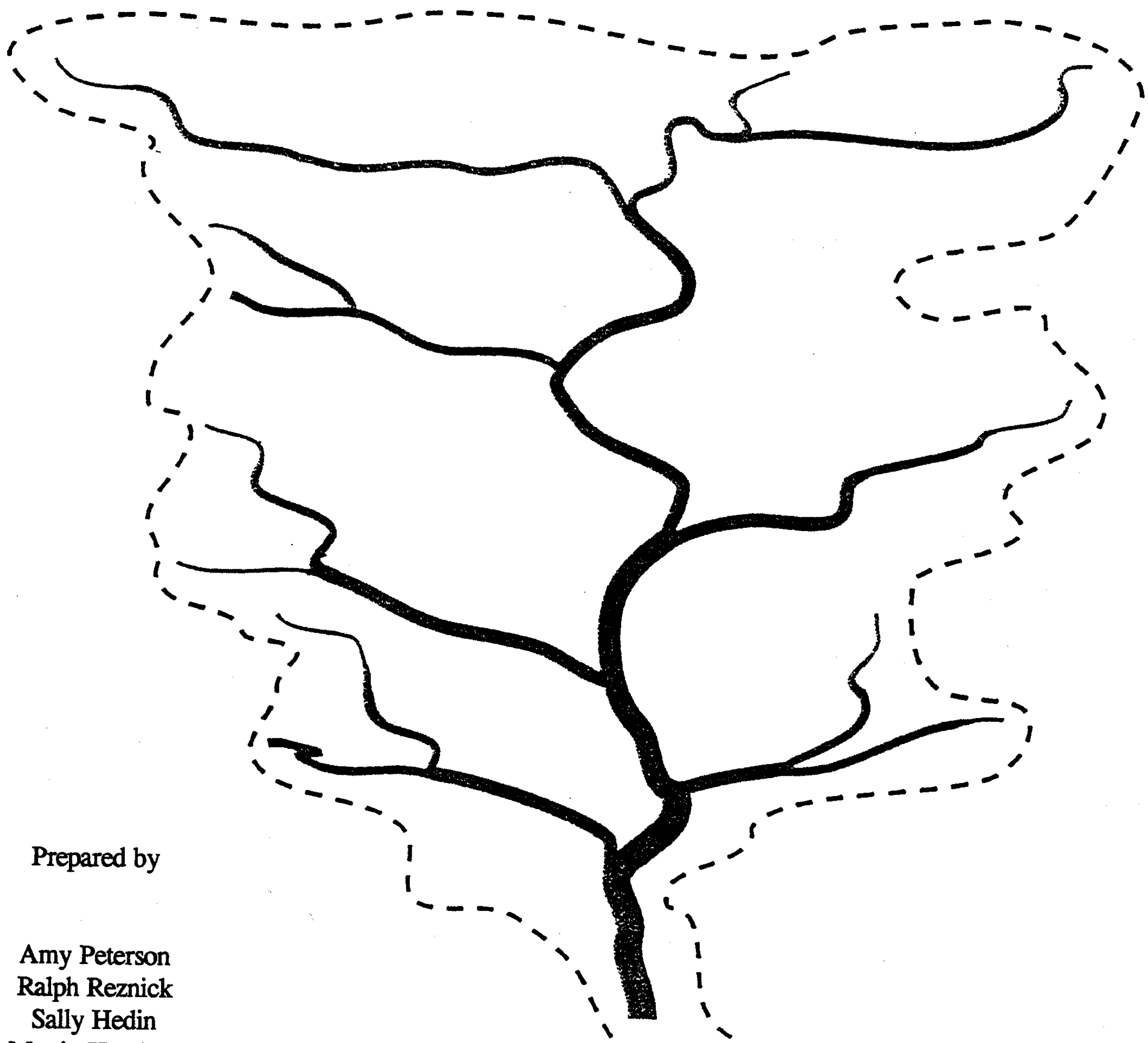
Guidebook of Best Management Practices for Michigan Watersheds

Reprinted October, 1998



Prepared by

Amy Peterson
Ralph Reznick
Sally Hedin
Martin Hendges
Dennis Dunlap

Michigan Department of Environmental Quality,
Surface Water Quality Division
Russell J. Harding, Director
John Engler, Governor

ACKNOWLEDGMENTS

Staff of the Michigan Department of Environmental Quality (MDEQ), Nonpoint Source Program, would like to thank everyone who helped in the development of this manual. The Appendices contain a list of the members of three technical committees which were instrumental both in developing and reviewing the various Best Management Practices (BMPs) and the Guidebook. In addition to these people, numerous other individuals offered support and assistance. Special thanks are extended to: Dave Bastian, MDEQ, Land and Water Management Division; Steve Davis, USDA, Soil Conservation Service; Jerry Fulcher, MDEQ, Land and Water Management Division; Dick Mikula, MDEQ, Land and Water Management Division; Dave Hamilton, MDEQ, Land and Water Management Division; Greg Lyman, Michigan State University, Cooperative Extension Service; Mike O'Malley and Doug Proper, Michigan Department of Transportation; Gary Rinkenberger, USDA, Soil Conservation Service; Frank Rossi, Michigan State University, Cooperative Extension Service; John Price, Price and Company, Inc.

Special thanks also go to MDEQ secretarial staff which made this project possible: Penny Stockel, Barb Wilcox, and Veronica Willard.

GUIDEBOOK CONTENTS

FOREWORD

This manual was prepared to help developers, contractors, city and township planners, engineers, architects and local citizens to control runoff* from construction sites, urban areas, and large recreational areas. Our goal is to provide people with a tool which can be used to help plan development projects in a way which will maintain the integrity of lakes, streams, wetlands and groundwater, and to reduce the pollutant loads to these waters. The concepts in this manual may also be used in developed areas to protect or improve water quality.

The manual was written in response to a need to address runoff and wind-generated pollution in Michigan. This diffuse, intermittent pollution is called nonpoint source pollution, and is usually contrasted with point sources which come from pipes (i.e. from areas such as waste water treatment plants, large businesses, etc.). Since point sources have been addressed nationally since the early 1970s, nonpoint sources remain the most significant challenge in protecting and preserving our surface and groundwaters. Other nonpoint sources which are being addressed in the state include agricultural operations, and forest harvesting activities.

The primary mechanism used to prevent nonpoint sources from impacting watersheds is Best Management Practices (BMPs). These are structural, vegetative or managerial practices used to protect and improve our surface waters and groundwaters. BMPs for urban areas, construction sites and golf courses were written in conjunction with this guidebook. BMPs will be updated as often as deemed necessary and when funding is available. A separate supplement for golf courses is available from the MDEQ, Nonpoint Source Unit.

If you have comments or questions on the concepts presented in this manual, or on the Best Management Practices, feel free to contact the Nonpoint Source Unit at 517-373-2867, or any of the district staff listed in Figure 1.

We look forward to working with you to continue protecting and preserving our surface waters.

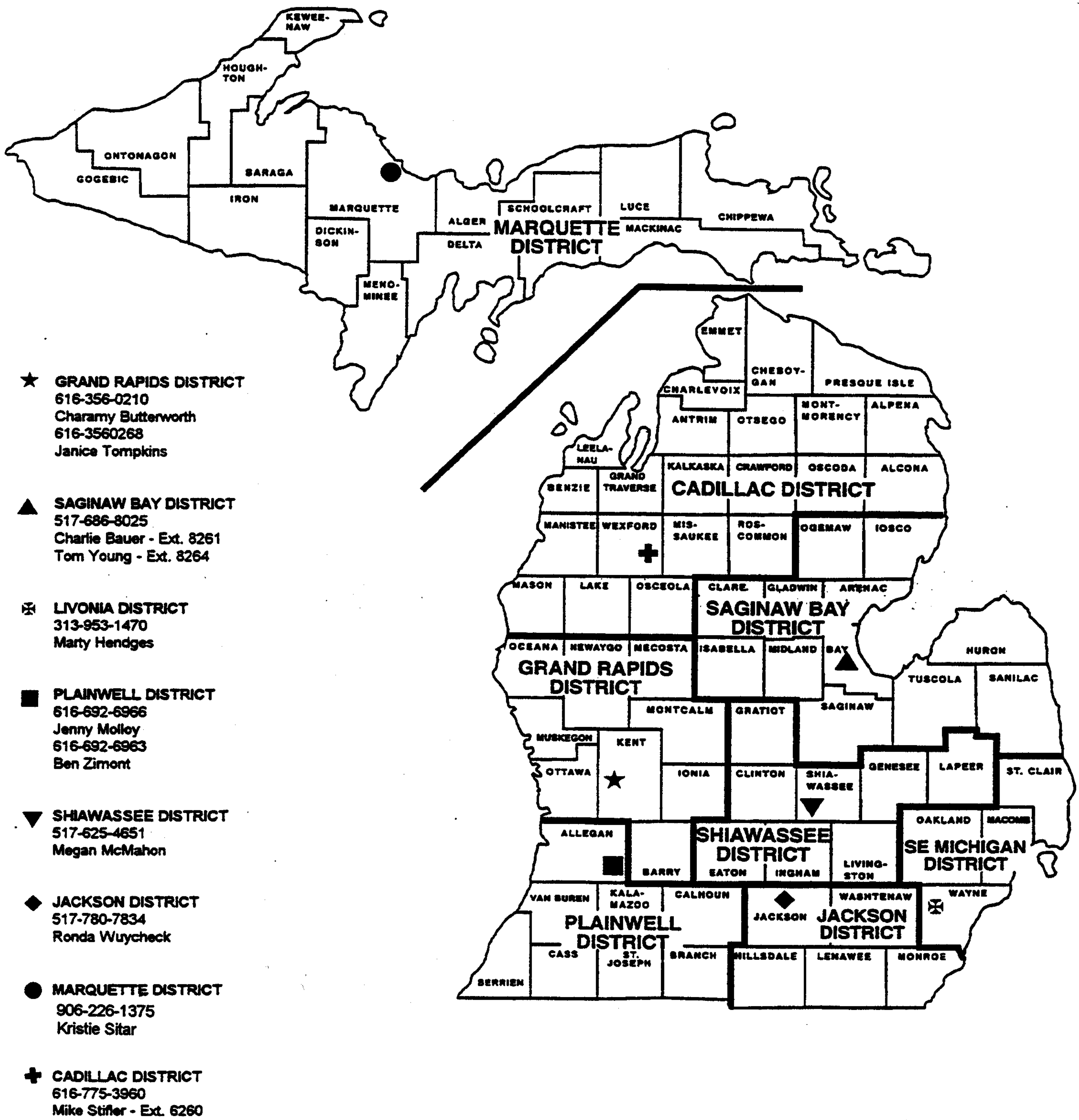
Note: For the purpose of this manual, a “surface water” is any body of water, including lakes, streams, rivers, and wetlands.

---

*Runoff: Rainwater, snow melt or irrigation which does not infiltrate into the ground and runs over or "off' the land, picking up soil particles and other pollutants as it goes and carrying them to surface waters.

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
District Boundaries and Offices

John Engler, Governor ♦ Russell J. Harding, Director



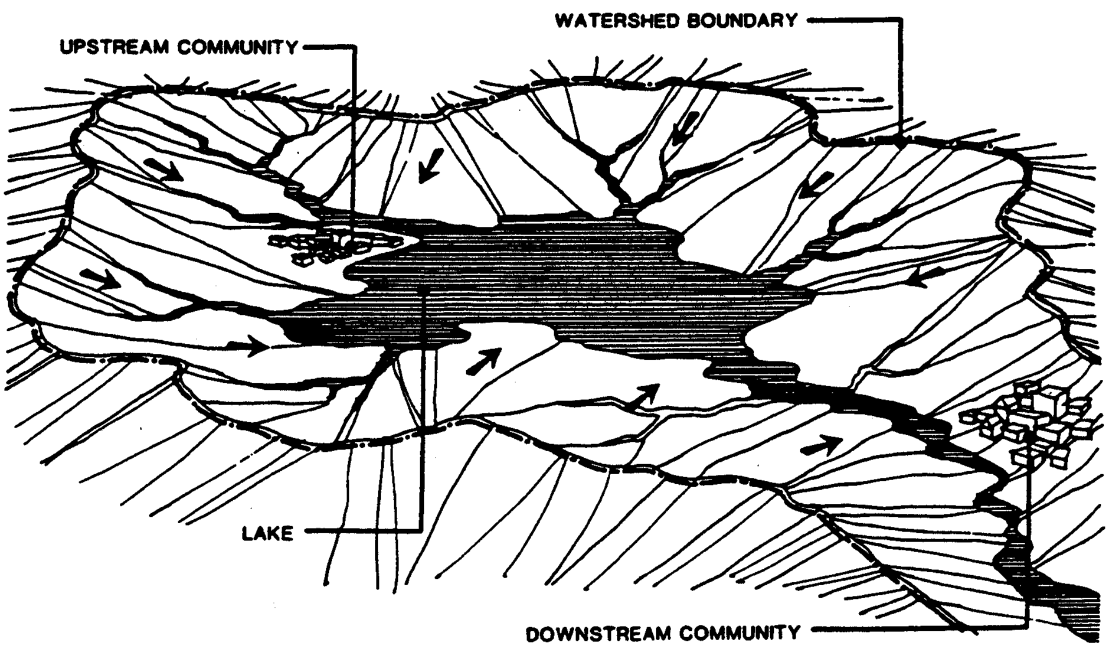
SURFACE WATER QUALITY DIVISION
NONPOINT SOURCE
DISTRICT CONTACTS

The 1987 Amendments to the Clean Water Act were written with the recognition that most point sources were being controlled and that nonpoint sources were causing most of the remaining water quality problems. The Amendments required all states to conduct an assessment of nonpoint sources in their state and develop a strategy to address the identified problems.

An assessment of Michigan's nonpoint sources was conducted in 1987. It involved distributing survey forms to agency personnel who had information on nonpoint source problems in their watershed. As shown in Figure 2, a watershed is all the land which drains into a body of water, such as a lake or river. The results of the assessment are available in "Michigan's 1988 Nonpoint Pollution Assessment Report, " with some information provided in the next two sections.

Figure 2

A Watershed



Source: Stormwater Management: A Guide for Floridians. Florida Department of Environmental Regulations.

"Michigan's Nonpoint Pollution Control Management Plan" was developed in 1988, and contains the specific programs that are necessary to prevent and reduce nonpoint sources in Michigan. Many of the program elements identified in the strategy are currently being implemented. One program, the Nonpoint Source Watershed Initiative, promotes the identification of nonpoint sources at the watershed level, and the implementation of best management practices to address the problems identified in the watershed. A list of Best Management Practices is included in the strategy for each of the major sources of nonpoint pollution. The BMP list has been revised, and the detailed BMPs for urban areas and construction sites are included in this binder. BMPs for golf courses have also been completed and are available from the Surface Water Quality Division of the Department of Natural Resources.

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

Michigan' s BMPs include specifications which will provide the user with information to help design and implement the BMP. This is an important concept, in that: 1) no BMP can be used at every site; and 2) no BMP can include so many specifications that all possible uses and all possible conditions are included. Each site must be evaluated, and specific BMPs can be selected which will perform under the site conditions.

Michigan's BMPs were developed for use in Michigan. BMPs developed for other states may not necessarily work in Michigan. For example, vegetative BMPs should emphasize the use of grasses which have adapted to Michigan. Vegetation which has adapted to Michigan is not necessarily going to adapt to other states.

We acknowledge that Michigan's set of BMPs is not all-inclusive. There are several BMPs that nonpoint staff still plans to develop specifications for. There are also other innovative BMPs being used for which there are no specifications. These and other lesser known BMPs should also be considered on a site-specific basis.

We encourage creativity and innovation, but provide potential users with our BMPs because they have been proven to work when designed, installed and maintained correctly. It is important to follow all specifications when designing and installing practices. It is also pertinent that the BMP be maintained. Maintenance is most often the shortcoming of BMP performance.

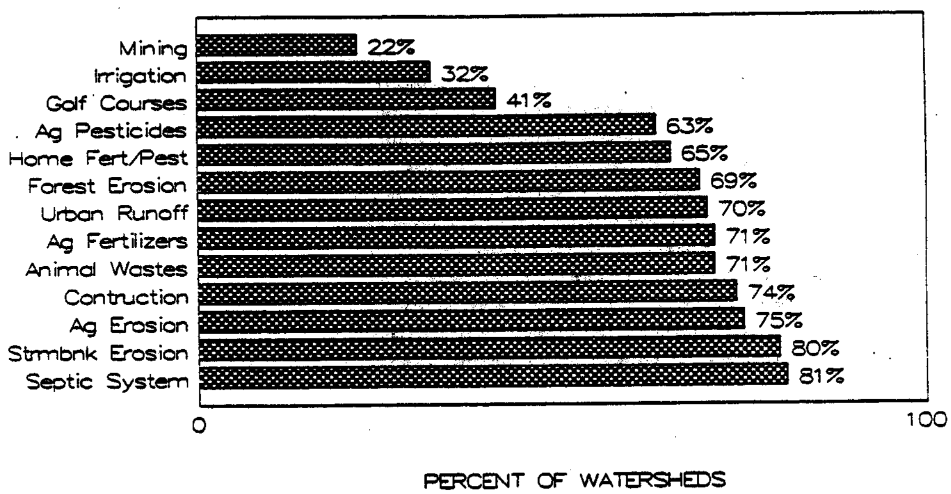
Following a section on the sources and impacts of nonpoint source pollution, the rest of this manual is devoted to identifying the type of BMPs to consider, both at the watershed level and the site level.

SOURCES OF NONPOINT POLLUTION

The sources of nonpoint pollution in Michigan are shown in Figure 3, a bar graph from the 1987 Nonpoint Source Assessment Report. The graph shows that 81% of Michigan's 297 watersheds are perceived to be impacted by failed septic systems, and 80% by stream bank erosion. Other nonpoint sources and the percentage of watersheds impacted by each major source are also shown in Figure 3.

Figure 3

Perceived Sources of Nonpoint Pollution



RURAL AREAS:

The most common nonpoint source problems in rural areas are septic systems, stream bank erosion, agricultural soil erosion, improper agricultural fertilizer and pesticide applications, improper animal manure management, and mining.

Failed sewage disposal systems are widespread throughout the state. Septic tanks should be pumped at least once every three years, and more often depending on the size of the family or group using the tank. Replacing sewage disposal systems is much more costly than routine maintenance.

Some rural **stream bank erosion** problems are due to historic logging practices. During the logging boom, some Michigan rivers were used to transport logs down to the mouth. Early forestry practices also included clear cutting (cutting all trees instead of selective species) and clearing trees right down to the edge of the lake or stream. Proper forestry practices include leaving a natural buffer/filter strip adjacent to surface waters and constructing temporary bridges to cross from one stream bank to another.

Soil erosion is caused by raindrops detaching soil particles and carrying the soil away. Soil erosion in agricultural areas occurs mostly in the spring, before crops develop adequate canopy.
Agricultural soil erosion is particularly problematic in row crops such as corn, because the soil can move easily between the rows. Practices such as no-till planting--which leaves the residue from the

previous year's crop on the surface--are effective in reducing soil erosion. Buffer/filter strips of vegetation along waterways are also effective in reducing soil erosion.

Soil erosion can also be caused by cattle and other livestock, anglers and recreational vehicles entering the water. This tramples banks and destroys stabilizing vegetation. Limiting access to the river and stabilizing the banks with vegetation or other means will prevent additional sediment from going into the water.

Forest erosion occurs mostly as a result of improperly sited, constructed or maintained roads that are needed for forestry operations. Forest erosion also occurs when buffer/filter strips are removed from the waters edge.

Improper use of pesticides and fertilizers is another source of nonpoint pollution. Landowners often apply fertilizers in excess of what is needed by the plant. Numerous agencies are trying to encourage landowners to apply only the amount of fertilizer needed based on an analysis of soil samples collected from their land. Landowners are also encouraged to apply only the amount of pesticides needed to control the pests to the economic threshold level of the plant.

Improper pesticide and fertilizer use can also impact local water bodies. Winter applications of fertilizers will likely run off the soil because plants only absorb fertilizers during the growing season. Applicators sometimes apply pesticides and fertilizers without consideration to weather forecasts or wind conditions. When properly stored, handled and applied, pesticides and fertilizers can be used in a way which will result in very little impact to the water resource. Separate BMPs are dedicated solely to pesticide and fertilizer management.

Improper animal manure management is also a nonpoint source problem in many of Michigan's watersheds. Tons of animal waste can be produced on a single farm, and if improperly stored or applied, nutrients can run off the land and enter surface waters. Proper animal manure management includes proper collection, storage, transport, and land application or other appropriate utilization methods.

Irrigation is used on golf courses, agricultural areas and by homeowners. Many irrigators apply fertilizers and pesticides using the irrigation system (called chemigation). There is a potential for groundwater contamination of nitrates and pesticides using chemigation.

Mining operations are most commonly a problem in Michigan’s Upper Peninsula where copper mines were abandoned without efforts to stabilize the area. Mine tailings containing trace amounts of copper and other elements can and have contaminated water resources. Mining operations in the Lower Peninsula include salt mining operations, many which are still active. Mining for gravel and sand is done throughout the state. Stabilization and restoration with vegetative and sometimes structural means is the best defense against nonpoint problems from mining operations.

URBAN AND URBANIZING AREAS:

Urbanizing areas are those areas which are in the transition between rural and urban--they are essentially experiencing expansion and development. Nonpoint source problems in urbanizing areas are problems which can be minimized with proper local planning and by implementing BMPs. Ordinances are also very effective in promoting development practices that protect the natural environment.

A common nonpoint source problem in urbanizing areas is soil erosion from **construction** sites. Bare soil is easily eroded, especially on sites which do not maintain a natural buffer/filter strip between the construction area and the water resource, and in areas which are not temporarily or permanently seeded. Natural buffer/filter strips, temporary seeding, sediment basins, and other best management practices can reduce the amount of soil that leaves the site and entering waterbodies. Access roads to construction sites can be designed and constructed to reduce the amount of sediment that is tracked off the site by vehicles.

Urban runoff occurs because the natural filtration system is covered with impervious surfaces such as roads and buildings. Before urbanization, most rainwater is infiltrated into the ground through wetlands and depressions. The rainwater was either stored there as groundwater or slowly found its way to a lake or stream. The majority of the land area was vegetated, keeping most soil in place and filtering the runoff which did occur. Stream flows were more stable causing less stream bank erosion and habitat destruction. Once the land is urbanized, very little water is able to infiltrate into the ground, and instead, is rapidly conveyed via storm drains to the nearest water resource. This results in significant changes in stream flow and wetland hydrology, which may result in stream bank erosion and loss of aquatic habitat. Some areas, such as the lower Rouge River in Detroit, have been channelized because alterations in flow have been so significant and destructive.

In addition to the problems caused by changes in hydrology, storm runoff in urban areas can collect a variety of pollutants and carry them to the nearest storm drain. For example, a parking lot constructed of concrete will collect pollutants such as oil and grease that drip off cars in the lot, as well as any sediment that washes off cars or blows onto the lot. A rainstorm washes the parking lot and carries these pollutants to the storm drain and directly to the water body. BMPs which could be implemented include: parking lot or rooftop storage to reduce peak discharge of stormwater, oil/grit separators to remove pollutants, and porous pavement, or infiltration trenches to increase infiltration.

Many homeowners also may unknowingly over-apply or misuse fertilizers and pesticides. Homeowners should read product labels on both pesticides and fertilizers because the labels include information on the use, storage, and disposal of the chemical. Riparian property owners should consider using fertilizers without phosphorus, where possible. Over fertilization may lead to accelerated eutrophication of the lake.

All property owners--including homeowners, farmers, golf course managers, etc.--are encouraged to have their soil tested for nutrient (e.g. phosphorus, nitrogen) and organic content, and only apply fertilizers when soil tests indicate fertilizers are needed. In some situations there is already elevated nutrient concentrations and no additional nutrients from fertilizers are needed.

Homeowners cause other nonpoint source problems. Some riparian homeowners improperly dispose of their organic debris* by raking them right into the lake, river, or wetland. Each year, over 11 million gallons of used motor oil are dumped down Michigan storm drains, in backyards or on driveways. In addition, hundreds of tons of household hazardous waste are dumped into Michigan landfills, some of which can leach out and contaminate groundwater and/or surface waters. Included in the BMPs are practices which homeowners can use to address lawn maintenance and the proper disposal of used oil and household hazardous wastes.

Golf courses are common in Michigan's urban and urbanizing areas. Like other large construction projects, golf courses under construction can result in soil erosion and sedimentation if a natural buffer/filter area isn't left in place and if other BMPs are not implemented. Both new and existing golf courses should have pesticide, fertilizer, and irrigation management programs. Proper disposal of organic debris, including grass clippings and leaves, is needed to prevent impact on local water resource. BMPs have been developed for pesticide management, fertilizer management, lawn maintenance, and organic debris disposal.

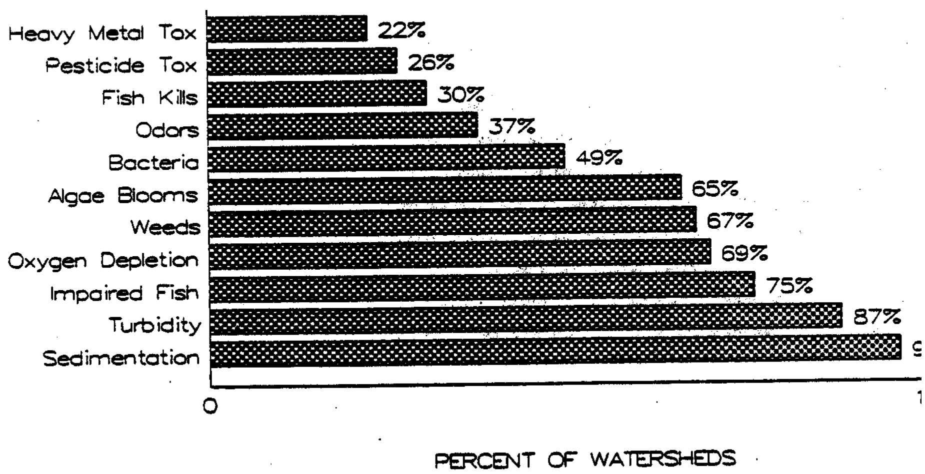
*As organic debris decomposes, the micro-organisms breaking down the debris consume oxygen. As the oxygen level decreases, fish and other aquatic life become stressed and can die. Also, nutrients are released from the organic debris which stimulates plant growth. Ideally, organic debris should be composted in upland areas away from water resources.

IMPACTS OF NONPOINT SOURCES ON SURFACE WATERS

The sources of nonpoint pollution have varying impacts on the environment. Results of Michigan's nonpoint source assessment indicated that the impacts of the various nonpoint sources include sedimentation (affecting 95% of Michigan's watersheds) and turbidity (affecting 87% of Michigan's watersheds). The perceived effects identified by the Assessment are shown in Figure 4.

Figure 4

Perceived Impacts of Nonpoint Sources on Surface Waters



SPECIFIC IMPACTS OF NONPOINT SOURCES

Sedimentation occurs when soil particles which are carried off the land enter surface waters and settle out. When the soil particles settle out, they fill in streams, lakes and wetlands, and cover up habitat needed by fish and other aquatic organisms. Sedimentation occurs as a result of stream bank erosion, excessive hydrologic fluctuation, agricultural soil erosion and construction site erosion.

Turbidity occurs in conjunction with sedimentation. Turbidity is basically a cloudy, muddy condition in the water which occurs when eroded soil is suspended in the water (i.e. before it settles out). Turbid water can stress or kill fish by clogging their gills and making it hard for them to see food sources.

Impacted Fish Habitat is directly associated with many other nonpoint source effects. Decreased habitat can be caused by sedimentation, increases in temperature, and alterations in stream hydrology.

Oxygen Depletion occurs in nutrient-enriched waters because excessive plant growth causes nighttime dissolved oxygen losses during plant respiration. Under severe situations oxygen concentrations may be almost entirely used up for short periods, stressing or killing fish. Excessive large deposits of organic debris also result in oxygen depletion. The microorganisms which break down the organic material use up the oxygen needed by other aquatic life. Common sources of organic material include improperly disposed leaves and grass clippings, raw sewage from "improper (illicit) connections" to storm sewers, and failing septic systems. Improper connections occur when sanitary sewers or industrial discharge pipes are connected to storm sewers, and concentrated waste is discharged directly into the surface water.

Algae Blooms also occur as a result of phosphorus and nitrogen loadings to surface waters. Algae blooms are those green mats of (sometimes slimy) vegetation which often float on top of the water. Like weeds, algae use up the same oxygen other aquatic life needs. Thick beds of algae can also block out sunlight to the aquatic life below.

Bacteria such as fecal streptococci and fecal coliform are found in human and other animal waste and are a natural by-product of the digestive process. The continued presence of bacteria in surface waters is usually indicative of combined sewer overflows or leaking sewer pipes in urban areas, or leaking animal waste storage ponds or other animal waste management problems in rural areas.

Odors can result from animal waste, sewage, and/or decomposing organic debris.

Fish Kills can be caused by sudden oxygen depletion, acute toxicity and excessive turbidity. (See pesticide toxicity below). "Winter kill" occurs when fish die under ice cover as a result of oxygen depletion. Winter kill occurs mostly in shallow lakes where oxygen-depleting weeds "use up" the oxygen. Winter kill is far less common in larger, deeper lakes.

Pesticide Toxicity is caused by exposure to herbicides, insecticides, fungicides or other chemical agents. Both acute and chronic toxicity are of concern. Acute toxicity is expressed in a relatively short period of time and may occur after exposure to a single dose of the pesticide. An example of acute toxicity would be a fish kill as a result of a pesticide spill. This "acute" action usually results from the biologically active ingredients of the pesticide, which shuts down or blocks some critically important life function of an organism.

Chronic toxicity is expressed over a long period of time, and results when an organism is exposed to repeated or continual sublethal concentrations of a pesticide. Chronic toxicity is difficult to assess because one species may gradually disappear from the aquatic environment over a long period of time. Examples of chronic toxicity would include reproductive impairment of aquatic organisms due to low-level herbicide concentrations in the water. All pesticides have certain exposure levels which can result in acute and chronic toxicity to aquatic organisms.

Like pesticides, heavy metals can cause acute and/or chronic toxic effects to aquatic organisms. Zinc, copper and lead are heavy metals, among others, that have many private, industrial, municipal and commercial uses and, as a result, are often found elevated in urban stormwater runoff. Atmospheric loadings of metals also serve as a substantial source to the urban area. The toxic effects of some heavy metals are often mitigated by chemical conditions of the receiving stream.

Wetland Degradation from nonpoint sources of pollution can also occur. In general terms, wetlands are areas where land and water meet. They are comprised of water, hydric soils, and plant species adaptable to fluctuating land/water conditions. Disturbance to these elements can potentially alter the natural functions that wetlands provide.

Improper land practices may result in soil erosion and sedimentation problems, pesticide and fertilizer runoff, excess flow, and other nonpoint problems which can significantly alter the wetland and its ability to remove pollutants. These problems can be manifested in the watershed quickly or over a long period of time.

The proper selection and application of Best Management Practices can control the sources, and therefore the effects, of nonpoint sources on the aquatic environment.

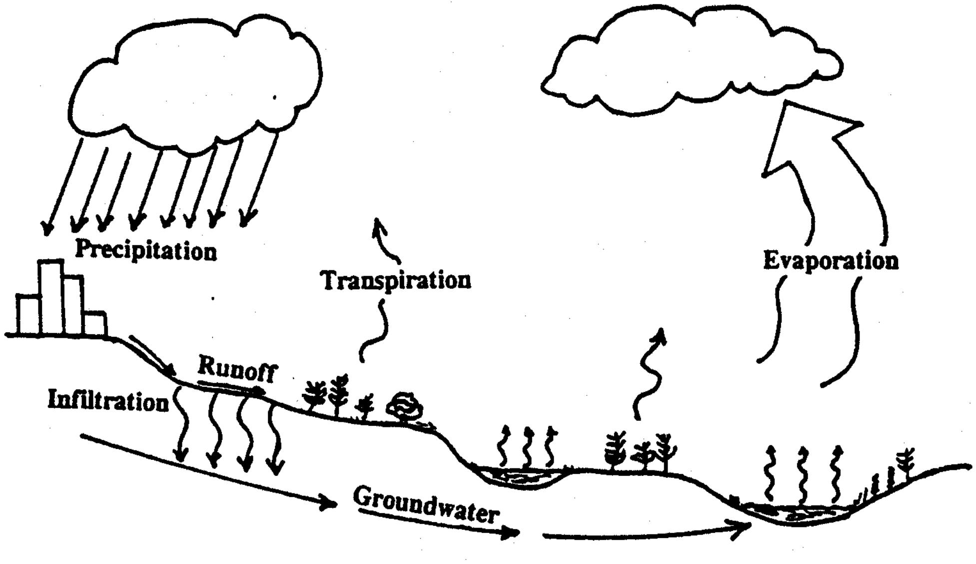
CHANGES IN WATERSHED HYDROLOGY

The impacts of nonpoint sources go above and beyond what was included in our assessment. For example, the hydrology of a surface water may be altered by increased imperviousness (i.e. paved areas) or by other changes in the watershed.

The most basic concept of watershed management is to try to maintain the natural hydrologic balance. Water is transported to the atmosphere from the surface primarily by evaporation, where it condenses and falls back to the land as precipitation. Precipitation either infiltrates the ground, or runs off the surface and is collected in lakes, streams and other water bodies. The collected water evaporates and the cycle starts all over. Figure 5 shows the relationship between surface and groundwaters and how altering any aspect of the **hydrologic cycle** will alter the hydrology of the watershed. In practice it is much more complicated than explained here, but this is the basic concept.

If land is developed, areas of infiltration decrease, transpiration decreases (because vegetation is removed) and runoff increases. Increased runoff results in increased flood flows, higher in-stream velocity, and alterations in wetlands. These and other changes in hydrology are discussed more technically below, as modified from "Mitigating the Adverse Impacts of Urbanization on Streams: A Comprehensive Strategy for Local Government," Metropolitan Washington Council of Governments (Schueler, 1987).

Figure 5



Generalized Hydrologic Cycle

Source: Stormwater Management Guidebook, MDEQ, Land and Water Management Division, 1992.

The magnitude and frequency of severe flood events increases. In extremely developed watersheds (impervious surface area > 50%), the peak discharge after development may increase by as much as five times the pre-development rate. More severe floods reshape the dimensions of the stream channel and its floodplain and wetlands.

In addition, watershed development increases the frequency of bankfull and sub-bankfull flooding events. Bankfull floods are defined as floods that completely fill the stream channel to the top of its banks, but do not spill over into the floodplain. Schueler (1987) estimated that the number of bankfull floods increases from one every other year prior to development, to over five each year for a 50% impervious watershed. In practical terms, this means that a short but intense summer thunderstorm that had scarcely raised water levels prior to development may turn an urban stream into a raging torrent. The greater number of bankfull floods subject the stream to continual disturbance by channel scour and erosion.

Increasing flood frequency or water level fluctuations in wetlands can kill certain wetland plant species while favoring the productivity of others. The character of riparian wetland areas is primarily governed by the flooding regime, with periodic inundation promoting richer and more abundant species composition than either predominantly dry or predominantly flooded conditions. Wetlands located along flowing waters generally receive high nutrient loads from these waters. Floodwaters distribute pollutants extensively through wetlands. Changes in velocity of flow through wetlands will cause changes in deposition as well as erosion.

More of the stream's annual flow is delivered as surface storm runoff rather than base flow or interflow. In undeveloped watersheds, anywhere from 5 to 15% of the annual stream flow is delivered during storm events, depending on watershed vegetative cover, soils and geology. By contrast, in developed watersheds, the majority of annual stream flow occurs as surface runoff. As a general rule, the amount of storm runoff increases in direct proportion to the amount of watershed imperviousness. For example, surface runoff typically comprises half the annual stream flow in a watershed that is 50% imperviousness.

Consequently, the amount of base flow and interflow available to support stream flow during extended periods of dry weather is greatly reduced. In smaller headwater streams, the reduction in dry weather flow can cause a perennial stream and adjacent wetlands to become seasonally dry .In larger urban streams, the reduced dry weather flow can significantly restrict the wetted perimeter of the stream or adjacent wetlands, thereby reducing the usual habitat available to aquatic life.

Reduction in groundwater base flows has the potential effect of extending the length of dry periods in wetlands which are seasonally affected by groundwater sources. This extended length of dry periods will impact the life cycles of the wetland species dependent on the water column.

The velocity of flow during storms becomes more rapid. This is due to the combined effect of greater discharge (flow), rapid time of concentration, and smoother hydraulic surfaces. In a 50% impervious watershed, post-development runoff velocities exceed thresholds for erosivity, requiring channel protection measures. In addition, stream flow becomes extremely flashy, with sudden and sharp increases in discharge, followed by an equally abrupt return to pre-storm discharge levels.

Increased flows can increase the velocity of water entering adjacent wetlands which can result in biotic disturbances. Changes in average water levels, or duration or frequency of flooding, will also alter the species composition of wetland plant and animal communities.

CHANGE IN WATERSHED MORPHOLOGY (Structure and Form)

As the flow of a surface water increases, the shape of the watercourse also changes. The channel generally widens to accommodate the additional flow, and stream bank erosion often occurs.

As sediment enters the system from stream bank erosion and runoff, pools within the stream, and lakes and wetlands within the watershed become filled with sediment and other types of pollutants. Stream channels and riparian wetlands also must respond and adjust to the altered hydrologic regime that accompanies urbanization. The severity and extent of stream adjustment is a function of the degree of watershed imperviousness. Generally, the impact to wetlands will vary depending upon the wetland type and size.

These and other ways the surface water may change are discussed in more detail below, as modified from "Mitigating the Adverse Impacts of Urbanization on Streams: A Comprehensive Strategy for Local Government".

<u>The primary adjustment to increased storm flow is channel widening,</u> and to a lesser extent, down-cutting. Stream channels in moderately developed watersheds may become four times wider than before development. The channel widening process is primarily accomplished by lateral cutting of the stream banks. As a consequence, the riparian zone adjacent to the channel is severely disturbed by undercutting, tree-fall and slumping. Disrupted flow patterns and channeling in wetlands can result in decreased natural pollutant removal efficiencies.

<u>Sediment loads to the stream increase sharply due to stream bank erosion and upland construction site runoff.</u> The coarser grained sediments are deposited in the new wider channels and may reside there for years until the stream can export them from the watershed. Much of the sediment remains in temporary storage, in the form of constantly shifting sandbars and silt deposits. The shifting bars often accelerate the stream bank erosion process by deflecting runoff into sensitive bank areas. Excessive suspended sediment loads through wetlands result in increased deposition of silts and debris. Over time, the deposited silts and debris become the new, higher ground surface. Wetland plants then receive less surface or groundwater. Eventually plants become stressed and replaced by plants more adaptable to dryer conditions.

Together, the massive sediment load and channel widening produce a major change in the morphology of urban streams. <u>The series of pools and riffles so characteristic of natural streams is eliminated,</u> as the gradient of the stream adjusts to accommodate the frequent floods. In addition, the depth of the flow in the channel becomes shallower and more uniform during dry weather periods. The loss of pool and riffle structure in urban streams greatly reduces the availability and diversity of habitat for the aquatic community.

The nature of the streambed is also modified by the urbanization process. <u>Typically, the grain size of the channel sediments shifts from coarse grained particles towards a mixture of fine and coarse grained particles.</u> This results in a phenomena known as imbedding, whereby sand, silt and even clay fill up the interstitial voids between larger cobbles and gravels. Imbedding reduces the circulation of water, organic matter and oxygen to the filter-feeding aquatic insects that live among and under the bed sediments. These insects are the basic foundation of the stream food chain. In addition, imbedding of the stream sharply limits the quality and availability of fish spawning areas, particularly for trout.

In intensively urbanized areas, many streams are totally modified by people to “improve” drainage and reduce flooding risks. Headwater streams tend to suffer disproportionately from enclosure in pipes. When enclosed, the headwater stream is entirely destroyed, and is replaced by an underground network of storm drain pipes. In the past, larger urban streams have been engineered and channelized to more efficiently and safely convey floodwaters. As a result of such channelization and storm drain construction, flooding problems are simply passed on to downstream communities and property owners. Although large-scale stream channelization is now discouraged, some form of future channel "improvement" is inevitable if development is allowed to continue without some form of stormwater management.

Another inevitable consequence of urbanization are stream crossings by roads and pipelines. These structures must be heavily armored to withstand the down-cutting power of stormwater. Many engineering techniques utilized for this purpose (e.g. drop structures, culverts, etc.) create barriers to the migration of both resident and anadromous fish. Even a six-inch drop can block the upstream movement of many fish species.

Additionally , pollutants in storm water can accumulate in wetlands. Urban stormwater input has the potential to change the pH and redox potential of soils, making many toxins in the storage pool available so that they can have an immediate effect on wetland soils, both in-situ and potentially downstream. The rate of metal accretion and the degree of burial in the sediments are critical factors in determining the loadings which can be endured by wetlands without damage.

CHANGES IN WATERSHED HABITAT AND ECOLOGY

The ecology of urban streams is shaped and molded by the extreme shifts in hydrology, morphology and water quality that accompany the development process. Changes within the aquatic community of urbanizing watersheds are both subtle and profound, and include a reduction in the habitat available and the number and kinds of species. The impacts of urbanization and stormwater discharge on wetland systems are interactive and are not always clearly understood. These changes are discussed in technical detail below, as modified from "Mitigating the Adverse Impacts of Urbanization on Streams: A Comprehensive Strategy for Local Government".

Shift from external to internal stream production. In natural streams, the primary energy source driving the entire aquatic community is the import and decomposition of leaf litter, woody debris and other organic matter. However, in many urban streams, internal benthic algal production becomes a major energy source supporting the aquatic community, due to the combined effect of increased light penetration and nutrients (and the rapid washout of organic matter through the stream system). This shift is often manifested in changes in the mix of species found in the stream community. For example, environmental conditions are more favorable for species that graze algae from rocks (e.g., snails) than for species that shred leaves or filter coarse grained detritus (e.g. caddisflies, stone flies etc.).

Reduction in Diversity in the Wetland and Stream Communities. The cumulative impact of the loss of habitat structure (pools/riffles), the imbedding of the stream bed, greater flooding frequency, higher water temperatures, extreme turbidity, lower dry weather flows, eutrophication, and toxic pollutants is to greatly reduce the diversity and richness of the urban stream and wetland communities. In intensively developed areas, streams support only a fraction of the fish and macroinvertebrates that exist in natural streams.

In wetlands, species richness is affected by increases in water level fluctuation, with decreased species richness associated with higher water level fluctuations than are found in natural systems. Wetland mammal populations may potentially be affected by change in hydroperiod because of loss of vegetative habitat and the increased potential for disease organisms and parasites due to shallower, warmer, base flow conditions. Changes in wetland water level may alter the quantity and quality of amphibian habitat triggering changes in breeding patterns and species composition.

Destruction of Stream Ecosystems, Freshwater Wetlands, Riparian Buffers and Springs. In the past decade, it has been necessary to abandon the notion that a watershed is defined solely by the stream ecosystem. It is now understood that extensive freshwater wetlands, floodplains, riparian buffers, seeps, springs, the stream ecosystem, and ephemeral channels are linked to the watershed. In varying ways, these areas contribute many of the ecological functions and processes upon which the watershed and its features depend. Unfortunately, these areas are subject to destruction during indiscriminate clearing and grading.

Lakes within urban watersheds are particularly sensitive to urbanization and stormwater discharge since lake water quality is critically linked to the quality of the incoming water from the watershed. Generally, lake eutrophication is a natural, usually irreversible process resulting from the gradual accumulation of nutrients, increased productivity, and a slow filling in of the basin with accumulated sediments, silt and organic matter from the watershed. However, human-induced disturbances in the watershed which dramatically increases nutrient, soil or organic matter loads will accelerate the natural eutrophication process. A lake's resource value can be reduced drastically by activities such as forest clearing, road building, cultivation and residential development because these activities increase soil and nutrient loads that eventually move to the lake. Once a lake has been degraded, restoration, if at all possible, will be difficult and costly.

STEPS TO TAKE TO ADDRESS URBAN/URBANIZING NONPOINT SOURCES AT THE WATERSHED LEVEL

It is important to remember that Best Management Practices are just some of the tools used to reduce nonpoint source impacts to surface and groundwaters. Other more long-lasting tools such as ordinances should be implemented to prevent unsound practices and encourage good practices throughout the watershed.

In order for BMPs to be effective, a systematic approach must be taken which evaluates the existing conditions in the watershed, determines the water quality goals of the watershed, and determines the steps needed to reach those goals. Randomly installed BMPs may provide the desired loca1 treatment, but when considering the overall effects in the watershed, they can actually increase nonpoint source problems.

The steps to developing a watershed plan are given in the following text, and are summarized in the flow chart on the next page. **The Department is encouraging the development of watershed plans because the hydrologic and water quality changes which occur in one portion of the watershed will impact the entire watershed.** In addition, watershed planning will allow the use of regional BMPs, which are often less expensive to install and maintain than several on-site BMPs. (See the section on "Detention and Infiltration.")

After a watershed plan is developed, specific individual site plans within the watershed can then be designed to meet the objectives of the watershed plan. The steps to developing a site plan are discussed in a separate section.

Watershed Evaluation: There are two major activities which need to be undertaken in order to develop a watershed plan (see Figure 6). The first major activity is conducting a watershed evaluation. A watershed evaluation is essentially an inventory of the existing natural, cultural and aesthetic features of the watershed, as well as the water quality goals of the community. Where logical, this information should be presented in map form.

Developing a watershed evaluation has been divided up into the following steps:

STEP 1: Delineate Watershed Boundaries

The first step in developing a watershed plan is to use topographic maps to delineate watershed boundaries. For planning purposes, and to help in prioritizing areas, if a watershed is larger than 100,000 acres in size, it is recommended that the watershed be divided into smaller, more manageable sections (sub-watersheds).

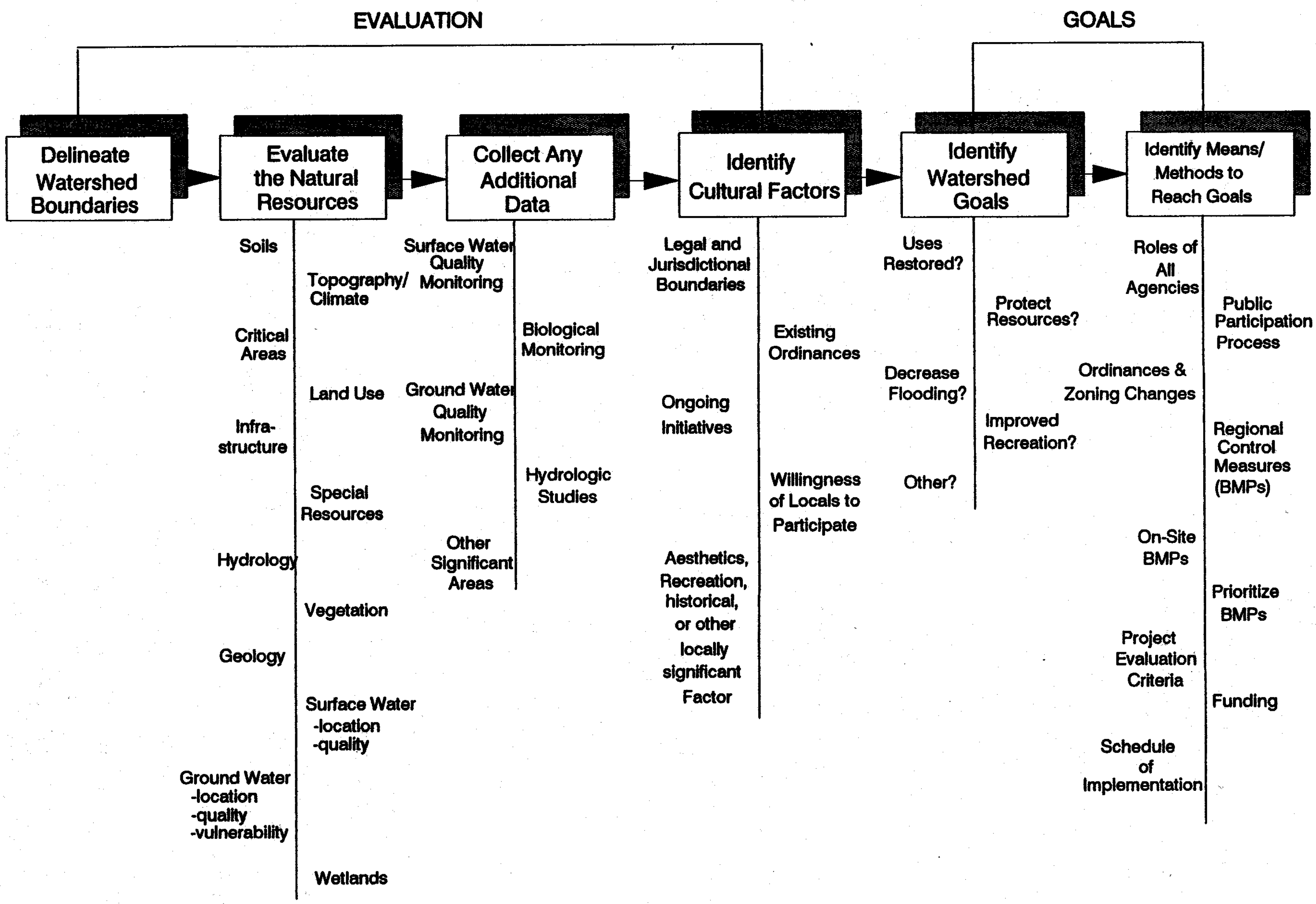
STEP 2: Evaluate the Natural Resources

When looking at the natural resources, include the following:

- **Soils.** It will be necessary to know the soil characteristics in the watershed, including permeability, erodibility and the hydrologic soil group. Soils information for most counties is contained in soil surveys which are available at local Soil Conservation District Offices. See the "Soils" section in the Appendix for additional information on soils.

Figure 6

How to develop a Watershed Plan



- **Topography and Climate.** Identify slopes, contours, natural depressions and elevations. Note rainfall distribution, areas which could be affected by wind and solar orientation, and freeze-thaw patterns.

- **Critically Eroding Areas.** These are areas which are likely to erode, including steep slopes, raw (i.e. exposed) areas, and other areas in which runoff has or will cause erosion and sedimentation. Include shorelines, natural drainageways, steep slopes, porous soils and wetlands. (These areas are discussed in further detail in STEP 3 of the "Step by Step method to Develop a Site Plan", below.) The recommended procedure for identifying wetlands is that established by the State's Goemaere-Anderson Wetland Protection Act and Administrative Rules. Contact county or regional planning agencies, or the MDEQ, Land and Water Management Division, Wetland Management Program, for land use information.

- **Land Use.** Land use is simply how the land is used. It is often indicative of the amount of impervious surface. (Impervious surfaces include all paved surfaces and buildings, and are a critical component of runoff calculations, pollutant load estimations, and hydrology).Typical land uses include rural, urbanizing or urban, commercial, industrial, residential, parks/recreational, and transportation. Each type of land use will generate different types of runoff .

  The choice of BMPs may be limited in order to fit in to existing land use. Therefore, determine both the existing land use and projected or known land use changes. Land use maps for many parts of the State are available from the MDEQ, Land and Water Management Division.

- **Infrastructure.** Identify location and all connections to storm drains. Start by identifying major storm outlets to waterbodies, including established county drains, road drains, and direct outlets from streamside/lakeside developments. Note the location of utilities, water mains and sanitary sewers.

- **Hydrology.** Determine the exact location of all surface waters, including lakes, streams, rivers, wetlands, drainage ditches, floodplains and groundwater recharge areas. Determine the flow patterns of all surface waters and the monthly 95% and 50% exceedance flows. Indicate areas which have been channelized and where dredging may occur in the next several years. Other hydrologic modifications such as dams should also be noted. Depending on the county , some of this information can be obtained from the MDEQ, Land and Water Management Division.

- **Special Resources.** Identify any special resources within the watershed, including endangered species, natural areas, and wild and scenic rivers. The list of Wild and Scenic Rivers is included in the Appendix. Information on endangered species can be obtained through the assistance of the Natural Heritage Program, MDNR, Wildlife Division. Note that the Department will not permit the development of land which contains endangered species.

- **Vegetation.** Note the types and locations of existing vegetation. Note areas where vegetation has been disturbed (i.e. clear cutting, excessive grazing) and where replacing indigenous vegetation would be beneficial. Also note significant woodlands.

- **Geology.** Note the location of bedrock and mineral deposits, and groundwater level.

- **Surface Water Quality.** Identify water quality and quantity problems. Look for any of the "Sources and Impacts of Nonpoint Sources", as well as any "Changes in Hydrology", "Changes in Stream Morphology" , or "Changes in Stream Habitat and Ecology" , as discussed previously. Document existing water quality .

  The water quality and quantity impacts in a watershed are best described in terms of designated uses. **All** waters of the state of Michigan are to meet the following seven designated uses:

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

  Those are the **minimum** uses that should be met for all waters of the state. Additional protection is given to high quality waters and other sensitive resources. Specific local uses should also be identified.

  When identifying if problems exist in a watershed, refer to the list of designated uses. If any uses are impaired, the Watershed Plan should include a map with prioritized activities which will restore those uses .

  An important part of identifying the impacts and sources is to walk, canoe or drive the entire watershed. Take notes as you investigate the watershed, noting all potential problems that can be seen and their possible sources. Local agencies such as the Soil Conservation District, health department, drain commissioners and others are also good sources of information.

- **Groundwater Quality.** Determine groundwater characteristics, including its vulnerability. Groundwater vulnerability information may be available from the county health department, MDEQ, Waste Management Division, or local universities. Also, contact the local health department to see if any groundwater samples have been collected.

  The watershed plan should also include the location and activities occurring at Act 307, LUST and Superfund sites. This information is available from the MDEQ, Environmental Response Division.

- **Wetlands.** Identify the location of all wetlands. The "Michigan Wetlands: Yours to Protect," published by the Tip of the Mitt Watershed Council, includes information on how to identify and delineate wetlands. Other sources of information include MlRIS, the Michigan Resource Inventory System, and the "Federal Wetlands Delineation Manual." MIRIS information may be available from the MDEQ, Land and Water Management Division. The federal manual can be obtained from the U.S. Environmental Protection Agency, wetlands and watersheds Section, at 312-886-0243.

Unless exempted, wetlands permits will be needed from the MDEQ Land and Water Management Division for activities that occur within 500 feet of an inland lake, stream or pond and 1,000 feet from a Great Lakes. These are contiguous wetlands. Non-contiguous wetlands are regulated only if they are greater than five acres in size and in counties with populations of 100,000.

STEP 3: Collect Any Additional Water Quality/Quantity Information

A monitoring plan should be developed to document existing (baseline) water quality and to determine changes in water quality as changes occur in the watershed. Water quality monitoring is especially important where there are concerns for heavy metals (such as zinc, lead and copper), conventional pollutants (such as dissolved oxygen, nutrients and suspended solids), and organics (such as PCBs).

Biological surveys are good indicators of water quality and should be considered, especially in areas where aquatic habitat is known or suspected to be impacted.

Also consider: hydrologic studies to determine hydrologic regimes, and to get baseline information to determine hydrologic changes in the watershed; and collecting groundwater samples to get background information on groundwater quality.

It is important to tailor your monitoring plan to the goals of the watershed, and to sample often enough and over a long enough period of time to show results. If the goal is to reduce nutrient inputs, then at a minimum the monitoring plan should include nutrient monitoring. If the goal is to restore eroded banks, then hydrologic monitoring should be done in conjunction with either biological surveys or monitoring for suspended solids. MDEQ staff may be able to provide assistance in developing a water quality sampling or monitoring program suitable for your site. Many Michigan streams and lakes have already been surveyed by MDEQ biologists.

STEP 4: Identify the Cultural Factors Affecting the Watershed

- **Legal and Jurisdictional Boundaries.** Identifying the legal and jurisdictional boundaries will help eliminate confusion as to who-does-what.

- **Ordinances.** What ordinances currently impact water quality or quantity? Include land use (zoning) restrictions, wetlands ordinances, stormwater ordinances, etc.

- **Ongoing Initiatives.** Determine the federal, state and local initiatives in the watershed or project area. How do these initiatives relate to the proposed project?

- **Willingness of Locals to Participate.** Survey all the local agencies and residents in the area to determine their awareness and willingness to assist with the project.

- **Aesthetics, Recreational Value, and Other Significant Areas.** Determine the aesthetic value of the watershed, including rolling hills, scenic views, beaches. Recreational areas, including access points to the water should be noted. Also note historically or archaeologically significant areas.

Once the watershed evaluation has been completed, display as much of the information as possible on maps. Geographic Information Systems (GISs) can be used to graphically show the interrelationship between various types of information. For example, areas with highly erodible soils can be compared with the locations of eroded stream banks to help prioritize stream bank erosion sites for stabilization .

Determining the Goals and How to Achieve Them. The second major activity in developing the watershed plan is determining the goals of the watershed and the means of obtaining the goals.

STEP 5: Determine the Goals and Desired Uses of the Watershed.

What does the community want from its watershed: improved recreation, water supply, fisheries, or aesthetics? Does the community wish to try to return the hydrology of the stream to its pre-development state? Describe the primary benefits of the project, such as meeting water quality standards, return of uses and protection of water resources. Describe the secondary benefits of the project, such as flood control, improved air quality, aesthetics, habitat protection, or soil erosion control. Each goal should be specific and given a specific time frame for implementation.

The section below on the "Step by Step Process for Developing a Site Plan. " This contains a set of goals which can be used at the watershed level, including such things as keeping hydrology to pre-development levels, etc.

STEP 6: Identify Methods/Means to Obtain the Goals. Do this by including in the watershed plan the following:

- **Identify Participating Agencies and Their Roles.** Since a watershed plan is a comprehensive, intensive effort, it is recommended that one agency take the lead in writing the plan and other agencies assist in its development by providing technical assistance or other types of expertise. Soil Conservation Districts, Soil Conservation Service, Cooperative Extension Service, county drain commissioners, road commissions, local health departments, and planning agencies can all be of assistance in developing the plan, or can take the lead role. MDEQ, Surface Water Quality staff is knowledgeable in designing sampling plans which may be needed to pinpoint nonpoint sources. Spell out who is responsible for the various aspects of the plan and be sure each agency agrees with its role. Include the municipalities, county and township governments, drain commissioners, health departments, state and federal agencies, citizen groups, developers, local universities, and all other interested groups. Each group should be tied to the implementation of one of the goals mentioned above.

- **Develop a Public Participation Process.** A process should be established for involving the local public in the planning and implementation activities (e.g. group meetings, public meetings, newsletters, news releases, tours, field days, demonstrations, etc.). Estimate the percentage of local participation needed to ensure the established goals are met.

- **Develop the Necessary Ordinances and Zoning Requirements.** Ordinances can be developed which provide wetland or flood plain protection, green belt requirements or site drainage specifications. Existing ordinances should be reviewed during the development of the watershed plan. Zoning can be used to protect critical areas or to promote cluster developments. For this and the identification of BMPs, see the section on "Developing a Site Plan," Step 3.

Also consider the possibility of conservation easements and trusts.

- **Identify Regional Control Measures.** Regional control measures are those measures (BMPs) applied over large parts of the watershed under some central control. Generally, regional BMPs are much more efficient to install, operate and maintain than on-site BMPs. It is easier to predict the effect of regional BMPs on a watershed, they are less expensive to build and maintain, and may provide uses beyond their use as nonpoint source controls, such as sports fields or parks.

  Regional control measures and on-site detention are discussed in the section below entitled "Detention and Infiltration to Address Urban Nonpoint Sources of Pollution. "

- **Maps.** If data is available on a geographic information system (GIS), overlays can be made of the soils information, land use, groundwater vulnerability, etc. If Geographic Information Systems are not available, use topographic maps to delineate the watershed boundaries and make continual references to soil surveys (where available) when making decisions about the watershed. Identify on the map all regional BMPs (see below).

- **Identify Other BMPs.** The implementation of certain BMPs could be encouraged throughout the watershed. For example, in areas with permeable soils, sites could be required to replace permeable areas lost during the course of development with infiltration practices. Also, in areas of the watershed that are particularly sensitive or have a special use, such as a wildlife preserve, special practices could be required.

- **Prioritize BMPs and Other Actions.** Resources are generally not available to tackle all the identified problems at once. Prioritizing BMPs and other actions will help get the greatest water quality/quantity benefit for your money. If fecal coliform is elevated throughout the watershed, priority will probably be given to considering more intensive water quality sampling to identify specific sources. Once the sources of bacteria are identified and corrective measures underway, begin tackling the next most significant water quality/quantity project. Always determine priority based on the desired goals of the watershed.

- **Project Evaluation Criteria.** Describe the criteria that will be used to evaluate the success of the project toward meeting the objectives (i.e. stream monitoring, BMP training, participation rate, modeling, etc.).

- **Funding Sources.** Identify all potential funding sources, from re-directing existing funds to address water quality , to cost-share monies, to low-interest loans and grants. See the section on "Funding. "

- **Schedule of Implementation.** A timeline needs to be developed to keep the local communities on target in the implementation of the BMPs.

STEP 7: Writing the Watershed Management Plan: The watershed plan is developed with information obtained from the Watershed Evaluation steps and the Goals. The plan may be for a very small sub-watershed and therefore relatively simple, or it may be for a large watershed crossing multiple jurisdictions or including multiple tributaries, making the plan more complex. The watershed plan will be a type of blueprint for how local communities want to manage their watershed.

The final watershed plan should contain a compilation of:

*A summary of all the data collected during the evaluation, including information on:
- the natural resources
- cultural factors

*The goals of the watershed
*The means of achieving the goals

STEP BY STEP METHOD TO DEVELOP A SITE PLAN

The types of activities which need to be undertaken to develop a site plan are similar to those needed for a watershed plan. The site plan should detail the practices that will be implemented on a particular site to protect the natural resources in the watershed. The goals of a site plan should be consistent with the goals of the watershed plan. If no watershed plan exists, the site plan should include the practices and strategies which will reduce adverse impacts on the hydrology and water quality of the watershed.

For the purposes of this document, an acceptable site plan should include, at a minimum, a grading plan, a soil erosion and sedimentation control plan, and a stormwater plan. A grading plan is a short-term plan which contains all existing structures, all cut and fill areas, and the elevations before and after construction will take place. A soil erosion/sedimentation control plan includes all temporary and permanent structures which are needed to keep soil from leaving a construction site. A stormwater management plan is a long-term plan which includes all the practices that will be used to manage stormwater. These three components of the site plan are discussed in detail in STEP 5.

We encourage a three-component site plan to ensure that the short-term soil erosion/sedimentation control (SE/SC) plan and the long-term storm water plan follow one another logically. For example, if a sediment basin is included in the SE/SC plan, then its location and eventual fate as a stormwater control practice should be logical. We also encourage including the grading plan so that all initial and final elevations are consistent with the SE/SC and stormwater plans.

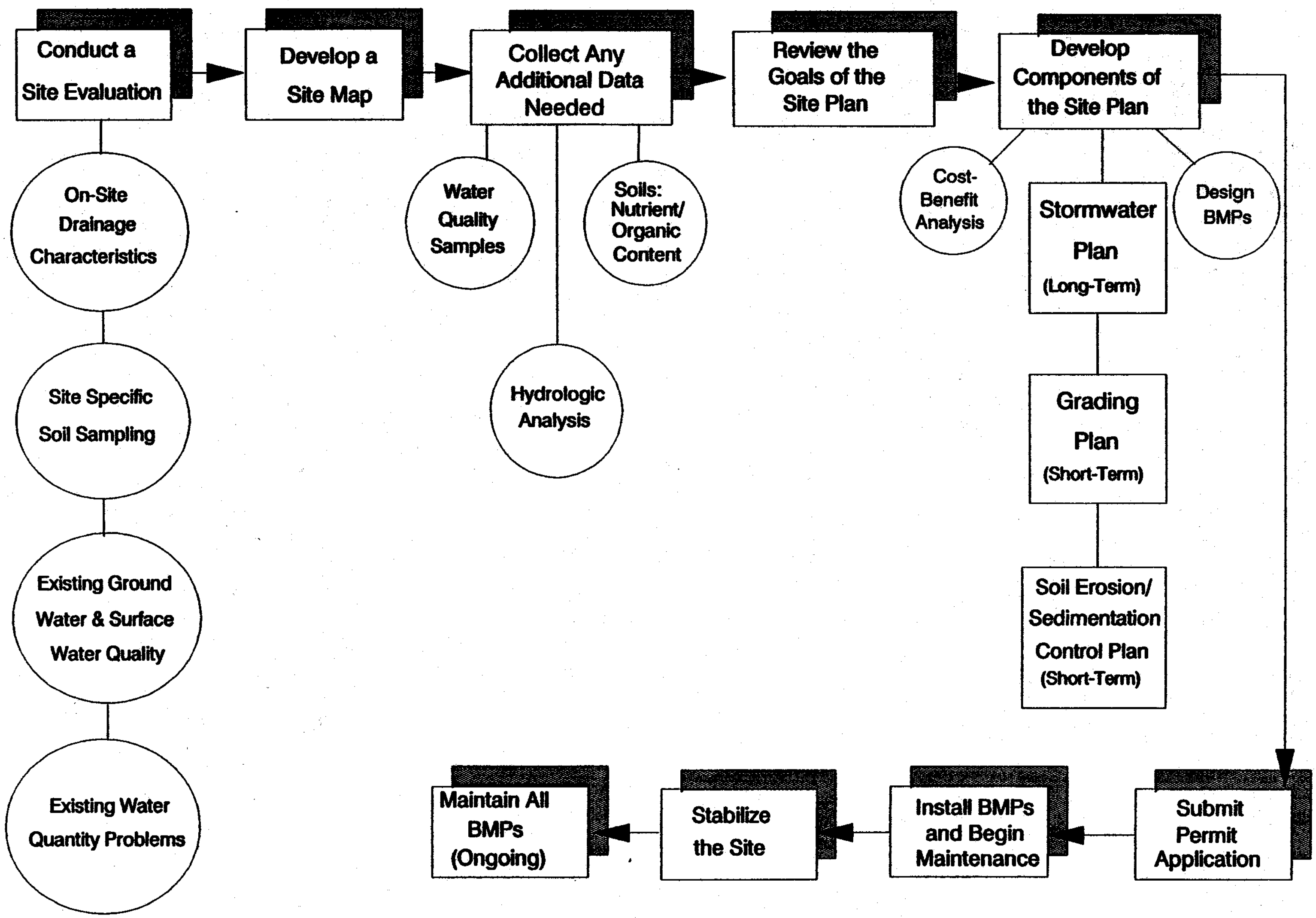
The following are steps which can be followed to develop a site plan and identify the BMPs needed at the site. These steps are summarized in Figure 7.

A note on Legal Implications of the Site Plan:

Under Act 347, the Michigan Soil Erosion and Sedimentation Control Act, a soil erosion/sedimentation control plan is a requirement of all construction sites of one acre or more in size or within 500 feet of a lake or stream. Under the recently promulgated stormwater regulations, all construction sites which expose five or more acres of land will also require a National Pollution Discharge Elimination System (NPDES) permit. Michigan's recently approved rule amendments (part 21 Rules) state that if you are permitted under Act 347, you are deemed to have a NPDES permit, "unless the Commission has required an individual national permit pursuant to the provisions...of this rule. " The rules state that for all construction sites of five or more acres, the construction permittee must file to the MDEQ a notice of coverage under this rule before commencing with construction activities. The rules also require maintenance of all soil erosion control structures to comply with the Act 347 permit, and inspections of the site once a week and within 24 hours after every precipitation event. There are also provisions for certified stormwater operators, proper waste disposal, reporting requirements and inspection requirements. See the appendices for the Part 21 Rule amendments.

Figure 7

How to Develop a Site Plan



STEP 1: Conduct a Site Evaluation. A site evaluation is basically a more focused version of a watershed evaluation. Some of the information needed here can be obtained from the watershed plan. Note information from the watershed evaluation, as well as the site conditions upstream and downstream of the site, and on-site conditions. Maps of the site should be produced detailing the various characteristics of the site. Use professional surveys when possible. Make the maps as large as possible because eventually you will want to identify and locate specific BMPs which will be needed. Be sure to include on your map the names of all surface waters, the location of trees and other vegetation that will be preserved, the approximate slopes after grading, areas of soil disturbance, the direction of drainage patterns, and:

- **on-site drainage characteristics,** including:

    *the **size of the drainage area.** This will be needed in the design of almost all BMPs.

    ***runoff calculations** for the design storm(s) needed per each BMP. Where possible, obtain either from direct measurement or determine by estimate the expected pollutant loadings from the watershed.

- Determine **site-specific soils information**. Soil tests will provide the most accurate information for the proper selection of BMPs. If soil tests cannot be done, use soil surveys, as available from the local Soil Conservation District. See also the Appendix text on "Soils".

Determine Existing or Potential Ground and Surface Water Quality Problems.

- Determine the cause of the problems identified. For example, if banks are sloughing, it may be necessary to look at upstream areas to see if development upstream is adding to flow velocities in your part of the watershed. It may be necessary to work with upstream users to control the sources of nonpoint pollution.

- Identify sites of potential problems so that problems may be reduced before they occur. Such problems areas may include sites which may result in increased hydrology or soil erosion, either during or after construction.

Where known problems exist or when retrofitting existing BMPs, the following information is also needed:

- Work with engineers or environmental consultants, MDEQ staff, Drain Commissioners, Soil Conservation District staff, Soil Conservation Service staff, the Cooperative Extension Service, or other appropriate professionals to discuss options for remediating the problem.

    Note: All structural BMPs should be designed by professional engineers experienced in the design of such BMPs. Structural BMPs include all runoff conveyances and outlets, sedimentation control structures, and runoff storage structures.

- Don't overlook the nonpoint problems that can be remediated by simple measures such as leaving existing woody vegetative buffers, re-seeding exposed soils, proper household hazardous waste disposal, and proper lawn maintenance. Include these measures as part of the site plan.

STEP 2: Develop a Site Map.

A site map should be developed which, at a minimum, contains the soil textures, elevation, the location of surface waters (including wetlands), and the location of vegetative buffers and any other resource in need of protection (such as endangered plants). This map should be used as a basis for all other components of the site plan.

STEP 3: Collect Any Additional Information Needed.

If little information is available on water quality, then a water quality sampling program may need to be developed to establish baseline data. Consider biological surveys and/or collecting water samples. If little information is available on the hydrologic regime, then a hydrologic study is recommended. MDEQ staff may be able to provide assistance in developing a water quality sampling or monitoring program suitable for your site.

Site-specific soil sampling should always be done, even in areas where there are soil surveys. The soil surveys are good tools for general planning purposes, but they don't provide the detail necessary for site-specific design.

STEP 4: Review the Goals of the Site Plan.

The goals of a site plan should be consistent with the goals of the watershed plan. If no watershed plan exists, identify goals that would help direct the choice of practices and strategies for site development toward those that will reduce adverse impacts on the hydrology and water quality of the watershed. The following goals provide such direction. (The following is modified from "Protecting Water Quality in Urban Areas", Minnesota Pollution Control Agency, Division of Water Quality.)

A. Reproduce pre-development hydrological conditions. This is a goal that can only be addressed comprehensively at the site planning level. It means trying to reproduce the full spectrum of hydrologic conditions: peak discharge, runoff volume, infiltration capacity, base flow levels, groundwater recharge, existing detention, and maintenance of water quality. A comprehensive approach is difficult and involves the whole context of site planning. Runoff volume, infiltration recharge and water quality must take into consideration the amount of paved surfaces in the watershed, its configuration in terms of its relationship to drainage paths, and vegetative cover.

B. Confine development and construction activities to the least sensitive areas. Protecting critical areas during construction and after development is extremely difficult and costly. It is best to avoid construction in critical areas and plan development around them. In this way the watershed is more easily protected at a much lower cost. The major types of sensitive areas are discussed below:

- **Avoid construction in and adjacent to natural drainageways.** Construction in natural drainageways destroys natural vegetation and often results in channelized streams. Once natural vegetation in drainageways is destroyed, it is very difficult to reestablish. Since natural drainageways contribute large amounts of water directly to receiving lakes or streams, once disturbed, they can become high-energy, high-volume conduits for moving pollutants to receiving waters. Site plans that call for disturbing natural drainageways are unlikely to be able to meet the goal of keeping the waterbody within pre-development hydrologic conditions. Therefore, protect the existing vegetation to the extent possible.

- **Avoid developing on steep slopes.** Generally, the steeper the slope, the greater the soil erosion potential. This is because the effects of gravity and reduced friction between soil particles on steep slopes means it takes less energy for water to dislodge and transport soil particles. In addition, steep slopes also limit the area in which buildings can be located. Good site planning avoids placing houses and roads on steep slopes (1:2 slopes or less).

- **Maintain and protect dense vegetation and buffer/filter strips.** Leaving a dense vegetative cover adjacent to surface waters is the most important factor in preventing erosion. Disturbance of areas with a well established dense vegetative cover will yield the greatest change or impact in terms of erosion. Wooded areas with understory are the most runoff-absorbent types of cover in the landscape. Destruction of such vegetation adds significant expense to the construction budget for clearing, and destroys the aesthetic and economic attributes of the site. A good site plan preserves large areas of existing dense vegetation.

- **Preserve porous soils.** Site planning should include avoiding development on highly porous soil areas. This will make porous soils available for infiltration and significantly reduce the land area that must be committed to detention facilities required to control peak discharges.

- **Avoid disturbing erodible soils.** When denuded of vegetation during construction, areas with easily eroded soils can yield great volumes of transported soils. If site planning can be done to avoid disturbing erodible soils, large erosion and sedimentation problems will also be avoided.

- **Protect wetlands.** Wetlands provide many water quality functions such as nutrient retention, filtration, and the storage and delay of flood and runoff waters. Wetlands also serve as habitat for fish and wildlife. Approximately 30% of Michigan’s threatened and endangered plants, and approximately 60% of the 65 threatened and endangered animals, are wetland species. It is therefore vital to protect them. Their use in stormwater control is discussed in section E, the "treatment train. "

Through careful site planning, sensitive areas can be set aside as natural open space areas to meet open space area requirements. Other areas can be used to preserve views from homesites, and to provide privacy between homesites.

C. **Fit the development to the terrain.** Choose road patterns to provide access schemes which match land form. For example, in rolling or dissected terrain use strict street hierarchies with local streets branching from collectors in short loops and cul-de-sacs along ridge lines. This approach results in a road pattern which resembles the branched patterns of ridge lines and drainageways in the natural landscape, facilitating the development of plans which control the landform and minimize disruption of existing grades and the natural drainage.

D. **Preserve and "more wisely" use the natural drainage system.** Keep pavement and other impervious surfaces out of low areas such as swales and valleys. This means keeping the roads and parking areas high in the landscape and along ridges wherever possible. Unfortunately, most existing development standards and approaches implicitly encourage developing roads and parking areas in low areas. However, this traditionally accepted practice does, in fact, cause nonpoint and point pollution problems.

The best example of this is the use of curbing on streets and parking areas in low- and medium-density subdivisions. Curbs are widely held to be the signature of quality development; they provide a neat, "improved" appearance and also help delineate roadway edges. Because curb-and-gutter streets trap runoff on the roadway, storm inlets and drains are logical solutions to providing good drainage for the roadway. As a result of such thinking, many municipalities require the use of storm drains and curb and gutter streets.

Unfortunately, this solution can create significant storm water management problems when looked at in the broader context of devising an environmentally sound land development scheme. The problem scenario goes something like this. Because storm drains operate on gravity flow principles, their efficiency is maximized if they are located in the lowest areas of the site. Since storm drains are the preferred technology for providing drainage for the curb and gutter streets, it is natural to locate the streets where the storm drains are best located--in the valleys and low areas which comprise the natural drainageways of any site. In this way, natural drainageways can become unintended targets for destruction: the natural vegetative cover in the most hydrologically critical areas of the landscape is replaced by impervious pavement. Natural filtration capacity is lost in the most strategic locations.

Further, in most locations, storm drains are designed only for short duration, high frequency storms with flood flows handled by street and gutter flows after the storm drain capacity is exceeded. This often means that the natural floodways have been converted from slow- moving, permeable, vegetated waterways to impermeable streets and gutters which move water at an increased velocity. The combination of storm drain and paved overland flow areas result in a watercourse that is "flashy", has an increased peak discharge, and, to some extent, a higher runoff volume. As natural waterways become paved and specifically designed to be quickly drained by storm drain, channel storage time is minimized and base flow and groundwater recharge are sharply reduced. The net effort of a seemingly beneficial decision to use curb and gutter can inadvertently cause nonpoint source pollution in water resources.

This scenario also has important effects on water quality. Trace metals, hydrocarbons and fuel spills from automobile are directly deposited on the now paved surfaces of the site's waterways. A certain amount of these pollutants, which might have settled out in the natural waterway, are now kept in suspension by the storm drain system during rainfall events.

In curb-and-gutter areas, pollutants are delivered via runoff to receiving waters where changes in velocity permit them to settle out. Pollutants such as nutrients from area lawns are quickly moved through the paved system with no opportunity to come in contact with plant roots and soil surfaces. The result is quick delivery of these pollutants to lakes, streams, and wetlands.

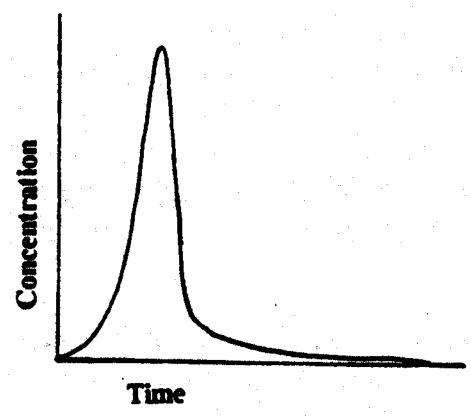
Note: Wetlands, like lakes and streams, are surface waters. They may in some cases act as natural drainageways. In these situations, wetlands must be protected from excessive point and nonpoint pollution loads. This is accomplished through maintaining the pre-development characteristics of wetland hydrology, and providing adequate pre-treatment of stormwater.

If natural vegetated drainageways are strictly preserved in the site planning process, flood volumes, peak discharges, and base flows will be held closer to their pre-development levels. Trace metals, hydrocarbon and other pollutants will have a much greater opportunity to become bound to the extent allowable through natural processes, with underlying soil. The infiltration which would occur along the entire drainageway would not only contribute to the reduction of runoff volumes, but would also allow nutrients to be taken up by the vegetation lining the drainageway.

E. All BMPs should be chosen using a **"treatment train"** concept. A treatment train is a series of BMPs used in conjunction with one another to "treat" runoff. Each BMP is chosen for its ability to remove or limit specific pollutants, and/or its ability to help regulate changes in hydrology. An example of a treatment train is parking lot runoff which outlets through a riprapped outlet, to a wet detention pond, which discharges to an infiltration basin. The riprapped outlet decreases the velocity of the water. The wet detention pond allows for settling of particles and biological uptake of nutrients. The infiltration basin removes some of the finest particles and provides infiltration.

Figure 8

Plot of Pollutant Concentration Versus Time



Source: Stormwater Management Guidebook, MDEQ, Land and Water Management Division, 1992.

The first flush is the term given to the fact that the majority of pollutants that enter surface waters during a rain event do so during the first part of the storm. This is shown graphically in Figure 8. The reason for this phenomenon is that during the first few minutes of a storm, the rain water picks up oil, grease and other pollutants that have accumulated on paved areas or roadways and transports them to the surface water or storm drain. After the first few minutes of the storm, there are fewer pollutants on the ground available for the rainwater to pick up. Because of this first flush effect, BMPs that capture the first ½ inch of runoff in Michigan would capture a higher percentage of pollutants. Our basin BMPs (detention and retention basins, for example) include a recommendation to design to capture at least the first ½ inch of runoff.

STEP 5: Develop Components of the Site Plan Based on the Goals.

General Considerations:
Since a site plan (which, again, consists of a grading plan, a soil erosion/sedimentation control plan, and a stormwater plan) will contain BMPs, it is important that the selection of site-specific BMPs takes into consideration the BMPs included in the watershed plan, especially in the case of regional controls. Again, this is important because the changes that occur on an individual site can affect the water quality and quantity of the entire watershed.

Design:
All BMPs which are identified for use on the site should be designed based on the specific site characteristics--soil type, slope, topography, climate, etc. The design of all structural practices should be done by engineers or other professionals qualified in the design of the BMPs needed. Persons designing BMPs should use the specifications in the attached BMPs as a basis for which to design the BMP for the specific location. It is important to remember that the specifications in the BMPs are not so inclusive as to be applicable to anyone particular site.

Whenever possible, design the BMPs with secondary uses in mind, particularly where large areas of land are needed to construct the BMP. Athletic fields and playgrounds are most often considered but fountains, waterfalls and aesthetics should also be considered. Wherever possible, the BMP should be designed to be aesthetically pleasing.

Maintenance procedures must be considered during the design phase to be sure the BMP can be easily maintained.

Cost and Time Comparisons:
When developing the components of the site plan, keep in mind that every BMP costs money to install, and many require design by professionals. Money will also be needed for the operation of the project, as well as for the maintenance of the control measures. Careful planning can minimize construction costs.

Before deciding on the use of a particular BMP, be sure to compare its cost effectiveness and the time that will be involved in its implementation with other similar BMPs. For example, although sodding may cost more money than seeding, establishing vegetation immediately to protect a sensitive area may outweigh the difference in cost. Temporary operations don't require the same expenses as long-term operations.

A. Developing the Grading (earth change) Plan:
(Note that earth change plans are required for all development sites under Act 347, the Soil Erosion and Sedimentation Control Act). The purpose of the earth change plan is to find the most harmonious fit between the natural characteristics of the site and its intended uses.

The site analysis done in Step 1 will help you determine which areas are best for development and which should remain undisturbed. An earth change plan consists of:

1. a written plan, which should include:

    - the site's proximity to surface waters
    - the severity of topography
    - the erodibility of soils
    - a description of existing woody vegetation
    - BMPs, including a planting program and other measures that will be used to control erosion and collect sediment during the grading operation.

2. a schematic earth change plan, which should include the location of:

    - all man-made structures, including buildings, vehicular and pedestrian routes, parking areas, open space areas, other site facilities, etc.
    - all cut and fill areas
    - the grades (elevation) both before and after development
    - all BMPs
    - all former and remaining woody vegetation

B. Developing the Soil Erosion and Sedimentation Control Plan:
The General Rules of the Soil Erosion and Sedimentation Control Act require the submission of an erosion and sedimentation control plan which includes both a graphic and written submission.

1. The **graphic submission** should include:

   - a description and location of the limits of all proposed earth changes.
   - a description and location of all existing and proposed on-site drainage. Plans should also take into account an estimate of the volume of water and the rate water runs off the site. These factors can be determined from field surveys, topographic maps, soil surveys, aerial photographs, and/or hydrologic computer models. Computer models can be used to determine runoff conditions on proposed earth changes in the land use and physical conditions of the watershed. Models can also be used to incorporate both water quality and water quantity considerations and to determine the effectiveness of selected BMPs. See the Appendix for two methods to calculate runoff.

   - a description and location of all proposed temporary erosion and sediment control measures. Using the Unified Keying System (UKS) during this part of the plan development can be very helpful. The UKS is a numbered listing of temporary and permanent soil erosion control measures, detailed with a simplified graphic and description. The keying numbers can be used by the planner to identify the type and location of the measures to be used on the site.

   - a description and location of all proposed permanent erosion and sediment control measures. Each permanent control measure should be documented and recorded with the county register of deeds and the enforcing agency prior to final approval of the project, or prior to occupancy, or use.

   - a description and location of all existing and remaining vegetation.

   - a schedule of the BMPs. Follow the Staging and Scheduling BMP .

   Plans should also take into account an estimate of the amount of soil that may erode during an earth change. The Universal Soil Loss Equation (USLE) is the most commonly used equation for estimating soil loss. The USLE can be used to estimate the annual average soil loss (in tons) from a site. It is used extensively for determining soil loss associated with farming activities, and is also a viable method for determining potential soil loss from construction activities. See the "Soils" Section in the Appendix for further explanation on the USLE.

2. The **written submission** should include a program proposal for the maintenance of all erosion and sedimentation control facilities which will remain after the project is completed, including the designation of a responsible party. Proper maintenance should include visual inspections of structures and vegetation for undercutting, erosion and failure. Particular attention should be given after each rain to ensure the measure will be effective during the next rain. Time should also be scheduled to allow for mowing, fertilizing, seeding and other non-structural maintenance.

   To ensure an effective means of controlling soil erosion and sedimentation, the soil erosion and sedimentation control plan should also include the following:

   - a site location map
   - a topographic map showing existing vegetation, predominant land features, and a description of existing site drainage patterns and facilities
   - a soil surveys and interpretation

- a site analysis to determine critically eroding areas
- an earth change plan to show how erosion and sedimentation will be controlled
- an erosion and sedimentation control plan to specify the schedule and control measures proposed

Source: Section 3 of "Michigan's Soil Erosion and Sedimentation Guidebook, " which contains several graphic illustrations and examples of soil erosion and sedimentation control plans.

C. Developing the Stormwater Control Plan:

A stormwater control plan should indicate the **existing drainage** characteristics of the site, including floodplains, wetlands, swales and conveyance systems. This information should be included on a map, with arrows denoting the direction of drainage.

The map should also indicate the practices or infrastructure that will alter the existing drainage patterns. Indicate on the map the **drainage changes** that will occur due to the proposed development.

Indicate the **BMPs** which will be used to prevent drainage from causing erosion or other water quality or quantity problems. BMPs to control runoff include check dams, stabilized outlets, grassed waterways, lined waterways, etc. Practices should be indicated on the map, and their general design (i.e. minimum storm design) indicated in writing. Be sure to keep in mind the goals of the waterbody being protected--extra precautions may be needed depending on the goals for the waterbody. All practices should be listed in writing. All practices should be shown on the construction blueprints.

In urban and industrial areas, **pre-treatment** of stormwater may be needed. Indicate in writing how pre-treatment will occur and indicate on the map the location where pre-treatment will occur.

D. Putting it All Together:

An example of how to incorporate BMPs into a site plan is given below, based on the types of practices that might be included in both the soil erosion/sedimentation control plan and the stormwater plan. These plans should then be checked against the grading plan to ensure all grades and elevations make sense.

1. **For the soil erosion/sedimentation control plan:**
    a. Using the map(s) made during the site investigation, identify the construction site preparation BMPs. These include things like Construction Barriers, Tree Protection devices, and Buffer/Filter Strips. These should be installed before any other earth changes occur.

    b. Identify the soil erosion and sedimentation control structures which should be used and include these on the map:

        - Remember, it is always easier (and usually cheaper) to prevent soil erosion using techniques such as mulching and seeding than it is to remove sediment from storm water.

        - Consider using filter fences at the downstream end of all sites which are adjacent to surface waters or wetlands. (See the Filters BMP).

- Consider using a Sediment Basin to allow sediment to settle out before water is released to a waterbody or wetland.

- When work must be done "in the dry", consider using cofferdams as part of the Dewatering operation.

- When applicable, identify where Watercourse Crossings are needed to safely and most feasibly cross a watercourse.

c. Based on the drainage characteristics identified during the site investigation, identify the runoff conveyance structures needed and include these on the map:

- Consider Diversions to direct water away from critically eroding areas.

- Water diverted via Diversions should be directed to Stabilized Outlets such as Grassed Waterways. Sediment Basins, Filters, and the runoff storage structures listed below can also serve as outlets.

- Consider Grade Stabilization Structures to move water from one grade to another without causing erosion. These include downdrains, drop control structures, flumes, etc.

- Consider using Check Dams in ditches, (especially those which will not be seeded) to decrease flow velocities.

- Determine whether Subsurface Drains are needed to remove ponding water that would inhibit establishment of desired vegetation.

d. Use the Staging and Scheduling BMP at all work sites both for installation of BMPs and during the general construction process. This BMP promotes conducting development operations in stages, and scheduling the implementation and maintenance of all BMPs. As each area is developed it should be temporarily seeded and mulched, or sodded to prevent erosion.

e. Determine the appropriate managerial BMPs. These include Dust Control, Fertilizer Management, Pesticide Management and the proper location of Spoil Piles. This should always include the Equipment Maintenance and Storage Area BMP, which includes the proper location, storage and use of all hazardous substances. Spill prevention of these substances should also be included in a separate spill prevention plan.

f. Consider the housekeeping BMPs and incorporate them into your maintenance efforts. Housekeeping BMPs include Street Sweeping and Household Hazardous Waste Disposa1.

All structural practices which will be used should be indicated on the construction blueprints.

2. **For the stormwater plan:**
   a. Identify the runoff storage structures which should be used, based on the site or watershed hydrology. Include these on the map:

- Consider the use of Porous Asphalt Pavement or Modular Pavement in place of standard pavement. Porous/modular pavement allows water to infiltrate into the ground.

- Specialized detention basins such as Rooftop Storage or Parking Lot Storage can be used in developed areas where little land is available.

- Infiltration practices such as Infiltration Trenches or Infiltration Basins are encouraged in areas where soils are such that water can infiltrate easily, and where pollutants are such that they will not impact groundwater.

- Extended Detention Basins should be used in those areas where water quantity must also be controlled.

- BMPs which should be considered to "treat" runoff before it leaves a site include Oil/Grit Separators, Catch Basins and Wet Detention Basins.

b. Review all managerial BMPs. These include Fertilizer Management, Pesticide Management and proper Household Hazardous Waste Disposa1. Be sure to review the Equipment Maintenance and Storage Area BMP, which includes the proper location, storage and use of all hazardous substances. Spill prevention of these substances should also be included in a separate spill prevention plan.

c. Review the housekeeping BMPs and incorporate them into your maintenance efforts. Housekeeping BMPs include Organic Debris Disposa1 and Street Sweeping.

All structural practices which will be used, should be indicated on the construction blueprints.

The soil erosion/sedimentation control plan and stormwater plan should then be checked against the grading plan. Again, the schematic part of the grading plan should include all man-made structures, (including buildings, vehicular and pedestrian routes, parking areas, open space areas, other site facilities, etc.), all cut and fill areas, and the grades (elevation) both before and after development.

Upon completion of the site plan:
Once the three components of the site plan are complete, we recommend that a pre-construction meeting occur with all persons who will be involved in the construction project. This will ensure that there is no confusion about what is being done and at what time. This will also ensure that all three components of the plan correspond logically with each other.

STEP 6: Submit Permit Applications to the Appropriate Agency

As described in the "Legal Implications" section, above, under Act 347, Michigan's Soil Erosion and Sedimentation Control Act, all construction activities which disturb l or more acres of land or within 500 feet of a lake or stream will require a permit from the Act 347 agency. An Act 347 agency is a local or county agency that is authorized by the MDEQ to approve soil erosion control plans, pursuant to Act 347. Also, construction activities which disturb five or more acres of land need to meet the federal requirements of the National Pollution Discharge Elimination System (NPDES) permit for construction sites. In Michigan, this coverage can be obtained under the permit-by-rule for construction activities. The construction permittee will need to submit to the MDEQ a notice of coverage, certifying that they have an approved plan or permit under Act 347.

For storm water activities in industrial areas, a storm water application will need to be submitted to the MDEQ, Surface Water Quality Division. We encourage industries to get involved in watershed management, because what is done at your industrial site affects the water quality and quantity of the entire watershed.

Use the "State/County Environmental Permits Check List" on pages 39 and 40 to decide which other permits are needed for your site plan. This state/county checklist is not a permit application form, but a means of determining which permits must be obtained. Keep in mind that you will also need to follow any local requirements.

STEP 7: Construct/Install BMPs

Construction should be done following the scheduling sequence outlined in the Staging and Scheduling BMP. All earthwork should follow specifications in the Land Clearing and Grading Practices BMPs. No other earthwork should be done until BMPs which protect the natural resources are in place--including such practices as Tree Protection, Construction Barriers, Filter (fences) and Sediment Basins. Begin the maintenance program.

STEP 8: Stabilize the Site

Procedures after construction include removing temporary BMPs (such as Construction Barriers and temporary Sediment Basins) and stabilizing the area with vegetation. Under the Part 17 Rules of the Michigan Soil Erosion and Sedimentation Control Act (1972, P.A. 347), permanent soil erosion control measures for all slopes, channels, ditches or any disturbed land area shall be completed within 15 calendar days after final grading or the final earth change has been completed. When it is not possible to permanently stabilize a disturbed area after an earth change has been completed or where significant earth change activity ceases, temporary soil erosion control measures shall be implemented within 30 calendar days. All temporary soil erosion control measures shall be maintained until permanent soil erosion control measures are implemented. Once the site is stabilized, managerial and housekeeping BMPs should be followed to prevent nonpoint source pollution from occurring.

STEP 9: Maintain BMPs

Ongoing maintenance of all BMPs will assure the continued protection of the natural resources from nonpoint sources. All temporary and permanent control measures must be periodically checked to ensure that they are functioning according to the original design. Some BMPs may require an end-of-day check, whereas others may need to be checked only during and after a storm. Weekly checks should be made on any BMPs which can be damaged by heavy equipment or other local traffic. Each BMP includes the maintenance procedures which should be followed, including frequency of inspections and problems to be aware of. For permanent BMPs, a mechanism must be agreed upon and in place to ensure the long-term maintenance of the practice.

CHANGING THE PLAN

We recommend that site inspections be done at least weekly, and following any precipitation events which can result in runoff from the site. Look at the stream for impacts from your activities. If the BMPs selected and approved for a site are not effective in protecting the resource, or if there are significant changes in the design, construction, operation, maintenance or scheduling of BMPs, the plan will need to be modified. For example, if the group of BMPs on a large construction site is not adequate to keep soil on the site, then additional practices may be needed. If additional structural practices are needed that require engineering, the revised plan should be submitted to the appropriate agency for review and approval.

Emergency changes to the plan--those that are required to take immediate action to prevent further soil erosion or sedimentation, flooding, or the contamination of surface or groundwaters--do not require agency pre-approval and should be undertaken as necessary to prevent additional damage to the water resources. The permitting agency should be notified of the emergency changes.

STATE/COUNTY ENVIRONMENTAL PERMITS CHECKLIST
FOR
(name & address of municipality)

This checklist has been prepared to alert businesses to state and county environmental permit requirements which may apply to new or existing facilities. Applicants are requested to complete this form and submit it to the municipal office with the proposed site plan. Upon receipt, the township will forward the information to the permit coordinator, MDEQ.

This checklist is not a permit application form; businesses are responsible for obtaining information and permit application forms from appropriate state and county offices. Please not that this checklist pertains only to state and county environmental permits. Additional permits and approvals may be required by the municipality or other government agencies.

<u>Circle the regulations which you think may apply to your business:</u>

1. Y N Will the project involve the discharge of any type of wastewater to a storm sewer, drain, lake, stream or other surface water?
   Contact: *MDEQ, Surface Water Quality Division.*
   District office telephone: ________________

2. Y N Will the project involve the discharge of liquids, sludges, wastewater and/or wastewater residuals into or onto the ground?
   Contact: *MDEQ, Waste Management Division.*
   District office telephone: _________________

3. Y N Will the project or facility store or use hazardous substances, oil or salt? Depending on the type of substance, secondary containment and a Pollution Incident Prevention Plan (or a material storage permit) may be required.
   Contact: *MDEQ, Waste Management Division.*
   District office telephone: _________________

4. Y N Will the facility use underground storage tanks? Existing tank must be registered with the State Police Fire Marshall Division. Tanks must be installed and operated in accordance with state regulations.
   Contact: *Michigan State Police Fire Marshall Division, Hazardous Materials Section, Lansing, (517) 322-1935 or 1-800 MICH UST.*

5. Y N Will the facility involve the transport, on-site treatment, storage or disposal of hazardous waste generated in quantities of 1000 kilograms (250 gallons or 2200 pounds) or more per month? If yes, one or more permits may be required.

   Will the facility generate between 100 kilograms/month (25 gallons or 220 pounds) and 1000 kilograms/month (250 gallons or 2200 pounds) of hazardous waste? If yes, the facility may be a small quantity generator, subject to federal and state regulations. An EPA identification number should be obtained from the MDEQ (special forms are available) and a manifest (shipping paper) should be used to transport waste off-site.
   Contact: *MDEQ, Waste Management Division.*
   District office telephone: ___________________

6. Y N Will the project involve bumming, landfilling, transferring or processing any type of solid non-hazardous wastes on-site?
   Contact: *MDEQ, Waste Management Division.*
   District office telephone: ____________________

7. Y N Will the project involve the installation, construction, reconstruction, relocation, or alteration of any process or process equipment (including air pollution control equipment) which has the potential to emit air contaminants?
   Contact: *MDEQ, Air Quality Division, Permit Section.*
   District office telephone: _____________________

8. Y N Will the project involve any man-made change in the natural cover or topography of land, including cut and fill activities which may contribute to soil erosion and sedimentation? Will the earth change disturb an area of one acre or more, or occur within 500 feet of a lake or stream? If the answer to both of these questions is yes, a soil erosion and sedimentation control permit is required.
   Contact: *Local Enforcing Agent or County Enforcing Agent for soil erosion/sedimentation control*_______________________

9. Y N Will the project involve any work (dredging, filling, construction) in a river, stream, creek, ditch, wetland or floodplain, or within 500 feet of an inland lake, stream, creek or ditch? Or will it impact special management areas such as dunes or wild and scenic rivers?
   Contact: *MDEQ, Land* & *Water Management Division.*
   District office telephone: ________________________

10. Y N Will an on-site wastewater treatment system or septic system be installed? Will septage be stored on-site prior to off-site disposal?
    Contact: *For* ***sanitary sewage*** *-County or District Environmental Health*______________
    For ***industrial/commercial wastewater in any quantity*** *or more than* ***10,000 gallons/day of sanitary sewage*** *-MDEQ, Waste Management Division.*
    District office telephone: __________________________

11. Y N Is this facility (or any facility under your ownership) currently involved in any compliance discussions with the MDEQ or the Michigan Attorney General's office?
    Contact: *MDEQ, Office of Environmental Enforcement.*
    Telephone: (517) 373-3503.

12. Y N If this facility/property (or any facility/property under your ownership) included on the Act 307 Priority List, "Michigan Sites of Environmental Contamination" or subject to corrective action under the Leaking Underground Storage Tank (LUST) program?
    Contact: *MDEQ, Environmental Response Division.*
    District office telephone: ___________________________

13. Y N Will the project involve any work in an established county or inter-county drain or in the right-of-way of an established drain, or discharge to an established drain?
    Contact: *County Drain Commissioner.*

NOTE: For assistance with permits and approvals from the MDEQ, including permit coordination among MDEQ divisions, contact the Permit Coordinator, Lansing Central office (517) 335-4235.

Business Name:	Mailing Address:
Street Address:	Telephone:
Facility Owner or Manager:	Type of Business:

DETENTION AND INFILTRATION TO ADDRESS URBAN NONPOINT SOURCES OF POLLUTION

The terms detention and retention have been used throughout this guidebook. The difference between the two is important. *Detention* practices are those practices which store stormwater for some period of time before discharging to a surface waterbody. *Retention* practices capture stormwater and release it through infiltration to the ground. Many people will use "retention" and "infiltration" interchangeably.

LOCATION OF DETENTION STORAGE

In the past, communities have passed ordinances that require peak runoff rates after development to be less than or equal to peak runoff rates before development. The criteria may change from community to community, however the goal is to maintain the current peak runoff rates through the use of on-site storage. While the concept may be honorable, in some instances, the result of the ordinance is the construction of a number of detention basins throughout the community for which the combined effects actually increase downstream flooding.

The size and location of detention storage has been shown to impact the peak flood flows. Basin-wide planning is essential to result in properly sized basins, and to prevent flood discharges from being increased.

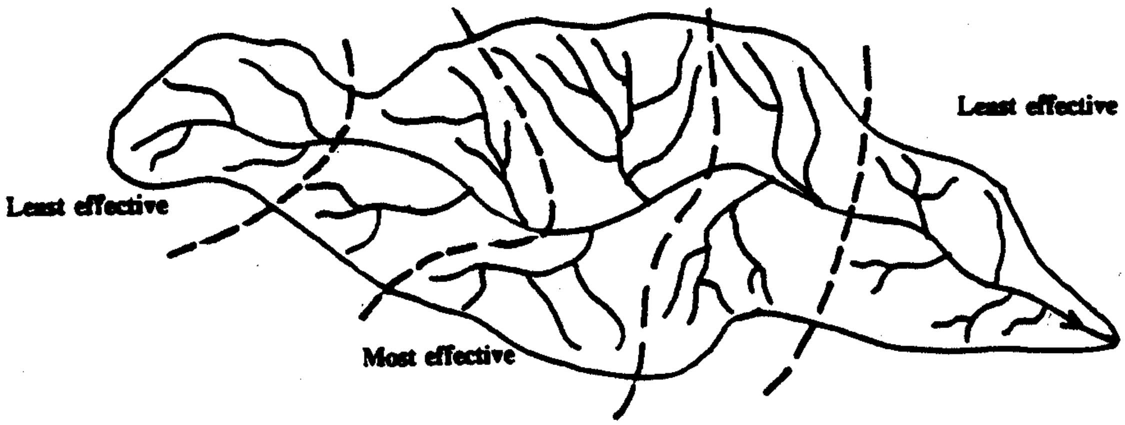
In 1986, the MDEQ studied the Sargent Creek Watershed, in Oakland County, to determine the impact detention has had on the flood flows of this urbanized basin. As the watershed was urbanizing, on-site stormwater detention was required. The study looked at the impact that the on-site detention basins had on the flood flows, as compared to a regional detention basin, or a series of detention basins. It was found that an in-line detention basin would need about one-half of the amount of land that the on-site detention basins needed to accomplish the same impact on flood discharges. The study also indicates that in some instances, regulated on-site detention ponds have increased peak flows downstream by delaying outlet peaks to the extent that all of the flood peaks combine simultaneously.

Figure 9 illustrates the most effective locations for detention ponds. At the extreme upper and lower ends of the watershed, detention ponds will have little beneficial impact on peak flows.

The installation of detention facilities at the lower end of the watershed, may hold water that would normally have been gone, and release it at the same time as the flood peak on the main channel reaches the site. As a result, a detention basin at such a location may actually increase the flood peak. For this reason, it is essential that the entire watershed be considered when the stormwater management plan is being developed. In addition to the volume of runoff, an effective detention pond design must be based on the timing of the flood hydrographs of the entire watershed.

Figure 9

Effectiveness of Detention Locations Within a Watershed



Source: Stormwater Management Guidebook, MDEQ, Land and Water Management Division, 1992.

ON-SITE DETENTION

There is quite a bit of information available for the design of individual detention ponds, which primarily deal with the volume and rate of runoff. However, there is not much information on the impacts of on-site detention ponds as opposed to a regional detention pond.

Another concern with on-site detention is the long-term maintenance requirements. Since the detention pond will likely be placed on private property, it will be necessary to have a maintenance agreement to clearly identify responsibility for maintenance, and easements to ensure that the ponds are maintained. If they are not maintained, the basins will not be as effective as intended, and will likely turn into "eye-sores". Because of the maintenance requirements and potential problems, the landowner may not readily accept a pond being placed on their property.

On-site stormwater management facilities should be designed to replicate the natural, pre-development runoff conditions to the greatest extent possible. This principle underlies detention requirements, which attempt to restrict the peak rate of stormwater discharge to pre-development conditions.

REGIONAL FACILITIES

As with on-site detention, the placement of a regional detention facility will require a hydrologic analysis of the watershed. Since a regional facility will likely be placed on a public land, the problem with easements and responsibility of maintenance will be minimized. However, there will still be the problem of providing adequate maintenance.

A regional facility will usually require less land than would be required to achieve the same effects from numerous on-site facilities. There will also be savings on construction and maintenance costs associated with a regional facility, as opposed to many on-site facilities.

Regional facilities can be more readily accepted by the public, if designed and maintained properly. Since regional facilities will be larger than on-site facilities, it is possible to incorporate multi-purpose uses into the design, such as soccer fields, football fields, fishing ponds, and parks.

BENEFITS OF INFILTRATION

When urban development takes place, pavement and buildings block the natural infiltration of stormwater into the ground. Groundwater base flow, which sustains small streams, wetlands, and lakes may be depleted, while surface water runoff increases. Infiltration helps maintain the natural flow of runoff into the ground, while still providing for both quantity and quality control of stormwater.

In addition to water quality and quantity control benefits, infiltration systems reduce the downstream bank erosion problems which may result from other types of stormwater detention structures. Even when discharge from detention ponds is restricted, the discharge comes from a single point, sometimes resulting in downstream channel erosion. Infiltration of stormwater helps to minimize the potential for downstream erosion and other adverse impacts. From an environmental protection standpoint, infiltration of stormwater is the optimal approach, provided that systems can be made to function.

It is important to note, however, that infiltration practices should be the last step in the treatment train. Soluble organic substances, oil and grease and coarse sediment must be removed by other management practices prior to infiltration in order to prevent groundwater contamination, and prevent clogging of the infiltration area. Infiltration could be used to simply return "clean" water to the ground to maintain the hydrologic regime. Infiltration practices must be properly designed, constructed and maintained to prevent groundwater contamination.

PREFERRED APPROACHES TO ON-SITE DETENTION AND RETENTION

To protect Michigan’s water resources, stormwater management for both quantity and quality control purposes are essential. With these two objectives in mind, stormwater detention and retention facilities can be ranked in order of preference. The following was derived from "Stormwater Management Guidebook for Michigan Communities," Clinton River Watershed Council, 1987.

<u>First Priority:</u> Infiltration systems, provided that soil and groundwater conditions are suitable, and provided that groundwater supplies will not become contaminated. By directing stormwater runoff into the soils, downstream impacts are minimized.

<u>Second Priority:</u> Wet detention basins with a fixed water level between runoff events. This type of basin holds stormwater long enough for sediment and attached pollutants to settle out.

<u>Third Priority:</u> Extended dry detention basins which hold stormwater for 24 to 72 hours before completely draining to become a dry basin. This extended detention time allows for some sediments to settle out before stormwater is released.

<u>Lowest Priority:</u> Dry detention basins which completely dewater within 3-4 hours after the end of the storm. Although dry basins can effectively reduce downstream flood peaks, they rarely provide substantial water quality benefits. The stormwater (carrying sediment and pollutants) reaches the basin, but the stormwater (with pollutants) is then discharged into the waterway after a short holding period.

SPILL RESPONSE PLAN

A spill response plan should be developed in conjunction with all stormwater facilities to deal with accidental spills into the system. These facilities can be a key in preventing environmental damage in the event of a spill, or they may provide a conduit for concentrated pollutants to get to sensitive areas depending on how they are managed. The spill response plan should describe in detailed steps who is responsible for what actions in the event of a spill and how they are contacted, particularly during off- duty hours.

Speed is often the most important aspect of reacting to a spill. If an outlet can be closed in time, pollutants can be contained in a basin and cleaned out there instead of being released to the watershed. Cleanup of downstream areas significantly increases the cleanup cost. Where infiltration is used, spills must be contained within the smallest area possible and cleaned up before groundwater is contaminated.

ORDINANCES

LOCAL ORDINANCE DEVELOPMENT

Ordinances provide a means by which county and municipal governments can assure that site planning and development take potential erosion and stormwater problems into account and include effective measures for their control. Ordinances can also be implemented which prohibit indiscriminate land clearing, or which require leaving natural buffer/filter areas around all surface waters. While the principal intent of the ordinances is preventative, they also include provisions for the enforcement action where this becomes necessary.

Listed below are elements that would typically be included in local stormwater management zoning ordinances.

1. **Statement of Authority to Regulate** (What statute gives the community the authority to enact the ordinance).

2. **Goals and Objectives** of the Stormwater Management Program.

3. **Definitions of terms** used in the ordinance.

4. Relationship between current and existing legislation should be included to avoid conflict.

5. **Stormwater Management Plan Review**

    a. Specifications (Descriptions, standard format and certifications that are required.)

    b. Evaluation of Plans (The agencies that will evaluate the plans, and the criteria that will use for the evaluation.)

    c. Zoning Approval (The proposal must meet current zoning requirements.)

    d. Review Fees (The fee schedule for review and evaluation should be included.)

6. **Permits**

    a. When permits are required (The situations that will require permits should be specifically described.)

    b. Waivers (Circumstances in which permit requirements are waived should be listed.)

    c. Appeals (An appeal procedure must be present to handle denials of a permit or waiver.)

    d. Expiration and renewal (The permit should be given an expiration date. There should also be a method to apply for an extension or renewal.)

e. Suspension or Revocation of Permit (It is necessary to have an enforcement section to ensure that the construction and implementation of the stormwater management plan is completed in accordance with the approved plans).

f. Fees (Any permit fees should be listed.)

g. Performance Bonds (To ensure the completion of the project.)

h. Compliance **and Enforcement** (The responsibility of completing the project should be clearly designated to the owner.)

i. Liability Insurance (An alternative to a performance bond, the liability insurance would allow the project to be completed even if the developer is not financially able.)

7. **Design Criteria**

a. Acceptable Methods of Stormwater Management

b. Performance Standards (List the amount of protection or control that is expected. Such as no increase the l00-year peak runoff.)

c. Acceptable Methods of Evaluating Stormwater Management Facilities

d. Reference List (Stormwater management technical references.)

e. Safety and Aesthetics (When the use of fencing and other safety devices is required.)

f. Emergency Spillways (When design conditions are exceeded, how the emergency spillway will function.)

8. **Maintenance and Inspection**

a. Access to Site (Access to the site must be guaranteed during construction and for the entire design life of the facility.)

b. Inspection During and After Construction

c. Responsibility of Maintenance (The responsibility should be noted in the ordinance. If given to landowner, the property title must indicate that the responsibility will transfer if the land is sold.)

d. How Funds for Maintenance will be Collected

9. **Severability** (If one portion of the ordinance is found to be unenforceable, the other provisions will remain in effect.)

EXAMPLE ORDINANCES

Grand Traverse County Soil Erosion and Stormwater Runoff Control Ordinance:

The drain commissioner is the county's designated enforcing agency to issue permits to control soil erosion and stormwater runoff.

Some of the purposes of the ordinance include the following:

* To ensure that property owners control the volume and rate of stormwater runoff originating from their property so that groundwater quality is protected, and soil erosion and flooding potential are minimized.

* To preserve the use of the natural drainage system for receiving and conveying stormwater runoff and to minimize the need to construct enclosed, below-grade storm drain systems.

* To preserve natural infiltration and the recharge of groundwater and to maintain subsurface flows which replenish lakes, streams and wetlands.

Earth changes which require permits from the Drain Commissioner include some of the following:

* Earth changes proposed for environmentally sensitive residential sites.

* Industrial or commercial development sites, regardless of size, location, or environmental sensitivity.

Standards for the review and approval of permit applications are specified in the ordinance. Examples of the some of the standards are as follows:

* Removal of vegetation and tree roots within 50 feet of the ordinary high water mark of any lake or stream shall be discouraged unless approved for recreation uses by the drain commissioner. Additional buffer areas may also be required.

* Removal of vegetation and tree roots within 25 feet of the ordinary high water mark of any protected wetland shall be discouraged unless approved for recreation uses by the drain commissioner. Additional buffer areas may also be required.

* Drainage wells (dry wells) shall be discouraged as a stormwater control method.

* A two-stage design for detention and retention basins shall be used on sites where parking lots and other impervious services exceed five acres in size, as well as other sites identified by the drain commissioner or the MDEQ as requiring special protection for water quality purposes.

* A 25-foot undeveloped buffer area shall be provided around the perimeter of all detention, retention, and infiltration basins which are 112 acre or more in size.

Maintenance:

All soil erosion and stormwater runoff control facilities must be maintained in working order. Options for maintenance responsibilities include: (a) the property owner; (b) a property owners association; or (c) drain commissioner.

<u>The Oakland Township and Orion Township Stormwater Management and Erosion Control Ordinances:</u>

The purpose of these ordinances is to protect against floods and water pollution. These dual goals are affirmed in many specific sections of the ordinances.

Legal authority for the ordinances is drawn from several state laws including the Township Ordinance Act, the Wetlands Protection act, the Soil Erosion and Sedimentation Control Act, and the Michigan Environmental Protection Act.

The stormwater management and erosion control ordinances reaffirm the common law principle that stormwater runoff control is the responsibility of the landowner. The requirements help to insure that new development projects will not adversely affect adjoining property owners and other township residents. The ordinances clarify township requirements and assure equitable application and benefits for residents and landowners.

The stormwater management and erosion control ordinances include the following major provisions:

* Each developer must submit a stormwater management plan for the site (in addition to a site plan and/or subdivision plat).

* Stormwater management plans are reviewed by the Planning Commission at the same time that the other aspects of the development proposals are reviewed.

* The stormwater management plan must include site data on water resources, topography, and natural drainage patterns, as well as a general description and locations for the proposed stormwater management system.

* The stormwater management plan must identify the primary stormwater management system designed to control the 10-year frequency storm as well as the secondary stormwater management system (a 100-year frequency storm event).

* Erosion control regulation is included in the ordinance. The Orion Township Ordinance will provide a Township with authority to issue erosion control permits in accordance with state law. The Oakland Township Ordinance will allow for a substantive erosion control review of the development plans, prior to the required county-level erosion permit review.

* Wetlands can be used for stormwater detention in selected locations, while ensuring that the natural functions and quality of wetlands throughout the township are protected to the maximum feasible extent. If wetlands are the primary detention area for stormwater, they must be set back at least 100 feet from the edge of any lake or stream. Wetlands with significant wildlife habitat or ecological values which would likely be impaired may not be used. To protect wetlands from excessive siltation, erosion control in upland areas near the wetland must be provided.

* On-site retention of stormwater is required, in accordance with standards in the ordinance and engineering design specifications of the consulting engineer.

* The requirement for on-site detention may be waived if a suitable off-site, shared stormwater detention area is identified.

* Through township agreements, arrangements for stormwater and erosion control facility maintenance must be made. In Orion Township, the Township will enter into the agreements and establish an inspections program through the Department of Public Works. In rural Oakland Township, agreements between the Drain Commissioner and landowner will be required for subdivisions.

* Engineered grading plans for individual lot development will be required and reviewed by township staff, separate from the more extensive stormwater management plan review outline.

The City of Ann Arbor's Stormwater Utility and Soil Erosion and Sedimentation Control Ordinances:

A note on stormwater utilities: A stormwater utility is a fee charged to property owners, attached to their monthly or quarterly utility bill. The fees are used for stormwater system planning and ongoing maintenance. Property owners are charged in relation to the actual cost of planning or maintaining facilities serving their properties.

Ann Arbor's Stormwater Utility: Chapter 33

All owners of real property in the City of Ann Arbor shall be charged for the use of a stormwater system based on the amount of stormwater and rate of flow of stormwater which is determined to be entering the stormwater system from the property. The impact of the stormwater from the property on the system shall be determined on the basis of the flat rates or the measurements contained within Chapter 33.

The quarterly charges for single-family or two-family dwellings shall be $6.09 per dwelling unit. However, if adequate stormwater retention is provided (see Section 5:673 of Chapter 63 of Title V of the Code of the City of Ann Arbor - Stormwater Retention Facilities), the charge shall be $5.15 per dwelling unit.

The quarterly charges for properties other than described above shall be computed in the following manner: $65.25 per acre multiplied by the following factors for the acreage of the following types of land area:

0.20 for pervious area;
0.95 for impervious area without adequate retention;
0.30 for impervious area with adequate retention.

All funds collected for stormwater service shall be placed in a separate account and shall be used solely for the construction, operation and maintenance of the stormwater system.

Soil Erosion and Sedimentation Control: Chapter 63

Fees. Fees shall be paid to the City of Ann Arbor in accordance with the following provisions:

1. The fee for a grading permit shall be at a rate of $60.00 per acre, computed to the nearest tenth of an acre, with a minimum fee of $30.00.

2. A monthly inspection fee shall be assessed, except in the subdivision or lot development which disturbs less than one acre of land, at a rate of $60.00 per acre subject to the accelerated soil erosion, computed to the nearest tenth of an acre, with a $30.00 minimum.

3. An additional inspection fee of $60.00 per acre of site area subject to accelerated soil erosion shall be assessed with a $60.00 minimum for each inspection following the issuance of a correction notice for work to be performed in less than one month.

4. Inspection fees are to be paid prior to the issuance of a Certificate of Occupancy.

5. Should construction activities begin prior to the issuance of a grading permit, the applicant is subject to double the plan checking and inspection fees, as determined by the Building Official.

For additional information:

The "Stormwater Management Guidebook for Michigan Communities," published by the Clinton River Watershed Council, includes ways local governments can address stormwater at the local level. The guidebook discusses on-site detention, infiltration, ordinances, soil erosion control, and maintenance. Several funding options are also discussed.

"Local Zoning to Protect Designated Natural Rivers: A Guide for Citizens and Local Officials," MDEQ, Land and Water Management Division, 1978, includes the "how-to" of local zoning regulations. Although it was written primarily for the protection of rivers which fall under Natural Rivers designation, the manual includes many basic zoning principles that can be applied to general water quality protection efforts at the local level.

The PEARL "Design Manual," Livingston County Planning Department, November, 1991, provides the basis for understanding rural clustering and how it can fit into a master plan. The manual promotes cluster development as a means to preserve wildlife habitat and vegetation, environmentally sensitive areas, scenic views, agricultural areas, and open space.

APPLICABLE STATE AND FEDERAL REGULATIONS

The following section briefly describes the federal, state, and local laws currently in effect which have some impact on the management of nonpoint source pollution. The purpose of this section is not to give a detailed analysis of each law, but to provide a brief description of the laws which affect land and water construction activities in Michigan. Figure 10 at the end of this section graphically illustrates these laws.

Federal Clean Water Act

Section 405 of the Water Quality Act of 1987 amended Section 402 of the Clean Water Act of 1972 by requiring EPA to develop regulations requiring permit applications for stormwater discharges associated with industrial activity, and storm sewers from municipalities with populations of 100,000 people or more (medium and large size municipalities). The requirements would eventually include small municipalities, those with populations of less than 100,000 people. These regulations were published on November 16, 1990.

There are a large number of industries that will be required to apply for permits under the regulation. One notable industry is the construction industry, for activities that will disturb more than five acres of land. The second phase of the regulations (effective 2002) will require construction sites greater than one acre to apply for a permit. Agricultural activities are exempted.

As a result of the amendments to the Water Quality Act, there will be an increased effort to eliminate non-storm water discharges into storm sewers. Requiring permits for discharges of storm water runoff from municipalities and industries is an attempt to reduce the discharge of pollutants through management, controls, education and engineering methods. Permits must require medium and large size municipalities to control pollutants in their storm water runoff to the Maximum Extent Practicable (MEP).

Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451 (formerly the Water Resources Act, Act 245).

Part 31 of Act 451 empowers the Director of DEQ to protect and conserve the water resources of the state. This includes the prohibition of pollution of the state's waters, and to prohibit the obstruction and occupation of floodways, and prohibit activity that would harmfully interfere with the stage discharge characteristics of the rivers and streams of the state.

Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act. 1994 P.A. 451 (formerly Soil Erosion and Sedimentation Control Act. Act 347)

Part 91 of Act 451 provides for the control of soil erosion, and protects the waters of the state from sedimentation. Part 91 is applicable to all earth changes of one acre or greater or to any earth change within 500 feet of a lake or stream.

Part 91 is enforced at three different levels of government: Local (City, village, or charter township), County, or State. Counties are given the primary responsibility for administration of this Part. In some instances, public agencies, such as road commissions and drain commissions are self-enforcing.

The methods for minimizing erosion have a significant impact on the amount of runoff as well as controlling sediments. Since sedimentation is estimated to be a pollutant in about 95% of the watersheds in Michigan, this Part is very important in controlling a high percentage of the nonpoint source pollution problems.

Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, (formerly Inland Lakes and Streams Act, Act 346).

Part 301, as amended was enacted to regulate activities occurring within inland lakes and streams; and to protect riparian rights and the public trust in inland lakes and streams.

One of the environmental concerns that is addressed by the Part includes regulating dredge or fill projects (within the banks of a watercourse). In one way, the Inland Lakes and Streams Act could be thought of as a "bottomland " version of the Soil Erosion and Sedimentation Act. Whenever bottomlands are dredged or filled, a permit must be obtained, and adequate soil erosion control measures are a condition of the permit. As noted above, the control of erosion and sedimentation is essential to begin to solve nonpoint source pollution.

Part 303, Wetland Protection, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, (formerly Goemaere-Anderson Wetland Protection Act, Act 203).

Part 303 provides for the preservation, management, protection, and use of wetlands. A permit is required for the alteration or use of a wetland. This Part applies to wetlands that are contiguous (a ground or surface water connection) to a lake, pond, river, or stream; to many isolated wetlands that are greater than 5 acres in size; in counties having a population in excess of 100,000 or to any wetland determined to be essential to the preservation of the natural resources of the state from pollution, impairment, or destruction.

Part 303, in part, indicates that some or all of the following benefits are derived from a wetland:

1. Flood and storm control by the hydrologic absorption and storage capacity.

2. Pollution treatment by serving as a biological and chemical oxidation basin.

3. Erosion control by serving as a sedimentation area and filtering basin, absorbing silt and organic matter.

It is imperative that wetlands not be exploited as the solution to all stormwater treatment problems. Wetlands must be recognized and protected against excessive point and nonpoint stormwater pollution loads just as any other surface water (lake or stream) would be protected. This can be accomplished by maintaining the pre-development hydrologic characteristics of the wetland. If use of a wetland area is considered as part of a stormwater management project, the District Office of the Land and Water Management Division, MDEQ, should be contacted for advice and guidance on permit requirements.

Part 17, Michigan Environmental Protection Act, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, (formerly Michigan Environmental Protection Act (MEPA), Act 127)

Act 127, P.A. of 1970 is an extremely important piece of legislation, as it provides protection of the air, water, and other natural resources, and the public trust associated with these resources. The Act provides the right to any person in the State to bring action against another person, agency, corporation, or political subdivision for conduct that may pollute, impair, or destroy the air, water, or natural resources.

Within Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, (formerly Flood Plain Control Act (1929 P.A. 245 as amended by Act 167 of P.A. 1968)

The purpose of this Part is to control encroachments, occupations and alterations of floodways. This would include bridges and culvert construction, fills and stream modifications.

Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451, (formerly Michigan Dam Safety Act, Act 300, P.A. of 1989).
This Act requires a Dam construction permit for the construction of a structure that will be six feet more in height and will impound five surface acres or more at the design flood elevation. Depending on size, some detention ponds may fall under the authority of this Act.

The Act requires dams to have a specified spillway capacity, based on the hazard rating of the dam. As an example, low hazard potential dams must have a spillway capacity that is capable of passing the 100-year flood, or the flood of record whichever is greater. (Low hazard potential dams are located in areas where failure would pose little to no danger to individuals, and damage would be limited to agriculture, uninhabited buildings, structures, or township or county roads). Other dam classifications with a height of less than 40 feet of height would require a spillway that is capable of passing the 200-year flood, or the flood of record whichever is greater.

Subdivision Control Act, Act 288, P.A. of 1967.
This Act was passed to regulate the subdivision of land; and to promote the public health, safety, and general welfare. Among the provisions of the Act (Section 192) is the review by the county drain commissioner, or the governing municipality for adequate storm water facilities within the proposed subdivision. At this time, there is no statewide standard that is being used in regard to quality and quantity issues. As a result, a standard--if one exists--will vary between communities and counties.

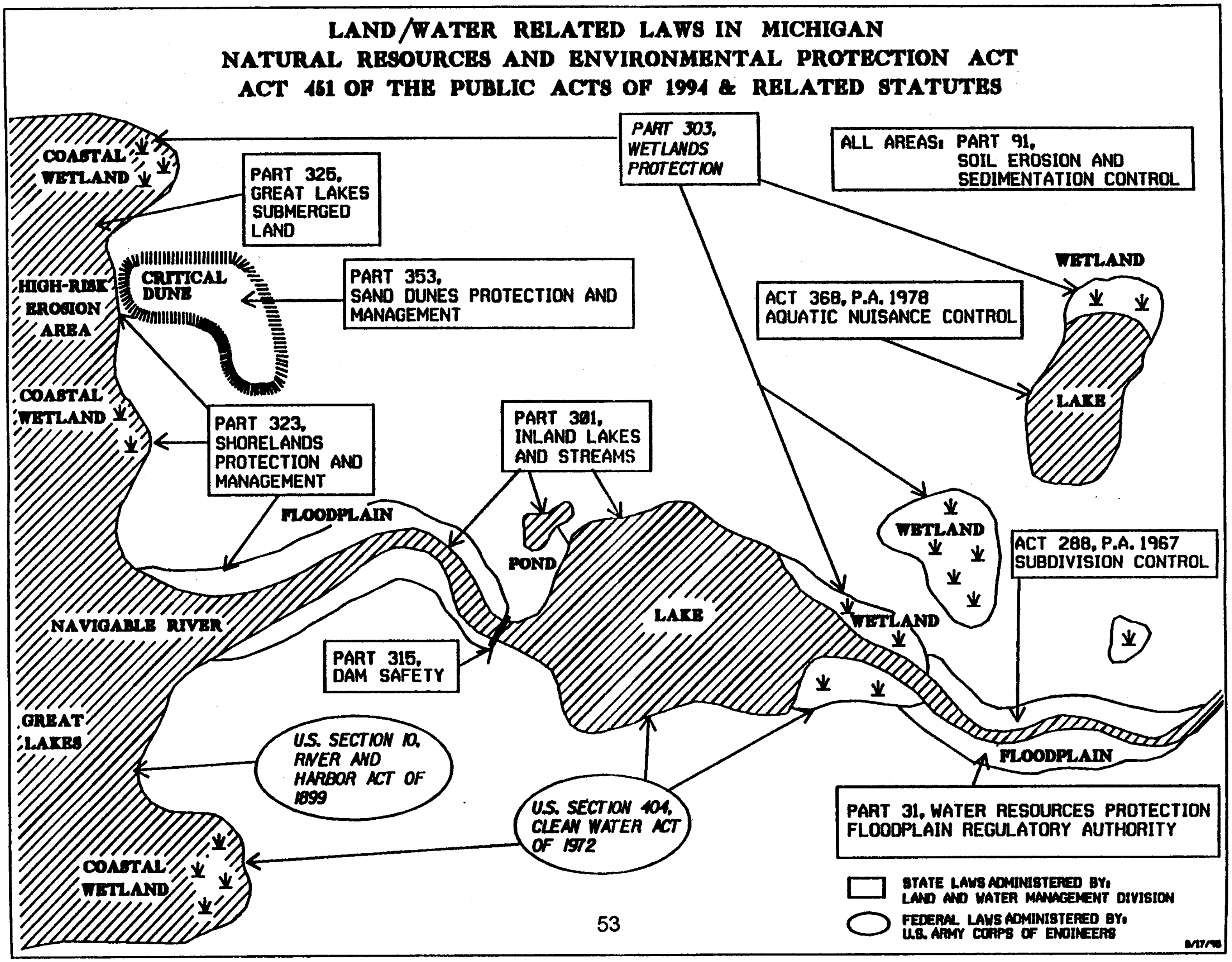
Part 305, Natural Rivers, of the Natural Resources and Environmental Protection Act, 1994 P.A. 451 (formerly Natural River Act, Act 231, P.A. of 1970).
The purpose is to establish a system of outstanding rivers in Michigan, and to preserve, protect, and enhance the wildlife, fisheries, scenic, historical, recreational, and other values associated with those river environments. A list of designated rivers is included in the Appendices.

Most activities within an established Natural River District (usually all land within 400 feet of the river's edge on both sides of the river) require state or local zoning permits. These include:

1. Building construction
2. Platting of lots
3. Cutting of vegetation within an established natural vegetation strip
4. Land alteration
5. Bridge construction

Michigan Drain Code, Act 40
Act 40, P.A. of 1956, as amended was passed with the primary objective of improving the drainage of agricultural lands. Over the years as these areas have become developed, the flooding problems faced by the county drain commissioner have increased.

The establishment of drains or improvements on existing drains are initiated by petition from landowners in the drainage district, or two or more public bodies. Once drainage districts are established, assessments may be levied to finance drain improvements. In the past, county drain projects have typically consisted of drain enclosures and clean-outs. However, in recent years, stormwater management has become a primary focus in various counties around the State.


LAND/WATER RELATED LAWS IN MICHIGAN
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT
ACT 451 OF THE PUBLIC ACTS OF 1994 & RELATED STATUTES
PART 303, WETLANDS PROTECTION
ALL AREAS: PART 91, SOIL EROSION AND SEDIMENTATION CONTROL
COASTAL WETLAND
PART 325, GREAT LAKES SUBMERGED LAND
HIGH-RISK EROSION AREA
CRITICAL DUNE
PART 353, SAND DUNES PROTECTION AND MANAGEMENT
WETLAND
ACT 368, P.A. 1978 AQUATIC NUISANCE CONTROL
LAKE
COASTAL WETLAND
PART 323, SHORELANDS PROTECTION AND MANAGEMENT
PART 301, INLAND LAKES AND STREAMS
FLOODPLAIN
POND
WETLAND
ACT 288, P.A. 1967 SUBDIVISION CONTROL
NAVIGABLE RIVER
LAKE
WETLAND
PART 315, DAM SAFETY
GREAT LAKES
U.S. SECTION 10, RIVER AND HARBOR ACT OF 1899
U.S. SECTION 404, CLEAN WATER ACT OF 1972
FLOODPLAIN
PART 31, WATER RESOURCES PROTECTION FLOODPLAIN REGULATORY AUTHORITY
COASTAL WETLAND
STATE LAWS ADMINISTERED BY: LAND AND WATER MANAGEMENT DIVISION
FEDERAL LAWS ADMINISTERED BY: U.S. ARMY CORPS OF ENGINEERS

FUNDING

The key to a successful project is not to count on anyone source of funding but to tap into as many different sources of funding as you can. Since very limited funding is available for nonpoint sources controls through federally funded programs--such as Sections 319, 604(b)(1) and 314 of the Federal Clean Water Act, and the State Revolving Fund (SRF)--local communities will have to be creative in generating funding for reducing nonpoint sources. Some local funding sources which various Michigan communities have tried are given below.

Ordinances can be developed at the local level to ensure that developers put in the BMPs needed to meet the goals of the watershed. Several townships have ordinances which require submitting fees as part of the soil erosion/sedimentation control permitting process. The fee system in Grand Traverse County funds all or most of their soil erosion control staff.

The fee system in the city of Ann Arbor charges developers for the amount of soil exposed. This has encouraged staging on development projects so that only certain portions of the area are exposed at any given time. Their fee system also includes a monthly inspection fee and an additional inspection fee if correction notices are issued. Ann Arbor's construction fee system is described in the "Example Ordinances" section, above.

Various funding sources can also be explored for funding stormwater activities. Stormwater utilities provide services of flood control, drainage, and stormwater management, and are financed with user charges. The user fees are typically based upon the runoff that would be anticipated from the property--a commercial property with paved parking lots would be required to pay more than a residential development, due to the greater runoff potential. Ann Arbor's stormwater users fees are described in the "Example Ordinances" section.

In urbanizing areas, sewer tap fees can be used to generate additional funds for stormwater. The city of Novi charges developers tap fees for maintaining stormwater basins. The tap fee is based on the percentage of impervious area and is charged if the development is to drain to a regional basin. (All regional basins are designed for the 100-year storm). If no regional basin is in place, the developer is required to put in an on-site detention basin (based on the 10-year storm). Once the regional basin is constructed, the on-site basin is put off-line and the developer is charged the tap fee. The design and construction of basins in Novi is funded through their millage.

BMP FORMAT AND ORGANIZATION WITHIN DOCUMENT

INDIVIDUAL BMP FORMAT:

Except for the " Specifications " section of the BMP, all BMPs are set up in the same format:

- The first section is a "Description" which gives a general definition and purpose of the BMP.
- The second section is "Other Terms Used to Describe" which lists the other names or terms which are used to describe the BMP. For example, fertilizer management may also be referred to as nutrient management.
- The third section is the "Pollutants Controlled and Impacts". This describes the pollutants which the BMP is designed to control and the positive impacts the BMP will have on the environment.
- The next section is "Application". This is broken down into several subsections:
- "Land Use" describes the types of land uses the BMP applies to. A land use is simply how the land is being used-- for recreation, transportation, agriculture, forestry, etc.
- "Soil/Topography/Climate" describes certain soils, topographic or climatic conditions which may affect the use of the BMP.
- "When to Apply" gives the time in which the BMP should (and sometimes should not) be applied.
- "Where to Apply" describes the types of locations the BMP is applicable to.
- The next section is "Relationship With Other BMPs". This includes the BMPs which can be implemented in conjunction with this BMP.

BMP SPECIFICATIONS:

The "Specifications" sections differ depending on whether the BMP is managerial, structural or vegetative:

In most cases, the "Specifications" section **for vegetative BMPs** contains the following:

- "Planning Considerations", including the specific time in which the practice should be implemented, species selection, etc.
- "Site Preparation", including actions which can be taken on the site to prepare the soil and site for vegetation.
- "Application", including how to apply the seed, sod, mulch, etc.

In most cases, the "Specifications" section **for structural BMPs** contains the following:

- "Planning Considerations", including conducting a site evaluation, determining soil types, and other factors which need to be determined before structural BMPs can be properly designed.

- "Design", including general design considerations such as proper slope length, sizing, material type, etc. per each aspect of the structure. In many cases, there is also a design example problem.

- "Construction", including the step-by-step method for installing the designed structure.

- "After Construction", including stabilizing the surrounding area and other post-construction activities.

The "Specifications" section **for managerial BMPs** varies depending on the specific BMP.

All BMPs also have a "Maintenance" section which describes the activities which must be done to ensure the BMP continues to function as it was designed.

Some BMPs also have an "Additional Considerations" section which includes information which does not fit into any of the above categories.

Note: Where needed in the BMP text, other BMPs will be underlined. For example, the Riprap BMP will include references to Lined Waterway and other BMPs.

BMP ORGANIZATION:

BMPs are organized in the binder by:

1. Housekeeping BMPs. These are managerial type BMPs which should be incorporated into your planning efforts.

2. Managerial BMPs. These are the BMPs which should be considered both during and after construction.

3. Construction Site Preparation BMPs. These BMPs should be considered on every construction site prior to the onset of land clearing.

4. Runoff Conveyance and Outlets. These BMPs convey runoff from eroding areas to more stabilized outlets.

5. Sedimentation Control Structures. These BMPs help reduce sedimentation. They are usually put in when it is not possible to keep the soil on-site.

6. Runoff Storage. These are structural BMPs which contain runoff, allowing it to infiltrate, evaporate or be treated before it is allowed to be released downstream.

7. Vegetative Establishment BMPs. These are practices which are usually used in conjunction with one another when establishing vegetation, including grasses, trees and ground covers.

8. Wetland BMPs. These BMPs help protect wetlands, or allow the least impact on wetlands.

   - All pertinent BMPs include specifications which serve as starting point for BMP selection, design and construction.

   - All BMPs include maintenance procedures which should be followed.

BEST MANAGEMENT PRACTICES FOR CONSTRUCTION SITES, URBAN AREAS AND GOLF COURSES

The BMPs are categorized in one of eight categories. The abbreviation listed in parentheses after the BMP name corresponds with the BMP page numbering system.

Construction Site Preparation:

- Access Road (AR)
- Construction Barriers (CoB)
- Grading Practices (GP)
- Land Clearing (LC)
- Spoil Piles (SP)
- Staging and Scheduling (S&S)
- Tree Protection (TP)

Housekeeping:

- Household Hazardous Waste Disposal (includes used oil disposal) (HHHW)
- Street Sweeping (SW)
- Community Car Wash (Car). New BMP, September, 1997.

Managerial:

- Critical Area Stabilization (CAS)
- Dune/Sand Stabilization (D/SS)
- Dust Control (DC)
- Equipment/Maintenance Storage Area (EMS)
- Fertilizer Management (FM)
- Lawn Maintenance (LM)
- Organic Debris Disposal (ODD)
- Pesticide Management (PM)
- Pond Construction and Management (PCM)
- Pond Sealing and Lining (PS)
- Slope/Shoreline Stabilization (S/SS)
- Stream Bank Stabilization (SBS). Updated September, 1997.
- Winter Road Management (WRM)

Runoff Conveyance and Outlets:

- Check Dams (CD)
- Diversions (DIV)
- Grade Stabilization Structures (GSS)
- Grassed Waterways (GW)
- Riprap (RIP). Updated September, 1997.
- Stabilized Outlets (SO)
- Stormwater Conveyance Channels (SCC)
- Subsurface Drain (SD)

Runoff Storage:

- Catch Basins (CaB)
- Extended Detention Basin (EDB)
- Infiltration Basin (IB)

Infiltration Trench (IT)
Modular Pavement (MP)
Oil/Grit Separators (O/GS)
Parking Lot Storage (PLS)
Porous Asphalt Pavement (PAP)
Roof Top Storage (RTS)
Wet Detention Basins (WDB)

Sedimentation Control Structures:

Buffer/Filter Strips (B/F). Updated September, 1997.
Dewatering (DW)
Filters (includes filter fencing) (FIL)
Sediment Basins (SB)
Watercourse Crossings (WaC)

Vegetative Establishment BMPs:

Mulching (MUL)
Seeding (includes Dormant Seeding) (SEE)
Sodding (SOD)
Soil Management (includes pH Control) (SM)
Trees, Shrubs and Ground Covers (T,S)

Wetland BMPs:

Wetland Crossings (WeC)
Constructed Wetland Use in Stormwater Control (ConW). New BMP, September, 1997.