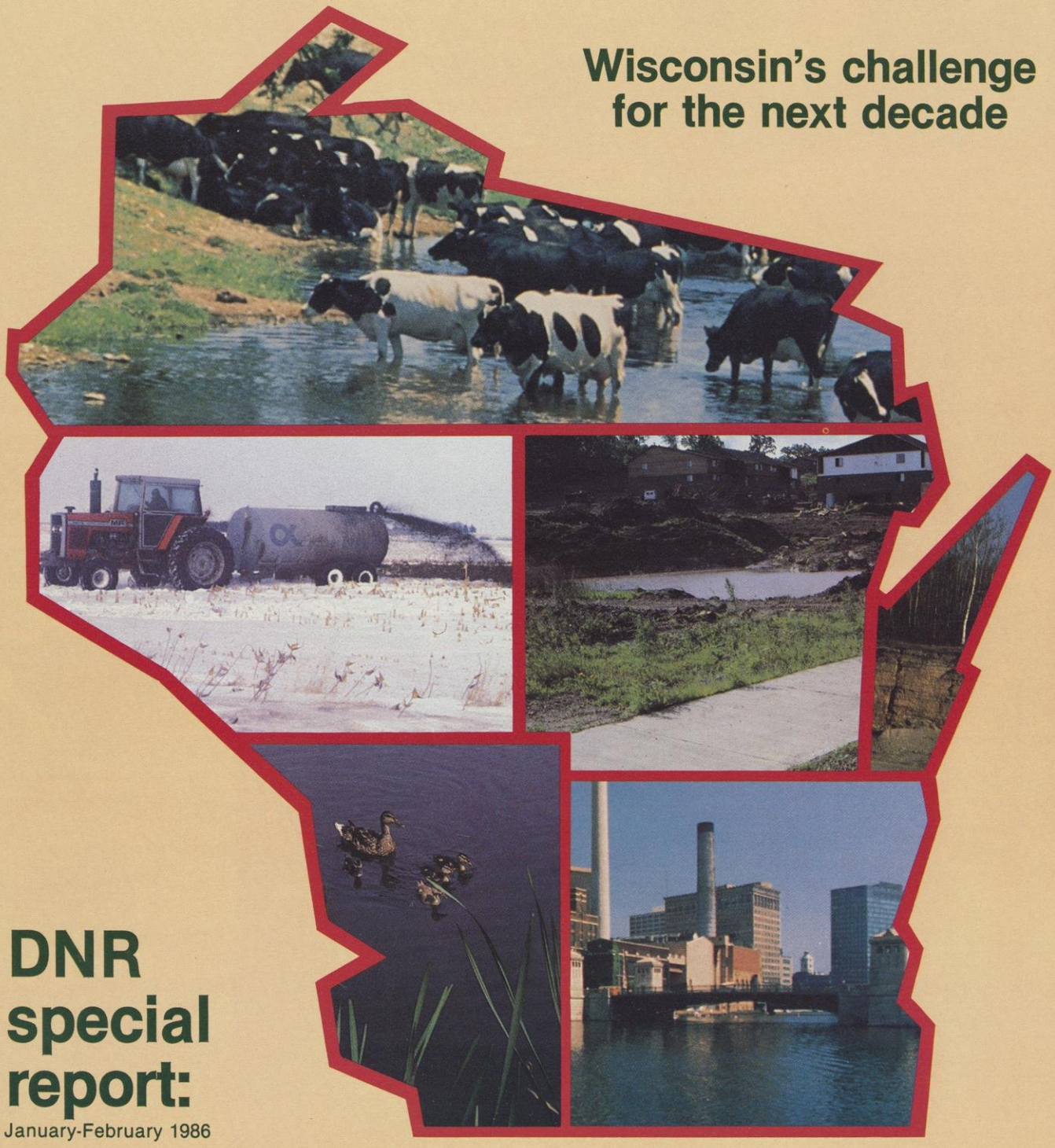
Nonpoint source pollution: where to go with the flow. Special report, [Vol. 10, No. 1] DNR special report January-February 1986

Nonpoint source pollution:

Where to go with the flow

Wisconsin's challenge for the next decade



DNR special report:

January-February 1986

Idyllic disaster. Trampled and exposed streambanks erode bare soil during rainfall. Cows stir up sediment, destroy vegetation and fish habitat. Animal wastes drop directly into the stream. To protect water quality, livestock should be fenced out. Photo courtesy of *The Milwaukee Journal*

EDITED BY SUSAN BERGQUIST

Introduction

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In the last few years, several kinds of environmental pollution have become better known to the public as scientists learn more and the media provide regular environmental coverage. Some types of pollutants make the headlines because they produce very dramatic effects, for example, fouled waterways with large fish die-offs caused by direct discharge of untreated municipal or industrial wastewater into lakes or streams. Fortunately, in Wisconsin, these occurrences are becoming things of the past because of massive state and federal point source control programs conducted in the 1970s and '80s.

Some other pollutants are seemingly undetectable until what initially sounds like isolated problems occur—examples are acid rain and groundwater contaminants. All the ramifications of these problems are not yet known.

This publication is concerned with still another group of pollutant sources that, while usually not very dramatic in impact, have been very visible to us for a long time but are largely overlooked. These sources generally are not the result of technological advances such as manufacturing or wastewater treatment processes; rather they generally result from more basic aspects of life—growing crops, raising livestock and poultry, building roadways, homes, and other buildings. However, the magnitude of their impacts increases as technology and populations increase. Often the difference between an area under control and an area that is contributing a significant level of pollutants is simply the way in which the land is managed.

We call this group of sources "nonpoint sources" and they comprise areas very common to us: barnyards, croplands, streams, woodlots, construction sites, and areas being developed or already altered by covering the ground with buildings and impervious surfaces such as concrete streets, sidewalks and vast asphalt parking lots. The pollutants carried in water from these sources are readily visible and familiar to us. They consist of manure; soil eroding from fields; soil loosened and deposited in streams as animals trample stream bottoms and banks; soil in woodlots washing away after anchoring vegetation is overgrazed by animals; soil washing off unprotected construction sites and chunks of soil being tracked off sites by trucks and other construction equipment; and sediment, chemicals, oil slicks, pet wastes, and leaves being carried along in the increased volumes of stormwater that result from the loss of pervious areas in urban centers.

A major difficulty associated with nonpoint sources and their pollutants is their degree of familiarity. We see these situations so frequently that these materials don't seem to be doing any harm. So we pass by unconcerned, unaware that they are pollutants. But in fact, nonpoint source pollutants are very real and the problems associated with erosive processes and pollutants are numerous, widespread, and long lasting. Often soil movement leaves the source damaged—fields gullied and stripped of topsoil; slumping streambanks encroached into croplands or pastures; woodlots with exposed tree roots and subsoil; new building foundations filled with mud and construction site soil washed away.

While damage to the resource may be either permanent or repaired, often at substantial cost, the major impact—the one we are most concerned with in this report is on the ultimate repository of much of this pollutant load—our streams, rivers, lakes, wetlands, and even groundwater. The impacts are the same whether the sediment, animal wastes and other pollutants are directly deposited into waterways or are carried in

stormwater or snowmelt for longer distances before entering water resources.

What are the impacts on our water resources? The major impacts were summarized in the nonpoint source control program's 1982 "Report to the Governor and Legislature" as follows:

"The effects of nonpoint source pollution on lakes, streams, groundwater, and wetlands are exhibited in many ways, including physical changes in water temperature and clarity, and chemical changes such as increased nutrient levels and decreased dissolved oxygen levels. All of these changes affect the ability of a waterbody to support desirable forms of aquatic life, which in turn affects recreational uses and the quality of drinking water supplies. Increased sediment and nutrient levels result in increased aquatic weed growth.

"Fish populations change from desirable sport species like trout to less desirable forage fish such as carp which are able to tolerate wider ranges in habitat conditions. The sedimentation of small lakes, Great Lakes harbors and the Mississippi River, and the degradation of wetland areas are occurring in Wisconsin as results of nonpoint source pollution. Additionally, groundwater is being contaminated by surface water containing nonpoint source pollutants, particularly in areas underlain by fractured bedrock such as Door and Kewaunee counties where animal wastes are the principal pollutants."

The impacts of nonpoint source pollution are often chronic, resulting from many years, even decades, of deposition of pollutants that slowly produce changes in water resources, fish habitat, and ultimately fish and other aquatic populations.

Sudden and dramatic impacts also occur. Fish kills result when stream oxygen is suddenly depleted following large manure spills. In urban areas, a heavy rainfall or quick snowmelt can rapidly carry suffocating quantities of sediment from construction sites or toxic levels of substances from paved surfaces into streams or lakes.

Since most of the nonpoint sources we are concerned with involve large land areas, so does Wisconsin's control program. Even with that thought in mind, the actual scope of the nonpoint source problem in Wisconsin does seem to be surprisingly extensive.

The accompanying map identifies a critical zone, a major portion of the state where intensive nonpoint source controls will most likely be needed in the future. Approximately 40% of the state's land area is included in this "U" shaped zone. However, areas not included in this zone are not exempt from nonpoint source problems. Rather, nonpoint source problems in the "noncritical" zone are likely to be more localized in nature. The state's critical zone was determined by a process in which major land use areas and associated types of land management were systematically compared to water resource data. Included in this zone are approximately 130 of the 330 watersheds in Wisconsin.

Nonpoint source pollution: a regional view

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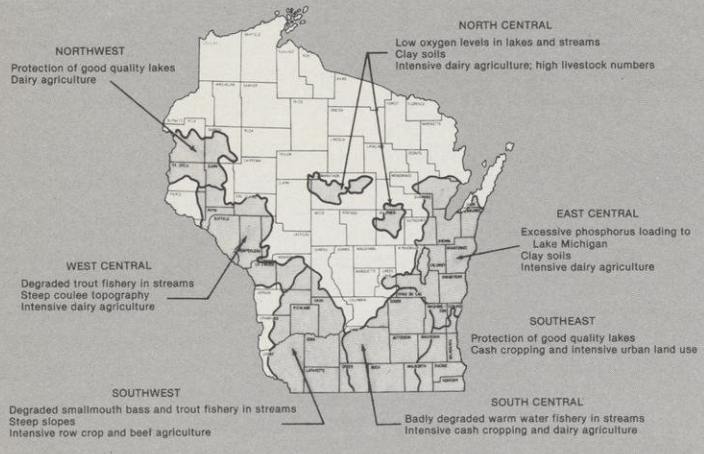


Summary of water quality and nonpoint source problems in the area of the state most likely to require Priority Watershed Projects in the future

An overview of nonpoint source pollution in Wisconsin reveals a critical "U"-shaped zone that includes the watersheds with the greatest potential for nonpoint source pollution and where future participation in the nonpoint source pollution control program will most likely be needed.

This critical "U" zone breaks down into seven regions where climate, water resources, soils, population, land use and topography are similar. Each has characteristic nonpoint sources, pollutants and water quality impacts. And each can be improved by making local people aware of the problem through education and by involving them in strategy planning for future abatement projects.

Many streams in the critical "U" zone show decreased fish populations due to habitat degradation such as reduced oxygen levels after rainstorms, snowmelt or other runoff events. Associated high bacteria levels in the water also raise health concerns for humans, livestock and wildlife.

The kind of fishery a stream supports can indicate water quality. For example, a 1964 fish survey found 1,000 smallmouth bass per mile in the Livingston Branch of the Pecatonica River in Iowa

Northwest Region

The Northwest region has many high quality trout streams and a good warmwater fishery in larger streams and rivers. Deep lakes of the region receive heavy recreational use. Agricultural operations are primarily dairy, but continuous row cropping has been on the rise. Phosphorus and other nutrients primarily from barnyards and winter-spread manure cause algae and weed problems in lakes. Sediment from eroding croplands also harms lakes, streams and rivers. Nonpoint source pollution affects approximately 387 stream miles with principal impact to trout streams and lakes. Critical areas of the Northwest region are largely in lower portions of the St. Croix and Chippewa River Basins.

More important than the amount of land or number of watersheds in this critical zone is the quantity and quality of major water resources in the zone: more than 120 deep, high quality recreational inland lakes; about 436 miles of Lake Michigan and Green Bay shoreline; 40% (3,000 miles) of the Class 1 and 2 trout streams found in the state; a large portion of the state's smallmouth bass streams; and the Mississippi River.

A 1985 survey showed 36% of Wisconsin's streams and rivers are either already effected or threatened by nonpoint source pollution. The water quality of these resources ranges from high quality but threatened, to severely degraded and in need of restoration. Thus, it is easy to see that a very substantial portion of Wisconsin's valuable water resources are already or potentially effected by nonpoint source pollution. Nonpoint sources of pollution clearly comprise a category of pollution that should concern all of us.

With 40% of the state's area in this potentially critical zone, a logical question would be how can we deal with this level of pollution control needs? A few major concepts should be mentioned here:

1. Rather than attempting to treat already polluted water, it is more efficient to install land management practices that control pollutants at the source, while still on land. This prevents the degradation of high quality water resources and limits the quantity of pollutants that enter waterways in the future.

2. The control of nonpoint sources is emphasized rather than "cleaning-up" already polluted waters because in many hydrological systems, if the addition of pollutants is limited, existing pollutant levels decrease through natural processes over time, thus achieving some "clean-up." It is important to remember, though, that many pollutants will be deposited and remain in place for many years, especially in lakes with limited outflow.

3. Land management practices to control nonpoint sources often utilize land contouring and natural materials, such as stone and vegetation. These practices slow the rate of runoff, prevent the movement of soil and attached pollutants, and hold water and pollutants in specific areas so natural infiltration can occur while still protecting groundwater. Some practices permit the safe storage of manure until the proper times of the year when it can be utilized on the land as a valuable resource rather than becoming a pollutant in water.

4. Some nonpoint source controls will require that many individuals and operators change long ingrained behaviors. They may also require both taxpayers and landowners to share in the cost of source controls. It must be recognized that these costs very often will not produce highly visible results.

These four concepts are being used to address nonpoint source management needs in Wisconsin.

County; a 1980 survey located no bass at all. Sediment, chemicals attached to soil particles and oxygen-demanding materials such as manure were major reasons for the decline in water quality that resulted in these fish kills.

Nor are the problems restricted to small streams. In 1980 and '81, dissolved oxygen in many miles of the Wisconsin River was almost depleted during spring runoff. Although there are numerous municipal and industrial point sources discharging pollutants into the river, DNR wasteload modelling specialists identified manure runoff from farmyards and fields as the major cause.

In Door County and some other areas, bacteria and nitrate levels in groundwater were so high in some places that private well water became unhealthy for human consumption. It is usually difficult to identify where contaminants in a particular well come from because pollutants often enter groundwater in creviced bedrock formations from diverse sources.

The control of these various kinds of nonpoint sources requires comprehensive management of entire watersheds. Only in this way will Wisconsin's water resources improve.

Summary of Nonpoint Source Effected Waters in Wisconsin

Region	Stream Miles	Principal Impact
Northwest	387	Trout streams and lakes
West Central	3,492	Trout streams
Southwest	4,935	Trout and smallmouth bass streams
South Central	2,770	Smallmouth bass streams
Southeast	930	Inland lakes and nearshore waters of Lake Michigan
East Central	3,096*	Trout streams and nearshore waters of Lake Michigan
North Central	611	Impoundments
TOTAL	16,231*	

*** Includes 436 miles of Lake Michigan shoreline**

West Central Region

The West Central region has a good smallmouth bass fishery in larger rivers and streams and a marginal to poor trout fishery in smaller streams and headwaters. There are no natural lakes in the region. It is an area of intensive dairy agriculture on steeply sloped coulee-type topography. Nutrients from livestock operations and sediment from eroding croplands have degraded many trout streams. Nonpoint source pollution affects approximately 3,492 stream miles, with principal impact to trout streams. As sedimentation increases, backwater areas of the Mississippi River are also being effected. Critical areas of the West Central region are in lower portions of the Chippewa, La Crosse and Black River Basins and in extensive portions of the Trempealeau and Buffalo River Basins.

Southeast Region

The Southeast region has many lakes that support a good fishery and receive heavy recreational use. Most agricultural land use is for continuous row or specialty crops. Phosphorus and sediment from cropland erosion cause algae and weed problems in lakes. Intensive urban land use causes problems with stormwater runoff from impervious surfaces and sediment from construction sites. Nonpoint source pollution affects approximately 930 stream miles, with principal impacts to inland lakes and nearshore waters of Lake Michigan. Critical areas of the Southeast region are in the Fox (Illinois), Des Plaines, Pike and Root River Basins and lower portions of the Milwaukee River Basin.

East Central Region

The East Central region has many streams that support a varied fishery and serve as spawning areas for Lake Michigan fish. The primary land use is dairying, but many streams pass through major urban areas before they enter Green Bay or Lake Michigan. Clay sediments, phosphorus and other nutrients from dairy operations, sediment from construction sites and pollutants from urban areas all flow into Lake Michigan harbors and cause severe problems. Phosphorus loading to Lake Michigan from nonpoint sources is equal to that from point sources. Nonpoint source pollution affects approximately 3,096 stream miles (including 436 miles along Lake Michigan's shoreline), with principal impacts to trout streams and nearshore waters of Lake Michigan. Critical areas of the East Central region are in the Sheboygan, Manitowoc, East and West Twin, Kewaunee and Fond du Lac River Basins, upper portions of the Milwaukee River Basin and lower portions of the Fox and Oconto River Basins. The region also has groundwater problems when animal wastes enter the creviced dolomite bedrock of the Niagara escarpment in Kewaunee and Door counties.

Southwest Region

The Southwest region has excellent smallmouth bass streams in the southern portion of the region, and many Wisconsin River tributaries that support trout. Agricultural activities include dairying, cash cropping and beef and hog operations. Reduced dissolved oxygen levels resulting from barnyard runoff and manure storage spills have caused fish kills and water quality degradation. Sedimentation has degraded many smallmouth bass streams and impairs the recreational use of the limited number of impoundments. Nonpoint source pollution affects approximately 4,935 stream miles, with principal impacts to trout and smallmouth bass streams. Critical areas of the Southwest region are in the Grant, Platte and Pecatonica River Basins and in lower portions of the Wisconsin and Baraboo River Basins.

South Central Region

The South Central region has several major lake chains and wetland areas. The fishery is somewhat limited, but water resources receive heavy recreational use. Agricultural operations include dairying and intensive cash cropping. Sedimentation and reduced dissolved oxygen levels are reducing the already limited fishery, while problems associated with urban land uses in the Madison metropolitan area and eastern portions of the region further degrade water quality. Nonpoint source pollution affects approximately 2,770 stream miles, with principal impact to smallmouth bass streams. The South Central region includes all of the Rock and Sugar River Basins.

North Central Region

The North Central region has water resources that support smallmouth bass fisheries and provide recreational opportunities. Intensive dairy operations on clay soils cause sedimentation and nutrient problems. Nonpoint source pollution affects approximately 611 stream miles, with principal impact to water impoundments. The North Central region includes the Big Eau Pleine River and Reservoir and portions of the Little Wolf and Pigeon River Basins.

Nonpoint sources can pollute groundwater

Allan Lulloff, Planning Analyst, Groundwater Management Section

Fertilizers and pesticides can be carried by rain or melting snow into the groundwater. DNR photo

DNR is concerned not only with the protection and improvement of Wisconsin lakes, rivers and streams, but also with the quality of groundwater. Directly linked to surface waters through the hydrologic cycle, groundwater provides nearly 70% of Wisconsin's drinking water and is the major source of supply for most industries and for agricultural irrigation. Unfortunately, like lakes and streams, it too can be polluted by human activities. Soil, which has been depended upon to filter out contaminants, sometimes fails to do so. Potentially hazardous substances can then move down through the soil into groundwater and possibly cause health problems in people who drink the water. Two of these potentially hazardous substances are the chemicals aldicarb and nitrate, both of which originate from nonpoint sources.

Aldicarb is a pesticide often applied to potato fields in central Wisconsin to control nematodes and Colorado potato beetles. As of mid-1985, tests had been run on 1,024 wells in the region and detectable levels of aldicarb found at least once in 190 of them . Ninety-five exceeded the groundwater enforcement standard of 10 parts per billion. Some of these contaminated wells have had to be abandoned or deepened by the owners to find safer water.

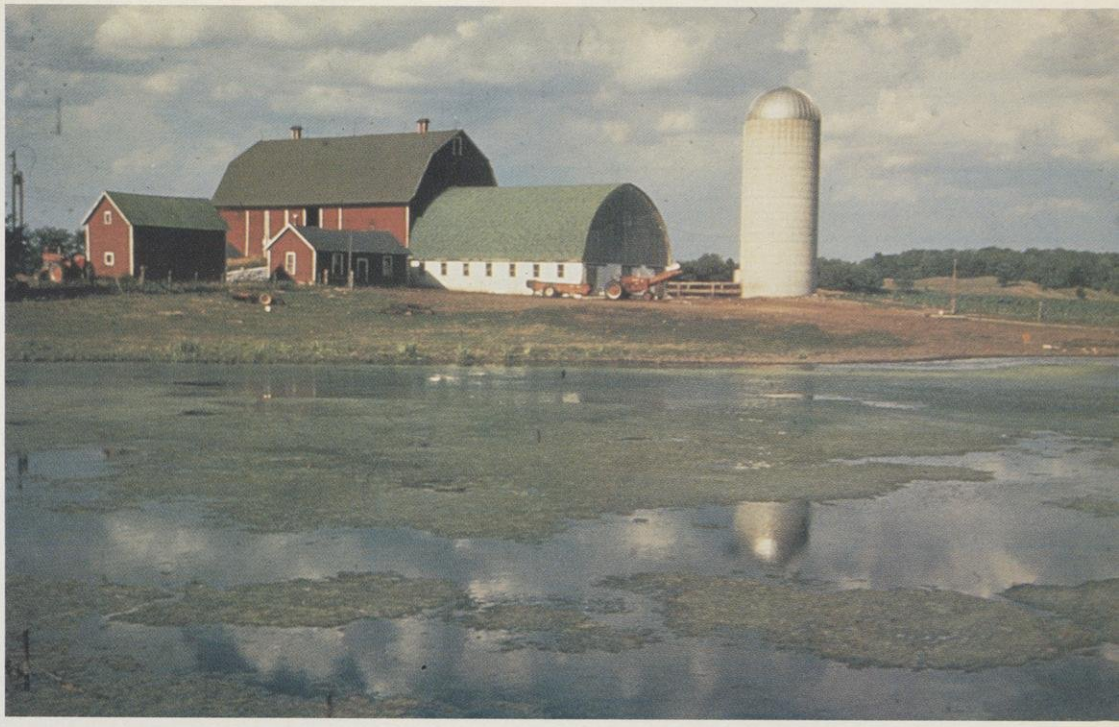
Meantime, to protect groundwater, the Wisconsin Department of Agriculture, Trade and Consumer Protection has adopted rules that restrict use of aldicarb. The question of whether these rules are working adequately and whether other problem pesticides are being used in rural or urban settings is under review.

Nitrate is the groundwater contaminant most often tested for in Wisconsin and most often found. Nonpoint sources are often to blame for its presence. Nitrate is not usually harmful to adults or older children. However, in some infants (less than 6 months of age) nitrate can convert to nitrite, which changes blood hemoglobin so it cannot transport oxygen. The result is methemoglobinemia, called the "blue baby syndrome," a possibly fatal ailment. If this condition is diagnosed, removing nitrate from the infant's diet will cause symptoms to rapidly disappear. The number of cases is unknown, since methemoglobinemia is difficult to diagnose and until recently was not a reportable disease. The drinking water standard for nitrate of 10 milligrams per liter is based on protecting infants from this disease.

Nonpoint sources of nitrate include fertilizer spread on croplands and lawns, improperly stored livestock wastes, failed septic systems and croplands spread with livestock, human or industrial wastes. Many experts believe that fertilizer leaching—often from excess irrigation—is the worst offender. University of Wisconsin researchers are finding new ways to avoid excess irrigation, which will save both fertilizer and pumping costs and at the same time protect groundwater.

The Wisconsin State Laboratory of Hygiene conveniently and inexpensively tests water for nitrate and well owners should take advantage of this service on a regular basis. A test kit can be obtained by writing: Wisconsin State Laboratory of Hygiene, 465 Henry Mall, Madison, WI 53707.

For more information on groundwater send for a copy of *Groundwater—Wisconsin's buried treasure*, which appeared in the September-October 1983 issue of *Wisconsin Natural Resources* magazine. That publication, as well as other pertinent material can be obtained from DNR's Groundwater Management Section, Box 7921, Madison, WI 53707, phone 608-266-9258.



Improperly managed barnyards are major sources of nonpoint pollution. This pondfull of algae was caused by barnyard drainage and animal waste.
DNR photo

Point and nonpoint source control:

Wisconsin waters need both

Susan Bergquist, Environmental Specialist, Nonpoint Source and Land Management Section

Information about water resource cleanup and pollution control has become a common part of our existence in the past decade. Terminology related to water quality has become part of our language. But we still need to review some of these terms to clear up any remaining confusion.

In this report, the terms *point source* and *nonpoint source* are used over and over. In the earlier days of water quality programs, these two major sources of pollution were regarded as two very distinct entities. However, as research, pollution control programs and legislation have advanced, it is sometimes difficult to neatly categorize some sources as point or nonpoint sources.

Point sources are the more familiar sources of water pollution to many people, especially as populations become more urban. Examples of point sources — factories, municipal wastewater treatment plants, and power plants — are more common in urban areas. In these examples, pollutants are discharged from the plants in wastewater that travels through pipes or culverts and enters rivers or lakes at readily identifiable locations. The discharges may carry "waste" heat or a wide variety of pollutants, usually chemical in nature.

The major thrust of state and federal water pollution programs in the 1970s was to control discharges from point sources. This was done by establishing standards for various receiving waters and requiring the sources to treat wastewater to meet these standards before disposal. Most point source control programs are regulatory and compliance is required by law. Pollutants are usually removed in very expensive, highly technical treatment plants. The huge cost has been borne by taxpayers and individual industrial companies. In Wisconsin, most treatment facilities have been completed with only a few, including the extensive Milwaukee municipal system, still under construction.

The point source control program has been highly effective. A survey in 1984 showed that 97% of the rivers and streams assessed were not effected by point sources.

Soil erosion isn't exclusively a farm problem. Heavy rains during a landscaping project literally carried away State Capitol grounds. DNR photo

The other major category is nonpoint source pollution. Nonpoint sources are often more easily understood when thought of as runoff and sedimentation. Many different kinds of pollutants—especially sediment, chemicals and organic materials—are carried by water running off broad land areas. In the past, nonpoint sources were thought of mainly as rural sources. But two very significant nonpoint sources—construction sites and vast impervious surfaces such as streets, parking lots and roofs—are mainly urban sources. Importantly, concentration of pollutants in runoff from nonpoint sources can be higher than concentrations in municipal wastewater. However, nonpoint source pollutants usually flow directly into rivers, streams and lakes without any treatment.

In Wisconsin, nonpoint sources are the major water pollution control emphasis in the 1980's and 90's. Why this emphasis? A 1985 survey showed that over a third (36%) of Wisconsin's rivers and streams are effected or threatened by nonpoint sources. Barnyards, animal feedlots, eroding croplands, streambanks and construction sites, overgrazed woodlots and urban areas are receiving intensive attention in selected watersheds through the voluntary Wisconsin Nonpoint Source Water Pollution Abatement Program.

These varied sources can be difficult to control because vast land areas and many landowners and operators are involved. Nonpoint source control usually means designing, installing and maintaining land management practices to control problem areas at the source, while pollutants are still on the land. The sophisticated, centralized, highly technical treatment plants used to control point source discharges are not appropriate for controlling nonpoint sources. If pollutants from nonpoint sources are allowed to reach the state's waters, far-reaching impacts occur and pollutant clean up becomes more difficult and expensive.

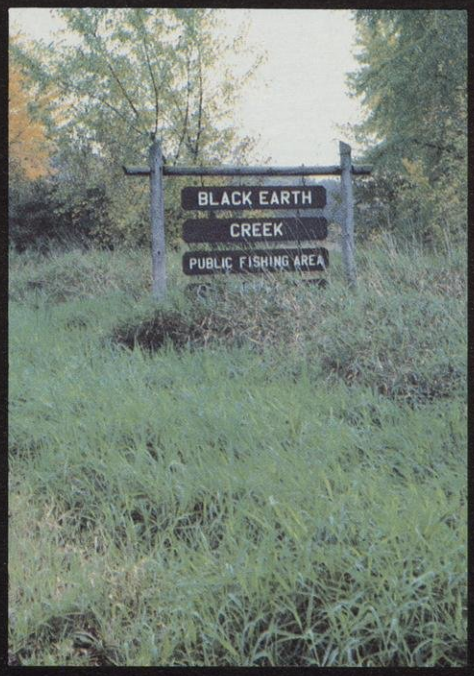
Earlier it was mentioned that the distinction between point and nonpoint sources has become less clear according to the traditional definitions. Research, sampling techniques and other methods now enable water quality scientists to locate, differentiate and measure many nonpoint sources quite accurately, much like point sources. And the runoff from some nonpoint sources, such as construction. sites and many animal operations, is obviously quite localized. In fact, a limited number of operations now need permits for wastewater discharge, similar to industrial and municipal wastewater treatment plants.

Regardless of definitions, both point and nonpoint sources of pollutants have to be controlled to protect Wisconsin's waters. Some areas have point sources as the major pollutant sources, some nonpoint. But in many areas significant point and nonpoint sources exist and must be controlled. Unlike many other states, Wisconsin fully recognizes the need to control significant point and nonpoint sources, and supports programs that address both sources of pollutants as the way to protect our valuable water resources.

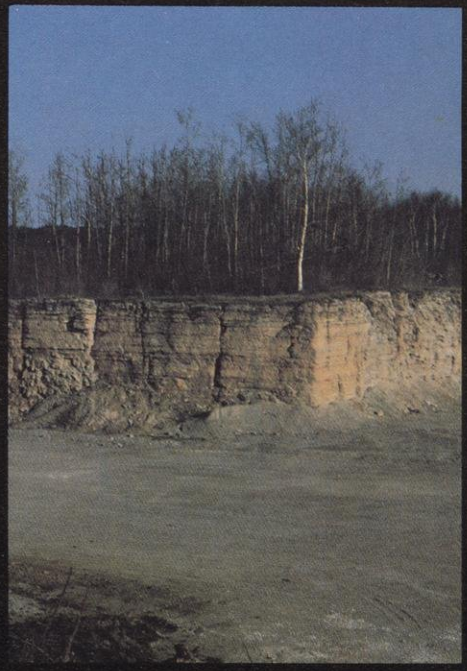
Case Studies

Milwaukee, like some other cities, hopes to cash in on business aesthetics with a clean river. A waterfront walkway with boat slips, shops and other amenities is planned. Photo courtesy of *The Milwaukee Journal*

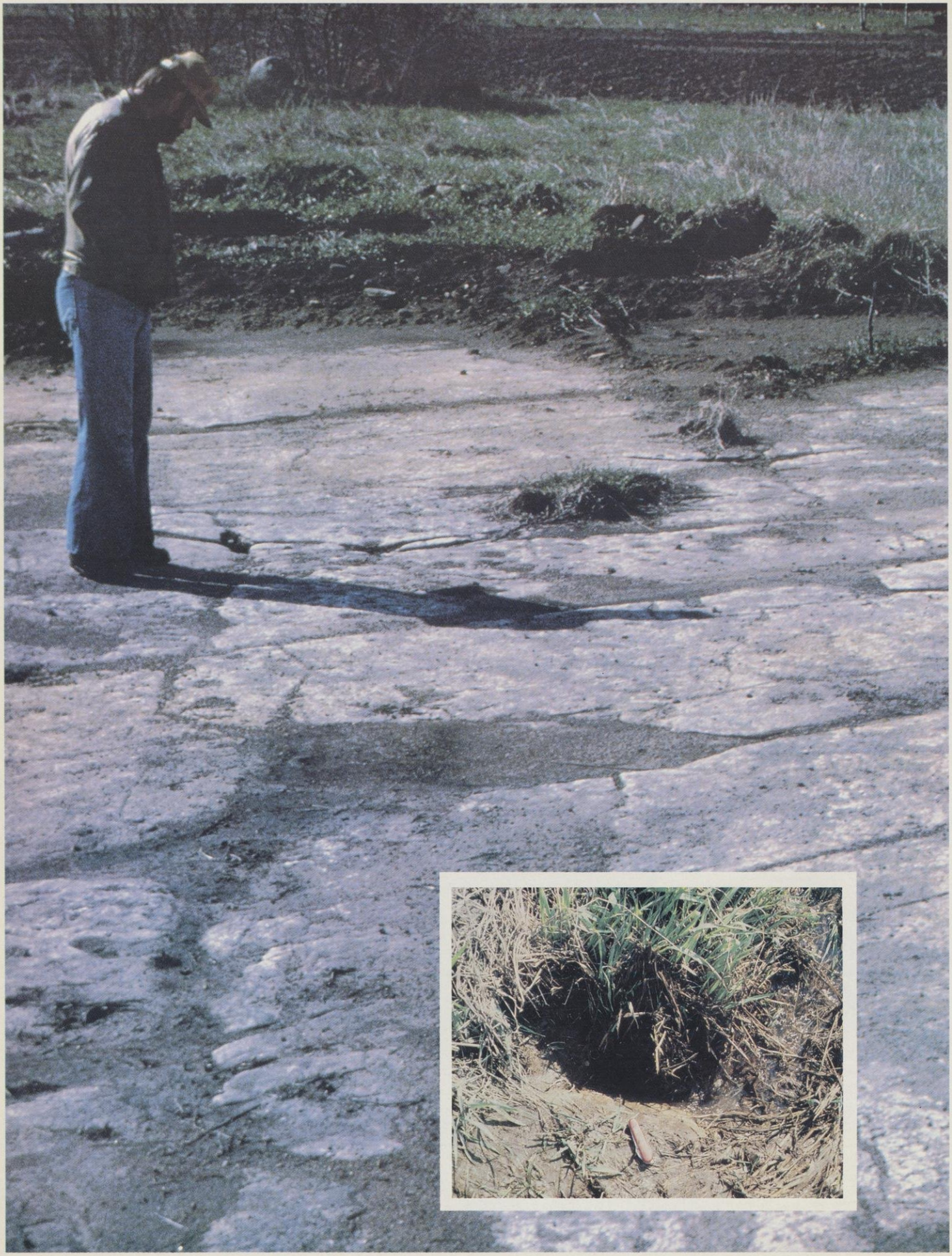
DNR's water resource management and fish management programs cooperate to ensure environmental conditions needed for healthy fish and healthy water. Photo by Dean Tvedt



Black Earth Creek, a trout stream near Madison, is a priority watershed project in Wisconsin's nonpoint source pollution control program. Photo by Susan Bergquist



Exposed cut in a Door County limestone quarry shows typical rock fractures that provide pathways for surface water and pollutants to enter groundwater. Photo by Jim Bachhuber



The Upper Door County priority watershed project

Jim Bachhuber, Planning Analyst, Nonpoint Source and Land Management Section
William Schuster, Door County Conservationist

Groundwater in this favored spot is seriously threatened and a unique watershed project is aimed at helping. But local action will be the key.

In most places groundwater pollution is a relatively recent environmental concern with new threats to this resource much in the media of late. However, for residents of northern Door County, problems with groundwater pollution have been a concern ever since the first wells were sunk. Door County records contain numerous cases of polluted well water causing diseases, including six documented outbreaks of typhoid fever between 1916 and 1926. While disease outbreaks are not common anymore, groundwater problems still persist. Today, they are so common that for many residents, finding an alternate drinking water source during certain times of the year has become a way of life. These periods usually correspond to incidents of high rainfall or snowmelt.

Why do these groundwater quality problems appear more often in Door County than other parts of the state? The answer has to do with soil and bedrock. In most of Wisconsin, the soil layer is thick enough to filter out many potential pollutants when surface water moves downward into the ground. However, in northern Door County, the glaciers left only a thin soil layer or none at all. In about 40% of the county, less than three feet of soil covers the bedrock, while in many areas bedrock is actually exposed on the surface.

The potential for groundwater pollution is also increased because the dolomite bedrock has large vertical and horizontal cracks. Water here moves through the ground rapidly. This bedrock contains the water source for nearly all the county's wells, and it has an average thickness of about 500 feet. These two physical characteristics—the sparse soil covering and fractured bedrock—mean that polluted surface water can move rapidly into and through the groundwater system.

During the past 20 years, the situation has become more critical. One reason is the increase in tourism coupled with second home development, which creates greater demand for both water supplies and wastewater disposal. Also, the number and types of pollutant sources that affect groundwater are increasing. In the past, livestock wastes from farming and human wastes from residences were the two major contaminant sources. Now, agricultural fertilizers, pesticides, septic wastes, landfill drainage, petroleum storage tanks, road salt runoff and many other sources exist.

In response to recent increased concern, Door County has begun trying to protect and improve its groundwater. In 1981, the county requested that lands north of the Sturgeon Bay ship canal be selected by DNR as a priority watershed project under the Nonpoint Source Water Pollution Abatement Program. At that time, program emphasis was primarily on improving surface water quality. Using nonpoint source control measures to protect groundwater was a relatively new idea. Whether this approach would work was questionable. But there was no question something had to be done. The threat to groundwater in Door County was serious and required action. But finding solutions to a very complicated and multi-faceted problem that involved numerous potential pollution sources would not be easy.

In addition to physical and geologic aspects, managers had to develop within DNR a mechanism that would bring the right talent to focus on Door County's groundwater problems. This required more than ordinary coordination because DNR is structured along program lines. Different administrative units are responsible for different aspects of groundwater protection. Nonpoint sources, point sources, private water supply, solid waste management and groundwater management are all handled by separate units. All of these had to be effectively coordinated if a priority watershed project was to benefit groundwater in Door County.

With these challenges in mind, the northern portion of Door County was selected as a priority watershed project in 1984 and the county promptly accepted the offer.

As with all such projects, the first phase is to prepare a watershed plan. A plan documents the location of all significant sources of pollution, how best to control them, what changes in water quality or water use will result from their control, how much the project will cost, how much staff is needed and what various governmental agency responsibilities will be. The plan for the Upper Door project will be completed in spring, 1986.

Central to the project is a thorough inventory of all water resources and all nonpoint pollution sources. In previous projects, typical sources included livestock wastes, upland erosion, streambank erosion and urban stormwater runoff. For the Upper Door project, however, it was decided to investigate additional sources not traditionally considered, and DNR allocated extra funding for this work.

Two major topics needed investigation: physical characteristics that contribute to the potential for groundwater contamination had to be pinpointed, and sources of groundwater contamination found and ranked by priority for control. Physical characteristics that influence whether contaminated surface water will enter the groundwater system include depth of soil, how easily water can flow through it (permeability), distance from land surface to water table and presence of "karstic" features. Karstic features include sinkholes and enlarged crevices in bedrock which can serve as direct paths for surface water to reach groundwater.

Actual and potential sources of groundwater pollutants have already been inventoried and results are being analyzed. Among the various sources investigated are livestock wastes. These can enter groundwater in runoff or seepage from barnyards, manure piles or manure spread on fields. More than 200 northern Door County farms were inventoried for their potential to contaminate groundwater. Repeated applications of pesticides and fertilizer on

Door County's groundwater pollution problems are directly related to thin soil layers and exposed bedrock. Soil filtering of surface water pollutants is limited, and bedrock crevices provide direct routes to groundwater. (inset) Sinkholes are another direct channel between surface and groundwater.
Photos courtesy of Door County Land Conservation Committee

fields are also a threat, especially where corn is planted every year. Approximately 46,000 acres of cropland have been inventoried as to location, crop rotation, fertilizer and pesticide application.

Also spotted on a map are residences and businesses not connected to a sanitary sewer system. These use either a septic tank and drain field or a holding tank to dispose of wastewater. Either of these systems can leak or fail and send untreated sewage into groundwater. In addition to location, physical characteristics of each tank's surroundings were also recorded to indicate which septic systems are likely to fail.

Both septic and holding tanks need to be pumped out on a regular basis. This pumped waste is often disposed of by land spreading, which is usually a safe method if done in flat areas with deep soils. However, in northern Door County, trucks sometimes dump their loads on shallow soils where the potential for groundwater pollution is high. The watershed project has analyzed sites used by septic haulers, measuring soil depth, presence of karstic features and amount of wastes spread.

In a related effort, DNR has inventoried active and abandoned landfill sites for potential to leak to the groundwater. Leaking underground gasoline storage tanks are also of concern. The Department of Industry, Labor and Human Relations has surveyed all service stations to determine the ages, sizes, locations and owners of such tanks in Door County. These records, along with the landfill information, will be integrated with all other data collected during the inventory phase of the watershed project.

Door County, with assistance from UW-Green Bay, began the inventory task in October, 1984. With a large quantity of information already collected, the next step is to analyze data and use it in planning project goals. The inventory will not only identify the most important sources to control for the protection of groundwater, it will also help guide the county in future decision making on development, zoning and land use.

The completed plan will require both county and DNR approval. The next step will be for county personnel to contact critical landowners and explain specific practice needs for the prevention of groundwater pollution on their property. The nonpoint source control program will cost share the installation of approved practices for certain sources, particularly to control livestock waste and cropland chemicals in critical areas. Up to 70% can be reimbursed. Since the nonpoint source control program is voluntary, the degree of groundwater protection achieved will depend largely on the cooperation of landowners.

Other government monies could fund the control of groundwater pollution sources that are not eligible for cost sharing under the nonpoint source program. A separate state program already provides funding to upgrade failing septic systems. Safe disposal of wastes from septic and holding tanks should become less of a problem when new, stronger rules now being formulated take effect. These rules will be administered either by DNR or the counties. DNR already regulates active landfills. Abandoned landfills that pollute groundwater may become eligible for federal cleanup funds.

But perhaps the most important steps that can be taken to protect groundwater in Door County will involve local decisions. The type and direction of future development in this beautiful and sensitive area will need strong control. The county has already shown it is seriously concerned. A special committee that has studied the problem will soon recommend to the county board what steps the county can initiate to protect groundwater. It must be accepted that there are certain portions of the county that simply cannot be developed without affecting groundwater.

Since the Upper Door Priority Watershed Project is still in the planning stage, the question remains: can all these different programs from different agencies be coordinated to benefit groundwater? While we work to determine areas of responsibility that ensure flexibility and give-and-take within various agency assignments, progress is being made toward the common goal: improvement of groundwater in northern Door County. The real answer will come sometime in the future—when the people of Door County will either be safely drinking the water from their taps, or else be shopping for it in the supermarket.

A typical Door County scene. Photo Courtesy of Northwestern Mutual Life

Completing the cleanup:

priority watershed treatment for the Milwaukee River

Gary Nelson, Milwaukee River Priority Watersheds Coordinator

Although millions have been spent to get rid of pollution in the Milwaukee River basin, the job remains unfinished. Nonpoint source control is next on the agenda. It will complement what's already been done on point sources.

A number of growing and resurging cities around the country have used rivers as critical elements in their economic development. The cleanup of the Milwaukee River represents the same potential for Wisconsin's largest city. As a part of this effort, the Milwaukee River priority watersheds program is a vast and ambitious nonpoint source program to protect and restore environmental resources within the most developed and populated river basin in Wisconsin. The basin includes much of the Milwaukee metropolitan area and encompasses about 815 square miles in seven counties: Milwaukee, Waukesha, Ozaukee, Washington, Fond du Lac, Sheboygan and Dodge.

This project is more complicated than most because it deals with five major watersheds: the southern portion of the Milwaukee River, its East-West and North branches, Cedar Creek and the Menomonee River. The basin has 432 miles of stream and 21 major lakes. It is the only nonpoint source pollution abatement project established by direct action of the state legislature.

The legislature recognized a need to strengthen the enormous cleanup effort now underway in the area served by the Milwaukee Metropolitan Sewerage District. That effort, primarily directed at reducing point source discharges to the lower Milwaukee River and harbor, represents an investment of approximately $1.7-billion dollars. While the amount is substantial, it won't address the entire water quality need. A major concern was that after spending nearly two billion dollars, water quality in the Milwaukee River and harbor would still be impaired. Therefore, lawmakers made a commitment to address nonpoint as well as point sources.

DNR, which will coordinate the program, is now funding an inventory to assess resource needs and determine what nonpoint source controls will be necessary basinwide. The inventory will be completed by the end of 1986. Afterwards, an implementation phase, to run through 1996, will put needed control practices in place and reduce pollutant discharges to levels that will meet water quality goals.

The program will go far beyond anything already accomplished to date in terms of water resource management and nonpoint source control. It will be one of the most comprehensive control programs ever attempted and will deal with virtually all elements of natural resource management.

Groundwater quality, dozens of abandoned landfills on the riverbank and in adjacent wetlands, dams, impoundments, stormwater and floods are all part of the complicated puzzle that must be solved in the effort to bring nonpoint source pollution under control. Habitat preservation as well as fish, wildlife and endangered resource management will also be part of the program. Each aspect will be inventoried, evaluated and ultimately worked into a comprehensive strategy.

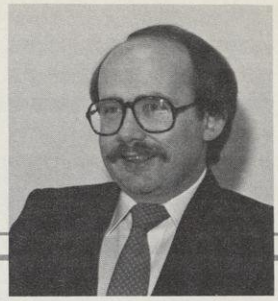
The participants in this serious effort are as numerous and complicated as the resource factors. In addition to the seven counties involved, there are 12 cities, 24 villages and 30 towns, all of which will have some involvement in the program. In addition to the local governments, a citizen advisory committee with six subcommittees will help develop the program. And resource inventory work currently underway involves not only DNR, but also many individuals from other governmental levels and agencies. This broad participation is necessary if the program is to succeed and it must be coupled with long term commitment and dedication because results will not be immediate.

The Milwaukee River basin program represents a substantial challenge and a rare opportunity to protect and restore environmental resources in a major urban river basin that has been seriously degraded.

The benefits to be realized are substantial not only from a natural resource perspective, but also from an economic and social perspective. Already, there is talk of river walkways, residential district revival and commercial development along or near a cleaner Milwaukee River. While the direct benefits will be realized primarily in southeastern Wisconsin, the results of this program will be of interest both statewide and nationally. A cleaner Milwaukee River will complement Milwaukee's attractive and internationally renowned lakefront.

Unmanaged construction sites and vast expanses of impervious roofs and pavement disrupt natural water infiltration and drainage. DNR photo

Fish, water and everything else



Bruce J. Baker, Director, Bureau of Water Resources Management

James T. Addis, Director, Bureau of Fish Management

Water is a ubiquitous resource. It's obvious that fish should be managed in conjunction with it. But so should every other resource. DNR's nonpoint source control program has developed the tools to make such cooperation possible.

It takes individuals and agencies at all levels joined together in a cooperative effort to achieve the kind of results planned for Wisconsin's unique nonpoint source pollution control program. The aim is to improve not only water quality in lakes and streams but all related resources. Much of the administrative procedure for the nonpoint program is set forth in state law or department policy and seven years of experience has refined and standardized the work. But in an effort of this magnitude, assembling the experts from different disciplines who know how to plan, implement and evaluate complicated watershed projects is a continuing challenge that requires constant attention.

It is this essential need to meld skills that brings us together—one bureau director in charge of fish management and the other, water resources—two closely related fields—yet so separate they belong to different administrative divisions in DNR. Fisheries does its work as part of a "Resource Management Division", while water resources functions under "Environmental Standards." Despite DNR's organization chart, the condition of watersheds intimately affects fish, so nonpoint source control should bring people together from each program—fish managers and water quality specialists. This has been more difficult to accomplish than it would seem on the surface, but gets easier as we mold DNR procedures to protect the environment.

In the past, fish managers and aquatic ecologists traditionally saw their engineer colleagues as adversaries. Some biologists even built careers on battles fought with water pollution engineers over fishery resources. But despite differences, enough farsighted engineers emerged to cooperate with fish biologists and start the US Public Health Service Water Pollution Control Program. Together they launched a federal point source cleanup program which helped finance new municipal wastewater treatment plants all across the country. This in turn led to creation of the US Environmental Protection Agency which continued the cleanup and fostered today's teamwork between engineers and biologists.

In Wisconsin too, fish managers and water resource people have had their differences. DNR's fisheries program was founded over 100 years ago and has a long tradition characterized by pride in its stewardship of lakes and streams. Fish managers sometime did not look kindly on the arrival of enthusiastic newcomers assigned to environmental protection. For their part, young environmental protection engineers and water resource biologists sometimes saw little merit in traditional long-range plans and goals of fishery programs. The divergence was further encouraged by an educational system which failed to demand that biologists and engineers understand and communicate with one another. This lack of communication has led engineers to design pollution controls without fully considering their biological significance. At the same time, fishery and other biologists have frequently demanded engineering results that are beyond the state of the art and impossible to achieve.

Difficulty has also arisen in assembling experts for cooperative enterprise because of DNR's historical structure. The department's resource management programs are old and have long been highly decentralized with staff located in six districts and 15 areas. Environmental programs, on the other hand, are newer and more centralized with more staff headquartered in Madison. This affects the interplay of ideas and people as well as work scheduling and planning.

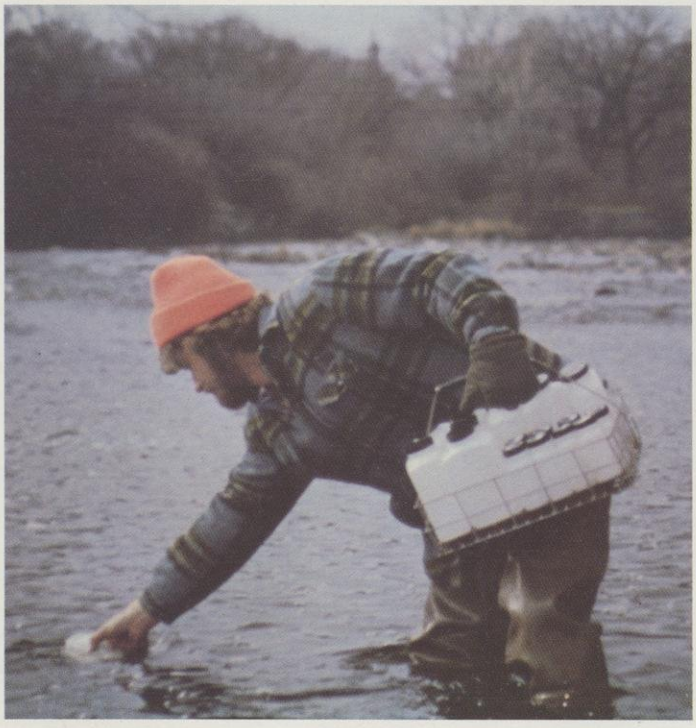
Added to all these factors have been the ubiquitous problems of all state administrators like us who try to coordinate the myriad federal programs that affect our areas of responsibility. For example, most environmental protection programs originate with the US Environmental Protection Agency while fishery programs are associated with the Department of Interior. Since these two federal agencies have been unable to fully coordinate at the national level, Wisconsin has tried to do it here on its own. However, agency or program-specific funding, inflexible constraints and often conflicting objectives further confound coordination, often causing difficulty and frustration. Thankfully, these administrative roadblocks are slowly being resolved as Washington grants the states more leeway.

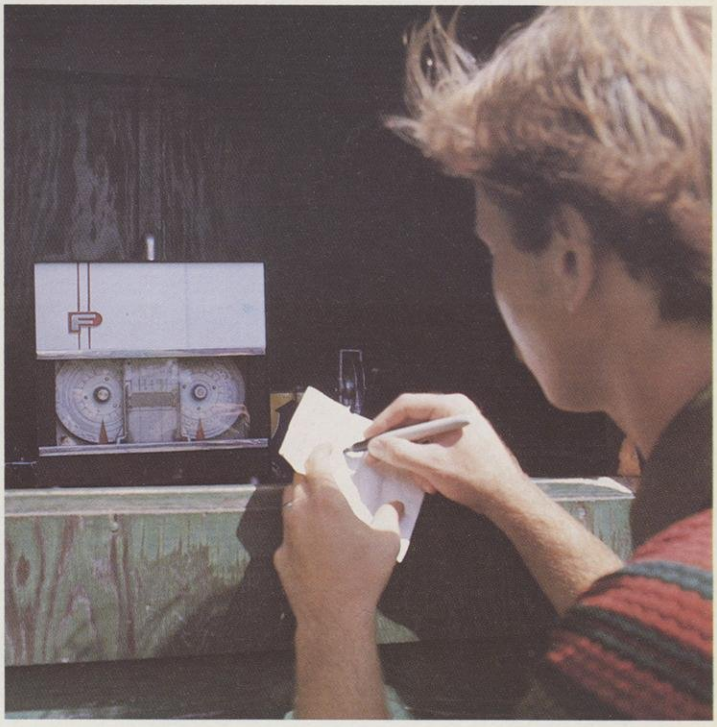
Many resource and pollution problems Wisconsin has faced in recent times are very complex, of a sensitive nature and often controversial. The same is true of the solutions, which are also costly and frequently require a multidisciplinary approach. For these reasons, in 1967 the State Legislature restructured the old Wisconsin Conservation Department into a new Department of Natural Resources, which combined resource management and environmental protection programs in a single department for the first time. This organizational change went far toward achieving teamwork and cooperation between the two programs.

Because controlling nonpoint source pollution is in many ways far more complicated than point source control, engineers, water resource biologists and fish managers have come to recognize that teamwork is essential if improvement is to occur. Not only is their technical talent needed, but also political and social acumen that can gain support for the cleanup. We are beyond the days when installation of sewage collection systems and treatment plants can solve the problems.

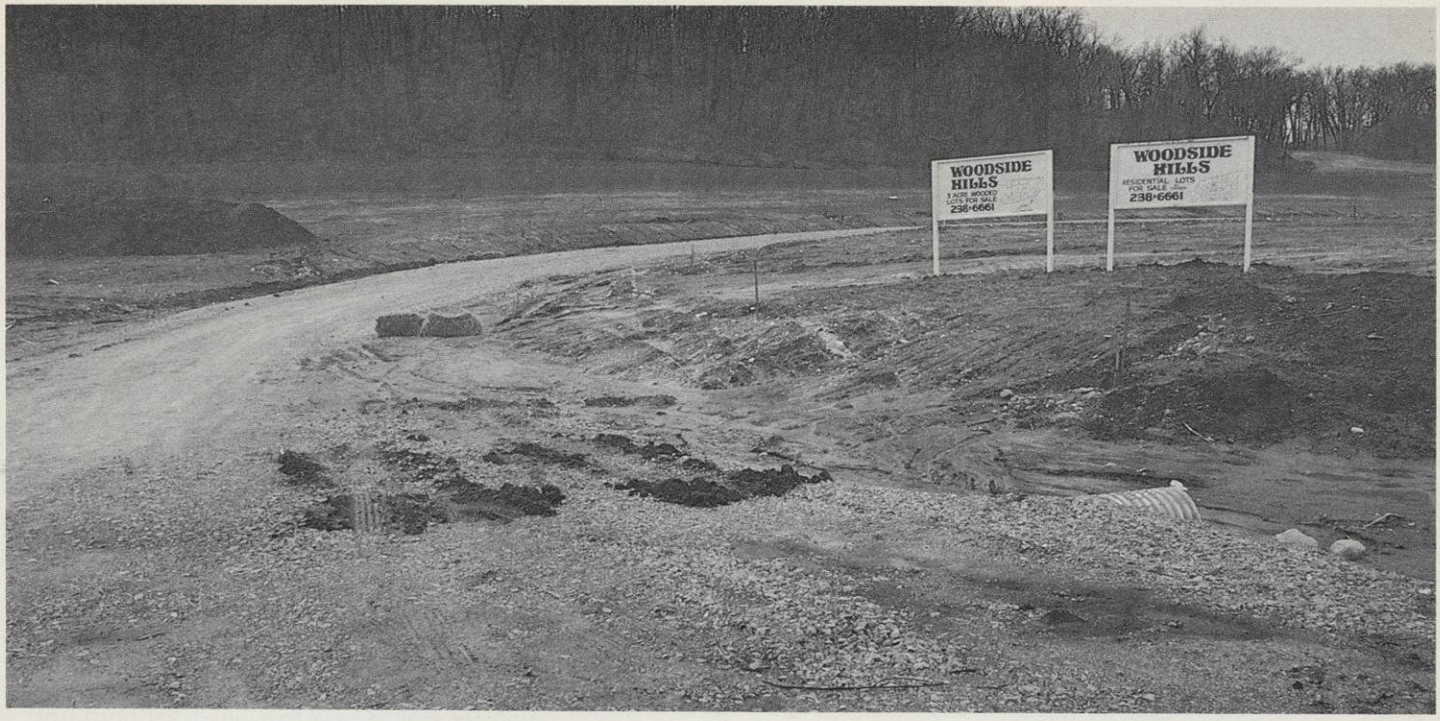
In the words of ecologist Barry Commoner, "Everything is interconnected to everything else." That's true for DNR programs too.

As bureau directors we realize this. We think we have managed to deal with all the obstacles in a forthright way. We're confident we are building a nonpoint source pollution control program that will not only clean up and protect Wisconsin waters but also lead to a flourishing recreational fishery and ensure diverse aquatic animal and plant communities. It will be a cleanup the state can be proud of and a pacesetter for the nation.





Fish management's sampling of fish populations and monitoring of radio tagged fish (above) provides information useful for water resource management. Similarly, the nonpoint source program's water inventory flow samples and river stage height records (below) are useful to fish managers. DNR photos



Building site erosion can be the largest contributor of sediment to streams. Control practices are needed during development and construction. Photo by Anne Weinberg

Physical exam for Black Earth Creek: a case study

Jim Baumann, Environmental Engineer, Nonpoint Source and Land Management Section

Dane County's Black Earth Creek, one of Wisconsin's most highly valued wild brown trout fisheries, is undergoing a complete physical exam. The stretch of stream above the village of Black Earth, its fishery and its 46 square mile watershed are being probed, shocked and scanned to examine all vital parts and signs. The purpose is to determine its condition and set out a prescription for a long and healthier life.

A comprehensive evaluation of Black Earth Creek was initiated in the fall of 1984 in response to a request to DNR from Trout Unlimited. The organization cited increases in rooted aquatic weeds, a decrease in weight of fish and general concern over conditions not conducive to the long-term health of the fishery. In response, a department-wide committee reviewed proposals and recommended a comprehensive evaluation that would cross DNR program lines and also involve staff from other agencies. This comprehensive study would bring department fish managers, nonpoint source specialists, water quality biologists, wastewater engineers, solid waste investigators and water resources planners together with one shared goal: identify what is needed to protect the naturally reproducing brown trout fishery in Black Earth Creek. Coordination was assigned to the Nonpoint Source and Land Management Section of the Bureau of Water Resources Management.

The exam began when the U.S. Geological Survey (USGS), with funding from DNR's fish management program, installed four automated monitoring stations. Two are on Black Earth Creek and one each on Garfoot and Brewery Creeks, both of which are tributaries. One was equipped with a continuous-reading dissolved oxygen meter tied directly by phone lines to a computer.

In January of 1985 the project got help from graduate students at UW-Madison when the Water Resources Management Workshop selected Black Earth Creek as a project. Fourteen students scoured the records of many agencies, worked side-by-side with DNR staff, surveyed anglers and local residents, analyzed the preliminary information collected by DNR and USGS and developed and used a number of new inventory techniques,

Also in 1985, DNR shocked fish throughout a 6.2 mile stretch of the stream, measured dissolved oxygen levels at 14 locations, measured sediment covering the stream bed, surveyed the streambanks for erosion, assessed the operation and maintenance of the one wastewater treatment plant and one landfill in the watershed, and made a preliminary identification of the location of animal lots and other nonpoint sources.

Threats to the fishery

Although the physical exam will not be complete until the fall of 1986, examiners have found a number of conditions that may threaten the fishery, and are already drawing conclusions. Fish shocking information collected over the last decade shows a large and relatively stable wild brown trout fishery. While the number of trout has not declined, in the spring of 1985 their total average weight per acre of stream was substantially lower than in all the years surveyed in the last decade.

Livestock crossings along Black Earth Creek are major sources of sediment and organic materials that endanger this high quality trout fishery. Photo by Susan Bergquist

Black Earth Creek: important from Cross Plains to Washington, D.C.

The trout fishery in Black Earth Creek ranks among the best in Wisconsin. Since it is located within 20 miles of 200,000 people in the Madison area, its value as a recreational resource is great. Although the Black Earth Creek project is of great importance to both residents of the watershed and to anglers, its importance extends well beyond the watershed. Statewide, it is significant as an example of integrated or comprehensive natural resource management. Nationally, it has significance as an example of a way to protect threatened streams and could be incorporated as part of a federal nonpoint source control program now under consideration by Congress and the US Environmental Protection Agency.

"The Black Earth Creek project," says Larry Claggett, coldwater fishery specialist in DNR's Bureau of Fish Management, "is a very good example of fishery resources being protected through a comprehensive, multi-program approach. It is one of the first in the nation and is likely to be an example for future projects."

Bruce Baker, director of DNR's Bureau of Water Resources Management, also sees Black Earth Creek as a national example. Baker is involved in a project to assist the US Environmental Protection Agency in developing a national nonpoint source control program through the Association of State and Interstate Water Pollution Control Administrators.

"One of my main interests," says Baker, "is to make sure threatened resources are included to prevent any degradation before it occurs. This must receive as much emphasis as rehabilitation of degraded waters and our intent is to make this kind of foresight part of the national program."

Dissolved oxygen levels are a likely threat to the fishery. The water quality standard for dissolved oxygen in trout streams is six milligrams per liter (mg/l). For 19 out of 21 days in June 1985, dissolved oxygen levels dropped to 5 mg/l as a result of consumption of oxygen by aquatic plants. While these levels are not lethal, they can inhibit growth of the trout. Dissolved oxygen also decreased during most rainfall runoff events. During one major storm in July 1985, dissolved oxygen dropped below 4 mg/l for 20 hours and reached a minimum of 3 mg/l, a potentially lethal level. During the snowmelt period and before all of the equipment was installed, analysis of samples found very high levels of oxygen-demanding material in the stream at about the same time the very sensitive trout hatch began. Rainfall runoff events also sent high levels of ammonia and other nutrients into the stream. Experts are not sure how this combination of high ammonia and low dissolved oxygen affects trout.

Examination of the fish habitat found both good and bad situations. In the late 1940's, cattle access to the stream was all too common, streambank erosion along the creek was extensive and the fishery nearly nonexistent. Efforts of conservation groups, farmers and a variety of agencies plus purchase of land along the stream to provide a buffer have nearly eliminated streambank erosion. Today, most streambank erosion found in the study area is coming from one farm.

But in the stream itself, DNR investigators still find more sediment covering the gravelly bed than is desirable. Between 30 and 50% of the streambed is covered with silty sediment.

In 1985, aquatic plants, both macrophytes and filamentous algae, were abundant. Although in the past macrophytes have been high every year, the filamentous algae haven't been. An investigation by the student workshop concluded that the stream's macrophytes probably could not be controlled by adjusting phosphorus concentrations in the water. However, it is possible that the filamentous algae could be. Phosphorus amounts double downstream from the Cross Plains wastewater treatment plant.

Sources

The likely sources of these threats include both nonpoint and point sources. Although all of them have not yet been inventoried, preliminary results are as follows:

1. The manure in runoff from barnyards, and to some degree from fields where it is spread in winter, is very likely the cause of both the high oxygen demand load and high nutrient levels during rainfall. The Brewery Creek and Garfoot Creek drainage areas repeatedly show the greatest pollutant amounts.

2. The sediment entering the stream in 1985 was most likely from eroding croplands and bare barnyards. In previous years, subdivision construction sites were significant sources. However, due to limited construction in 1985 and better management of sites, the amount of sediment from this source was substantially less than previous years.

3. The Cross Plains wastewater treatment plant is generally discharging high quality effluent that is not directly depleting dissolved oxygen levels in the stream. However, if malfunctions such as those which occurred in March of 1985 occurred in summer, the potential exists for a major fish kill. Also, discharge from the plant is an important source of nutrients that may increase growth of certain aquatic plants.

4. The discharge from an inadequately managed landfill has been documented to be a significant contributor of oxygen-demanding matter and nutrients.

The Prescription

During 1986, DNR along with local units of government, other agencies, interest groups and the general public will complete a prescription for maintaining the long-term health of Black Earth Creek and its fishery. That prescription may call for a familiar practice: Black Earth Creek will probably have to go on a diet. Its sediment, nutrient and oxygen-demanding load may be too much for its own good.

Many parts of the prescription are already in place. DNR wastewater engineers are working with the village of Cross Plains to prevent treatment plant malfunctions and determine how to deal with equipment breakdowns if they occur. Solid waste specialists are working with the landfill operator to eliminate pollutant-laden discharge.

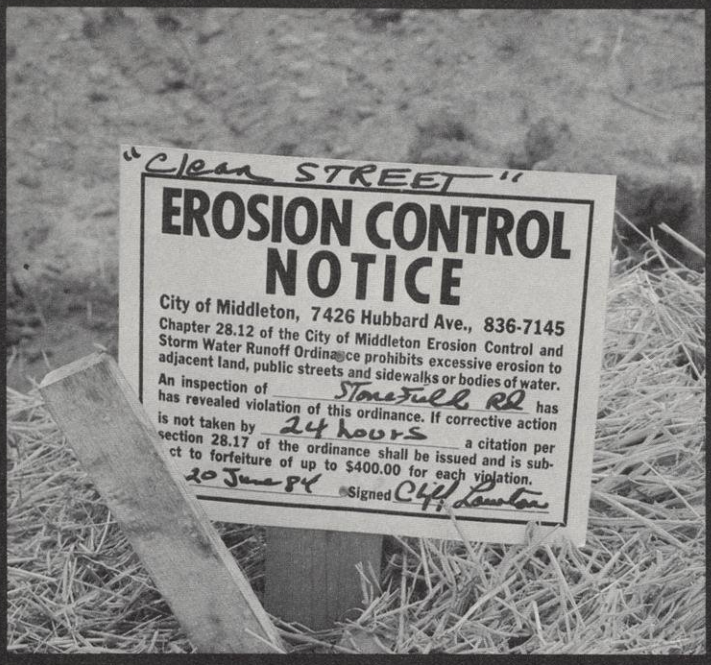
In the fall of 1985, DNR selected Black Earth Creek as a priority watershed project through the Wisconsin Nonpoint Source Water Pollution Abatement Program. As a result, in 1986 DNR will be working jointly with the Dane County Land Conservation Department and villages such as Cross Plains to develop a plan for the control of both urban and rural nonpoint sources. Installation of nonpoint source control measures specified in the plan will be carried out by local units of government over an eight year period.

Other parts of the prescription for Black Earth Creek may include fish management activities such as in-stream habitat structures and changes in size limits. Phosphorus removal at the Cross Plains wastewater treatment plant is a touchy problem but must be dealt with. Other point sources may also need further control.

The use of this prescription should lead to a long and healthy life for the wild brown trout fishery in Black Earth Creek and many enjoyable moments for anglers and residents alike.

A Wisconsin Handbook

An administrative guide to nonpoint source control



Municipal ordinances require contractors to properly contain soil on building sites. Photo by Susan Bergquist

Strip cropping prevents runoff and controls erosion. Photo courtesy of Door County Land Conservation Committee

Uncontrolled sediment and nutrient deposition results in this kind of overfertilization and degraded water quality.

Eroded streambanks can be caused by natural flow as well as uncontrolled livestock access. Wisconsin's nonpoint source control program will correct both.

DNR's comprehensive watershed approach

Susan Bergquist, Nonpoint Source and Land Management Section

Wisconsin's state-supported, voluntary program for control of nonpoint source pollution is unique in both its comprehensive watershed approach and its cooperative attack on the problem. The program features a joint effort by state and federal agencies along with local governments to keep a diffuse group of contaminants out of lakes, rivers, streams and groundwater.

Unlike programs focused only on soil erosion or those that deal with separate, isolated problems piecemeal, the Wisconsin program is systematic amd comprehensive. It does not merely deal with a polluted barnyard here, an eroded streambank there or a stormwater problem somewhere else. Nor does it dredge a lake or apply weed-killing chemicals without at the same time stopping the input of most sediment and nutrients that caused the problems. Instead, the Wisconsin program deals with entire watersheds on a selective basis and strives to control every significant source of nonpoint pollution in these watersheds. Its success lies in the fact that it brings several important elements together:

1—A major water quality program sharply focused on entire hydrologic units or watersheds.

2—Participation by affected local residents, both directly and through town, county and municipal governments.

3—Appropriate technical expertise from various agencies.

4—Cooperative effort by all involved, exerted in scientifically selected areas which directly contribute nonpoint source pollutants to valuable water resources.

Landowners and municipalities that voluntarily participate receive educational and technical assistance plus 50 to 70% cost sharing from state funds to install approved management practices.

The following is a detailed discussion of this comprehensive watershed approach and how it is used in Wisconsin's priority watershed projects.

BEGINNINGS

In 1978 the state legislature established the Wisconsin Fund to finance a multi-faceted environmental pollution control program. The fund is most widely known as a massive state-federal effort that brought discharges from municipal wastewater treatment plants and other point sources into compliance with water quality standards. Fortunately, the same law also established the Wisconsin Nonpoint Source Water Pollution Abatement Program. As more and more point sources were brought under control, emphasis shifted to nonpoint control which remains a major state-funded water quality program today.

As discussed earlier, the realization that nonpoint sources were major contributors to water pollution, either alone or in association with point sources, goes back a long way. Long before it evolved into the present Nonpoint Source and Land Management Section, a special DNR unit had been conducting studies on the problem. That section now administers the program. Areawide water quality management plans prepared by DNR as required by the federal Clean Water Act (section 208 of Public Law 92-500) also helped put the need for nonpoint source control into perspective.

Initial effort following creation of the Wisconsin Fund went into establishing principles, policies and procedures for carrying out the nonpoint source control program. These formed the basis for operations when the initial group of five priority watershed projects was selected in 1979. Today there are 29 ongoing projects and all still follow the same basic tenets, despite the fact that each involves a range of nonpoint problems and objectives and are geographically widespread throughout the state.

The three basic premises that shape the nonpoint source pollution control program are these:

1—It must be comprehensive. All critical nonpoint sources must be controlled to achieve the desired water quality objectives. This recognizes the fact that pollutants originate from many different sources.

2—Because of the comprehensive nature of Wisconsin's program and the emphasis on water quality goals, the nonpoint source control program is separate from existing soil conservation programs. (In 1982, the Wisconsin Legislature established a state erosion control program which is administered by the Wisconsin Department of Agriculture, Trade, and Consumer Protection. This program is separate from and has different objectives than the nonpoint source control program, but the two are coordinated through an interagency memorandum of understanding.)

3—Nonpoint source pollution control is, by definition, a water quality program. As such, it requires strong technical involvement and leadership by DNR, the state's water quality agency. This leadership is essential, particularly in identifying water quality objectives and using assessment techniques, such as watershed models.

These three premises have not changed even after seven years of operational experience. By contrast, however, many separate program components and procedures have undergone refinement as more was learned about how to achieve desired goals.

It is important to note that cities, villages, and counties are responsible for local implementation in project areas. DNR and several other entities also have responsibilities. This blend of many agencies and units of government has proven successful and has resulted in a comprehensive program that assures the achievement of nonpoint source pollution control objectives.

THE FIVE MAJOR PROGRAM COMPONENTS

The Wisconsin nonpoint source control program has five major components:

1—A statement of program purpose and objectives.

2—Establishment of criteria for project selection.

3—A plan stating project objectives and identifying critical pollution sources.

4—Program and project administrative structure.

5—State budget support.

Here are the details on each component:

1—Purpose and objectives—The program's purpose is to control nonpoint source pollution in a systematic manner so surface and groundwater quality goals can be accomplished within a reasonable time frame. The program is designed to deal with the wide variety of nonpoint sources that exist throughout the state including sediment from croplands, construction sites, streambanks, and grazed woodlots; nutrient loads from barnyard runoff, cropland runoff, manure spread on croplands, and runoff from city lawns and streets; and heavy metals and other toxic substances in stormwater runoff from various urban sources .

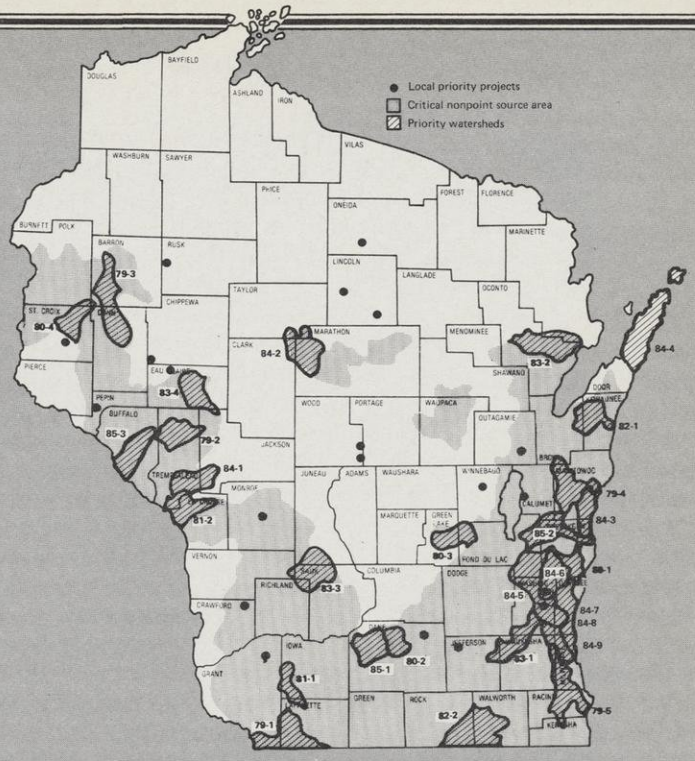
There are three major program objectives:

A—To identify the most effective approach for achieving specific water quality objectives and to provide adequate financial and technical assistance to landowners and operators for installation of approved nonpoint source control practices, called Best Management Practices (BMPs).

B—To provide coordination between the nonpoint source pollution control program and other state water quality programs.

C—To focus limited technical, educational and financial resources on critical geographic areas.

Unlike most erosion control programs, the Wisconsin nonpoint source control effort concentrates on hydrological units rather than on random or political boundaries. It deals with all urban and rural categories of nonpoint sources rather than only selected ones. And it uses a systematic approach to identify, rank, and select critical watersheds or portions of them for comprehensive attention.



Location of nonpoint source abatement projects and identification of the critical nonpoint source areas.

CURRENT PRIORITY WATERSHED PROJECTS IN WISCONSIN

Project	*County(ies)*	*Year Project Selected*	*Area (square miles)*	*Primary Water Quality Objective**	*Major Nonpoint Sources†*
Galena River	Grant, Lafayette	1979	242	2	a,c
Elk Creek	Trempealeau	1979	113	3	a,d
Hay River	Barron, Dunn	1979	276	3,5	a,d
Lower Manitowoc River	Manitowoc, Brown	1979	160	1	b
Root River	Racine, Milwaukee, Waukesha	1979	197	1	c,d,e
Onion River	Sheboygan, Ozaukee	1980	111	1	b,c
Sixmile-Pheasant Branch Creek	Dane	1980	118	6	c,e
Green Lake	Green Lake, Fond du Lac	1980	98	7	a,d
Upper Willow River	Polk, St. Croix	1980	177	6	c,d
Upper West Branch Pecatonica River	Iowa, Lafayette	1981	77	2	a,d
Lower Black River	La Crosse, Trempealeau	1981	164	2,3	a,c,d
Kewaunee River	Kewaunee, Brown	1982	135	1,3	b
Turtle Creek	Walworth, Rock	1982	299	2	c,d
Oconomowoc River	Waukesha, Washington, Jefferson	1983	131	7	a,e
Little River	Oconto	1983	216	1,4	a,d
Crossman Creek/Little Baraboo River	Sauk, Juneau, Richland	1983	218	2,3	a,c
Lower Eau Claire River	Eau Claire	1983	117	3	a,d
Beaver Creek	Trempealeau, Jackson	1984	155	3	a,d
Upper Big Eau Pleine River	Marathon, Taylor, Clark	1984	230	6	b
Seven Mile-Silver Creeks	Manitowoc, Sheboygan	1984	112	1,6	b
Upper Door Peninsula	Door	1984	324	8	a,b
East & West Branch Milwaukee River	Fond du Lac, Washington, Sheboygan, Dodge	1984	264	1,2	a,c
North Branch Milwaukee River	Sheboygan, Washington, Ozaukee	1984	147	1,3	a
Cedar Creek	Washington, Ozaukee	1984	127	1	c,e
Milwaukee River South	Ozaukee, Milwaukee	1984	156	1	e,f
Menomonee River	Milwaukee, Waukesha, Ozaukee, Washington	1984	136	1	e,f
Black Earth Creek	Dane	1985	105	3,4,5	a,d,c
Sheboygan River	Sheboygan, Fond du Lac, Manitowoc, Calumet	1985	261	1,7	a,b,c,f
Waumandee Creek	Buffalo	1985	204	2,4	a,b,c,d

*1. Protect nearshore waters of Lake Michigan; 2. Rehabilitate warmwater fishery; 3. Rehabilitate coldwater fishery; 4. Protect warmwater fishery; 5. Protect coldwater fishery; 6. Rehabilitate inland lake; 7. Protect inland lake; 8. Rehabilitate groundwater.

†a. Barnyard runoff; b. Manure spread on cropland; c. Cropland erosion; d. Streambank erosion; e. Construction site erosion; f. Urban runoff

While single-source management efforts like those aimed at soil erosion do achieve on-site land management objectives and some pollution control, the installations are widely scattered and of limited value in solving pollution problems in large hydrologic units. To avoid this scattered approach, Wisconsin deals with nonpoint sources in a systematic and comprehensive manner to accomplish the most for the state's investment. The program concentrates available funds on technical and educational support in selected watersheds to achieve maximum improvement in water quality. It addresses all categories of nonpoint source pollution in the watershed, identifies other resource problems and coordinates solutions to them with the nonpoint source control work.

This hydrologic unit approach results in selection of what are called priority watershed projects. These are chosen from among the 130 watersheds located in the state's critical U-zone. After extensive inventories of each priority watershed, the specific areas that contribute pollutants to lakes and streams are identified. These are called priority management areas. It is within these specific areas that available educational, technical and financial resources are concentrated so that all nonpoint pollution sources can be controlled through voluntary installation of approved management practices. This priority watershed approach thus identifies sources and problems, and provides a framework for project implementation. Wisconsin officials believe it achieves maximum water quality benefits for the dollars and personnel invested.

2—Criteria for project selection. Six criteria are used for the selection of priority watershed projects: (1) the severity of water quality problems; (2) the magnitude of the pollutant load and potential for significant reduction; (3) the landowners' willingness to participate; (4) the willingness and capability of local agencies to carry out their role; (5) the willingness and capability of local agencies and units of government to control other sources of pollution, for example, by enacting erosion control ordinances for construction sites; and (6) the potential public use and benefits that will result from the proposed watershed project.

The selection process developed by DNR requires input from state, federal, local, and regional interests. The process emphasizes projects where water quality problems are critical and land management practices are the most feasible means of control. Although cropland with heavy soil erosion is considered in the selection process, this is not the sole criteria. Emphasis is placed on areas with water quality problems that may be the result of many different nonpoint sources.

Priority watershed project selection uses a four-step process: (1) a numerical ranking of watersheds after technical evaluation of water quality and pollution potential by DNR; (2) review and recommendations by regional committees; (3) further refinement to a list of 15 to 20 watersheds by a committee with various agency and interest group representation; and (4) final selection of projects by DNR.

Although the projects selected annually by DNR depend on funding from the Legislature, the first three steps of the selection process are repeated every two or three years. This maintains a continuing pool of eligible watersheds from which projects can be selected.

3—Project objectives and critical source identification. Selection of a priority watershed project and its acceptance by local governments involved is followed by an eight to nine year planning and implementation process. A watershed plan is prepared based on detailed inventory and assessment of critical-source areas in the watershed and the project's water quality objectives. Generally, about one year is required to complete the assessment and prepare the plan. Barnyard, cropland, streambank, and urban-area models are used by DNR technical staff to evaluate the significance of the sources. The priority watershed plan links water quality and land use information together in one document.

The priority watershed plan sets the watershed project goals by (a) assessing water quality problems and identifying specific water resource objectives; (b) identifying important nonpoint pollution sources and determining the significance of other pollution sources such as point sources and septic systems; (c) identifying water quality improvements that can reasonably be achieved through nonpoint source controls; and (d) identifying management needs by determining the priority management areas and figuring which practices (BMPs) will effectively control the nonpoint source pollution.

After completion of the assessment, the implementation strategy is drawn up. It identifies (a) the tasks necessary to accomplish results called for in the technical assessment, (b) the agencies responsible for carrying out those tasks, (c) the time frame for carrying out the tasks, (d) the estimated hours of staff required, and (e) the estimated cost share dollars needed to implement the recommended nonpoint source control practices.

The plan guides the priority watershed project and spells out procedures and responsibilities to aid local staff in working more

Stormwater:

Robert Pitt,
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Rainwater and snowmelt, flowing off paved streets, sidewalks, parking areas and large expanses of roof pick up a variety of pollutants and carry them into lakes and streams. DNR is analyzing flows, pollutants and control possibilities to find ways of reducing this runoff so that receiving waters, including groundwater, will be protected.

Impervious surfaces like paved streets and parking lots reduce the amount of rain or melt water that naturally infiltrates into soil and groundwater. This alters the hydrologic cycle. With urbanization, the flow of surface receiving waters increases significantly during wet weather and decreases in dry weather. At the same time, groundwater recharge is reduced. These paved-over, impervious areas cause most of the flow increases associated with urban runoff.

Urbanization can increase flooding in downstream areas. As an example, between 1950 and 1975 the Menomonee River watershed in the Milwaukee area experienced a rapid increase in population plus conversion from rural to urban land uses. This caused an increase of about 60% in the 100 year flood flow rate in the river. The 100 year rate is the worst flood that will occur in a century and is used for planning and zoning and by insurance companies to establish premium charges. Computer modeling has predicted that downstream of these developing areas on the Menomonee River, flood damage can be expected to increase by about 75% to more than $1-million annually by the year 2,000.

how to handle it in town

Urban flooding may flush fish and other organisms out of streams, and low flows in dry summer weather can reduce the amount of water available to aquatic organisms.

Urban runoff can also send large amounts of pollutants into receiving waters. In a typical city, industrial areas contribute most of the toxic pollutants, but residential and commercial neighborhoods are also important sources of many pollutants.

Menomonee and Milwaukee River studies have shown that heavy metal concentrations in urban stream sediments are typically many times greater than in rural streams. They are probably responsible, along with changes in flow, for decreased fish populations and aquatic diversity. The organisms living in these waters may contain high concentrations of heavy metals.

Fecal coliform bacteria levels commonly exceed standards for several days after heavy rains and periodically close swimming beaches on urban lakes or streams that receive runoff.

In general, long-term effects of toxic pollutant accumulations in sediments caused by urban runoff are more important than short-term toxic concentrations found in water or temporary oxygen depletions that occur during rains.

Urban runoff can also pollute groundwater and can contaminate soil. Usually where urban runoff recharges groundwater used for drinking, most pollutants are effectively filtered out by the first few inches of soil. However, urban soils can be seriously contaminated with heavy metals, especially near roads and in roadside drainage ditches.

There are primary, secondary and final nonpoint sources of runoff pollutants. Not a great deal can be economically done to contain most primary sources, but effective controls are possible for the other two source categories.

Some primary sources are:

- Automobiles (heavy metals and polycyclic aromatic hydrocarbons or PAHs)
- Fertilizer and pesticides
- Metal corrosion (heavy metals)
- Pet wastes (bacteria)
- Leachate from preserved wood (pentachlorophenol, PAHs, arsenic, and copper)
- Soil erosion from undeveloped and landscaped areas (total solids)

Secondary nonpoint sources are areas where pollutants accumulate and from which they may be removed before being washed off by rains. These include streets, parking lots, rooftops, and storage areas.

The urban runoff outfalls themselves may be considered as final nonpoint sources, or control locations, before discharging to receiving waters. Their relative importance varies greatly for different pollutants, land uses, rain conditions and development practices. For example, runoff from shopping centers which have very large impervious roofs and parking areas is substantial and polluted with heavy metals. By contrast, in residential areas erosion of unpaved areas can be significant during heavy rains when most of the runoff comes from lawns, gardens and other unpaved surfaces. However, in a light rain, residential runoff comes from paved surfaces and contains different pollutants.

Development practices are also important. For example, if roofs are drained to lawns instead of pavement, fewer pollutants end up in lakes and streams. Conditions vary a great deal and therefore site-specific factors must always be considered in evaluating urban runoff sources.

Urban Runoff Controls

Many urban runoff control options are available. The selection of which options to use should be based on a thorough knowledge of the specific water quality problems and their sources. Unfortunately, many current development practices designed to improve local drainage, such as curb and gutter systems or paving natural drainage channels, result in increased runoff downstream. Detention basins can help by reducing the flow in receiving waters, but don't reduce total volume or increase dry weather flows. Also, unless a complete detention basin plan for the whole watershed is carefully designed, little improvement in downstream flooding may result. In some places independent design of separate detention facilities has actually increased downstream flooding.

Infiltration

Among the options available for runoff control are a variety of infiltration devices. These are installed at runoff sources to increase the percolation of water into soil and thus decrease overland runoff volume. Among them are downspouts that direct roof drainage to lawns, porous pavement, soak-away pits or dry wells, seepage or infiltration trenches, recharge or percolation basins and grass swales. Trenches are most common and recharge basins are also popular. These devices can serve nearly every

effectively. It can also serve an important educational function by showing the cause-and-effect relationship between land management and water quality.

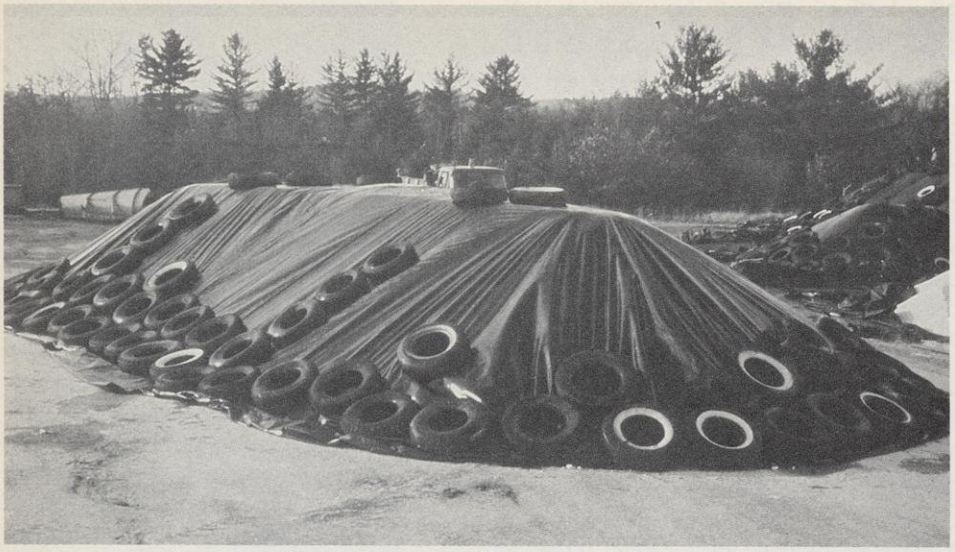
Following approval of a priority watershed plan, there is a three-year period during which landowners and municipalities can voluntarily sign cost share agreements for design and installation of BMPs. Installations must take place within five years of the date agreements are signed. The cost share recipient agrees to operate and maintain the BMPs for a specified period, normally 10 to 20 years. Failure to do so is considered a breach of the agreement and repayment of the cost share funds is required.

4—Program and project administrative structure. The administrative framework is designed for local implementation of each watershed project under state administration and coordination. In rural areas, the framework maximizes local agency contact with individual landowners and uses existing agencies and institutions as much as possible. In urban areas, the framework is designed to maximize city and village involvement.

DNR provides program administration at the state level. This includes selection of priority watershed projects and technical expertise in water quality assessment, including source evaluation models to determine management needs. DNR also allocates cost share and local staff assistance funds to implement watershed project activities.

Locally, municipalities, and land conservation committees acting on behalf of their county boards, administer and implement the projects. This includes development of cost share agreements with individual landowners and design and installation of management practices. Local governments are also responsible for record-keeping and are accountable to the state for project implementation. Land conservation committees receive assistance from the UW-Extension Service, Soil Conservation Service (SCS), and Agricultural Stabilization and Conservation Service (ASCS). Many counties enter into contractual agreements with these agencies to provide technical, financial, or educational assistance needed to carry out priority watershed projects.

This administrative structure for priority watershed projects assures that statewide water quality goals will be achieved and that effective coordination exists between other water quality and re-



Salt for winter use on roads is a fact of life in Wisconsin. Its proper storage and application have a direct effect on water quality. DOT photo

land use, and can be located throughout an area and incorporated into landscaped sites of all types. They not only reduce stormwater runoff volume, they also reduce the contaminants discharged to surface receiving waters. Since infiltration devices redirect runoff from surface to subsurface environments, they must be carefully designed to protect groundwater. Since they reduce stormwater volume, their use can significantly reduce the size and cost of required storm drainage systems.

Porous pavements are "hard" surfaces that can support a certain amount of activity while still allowing water to pass through. They are generally used in places where there is low traffic, such as service roads, storage areas and low use parking lots. There are several different types available. Some are made of asphalt similar to regular road surfacing, but with a specific size rock mixture used in the hot mix. Porosity then becomes much higher than that of regular asphalt. Concrete grids or lattice blocks are also used. These feature open holes up to several inches wide with sand or gravel in the holes. Grass can be planted in them if traffic is very light and growing conditions adequate.

Recent tests have found few problems with porous pavements even in areas with severe winters. They can be designed to eliminate all runoff but care must be taken to protect against groundwater contamination. While porous pavement is suitable for walkways and low-traffic access roads, conventional pavement with runoff directed to an infiltration trench is better for heavily used parking lots in places like shopping centers or industrial areas.

Recharge or percolation basins are another infiltration device. These basins are usually located at stormwater outfalls but can also be used to control other major urban runoff sources. Pervious catchbasins are smaller infiltration devices. Perforated storm sewer pipe performs a similar function. All of these devices can reduce flows and pollutants from just about any source, but they are difficult to site and, to be effective, must treat all flows, not just those from the most important sources.

Recent research has examined the performance of different infiltration devices. In one study, a series of interconnected percolating catchbasins was found to almost totally eliminate all stormwater discharges. Another determined that porous pavement reduced pollutant runoff from stormwater by 85 to 95%, while an infiltration trench reduced urban runoff flows by about 50%. The US Environmental Protection Agency has concluded that with a reasonable degree of site-specific design consideration to compensate for soil characteristics, infiltration devices can be very effective in controlling urban runoff.

The cost of a large 6,000 cubic foot infiltration pit is about $6,000. This size could effectively treat a roof or parking area of about one acre. More than 80% of the cost is for gravel and filter fabric, while excavation accounts for about 20% of the total cost. Constructing these pits would save on dollars needed to install large storm sewer systems because of reduced runoff flows.

Grass filter strips are a device that costs very little when incorporated into a landscaping plan. The filtering effects of grasses, along with increased infiltration, reduces the particulate sediment load in runoff from landscaped areas and thus lowers the amount that gets into the storm drainage system. Directing roof runoff to grassed areas instead of pavement is one effective strategy. Planting grass as a buffer between storm drains and eroding slopes, parking lots or storage areas is another.

Nearly complete control of most urban runoff pollutants can occur using a Bermuda grass strip between 50 and 400 feet long. While the large expanse of grass required is usually not available in small developments, other areas such as hospitals, schools, office parks and cluster residential developments are prime candidates for this kind of runoff treatment.

source management agencies. Under it, local implementing agencies are directly responsible to state level government; and a direct link exists between the local implementing agencies and the state water quality agency. This structure also allows projects to be carried out by local resource management agencies which have daily involvement with the landowners.

5—State budget support. State appropriations support the Wisconsin nonpoint source pollution control program in three ways: with cost share funds to landowners and municipalities for installation of management practices; with local assistance funds to local units of government for additional technical assistance, information and education programs, and financial and project management; and with funds for state level administration and for state preparation of priority watershed plans. These appropriations for fiscal years 1979 through 1987 have totaled nearly $36-million. Less than 20% has gone for state and local administration.

Best management practices are cost shared at 50 to 70% of installation costs with higher rates going for practices where off-site water quality benefits exceed on-site benefits to landowners.

Program Principles and Policies

Wisconsin's nonpoint source pollution program involves six essential principles and policies:

1—Identification of water quality objectives.
2—Assessment of all critical nonpoint sources.
3—Development of implementation strategies.
4—Program impacts on ongoing county programs.
5—A package approach to the installation of control practices.
6—Tracking project accomplishments.

1—Identification of water quality objectives. Central to each priority watershed project are the water quality objectives set for its lakes and streams. The determination of critical pollutants, significant sources, level of desired load-reduction in nonpoint source pollutants, and measurement of accomplishments are all based on these specific objectives. In addition, the severity of water quality problems and the attainability of objectives are primary factors in selecting priority watershed projects.

An understanding of pollutant impacts is essential in setting water quality objectives and depends to a large degree on biological

Grass waterways or swales also work well in controlling urban runoff. Infiltration of the runoff is the main control process, but some filtering of particulates may occur. Filtering efficiency is reduced by heavy flows. Grass waterways can be used in place of paved or concrete curbs and gutters, except possibly in strip commercial and high density residential areas. They work best in low and medium density residential, industrial, and institutional locations. Grass waterways can either connect to underground pipes that go to a lake or stream, or to larger waterways that form a complete surface drainage system. The effectiveness of grass waterways is attested to by various research projects, including one in the Milwaukee area which monitored two similar residential sites, one served by grass waterways and another by concrete curb and gutters. The monitoring included extensive flow and pollutant concentration measurements during a variety of rains. Flows and pollutants were significantly lower in the swaled area (up to 95% less) than for the curb and gutter site.

Wet Detention Basins

Wet detention basins maintain several feet of water in a permanent pool. They are very effective in controlling runoff at both outfalls and upland runoff sources. Runoff water is detained for varying periods of time, from a few minutes to several days, depending on the basin detention volume and storm runoff flow rate and duration. Monitored performance of wet basins has ranged from poor to excellent, depending on the size of the basin relative to the service area size and storm characteristics.

Pollutants are removed from the detained water, mainly by settling out along with sediment. Biological processes also substantially reduce concentrations of soluble nutrients by converting them to algae. If algae is removed from detention basins, nutrient discharges are reduced. If not, dead algae decompose back

Rainfall flushes pollutants through storm sewers directly into lakes and streams. Mixed with it are leaves, sediment, road salt, grease, oil, exhaust particles, yard fertilizer and pet wastes. Photo by Jill Kerttula

and physical techniques. To rely on chemical parameters alone could easily result in many impaired uses being overlooked. Biological indicators often integrate fluctuations in chemical parameters and retain an overall measure of water quality impacts for a long period of time. The identification of water quality objectives in this manner requires expertise of aquatic biologists and fish managers.

Three techniques frequently used in identifying objectives for impaired stream fisheries are (1) the Hilsenhoff Biotic Index, which evaluates aquatic insects as indicators of instream effects of oxygen-demanding materials such as manure; (2) a stream classification system based on potential use; and (3) fish population and distribution surveys.

2—Assessment of all critical nonpoint sources. With the variety of animal operations, farm crops and urban land uses in Wisconsin, water quality problems are rarely caused by a single nonpoint source. Therefore, an approach dealing with just one category of sources, such as eroding cropland, is insufficient to control nonpoint source pollution. On the other hand, to include all landowners and all sources, regardless of significance, would be inefficient and not cost-effective. The Wisconsin approach is based on identifying the critical land areas and operations producing most of the pollutant load, and concentrating on these sources. In many areas, about 25% of the land area produces about 75% of the nonpoint source pollutant load.

Early in a priority watershed project a comprehensive assessment of all nonpoint sources is conducted jointly by DNR and the counties, cities, and villages involved. All sources, including barnyards, fields where manure is spread, eroding streambanks and croplands, construction sites, and urban areas are assessed during this phase. These inventories are time consuming but in the long run translate into more efficient use of personnel and money during the implementation phase. Without them, practices might be designed and installed for sources which are not really critical. DNR employs specialized techniques for these assessments, including various mathematical models.

3—Development of implementation strategies. Development of detailed strategies for project implementation is considered as important as the watershed inventories. A strategy for each

Porous pavement provides a hard surface yet allows infiltration of water. The openings can be planted with grass or filled with loose material.
Photo by Robert Pitt

Finding room for detention basins is often difficult in established urban areas. This one near the UW Arboretum in Madison controls stormwater and sediment which threaten nearby Lake Wingra.
Photo by Robert Pitt

individual priority watershed is prepared jointly by DNR and local governmental units. They include preparing detailed landowner contact lists based on results of the watershed inventories. These lists contain a preliminary assessment of the severity and extent of nonpoint sources for each operation. County staff can thus concentrate efforts on the 20 to 30% that are critical rather than individually contacting all landowners in the watershed. Project implementation strategies also identify and schedule educational activities, outline fiscal management procedures, discuss preliminary project budgets and estimate staff needs.

4—Impacts on ongoing county programs. The implementation of priority watershed projects is the primary responsibility of the cities, villages, and counties involved in the projects. In recent years, several environmental programs have been assigned to county governments for local coordination and implementation. These include the state erosion control program, forestry programs, animal waste regulation and groundwater management in addition to nonpoint source control. The traditional soil and water conservation programs have been in county hands a long time. Coordination between these programs at the county level is more effective when done by a general unit of government rather than a specialized one such as the former soil and water conservation districts, whose focus was often too narrow.

County responsibilities for the nonpoint source control program as well as many other state programs are assigned to land conservation committees. This is a good way to integrate state and federal programs into a coordinated local program that can meet comprehensive natural resource needs of landowners and the state. But it also requires greater involvement by local officials in decision-making.

While the nonpoint source control program uses counties' experience with land management, it has also required substantial county adjustment. Many counties have had to modify the scope of existing programs. For example, some with strong cropland erosion control programs had no experience in manure management and little experience in streambank erosion control. This could be seen when trout habitat in county streams remained degraded and bacteria levels remained high despite progress with cropland erosion control. Two common changes have been that county staff

into soluble nutrients either in the detention basin or later in the receiving water.

Although wet basins are effective, they must be carefully designed and maintained to avoid nuisance conditions. For the best basins, removal of 70% of the biological oxygen demand (BOD) and chemical oxygen demand (COD) materials, 60 to 70% of the nutrients and 60 to 95% of the heavy metals have been reported.

Wet detention basins are best installed in newly developed areas, since they are very difficult to effectively locate in existing areas. Costs are moderate, ranging from $50,000 to $100,000 for a two acre wet basin pond. This size will treat runoff from a residential area of about 200 acres or an industrial or commercial development of about 75 acres.

Public works cleaning practices

Urban runoff water quality can be improved by a variety of public works practices. Cleaning streets and storm sewers will remove various pollutants. Depending on rainfall, street and catchbasin characteristics, these cleaning activities can result in control that varies anywhere from only one percent to a high of about 10%. Street cleaning is much more effective in cutting back pollution that comes from light rains than from heavy ones. When dealing with a tenth of an inch of rainfall, street cleaning in residential areas may remove up to 30% of runoff pollutants. It can do even better in industrial areas, especially if paved parking and storage areas can be effectively cleaned. Up to 70% control of runoff pollutants may then occur. However, control is generally less than 10% using common methods.

Cleaning catchbasins and storm sewer pipes twice a year is estimated to reduce the total solids and lead in urban runoff by between 10 and 25%. It can also lower chemical oxygen demand, nitrogen, phosphorus, and zinc by between five and 10%.

Other important ways to reduce amounts of polluted urban runoff include public education, regulating disposal of pet wastes, conveniently located waste tanks for oil, and community hazardous material collection programs such as Madison's "Clean Sweep" program.

Conclusions

Stormwater management alternatives have been studied for about the past 15 years in many parts of the United States, including several major projects in the Milwaukee area. These projects have defined the types of pollutants originating from different land uses and the controls needed for their reduction. Computer models have used this information to evaluate urban runoff problems in many planning studies.

The United States and Canada International Joint Commission sponsored a project in the mid-1970s that evaluated stormwater discharges for a variety of land uses in the Menomonee River watershed. More recently, the US Environmental Protection Agency sponsored a Nationwide Urban Runoff Program project in Milwaukee County that evaluated the effects of street cleaning and determined the sources of urban runoff pollutants.

Some of the urban stormwater control practices discussed in this article have already been included in watershed plans for two priority watershed projects—Sixmile and Pheasant Branch Creeks in Dane County, and the Root River in Racine, Waukesha and Milwaukee Counties. In addition, at West Bend in Washington County a demonstration project is underway to install and evaluate the effectiveness of detention basins in a developing industrial park.

A law passed in 1983 authorizes DNR to develop priority watershed plans for the five watersheds in the heavily urbanized Milwaukee and Menomonee River Basins. These plans will contain programs to reduce urban as well as agricultural runoff discharges to acceptable levels that will protect and enhance receiving water uses. The State of Wisconsin will also provide cost sharing funds to encourage implementation of the watershed plans.

Part of the law requires DNR to prepare a state stormwater and construction site erosion management plan and model ordinance. The plan, already in draft form, contains a comprehensive "manual of practice" that describes runoff control options and guidelines for their design. The model ordinance will be followed for all state agency construction, and will be useful as a guideline for local ordinance adoption.

Communities wishing to develop stormwater management plans should consider these three main elements: define the existing or anticipated receiving-water problems caused by runoff; determine the sources of problem pollutants and the flows that cause the problems; and identify and evaluate control options. Many of the options are described in this article.

Important nonpoint urban runoff pollutants

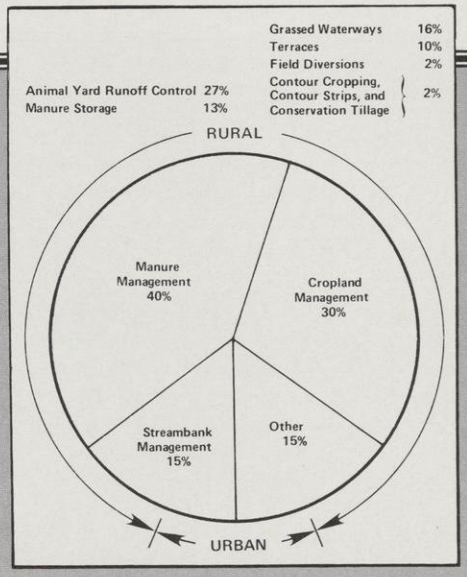
- **Toxic organic pollutants** (such as pentachlorophenol and polycyclic aromatic hydrocarbons, or PAHs),
- **Heavy metals** (lead, zinc, and copper)
- **Sediment**
- **Oxygen demanding materials**
- **Nutrients** (nitrogen and phosphorus)
- **Bacteria** (fecal coliforms and *Pseudomonas aeruginosa*, which causes skin rashes)

expertise had to be developed in manure management and a new approach for increasing landowner awareness had to be created.

In many counties, organizational skills have had to be improved. Priority watershed projects require bookkeeping to accommodate annual budgets several times higher than those of previous programs. Design and installation of control practices must be scheduled over a five-year implementation period and coordination of educational activities with landowners requires improved working relationships among agencies.

In almost every county selected for a watershed project, additional staff has been needed. The Wisconsin nonpoint source control program provides state funds for this purpose. So far, counties have either hired additional people or contracted with the Soil Conservation Service for additional staff.

5—Best management practice—package approach. The nonpoint source program uses a package approach to installation of BMPs. This means that cost share agreements must contain all practices necessary to control nonpoint sources on each farm or in each municipality that participates in the program. This prevents



Distribution of expenditures by practice in the Wisconsin nonpoint source control program.

Sediment from construction sites is a

Susan Bergquist, Nonpoint Source and Land Management Section

To many people, construction sites for homes, industries, shopping centers, schools, utilities, highways, airports and vacation homes are a sign of a healthy economy and community growth. Overlooked are the pollutants, especially sediment from these construction sites that pollute lakes and streams, particularly those in developing urban areas. Sediment from construction sites can easily be the most serious source of nonpoint pollutants in a watershed.

Sediment easily erodes off bare, unprotected land during rainfall and snow melt. It often is tracked off sites by heavy equipment, especially when it is muddy, and may also blow off during dry periods.

Sediment from construction sites can cause many of the same impacts as sediment from rural areas—polluted waters, smothered fish spawning grounds, filling in of streams, lakes and reservoirs, and harmful deposits on land areas. Other impacts are primarily urban problems—washed out and undercut streets and pipelines, clogged storm sewers and sediment in basements. Still other problems occur right on the construction site—loss of soil, washouts and gullies on graded land, filled in structures and damaged streets and sidewalks. Construction site damage translates into increased costs and work delays for contractors.

Stormwater runoff increases as areas of infiltration are eliminated and impervious surfaces are created. After development, it can be 10 times the predevelopment runoff level. Stormwater runoff provides an unfortunately handy conveyance for sediment, and can move it long distances from the source. Construction sites and urban runoff are the two prevalent urban nonpoint sources and often go hand-in-hand in polluting urban waterways.

The rate of erosion from construction sites can be very high. A 1970 Soil Conservation Service brochure cites studies showing rates of erosion to be 10 times greater on construction sites than on land used for cultivated row crops, 200 times greater than land used for pasture and 2,000 times more than on timberland. A Wisconsin DNR study in the Menomonee River Watershed found that less than 7% of the area was under construction but produced over half the sediment loading to the Menomonee River. A statewide survey showed only one percent of the state under construction at any time but that small area produced 10% of the sediment loading to waterways.

Most erosion occurs during construction periods. However, areas below construction sites may encounter increased erosion rates following completion of building projects because of heavier and faster runoff, the result of more impervious areas at the completed construction sites.

It would be easy to rationalize that construction site erosion lasts for relatively short periods of time in contrast to other sources, such as croplands. However many large construction projects mean cleared and graded areas left exposed for a year or even several years. And construction now often takes place on steeper, less desirable sites, especially in western states, but also here in Wisconsin.

Technically, the potential amount of construction erosion depends on factors such as type of soils, degree of slope, intensity of rainfall, and type and density of vegetation. While all are important, the amount of sediment-laden runoff and mechanically removed soil are directly tied to man-made factors, such as project design, type and sequence of construction, utilization of control practices and overall control of the land under development, whether the project is a single house or a large complex.

As with other nonpoint sources, the best solution is prevention—which translates into proper land management. Much construction site erosion is avoidable and the major responsibility for holding soil on-site belongs to developers, contractors and subcontractors. For their part, local governments should enact stringent ordinances to control erosion and construction runoff and should provide constant, dedicated enforcement. Citizens should insist on these actions because once sediment leaves the site and damages water resources and public facilities, cleanup and repair are more difficult and costly, and these expenses often fall on the taxpayer, not the developer or contractor who created the problem.

While some developers and builders claim on-site controls are too costly, other civic and environmentally conscious people in the business routinely use control practices. Many practices are relatively low in cost. Some practices apply only to large developments, others to almost any project from small home additions all the way to major developments. Many practices are far less expensive when incorporated into projects at the design and construction phases rather than adding on later when building is already underway or completed. Some practices actually enhance the final appearance and character of a project. Many practices rely

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a landowner, city, or village from installing only the practices it prefers while avoiding those such as streambank stabilization which may be less popular because they have no direct effect on the management of an operation. This approach is similar to that used in the Rural Clean Water Program but quite different from the Agricultural Conservation Program approach, which is familiar to most farmers.

The package approach has worked well, resulting in practices that produce a total pollution control system rather than a piecemeal one . Among other obvious advantages, it has resulted in passage of local ordinances to control both construction site erosion and stormwater runoff.

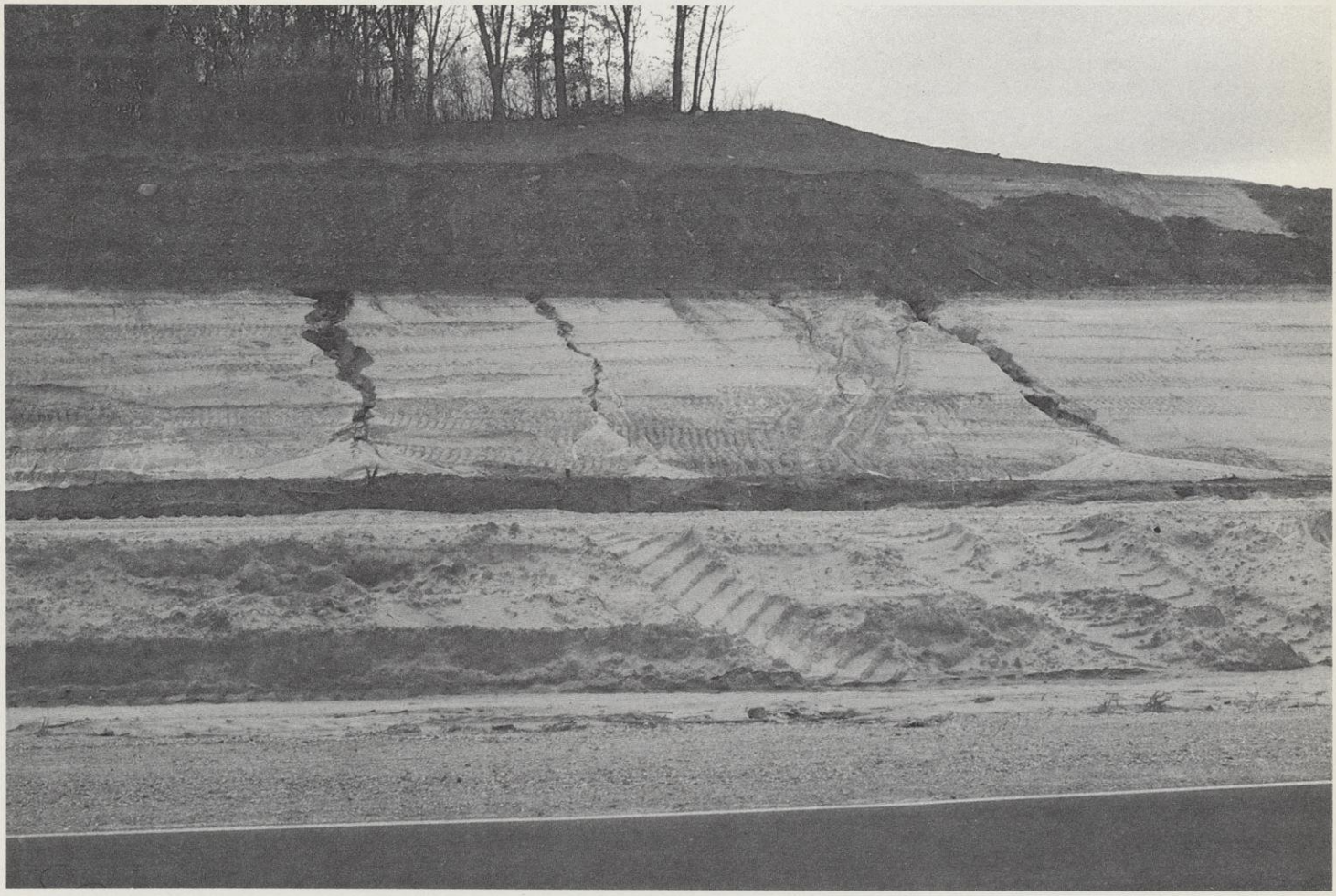
6—Tracking project accomplishments. Early priority watershed projects demonstrated a need to track project progress on a continuing basis. While in the past, accomplishment indicators had been used to some degree in all projects, they are now routine. Indicators relate to the water quality objectives, the pollutants causing the problems, and the type and severity of the sources to be controlled. They also provide feedback to implementing governmental units so that progress can be measured.

Even though participation by landowners and operators is voluntary in the state funded program, substantial pollutant load reductions of 50 to 70% have been achieved in priority watershed projects evaluated to date.

State officials recognize that, even with the accomplishments so far, no voluntary program will achieve the desired degree of control in every priority watershed project. This means that sometime in the future some regulation may be necessary.

Development of Wisconsin's nonpoint source pollution control program with its long range comprehensive approach to watershed management has required a great deal of planning, study and work-learn experience. But results have been worth it. By complementing other resource management efforts the program will make sure that the many beneficial uses of state waters remain intact. It will also make sure that they continue to be protected and improved.

major - yet avoidable - pollutant



Typical highway construction scene. Raw roadbeds and banks are often left exposed for months. Rapid soil stabilization and revegetation are needed, coupled with water detention strategies, to protect receiving waters and avoid costly cleanup. Photo by Susan Bergquist

Best management practices eligible for priority watershed projects

Best Management Practice	*Effectiveness*	*Capital Cost*	*Private On-site Benefit*	*Relationship to Customary Operating Practices*	*Maximum State Cost-Sharing*
Contour cropping	High	Low	Moderate	Moderate	50%
Stripcropping	High	Low	Moderate	Moderate	50%
Field diversions	High	Moderate	Moderate	Low	70%
Terraces	High	Moderate	Moderate	Low	70%
Waterways	High	Moderate	Moderate	Moderate	70%
Reduced tillage	High	Low	Moderate	High	50%
Critical-area stabilization	High	High	Low	Low	70%
Grade stabilization structure	High	High	Low	Low	70%
Shoreline protection	High	High	Low	Low	70%
Barnyard runoff management	High	Moderate	Moderate	Low	70%
Long-term manure storage facilities	High	High	Moderate	Moderate	70% up to $10,000
Short-term manure storage facilities	High	Moderate	Moderate	Moderate	70% up to $ 6,000
Livestock exclusion from woodlots	High	Low	Low	Moderate	50%
Structural urban runoff practices	Moderate to High	Moderate	Low	Low	70%

on vegetative rather than structural approaches. And some involve only site control and common sense.

Before any construction takes place, developers should choose suitable sites, cluster buildings and plan roads to avoid steep areas. As much natural contouring and open space as possible should be maintained with erosion controls and construction sequences planned in advance to minimize vegetation removal and soil disturbance.

For a large project, early protective measures can include a seeded earth berm around the site; detention basins to trap runoff and sediments; graded grassed waterways; safe dispersal of water and sediment; proper locations and procedures for storing topsoil; and measures for protecting nearby lakes and streams.

During development and construction, management practices might include preserving trees, grassed areas, and other natural vegetation; restrictions on grading, vehicle access, parking, materials delivery and storage; stabilizing bare soil as soon as possible by seeding and mulching, sodding, installing filter fabric, jute or other types of matting and netting, and landscaping finished areas; installing anchored straw bale dams, and laying a gravel base for roads or individual driveways. Since roots hold soil and vegetation retards movement of water, many common practices aim first at preserving and replacing vegetation. A wide range of relatively simple practices are available.

Controlling the use of a site is of great importance although often overlooked. DNR staff who visit construction sites have repeatedly noticed that on both large and small ones, failure to control access results in extensive, largely avoidable loss of soil. Other poor habits commonly seen are excessive grading, improper and excessive stockpiling of soil, removal of all vegetation, haphazard storage of building materials, unrestricted driving and parking on site, especially when soils are wet, and removal of sediment control practices already installed. Situations have been seen where gravel driveways are used for material storage rather than access and vehicles are forced to drive on bare, unprotected soil; where controls such as straw bales are removed by subcontractors and not put back; and where vehicles leaving a site track such large quantities of chunky soil (usually compacted mud) onto adjacent streets that traffic is impaired. Neglect of this type highlights the need for municipal ordinances to control runoff and erosion at construction sites.

However, enactment of erosion control ordinances by Wisconsin counties and municipalities has been a very slow process. Only a few have done so on their own initiative, usually in response to severe, costly problems. A three year federally funded demonstration project to encourage communities to adopt ordinances was only moderately successful, and the Wisconsin nonpoint source control program has made ordinance adoption a cost share condition for certain practices in urban watersheds.

Legislative proposals to require ordinance adoption have not succeeded, even though the demonstration project showed little inclination by local governments to voluntarily adopt ordinances. Some progress was made in legislation that established the Milwaukee River Basin priority watershed projects as part of the nonpoint source pollution control program. It calls for DNR to develop a construction site erosion control and stormwater management plan that would apply to state construction; to establish minimum standards for construction site erosion and stormwater management; to encourage counties, cities and villages to comply with these minimum standards through local ordinances; and to develop a model ordinance for use by local government. DNR has nearly completed these requirements. But the plans and model ordinance do not assure action. For the time being, the best approach to controlling construction site runoff and erosion is citizen awareness and insistence that their counties and communities enact and enforce ordinances to do the job.

Filter fabric controls construction site erosion by trapping sediment. Strawbales, sodstrips, seeding and mulching also work. Photo by Jim Baumann

Detention basins can trap runoff and sediment during construction, then later be attractively incorporated into landscape design and continue to serve the same function. This is a condominium project in Madison. Photos by Susan Bergquist

The okay and the bad at two construction sites. Straw bales at one hold back sediment and protect receiving waters. The other messes up the street and fills the storm sewer. Actually, the bare soil on both should have been protected. Photos by Susan Bergquist

Jute matting holds straw mulch in place on seeded waterways to let grass get a start before seeds can be washed away.

Jim McEvoy

Minimum Tillage

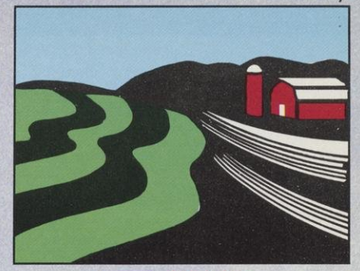
Stock Containment

Grass Infiltration Area

Detention Basin

Grass Waterway

Street Sweeping



Contour Farming

Manure Storage

Strawbales

Porous Pavement

Some Best Management Practices

Grazing and trampling in pastured woodlots destroy soil-holding vegetation and cause erosion. The damage can often be repaired by simply fencing out the cows. Here, however, not only fencing but brush removal, grading and seeding were required. "After" photo by Susan Bergquist

Properly applied, as it is here in liquid form, manure is a valuable resource. However, if manure washes into streams serious water quality problems arise. Photo by Susan Bergquist

Conservation tillage leaves a layer of plant residue on the surface to protect soil from erosion year round. Photo courtesy of the Dane County Land Conservation Committee

Well managed forests benefit water resources

Adrian E. Hagen, DNR Area Forester, La Crosse

Properly managed forests yield little surface water runoff. As such they are unlikely nonpoint sources since water flowing over ground is needed to carry sediment and other pollutants into streams. The nature of their soils and cover give forests their water retention characteristics.

A natural forest soil is deep and porous, filled with air spaces and covered by a layer of litter and humus. This litter layer protects the soil surface from the force of raindrops and allows water to move into the soil. Rainfall is also intercepted by leaves, limbs and trunk, all of which reduce the force of raindrops. Undisturbed forest soils in Wisconsin can absorb rain at rates of eight to 12 inches per hour. By contrast, the absorption rate of cultivated lands is only a fraction of this. Forest soils are able to act as reservoirs, recharging streams, springs and groundwater. Any action that destroys, removes or compacts the litter layer reduces these very beneficial actions.

Cutting trees has little effect on runoff because the litter layer remains intact. Careful removal of cut logs on a well-designed road system minimizes the amount of area disturbed. Proper drainage and seeding, together with typically rapid natural revegetation, returns a forest to normal one or two years after logging.

Grazing livestock in forested areas is the activity most detrimental to forests. Livestock destroy the protective layer of leaves and plant remains and expose soil to direct rainfall. They also compact the soil, reducing the pore space within the soil. The result is less infiltration and storage of water and more erosion and runoff.

Forest fires also result in the loss of the protective litter layer and increased erosion and runoff.

In many regions of the state, the remaining wooded lands are primarily in small tracts. These often provide valuable wildlife habitat and timber species in addition to protecting soil and water. Frequently these wooded tracts are on steep terrain. Where forests cover both steep slopes and hillcrests, the volume of runoff flowing to croplands below can be minimal. A different situation occurs in areas of the state which were originally high ridges but now are cut by deep valleys, leaving steep slopes and portions of the original ridgetops. The ridgetop lands customarily are cultivated, slopes are wooded and valleys are cropped or pastured. Large volumes of runoff and sediment from the cropped ridgetops enter the hillside forest to create gullies or keep existing ones raw and eroded. Soil, rock and debris are washed out of wooded areas onto fields and pastures below, eventually reaching water courses in the valleys.

To best protect our valuable forest resource and its beneficial impacts in reducing runoff and preventing erosion, thus maximizing its watershed values, the following actions should be taken:

Keep livestock out of woodlands by installing fences.

Prevent wildfires.

Prevent runoff from higher elevation croplands and developed areas from draining into forests on steep slopes

Use proper logging techniques, including proper road layout and construction and timely revegetation

The Managed Forest Law available to forest owners in Wisconsin requires protection from grazing and wildfires as primary requirements for entry of lands under the law. After sign-up, landowners receive tax incentives in exchange for ensuring proper long-term forest management on their lands.

Soil erosion: the unseen problem

Kevin F. Connors
Dane County Conservationist

Soil erosion is even greater today than it was in the '30s—and something can be done about it.

Croplands are a major source of nonpoint source pollutants, especially sediment that erodes from fields and various fertilizers, herbicides, pesticides and organic materials that are washed off along with the sediment. Over a period of time, soil particles are moved by wind and water. Some settle out elsewhere on the land, but a portion end up as pollutants in our lakes, streams and rivers.

Unlike feedlots, eroding streambanks and construction sites where you can "point" to a particular area and identify the problem, eroding croplands are not as readily discernable as problem sites. In fact, of all the nonpoint sources, eroding cropland may be the most difficult to recognize as a pollutant source.

Those of us who work with the Universal Soil Loss equation (USLE) on individual parcels and fields several times a day in many areas can quantify rates of erosion on "conservation treatment units" or crop fields. People who don't have training or experience with the USLE, be they farmers or nonfarmers, find it difficult to appreciate all the factors that contribute to erosion.

First of all, let's look at how the farm operator views soil erosion. Usually, it's perceived to be the type most dominant during the '30s and '40s—"gullies so deep you could drive a semi-trailer and tractor in the bottom, stand on the edge and look over the top to the other side." Today that extreme is easily recognized, and landowners do something about it; not only to protect the resource base, but also for ease of cropland management. In talking to today's farmers, you sense a feeling of pride that they have improved the land—made it better than it was before they took over.

A drive through the countryside today doesn't reveal the large gullies shown in pictures from the '30s and '40s. Instead, there are grain fields yielding large bumper crops and hayfields that used to yield "acres per cow," now producing alfalfa in terms of "cows per acre."

But despite these scenes, statistics show that cropland soil erosion is even more severe today than it was during those earlier years. So if

Riprap and gabions (wire) protect Pheasant Branch Creek in Dane County during both high and low water. Extreme variations in flow are one result of urban development. Photo by Susan Bergquist

erosion is more severe now than before, just where is all the erosion and where is it going?

In the Sixmile and Pheasant Branch Creeks Priority Watershed Project in Dane County, cropland inventories showed that sediment delivery to Lake Mendota amounted to the equivalent of eight to 10 dump truck loads per day per year. Even though these figures seem astronomical, they are actually small considering that what goes into the lake is roughly only 10 to 15% of gross soil erosion in the watershed from a variety of sources.

In view of this, the Dane County Land Conservation Committee has launched a program to gain increased awareness and appreciation of the scope of soil erosion in the county. They are involved in a multi-agency program using computerized mapping technology. This technique is being developed in response to the Soil Erosion Control Law (1982) that required counties to develop erosion control plans.

The approach currently being developed computerizes the complete soil survey of Dane County. Soil attributes, such as slope and erodibility, can be used to "overlay" land cover maps to demonstrate the relationship between crop type and soil slope and thus illustrate soil erosion potential. By using this approach, it is hoped that farmers will recognize how the soil erosion potential of their own operation compares with others. Hopefully, an increased awareness which will bring improved cropland management will be the result.

In the soil conservation field, two approaches are used to control soil erosion. The first is related to management practices and can significantly reduce soil loss at little or no cost. Examples of these soil saving practices include contouring, crop rotation, contour strips, and conservation tillage. One option is to adopt a less intensive cropping system by changing from continuous row crops, which are more susceptible to severe erosion, to crop rotations. An alternative, which can produce similar results, is to adopt some form of conservation tillage on continuous row cropped land.

The second approach to conserving soil is to apply structural practices to the land. Examples are grassed waterways, diversions and terraces. In general, these practices convey runoff to a safe outlet, thereby reducing soil erosion and pollutant loading to streams. Since structural practices require earth moving, the cost is higher than a change in management practices.

Streambank story

Jim Baumann,
Environmental Engineer,
Nonpoint Source and
Land Management Section

Protection and restoration of streambanks is essential for productive fish habitat.

Many anglers say you can tell a great deal about a stream by its shoreline. Banks slumping, eroding or worn raw by cattle grazing are generally signs of a stream in trouble. Sediment from eroding banks may cover the stream bed and destroy productive spawning areas. Overhanging grassy vegetation is of critical importance to fish habitat, providing cover, places for insects to live and shade to keep the water cool. The full potential of a fishery can't be reached without adequate vegetative cover. This makes streambank erosion control a very important component of Wisconsin's Nonpoint Source Water Pollution Abatement Program.

Streambank erosion occurs for a number of reasons. First and foremost is cattle in the stream. They trample soft banks, destroy grassy vegetation and cause overhanging soil to slump into the water. However, cows and fish can coexist in the same watershed, but cows must be kept out of the streams. Streambank fencing, cattle crossings and limited access points for watering work best. These three practices are cost shared at 70% in DNR's priority watershed projects for nonpoint source control.

Fishery improvement through minimizing cattle access has been documented many times. Black Earth Creek in Dane County is a long-term example. During the late 1940s, the stream suffered severe bank erosion. Through extensive volunteer efforts from conservation groups and various sources of financial assistance, substantial fencing, riprap, cattle crossings and upland control measures were installed over the years. Fish habitat has improved to the point where the creek now supports one of the best wild brown trout fisheries in Wisconsin. Vance Creek in the Hay River Priority Watershed Project (Barron and Dunn counties) is a more recent example. The creek, which is 4.3 miles in length, had siltation problems caused by cattle access and poor farming practices. DNR fish managers surveyed the stream's trout population in 1981 about the time 2,100 feet of streambank fencing were installed. Two years later, it was resurveyed. The second survey found a substantial increase (40 to 900%) in the number of adult and fingerling brook and brown trout. This increase was undoubtedly due to both improved trout reproduction in the stream segment and fish migrating from less desirable habitat areas to the improved habitat.

Bank erosion can also be caused by changes in watershed hydrology with urbanization and deforestation two of the most common factors. Both processes reduce infiltration, resulting in increases in stream volume and peak flow which often result in the stream trying to form a different channel. Effects persist for many years and require two relatively expensive control practices: riprap and gabions (streambank stabilizing structures made of rocks stacked in wire cribs). However, these practices are often not very cost-effective unless stormwater runoff from urban and rural lands in the watershed is also properly managed.

A number of improvements have been made in streambank management practices during the last decade. However, as with many other nonpoint source control practices, the majority of the practices are not new. The issue has always been how to get the job done. Much streambank management remains to be done throughout the state. The nonpoint source program's watershed projects provide the means to bring the awareness, technical assistance and dollars together to get the job done.

Animal waste: valuable resource or major pollutant

Jim Baumann,
Environmental Engineer,
Nonpoint Source and
Land Management Section

Manure properly applied to the land is a valuable resource to the farmer. However, improperly managed it is a resource out of place and becomes a pollutant when it enters lakes, streams and groundwater.

Although animal waste has been recognized as a significant pollutant for many years, it has received the majority of its attention only in the last 10 to 15 years. In much of Wisconsin, its significant detrimental effects on lakes, streams and groundwater have made management of animal wastes a major focus of Wisconsin's Nonpoint Source Water Pollution Abatement Program. Between 40 and 45% of the program's financial assistance is spent on improving manure management.

Animal waste adversely affects water quality in the state more than any other nonpoint source pollutant. First, there is a lot of it. An adult milk cow produces 80 or so pounds per day. Second, animal waste is high in nutrients, pathogens and bacteria and in a lake or stream uses dissolved oxygen necessary to support fish.

Nutrients from animal waste have been identified as a major cause of algae growth in many Wisconsin lakes. Bass Lake in Marinette County is a dramatic example of the effect of animal waste on water quality. Fifteen years ago, Bass Lake not only supported bass but also a flourishing lake trout fishery. Today, algae blooms occur under the ice and are so severe they create environmental conditions so lethal to fish that few remain.

Nitrogen in animal waste can cause high nitrate levels in groundwater. This is particularly true in areas of karst topography such as Door and Kewaunee Counties where sinkholes and large crevices in the bedrock can channel surface water directly to the aquifer. The Upper Door Priority Watershed Project will deal with this type of situation.

Both ammonia and the amount of dissolved oxygen animal wastes use, are major concerns in many of Wisconsin's sport fishery streams. For example, in Black Earth Creek, water quality monitoring during runoff periods in spring 1985 showed very high biochemical oxygen demand (BOD) at about the same time brown trout were hatching. High ammonia levels were

found during spring and summer runoff events. Field investigations revealed the sources.

Feedlots and manure spread on fields within 50 feet of the water are sources of runoff of animal waste which enters the stream and its tributaries. Livingston Branch, which is part of the Upper West Branch Pecatonica River Priority Watershed Project is another example of the impacts of animal waste on a stream. Twenty years ago, it supported a substantial smallmouth bass fishery. Today the fishery is almost nonexistent.

Pathogens in animal waste are another concern. They may be transferred to cattle or humans using a lake or stream. Animal waste in runoff from a UW-Madison animal lot has been identified as the source of a disease contracted by a swimmer at a nearby beach on Lake Mendota.

Inadequately controlled animal lots or barnyards, unconfined manure stacks, improperly constructed manure ponds and improper manure spreading are the main sources of animal waste contamination of surface and groundwaters. Although Wisconsin has 75,000 livestock operations, the majority are not significant sources of pollution. Evaluations in priority watershed projects consistently show that 20 to 40% of the operations are responsible for nearly all the animal waste that reaches state waters. The proximity to lakes or streams, closeness to bedrock, type of operation, topography and most importantly, the management of the operation all determine whether a yard, stack or field is a significant source.

Animal waste management in Wisconsin has improved substantially in the last five years. Many farmers have become aware of the problem and voluntarily taken steps to minimize amounts carried away in runoff. Improvements have also been made in methods used to identify significant sources. The barnyard runoff model designed for the state of Minnesota by the research service of the US Department of Agriculture has been brought to Wisconsin and modified by experts in DNR and the Soil Conservation Service. It is now used extensively in all Wisconsin priority watershed projects and by a number of other programs. In addition, design criteria and standards and specifications for management practices such as barnyard runoff filter strips, manure stacking facilities and earthen manure storage basins have been upgraded in the last five years. This has been done in a cooperative effort by DNR, the Soil Conservation Service, the University of Wisconsin and the State Department of Agriculture, Trade and Consumer Protection.

The Wisconsin Legislature has recognized that financial assistance is needed to correct or control many animal waste and other nonpoint sources. Ever since 1978, when the nonpoint source control program was enacted, cost sharing has been available for the construction of barnyard runoff management systems and manure storage facilities in priority watershed projects. Also as part of this program, a substantial number of hours of technical assistance has been provided by county land conservation departments and the Soil Conservation Service.

A well designed barnyard. Manure is stored until time for safe application and liquids drain off into a grassed infiltration area. Photo courtesy of Dane County Land Conservation Committee

Although the nonpoint source control program is voluntary, livestock operators have responded well in all ongoing priority watershed projects. For example, in both the Elk Creek and Hay River projects, signed cost share agreements include barnyard runoff control for about 70% of the animals in yards identified as significant. Unfortunately, operators of a number of very significant animal waste sources have chosen not to participate. Thus the voluntary actions taken by many livestock operators and the potential improvement in water quality have been diminished.

In addition to the priority watershed program, in 1984 the Wisconsin Legislature passed two new programs to control animal waste. First, an animal waste regulatory program (NR 243 of the Wisconsin Administrative Code) was enacted. Second, to complement NR 243 and provide additional financial assistance, the Wisconsin Farmers Fund Program was created.

All of these efforts are having an impact. Although Wisconsin has one of the biggest animal waste problems in the nation, today it is a forerunner in dealing with the problem. While much has been done to improve animal waste management in the last decade, much more remains to be done. Even though Wisconsin has the state and local experts to deal with the problem and a number of programs are in place, more than a decade of hard work lies ahead. Then streams like Black Earth Creek will always be able to support wild trout fisheries, streams like Livingston Branch will again produce smallmouth bass, lakes like Bass Lake will again support viable fisheries and there will be no worry about groundwater in places like Door County.

Wisconsin's nonpoint source timetable

John G. Konrad, Chief, Nonpoint Source and Land Management Section

A 25-year plan to protect critical watersheds.

DNR has developed a 25-year strategy to control nonpoint source pollution in the state's critical watersheds. The strategy, which puts nonpoint source plannning and implementation on a systematic footing, is based on two factors:

1-The need to start and carry out projects as quickly as possible to minimize irreversible degradation of state lakes and streams.

2-The recognition that county staffing levels limit the rate at which projects can be started as well as whether a county can handle more than one project at a time.

Given these two divergent factors, a 25-year timetable appears realistic. A substantially shorter period is impractical without major increases in county staff. On the other hand, increasing the time period increases the potential for irreversible harm to state waters. A recent review which identified the magnitude of the problem in Wisconsin indicated that the 25-year goal is feasible and should be pursued. This strategy was first proposed in a 1982 program report to the governor and legislature.

Of the state's 330 watersheds, 130 will likely require comprehensive management to control nonpoint source pollution—29 have been selected as priority watershed projects and are in some phase of either planning or implementation. Right now, the program is slightly behind the schedule proposed in 1982. To meet the 25-year goal, the number of projects started will have to increase from the current four or five annually to eight or nine by the end of this decade. Thus, continued support from the legislature, county government, landowners and farm operators will be necessary in order to achieve the desired levels of nonpoint source control by the year 2005, as proposed in the 1982 report.

Wisconsin watersheds which will require comprehensive nonpoint source management by 2005

(Priority watershed projects listed with year of selection.)

West Central Region
- Bear and Fall Creeks*
- Beaver Creek and Lake Marinuka—1984
- Black River (lower portion)—1981
- Buffalo River (lower portion)
- Eau Claire River (lower portion)—1983
- Eau Galle River
- Elk Creek—1979
- Little La Crosse River
- Pigeon Creek
- Trempealeau River (middle portion)*
- Waumandee Creek—1985
- Wilson Creek

Southwest Region
- Black Earth Creek—1985
- Blue River
- Crossman Creek and Little Baraboo River—1983
- Galena River—1979
- Gordon Creek
- Grant River (upper portion)
- Grant River (middle portion)*
- Grant River (lower portion)*
- Green River and Crooked Creek
- Honey and Richland Creeks
- Jordan and Skinner Creeks
- Kickapoo River (middle portion)*
- Knapp River
- Little Platte River
- Mill and Blue Mounds Creeks
- Mill and Indian Creeks
- Narrows Creek and Baraboo River (lower portion)*
- Otter and Morrey Creeks
- Pecatonica River (upper portion of west branch)—1981
- Pecatonica River (upper portion of east branch)
- Pecatonica River (lower portion of east branch)*
- Pecatonica River (middle portion)
- Pecatonica River (lower portion)
- Pine Creek (upper portion)
- Platte River
- Reeds and Tainter Creeks
- Rocky Run Creek
- Sandy Creek and Mississippi River
- Seymour Creek and Baraboo River (upper portion)
- Sudan Branch Creek
- Willow Creek
- Yellowstone River*

Southeast Region
- Barnes and Pike Creeks
- Des Plaines River
- Fox River (upper portion)*
- Fox River (middle portion)
- Fox River (lower portion)
- Kinnickinnic River
- Lake Geneva and Fox River
- Menomonee River—1984
- Milwaukee River (south portion)—1984
- Mukwonago and Lauderdale Lakes
- Oak Creek
- Pike River
- Root River—1979
- Wind Point

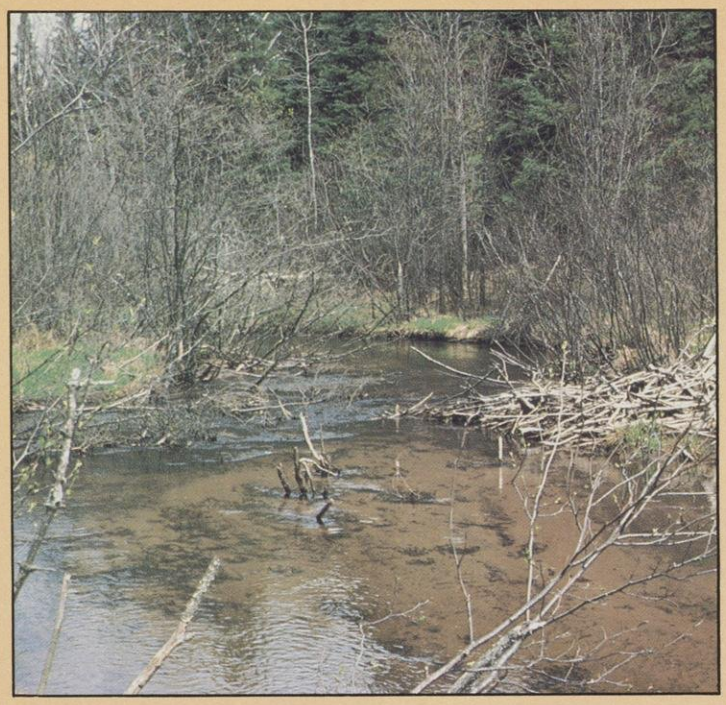
South Central Region
- Allen Creek and Sugar River (middle portion)
- Ashippun River
- Bark River
- Bass Creek
- Beaver Dam River
- Calamus Creek
- Crawfish River (upper portion)*
- Crawfish River (lower portion)
- Koshkonong Creek (upper portion)
- Koshkonong Creek (lower portion)
- Little Sugar River
- Marsh Creek
- Maunesha River
- Oconomowoc River—1983
- Rock River (east branch)
- Rock River (upper portion)
- Rock River (upper middle portion)
- Rock River (middle portion)
- Rubicon River
- Scuppernong River
- Sixmile and Pheasant Branch Creeks—1980
- Sugar River (west branch) and Mount Vernon Creek
- Sugar River (lower middle portion)
- Sugar River (lower portion)
- Turtle Creek—1982
- Whitewater Creek
- Yahara River and Lake Kegonsa
- Yahara River and Lake Mendota
- Yahara River and Lake Monona*

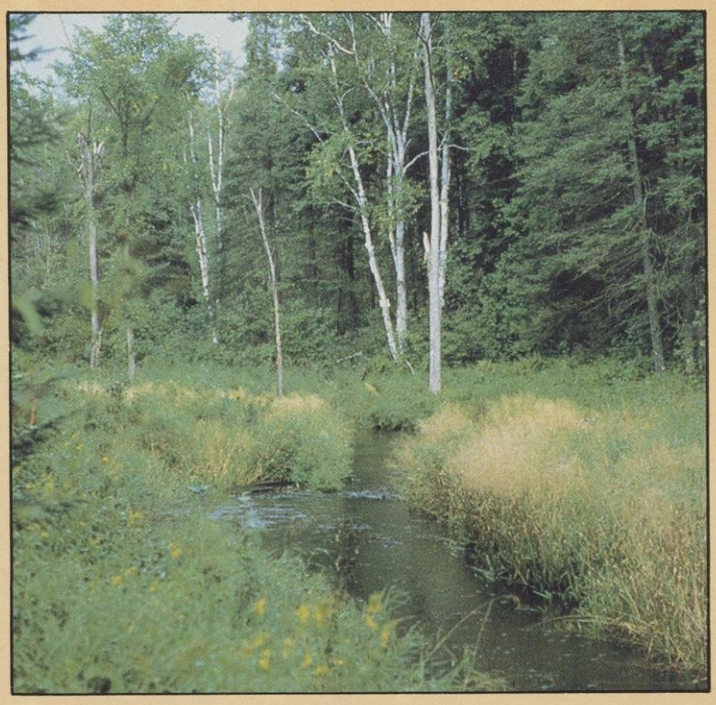
Northwest Region
- Apple River (upper portion)
- Apple River (lower portion)
- Balsam Branch Creek
- Beaver Brook
- Hay River—1979
- Willow River (upper portion)—1980
- Willow River (lower portion)
- Wolf Creek
- Yellow River*

East Central Region
- Apple and Ashwaubenon Creeks
- Big Green Lake—1980
- Black River
- Branch River*
- Cedar Creek—1984
- Door County (upper portion)—1984
- East River*
- East Twin River
- Fond du Lac River
- Kewaunee River—1982
- Lake Winnebago (north and west portions)
- Lake Winnebago (east portion)
- Little River—1983
- Manitowoc River (south branch)
- Manitowoc River (lower portion)—1979
- Milwaukee River (north branch)—1984
- Milwaukee River (east and west branches)—1984
- Mullet River
- Oconto River (lower portion)
- Onion River—1980
- Pigeon River
- Plum Creek
- Red River and Little Sturgeon Bay
- Sauk and Sucker Creeks
- Sevenmile and Silver Creeks—1984
- Shawano Lake*
- Sheboygan River—1985
- Spring Brook and Lake Butte des Morts*
- Swan Lake
- Sturgeon Bay (south portion) and Stoney Creek
- West Twin River

North Central Region
- Big Eau Pleine River (upper portion)—1984
- Little Wolf River (lower portion)*
- Pigeon River

*Included on list of eligible watersheds recommended by the State Nonpoint Source Coordinating Committee in 1982 and 1985.





Stable streambanks provide habitats for fish and other aquatic organisms as well as provide a more pleasing view. Here the same streambank before treatment and one year after treatment.
Photo by Larry Claggett

"The economic, environmental and recreational fates of water are intricately linked."

As an integrated natural resource agency combining resource management and environmental protection, the Wisconsin DNR has been able to view Wisconsin's environment in a holistic way. This means we recognize and emphasize that the whole of our environment is greater in value than the sum of its parts, such as water, air, fish, wildlife, forests and so on down the list. This approach also recognizes the interdependence of its parts. I believe strongly that this "big picture" approach is the only way to assure protection of our water, our land and of those who inhabit both realms.

Everything we have been able to accomplish in our water pollution control programs has been made possible because historically the people of Wisconsin have recognized water as a significant economic asset that can be enhanced and developed for more than recreation. The economic, environmental and recreational fates of water are intricately linked.

Today, Wisconsin is a national leader in nonpoint source control just as it has been in point source control. We have achieved this status not only because of financial and institutional commitments but also because of our interdisciplinary attack on the nonpoint source control problem. Wisconsin's nonpoint source control program has cleared both intergovernmental and interpersonal hurdles. Priority watersheds have been identified and a comprehensive management strategy implemented.

Two important elements make Wisconsin's nonpoint source program a model for national attention: it recognizes the individual responsibility of the landowner to be a respectful steward of the land, and it provides financial assistance to private property owners so society can share in protecting a public resource. Both are strong incentives for voluntary participation.

Many landowners and operators realize that short-term gains or expediency can lead to long-term disaster. Wisconsin has an opportunity to help avoid that disaster. As you read this report, I hope you gain the knowledge and conviction that nonpoint source pollution control is a long-term challenge reaching far beyond improving the aesthetics of our natural environment. It is a challenge that addresses the very ability of humankind to sustain itself through the wise protection and management of its life-giving soil and water.

C. D. "Buzz" Besadny,
Secretary,
Wisconsin Department of Natural Resources