces that are unavoidable. **Cluster development**, where homes are concentrated in certain areas, minimizes the amount of disturbed land. Shared parking, smaller lot sizes, and flexible private road standards reduce **impervious cover**. An important consideration in stormwater management is the safe conveyance of stormwater to reduce the negative and destructive capacities of the runoff. Using natural approaches to manage stormwater on site, such as **constructed wetlands**, **swales**, **water harvesting**, and **infiltration** techniques will decrease the risks associated with **stormwater runoff**.

Runoff that cannot be controlled on site requires environmentally sensitive management to reduce the pollution entering waterways. Standards for water quality and stream channel protection address the conditions that are most damaging. **First flush** flows, channel-forming flows, and large storm events all need specific types of management. Recommendations to reduce hydrological impacts due to the increased quantity of stormwater are included in Section 8.02 of the Proposed Model Stormwater Ordinance for Kent County Townships and Municipalities.

2.2 Stormwater Management Controls

The conditions of a community's water resources depend to a large extent on the management of **stormwater runoff**. Developing design criteria for local officials and developers provides tools that can be used for the planning and design of stormwater facilities. Storm events that produce active erosion needs to be addressed in the channels that are impacted. Different areas require different management solutions. In some communities, the management philosophy might be to maximize **infiltration** of stormwater to promote **groundwater recharge**. Other areas might have aquifers that are extremely vulnerable to **groundwater** contamination and therefore need to limit **infiltration**. Still other areas might have sensitive cold water streams that would be degraded by warmer waters **discharged** from **detention basins**. There are creative and innovative solutions to many of these problems. The table in Appendix C describes some of these structural and vegetative solutions to stormwater management and includes characteristics that could be used to determine management practices if the solutions are appropriate to the sites under consideration. This overview can be used by designers, planners, developers and homeowners.

Wetlands are natural systems that filter stormwater and release it slowly into lakes, streams, and rivers.

Natural Systems

Nonstructural controls are used for pollutant source reduction and the protection of the natural environment. Developers can often greatly reduce construction and maintenance costs by coupling natural systems with constructed systems. Although natural systems can be used to filter stormwater runoff, proper stormwater management facilities, such as **detention or retention basins**, should be used.

Constructed Systems

For additional runoff that cannot be controlled onsite, structural site controls must be implemented. The goals of constructed systems are usually to maximize **infiltration** in areas where **groundwater** contamination is not a threat. This is accomplished through retention and **detention basins**, **stormwater wetlands**, and other **filtering practices**.

Detention basins are constructed systems that temporarily store water before discharging into the water body. The water **discharges** from the basin at a rate that will not increase flooding conditions in the stream.

Stormwater Quantity Controls

Detention and **Infiltration**

Most communities have performance standards requiring that post development peak **discharge** rates not exceed the predevelopment **discharge** rates from that development for a certain storm event. The release rate from each sub-basin is based on a variety of criteria, ensuring that increases in the downstream flood stage are acceptable. Onsite detention requires any new development to store the increase in runoff generated by the construction activities on the property. This is accomplished through detention or **infiltration** of **stormwater runoff**. The **stormwater runoff** that is stored onsite either infiltrates to recharge the **groundwater** or is **discharged** from the property at a rate that will not increase flooding conditions in the stream.

Regional Detention

Safe conveyance of stormwater is a consideration in managing runoff so as not to increase the risk of flooding downstream properties or compromise the integrity of any dams or structures used to detain stormwater. In some instances, **regional detention** sites can be located where they benefit several properties by detaining a large amount of runoff from a sizable area. The primary incentive of using **regional detention** is the reduction of the number of **detention basins** and corresponding operations and maintenance costs. A regional basin will usually require less land overall than many separate basins to achieve the same water storage results, and since it will normally be placed on public land, easements and the responsibility of maintenance will be minimized. Regional basins are also more accepted by the public and since a larger area is

involved, better siting of the basin is possible as well as the incorporation of multipurpose uses, such as parks, fishing ponds, and recreational playing fields, into the design. Although regional detention has its advantages, there may be resistance in communities because this land may have tax implications.

Based on limited analysis conducted in comparing different drainage classes, studies found that regional **wetlands** are better at pollutant removal than **wetlands** with smaller drainage areas such as pocket and regular wetland designs. Regional ponds, however, have slightly lower efficiencies, possibly due to the influence of **base flow** on these larger systems. Regional stormwater basins that are in-stream do not provide upstream protection from **first flush** impacts.

Post Development Controls

Generally, designs based on existing land features should establish clear and definite channel protection criteria. Quick fixes, such as **grade controls** and **rip rap**, may protect **ditches** and channels from eroding but do not address the cause of the erosion. Stormwater management practices should be designed to reduce the impacts of post-development runoff on the natural drainage system and also ensure that the drainage system can safely withstand the erosive conditions that often follow development.

Stormwater Quality Requirements

Surface water and **groundwater** protection should be considered in any stormwater management decision. The goal of water management practices is to restore the waters to their **designated uses** as determined by the local community. All streams are designated for specific uses established by state and federal water resource programs. In Michigan, the **designated uses** are:


Agriculture is a recognized use of water in Michigan.

- Agriculture
- Industrial water supply
- Public water supply at the point of intake
- Navigation
- Warmwater/coldwater fishery
- Other indigenous aquatic life and wildlife
- **Partial body contact recreation**
- **Total body contact recreation** between May 1 and October 31

The State of Michigan has set a goal of having all waters of the state meet all the **designated uses**. However, **stormwater runoff** has severely impaired many of the state's waters. The impacts of pollutants on the **designated uses** are described in Appendix D.

Best Management Practices (BMPs) are used to remove pollutants from **stormwater runoff**. **BMPs** differ in their pollutant removal capabilities, maintenance requirements, feasibility of construction, and financial or environmental constraints. A publication from the Center for Watershed Protection shows the results of an analysis of the pollutant reducing capabilities of

various **BMPs** (Winter, 2000). The following stormwater treatment practices were monitored in the study:

Stormwater ponds are one kind of treatment practice for **stormwater runoff**. These ponds remove nutrients and other pollutants that are carried in **stormwater runoff**.

- Stormwater Ponds
- **Quantity Control Ponds**
- **Dry Extended Detention Basin**
- **Multiple Pond System**
- **Wet Extended Detention Pond**
- **Wet Pond**

- Stormwater Wetlands
- **Shallow Marsh**
- **Extended Detention Wetlands**
- **Pond/Wetland System**
- **Submerged Gravel Wetlands**

- Open Channel
- **Grass Channel**
- **Ditch** (not explicitly designed for water quality)
- **Dry Swale**
- **Wet Swale**

Open channels are another kind of treatment practice used for stormwater. The channels and **swales** are designed to detain and promote infiltration of **stormwater runoff** into the soil.

- Filtering Practice
- **Perimeter Sand Filter**
- **Surface Sand Filter**
- **Vertical Sand Filter**
- **Bioretention**
- **Organic Filter**
- **Multi-Chambered Treatment Train**

- Infiltration
- **Porous Pavement**
- **Infiltration Trench**

- Other
- **Stormceptor**
- **Oil-grit separator**

Designs for these practices and supporting documentation can be found in the Michigan Department of Environmental Quality's Guidebook of BMPs for Michigan Watersheds (see References). A summary of results of the analyses of stormwater practices is included in Appendix E. Other references comparing and evaluating systems are listed in Part 5 of this booklet.

Operation and Maintenance

Where leach basins and/or **detention and retention basins** are proposed as part of the stormwater collection system, an agreement must be made with the township/municipality to operate and maintain the stormwater collection system properly. This should include, but not be limited to, cleaning out the leach basins and/or **detention and retention basins** at least annually. The township should reserve the right to contract any necessary cleaning to be done, at the property owner's expense, if proper maintenance is not performed.

Design Standards

The Design Standards developed for Kent County Townships and Municipalities can be used by decisionmakers when considering the type of stormwater controls needed for land use changes. The process is to be applied at the **sub-watershed** or stream/creek scale, preferably no larger than 10 square miles. The criteria determine in which water management zone (sensitive, impacted, or conveyance) a stream or creek would be classified, aiding decisions about what stormwater controls would be necessary. Goals for individual water bodies may vary, but they all follow the overall goals of stormwater management for the area.

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Part 3: What You Can Do to Reduce the Impact of Stormwater

Stormwater can be a resource or a problem, depending on the decisions made by individuals. The cumulative effects of bad decisions result in polluted streams, rivers, and lakes in our communities. With the appropriate information, people can make decisions that will improve water quality. This section of the handbook will talk about the action steps that individuals and groups can take to ensure that stormwater remains a valuable resource. Rain is a valuable resource that is supposed to nourish our world and should not be thrown away.

3.1 Local Decision Makers

Local **Master Plan** language should support and explain the reasoning behind stormwater-related ordinances. It should describe the community's reasoning behind the desire to protect water quality in locally valued features such as **wetlands**, streams, rivers and lakes. The plan should identify features to be preserved; a map is useful to clearly identify and locate the features and boundaries that are to be protected. If the **Master Plan** does not have this, the ordinances may not be enforceable.

The adoption of ordinances should accomplish the following objectives:

Ordinances should be adopted to protect **wetlands**. **Wetlands** are important in treating **stormwater runoff** because they naturally filter the runoff and release it slowly into lakes, rivers, and streams.

- Protect Natural **Wetlands**

Wetlands naturally filter stormwater and slow its release into streams and rivers. In counties with human populations greater than 100,000, such as Kent County, **wetlands** that are five acres or more in size are regulated by the state. **Wetlands** smaller than five acres in size are regulated if they fall, in whole or in part, within five hundred feet of a lake, pond, or stream (as described under Part 301 of Act 451 and rules). Other **wetlands** may be regulated by a local ordinance.

Studies have shown that smaller **wetlands** perform the same functions as larger ones. However, smaller **wetlands** are much less **resilient** than larger systems. Small systems must be incorporated into a site plan for the larger landscape, using natural corridors to connect them with uplands and other **wetlands**. Without those connections, many of their functions either disappear over time (particularly wildlife and plant populations) or are greatly impaired. Indeed, one of the major impacts to smaller wetland systems comes from grade changes that either starve them of water or do exactly the opposite: supply an overabundance of water that changes their vegetative structure and ability to function. If the wetland systems are compromised by way of hydrologic changes, their ability to improve water quality is probably hindered to a great degree as well. Poor water quality also has negative effects on wetland health. Our ability to predict these changes accurately is still limited.

At the landscape scale then, smaller **wetlands** are critical resources, but they must be integrated in a meaningful way into a site plan during the planning process. This generally means that these **wetlands** and associated upland corridors should be identified well in advance and that the site planning process should make every effort to avoid both direct and indirect impacts to preserve their structure over a large number of parcels and over the long term.

- Protect **Floodplains**

Floodplains can be hazardous areas to occupy and, like **wetlands**, are important areas that help manage the flow of excess water. While these areas may appear to be desirable for development because they are flat and located near flowing water, they may in fact be very poor places to build. **Floodplains** and the vegetation in them are vital for controlling periodic flood events. Alterations in **floodplains**, such as removal of vegetation or changes in grade or fill, can degrade their ability to help manage flood events. There is also a natural exchange of **nutrients** and **organic matter** between rivers and their **floodplains**. This exchange is essential to sustain river systems and their **biodiversity**.

- Require and Protect Riparian Buffers

Riparian buffers are protective strips of filtering vegetation along the shores or banks of water bodies. They provide shade, stabilize soils, and slow the release of stormwater to surface waters. Any greenbelt or buffer will provide benefits, but the wider and more natural the buffer, the greater positive effect it will have on water quality.

Ordinances should be adopted to require and protect riparian buffers. This vegetation along the shores or banks of water bodies provides shade, stabilize soils, and slow the release of stormwater to surface waters.

- Allow and Promote Natural Landscaping

Water quality is degraded by traditional landscaping techniques. Waterfront parcels in particular benefit from landscape designs that minimize or eliminate mowed lawn areas and make use of native Michigan plants. It is possible to create an ordinance that requires this type of landscaping in areas adjacent to a sensitive water body.

Native plants and reduced lawn areas create attractive landscapes and require less watering, maintenance, and chemicals.

Sometimes an ordinance must be passed or amended to allow this type of innovative landscaping, as most weed ordinances prohibit unmowed areas on properties. Communities adopt weed laws in order to prevent unsightliness from poor property maintenance and to prevent hazards from vermin and fire, which were wrongly believed to be caused by unkempt vegetation. In such cases, a permit type of ordinance can be used that requires homeowners to file an application for natural landscaping and obtain approval from a majority of neighbors.

- Promote Onsite **Infiltration** Methods of Handling Stormwater

The amount of stormwater and related pollutants can be reduced if runoff is directed to locations other than the storm sewers. On many sites, stormwater can be drained to natural or created **swales**, **infiltration** ponds or **rain gardens.**

- Permit Development Techniques That Are Environmentally Sensitive
Traditional development regulations create sites with large amounts of **impervious cover** that crowd out natural areas and **open space**. To encourage **open space** and natural areas, the development policy should be evaluated and changed to make it possible for designers to create developments that protect the quality of rivers, lakes, and streams.

3.2 Local Residents
Studies in Michigan have shown that about 50% of the pollution entering our waterways comes from local residents (http://www.wcdoe.org/rougeriver/ Rouge River Watershed Council, 1/27/02). Planting and maintenance activities for home and business landscapes have a direct impact on polluted stormwater.

Runoff from home lawns and gardens flows into storm drains, combined storm-sanitary sewers or into roadside **ditches** connected to lakes and streams. Pollutants carried in this runoff may include: fertilizer, pesticides, chemicals, salt, soil eroding from bare areas, pet wastes, and oil or grease that may have leaked or spilled onto the ground.

Lawn clippings are also carried in runoff to storm drains and into lakes, streams, and rivers. This can be avoided by composting your yard and garden waste instead of disposing of it.

Home landscapes can be designed to retain water on site, encourage **infiltration**, and even to "treat" some pollutants through small ponds and **wetlands**. Trees, shrubs, groundcovers, and other plantings can be selected with water quality protection in mind.

You can make a difference by:

Reducing Pollutants in Run-off

- Store and use household chemicals away from areas where they can enter stormwater. Keep their use to a minimum, and store them in waterproof containers.

- Keep petroleum products, road salt, cleaning compounds, and other products off driveways and other areas where they can wash into drains.
- Do not dispose of unused chemicals in storm drains.
- Use cleaning compounds that contain low or no **phosphorus**. Excess **phosphorus** degrades surface water quality. Compost your yard and garden waste instead of disposing of it.
- Test your soil to see if you really need lawn and garden chemicals. If you must use pesticides, follow the application and safety instructions carefully. Avoid applying them when heavy rain is forecast. Use fertilizers without **phosphorus** and use slow-release types.

- Pick up pet waste and dispose of it properly in designated waste receptacles.
- Make sure your septic and plumbing systems are operating correctly.
- Look for alternatives to single passenger car driving, such as carpooling. This will reduce the amount of pollutants in **stormwater runoff** from parking lots and roads.
- Maintain your vehicles. Leaking fluids end up on roads and parking lots and wash into streams after it rains.
- Wash your car in a car wash, where the water may be sent to a treatment plant instead of a storm drain. If you do not wash it in a car wash, wash it on the lawn where the water can soak into the soil instead of washing down a storm drain.

Landscaping Your Yard to Retain Stormwater on Site

- Install low maintenance landscaping. Traditional landscaping techniques degrade water quality. Native plants and reduced lawn areas create attractive landscapes and require less watering, maintenance, and chemicals. They also attract wildlife to the area. If you live on a lake or stream, use natural landscaping techniques with native plants, and keep a **buffer** zone of native, unmowed plants in place along the shore or bank. Repair eroding banks.

Rain barrels can be used to retain stormwater on site. Rain barrels provide a source of chemically untreated water for plants and compost while diverting water from uncontrolled dumping into storm drains.

- If you are putting in paving, use porous material and slope it to drain to vegetated areas.
- Prevent soil erosion by covering bare soil with plants or mulch.
- Direct roof downspouts into garden areas or rain barrels instead of storm drains.
- Create a Rain Garden. These attractive garden areas are created to collect and filter stormwater in your yard, and provide wildlife habitat and natural beauty.

Preserve the Land You Love

Instead of selling land for development, natural land can be preserved and remain largely unspoiled. One way to make owning natural or rural land more affordable is through conservation easements. A conservation easement is a voluntary legal agreement between a landowner and a land conservancy or government agency that permanently limits uses of property in order to protect the conservation values of the lands (Appendix F). Conservation easements are practical, flexible, and offer tax benefits to many landowners. The greatest reward for most landowners is knowing that their land's special features will be protected – forever. To

learn more about how a conservation easement might work in your situation, please contact the Land Conservancy of West Michigan at (616) 451-9476 or email lcwm@naturenearby.org.

Educating Others

- Get involved in the planning and zoning process in your community. That is where the decisions are made that shape the course of development and the future quality of your environment.

- Promote environmental education. Help educate people in your community about ways in which they can help protect water quality. Get community groups involved.

3.3 Other Stakeholder Groups

Agricultural Producers

The culture of agriculture shapes our land, our lives, and our values. Agriculture provides food for our rapidly growing population and provides land for many plants and animals. In order for agriculture to be **sustainable**, it must integrate the goal of environmental health.

Agricultural runoff is a pollutant that can threaten the health of the environment. It contains pollutants including **nutrients**, sediment, animal wastes, soil enhancers, and pesticides. There are many ways to control runoff and reduce the erosion and transport of sediment from agricultural fields. There are cost-share programs available for instituting practices to protect water quality. Many programs that will advise you on how to protect and improve water quality on your property are available at no cost (See Farm-A-Syst in References).

Some examples of agricultural practices that improve water quality include:

- Conservation Tillage
  Conservation tillage includes any tillage or planting system that maintains at least 30 percent of the soil surface covered by residue after planting to reduce soil erosion by water or wind. Surface residues reduce soil compaction from raindrops and provide soil cover during critical times in the cropping cycle.

- Contour Strip Farming
  Contour strip farming reduces erosion and sediment production, thus decreasing the transport of sediment and related pollutants to receiving waters. Under this practice, sloping land is farmed across the slopes to impede runoff and soil movement downhill.

- **Buffers**
  Buffers are strips of vegetation, established between a pollution source and a water body, which remove pollutants in runoff. **Buffers** vary in width according to the site needs, and can be vegetated filter strips, **wetlands**, or other uncultivated areas next to surface water.

- Restoration of **Wetlands** And Riparian Areas
  Decades of economic pressure have encouraged the replacement of natural streamside vegetation with crops, and the draining of **wetlands** for cropland. Removing these natural

areas from agricultural production and restoring them to their natural state improves water quality.

- Prevention of Animal Waste from Entering Surface Waters
  Animal waste, including manure and urinary waste, can enter streams directly when cattle wade in and around the water. Animal wastes deposited in water bodies can accelerate **eutrophication**. Animals also trample stream banks, increasing erosion potential, and damage fish habitat. Installation of alternative drinking water sources or restricting stream access will keep livestock out of streams, thus protecting stream banks and water quality.

Animal waste can enter streams directly when cattle wade in and around the water. Restricting stream access will keep livestock out of streams and protect stream banks and water quality.

- Proper Disposal of Milk-Parlor Waste
  Milk parlor waste should be treated as agricultural waste.

- Prevention of Silage from Leaking Nutrients into Waterways
  Locate silage and feed piles away from areas where runoff drains to surface waters. Install **buffers** and barriers to prevent nutrients from reaching surface waters.

<u>Developers</u>

- Incorporation of Better Site Design into Engineering Plans And Reduction of **Impervious Cover**.
  Explore design options to reduce the amount of paved areas and the length and width of roads. Protect **wetlands**, trees, natural features, riparian **buffers**, and **open space** in site plans. Home lots with natural features preserved command top dollar.

- Handling Stormwater with Practices That Avoid Pollution of Surface Waters

Direct **stormwater runoff** to stormwater retention and **infiltration** systems. Do not create direct channels from streets for stormwater to enter natural systems.

Research has shown that urban streets and stormwater systems deliver a majority of pollution in **stormwater runoff**. Onsite stormwater retention and **infiltration** systems are preferred. Do not create direct channels from parking lots, streets, or service areas for stormwater to enter natural systems.

- Landscaping with Nature
  Altering the natural contours of the land during landscaping and planting with non-native plants that need fertilizer and extra water can increase the potential for higher runoff volumes, intensify erosion, and introduce chemicals into the path of runoff. Landscape plans that protect water quality and make use of native plants can be very attractive, creating habitat for wildlife as well as an interesting setting for architecture.

Construction Engineers

Tons of sediment enters streams, lakes, and rivers annually from construction sites (http://www.watershedrestoration.org/news/erosion2.htm , Sulphur Creek Coordinated Resource Management Planning Group). Construction sites can be worked in such a way as to prevent erosion from occurring if silt fences and soil stabilization techniques are properly used. Periodic and frequent inspections of construction sites will prevent problems from getting out of control.

Following is a list of measures that can be taken during construction to decrease soil erosion and off-site sedimentation:

- Sedimentation control: 1) install silt fences properly (they often are improperly installed). They must be trenched in and not used in concentrated flow areas. Check them on a schedule to make sure they are performing properly. 2) Protect all catch basins. 3) Utilize sediment basins and traps.
- Develop a soil erosion and sedimentation plan that utilizes a series of **BMPs**.
- Soil stabilization – plant vegetation and use erosion control mats to prevent soil from washing away on bare soil areas.

For sedimentation control, silt fences must be installed properly. The silt fence above is improperly installed because it is not trenched into the ground.

- Use check dams in concentrated flow areas.
- Do not create direct channels from parking lots or service areas for stormwater to enter natural systems.
- Stage construction to minimize exposure of bare soil.
- Use washdown areas if possible or gravel access pads. Washdown areas are specifically designed to prevent construction vehicles from transporting sediment from a construction site to roads and surface waters.

3.4 Onsite Recommendations

Industrial Sites

- Contain spills; make sure chemical spills do not contaminate areas that handle stormwater.
- Do not create direct drainage channels to surface water bodies. Drain parking areas to **swales** and retention ponds for onsite **infiltration** to soil. Onsite storage of stormwater should be maximized.
- Landscape to reduce watering and chemical maintenance needs. Landscaping with native plants reduces or eliminates need for watering, mowing, and chemical maintenance.
- Have emergency plans in place to protect surface water in case of spills. Washdown areas are specifically designed to prevent vehicles from transporting chemicals from industry to roads and surface waters.

Commercial and Institutional Sites

Schools, businesses, hospitals, libraries, and shopping malls typically create large areas of impervious surfaces that create water pollution problems. Runoff from roofs, lawns, and paved areas can be sources of pollution to stormwater. In addition, the large volume of stormwater running off such sites can degrade natural water ecosystems.

- Use native landscaping techniques that protect water quality instead of high maintenance landscaping designs that depend on chemicals and frequent watering.
- Manage stormwater with practices that avoid pollution of surface waters. Stormwater from commercial sites potentially can deliver a great deal of pollution to nearby waters. Onsite stormwater retention and **infiltration** systems are preferred and can eliminate direct channels from parking lots, streets, or service areas for stormwater to enter natural systems. Use of **swales** and **rain gardens** to handle parking lot runoff is preferred.

Rain gardens are one kind of treatment practice for **stormwater runoff**. A rain garden can eliminate direct channels from parking lots for stormwater to enter natural systems.

Golf Courses

Golf courses are often the only green spaces in urbanized areas, making them potential assets. However, poorly designed and managed golf courses can degrade surface water quality and produce runoff pollution. The use of streams and constructed ponds to create water hazards can warm water enough to destroy aquatic habitats. Poorly designed golf courses can disrupt and degrade **wetlands**, **floodplains**, riparian areas, and forests that contribute to surface water quality.

Of additional concern is the intensive use of chemicals that are required to maintain the green turfgrass. Golf courses have the potential to deliver these pollutants to surface waters.

Following are some recommendations for designing and maintaining a golf course:

Poorly designed and managed golf courses can degrade surface water quality and produce runoff pollution. Some recommendations for designing and maintaining golf courses include designing courses around sensitive areas, maintain a **buffer** around surface waters, and use of low phosphate fertilizers.

- Do not locate greens in sensitive forest, wetland or riparian areas. Design the course around these areas, incorporating the natural areas into the design.
- Retain shade over streams and ponds wherever possible.
- Maintain 100-foot **buffers** to surface water bodies, including **wetlands**. **Buffers** are not mowed and contain native plants, trees, and shrubs. This protects water quality and provides beautiful natural landscapes and wildlife habitat, making the course more attractive and interesting.
- Use slow-release chemicals and low phosphate fertilizers. Do not apply chemicals within riparian **buffers**.
- Do not apply chemicals before a heavy rain.
- Participate in existing programs such as Michigan State University's **groundwater** stewardship program, which assists courses in safe, economical use of chemicals.

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http://www.nrcs.usda.gov
United States Department of Agriculture - Natural Resource Conservation Service
Conservation reserve programs and cost-share conservation for agriculture.

http://ic.net/~wildones/michigan
Wild Ones
Information about landscaping

http://www.epa.gov/glnpo/greenacres/toolkit
Environmental Protection Agency
Natural landscaping for public officials.

http://www.wmeac.org
West Michigan Environmental Action Council

http://www.macd.org/macdsdir.html
Michigan Conservation Districts
Directory of Michigan's Conservation Districts

http://www.mda.state.mi.us/environm/groundwater/local/farm/index.html
Farm*A*Syst

http://www.sarep.ucdavis.edu/concept.htm
University of California
Sustainable Agriculture Research and Education Program

http://www.naturenearby.org
Land Conservancy of West Michigan

http://www.raingardens.org
West Michigan Environmental Action Council and the City of Grand Rapids
Information about raingardens

Part 4: Model Ordinance and Management Tools

4.1 Integration with the Master Plan

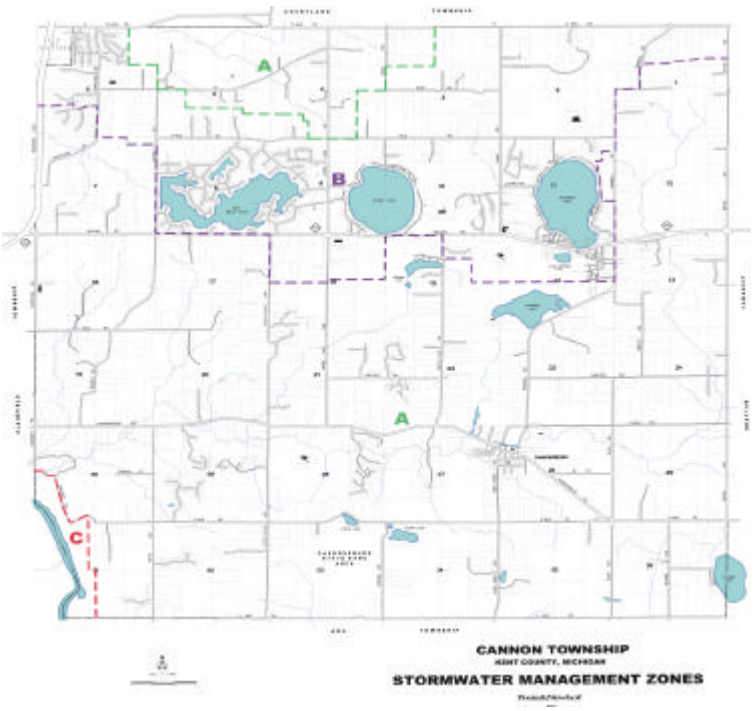
Each unit of government should have a **Stormwater ``**. The plan must anticipate and integrate with upstream and downstream development and cross political boundaries so that the whole system works as a watershed district. The following is a list of suggested steps to develop a **stormwater master plan**:

- Identify the existing drainage patterns in your city/township and delineate the watershed boundaries including the existing **wetlands**. These can be identified using USGS topographic maps and wetland inventory maps.

- Achieve and/or maintain quality waters by defining three different stormwater management zones:

A) Zone A – to preserve the natural conditions of the water resource. Characteristics of Zone A include less than 10% imperviousness and waters that meet high quality standards.

B) Zone B – to control the peak rate of run-off to prevent further destabilizing of the stream hydrology. Generally the lands in Zone B have from 10% to 25% imperviousness. The criteria used in Zone A would be encouraged for use in Zone B as well in order to gain improvement in water quality.



Cannon Township mapped out the stormwater management zones for their area. To determine these zones the percent imperviousness and drainage patterns were identified.

C) Zone C – (1) for use in highly urbanized areas, (2) areas where there has been significant modification of drainage ways or, (3) areas located in such proximity to water bodies that detention of stormwater runoff would be generally detrimental to such water bodies. The amount of impervious surface area in Zone C is generally greater than 25%. Use of Zone A criteria are encouraged in Zone C when possible to achieve greater water quality improvements. The zones are further elaborated in Article 8 of the model ordinance. Different management strategies are associated with each zone.

- Delineate the 100-year **floodplain** in each watershed through hydraulic analysis.

- Conduct an analysis of each watershed. Determine flow rates for the 100-year 24-hour storm at each existing road crossing. Identify problem areas and determine for each watershed the

management practice to be used (i.e. **regional detention**, onsite detention, or conveyance). Include in the analysis the sizing of culverts, the best location for detention and where conveyance is important. The analysis will pinpoint problematic areas. Useful data for this kind of analysis can be found in "A Road/Stream Crossing Inventory in Kent County, Michigan" which was conducted for the Kent County Road Commission by the Annis Water Resources Institute in June 1997. To request a copy of this inventory please call (616) 895-3749.

- Make recommendations to correct any existing watershed problems based on the analysis. A table can be developed for each watershed showing preliminary **detention basin** sizes, culvert sizes, corrective action for proper conveyance, and the management strategy used. Once a detailed description of work items is completed for each district, construction cost can be estimated. After the construction hard cost is known, 30% should be added for soft cost that reflects engineering, legal, administrative, easement acquisition and contingencies.

- Begin scheduling problem areas for detailed study and repair. This will require a financial commitment from the units of government.

It is strongly recommended that each unit of government adopt their own **Stormwater Master Plan** addressing the issues of water quantity and quality. Many of the more rural townships with less infrastructure will not need plans as sophisticated as those for more urbanized areas. Much of the cost of the stormwater systems in private developments will be borne by the developers and not by the unit of government. The **Stormwater Master Plan** should be updated every five years.

Each township and city has a Comprehensive Plan, often referred to as a **Master Plan**, that is a guide to how that governmental unit wishes to grow and develop. It is common for these plans to include ideas concerning types of land use, but dealing with stormwater is often not included. A **Stormwater Master Plan** creates the opportunity to reduce the frequency of flooding and improve the quality of runoff reaching surface waters. The **Stormwater Master Plan** should be referenced in the Comprehensive Plan and should correlate with the objectives therein. Comprehensive Plans also should reflect the various zones as determined in the governmental unit based on the three zones found in Section 8.01 of the model ordinance.

4.2 Case Studies

Importance of Stormwater Ordinances

The quality of surface waters in Kent County is at risk due to changes in land use. The Grand Rapids metropolitan area is one of the fastest growing areas in Michigan with the population projected to exceed 700,000 by 2015, a thirty percent increase since 1980. Twenty-seven percent of the land in Kent County is expected to be transformed from forest and agricultural uses to residential use between 1990 and 2020.

Of significant concern is the effect that these land use changes will have on **stormwater runoff** volumes. Increasing impervious surface in the form of new roads, rooftops, and parking lots generates greater volumes of **stormwater runoff**. The Model Stormwater Ordinance for Kent County Townships and Municipalities is intended to help Kent County respond to the environmental challenges created by increased **stormwater runoff** associated with growth. The Kent County Stormwater Task Force hopes that an informed public and concerned local governments can make stormwater decisions that will support healthier waterways and a higher quality of life.

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Blakeslee Creek

Blakeslee Creek is one example of the state of many creeks in Kent County as a result of **stormwater runoff**. Through adoption of the Stormwater Model Ordinance, many of these situations can be corrected.

Blakeslee Creek is a tributary of the Rogue River and is located in the City of Rockford. The creek is experiencing severe erosion that is caused by increased runoff volumes and velocities due to development in the watershed. Forty-seven acres of forests and fields located in the middle of the 206-acre watershed have changed to a single-family residential subdivision in the past few years.

Blakeslee Creek is one example of the state of many creeks in Kent County as a result of **stormwater runoff**. The creek is experiencing severe erosion that is caused by increased runoff volumes and velocities due to development in the watershed.

Sediment, both from eroding streambanks and poor soil protection practices during construction, has filled three impoundments behind the **weirs** on the creek and now enters the Rogue River unchecked. Portions of the creek have **downcut** and no longer have an active **floodplain** to help reduce peak flood flows. A bridge near the mouth was overtopped by floodwaters in the spring of 2000, possibly for the first time. Continued downcutting of the creek will eliminate the braided channel network within the wetland located in the lower third of the watershed, resulting in the loss of wetland and further increasing streambank erosion below the wetland.

Except for the poor soil erosion practices during construction, the developer appears to have complied with the stormwater regulations, namely the requirement to release runoff from a 25-year storm at a maximum rate of 0.13 cubic feet per second per acre. The erosion problems are presumably caused by increases in the channel-forming flows, typically flows that reoccur every one to two years.

A Blakeslee Creek Restoration Project is being proposed to address these issues. The project goals are to restore the ecological value and physical functionality of the creek, reduce the impacts of existing and anticipated development, and educate stakeholders and engineers about methods to decrease the impacts associated with development. This impairment may have been avoided by applying Zone A criteria to the Blakeslee Creek Watershed.

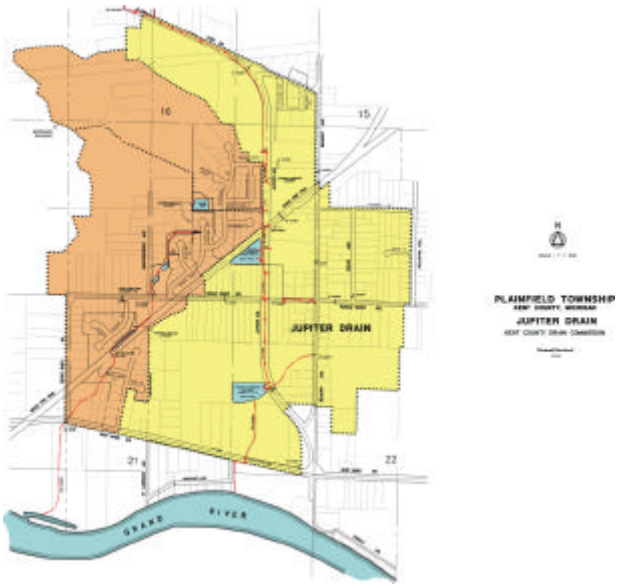
Adoption of a Stormwater Ordinance

Several townships have already begun working on stormwater ordinances. Plainfield Township has adopted an ordinance, Cannon Township has a special committee working on one, and Alpine Township is looking forward to an adoption of the ordinance.

Plainfield Township
Plainfield Township was experiencing drainage problems along the Jupiter Drain and wanted a way to assess the property owners to pay for stormwater management. They had adopted a policy statement, but discovered this did not have the enforcement provisions that were needed. Because they were eager to have an ordinance in place, they used the Kent County model ordinance at its draft stage and their attorney revised it to meet their own needs. In turn, the Ordinance Subcommittee of the Kent County Task Force has used the adopted Plainfield ordinance to further refine the model ordinance.

Plainfield's ordinance, adopted in November 2000, contains language not found in the model ordinance. Their intention was to deal with an immediate problem of flooding in a certain area, so many of the regulations addressed those issues.

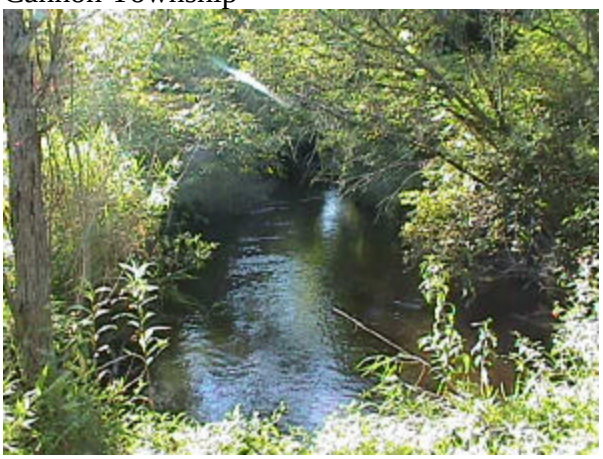
Since the Plainfield stormwater ordinance was adopted, it has been used in one development, Country Club Village. This area was determined to be "Zone A," so a 0.05 cfs/acre release rate for a 2-year event was required. The only change the developer had to make in order to achieve the more stringent criterion was to raise a berm by a foot. This demonstrates that in some cases developers will be able to comply with the new regulations without an exorbitant increase in development costs.



Plainfield Township was experiencing drainage problems along the Jupiter Drain. Plainfield adopted a stormwater ordinance as a way to deal with the immediate problem of flooding in this area.

After the County completes the work on the model ordinance, it is Plainfield's intention to look again at the model and compare it with what they have adopted. They may amend their ordinance to mimic the County's more closely. Their zones will most likely evolve from their stormwater management plan, which is already in place -- a result of a study by their engineering firm.

Cannon Township



Cannon Township began looking at a stormwater ordinance in May of 1998 when a committee was formed to continue with efforts begun with the Bear Creek Project.

Cannon Township began looking at a stormwater ordinance in May of 1998 when a committee was formed to continue with the efforts begun with the Bear Creek Project. The committee spent many months doing research on the **Best Management Practices** related to stormwater control.

In order to gain more information, representatives from this committee began attending the County Task Force meetings. The Township committee would then look at the progress of the model ordinance and provide feedback to the County committee.

Cannon Township made the decision to wait until the County model is finished before revising it for their own needs and then sending it to the Township Board for adoption. In the meantime, lessons learned from their research have led to input on a recently adopted zoning ordinance to address private road issues.

Alpine Township

Alpine Township is looking forward to the completion of the model ordinance because they intend to adopt it, possibly with some variations. Motivation for adopting this ordinance is that drainage in urbanizing areas is causing flooding, and the township is also facing the **NPDES Phase II regulations**. These regulations will require Alpine to have permits and reduce **nonpoint source pollutants** and streambank erosion. Alpine Township is fortunate, in that they have been using a GIS system for several years. The system provides considerable background information about land surfaces, giving township officials a better understanding how various land use types impact water quality.

Alpine Township's motivation for adopting the model ordinance is that drainage in urbanizing areas is causing flooding, and the township is also facing the **NPDES Phase II** regulations.

4.3 Supporting Management Tools

The Model Ordinance not only contains the legal mechanisms with which the Township/Municipality can better manage development and the resulting impacts from stormwater, but also includes more technical management tools specifically geared towards the developers' design engineers and the Township/Municipality review engineers. These tools provide the basis for onsite stormwater design and control, including determination of stormwater detention volume, detailed criteria for determining which control measures should be used, baseline rainfall curve data, a checklist for stormwater plan review, and an atlas containing various sets of useful information.

Stormwater Detention Volume

An appropriate stormwater detention volume requirement must consider both the environmental impact and the social and economic impacts caused by the increases of runoff from urbanized areas. These impacts can be quite different for different watersheds and for different areas within a watershed. Therefore, a single standard is inappropriate for every watershed or for an entire watershed area. A detailed comprehensive watershed analysis is needed for establishing appropriate standards for various stormwater detention zones. However, comprehensive watershed analysis with sufficient detail for establishing stormwater detention zones can be costly and may not be immediately available for a community wanting to establish stormwater management controls. In the interim, a community can adopt general standards based on the following general considerations. Where two or more communities are part of a watershed, these communities need to concur in establishing the appropriate standard for that watershed.

Mitigating Flow Impacts on Natural Streams

Recent research has suggested that **discharge** and storage design parameters are needed for urbanizing areas to protect natural creeks and streams of a watershed from accelerated channel erosion. As a result of the research, the Stormwater Task Force recommended that the **discharge** rate should be limited to about 0.05 cubic feet per second per acre for runoff from storms up to the 2-year storm and 0.13 cubic feet per second per acre for larger runoff volumes. The total detention storage should be designed to hold the runoff volume from the 25-year design storm. The runoff volume or flood volume from a 25-year design storm is about two-thirds the volume of a 100 year design storm. The difference in runoff volumes between the 25-year and 100-year design storms coming from an urbanized area is about the same as the flood volumes expected had the area remained in its natural condition. Therefore, if the more frequent runoff flows (less than 10-year events) have been sufficiently controlled to maintain stream bank stability, detention storage for the 25-year design storm is considered adequate for protecting the natural environment and structures from the effects of peak flows coming from urbanized areas.

Mitigating Flooding Impacts

It is also necessary to evaluate the potential for serious downstream flooding problems when determining the appropriate detention volume. The assumption when using the standard of a 25-year-design storm detention volume is that the urbanizing site is discharging into a natural, open channel system with an available floodway and **floodplain** capable of conveying the floodwaters with minimal risk to life or property when the rain event exceeds the design storm. Piped drainage systems can usually convey the runoff from between a 5-year and a 10-year design

storm. When the capacities of these piped systems are exceeded, surface flooding occurs. Often, once an open drainage system is enclosed in a pipe, no one is aware that the **floodplain** still exists, resulting in encroachments and obstructions of the floodways. This may not be a serious problem for a watershed with a relatively flat terrain where the floodwaters can disperse over large shallow areas, because flood depths remain less than a foot deep and overland flows are slow moving. Yet, in a watershed with significant elevation differences, the floodwaters concentrate into small areas, at much greater depths, and can develop into rapidly flowing masses of water. Watersheds of this nature will need a much higher standard for the detention volume to mitigate the increased flood volumes and velocities coming from an urbanizing area.

The common expectation for an urbanized community is for it to provide drainage facilities and construction standards that will avoid serious property damage from rain events up to the 100-year rain. Courts have held urbanized communities accountable for what is called a "Trespass Nuisance" when flooding occurs during a more frequent rain event. Therefore, some communities have adopted a 100-year detention storage requirement.

When drainage system capacities are exceeded, surface flooding occurs.

When Peak Flow Mitigation May Not Be Needed

There are watersheds or areas within watersheds where property damage caused by downstream flooding is not a serious problem. Applying the higher 100-year detention standard to those areas places an unneeded economic burden upon property owners. It would be better to require a lower detention storage standard and invest those resources and efforts towards insuring improved water quality from the site's **stormwater runoff** and maintaining the stability of the stream channel.

There are also tributary areas within the watershed of larger rivers that may not be adversely affected by higher peak **discharges**. These areas are found at the lower end of the tributary's watershed. In this portion of the watershed, the flow channel may have sufficient capacity and stability to convey the peak flows from the immediately adjacent areas before the peak flows from the upper regions reach the lower portion of the watershed. It is possible that detention in these lower tributary areas could actually cause an adverse impact on flood levels. The detention could cause the **discharge** from these areas to occur concurrently with the peak flows from the upper regions, which would further increase the peak flow in the lower portion of the tributary. The water resource that the tributary flows to would be large enough that the changes in peak flow timing would not be noticeable. Treatment of the runoff to control water quality is still required.

Establishing a Detention Standard

A comprehensive analysis of each watershed should be done to assign appropriate detention standards to different zones within your community's watersheds.

The following guidance can be used both for establishing an interim community wide standard and for establishing appropriate detention standards in the various watershed zones once a comprehensive watershed analysis has been completed. Although, a community can adopt a community-wide standard using this guidance, it is strongly recommended that these communities conduct comprehensive analysis of each of their watersheds to assign appropriate standards to the different zones within their community's watersheds.

It is also recommended that, when adopting a community-wide standard, an administrative review process be established to consider site-specific conditions that may merit modification of the standard. The granting of a modification should be based on engineering analysis and judgment regarding the potential downstream impacts to justify amending the requirement. Again, the following guidance can be used to evaluate the merits of the requested modification. Economic hardship to an involved party should not be a consideration for amending the detention requirement. Downstream communities that may be affected by a proposed amendment should be notified and given the opportunity to object to the proposed change.

Evaluation Guidance

The 25-year stormwater detention storage volume should be considered when:

- The drainage system serving the watershed is predominately (70% or more of its conveyance length) naturally occurring creeks and streams,
- the **floodplain** and floodways are preserved and available to convey the runoff from the less frequent rain events, or the watershed area has a relatively flat terrain, and
- there are no known downstream flooding problems affected by the runoff from the area under consideration.

The 100-year stormwater detention storage volume should be considered when:

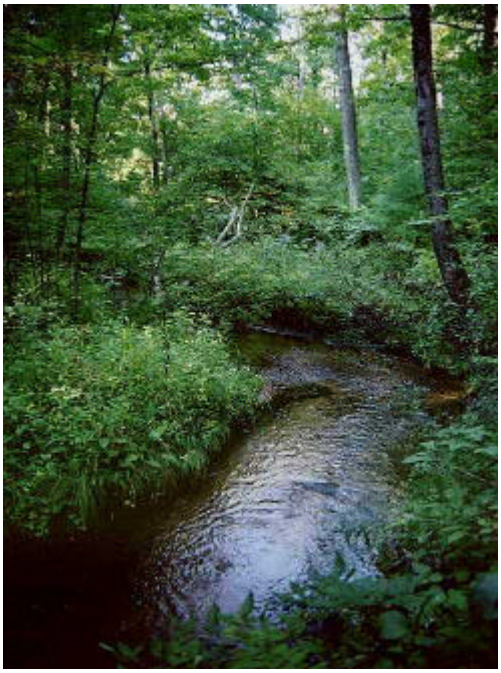
- A significant portion (30% or more of its conveyance length) of the drainage system serving the watershed is enclosed in a piped system,
- the **floodplain** and floodways are not available to convey the runoff from the less frequent rain events, or the terrain of the watershed area is sloping (sloping threshold of 10%),
- there are no identified alternative floodways capable of conveying the excess runoff from the less frequent rain events, and
- there are no acceptable alternatives for mitigating any known downstream flooding problem.

Stormwater detention may not need to be required when:

- An area **discharges** into the lower end of a watershed where it would not be significantly impacted by higher peak **discharges** coming from that area, and
- the area is relatively flat whereby increased flooding within the area remains shallow, and where the potential risk to life or property would be minimal.

Design Standards

To assist the design and review engineers in determining specific stormwater management strategies, a matrix has been developed showing the different zones and criteria (Section 8.02 in the model ordinance). The criteria matrix items are to be applied at the watershed or stream/creek and lake scale. Those outcomes include water quality control, bank erosion control, and flood control. Within each zone, different measures or **Best Management Practices** are described. The design and review engineers will use this information when implementing specific plans for residential, commercial, industrial, or other types of development. These are minimum standards designed to protect water bodies from degradation because of changing land use. Additional effort will be required to improve water resources in areas where they have been degraded and to maintain particularly high quality waters. Higher standards should be followed whenever possible.



Outcomes of the design standards include water quality control, bank erosion control, and flood control. These are minimum standards designed to protect water bodies from degradation because of changing land use.

Appendix G shows the criteria used to determine each zone. A more detailed description of each follows:

- Receiving Water Resource Characteristics **(**see the Stormwater Atlas for the following mapped resources: "Project Area", "Watersheds And Hydrography")

Characteristics and capacities of receiving rivers, lakes, and streams are important because the information helps one determine the type and design criteria needed for **Best Management Practices** to protect our water resources from any land use change.

River and stream characteristics fall into two categories and include:

Hydraulic

- soil types
- vegetation
- **floodplain** extent
- hydraulic capacity of any artificial structures
- channel **plan form**, dimensions, and profile
- active erosion sites

Biological

- type of fisheries
- aquatic habitat
- temperature
- designated use

The presence of certain soils, the lack of vegetation, or the loss of **floodplain** increases the likelihood of erosion if flows are increased. The presence of multiple active erosion sites can indicate that the stream morphology is already unstable and further increases in flow will accelerate the erosion.

The interaction of the hydraulic characteristics determines how well a river or stream conveys stormwater and how susceptible it is to changes in the hydrology of the watershed. The presence of certain soils, the lack of vegetation, or the loss of **floodplain** increases the likelihood of erosion if flows are increased. The presence of artificial structures, such as culverts, may restrict flows, locally increasing water depth but providing some storage if their hydraulic capacity is exceeded. Other hardened structures, such as walls and riprap, efficiently transmit energy downstream, increasing erosive stresses. The river or stream's morphology - its **plan form**, dimensions, and profile - develops in response to flood flows. Relatively modest flows, because of their higher frequency, have more effect on stream channel morphology than extreme flood flows. Flows with a one-to-two-year recurrence interval are generally the dominant channel-forming flows in stable streams. Hydrologic changes that increase these flows can cause the stream to become unstable. The presence of multiple active erosion sites can indicate that the stream morphology is already unstable and further increases in flow will accelerate the erosion.

If the hydraulic characteristics are not in balance they affect the biological characteristics of the river or stream. For example, if erosion is accelerated, increased sedimentation of the stream or riverbed occurs, impairing aquatic habitat for both fish and aquatic insects (fish food source). Sediment and runoff from hard surfaces on the land can increase the temperature of the water, changing it from a coldwater stream/river and fishery to a warmwater stream/river and fishery.

Stonefly Nymph

Lake characteristics fall into three categories and include:

Watershed

- hydrology
- soil types
- land cover
- geology
- active erosion sites
- nutrient loading

Biological

- trophic status
- aquatic habitat
- food web
- type of fisheries

Physical/Chemical

- size (surface area)
- volume
- depth (mean, maximum)
- hydraulic retention
- temperature
- clarity
- **nutrients** (total phosphates, total **nitrogen**)
- **dissolved oxygen**

Stormwater entering a lake from hard surfaces carries pollutants such as nutrients, petroleum, metals, and de-icing salts, and it has an increased water temperature and lower **dissolved oxygen**. **Nutrients**, especially **phosphorus** and **nitrogen**, are the leading cause of **eutrophication** in lakes.

Large areas of urban development result in less ground available to absorb rainwater and more opportunity for pollutants to be carried across land and into lakes. When rain seeps into the soil, it carries pollutants with it. The rate at which water seeps into the ground is different depending upon the area covered by natural vegetation, the soil temperature, the soil type or the amount of impermeable surface. Stormwater entering a lake from hard surfaces carries pollutants such as **nutrients**, petroleum, metals, and de-icing salts, and it has an increased water temperature, and lower **dissolved oxygen**. **Nutrients**, especially **phosphorus** and **nitrogen**, are the leading cause of **eutrophication**. A change in lake water temperature affects the growth of plants, the

release of **nutrients**, the amount of oxygen that can be dissolved in water, and the mixing of layers of water in the lake. **Dissolved oxygen** (DO) is the oxygen dissolved in water; a minimum level is necessary to sustain fish populations. Coldwater fish such as trout require more DO than warmwater species such as bass and perch. When DO falls below the minimum for the type of fish species, fish kills can result.

This information is important in determining which **Best Management Practices** are needed to maintain the stability of the river, lake, stream, or wetland. For example, it will help determine if detention is needed and, if so, the type, size, and release rate. Knowing the water resource characteristics and capacities is critical to local decision-makers in making wise land use decisions that protect the value of their water resources.

- Designated Trout Stream Status (See the Stormwater Atlas for the following mapped resources: "Designated Trout Streams")

Designated trout streams depend on cold, high quality **groundwater**, cobble and gravel streambeds, and shade to minimize stream temperatures. Watersheds that support high quality trout streams typically have little surface runoff.

The Michigan Department of Natural Resources (DNR) classifies Michigan streams as either coldwater or warmwater fisheries. This classification is based on the temperature of the water and the corresponding type of fish. The Michigan DNR, through Director's Order, NO FO –210.01, has identified certain coldwater streams as designated trout streams for the State of Michigan.

Designated trout streams depend on cold, high quality **groundwater**, cobble and gravel streambeds, and shade to minimize stream temperatures. Watersheds that support high quality trout streams typically have little surface runoff. Land use changes, such as development projects, that increase runoff volume cause a corresponding decrease in **infiltration** to **groundwater**. This can result in a reduction in **groundwater** flow to the stream (**base flow**) and a higher stream temperature. Further, the increased runoff typically increases the stream's peak flow, velocities, and volume during rain events contributing to accelerated stream bank erosion. This can result in sediment smothering fish eggs, clogging fish gills, destroying the fish food source, and reducing the amount of available oxygen in the water, as well as destroying the stream's natural "**riffle** and **pool**" pattern. The runoff also usually carries **nutrients** and other pollutants with it, which can contribute to the increase of weeds and algae as well as reduce oxygen levels in streams. The increased runoff also adds warmer water to the stream as it has flowed over impervious surfaces such as pavement and roofs. All this can damage habitat such that the stream no longer supports a trout fishery.

- Status under the Natural Rivers Act of 1970 (See the Stormwater Atlas for the following mapped resources: "Natural Rivers Act Tributaries")

The Natural Rivers Act of 1970 has allowed the state to encourage and enforce protection techniques that will help preserve riparian habitat, water quality, and scenic values of any stream designated as a "Natural River". The "Natural River District" or "**buffer**" is a strip of land 300 feet wide on each side of and parallel to the river and its specified tributaries. The **buffer** is used

to establish a definable area, within which certain types of developments and uses are controlled, so that a river's many natural values are protected and maintained.

- Impervious Surfaces (See the Stormwater Atlas for the following mapped resources: "Satellite Image of Kent County", "Impervious Surface Assessment", "Impervious Surface Assessment By Watershed", Impervious Surface Assessment Statistics")

From a water resources perspective, "imperviousness" is one of the most critical physical qualities of a watershed. Impervious surfaces (building rooftops, concrete and asphalt roads, parking lots, patios and sidewalks) within a watershed decrease the amount of land surface area capable of infiltrating **stormwater runoff**. As a result of increased imperviousness, runoff during a rain event will increase in volume and frequency of flows. Also, the velocity of the water moving through the hydrologic system increases. These factors together can cause flooding, accelerated erosion, and reduced **groundwater recharge**. Water quality is also impacted by the introduction of various pollutants washing off impervious surfaces. Water temperature of the receiving stream tends to increase as runoff flows over heated impervious surfaces. As a result, the ecological integrity of the receiving stream is affected.

Impervious surfaces within a watershed decrease the amount of land surface area capable of infiltrating **stormwater runoff**. As a result of increased imperviousness, runoff during a rain event will increase in volume and frequency of flows.

- Existing Land Use/Cover (See the Stormwater Atlas for the following mapped resources: "Land Use/Cover Conditions")

Land use has a major impact on a watershed. Land use determines the amount of impervious surfaces in a watershed, which in turn strongly influences stream hydrology and water quality. Land cover, represented by pervious areas such as vegetation and bare soil, is also impacted by changes in the landscape. Land use also affects the types and amounts of pollutants that are present in runoff from both pervious and impervious areas.

Ideally, future land use changes should have minimal impact on the stormwater management goals for an area, as the appropriate level of stormwater management should be based on existing or desired characteristics of the watershed and the receiving water resources. If a water resource requires high levels of protection, such as **infiltration** of stormwater, then such measures should be implemented, whether the surrounding watershed will be a shopping mall or a low density residential area in the future.

- Location of the Development within the Watershed

Detention basins located near the outlet of watersheds (within approximately the lower 1/3 of the watershed) can result in a higher total peak flow from the drainage area by slowing the

release of water until it coincides with the peak flow from the upper watershed. A direct release of runoff from the portion of the watershed that is in close proximity to a river or lake can help prevent flooding in the downstream drainage system. Water quality protection measures such as sedimentation control should still be implemented. The capacity of the stormwater conveyance system in the area also must be considered before a direct release without detention is approved. "No detention" areas should be determined based on an overall stormwater management plan for the watershed.

- Existing Stormwater Infrastructure (See the Stormwater Atlas for the following mapped resources: "Kent County Designated Drains")

The status of existing infrastructure is an important factor in establishing a plan. To identify existing infrastructure, verify the location and type of culvert and upstream and downstream culvert size.

The status of existing infrastructure is an important factor in establishing a plan. To identify existing infrastructure, verify the location and type of culvert and upstream and downstream culvert size. An analysis should be performed to compare the existing culvert flow condition and the impact of additional **discharge**. If a storm a sewer exists adjacent to the proposed site, an analysis should be performed to determine if additional flow can be added to the existing storm sewer system prior to requesting permission from the owner to utilize the system.

- Soil Characteristics (See the Stormwater Atlas for the following mapped resources: "Natural Runoff Potential", "Natural Erosion Potential", "Topographic Slope", "Natural **Wetlands** Inventory", "Hydric Soils")

Another criterion that was included in determining stormwater management zones is soil characteristics. Soils vary widely throughout Kent County. Therefore, it is important to know how the different characteristics and properties of the soils would influence the selection of the stormwater management strategy for a specific development or watershed. Among the soil characteristics that are most important relative to this concern are natural drainage, soil type or texture, soil structure, soil color and soil permeability.

All soils have been classified within two major classification systems. The first classification system groups the soils based on their ability to drain. There are four drainage classes in which soils are defined according to height of the water table during the wettest time of the year and the duration of saturation at that level. The four groups are well drained, moderately well drained, somewhat poorly drained, and poorly drained.

The other major classification system groups the soils in accordance with the soil **infiltration** and transmission rates. The **infiltration** rate is the rate at which the water enters the soil at the surface and is controlled by surface conditions. The transmission rate is the rate at which water moves through the soil and is controlled by the soil layers. In general, the higher the rate of **infiltration** and transmission through the soil, the smaller the volume of runoff. All soils have been assigned to one of four Hydrologic Soils Groups:

Group A (low runoff potential): These soils exhibit high **infiltration** and transmission rates and low runoff volume. They are chiefly deep, well drained sands or gravel.

Group B: These soils display moderate **infiltration** and transmission rates and runoff volume. They are moderately to well-drained soils, generally moderate in depth, and moderately fine to moderately coarse in texture, including sandy loam, loam, silt loam, and silt.

Group C: These soils have slow **infiltration** and transmission rates and high runoff volume when wet. They are distinguished by a layer that impedes downward movement of water and are moderately fine to finely textured. This group includes clay loam.

Group D (high runoff potential): These soils have the slowest infiltration and transmission rates and the highest runoff potential. They are chiefly clay soils with a high swelling potential or have a high and permanent water table. Other characteristics may include a **claypan** at or near the surface and shallow soils over nearly impervious material.

Additional Design and Performance Standards for Stormwater Runoff Facilities

Additional design and performance standards are put together in a resolution in the back of the model ordinance. There are three sections in the resolution which cover the topics of lot drainage, stormwater management zones, and flood plain protection in great detail. A resolution was created because these standards are prone to change. If these standards need to be refined, they can easily be amended in a resolution rather than amending the entire model ordinance. Adopting both the model ordinance and resolution will strengthen stormwater management in your community.

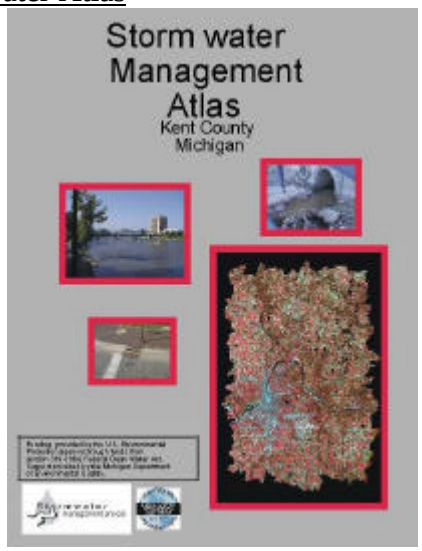
Rainfall Curve Data

Rainfall data are used in the determination of how much runoff will result from a particular development. The amount of rainfall has been tracked historically in the Western Michigan region, allowing statistical models of recurring storm events to be graphed and labeled according to intensity, duration, and occurrence (Appendix H). Different rainfall volumes from various recurrence intervals are used in stormwater management according to the design criteria.

Checklist For Stormwater Plan Review

The checklist provides the potential developer as well as the Township/Municipality with detailed standards that must be shown on any plan submitted for site or stormwater management approval (Appendix I). Calculations required for the review engineer to evaluate the stormwater management design are also listed.

Stormwater Atlas



The Stormwater Management Atlas developed by the Grand Valley State University Annis Water Resources Institute contains many tools for the design or review engineer. These include the present locations and percentages of impervious surfaces, present land uses, along with many other map products.

The Grand Valley State University Annis Water Resources Institute has provided the Stormwater Management Atlas. The atlas contains many tools for the design or review engineer. These include the present locations and percentages of impervious surfaces, present land uses, and outlines of watersheds in Kent County. A copy of the entire atlas is available upon request from the Annis Water Resources Institute of Grand Valley State University. To request an atlas call (616) 895-3749.

The Stormwater Management Atlas was developed to include map products that will be useful during the development of the various stormwater management zones (A, B, C). The Atlas incorporates a number of the factors that are outlined in the detailed criteria in Appendix F. The atlas provides for example, information on which streams in the county are protected under the Natural Rivers Act of 1970 or where hydric (wetland) soils are located in the County.

The atlas also shows 210 watershed boundaries within Kent County. The watersheds average about five square miles with a minimum size of 0.35 square miles to a maximum of ten square miles. These watersheds would make ideal areas in which to develop the stormwater management zones.

A major focus of the atlas is the assessment of impervious surfaces within Kent County. Each of the 210 watersheds that have been delineated has been given a percent-impervious value that will allow the user to assess just what impervious threshold has been reached (i.e. less than 10%, 10 to 25% or greater than 25%).

Other components of the Atlas allow the user to locate areas that are susceptible to sheet and rill erosion or to identify areas that generate high amounts of surface runoff based on soil types.

Part 5: Support Materials

5.1 Hydrologic Studies

Buck and Plaster Creek Stormwater Management Master Plan. January 1991. Camp Dresser & McKee. The Kent County Drain Commissioner's Office contracted to have a study and stormwater management plan done to address flooding issues in Buck and Plaster Creeks.

Mitchell Creek Hydrologic Investigation, Incorporating Both Water Quantity and Quality Considerations In Urbanizing Watersheds. September 1991. Jerry Fulcher, Michigan Department of Natural Resources.
http://www.deq.state.mi.us/lwm/water_mgmt/Publications/reports.htm
A hydrologic model of the Mitchell Creek watershed was developed to evaluate the affect potential urbanization would have on peak streamflows. The impact of predicted changes in the channel-forming and flood flows are discussed.

Bear Creek Hydrologic Investigation, Incorporating Both Water Quantity and Quality Considerations In Urbanizing Watersheds. September 1991. Jerry Fulcher, Michigan Department of Natural Resources.
http://www.deq.state.mi.us/lwm/water_mgmt/Publications/reports.htm
A hydrologic model of the Bear Creek watershed was developed to evaluate the effect potential urbanization would have on peak streamflows. The impact of predicted changes in the channel-forming and flood flows are discussed.

Hydrologic Impacts Due To Development, The Need For Adequate Detention and Protection. June 2001. Dave Fongers and Jerry Fulcher, Michigan Department of Environmental Quality.
http://www.deq.state.mi.us/lwm/water_mgmt/Publications/reports.htm
This paper discusses the impact of runoff from an urbanizing watershed on water quality, stream form and flood flows. The use of **Best Management Practices** to offset the impacts is reviewed.

Mitigating the Adverse Impacts of Urbanization on Streams: A Comprehensive Strategy for Local Government. Thomas R. Schueler, Metropolitan Washington Council of Governments, 777 North Capitol Street, N.E. Washington, D.C. 20002-4201.
The paper reviews the major impacts to streams associated with urban land development and the key role of watershed imperviousness in determining the severity of the impacts to the stream hydrology, morphology, water quality and ecology. It also outlines a stream protection strategy for local governments to mitigate the adverse impacts of development.

Applied River Morphology. 1996. Dave Rosgen, Printed Media Companies.
This book discusses how rivers and streams are formed, proposes a classification method, and discusses techniques to restore streams keyed to the classification system.

Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. 1987. Thomas R. Scheuler, Metropolitan Washington Council of Governments, 1875 Eye Street, N.W., Suite 200, Washington D.C. 20006.
This book provides detailed guidance for engineers and site planners on how to plan and design urban **BMPs** to remove pollutants and protect stream habitat. A comparison of the effectiveness of various **first flush** volume requirements is included.

5.2 Internet Resources
Center for Watershed Protection:
http://www.cwp.org

United States Environmental Protections Agency:
http://www.epa.gov/waters

Kent County Drain Commissioner:
http://www.accesskent.com/government/departments/drain_index.htm

The State of Maryland's Stormwater Site:
http://www.mde.state.md.us/environment/wma/stormwatermanual/

Low-Impact Development documents: http://www.epa.gov/owow/nps/urban.html

River Network: http://www.rivernetwork.org

Michigan Nonpoint Source Program: http://www.deq.state.mi.us/swq/nps/npshome.htm

Department Of Environmental Quality, Land & Water Management Division:
http://www.deq.state.mi.us/lwm/

Department Of Environmental Quality, Land & Water Management Division, Nonpoint Program Hydrologic Support: http://www.deq.state.mi.us/lwm/water_mgmt/nps/index.htm

Wildland Hydrology (Dave Rosgen): http://www.wildlandhydrology.com/index.htm

Stormwater Manager's Resource Center (Thomas Schuler): http://www.stormwatercenter.net/

North Carolina Stream Restoration Institute:
http://www5.bae.ncsu.edu/programs/extension/wqg/sri/

Environmental Protection Agencies Watershed Protection Program:
http://www.epa.gov/owow/watershed/

USDA Stream Corridor Restoration: http://www.usda.gov/stream_restoration/

Grand Valley State University, Annis Water Resources Institute: http://www.gvsu.edu/wri/

Stream Stability And Channel Forming Flows:
http://www.deq.state.mi.us/lwm/water_mgmt/nps/NPS_Stability.pdf

Stormwater (a professional trade journal): http://www.forester.net/sw.html

Rogue River Watershed Project http://www.gvsu.edu/wri/isc/rogue/index.htm

Stormwater Project http://www.gvsu.edu/wri/isc/stormwater/index.htm

http://www.raingardens.org Partnership stormwater education project between WMEAC and the City of Grand Rapids Environmental Protective Services

Natural Resource Defense Council http://www.nrcd.org/water/pollution/storm/stoinx.asp "Stormwater Strategies" is a manual which describes and illustrates better site design techniques

5.3 Resource Documents
Technical
A Road/Stream Crossing Inventory in Kent County, Michigan. June 1997. Annis Water Resources Institute. PUB # TM-97-4.

Guidebook of Best Management Practices for Michigan Watersheds. 1992. Michigan Department of Water Quality, Surface Water Quality Division. (Reprinted October 1998.)

Stormwater Management Guidebook. March 1992. Bruce Menerey, Michigan Department of Natural Resources, Land and Water Management Division. (Revised August 1999 and distributed by Department of Environmental Quality, Land and Water Management Division.) http://www.deq.state.mi.us/lwm/water_mgmt/Publications/reports.htm

Floodplain Management for Local Officials, Third Edition. August 1992. George Hosek, Michigan Department of Environmental Quality, Land and Water Management Division. http://www.deq.state.mi.us/lwm/water_mgmt/Publications/reports.htm

Material targeted to government officials and watershed planners, designers, and engineers:
Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds. October 1998. Center for Watershed Protection, Ellicott City, MD for US EPA Office of Wetlands, Oceans, and Watersheds and Region 5.

Better Site Design: A Handbook for Changing Development Rules In Your Community. August 1998. Center for Watershed Protection, Ellicott City, MD.

Preserving Michigan Wetlands: Options for Local Government. 1997. Tip of the Mitt Watershed Council, P.O. Box 300, Conway, MI 49770. tel: (616) 347-1181, fax: (616) 347-5928.

Land Development Checklist For Environmental Concerns. Updated 1/21/98. Environment and Development Committee of the Greater Grand Rapid Home Builders Association, 2021 44th Street SE, Grand Rapids, MI 49508-5009, tel: (616) 281-2021.

A Guide For Land Preservation. 1/30/98 Environment and Development Committee of the Greater Grand Rapids Home Builders Association, 2021 44th Street SE, Grand Rapids, MI 49508-5009, tel: (616) 281-2021.

Material targeted to individuals:
Protecting Inland Lakes: You Can Make A Difference. 1990. John Warbach, M. Wyckoff, K.Williams, Planning and Zoning Center, Lansing, MI for Michigan Department of Natural Resources. (Reprinted May 1999 and distributed by the Department of Environmental Quality)

Lakescaping for Wildlife and Water Quality. 1999. Henderson, Dindorf, Rozumalski. Minnesota Department of Natural Resources, Nongame Wildlife Program – Section of Wildlife, ISBN 0-9647451-2-7.

Living With Michigan's Wetlands: A Landowner's Guide. 1997 Second Printing, Tip of the Mitt Watershed Council, P.O. Box 300, Conway, MI 49770. tel: (616) 347-1181, FX: (616) 347-5928.

Practical Tips for Home and Yard To Improve Water Quality, Michigan Nonpoint Source Program, www.deq.state.mi.us/swq/nps/npshome.htm.

Reducing Polluted Runoff from Institutional Areas. 1990. WMEAC, 1514 Wealthy SE, Suite 280, Grand Rapids, MI 49505 tel: (616) 451-3051.

Homeowners Guide to Reducing Water Pollution. 1990. WMEAC, 1514 Wealthy SE, Suite 280, Grand Rapids, MI 49505 PH: (616) 451-3051.

Home*A*Syst, http://www.mda.state.mi.us/environm/groundwater/local/home/index.html.

Farm *A* Syst, http://www.mda.state.mi.us/environm/groundwater/local/farm/index.html.

Field*A*Syst, http://www.mda.state.mi.us/environm/groundwater/local/field/index.html.

Michigan Turfgrass Environmental Stewardship Program (MTESP). www.msue.msu.edu/stewardship/ tel: (517) 353-0860.

How Does Your Garden Grow, Prince George's County Department of Environmental Resources, tel: (301) 883-5833.

Rain Gardens, The Natural Solution, Prince George's County Department of Environmental Resources, tel: (301) 883-5833.

The Clean Water Act: An Owner's Manual. Elder, Killam, & Koberstein, River Network, Eastern Office: 4000 Albemarle Street, NW #303, Washington, DC 20016. tel: (202) 364-2550 fax: (202) 364-2520 e-mail: rivernet2@aol.com

Glossary

Base flow - the part of the stream flow that is not due to direct runoff from precipitation; it is usually supported by water draining from natural storage in groundwater bodies, lakes or wetlands.

Best Management Practices (BMPs) - structural devices or nonstructural practices that are designed to prevent pollutants from entering into stormwater flows, to direct the flow of stormwater or to treat polluted stormwater flows.

Biodiversity - an assortment of species in a certain location.

Bioretention - a water quality practice that utilizes landscaping and soils to treat urban stormwater runoff by collecting it in shallow depressions, before filtering through soils.

Buffer - an area of trees, shrubs, and other vegetation located in areas adjacent to and upgradient from water bodies.

Claypan - a soil comprised of clay.

Cluster Development - type of development where homes are concentrated in a certain area.

Constructed Wetlands - a designed and manmade complex of saturated substrates, emergent and submergent vegetation, animal life, and water that simulates natural wetlands for human use and benefits.

Designated Uses - recognized uses of water established by state and federal water quality programs.

Detention Basin - temporarily stores water before discharging into a surface water body. Primarily used to reduce flood peaks.

Diffuse - spread out; not concentrated.

Discharge - a release or flow of stormwater or other substance from a conveyance or storage container. It is usually expressed as cubic feet per second (CFS).

Dissolved Oxygen - the amount of gaseous oxygen (0_2) dissolved in an aqueous solution.

Ditch - a long, narrow channel dug into the earth, as for drainage.

Downcut - occurs when the streambed is eroded away. Sediment from the streambed is carried away by the water in the stream channel and the streambed is carved out.

Dry Extended Detention Basin - a dry detention basin that has been modified to increase the time that the stormwater will be detained in the basin. The typical detention time is 24 to 48

hours. Not effective at removing nutrients such as phosphorus and nitrogen, unless a shallow marsh at the outlet is incorporated into the design.

Dry Swale - an open drainage channel or depression, explicitly designed to detain and promote the filtration of stormwater runoff into an underlying soil media.

E. coli (*Escherichia coli*) - bacterium used as an indicator of the presence of waste from humans and other warm-blooded animals.

Extended Detention Wetlands - provide extended detention in addition to settling and biological treatment. The extended detention zone must tolerate saturation, frequent inundation and fluctuating water levels.

Eutrophication - the process of enrichment of water bodies by nutrients, which may lead to increased growth of algae or rooted plants. Process can be natural or accelerated by human activity (cultural eutrophication).

Filtering Practices - stormwater treatment methods that utilize an artificial medium to filter out pollutants carried in urban runoff.

First Flush - highly concentrated pollutant loading during the early portion of stormwater runoff, due to the rapid runoff of accumulated pollutants.

Floodplain - the area in a river valley covered with soil deposited by floods.

Grade Controls - automatic controls on an asphalt pavement that compensate for grade variations. A grade control sensor transmits an electronic signal to either thicken or thin out the depth of the asphalt mat.

Grass Channel - broad, mildly sloped channel, with a thick vegetative cover. The flow rate is the principal design criterion for this channel.

Groundwater - water found underground in porous rock strata and soils.

Groundwater Recharge - inflow of water to a groundwater reservoir from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge.

Impervious Cover - a surface through which little or no water will move. Impervious areas include paved parking lots and roof tops.

Infiltration - the penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.

Infiltration Trench - **Conventional Infiltration Trenches** are shallow, excavated trenches that have been backfilled with stone to create underground reservoirs. Stormwater runoff diverted into the trenches gradually exfiltrates from the bottom of the trenches into the subsoil and

eventually into the water table. **Enhanced Infiltration Trenches** have extensive pretreatment systems to remove sediment and oil.

Intermittent - stopping and starting again at intervals; pausing from time to time; periodic.

Master Plan - a comprehensive plan to guide the long-term physical development of a particular area.

Milk Parlor Waste - waste water created by the washing and rinsing of milk utensils and tanks or the washing down of the interior of a milkhouse.

Multi-Chambered Treatment Train - a three-chambered system for cleaning stormwater. The first chamber is a grit chamber to remove the largest particles; the second chamber is for settling and absorption; the third chamber completes the process and consists of a filtration system.

Multiple Pond System - collective term for a cluster of pond designs that incorporate redundant runoff treatment techniques within single ponds.

Nitrogen - a colorless, odorless, gaseous element that constitutes about four fifths of the volume of the atmosphere and is present in combined forms in animal and vegetable tissues, especially in proteins: used chiefly in the manufacture of ammonia, nitric acid, cyanide, explosives, fertilizers, and dyes (as a cooling agent). Also an essential nutrient needed by healthy plants.

Nonpoint Source Pollution - pollution that is not traceable to one particular source and is occurring at locations scattered throughout the drainage basin; typical sources include erosion, agricultural activities and urban runoff.

NPDES Phase II (National Pollution Discharge Elimination System) - part of the U.S. Environmental Protection Agency's stormwater program that is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of stormwater discharges that have the greatest likelihood of causing continued environmental degradation.

Nutrients - Animal, vegetable or mineral substances that sustain individual organisms and ecosystems, or any substance that is assimilated by organisms and promotes growth.

Oil-grit Separator - structure that removes concentrations of petroleum compounds, grease, and grit through gravity or coalescing plates.

Open Channels - also known as swales, grass channels, and biofilters, these systems are used for the conveyance, retention, infiltration and filtration of stormwater runoff.

Open Space - agricultural land, greenbelt, parks, golf courses and other areas in which human structures are minimal or nonexistent.

Organic Filter - a modification of the sand filter in which peat, compost or other organic material is added to the filter. Organic filters can be surface or underground filters.

Organic Matter - dead material coming from living organisms.

Partial Body Contact Recreation - Recreation activities include wading or fishing in which full body immersion is not expected.

Perimeter Sand Filter - a smaller version of the underground sand filter. It is usually placed next to a parking lot or other impervious area. The **first flush** stormwater flows over an inlet into the sedimentation chamber, then into the sand filter. The remainder of the stormwater runoff is directed to a bypass drop inlet.

Phosphorus - a necessary element for bones, nerves, and embryos; its compounds are used in matches and phosphate fertilizers. Also, an essential nutrient needed by healthy plants.

Plan Form - is the shape or pattern of the stream as seen from above.

Point Source - any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Pond/Wetland System - has the deepest water of the stormwater wetland options; the deep pool is usually about half of the treatment volume. This option has less habitat value than the marsh option, but is effective because of the multiple treatment mechanisms (pond and wetland).

Pool - A stretch of slow water in a stream or river that is deep with a sandy bottom.

Porous Pavement - an infiltration system in which stormwater runoff filters into the ground through a permeable layer of pavement or other stabilized permeable surface. These systems can include porous asphalt, porous concrete, modular perforated concrete block, cobble pavers with porous joints or gaps or reinforced/stabilized turf.

Post Development Controls - include erosion and sediment control on construction sites, highways, bridges, households, and onsite sewage disposal systems.

Quantity Control Pond - a low level drain that releases water over a period of time, emulating natural streamflow and allowing removal of nutrients and bacteria by natural processes.

Rain Gardens - use the concept of bioretention, a water quality practice in which plants and soils remove pollutants from stormwater naturally. Rain Gardens are created in low-lying area, with specific layers of soil, sand, and organic mulch. These layers naturally filter the rain as it runs into the Rain Garden. During the next few days after a storm, the soil absorbs and stores the rainwater and nourishes the Garden's grasses, trees, and flowers. Rain Gardens filter and reuse

the water, reducing stormwater pollution, while providing attractive landscaping.

Regional Detention - a system using large basins, publicly owned, that are designed to hold stormwater and release it slowly to avoid channel overflow or drainage system failure.

Resilient - bouncing or springing back into shape.

Retention Basins - basins that capture stormwater and release it slowly through infiltration into the ground.

Riffle - a stretch of faster well oxygenated water in a stream or river that is shallow and runs over rocks or gravel.

Rip Rap - a permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows.

Shallow Marsh - most of the storage is in the high and low marsh areas, with the only deep water sections being the forebay and micropool. This wetland type provides significant habitat value, but is the most space consumptive of the wetland treatment options.

Soil Erosion and Sediment Control Ordinances - a statute or regulation to prevent soil erosion and sedimentation from occurring as a result of nonagricultural development within the city or town. They function by requiring proper provisions for water disposal and the protection of soil surfaces during and after construction.

Stormceptor - a patented stormwater quality treatment device that efficiently removes oil and suspended solids. The Stormceptor is divided into a lower storage/separation chamber and an upper bypass chamber.

Stormwater Master Plan - a plan for reducing the frequency of flooding and improving the quality of runoff reaching surface water bodies; also inventories control facilities and proposes a plan to reduce flooding and prevent pollution.

Stormwater Ponds - land depressions created for the detention or retention of stormwater runoff.

Stormwater Runoff - Surface water movement resulting from a storm event, snow melt runoff, or surface runoff and drainage.

Stormwater Wetlands - shallow, constructed pools that capture stormwater and allow for the growth of characteristic wetland vegetation.

Sub-watershed - smaller drainage area within a watershed or river/stream basin.

Submerged Gravel Wetlands - a filtering BMP that uses gravel based substrate, supporting a wetland vegetation cover crop, to treat urban runoff.

Surface Sand Filter - a system in which runoff flows through a pretreatment chamber, where large particles settle out. It is then treated as it flows through the sand bed, collected in the underdrain and returned to the drainage network or receiving water.

Sustainable - is the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs.

Swale - an elongated depression in the land surface that is at least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales direct stormwater flows into primary drainage channels and allow some of the stormwater to infiltrate into the ground surface.

Total Body Contact Recreation - Recreational activities, including swimming or tubing, in which the full body is immersed in water.

Vertical Sand Filter - a two-chambered line or concrete structure that improves water quality of runoff by providing settling and filtration to the stormwater runoff.

Water Harvesting - the collection and concentration of rainwater and runoff and its productive use for: the irrigation of annual crops, pastures and trees; domestic consumption; livestock consumption; and fish and duck ponds.

Weirs - typically installed in open channels such as streams to determine discharge (flow rate).

Wet Extended Detention Pond - a stormwater treatment structure in which part of the runoff is detained, and the remainder is treated in a permanent pool.

Wetlands - an area that is saturated with water to the surface for a sufficient time to promote the growth of water dependent plants and/or the development of saturated soils.

Wet Pond - a detention basin containing a permanent pool of water that will effectively remove nutrients and other pollutants.

Wet Swale - an open drainage channel or depression, explicitly designed to retain water or intercept groundwater for water quality treatment.

Appendix A

Proposed Model Stormwater Ordinance for Kent County Townships and Municipalities

Proposed Model Storm Water Ordinance
for
Kent County Townships and Municipalities

Prepared by the Kent County Drain Commissioner
Storm Water Management Task Force

July 2001

Stormwater management project

Prepared by the Annis Water Resources Institute of Grand Valley State University as part of the "Developing Administrative Tools And Authority For Stormwater Management In The Grand Rapids Metropolitan Area" project with support from the Michigan Department of Environmental Quality and the Environmental Protection Agency through funds from Section 319 of the Federal Clean Water Act.

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF ENVIRONMENTAL QUALITY

"Better Service for a Better Environment"

HOLLISTER BUILDING, PO BOX 30473, LANSING MI 48909-7973

INTERNET: www.deq.state.mi.us

RUSSELL J. HARDING, Director

REPLY TO:

SURFACE WATER QUALITY DIVISION
KNAPPS CENTRE
PO BOX 30273
LANSING MI 48909-7773

November 26, 2001

Storm Water Task Force
Attn: Nichol Stout
Annis Water Resources Institute
Grand Valley State University
740 West Shoreline Drive
Muskegon, Michigan 49441

Dear Storm Water Task Force:

SUBJECT: Kent County Storm Water Model Ordinance

I would like to thank all the members who participated on the Kent County Storm Water Task Force. I appreciate the wide diversity of participants and your level of effort and diligence in addressing many complex issues relating to storm water management during the development of this model ordinance.

The Department of Environmental Quality (DEQ), Surface Water Quality Division (SWQD), has reviewed the proposed model storm water ordinance in terms of the Phase I and Phase II regulations. The traditional storm water general permit for Phase I and Phase II communities includes as a minimum control measure, a post construction storm water management program for new development and redevelopment projects. This model ordinance appears to be consistent with the requirement to implement ordinances or other regulatory mechanisms to address post construction storm water runoff from new development and redevelopment projects.

In addition, implementation of this ordinance by all the units of government in Kent County will provide a significant level of consistency across the region. This consistency will provide a good basis for storm water master planning on a watershed basis. Storm water master planning is a requirement of both the Phase I and the draft Phase II storm water permits.

The SWQD looks forward to our continuing partnership with the Grand Valley Metro Area stakeholders in addressing the various watershed issues in order to protect and preserve our water resources.

Sincerely,

David A. Hamilton, Chief
Surface Water Quality Division
517-335-4176

cc: Mr. Steve Houtteman, DEQ
Ms. Janice Tompkins, DEQ
Mr. Mark Fife, DEQ
Mr. Dave Drullinger, DEQ

EQP 0100e
(Rev. 1/98)

OFFICE OF THE DRAIN COMMISSIONER

Roger G. Laninga, Drain Commissioner
1500 Scribner NW, Grand Rapids, Michigan 49504-3233
Telephone (616) 336-3688 Fax: (616) 336-3575
Office Hours: 7:30 am - 4:00 pm

January, 2002

To Public Officials and Citizens of Michigan:

I am pleased to present to you this Model Stormwater Ordinance. This ordinance was prepared by the Kent County Drain Commissioner's Task Force, with representation from local, county, and state governments, as well as engineers, attorneys, developers, environmentalists and university researchers.

The technical basis for the ordinance reflects a whole new approach to Stormwater Management, which is on the cutting edge of technology in Michigan. It recognized that one set of criteria cannot be used to address a wide range of conditions, but rather design standards for three different stormwater management zones have been developed. With this in mind, it is important that the ordinance be considered in its entirety and that alterations be kept to a minimum. If your municipality considers adoption with significant changes, we would strongly recommend that you consult with our offices or your engineer to ensure that the effectiveness of the ordinance has not been diminished.

The task force hopes that this model ordinance will assist local governments in preserving our natural environment and assuring a higher quality of life for the people of Michigan.

Sincerely,

Roger G. Laninga

Roger G. Laninga, Chairperson
Kent County Drain Commissioner's
Stormwater Task Force

ACKNOWLEDGEMENTS

Many interested persons contributed their time, efforts and talent toward the preparation of this Model Ordinance. We acknowledge the contributions of all of the members of the Storm Water Management Task Force, and thank them for their efforts toward improved storm water management and regulation among Kent County local governments.

Kent County Drain Commissioner
Roger Laninga (Chair)
Dick Connell
Jeff Gritter
Doug Sporte

Alpine Township
Mark Fleet
Sharon Steffens
Frank Wash

Caledonia Township
John Wallace

Cannon Township
Bonnie Shupe

Center for Environmental Study
Rick Sullivan

City of Grand Rapids Environmental Protection Services Department
Eric DeLong
Randy Lemoine
Corky Overmyer
Chuck Schroeder
John Schaut

City of Walker
Scott Conners

City of Wyoming
Jerry Snyder

Courtland Township
Jerry Lyon

Dykema Excavating
Mike Berg

Earth Tech
Aaron Volkening

Exxel Engineering
Todd Stuive

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Grand Rapids Area Home Builders Association
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Kent County Conservation District
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Kent County Road Commission
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Michigan Department of Environmental Quality
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Plainfield Township
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Prein & Newhof
Dennis Cole
Jim Kirkwood

Timberland R.C. & D.
Cynthia Price

West Michigan Environmental Action Council
Tom Cary
Patricia Pennell
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Legal Issues Subcommittee, Storm Water Management Task Force
Jeffrey S. Ammon, of Miller, Johnson, Snell & Cummiskey
Clifford H. Bloom, of Law, Weathers & Richardson PC
James R. Brown, of Mika, Meyers, Beckett & Jones, PLC
Richard W. Butler, Jr., of Richard W. Butler, Jr. PLC
Jeffrey V.H. Sluggett, of Law, Weathers & Richardson PC
On Monday, July 9, 2001, the Kent County Stormwater Management Task Force recommended unanimously that the proposed Stormwater Ordinance language contained within this document be distributed with appropriate educational materials and support to all Townships and Municipalities in Kent County. In the interest of preserving and protecting our precious water resources, these communities are strongly encouraged to give serious consideration to the adoption of this model ordinance.

PROPOSED MODEL STORM WATER ORDINANCE
FOR
KENT COUNTY TOWNSHIPS AND MUNICIPALITIES

CONTENTS

Page

_____ of _____

COUNTY OF KENT, MICHIGAN

AN ORDINANCE to provide for the regulation and control of storm water runoff; to provide for storm water permits and the procedures and standards for the issuance thereof; to provide for payment or reimbursement of costs and expenses incurred by the **Township/Municipality** associated with storm water permits and the consideration thereof; to establish standards and requirements for the protection of floodways and for the control of soil erosion and sedimentation; to adopt other provisions for the establishing, maintaining and protection of drains and drainageways; to provide regulations for the inspection, sampling and monitoring of storm water and other discharges; to establish performance and design standards for storm water management in specified zones of the **Township/Municipality**; and to provide penalties for violations of the ordinance.

THE _____ OF _____ ORDAINS:

Article I - General

Sec. 1.01 Statutory Authority and Title

[For a General Law Township:]

This ordinance is adopted in accordance with the Township Ordinance Act, as amended, being MCL 41.181, et seq.; the Township and Village Public Improvement Act, as amended, being MCL 41.721, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws.

[For a Charter Township:]

This ordinance is adopted in accordance with the Charter Township Act, as amended, being MCL 42.1, et seq.; the Township and Village Public Improvement Act, as amended, being MCL 41.721, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as

amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws.

[For a Home Rule City:]

This ordinance is adopted in accordance with the Home Rule City Act, as amended, being MCL 117.1, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws.

[For a General Law Village:]

This ordinance is adopted in accordance with the Incorporation of Villages Act, as amended, being MCL 61.1, et seq.; the Township and Village Public Improvement Act, as amended, being MCL 41.721, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401(p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws.

[For a Charter Village:]

This ordinance is adopted in accordance with the Home Rule Village Act, as amended, being MCL 78.1, et seq.; the Township and Village Public Improvement Act, as amended, being MCL 41.721, et seq.; the Drain Code of 1956, as amended, being MCL 280.1, et seq.; the Land Division Act, as amended, being MCL 560.1, et seq.; the Revenue Bond Act, as amended, being MCL 141.101, et seq.; and the Natural Resources and Environmental Protection Act, as amended, being MCL 324.101, et seq.; Section 401 (p) of the Federal Water Pollution Control Act (also known as the Clean Water Act), as amended, being 33 USC 1342(p) and 40 CFR Parts 9, 122, 123 and 124; and other applicable state and federal laws.

This ordinance shall be known and may be cited as the _____ of _____ Storm Water Ordinance.

Sec. 1.02 Findings

The **Township/Municipality** finds that:

(1) Water bodies, roadways, structures, and other property within, and downstream of the **Township/Municipality** are at times subjected to flooding;

(2) Flooding is a danger to the lives and property of the public and is also a danger to the natural resources of the **Township/Municipality** and the region;

(3) Land development alters the hydrologic response of watersheds, resulting in increased storm water runoff rates and volumes, increased flooding, increased stream channel erosion, and increased sediment transport and deposition;

(4) Storm water runoff produced by land development contributes to increased quantities of water-borne pollutants;

(5) Increases of storm water runoff, soil erosion, and non-point source pollution have occurred as a result of land development, and cause deterioration of the water resources of the **Township/Municipality** and downstream municipalities;

(6) Storm water runoff, soil erosion, and non-point source pollution, due to land development within the **Township/Municipality**, have resulted in a deterioration of the water resources of the **Township/Municipality** and downstream municipalities;

(7) Increased storm water runoff rates and volumes, and the sediments and pollutants associated with storm water runoff from future development projects within the **Township/Municipality** will, absent reasonable regulation and control, adversely affect the **Township/Municipality's** water bodies and water resources, and those of downstream municipalities;

(8) Storm water runoff, soil erosion, and non-point source pollution can be controlled and minimized by the regulation of storm water runoff from development;

(9) Adopting the standards, criteria and procedures contained in this ordinance and implementing the same will address many of the deleterious effects of storm water runoff;

(10) Adopting these standards is necessary for the preservation of the public health, safety and welfare.

Sec. 1.03 Purpose

It is the purpose of this ordinance to establish minimum storm water management requirements and controls to accomplish, among others, the following objectives:

(1) To reduce artificially induced flood damage;

(2) To minimize increased storm water runoff rates and volumes from identified new land development;

(3) To minimize the deterioration of existing watercourses, culverts and bridges, and other structures;

(4) To encourage water recharge into the ground where geologically favorable conditions exist;

(5) To prevent an increase in non-point source pollution;

(6) To maintain the integrity of stream channels for their biological functions, as well as for drainage and other purposes;

(7) To minimize the impact of development upon stream bank and streambed stability;

(8) To reduce erosion from development or construction projects;

(9) To preserve and protect water supply facilities and water resources by means of controlling increased flood discharges, stream erosion, and runoff pollution; and,

(10) To reduce storm water runoff rates and volumes, soil erosion, and non-point source pollution, wherever practicable, from lands that were developed without storm water management controls meeting the purposes and standards of this ordinance.

(11) To reduce the adverse impact of changing land use on water bodies and, to that end, this ordinance establishes minimum standards to protect water bodies from degradation resulting from changing land use where there are insufficient storm water management controls.

Sec. 1.04 Applicability, Exemptions and General Provisions

(1) This ordinance shall apply to any development site which requires approval of a plat, a site development plan, building permit, or any other permit for work which will alter storm water drainage characteristics of the development site, provided, however, that this ordinance shall not apply to the following:

(a) The installation or removal of individual mobile homes within a mobile home park. This exemption shall not be construed to apply to the construction, expansion, or modification of a mobile home park.

(b) Farm operations and buildings, except dwellings, directly related to farm operations. This exemption shall not apply to greenhouses and other similar structures.

(c) Plats with preliminary plat approval and other developments with final land use approval prior to the effective date of this ordinance, where such approvals remain in effect.

Sec. 1.05 Definitions

For the purpose of this ordinance, the following words and phrases shall have the meanings respectively ascribed to them by this Section unless the context in which they are used specifically indicates otherwise:

(1) Base Flood – A flood having a one (1) percent chance of being equaled or exceeded in any given year.

(2) Base Flood Elevation – The high water elevation of the Base Flood, commonly referred to as the "100-year flood elevation".

(3) Base Flood Plain – The area inundated by the Base Flood.

(4) Best Management Practices (BMPs) – A practice, or combination of practices and design criteria that comply with the Michigan Department of Environmental Quality's Guidebook of BMPs for Michigan Watersheds, or equivalent practices and design criteria that accomplish the purposes of this ordinance (including, but not limited to minimizing storm water runoff and preventing the discharge of pollutants into storm water) as determined by the **Township/Municipal** Engineer, and, where appropriate, the standards of the Kent County Drain Commissioner.

(5) Building Opening – Any opening of a solid wall such as a window or door, through which floodwaters could penetrate.

(6) Clean Water Act – The Federal Water Pollution Control Act, 33 USC Sec 1251 et seq., as amended, and the applicable regulations promulgated thereunder.

(7) Construction Site Storm Water Runoff – Storm water runoff from a development site following an earth change.

(8) Design Engineer – Registered and licensed professional engineer responsible for the design of a drainage plan.

(9) Detention – A system which is designed to capture storm water and release it over a given period of time through an outlet structure at a controlled rate.

(10) Developed or Development – The installation or construction of impervious surfaces on a development site that require, pursuant to state law or local ordinance, the **Township/Municipality's** approval of a site plan, plat, site condominium, special land use, planned unit development, rezoning of land, land division approval, private road approval or other approvals required for the development of land or the erection of buildings or structures; provided, however, that for purposes of Article II only, developed or development shall not include the actual construction of, or an addition, extension or modification to, an individual single-family or a two-family detached dwelling.

(11) Developer – Any person proposing or implementing the development of land.

(12) Development Site – Any land that is being or has been developed, or that a developer proposes for development.

(13) Discharger – Any person or entity who directly or indirectly discharges storm water from any property. Discharger also means any employee, officer, director, partner, contractor, or other person who participates in, or is legally or factually responsible for, any act or omission which is or results in a violation of this ordinance.

(14) Drain – Any drain as defined in the Drain Code of 1956, as amended, being MCL 280.1, et. seq., other than an established county or intercounty drain.

(15) Drainage – The collection, conveyance, or discharge of ground water and/or surface water.

(16) Drainageway – The area within which surface water or ground water is carried from one part of a lot or parcel to another part of the lot or parcel or to adjacent land.

(17) Earth Change – Any human activity which removes ground cover, changes the slope or contours of the land, or exposes the soil surface to the actions of wind and rain. Earth change includes, but is not limited to, any excavating, surface grading, filling, landscaping, or removal of vegetative roots.

(18) EPA – The United States Environmental Protection Agency.

(19) Erosion – The process by which the ground surface is worn away by action of wind, water, gravity or a combination thereof.

(20) Exempted Discharges – Discharges other than storm water as specified in Section 4.02 of this ordinance.

(21) Federal Emergency Management Agency (FEMA) – The agency of the federal government charged with emergency management.

(22) Flood or Flooding – A general and temporary condition of partial or complete inundation of normally dry land areas resulting from the overflow of water bodies or the unusual and rapid accumulation of surface water runoff from any source.

(23) Floodplain – Any land area subject to periodic flooding.

(24) Flood-Proofing – Any structural and/or non-structural additions, changes, or adjustments to structures or property that reduce or eliminate flood damage to land, or improvements utilities and structures.

(25) Flood Protection Elevation (FPE) – The Base Flood Elevation plus one (1) foot at any given location.

(26) Floodway – The channel of any watercourse and the adjacent land areas that must be reserved to carry and discharge a base flood without cumulatively increasing the water surface elevation more than one-tenth (1/10) of a foot due to the loss of flood conveyance or storage.

(27) Grading – Any stripping, excavating, filling, and stockpiling of soil or any combination thereof and the land in its excavated or filled condition.

(28) Illicit Connection – Any method or means for conveying an illicit discharge into water bodies or the **Township/Municipality's** storm water system.

(29) Illicit Discharge – Any discharge to water bodies that does not consist entirely of storm water, discharges pursuant to the terms of an NPDES permit, or exempted discharges as defined in this ordinance.

(30) Impervious Surface – Surface that does not allow storm water runoff to slowly percolate into the ground.

(31) KCDC – Kent County Drain Commissioner.

(32) Lowest Floor – The lowest floor or the lowest enclosed area (including a basement), but not including an unfinished or flood-resistant enclosure which is usable solely for parking of vehicles or building access.

(33) MDEQ – Michigan Department of Environmental Quality.

(34) NPDES – National Pollution Discharge Elimination System.

(35) Overland flow-way – Surface area that conveys a concentrated flow of storm water runoff.

(36) Person – An individual, firm, partnership, association, public or private corporation, public agency, instrumentality, or any other legal entity.

(37) Plan – Written narratives, specifications, drawings, sketches, written standards, operating procedures, or any combination of these which contain information pursuant to this ordinance.

(38) Pollutant – A substance discharged which includes, but is not limited to the following: any dredged spoil, solid waste, vehicle fluids, yard wastes, animal wastes, agricultural waste products, sediment, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological wastes, radioactive materials, heat, wrecked or discharged equipment, rock, sand, cellar dirt, and industrial, municipal, commercial and agricultural waste, or any other contaminant or other substance defined as a pollutant under the Clean Water Act.

(39) Property Owner – Any person having legal or equitable title to property or any person having or exercising care, custody, or control over any property.

(40) Retention – A system which is designed to capture storm water and contain it until it infiltrates the soil or evaporates.

(41) Soil Erosion – The stripping of soil and weathered rock from land creating sediment for transportation by water, wind or ice, and enabling formation of new sedimentary deposits.

(42) State of Michigan Water Quality Standards – All applicable State rules, regulations, and laws pertaining to water quality, including the provisions of Section 3106 of Part 31 of 1994 PA 451, as amended.

(43) Storm Drain – A system of open or enclosed conduits and appurtenant structures intended to convey or manage storm water runoff, ground water and drainage.

(44) Storm Water Permit – A permit issued pursuant to this ordinance.

(45) Storm Water Runoff – The runoff and drainage of precipitation resulting from rainfall or snowmelt or other natural event or process.

(46) Storm Water Runoff Facility – The method, structure, area, system, or other equipment or measures which are designed to receive, control, store, or convey storm water.

(47) Stream – A river, stream or creek which may or may not be serving as a drain, or any other water body that has definite banks, a bed, and visible evidence of a continued flow or continued occurrence of water.

(48) **Township/Municipality** – The City/Township/Charter Township/Village of _____.

(49) Water Body – A river, lake, stream, creek or other watercourse or wetlands.

(50) Watershed – A region draining into a water body.

(51) Wetlands – Land characterized by the presence of water at a frequency and duration sufficient to support wetland vegetation or aquatic life.

Article II – Storm Water Permits

Sec. 2.01 Permit Required.

(1) A developer shall not engage in any development without first receiving a storm water permit from the **Township/Municipality** pursuant to Section 2.02.

(2) The granting of a storm water permit shall authorize only such development for which the permit is required, subject to the terms of the permit, and it shall not be deemed to approve other development or other land use activities.

Sec. 2.02 Storm Water Permit Review Procedures

The **Township/Municipality** shall grant a storm water permit, which may impose terms and conditions in accordance with Section 2.09, and which shall be granted only upon compliance with each of the following requirements:

(1) The developer has submitted a drainage plan complying with Section 2.03.

(2) The drainage plan contains a description of an adequate, temporary storm water retention system to prevent construction site storm water runoff, satisfying the requirements of Section 2.05, and the developer has obtained a soil erosion permit, if necessary.

(3) One of the following conditions is satisfied:

(a) The developer provides:

(1) A permanent on-site storm water system sufficient to provide on-site detention of storm water runoff in a twenty-five (25) year storm event, and

(2) A direct connection for all storm water runoff that will be discharged from and through the development site in a one hundred (100) year storm event; or

(b) The developer provides a permanent on-site storm water system with a restricted outlet designed to result in no net increase in storm water runoff volume or rate onto any adjacent property in a one hundred (100) year storm event.

(4) The developer has paid or deposited the storm water permit review fee pursuant to Section 2.04.

(5) The developer has paid or posted the applicable financial guarantee pursuant to Section 2.06.

(6) The developer provides all easements necessary to implement the approved drainage plan and to otherwise comply with this Ordinance including, but not limited to, Section 7.02. All easements shall be acceptable to the **Township/Municipality** in form and substance and shall be recorded with the Kent County Register of Deeds.

(7) The drainage plan is designed in conformity with the **Township/Municipality's** design and performance standards for drains and storm water management systems, as set forth in Article VIII.

(8) All storm water runoff facilities shall be designed in accordance with the then-current BMPs.

(9) The developer provides the required maintenance agreement for routine, emergency, and long-term maintenance of all storm water runoff facilities and in compliance with the approved drainage plan and this Ordinance including, but not limited to, Section 7.03. The maintenance agreement shall be acceptable to the **Township/Municipality** in form and substance and shall be recorded with the Kent County Register of Deeds.

Sec. 2.03 Drainage Plan.

The developer shall provide a drainage plan to the **Township/Municipality** for review and approval by the **Township/Municipality**. The drainage plan shall identify and contain all of the following:

(1) The location of the development site and water bodies that will receive storm water runoff.

(2) The existing and proposed topography of the development site, including the alignment and boundary of the natural drainage courses, with contours having a maximum interval of one foot (using USGS datum). The information shall be superimposed on the pertinent Kent County soil map.

(3) The development tributary area to each point of discharge from the development.

(4) Calculations for the final peak discharge rates.

(5) Calculations for any facility or structure size and configuration.

(6) A drawing showing all proposed storm water runoff facilities with existing and final grades.

(7) The sizes and locations of upstream and downstream culverts serving the major drainage routes flowing into and out of the development site. Any significant off-site and on-site drainage outlet restrictions other than culverts should be noted on the drainage map.

(8) An implementation plan for construction and inspection of all storm water runoff facilities necessary to the overall drainage plan, including a schedule of the estimated dates of completing construction of the storm water runoff facilities shown on the plan and an identification of the proposed inspection procedures to ensure that the storm water runoff facilities are constructed in accordance with the approved drainage plan.

(9) A plan to ensure the effective control of construction site storm water runoff and sediment track-out onto roadways.

(10) Drawings, profiles, and specifications for the construction of the storm water runoff facilities reasonably necessary to ensure that storm water runoff will be drained, stored, or otherwise controlled in accordance with this ordinance.

(11) A maintenance agreement, in form and substance acceptable to the **Township/Municipality**, for ensuring maintenance of any privately-owned storm water runoff facilities. The maintenance agreement shall include the developer's written commitment to provide routine, emergency, and long-term maintenance of the facilities and, in the event that the facilities are not maintained in accordance with the approved drainage plan, the agreement shall authorize the **Township/Municipality** to maintain any on-site storm water runoff facility as reasonably necessary, at the developer's expense.

(12) The name of the engineering firm and the registered professional engineer that designed the drainage plan and that will inspect final construction of the storm water runoff facilities.

(13) All design information must be compatible for conversion to Grand Valley Regional Geographic Information System (REGIS).

(14) Any other information necessary for the **Township/Municipality** to verify that the drainage plan complies with the **Township/Municipality's** design and performance standards for drains and storm water management systems.

Sec. 2.04 Storm Water Permit Review Fees.

(1) All expenses and costs incurred by the **Township/Municipality** directly associated with processing, reviewing and approving or denying a storm water permit application shall be paid (or reimbursed) to the **Township/Municipality** from the funds in a separate escrow account established by the developer, as provided in subsection (2). The **Township/Municipality** may draw funds from a developer's escrow account to reimburse the **Township/Municipality** for out-of-pocket expenses incurred by the **Township/Municipality** relating to the application. Such reimbursable expenses include, but are not limited to, expenses related to the following:

(a) Services of the **Township/Municipality** Attorney directly related to the application.

(b) Services of the **Township/Municipality** Engineer directly related to the application.

(c) Services of other independent contractors working for the **Township/Municipality** which are directly related to the application.

(d) Any additional public hearings, required mailings and legal notice requirements necessitated by the application.

(2) At the time a developer applies for a storm water permit, the developer shall deposit with the **Township/Municipality** clerk, as an escrow deposit, an initial amount as determined by resolution of the **[legislative body]** for such matters and shall provide additional amounts as requested by the **Township/Municipality** in such increments as are specified in said resolution. Any excess funds remaining in the escrow account after the application has been fully processed, reviewed, and the final **Township/Municipality** approval and acceptance of the development has occurred will be refunded to the developer with no interest to be paid on those funds. At no time prior to the **Township/Municipality's** final decision on an application shall the balance in the escrow account fall below the required initial amount. If the funds in the account are reduced to less than the required initial amount, the developer shall deposit into the account an additional amount as determined by **[Legislative Body]** resolution, before the application review process will be continued. Additional amounts may be required to be placed in the escrow account by the developer, at the discretion of the **Township/Municipality**.

Sec. 2.05 Construction Site Runoff Controls

Prior to making any earth change on a development site regulated by this ordinance, the developer shall first obtain a soil erosion permit issued in accordance with Part 91 of Act No. 451 of the Public Acts of 1994, as amended, if one is required. The developer shall install storm water runoff facilities and shall phase the development activities so as to prevent construction site storm water runoff and off-site sedimentation. During all construction activities on the development site, the **Township/Municipality** Engineer may inspect the development site to ensure compliance with the approved construction site runoff controls.

Sec. 2.06 Financial Guarantee

(1) The **Township/Municipality** Engineer shall not approve a storm water permit until the developer submits to the **Township/Municipality**, in a form and amount satisfactory to the **Township/Municipality**, a letter of credit or other financial guarantee for the timely and satisfactory construction of all storm water runoff facilities and site grading in accordance with the approved drainage plan. Upon certification by a registered professional engineer that the storm water runoff facilities have been completed in accordance with the approved drainage plan including, but not limited to, the provisions contained in Section 2.03(8), the **Township/Municipality** may release the letter of credit, or other financial guarantee subject to final **Township/Municipality** acceptance and approval.

(2) Except as provided in subsection (3), the amount of the financial guarantee shall be $_____, unless the **Township/Municipality** determines that a greater amount is appropriate, in which case the basis for such determination shall be provided to the developer in writing. In determining whether an amount greater than $_____ is appropriate, the **Township/Municipality** shall consider the size and type of the development, the size and type of the on-site storm water system, and the nature of the off-site storm water runoff facilities the development will utilize.

(3) The **Township/Municipality** _____ [planner, zoning administrator, etc.] may reduce or waive the amount of the financial guarantee for a development that will not increase the percentage of impervious surface of the development site by more than ten percent (10%).

(4) This ordinance shall not be construed or interpreted as relieving a developer of its obligation to pay all costs associated with on-site private storm water runoff facilities as well as those costs arising from the need to

make other drainage improvements in order to reduce a development's impact on a drain consistent with adopted design standards.

Sec. 2.07 Certificate of Occupancy

No certificate of occupancy shall be issued until storm water runoff facilities have been completed in accordance with the approved drainage plan; provided, however, the **Township/Municipality** may issue a certificate of occupancy if an acceptable letter of credit or other financial guarantee has been submitted to the **Township/Municipality**, for the timely and satisfactory construction of all storm water runoff facilities and site grading in accordance with the approved drainage plan.

Sec. 2.08 No Change in Approved Facilities

Storm water runoff facilities, after construction and approval, shall be maintained in good condition, in accordance with the approved drainage plan, and shall not be subsequently altered, revised or replaced except in accordance with the approved drainage plan, or in accordance with approved amendments or revisions in the plan.

Sec. 2.09 Terms and Conditions of Permits

In granting a storm water permit, the **Township/Municipality** may impose such terms and conditions as are reasonably necessary to effectuate the purposes of this ordinance. A developer shall comply with such terms and conditions.

Article III – Storm Water System, Floodplain and Other Standards, Soil Erosion Control

Sec. 3.01 Management of and Responsibility for Storm Water System

The **Township/Municipality** is not responsible for providing drainage facilities on private property for the management of storm water on said property. It shall be the responsibility of the property owner to provide for, and maintain, private storm water runoff facilities serving the property and to prevent or correct the accumulation of debris that interferes with the drainage function of a water body.

Sec. 3.02 Storm Water System

All storm water runoff facilities shall be constructed and maintained in accordance with all applicable federal, state and local ordinances, and rules and regulations.

Sec. 3.03 Storm Water Discharge Rates and Volumes

The **Township/Municipality** is authorized to establish minimum design standards for storm water discharge release rates and to require dischargers to implement on-site retention, detention or other methods necessary to control the rate and volume of surface water runoff discharged into the storm water drainage system, in the following circumstances:

(1) A parcel of land is being developed in a manner that increases the impervious surface area of the parcel; or

(2) The discharge exceeds the **Township/Municipality-**calculated pre-development discharge characteristics for the subject property, and the **Township/Municipality** determines that the discharge is a violation of the drainage, flooding or soil erosion regulations of this ordinance.

Sec. 3.04 Floodplain Standards

(1) All new buildings and substantial improvements to existing buildings shall be protected from flood damage up to the Flood Protection Elevation (FPE) and shall be in accordance with all applicable federal, state and local ordinances, and rules and regulations. Floodway alteration shall be permitted only upon review and approval by the **Township/Municipality**, in accordance with an approved drainage plan.

(2) A drainage plan providing for the filling or alteration of a floodway may include provisions for maintaining stability of the banks of streams or other water bodies, by means of the establishing of buffer zones and

other means of providing protection of the slopes and banks of water bodies.

(3) Within any required buffer zone, no earth change shall take place except in accordance with the approved drainage plan. Such a plan may also include provisions for the replacement of floodplain storage volume, where such storage volume is lost or diminished as a result of approved development.

Sec. 3.05 Soil Erosion and Sedimentation Control

(1) All persons who cause, in whole or in part, any earth change to occur shall provide soil erosion and sedimentation control so as to adequately prevent soils from being eroded and discharged or deposited onto adjacent properties or into a storm water drainage system, a public street or right of way, wetland, creek, stream, water body, or floodplain. All development shall be in accordance with all applicable federal, state and local ordinances, rules and regulations.

(2) During any earth change which exposes soil to an increased risk of erosion or sediment track-out, the property owner and other persons causing or participating in the earth change shall do the following:

(a) Comply with the storm water management standards of this ordinance.

(b) Obtain and comply with the terms of a soil erosion and sedimentation control permit if required by law.

(c) Prevent damage to any public utilities or services within the limits of grading and within any routes of travel or areas of work of construction equipment.

(d) Prevent damage to or impairment of any water body on or near the location of the earth change or affected thereby.

(e) Prevent damage to adjacent or nearby land.

(f) Apply for all required approvals or permits prior to the commencement of work.

(g) Proceed with the proposed work only in accordance with the approved plans and in compliance with this ordinance.

(h) Maintain all required soil erosion and sedimentation control measures, including but not limited to, measures required for compliance with the terms of this ordinance.

(i) Promptly remove all soil, sediment, debris, or other materials applied, dumped, tracked, or otherwise deposited on any lands, public streets, sidewalks, or other public ways or facilities, including catch basins, storm sewers, ditches, drainage swales, or water bodies. Removal of all such soil, sediment, debris or other materials within twenty-four (24) hours shall be considered prima facie compliance with this requirement, unless such materials present an immediate hazard to public health and safety.

(j) Refrain from grading lands at locations near or adjoining lands, public streets, sidewalks, alleys, or other public or private property without providing adequate support or other measures so as to protect such other lands, streets, sidewalks or other property from settling, cracking or sustaining other damage.

(k) Request and obtain inspection of soil erosion and sedimentation control facilities, by the **Township/Municipality** at such frequency as required by the **Township/Municipality.**

Sec. 3.06 Building Openings

(1) No building opening shall be constructed below the following elevations:

(a) One foot above the 100-year floodplain.

(b) The building opening established at the time of plat or development approval and on file in the **Township/Municipal** Engineering Department.

(c) Three feet above the top of any downstream culvert.

(d) Four feet above the bottom of any permanent and defined drain.

(2) A waiver from elevations stated in Section 3.05(1) may be granted by the **Township/Municipal** Engineer following receipt of a certification from a registered professional engineer demonstrating that the proposed elevation does not pose a risk of flooding.

(3) Upon completion of construction of the structure's foundation and or slab on grade, a registered land surveyor shall certify any minimum building opening elevation specified by this ordinance. This certificate shall attest that the building opening elevation complies with the standards of this

ordinance. The permittee for the building permit shall submit the certificate to the **Township/Municipal** Building Inspections official prior to the commencement of framing and/or structural steel placement. If the surveyor should find that the minimum building opening elevation is below the elevation specified in Section 3.06(1)(b) or (c), that opening must be raised using a method that meets with the approval of the **Township/Municipality**. After reconstruction, a registered land surveyor or engineer shall re-certify that the minimum building opening elevation complies with the standards of this ordinance prior to the commencement of framing and or structural steel placement.

[optional] Sec. 3.07 Sump Pump Discharge

(1) Whenever building footing drains are required or utilized, a direct connection between the footing drains through a sump pump-check valve system to a storm sewer is required. A gravity system is not permitted.

(2) A storm water lateral shall be provided for each parcel at the time of storm sewer construction.

Sec. 3.08 Public Health, Safety and Welfare

Protection of the public health, safety and welfare shall be a primary consideration in the design of all storm water runoff facilities.

Article IV – Prohibitions and Exemptions

Sec. 4.01 Prohibited Discharges

(1) No person shall discharge to a water body, directly or indirectly, any substance other than storm water or an exempted discharge. Any person discharging storm water shall effectively prevent pollutants from being discharged with the storm water, except in accordance with best management practices.

(2) The **Township/Municipality** is authorized to require dischargers to implement pollution prevention measures, utilizing BMPs, necessary to prevent or reduce the discharge of pollutants into the **Township's/Municipality's** storm water drainage system.

Sec. 4.02 Exempted Discharges

The following non-storm water discharges shall be permissible, provided that they do not result in a violation of State of Michigan water quality standards:

Water supply line flushing
Landscape irrigation
Diverted stream flows
Rising ground water
Uncontaminated ground water infiltration to storm drains
Uncontaminated pumped ground water
Discharges from potable water sources
Foundation drains
Air conditioning condensate
Individual residential car washing
Dechlorinated swimming pool water
Street washwater
Discharges or flows from emergency fire fighting activities
Discharges for which a specific federal or state permit has been issued.

Sec. 4.03 Interference with Natural or Artificial Drains

(1) It shall be unlawful for any person to stop, fill, dam, confine, pave, alter the course of, or otherwise interfere with any natural or constructed drain, or drainageway without first submitting a drainage plan to the **Township/Municipality** and receiving approval of that plan. Any deviation from the approved plan is a violation of this ordinance. This section shall not prohibit, however, necessary emergency action so as to prevent or mitigate drainage that would be injurious to the environment, the public health, safety, or welfare.

(2) No filling, blocking, fencing or above-surface vegetation planting shall take place within a floodway.

(3) For an overland flow-way:

(a) Silt screen fences shall not be permitted below the top of the bank of a water body.

(b) Chain link fences shall be permitted if the **Township/Municipality** determines that the fence will not obstruct or divert the flow of water.

(c) If a fence is removed by the **Township/Municipality** for drain access or drain maintenance, the fence shall be replaced by the owner of the fence at the owner's expense.

(d) No shrubs or trees shall be planted below the top of the bank of a water body.

(4) Shrubs, trees or other above-ground vegetation shall not be planted over the top of an underground storm sewer or over the top of the easement within which the storm sewer has been installed.

Sec. 4.04 Storage of Hazardous or Toxic Materials in Drainageway

Except as permitted by law, it shall be unlawful for any person to store or stockpile within a drainageway any hazardous or toxic materials unless adequate protection and/or containment has been provided so as to prevent any such materials from entering a drainageway.

Article V – Inspection, Monitoring, Reporting, and Recordkeeping.

Sec. 5.01 Inspection and Sampling

To assure compliance with the standards in this pervasively regulated area, the **Township/Municipality** may inspect and/or obtain storm water samples from storm water runoff facilities of any discharger to determine compliance with the requirements of this ordinance. Upon request, the discharger shall allow the **Township/Municipality's** properly identified representative to enter upon the premises of the discharger at all hours necessary for the purposes of such inspection or sampling. The **Township/Municipality** shall provide the discharger reasonable advance notice of such inspection and/or sampling. The **Township/Municipality** or its properly identified representative may place on the discharger's property the equipment or devices used for such sampling or inspection.

Sec. 5.02 Storm Water Monitoring Facilities

A discharger of storm water runoff shall provide and operate equipment or devices for the monitoring of storm water runoff, so as to provide for inspection, sampling, and flow measurement of each discharge to a water body or a storm water runoff facility, when directed in writing to do so by the **Township/Municipality**. The **Township/Municipality** may require a discharger to provide and operate such equipment and devices if it is necessary or appropriate for the inspection, sampling and flow measurement of discharges in order to determine whether adverse effects from or as a result of such discharges may occur. All such equipment and devices for the inspection, sampling and flow measurement of discharges shall be installed and maintained in accordance with applicable laws, ordinances and regulations.

Sec. 5.03 Accidental Discharges

(1) Any discharger who accidentally discharges into a water body any substance other than storm water or an exempted discharge shall immediately inform the **Township/Municipality** concerning the discharge. If such information is given orally, a written report concerning the discharge shall be filed with the **Township/Municipality** within five (5) days. The written report shall specify:

(a) The composition of the discharge and the cause thereof.

(b) The exact date, time, and estimated volume of the discharge.

(c) All measures taken to clean up the accidental discharge, and all measures proposed to be taken to reduce and prevent any recurrence.

(d) The name and telephone number of the person making the report, and the name of a person who may be contacted for additional information on the matter.

(2) A properly-reported accidental discharge shall be an affirmative defense to a civil infraction proceeding brought under this ordinance against a discharger for such discharge. It shall not, however, be a defense to a legal action brought to obtain an injunction, to obtain recovery of costs or to obtain other relief as a result of or arising out of the discharge. A discharge shall be considered properly reported only if the discharger complies with all the requirements of Section 5.03(1).

Sec. 5.04 Record Keeping Requirement

Any person subject to this ordinance shall retain and preserve for no less than three (3) years any and all books, drawings, plans, prints, documents, memoranda, reports, correspondence and records, including records on magnetic or electronic media and any and all summaries of such records, relating to monitoring, sampling and chemical analysis of any discharge or storm water runoff from any property.

Article VI – Enforcement

Sec. 6.01 Sanctions for Violation

(1) Any person violating any provision of this ordinance shall be responsible for a municipal civil infraction and subject to a fine of not less than $_____ for a first offense, and not less than $ _____ for a subsequent offense, plus costs, damages, expenses, and other sanctions as authorized under Chapter 87 of the Revised Judicature Act of 1961 and other applicable laws, including, without limitation, equitable relief; provided, however, that the violation stated in Section 6.01(2) shall be a misdemeanor. Each day such violation occurs or continues shall be deemed a separate offense and shall make the violator liable for the imposition of a fine for each day. The rights and remedies provided for in this section are cumulative and in addition to any other remedies provided by law. An admission or determination of responsibility shall not exempt the offender from compliance with the requirements of this ordinance.

For purposes of this section, "subsequent offense" means a violation of the provisions of this ordinance committed by the same person within 12 months of a previous violation of the same provision of this ordinance for which said person admitted responsibility or was adjudicated to be responsible.

The **Township/Municipality** [zoning administrator, building inspector, enforcement officer, etc.] is authorized to issue municipal civil infraction citations to any person alleged to be violating any provision of this ordinance.

(2) Any person who neglects or fails to comply with a stop work order issued under Section 6.02 shall, upon conviction, be guilty of a misdemeanor, punishable by a fine of not more than $500 or imprisonment in the county jail for not more than 93 days, or both such fine and imprisonment, and such person shall also pay such costs as may be imposed in the discretion of the court.

(3) Any person who aids or abets a person in a violation of this ordinance shall be subject to the sanctions provided in this section.

Sec. 6.02 Stop Work Order

Where there is work in progress that causes or constitutes in whole or in part, a violation of any provision of this ordinance, the **Township/Municipality** is authorized to issue a Stop Work Order so as to prevent further or continuing violations or adverse effects. All persons to whom the stop work order is directed, or who are involved in any way with the work or matter described in the

stop work order shall fully and promptly comply therewith. The **Township/Municipality** may also undertake or cause to be undertaken, any necessary or advisable protective measures so as to prevent violations of this ordinance or to avoid or reduce the effects of noncompliance herewith. The cost of any such protective measures shall be the responsibility of the owner of the property upon which the work is being done and the responsibility of any person carrying out or participating in the work, and such cost shall be a lien upon the property.

Sec. 6.03 Failure to Comply; Completion

In addition to any other remedies, should any owner fail to comply with the provisions of this ordinance, the **Township/Municipality** may, after the giving of reasonable notice and opportunity for compliance, have the necessary work done, and the owner shall be obligated to promptly reimburse the **Township/Municipality** for all costs of such work.

Sec. 6.04 Emergency Measures

When emergency measures are necessary to moderate a nuisance, to protect public safety, health and welfare, and/or to prevent loss of life, injury or damage to property, the **Township/Municipality** is authorized to carry out or arrange for all such emergency measures. Property owners shall be responsible for the cost of such measures made necessary as a result of a violation of this ordinance, and shall promptly reimburse the **Township/Municipality** for all of such costs.

Sec. 6.05 Cost Recovery for Damage to Storm Drain System

A discharger shall be liable for all costs incurred by the **Township/Municipality** as the result of causing a discharge that produces a deposit or obstruction, or causes damage to, or impairs a storm drain, or violates any of the provisions of this ordinance. Costs include, but are not limited to, those penalties levied by the EPA or MDEQ for violation of an NPDES permit, attorney fees, and other costs and expenses.

Sec. 6.06 Collection of Costs; Lien

Costs incurred by the **Township/Municipality** and the Drain Commissioner pursuant to Sections 6.02, 6.03, 6.04 and 6.05 shall be a lien on the premises which shall be enforceable in accordance with Act No. 94 of the Public Acts of 1933, as amended from time to time. Any such charges which are delinquent for six (6) months or more may be certified annually to the **Township/Municipality** Treasurer who shall enter the lien on the next tax roll against the premises and the costs shall be collected and the lien shall be enforced in the same manner as provided for in the collection of taxes assessed upon the roll and the enforcement of a lien for taxes. In addition to any other lawful enforcement

methods, the **Township/Municipality** or the Drain Commissioner shall have all remedies authorized by Act No. 94 of the Public Acts of 1933, as amended.

Sec. 6.07 Appeals

Any person as to whom any provision of this ordinance has been applied may appeal in writing, not later than 30 days after the action or decision being appealed from, to the **Township/Municipal [legislative body or other board]** the action or decision whereby any such provision was so applied. Such appeal shall identify the matter being appealed, and the basis for the appeal. The **Township/Municipality [legislative body or other board]** shall consider the appeal and make a decision whereby it affirms, rejects or modifies the action being appealed. In considering any such appeal, the **Township/Municipality** [**legislative body or other board]** may consider the recommendations of the **Township/Municipal** Engineer and the comments of other persons having knowledge of the matter. In considering any such appeal, the **Township/Municipal [legislative body or other board]** may grant a variance from the terms of this ordinance so as to provide relief, in whole or in part, from the action being appealed, but only upon finding that the following requirements are satisfied:

(1) The application of the ordinance provisions being appealed will present or cause practical difficulties for a development or development site; provided, however, that practical difficulties shall not include the need for the developer to incur additional reasonable expenses in order to comply with the ordinance; and

(2) The granting of the relief requested will not substantially prevent the goals and purposes sought to be accomplished by this ordinance, nor result in less effective management of storm water runoff.

Article VII – Storm Water Easements and Maintenance Agreements

Sec. 7.01 Applicability of Requirements

The requirements of this Article concerning storm water easements and maintenance agreements shall apply to all persons required to submit a drainage plan to the **Township/Municipality** for review and approval.

Sec. 7.02 Storm Water Management Easements

The developer shall provide all storm water management easements necessary to implement the approved drainage plan and to otherwise comply with this ordinance in form and substance required by the **Township/Municipality** and shall record such easements as directed by the **Township/Municipality**. The easements shall assure access for proper inspection and maintenance of storm water runoff facilities and shall provide adequate emergency overland flow-ways.

Sec. 7.03 Maintenance Agreements

The developer shall provide all storm water maintenance agreements necessary to implement the approved drainage plan and to otherwise comply with this ordinance in form and substance as required by the **Township/Municipality**, and shall record such agreements as directed by the **Township/Municipality**. The maintenance agreements shall, among other matters, assure access for proper inspection and maintenance of storm water runoff facilities and adequate emergency overland flow-ways.

Sec. 7.04 Establishment of County Drains

Prior to final approval, all storm water management facilities for platted subdivisions shall be established as county drains, as authorized in Section 433, Chapter 18 of the Michigan Drain Code (P.A. 40 of 1956, as amended) for long-term maintenance.

Article VIII – Performance and Design Standards

Sec. 8.01 Performance Standards

In order to achieve the goals and purposes of this ordinance, the following three storm water management zones (Zones A, B and C) are hereby established. The Zones are shown on the map attached as Appendix A and made a part of this ordinance.

(1) Zone A represents areas which require the most protective storm water management regulations. The goal of this zone is to preserve the natural condition of water bodies included in it, in whole or in part. Zone A has, in general, little impervious surface area and few storm water facilities. In this zone, when site conditions permit, infiltration of storm water runoff shall be required, rather than the directed flow of storm water runoff into water bodies. This storm water management practice provides greater protection for surface water quality, and also assists in augmenting stream base flow, reduction of flash storm flows and prevention of stream bank erosion. Section 8.02 specifies design criteria for Zone A, in order that the volume and rate of storm water runoff are controlled at predevelopment levels.

(2) Zone B represents developed areas that have significant impervious surfaces and storm water runoff facilities in place. The goal of Zone B is the control of storm water runoff in order to prevent further destabilizing of streams and other water bodies. In this zone, the use of detention ponds, the maintenance and enhancement of buffer strips and other measures to reduce directly-connected impervious areas are specified in Section 8.02 for the achieving of the storm water management standards applicable to Zone B. The management practices for this zone are intended to maintain existing water quality and to alleviate adverse downstream impact on water bodies.

(3) Zone C consists of highly urbanized areas, or areas where there has been significant modification of drainageways. The amount of impervious surface area in Zone C is generally greater than 25%. Among the measures required in Zone C, as stated in Section 8.02, are the use of sediment basins, the maintenance and enhancement of buffer strips along water bodies and the reduction of impervious surface areas that are directly connected to water bodies. An important element of storm water management practice in Zone C is the control and prevention of sedimentation, in order to reduce pollution of water bodies.

Sec. 8.02 Design Standards

The design standards for storm water runoff facilities for Zones A, B and C, as described in Section 8.01, are the following:

	Zone A	Zone B	Zone C
Criteria	High quality waters. Meets water quality standards. Less than 10% imperviousness.	Degraded physical, biological, or water quality indicators. 10% to 25% imperviousness.	Heavily degraded physical, biological, or water quality indicators. Greater than 25% imperviousness.
Storm Water Management Standards	Use infiltration basins, infiltration trenches, extended detention basins, and/or constructed wetlands. Maintain and enhance buffer strips.	Use detention ponds; maintain and enhance buffer strips, and reduce directly connected impervious area.	Use sediment basins, maintain and enhance buffer strips, and reduce directly connected impervious area.
Water Quality Control	Detain the first 0.5" of runoff from the contributing watershed, with detention per Zone B and infiltration where conditions permit, or provide equivalent treatment.	Detain the first 0.5" of runoff from the contributing watershed for 24 hours or provide equivalent treatment.	Provide sedimentation control within the drainage system.
Bank Erosion Control	Rate of release shall be limited to 0.05 cfs/acre for a 2-year storm event.	None	Storm water runoff shall not exceed the capacity of the downstream conveyance system.
Flood Control	Detention with infiltration when conditions permit. Release rate of 0.13 cfs/acre per KCDC rules.	Release rate of 0.13 cfs/acre per KCDC rules.	Direct conveyance of storm water runoff within the capacity of downstream system.

Sec. 8.03 Resolution to Implement Performance and Design Standards

The **[legislative body]** of the **Township/Municipality** may adopt a resolution establishing more detailed design and performance standards for storm water runoff facilities, consistent with the terms of this ordinance, and in order to further implement its goals and purposes.

Article IX – Other Matters

Sec. 9.01 Interpretation

Words and phrases in this ordinance shall be construed according to their common and accepted meanings, except that words and phrases defined in Section 1.05 shall be construed according to the respective definitions given in that section. Technical words and technical phrases that are not defined in this ordinance but which have acquired particular meanings in law or in technical usage shall be construed according to such meanings.

Sec. 9.02 Catch-Line Headings

The catch-line headings of the articles and sections of this ordinance are intended for convenience only, and shall not be construed as affecting the meaning or interpretation of the text of the articles or sections to which they may refer.

Sec. 9.03 Severability

The provisions of this ordinance are hereby declared to be severable, and if any part or provision of this ordinance should be declared invalid or unenforceable by any court of competent jurisdiction, such invalidity or unenforceability shall not affect any other part or provision of the ordinance.

Sec. 9.04 Other Ordinances

This ordinance shall be in addition to other ordinances of the **Township/Municipality**, and shall not be deemed to repeal or replace other ordinances or parts thereof except to the extent that such repeal is specifically provided for in this Article.

Sec. 9.05 Effective Date

This ordinance shall become effective _____, following its publication or following the publication of a summary of its provisions in a local newspaper of general circulation.

Sec. 9.06 Repeal [if applicable]

Ordinance No. ___, titled _____, is hereby repealed, as of the effective date of this ordinance.

This ordinance was adopted _____, by the **[Township Board, City Council or City Commission, Village Council]** and made effective _____.

_____
Township/Municipality Clerk

_____ OF _____

COUNTY OF KENT, MICHIGAN

RESOLUTION TO APPROVE ADDITIONAL DESIGN AND PERFORMANCE STANDARDS FOR STORM WATER RUNOFF FACILITIES AND TO APPROVE OTHER STANDARDS PERTAINING TO STORM WATER MANAGEMENT

WHEREAS on _____, the [**Township Board, City Council, City Commission or Village Council**] adopted Ordinance No. ___, the _____ of _____ Storm Water Ordinance;

WHEREAS, Section 8.03 of said ordinance provides that the [**Township Board, City Council, City Commission or Village Council**] may adopt by resolution additional design and performance standards for storm water runoff facilities, consistent with the terms of the ordinance, in order to further implement its goals and purposes;

WHEREAS, the [**Township Board, City Council, City Commission or Village Council**] now desires to adopt such additional design and performance standards for storm water runoff facilities and other standards pertaining to storm water management.

IT IS, THEREFORE, RESOLVED AS FOLLOWS:

Section 1. **Lot Drainage**.

(a) Any drainage situation not involving any public property water is the responsibility of the property owner.

(b) In plat and site plan review, the **Township/Municipality** will only review private property drainage for the purpose of assuring that private property can be drained.

(c) Lot grading and private property drainage is a civil matter among the property owners affected.

(d) To aid contractors and builders in grading private property, a lot grading plan will be required on all development and such information shall be disbursed along with the building permit. This lot grading plan must show:

(1) Any established minimum building opening.

(2) Floodway and floodplain elevations.

(3) All storm sewers, the rise, grades, invert elevations and top of casting elevations.

(4) All storm sewer laterals.

(5) All utility and drainage easements and their full description.

(6) Minimum basement elevation for sanitary sewer.

(7) Direction of drainage on each lot.

(8) Elevations of any constructed surface drainage facilities.

(9) Surface grading of the entire parcel.

(e) A minimum rear yard of twenty-five (25') prior to any drainage encumbrance is required. This will allow opportunity for rear yard use for sheds, play equipment, etc., without concern about water damage or inconvenience.

(f) Prior to construction of any structure on a parcel or lot upon which a floodway easement, floodplain and drainageway exists, the permittee must obtain from the

Township/Municipality, a copy of the approved plans showing the location and design elevations of that floodway, floodplain and drainageway. Upon completion of the structure and prior to the issuance of an occupancy permit, the permittee must provide a certification from a registered land surveyor that the floodway, floodplain and drainageway grades and dimensions are as designed. If the floodway, floodplain and drainageway does not conform to the approved plans, the floodway, floodplain and drainageway must be reconstructed and certified prior to the issuance of an occupancy permit for that lot or parcel. Concurrent floodway, floodplain and drainageway reconstruction and issuance of an occupancy permit are permitted only if that action does not present a danger to the safety and welfare of any affected property. To permit concurrent action, the permittee shall provide the **Township/Municipality** with a performance bond, a letter of credit, or a cash deposit to cover the cost of said reconstruction at a dollar amount established by the **Township/Municipality.**

Section 2. **Storm Water Management Zones.** The performance standards stated in Section 8.01 of said ordinance are hereby supplemented as follows:

(a) In any single development site, up to three different detention volumes may be calculated to determine the staged outlet elevations: (1) water quality control, (2) bank erosion control, and (3) flood control. These volumes are not intended to be additive; the flood control volume shall include the water quality control and bank erosion control volumes.

(b) The default flood control volume shall be based on detaining the 25-year storm frequency so long as the downstream storm water conveyance system has adequate capacity and includes an acceptable emergency overland floodway. If the design engineer determines the

downstream conveyance system is not adequate or an acceptable emergency overland floodway does not exist, then the Flood control volume shall be based on detaining the 100-year storm.

Section 3. **Flood Plain Protection.** Section 8.01 of said ordinance is supplemented as follows:

(a) Natural floodway filling or alteration shall not be allowed without review and approval by the **Township/Municipality** and compliance with the Floodplain Regulatory Authority found in Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) on watercourses with contributing drainage area of 2 square miles or greater. If a floodway has not been mapped, the applicant's consultant shall provide the floodway delineation to the **Township/Municipality** for approval.

(b) Natural floodway fringe filling or alteration shall not be allowed without review and approval by the **Township/Municipality** and compliance with the Floodplain Regulatory Authority found in Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) on watercourses with contributing drainage area of 2 square miles or greater. If a floodplain has not been mapped, the applicant's consultant shall provide the floodplain delineation including the floodway, to the **Township/Municipality** for approval. (c) To provide for streambank stability a buffer zone is to be established and called out on a recorded plat, an approved block grading plan, a site plan, or an improvement plan. This zone shall consist of existing natural tree and vegetation slope protection within a minimum of 25 feet from the ordinary high-water mark. This buffer zone shall be maintained as is, that is, no earth change or disturbance is to take place.

(d) Replacement of lost floodplain shall meet the following criteria.

(i) Replacement of the loss of floodplain storage volume at a 1 to 1 ratio unless watershed conditions warrant a higher ratio. This applies to floodplain associated with rainfall events up to a 100-year frequency. The grading plan shall provide for an equivalent volume of storage for floodplains associated with more frequent events such as 10 and 25 year frequencies.

(ii) Storm water detention does not apply toward the replacement volume.

(iii) Floodplain storage volume shall be computed above the seasonal high ground water level only.

(iv) The inflow and outflow rates to the area shall be consistent with pre-development rates.

(v) Up to 50 percent of the floodplain mitigation storage volume may be used for snow storage.

(vi) The proximity of the floodplain mitigation area shall provide for an equivalent hydrologic impact to the receiving stream and adjacent parcels.

AYES: _____

NAYS: _____

RESOLUTION DECLARED ADOPTED.

_____

_____, Clerk

Appendix B

A History of The Model Ordinance and Management Tools

History Of Model Ordinance And Management Tools

A booklet titled “Rain, Rain, Go Away...” was prepared for the Metropolitan Water & Sewer Planning Agency (MWSPA) by the Annis Water Resources Institute of Grand Valley State University (AWRI) in cooperation with the consulting firm Fishbeck, Thompson, Carr & Huber, Inc (FTC&H). It was specifically intended to describe and explain existing stormwater management rules, guidelines, and program initiatives sponsored and administered by the Kent County Drain Commissioner. The “Rain, Rain, Go Away...” booklet recommended a new approach to stormwater management policy. The new approach was stated as follows: “It is the goal of the Kent County Drain Commissioner to maintain Kent County lakes and streams in their natural state and whenever possible minimize the environmental impact associated with the construction and maintenance of stormwater-related projects”.

As a result of the “Rain, Rain, Go Away...” effort the AWRI applied in August 1999 for Environmental Protection Agency Nonpoint Source funding from the MDEQ for the “Developing Administrative Tools and Authority for Stormwater Management in the Grand Rapids Metropolitan Area” project. During the summer of 1999, Mr. Roger Laninga, the Kent County Drain Commissioner, received inquiries from a number of townships within Kent County asking if there was a model stormwater ordinance in existence. In response, Mr. Laninga appointed a Stormwater Task Force in September 1999 whose mission was to review stormwater ordinances from different units of government in order to improve on Kent County’s standard rules and regulations. Seven people attended the first meeting, including representatives from local governmental units, the MDEQ, the AWRI, and experts in the technical fields. This laid the foundation for the expanded effort of the “Developing Administrative Tools and Authority for Stormwater Management in the Grand Rapids Metropolitan Area” project which was funded in April 2000.

Once the “Developing Administrative Tools and Authority for Stormwater Management in the Grand Rapids Metropolitan Area” project was underway, the Kent County Stormwater Task Force drew in more interested parties. There were approximately forty members of the group including representatives from cities, townships, engineering firms, AWRI, Home Builders’ Association, Center for Environmental Study at Grand Rapids Community College, MDEQ, Grand Valley Metro Council, and West Michigan Environmental Action Council. Three subcommittees of the Task Force were created to 1) refine the model ordinance, 2) develop design standards, and 3) create an educational handbook.

The model ordinance has been written, evaluated, reevaluated, and revised many times over many months. Performance standards have been debated and clarified. The model ordinance presented in this educational package is intended to be the best possible model the Task Force could create in the given time. However, as we completed the process, the Task Force came to the realization that there will always be more that could be added or refined. While the intent of the task force is to present this model ordinance to each community in Kent County, the ordinance should be adjusted to meet the needs of the individual community. This educational handbook was developed to promote the ordinance and to educate public officials and citizens on its implementation.

This stormwater effort will also help communities obtain permit coverage for the Federal *NPDES Phase II** stormwater regulations. The Phase II program is an expansion of the Phase I program which was adopted in 1990 under the Clean Water Act. Phase I addressed the stormwater runoff issue by requiring National Pollutant Discharge Elimination System (NPDES) permit coverage for medium and large municipal separate storm sewer systems serving populations of 100,000 or greater and for construction activity that disturbs five acres of land or more .

Phase II requires additional operators of storm sewer systems in urbanized areas and operators of small construction sites to implement programs and practices to control polluted stormwater runoff. These controls are intended to further reduce unfavorable impacts to water quality and aquatic habitat. The products and educational efforts produced during the “Developing Administrative Tools and Authority for Stormwater Management in the Grand Rapids Metropolitan Area” project will be crucial in assisting with the NPDES Phase II.

Appendix C

Guide and Description of Structural and Vegetative BMPs

Guide and Description of Structural and Vegetative BMPs

BMP	Description	Applicability	Approach	Effectiveness	Cost Considerations
Detention Basins	Either natural or man-made to receive and store storm water runoff. Detention basins are either wet or dry between storage periods.	Installed to minimize erosion, reduce flooding, and provide for pollutant removal. Effective for drainage of larger watershed areas (7+ acres).	Designed to release runoff water to a surface water body or storm sewer at a controlled discharge rate.	Not effective for removing pollutants. Pollutants that settle may be transported by future flooding.	Larger ponds are generally less expensive to construct per cubic foot.
Extended Detention Basin (Figure 6)	Designed for flood control by receiving and detaining storm water runoff for up to 48 hours reducing peak discharges from frequent events.	A two-stage outlet reduces peak discharges in urban areas from frequent, less intensive rainfall events. Maintains or increases base flows.	Easily modified to provide greater treatment of storm water quality and enhanced pollutant removal. Provides downstream channel protection if the appropriate design storm is selected and adequate upstream pretreatment is incorporated.	Reasonably effective in removing sediment and other pollutants associated with particulate matter. Not effective in removing soluble pollutants, such as nitrogen and phosphorus.	Costs include creating separate inlets and outlets to eliminate a short circuit flow and to improve catching and treating first flush flows.
Wet Detention (Figure 7)	Permanent pool of water completely or partially displaced by storm water received.	Provide increased pollutant removal in comparison to a dry detention basin.	Must keep a positive drainage flow through basin. Used in larger (7+ acres) drainage areas.	Wetland vegetation effectively removes nutrients and other pollutants.	Exhibits greater pollutant removal than other storm water practices at a lower cost per volume treated.
Sediment Trap (Figure 3)	Device installed at inlets or outfall points.	Removes sediment from water flows.	Installed as a pretreatment practice to enhance basin performance.	Effective as a pretreatment practice to remove sediment.	Can be costly if trap needed at each inlet. Maintenance required to remove accumulated sediment.
Constructed Storm Water Wetlands (Table 3 & 4)	Man-made basin with a significant percentage covered by wetland vegetation.	Saturated by surface or groundwater.	Characterized by a prevalence of vegetation that is adopted for life in saturated soil conditions.	Best treatment fo water quality since plants remove nutrients for growth. Provides wildlife habitat.	May need added expense of liner if soils are permeable.
Swales and Filter Strips	Channels or flat surfaces widely used in residential developments.	Direct flows into primary drainage channels and allows some infiltration into the ground surface.	At least seasonally wet and heavily vegetated.	Provide excellent pollutant removal when water depths are shallower then height of thick turf.	Continued maintenance costs to keep thick turf or grasses healthy.
Infiltration Basins	Natural or man-made facility located over permeable soils to receive and store runoff and discharge into the ground..	Removes coarse to fine sediment and associated pollutants.	Sites must have pervious soils. Better for smaller sites.	Not as effective at removing pollutants and could contaminate groundwater.	Costs include design, construction, and maintenance.
Grassed Waterways	Either natural or man-made watercourses consisting of vegetated banks and bottom designed to accommodate concentrated flows without erosion.	Grassed waterways should be used for conveyance of storm water runoff in area of low-risk of groundwater contamination.	Design must use appropriate sizing, with considering right-of-way restrictions.	The vegetation in the waterways reduces runoff velocity, filters sediment, and absorbs pollutants prior to infiltration or discharge to surface waters.	
Other Media Infiltration	Settling basin to remove particulate and/or dissolved pollutants, which outlets to filter of sand or other media.	Used at sites where space is limited or unsuitable for vegetation	Design to minimize clogging and facilitate cleaning	Removes suspended materials. Can be used with almost any soil type.	Generally more expensive than basins are more maintenance required. Designs continue to evolve
Oil and Grit Separators (Figure 8)	Structures remove concentrations of petroleum compounds, grease, and grit through gravity or coalescing plates.	Used in areas of high potential for accidental spill or where hazardous materials discharge into storm sewer system.	On small sites, with a high risk designation, separators may be the only practical solution to incorporate groundwater and surface water protective measures into the system.	These are not generally recommended. Structures must be frequently inspected and cleaned to function properly and provide water quality benefits.	High design and maintenance costs.
Culvert	Directs water flow below the ground level through covered channel or large diameter pipe.	Evaluated for condition to handle additional flows of proposed development. May provide storage if capacity is exceeded.	Type, location, and size of upstream and downstream culverts should be known.	May restrict flows.	Costs include design, construction and maintenance.

Appendix D

Impacts of Nonpoint Source Pollutants on Designated Uses

Designated Uses

Pollutants	Agriculture (drainage/irrigation)	Industrial Water Supply	Public Water Supply	Navigation	Fishery Warmwater/Coldwater		Other Aquatic Life and Wildlife	Partial Body Contact Recreation	Total Body Contact Recreation (May 1 through October 31)
Sediment	Restricts drainage Reduces storage capacity Clogs irrigation	Restricts intake pipes Reduces channel capacity	Restricts intake pipes	Restricts channels	Covers spawning areas Clogs fish gills Limits food supply Reduces light penetration	Covers spawning areas Clogs fish gills Limits food supply Reduces light penetration	Covers substrate Decreases food supply Diminishes species diversity	Unpleasant conditions Interferes with aesthetic enjoyment	Reduces water clarity
Nitrogen	Elevated levels cause excessive algae and aquatic weed growth Leaches to underground water		Converts to nitrates, contaminates groundwater		Reduces dissolved oxygen	Reduces dissolved oxygen	Beds of algae block out sunlight to aquatic life	Eutrofication of lakes, reducing recreation opportunities Excessive algae creates problems for boating	Eutrofication of lakes, reducing recreation opportunities Excessive algae decreases swimming pleasure
Phosphorus	Elevated levels cause excessive algae and aquatic weed growth							Eutrofication of lakes, reducing recreation opportunities Excessive algae creates problems for boating	Eutrofication of lakes, reducing recreation opportunities Excessive algae decreases swimming pleasure
Organic Matter	Clogs inlets	Clogs inlets	Clogs infiltration	Debris causes obstructions in channel	Lowers dissolved oxygen levels	Lowers dissolved oxygen levels	Excessive amounts lower dissolved oxygen levels		
Metals (copper, lead, cadmium, and zinc)				Contaminates drinking water supply		Direct toxic impact to freshwater aquatic life	Direct toxic impact to freshwater aquatic life	Acute and chronic degradation	Degrades appearance of water surfaces
Trash and Debris				Obstacles and nuisances					
Biological Oxygen Demand					Decreases readily available oxygen to aquatic organisms	Fish kills	Decreases readily available oxygen to aquatic organisms		
Manure									
Pathogens (Bacteria)					Threatens fish harvests Bacteria multiply faster in warmer water	Threatens fish harvests	Introduces diseases	Introduces bacteria or viruses causing human disease Closes beaches due to health hazard Causes unpleasant odors	Introduces bacteria or viruses causing human disease Closes beaches due to health hazard Causes unpleasant odors
Pesticides	Leaches to groundwater				Accumulates in sediment Bioaccumulates in fish, passed up food chain	Accumulates in sediment Bioaccumulates in fish, passed up food chain	Acute die-offs		

Petroleum, oil & grease (Hydrocarbons)					Very soluble. Toxic to freshwater organisms not able to withstand salty conditions	Very soluble. Toxic to freshwater organisms not able to withstand salty conditions	Very soluble. Toxic to freshwater organisms not able to withstand salty conditions		
Salts (Chlorides)	Toxic to crops				Elevated temperatures stress fish and aquatic insects	Changes species composition Fish kills	Elevated temperatures increase metabolic and reproductive rates throughout the food chain causing imbalance in ecosystem		
Temperature									
Flow									
High	Flooding				Flooding disrupts habitat	Flooding disrupts habitat	Reduces diversity	Creates dangerous conditions	Creates dangerous conditions
Low	Limits supply for irrigation	Limits supply for intake	Limits supply for intake	Reduces passages	No base flow limits populations	No base flow limits populations	Reduces diversity	Alters access sites, reduces boating opportunities	Reduces opportunities for enjoyment

Appendix E

Median Pollutant Removal (%) of Stormwater Practices

Table E.1 Median Pollutant Removal (%) of Stormwater Treatment Practices

	TSS	TP	Sol P	TN	NOx	Cu	Zn
Stormwater Dry Ponds	47	19	-6.0	25	4.0	26[1]	26
Stormwater Wet Ponds	80 (67)	51 (48)	66 (52)	33 (31)	43 (24)	57 (57)	66 (61)
Stormwater Wetlands	76 (78)	49 (51)	35 (39)	39 (21)	67 (67)	40 (39)	44 (54)
Filtering Practices[2]	86 (87)	59 (51)	67 (31)	38 (44)	-14 (-13)	49 (39)	89 (80)
Infiltration Practices	95[1]	70	85[1]	51	82[1]	N/A	99[1]
Water Quality Swales[3]	81 (81)	34 (29)	38 (34)	84[1]	31	51 (51)	71 (71)

1. Data based on fewer than five data points
2. Excludes vertical sand filters and filter strips
3. Refers to open channel practices designed for water quality

NOTES:
- Data in parentheses represent values from the First Edition (Schueler, 1997; Appendix D).
- Shaded regions indicate a difference of at least ± 5% from the First Edition.
- N/A indicates that the data are not available.
- TSS = Total Suspended Solids; TP = Total Phosphorus; Sol P= Soluble Phosphorus; TN = Total Nitrogen; NOx = Nitrate and Nitrite Nitrogen; Cu = Copper; Zn = Zinc

The statistical reanalysis of the First Edition revealed some changes in the pollutant removal efficiencies of STPs (Table E.1). These changes can be attributed to the addition of new studies and revisions to the older studies. Most of the shaded regions represent a pollutant removal increase of at least 5%. Three exceptions are nitrogen removal for filtering practices, which decreased by 16%; and zinc and soluble phosphorus removal of stormwater wetlands, which decreased by 18% and 10% respectively. The STP group with the greatest change over original data is filtering practices. This result is not surprising, since a significant number of changes were made to this group (five studies were added to the original 14). In particular, the negative soluble phosphorus in the original was caused by a few values from organic filters, and from one perimeter filter that had become submerged, releasing soluble phosphorus.

Table E.2 Median Effluent Concentration (mg/L)[1] of Stormwater Treatment Practice Groups

	TSS	TP	OP	TN	NOx	Cu	Zn
Stormwater Dry Ponds	28[2]	0.18[2]	0.13[2]	0.86[2]	N/A[3]	9.0[2]	98[2]
Stormwater Wet Ponds	17	0.11	0.03	1.3	0.26	5.0	30
Stormwater Wetlands	22	0.20	0.09	1.7	0.36	7.0	31
Filtering Practices[3]	11	0.10	0.08	1.1[2]	0.55[2]	10	21
Infiltration Practices	17[2]	0.05[2]	0.003[2]	3.8[2]	0.09[2]	4.8[2]	39[2]
Water Quality Swales[4]	14	0.19	0.08	1.1[2]	0.35	10	53

1. Units for Zn and Cu are micrograms per liter
2. Data based on fewer than five data points
3. Excludes vertical sand filters and filter strips
4. Refers to open channel practices designed for water quality

NOTES:
- N/A indicates that the data is not available.
- TSS = Total Suspended Solids; TP = Total Phosphorus; OP = Ortho-Phosphorus; TN = Total Nitrogen; NOx = Nitrate and Nitrite Nitrogen; Cu = Copper; Zn = Zinc

Median effluent concentrations by STP groups are summarized in Table E.2. Effluent concentration data were added to the Database as a supplement to the pollutant removal capability of STPs. In some instances, pollutant removal percentage may not be a good indicator of the overall removal capability of a STP. Pollutant removal percentages can be strongly influenced by the variability of the pollutant concentrations in incoming stormwater. If the concentration is near the "irreducible level" (Schueler, 1996), a low or negative removal percentage can be recorded even though outflow concentrations discharged from the STP were relatively low. Although these data represent a median, unlike the group mean reported in Schueler (1996), the data suggest that the typical concentration data reported in this initial study and are high compared with the results from the Database (see Appendix E).

The data presented in this study support the contention that most STP designs can remove significant amounts of sediment and total phosphorus in urban runoff. Most STP groups, on the other hand, showed a lower ability to remove nitrogen. This result suggests that non-structural nutrient reduction methods, in addition to stormwater STPs, may be needed to meet nutrient reduction targets.

Appendix F

Conservation Easements

DEQ DEPARTMENT OF ENVIRONMENTAL QUALITY	OPERATING PROCEDURE LAND AND WATER MANGEMENT DIVISION	NUMBER: Admin-99-02 PAGE: 1 of 2
SUBJECT: Conservation Easement Processing		EFFECTIVE DATE: 10/25/99
SECTION AND/OR UNIT: Administration Section	APPROVAL SIGNATURE: Original signed by Richard A. Powers TITLE: Chief, Land and Water Management Division	ALSO SEE:

PURPOSE: Provide guidance to Division staff regarding the processing of conservation easements.

Background: The Division receives 40-50 conservation easements annually, generally in fulfillment of permit conditions. The conservation easements are conveyances of interests in real property and must be properly handled to be valid. Therefore, the division establishes the following procedures for processing conservation easements.

WHO	DOES WHAT
DISTRICT STAFF	Requires mitigation as a permit condition and a conservation easement.
APPLICANT	Submits executed conservation easement to District Staff.
DISTRICT STAFF	Reviews the easement to check compliance with the permit conditions. If the executed easement fulfills the permit conditions, District Staff will submit the executed easement to the Conservation Easement Coordinator (CEC).
CONSERVATION EASEMENT COORDINATOR	Reviews the easement for compliance with substantative and formatting requirements and enters it in the database. The CEC may also request a check of the legal description from the Great Lakes Submerged Lands Unit.
CONSERVATION EASEMENT COORDINATOR	- If the easement is satisfactory, the CEC transmits it to the Division Chief for signature. - If the easement needs changes, the CEC contacts the Grantor regarding the necessary changes.
DIVISION CHIEF	Signs and returns to the CEC.
DIVISION CHIEF SECRETARY OR OTHER NOTARY	Notarizes the Division Chief's signature.
CONSERVATION EASEMENT COORDINATOR	Signs the easement as the second witness.
CONSERVATION EASEMENT COORDINATOR	Requests a check for recording fees from accounting.
ACCOUNTING	Processes a check for recording fees and notifies the CEC when it is ready.

DEQ DEPARTMENT OF ENVIRONMENTAL QUALITY	OPERATING PROCEDURE LAND AND WATER MANGEMENT DIVISION	NUMBER: Admin-99-02 PAGE: 2 of 2
SUBJECT: Conservation Easement Processing		EFFECTIVE DATE:

WHO	DOES WHAT
CONSERVATION EASEMENT COORDINATOR	Sends the original executed easement and the check, along with a form cover letter, to the Register of Deeds. The letter requests the return of the original easement to the CEC.
REGISTER OF DEEDS	Records the easement and returns to the CEC – *or* – Returns the easement for correction.
CONSERVATION EASEMENT COORDINATOR	- If the easement has been recorded, the CEC enters that information in the database and makes two copies. One copy is sent to the Grantor and one is sent to the District Staff assigned to the file. The original is placed in the CEC's Lansing files. - If the easement has been returned for corrections, the CEC contacts the Grantor for correction. Once the corrections are made, the CEC resubmits the easement to the Register of Deeds.
CONSERVATION EASEMENT COORDINATOR	When the easement has been properly recorded, the CEC will get the information entered into CIWPIS.

CONSERVATION EASEMENT

THIS CONSERVATION EASEMENT, made this _____ day of _____, 20___, by and between _____ _____(name) married/single (*circle one*), or corporation, partnership, or limited liability company (*circle one*), whose address is, _____ _____ _____(hereafter "Grantor") and the Michigan Department of Environmental Quality (MDEQ), whose address is, P.O. Box 30458, Lansing, Michigan 48909-7958 (hereafter "Grantee");

WITNESSETH, for and in consideration of the sum of One and No/100ths Dollar ($1.00), the receipt of which is acknowledged, GRANTOR hereby GRANTS AND CONVEYS TO GRANTEE a Conservation Easement pursuant to Subpart 11 of Part 21, Conservation and Historic Preservation Easement, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.2140 et. seq., on the terms and conditions stated below.

1. The premises subject to this Conservation Easement (hereafter "the Easement Premises") are situated in the (*circle one*) township/city of _____, _____ County, Michigan and are legally described as follows:

   (Insert legal description including amount of acreage here or attach as Exhibit A)

   (A map depicting the Easement Premises is attached as Exhibit B)

2. The purpose of this Easement is to protect the wetland functions and values existing (or established on the property for MDEQ Permit _____-_____-_____ as permitted____/____/20___) on the Easement Premises. Grantor shall maintain the Easement Premises in their natural and undeveloped condition.

3. Except as authorized under MDEQ Permit _____-_____-_____ and Paragraph 4, Grantor shall refrain from altering or developing the Easement Premises in any way. This includes, but is not limited to, the alteration of the topography, the placement of fill material, the dredging, removal, or excavation of any soil or minerals, the draining of surface water, the construction or placement of any structure, plowing, tilling, or cultivating, and the alteration or removal of vegetation.

4. With the prior approval of the Grantee, the Grantor may perform activities associated with the construction or maintenance of a mitigation project within the Easement Premises. Grantor shall provide 5 days notice of undertaking any mitigation activity even if the mitigation project has been conceptually approved. Any activities undertaken pursuant to this paragraph shall be performed in a manner to minimize the adverse impacts to existing wetland or mitigation areas.

5. This Conservation Easement does not grant or convey to Grantee or members of the general public any right of ownership, possession, or use of the Easement Premises.

6. Upon reasonable notice to Grantor, Grantee, and its authorized employees and agents, may enter upon and inspect the Easement Premises to determine whether they are being maintained in compliance with the terms of this Conservation Easement.

7. This Conservation Easement may be enforced by either an action at law or in equity and shall be enforceable against the owner of the Easement Premises or any other person despite a lack of privity of estate or contract.

8. This Conservation Easement shall run with the land in perpetuity unless modified or terminated by written agreement of the parties.

9. Grantor shall indicate the existence of this Conservation Easement on all deeds, mortgages, land contracts, plats, and any other legal instrument used to convey an interest in the Easement Premises.

10. Within 90 days after this Conservation Easement is executed, Grantor, at its sole expense, shall place signs, fences, or other suitable markings along the boundary of the Easement Premises to clearly demarcate the boundary of the Easement Premises.

11. This Conservation Easement shall be binding upon the successors and assigns of the parties.

IN WITNESS WHEREOF, the parties have executed this Agreement on the date first above written.

Signed in the presence of:

Signature:_____

_____
Type/Print Witness' Name

Signature:_____

_____
Type/Print Witness' Name

(Grantor)

Signature:_____

_____
Type/Print Grantor's Name

_____
Title (if signing on behalf of an organization)

STATE OF MICHIGAN}
} ss
COUNTY OF }

IF SIGNING ON BEHALF OF AN ORGANIZATION, THIS MUST BE COMPLETED.

The foregoing instrument was acknowledged before me this _____ day of _____, 20___
by _____, (name(s)) the _____, (title) of
a _____, (state/country) _____ (organization name)
corporation, partnership, or limited liability company (*circle one*), on behalf of the organization.

_____

Notary Public
_____County, Michigan

My Commission Expires: _____

IF SIGNING AS AN INDIVIDUAL OR MARRIED PERSON, THIS MUST BE COMPLETED.

The foregoing instrument was acknowledged before me this _____ day of _____, 20____

by _____, (name(s)) _____ (marital status).

_____

Notary Public
_____County, Michigan

My Commission Expires: _____

(Grantee)
STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LAND AND WATER MANAGEMENT DIVISION

Signature: _____ _____

Richard A. Powers, Its Chief

_____
Type/Print Witness' Name

Signature:_____

_____
Type/Print Witness' Name

STATE OF MICHIGAN}

} ss

COUNTY OF INGHAM}

The foregoing instrument was acknowledged before me this ___ day of _____, 20_____, by _____, Land and Water Management Division Chief, State of Michigan, on behalf of the Michigan Department of Environmental Quality.

_____

Notary Public
_____, County, Michigan

My Commission Expires: _____

Drafted by:

The Honorable Jennifer M. Granholm,
Attorney General
Department of Attorney General
Natural Resources and Environmental Quality
P.0. Box 30212
Lansing, MI 48909

After recording, return to:

Land and Water Management Division
Michigan Department of Environmental Quality
P.O. Box 30458
Lansing, MI 48909-7958

(August 1, 2001)

Appendix G

Detailed Criteria Guidelines

DETAILED CRITERIA GUIDELINES

CRITERIA	**ZONE A (Sensitive)**	**ZONE B (Impacted)**	**ZONE C (Conveyance)**
1. Receiving water resource characteristics (rivers, lakes, and streams).	• Abundant riparian vegetation • Undeveloped floodplain • A natural channel with stable stream morphology or an undeveloped lake with wetland fringe.	• Riparian vegetation variable in abundance • Some development within the floodplain • Natural channel stream is unstable with evidence of multiple erosion sites.	• Riparian vegetation lacking in many places • Highly developed floodplain • Natural stream channel morphology is very unstable where stream bank erosion is common. • Storm sewers or lined channels provide the majority of conveyance and adequate capacity is necessary to control flooding.
2. Is the receiving stream a designated trout stream?	**Yes**		
3. Is the receiving stream protected under the Natural Rivers Act of 1970?	**Yes**		
4. Percent imperviousness of watershed.	<10%	10-25%	>25%

DETAILED CRITERIA GUIDELINES (CONTINUED)

CRITERIA	ZONE A (Sensitive)	ZONE B (Impacted)	ZONE C (Conveyance)
5. What is the present land use/cover condition of the watershed?	Typically natural conditions or pervious surfaces dominate (forest, parks, open field, greenspace etc.) the landscape. Development in the watershed is usually low density and widely dispersed.	Typically low to medium density residential, urban and built-up uses. Higher density development occurs in small areas. Natural areas are evident but may be small and fragmented.	Urban and Built-up uses dominate. High amounts of impervious surfaces are present.
6. Location of the development within the watershed.	Typically, an area in the upper watershed with natural drainage patterns and headwater streams.	Areas throughout the watershed where detention provides adequate stormwater management.	Areas in close proximity to lakes or rivers where detention can be waived without increasing the risk of flooding.
7. Stormwater infrastructure capacity within the receiving stream.	The presence of artificial structures (culverts) is limited. If present they do not restrict flows.	Artificial structures are common. Some culvert sizes tend to limit flows at certain points in the stream.	Storm sewer system provides the majority of conveyance.

Appendix H

Rainfall Curves

MANNING'S 'n' VALUES

RECOMMENDED MANNING'S 'n' VALUES
FOR ARTIFICIAL OPEN CHANNELS

Lining Category	Lining Type	'n' Value for Depth of Flow Ranges 0-0.5 ft	0.5-2.0ft	>2.0ft
Rigid	Concrete (Broom or Float Finish)	0.015	0.013	0.013
	Gunite	0.022	0.020	0.020
	Grouted Riprap	0.040	0.030	0.028
	Stone Masonry	0.042	0.032	0.030
	Soil Cement	0.025	0.022	0.020
	Asphalt	0.018	0.016	0.016
Unlined	Bare Soil	0.023	0.020	0.020
	Rock Cut	0.045	0.035	0.025
Temporary	Woven Paper Net	0.016	0.015	0.025
	Jute Net	0.028	0.022	0.019
	Fiberglass Roving	0.028	0.021	0.019
	Straw with Net	0.065	0.033	0.025
	Curled Wood Mat	0.066	0.035	0.028
	Synthetic Mat	0.036	0.025	0.021
Gravel Riprap	1-inch (2.5-cm) d_{50}	0.044	0.033	0.030
	2-inch (5-cm) d_{50}	0.066	0.041	0.034
Rock Riprap		$n=0.0395\ (d_{50})^{1/6}$ d_{50} = Diameter of stone for which 50 percent, by weight, of the gradation is finer, in feet		

RAINFALL DATA
for the
CITY of GRAND RAPIDS

* Data from "Rainfall Frequency Atlas of the Midwest" by Floyd A. Huff and James R. Angel, Bulletin 71, Midwestern Climate Center, National Weather Service, NOAA, 1992

RAINFALL IN INCHES

		<---------- Recurrence Intervals ---------->						
Duration	**Hours**	**1-year**	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
5-min.	0.08	0.23	0.28	0.36	0.42	0.53	0.63	0.74
10-min.	0.17	0.41	0.50	0.63	0.74	0.93	1.11	1.29
15-min.	0.25	0.53	0.64	0.81	0.95	1.20	1.42	1.66
30-min.	0.50	0.72	0.88	1.11	1.30	1.65	1.95	2.28
1-hr.	1.00	0.92	1.11	1.41	1.65	2.09	2.48	2.89
2-hr.	2.00	1.13	1.37	1.74	2.04	2.58	3.06	3.57
3-hr.	3.00	1.25	1.52	1.92	2.25	2.85	3.37	3.94
6-hr.	6.00	1.46	1.78	2.25	2.64	3.34	3.95	4.61
12-hr	12.00	1.70	2.06	2.61	3.06	3.87	4.58	5.35
18-hr.	18.00	1.83	2.23	2.82	3.31	4.18	4.95	5.78
24-hr.	24.00	1.95	2.37	3.00	3.52	4.45	5.27	6.15
48-hr.	48.00	2.15	2.63	3.32	3.91	4.93	5.83	6.82

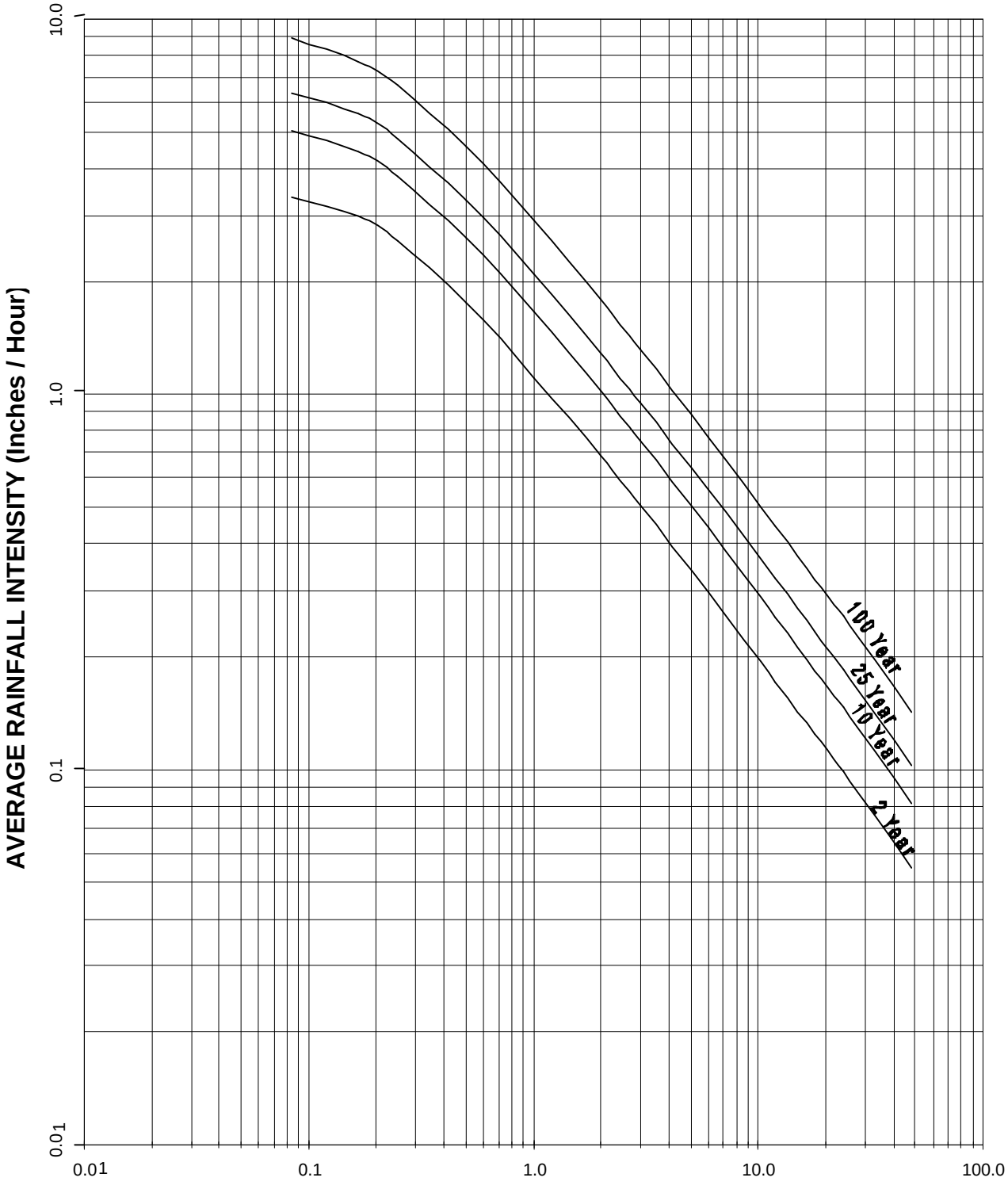
RAINFALL INTENSITIES
IN INCHES PER HOUR

		←---------- Recurrence Intervals ----------→						
Duration	**Hours**	**1-year**	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
5-min.	0.08	2.76	3.36	4.32	5.04	6.36	7.56	8.88
10-min.	0.17	2.46	3.00	3.78	4.44	5.58	6.66	7.74
15-min.	0.25	2.12	2.56	3.24	3.80	4.80	5.68	6.64
30-min.	0.50	1.44	1.76	2.22	2.60	3.30	3.90	4.56
1-hr.	1.00	0.92	1.11	1.41	1.65	2.09	2.48	2.89
2-hr.	2.00	0.57	0.69	0.87	1.02	1.29	1.53	1.79
3-hr.	3.00	0.42	0.51	0.64	0.75	0.95	1.12	1.31
6-hr.	6.00	0.24	0.30	0.38	0.44	0.56	0.66	0.77
12-hr	12.00	0.14	0.17	0.22	0.26	0.32	0.38	0.45
18-hr.	18.00	0.10	0.12	0.16	0.18	0.23	0.28	0.32
24-hr.	24.00	0.08	0.10	0.13	0.15	0.19	0.22	0.26
48-hr.	48.00	0.04	0.05	0.07	0.08	0.10	0.12	0.14

RAINFALL

INTENSITY - DURATION - FREQUENCY CURVES

* Based on "Ratnfall Frequency Atlas of the Midw est" by Floyd Huff and James Angel, Bulletin 71, NWS, NOAA, 1992



November 10, 1998

Appendix I

Checklist for Stormwater Plan Review

CHECKLIST FOR STORM WATER PLAN REVIEW

	Provided/ Satisfactory	Comments
General		
1. Project or Plat Name.	_____	_____
2. Site Address.	_____	_____
3. Location Map.	_____	_____
4. Proprietor's Name, Address, Telephone Number, and FAX Number.	_____	_____
5. Engineer/Architect/Surveyor's Name, Address, Telephone Number, and FAX Number.	_____	_____
6. North Arrow and Scale (Scale: 1 inch =100 feet or larger scale).	_____	_____
7. Project or Plat Boundary.	_____	_____
8. Identification of all adjoining Parcels (for subdivisions show lot number, subdivision name, liber, and page numbers; for metes and bounds parcels show permanent parcel number).	_____	_____
9. Overall Property Description Metes and Bounds (with ties to government corner).	_____	_____
10. Lot Dimensions (scaled or computed).	_____	_____
11. Lot Numbers.	_____	_____
12. Building Setback Lines.	_____	_____
Topographical		
13. Existing Buildings (label those under construction with address and minimum building opening elevation).	_____	_____
14. Existing and Proposed Roads (name, ROW width, and type of surface).	_____	_____
15. Existing and Proposed Land Surface Contours (minimum 2.0-foot contour interval referenced to a national datum).	_____	_____

16. Preliminary Draft of the Block Grading Plan and Plat Restrictions (per KCDC standards). _____ _____
17. Available Soils Data, Soil Boring Logs, and Locations (include ground elevation and water table information). _____ _____

Drainage

18. Offsite Watershed Areas (with boundaries and acreage to be shown on the required location map). _____ _____
19. Existing Creeks, Stream, Ditches, and Other Surface Drainageways. _____ _____
20. All Existing Drainage Courses and Structures (with proper labeling as to type, size, invert elevation, and ownership). _____ _____
21. County, Municipal, MDOT, and Private Drains (permission required to connect). _____ _____
22. Proposed Drainage Systems (clearly identify all open and enclosed portions, size, and proposed ownership). _____ _____
23. Floodplain Contour. _____ _____
24. Wetland Boundaries. _____ _____
25. Existing and Proposed Utilities. _____ _____
26. Proposed Storm Water Detention/Infiltration Basins. _____ _____
27. Site’s Storm Water Runoff Discharge Location (including roof water). _____ _____

Storm Water Design

28. Calculations for: (1) Detention, (2) Sewer Capacity, (3) Overflow Protection. _____ _____
29. Inlet Capacity/Spacing. _____ _____
30. Adequate Size/Slopes. _____ _____
31. Pipe. _____ _____
32. Material. _____ _____
33. Submergence. _____ _____
34. Outlet Erosion Control. _____ _____
35. HWL in Relation to Spillway Elevation. _____ _____

Detention/Infiltration Basins

36. Required Volume/Release Rate. _____ _____
37. Adequate Volume Provided. _____ _____
38. Side Slopes. _____ _____
39. Overflow Spillway & Emergency Overflow Floodway. _____ _____
40. Hydraulic Calculations for Transfer or Outlet Pipe. _____ _____
41. Minimum Basement Floor Elevations & Minimum Building Opening Elevations Established. _____ _____
42. Subsurface Storage. _____ _____

Easements

43. Existing and Proposed Utility Easements (labeled with dimensions, purpose, and easement recipient). _____ _____
44. Existing and Proposed Drainage Easements. _____ _____
45. Offsite Drainage Easements or Right-of-way. _____ _____
46. Existing and Proposed Access to the Property and Drainage Structures. _____ _____

Additional Development Facilities

47. Existing and Proposed Paved/Parking/Loading/Sidewalks/Patios Areas. _____ _____
48. Areas Dedicated for Public Use (open spaces, parks, out-lots, walkways, and conservation easements). _____ _____
49. Existing and Proposed Landscaping, Fencing, and Signage. _____ _____

Maintenance

50. Identification of Agency Proposed to Assume Ownership of the Drainage System (including the detention and/or infiltration basins). _____ _____

Fee

51. Development Fee. _____ _____