

MINNESOTA
NONPOINT SOURCE POLLUTION
ASSESSMENT REPORT

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Prepared by the



Minnesota Pollution Control Agency

Division of Water Quality

Preface

This document represents the second generation of assessment and planning for abatement of the nonpoint source pollution problem in Minnesota. As such, it builds upon and replaces the 1980 Water Quality Management Plan (208 Plan). This document, presented in two parts; 1) the Assessment Report and 2) the Management Program, was prepared by the State of Minnesota pursuant to Nonpoint Source Guidance published December 1987 by U.S. Environmental Protection Agency and United States Code, title 33, section 1329.

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I. INTRODUCTION

RECOGNIZING NONPOINT SOURCE POLLUTION

In Minnesota, it is well known that nonpoint sources of pollution degrade water quality. In fact, water quality monitoring of rivers has shown that the majority of impaired uses are the result of nonpoint sources or a combination of point and nonpoint sources. The need for effective programs to control nonpoint sources of pollution is clear if Minnesota is to achieve its water quality goal of maintaining the chemical, physical and biological integrity of the State's waters. The Minnesota Pollution Control Agency (MPCA) has followed an extensive process of development in working towards this goal. This same process also assists the State in meeting the requirements for Section 319 of the 1987 Clean Water Act.

In 1967, the Minnesota Legislature established the Minnesota Pollution Control Agency, "To meet the variety and complexity of problems relating to water, air and land pollution in areas of the state affected thereby, and to achieve a reasonable degree of purity of water, air and land resources of the state consistent with the maximum enjoyment and uses . . ." Minnesota Statutes Chapter 116. In conjunction with the State's effort, a major national effort to combat water pollution began with the passage of the federal Clean Water Act of 1972. The basic goal of the Clean Water Act was to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." This is a goal the State of Minnesota is committed to achieving and maintaining. This legislation created a variety of programs to study and regulate sources of water pollution. Most of the responsibility for carrying out these programs was assigned to state governments, under supervision of the federal Environmental Protection Agency (EPA).

Since passage of the legislation, MPCA and EPA have concentrated their water cleanup efforts on so called "point sources" of pollution: discharges of wastewater, usually via pipes, from municipal sewage systems and from industrial or commercial operations. In the mid-1970s, however, the Minnesota Pollution Control Agency (MPCA), in cooperation with state and federal agencies and local officials, initiated the Water Quality Management Planning effort required under Section 208 of the Clean Water Act. The purpose of the planning effort was to identify significant water quality problems due to nonpoint sources of water pollution and set forth effective programs to correct those problems.

A number of significant developments have occurred and impacted the original intent of the 1980 Minnesota Water Quality Management Plan. Fiscal, administrative and legislative constraints limited its implementation. Recognizing the seriousness of the nonpoint source (NPS) pollution problem, the Energy/Environment/Resources subcabinet approved the charge to the NPS Issues Team, "to develop recommendations for a state and local program to protect and improve the water quality of Minnesota's lakes, rivers and ground water through control of nonpoint sources of pollution." To accomplish this charge, the NPS Issues Team brought many of the agencies with responsibility and authorities for addressing the problem together to review past state and federal program recommendations, including the 1980 Water Quality Management Plan (208), current programs and activities, and provide current recommendations for a comprehensive program to solve water quality problems resulting from nonpoint source pollution.

The NPS Issues Team recommended a comprehensive water quality program be implemented through a variety of existing programs and a new program, the Clean Water Partnership (CWP) be established to protect and improve surface and ground water quality in Minnesota by providing state financial and technical assistance to local units of government. In 1987, the Clean Water Partnership was established by the Minnesota Legislature (Minnesota Statutes Sections 115.091 to 115.103).

Many of the activities, resources and accomplishments of the 208 planning process, the interagency NPS Issues Team, and the Clean Water Partnership provided the basis for Minnesota's NPS assessment for Section 319 of the 1987 Clean Water Act. This includes advisory assistance provided by the project Coordination Team, an advisory group made up of seventeen federal, state, and local agencies established for the Clean Water Partnership Program and a definition of nonpoint source.

Defining nonpoint source is, itself, a difficult problem because of the complex nature of the nonpoint source issue. For activities related to Section 319 of the 1987 Clean Water Act, a nonpoint source is defined as "a land management activity or land use activity that contributes or may contribute to ground and surface water pollution as a result of runoff, seepage or percolation and that is not defined as a point source in section 115.01, subdivision 15. Nonpoint sources include, but are not limited to rural and urban land management activities and land use activities and specialty land use activities such as transportation." (Section 115.093, Subdivision 6.) As a practical measure for Section 319, Minnesota considers:

- agricultural runoff,
- animal feedlots,
- pesticide and fertilizer application,
- urban runoff/infiltration,
- construction,
- on-site sewage systems,
- hydrologic modifications,
- forestry,
- mining runoff,
- highway runoff, and
- special erosion problems

as nonpoint source, but excludes in-place pollutants and atmospheric acid deposition for which programs already exist.

In addition to the information provided by the above activities, the Minnesota NPS assessment requires specific information available from local resource management groups. This specific information was sought and obtained through a series of public participation meetings conducted as part of the development of Minnesota's Ground Water Protection Strategy and through a survey of over 350 local resource management groups.

Through the state's nonpoint source management efforts and participation by local resource management groups, Minnesota has assessed its water resources for known nonpoint source problems.

NATURE OF THE PROBLEM

Nonpoint sources of water pollution are the major reason that a number of Minnesota surface and ground waters are not clean enough to support desired uses, ranging from drinking water to fishing. This pollution is a result of many land use activities. Soil erosion has long been recognized as a visible problem resulting from intensive land use. In addition to sediment, nutrients, pesticides, bacteria, toxic chemicals and other pollutants are carried from urban and rural areas into surface and ground water. The ground water aspect of nonpoint source pollution is a relatively new consideration.

Table 1 describes the potential water quality impacts of several nonpoint pollutants. Additional information related to the nature of the pollution problems follows the table.

TABLE 1 NONPOINT SOURCE WATER QUALITY IMPACTS

Pollutant	Origins	Impacts on Water Quality and Associated Users
Sediment	Agriculture	<ul style="list-style-type: none"> o Decrease in transmission of light through water. <ul style="list-style-type: none"> - Decrease in primary productivity (aquatic plants and phytoplankton) upon which other species feed, causing decrease in food supply. - Obscures sources of food, habitat, hiding places, nesting sites; also interferes with mating activities that rely on sight and delays reproduction timing. o Directly affects respiration and digestion of aquatic species (e.g., gill abrasion). o Decreases viability of aquatic life. Decreases survival rates of fish eggs; affects species composition. o Decreases the life of wetlands, lakes and riverine backwaters. o Increases temperature of surface layer of water--increases stratification and reduces oxygen-mixing with lower layers, therefore decreasing oxygen supply for supporting aquatic life. o Decreases value for recreational and commercial activities. <ul style="list-style-type: none"> - Reduces aesthetic value. - Reduces sport and commercial fish populations. - Decreases boating and swimming activities. - Interferes with navigation. o Increases drinking water costs.
	Urban Runoff	
Toxic Chemicals	Construction	<ul style="list-style-type: none"> o Hinders photosynthesis in aquatic plants. o Sublethal effects lower organism's resistance and increase susceptibility to other environmental stresses. o Can affect reproduction, respiration, growth and development, reduce food supply and be fatal to life. o Some toxic chemicals can bioaccumulate in tissues of fish and other species. o Some pesticides are mutagenic and carcinogenic or teratogenic to aquatic life. o Reduces commercial/sport fishing and other recreational values. o Creates health hazard from human consumption of contaminated fish/water.
	Mining	
	Forestry	

TABLE 1 (Continued)

Pollutant	Origins	Impacts on Water Quality and Associated Uses
Nutrients (Phosphorus, Nitrogen)	Agriculture	o Promotes accelerated aging of lakes.
	Animal Feedlots	- Algal blooms and decay of organic materials create turbid conditions that eliminate submerged aquatic vegetation and destroy habitat and food for aquatic animals and waterfowl.
	Urban Runoff	- Blooms of toxic algae can affect health of swimmers and aesthetic qualities of waterbodies (odor and murkiness).
	Construction	- Blooms of toxic algae can cause illness and death in animals and livestock that drink water.
	Forestry	- Favors survival of less desirable fish species.
	On-Site Sewage Systems	- Interferes with boating and fishing.
		- Reduced dissolved-oxygen levels can suffocate fish.
		- Reduces waterfront property values.
		o Degradation of ground water quality.
		- Reduces quality of drinking water supplies.
		- NO ₃ (nitrates) can cause infant health problems.
Bacteria	Agriculture	o Introduces pathogens (disease-bearing organisms) to surface and ground waters.
	Animal Feedlots	
	Urban Runoffs	o Reduces recreational uses.
	On-site Sewage Systems	o Increases treatment costs for drinking water.
		o Creates a human health hazard.

Agricultural Runoff

Sediment, nutrients, oxygen-consuming substances and microbiological contaminants are pollutants from agricultural land use.

By volume, sediment is the pollutant entering Minnesota's waters in the greatest quantity. Cropland erosion is the major source of sediment. According to the 1982 National Resources Inventory, prepared by USDA Soil Conservation Service, approximately 153 million tons of soil are eroded each year in Minnesota as a result of wind and water. One hundred and forty-eight million tons or 96% of this erosion occurs on Minnesota's cropland, even though the state's 23 million acres of cropland represents only 43% of the state's rural land. Twelve million eight hundred thousand acres of cropland are in serious need of erosion control.

While much of the resultant sediment is deposited close to its point of origin, a significant amount enters the waters of the state contributing to their degradation. Water quality data from monitored waters in the major farming areas of the state show that levels of sediment frequently are high enough to cause serious water quality problems and frequently exceed the criteria indicative of good conditions for aquatic life. These areas include the Minnesota, Missouri-Des Moines, Cedar and portions of the Red and Mississippi River basins. In these watersheds the sediment levels markedly exceed those of non-farming watersheds. This sediment also transports appreciable quantities of phosphorus and some pesticides.

Phosphorus impacts on lakes and lake eutrophication are a major water quality concern in Minnesota. Essentially all monitored lakes in predominately agricultural basins of Minnesota are in a eutrophic condition, characterized by excessive algae and/or weed growth. While agricultural practices are not the only cause of the eutrophic conditions of many of the state's lakes, reducing phosphorus in runoff from farming can be a means of protecting lakes from degradation.

Improper manure storage and handling, improper manure/commercial fertilizer management can contribute to surface water pollution by ammonia, oxygen-consuming organic materials or microbiological contamination and lead to ground water pollution by nitrates or bacteria, particularly in southwestern Minnesota and the Karst areas of southeastern Minnesota.

Water quality data show that microbiological contamination, measured by fecal coliform counts, frequently exceed state standards in the areas of the state devoted to agriculture. There is some threat to ground water as well, especially in the Karst areas of southeast Minnesota.

Direct access of livestock to streams and lakes cause serious surface water problems from ammonia, oxygen-consuming organic materials or microbiological contamination from animal wastes. Livestock also trample banks and vegetation, causing streambank erosion and stir-up bottom sediment, destroying stream vegetation and fish habitat.

To date, the emphasis of research and erosion control programs has focused on limiting soil losses to "tolerable" levels for maintaining soil productivity.

To achieve water quality goals, emphasis must also be placed on the cost of water quality damages of agricultural runoff.

The adoption of water quality and soil erosion management practices by individual land managers is the key to solving water quality and soil erosion problems. Dr. Peter J. Nowak, Associate Professor, University of Wisconsin, has made the following generalizations from research on land manager attitudes toward adoption of conservation practices.

- a. Land managers often fail to accurately identify resource problems and fail to recognize the consequences of their management practices on natural resources.
- b. There is confusion about the roles and responsibilities of the different agencies responsible for resource management.
- c. Land managers often base decisions on management practices on inaccurate beliefs, including inaccurate economic information, perceived problems and the requirements associated with receiving technical and financial assistance.

Controlling the agricultural runoff problem requires targeting scarce resources to get maximum water quality protection. Such targeting efforts must use state of the art techniques rather than simple geographical distributions. It will also require that information and education programs become a priority and be designed to address the barriers to land managers adoption of management practices, identified above. Finally, a strong delivery system which is accepted by the agricultural community is necessary to provide direct assistance to farmers and other land managers.

Animal Feedlots

Pollution from feedlots occurs when surface water runoff from a feedlot carries pollutants from the accumulated animal manure into ground and surface water.

The pollutants include:

Phosphorus and nitrogen compounds which may cause a variety of problems. Phosphorus accelerates the enrichment of lakes and eutrophication. Animal manure and feedlot runoff can be a major source of phosphorus. Untreated municipal sewage typically has a phosphorus content around 8 milligrams per liter, while feedlot runoff is 85 milligrams per liter. Cattle or hog manure may be 2,500 milligrams per liter and is a serious pollutant source. Nitrogen compounds, such as ammonia, which can be toxic to aquatic life, and nitrate, which can cause methemoglobinemia in human infants, are concerns, especially in ground water.

Organic compounds are serious pollutants because they cause a depletion of oxygen in water. This depletion of oxygen can cause fish kills and odors. Untreated municipal sewage typically has an oxygen demand (BOD) around 250 milligrams per liter, compared to feedlot runoff which is 4,500 milligrams per liter and cattle or hog manure which may be 50,000 milligrams per liter.

Microorganisms, some of which are pathogenic and cause disease in humans as well as other animals.

The potential for pollution from animal manure and feedlot runoff can be clearly seen by the strength of the waste. In addition, the number of feedlots increases the potential for problems. The 1980 208 Plan estimated that there were as many as 90,000 feedlots in Minnesota; of these 9,000 to 14,000 were located in shoreland areas and considered to be pollution hazards. Using 1984 agricultural statistics, we can infer that there are probably between 70,000 and 80,000 feedlots in Minnesota today, with a slightly smaller proportion causing pollution problems. Although the trend has been toward fewer feedlots, they tend to be larger, more concentrated operations.

During 1977 and 1978, forty Soil and Water Conservation Districts were contracted to undertake a feedlot survey aimed at quantifying the number and pollution potential of feedlots in shoreland areas. Ninety five percent of the 5,100 feedlots surveyed in shoreland areas were determined to be "potential pollution hazards". The study concluded that the seriousness of a feedlot's threat to water quality depends upon the operator's current management practices, the characteristics of the receiving water, and the physical setting of the feedlot. Certain areas of the state are more subject to water quality degradation than others, especially the Karst area in southeastern Minnesota. Many counties were identified as having surface waters highly subject to degradation as a result of phosphorus enrichment in deeper lakes and excessive BOD loadings.

Pesticides and Fertilizers

The use of pesticides and fertilizers in Minnesota can result in the pollution of surface and ground water. This is a significant water quality concern and can be a serious health risk. Regional ground water aquifers cannot be realistically decontaminated and the long term health effects from continued low level exposure are unknown. Therefore, the implications of contaminated ground water are potentially expensive and serious.

Pesticides

Pesticides are a wide range of chemical substances intended to prevent, destroy or repel organisms harmful to man or his activities, and include herbicides, insecticides, fungicides, nematicides and rodenticides, as well as substances targeted to other organisms. There are approximately 7500 such products registered for use in Minnesota. These chemicals have a wide variety of chemical and physical characteristics and, therefore, their toxicity and environmental impacts vary considerably. Regulation of pesticide sale, storage, transportation, use, and disposal is a responsibility of the Minnesota Department of Agriculture (MDA). Enforcement is achieved through the implementation and administration of the Minnesota Pesticide Control Law and the Federal Insecticide, Fungicide and Rodenticide Act. As part of that responsibility, the MDA collects a registration fee for each product registered for sale in Minnesota.

Usage of pesticides in Minnesota is widespread, but largely unquantified. Federal and state laws require accounting of only 'Restricted Use' pesticides. 'General Use' pesticides, including those in urban use, are not tracked.

- Agriculture accounts for the greatest usage of pesticides. Herbicides account for 90% of agricultural pesticide use. In 1984, it is estimated that 23,237,000 acres of agricultural land in Minnesota were treated for weed control by both aerial and ground application methods. Minnesota farmers used pesticides at least once on over 96% of their corn, soybean and sugar beet acreage for harvest in 1984. An estimated 89% of the wheat acreage was treated, 88% of the sunflowers, 80% of the flax and 60% of other small grains.

Eighty-five percent of the herbicides used in Minnesota are self applied and 15 percent are commercially applied. It was estimated from the 1984 Agricultural Statistics Survey that 39,674,000 pounds of active pesticide ingredients are used in Minnesota annually.

- Urban usage of pesticides presents special concerns because of the large number of people in close proximity to the areas of application and the large number of untrained homeowner applicators. The total amounts of commonly used products has not been quantified for urban areas.
- Aquatic nuisance control through use of pesticides is an activity regulated by the Minnesota Department of Natural Resources (MDNR).

In the years 1982, 1983, and 1984, the MDNR issued permits for pesticide application to approximately 65,334, 70,267, 46,760 acres of water respectively for vegetation, algae, snails, leeches and swimmers itch control. Although undocumented, there appears to be a significant amount of unpermitted use.

- Forestry usage of herbicides are part of the management of commercially harvested forests. The applications are primarily during early growth stages, perhaps twice in the 60-120 year life of a forest. Only about 27,390 acres of the approximately 13,695,000 acres of commercial forest receive pesticide application each year.

In recent years, pesticides have been detected in ground water/drinking water in many areas of the nation. These findings, coupled with Minnesota's extensive pesticide usage and widespread dependence on ground water as a source of drinking water, have given rise to increasing public health and water quality concerns. At present, there is very limited information on the fate of pesticides in the environment and ground water/drinking water in Minnesota. Past monitoring efforts have generally been limited to emergency responses, special studies of limited scope and to public surface water supply monitoring for Safe Drinking Water Act pesticide parameters. These findings do not adequately describe the nature or extent of pesticide-related ground water/drinking water contamination in the state.

Pesticides may contaminate ground water from improper application, disposal of incompletely rinsed containers, and runoff or seepage from storage, mixing, loading or spray tank cleaning areas. Recently, there has been increasing concern about movement of pesticides through the soil into ground water when pesticides are applied to fields under normal farming practices.

Pesticides can be transported to surface water by application of chemicals; drift from spray; erosion of pesticide treated soil; disposal of incompletely

rinsed containers; and runoff from storage, mixing, loading or spray tank cleaning areas.

In addition to the lack of historic, comprehensive, systematically-gathered pesticide monitoring data, the following other factors make definition of the nature and magnitude of pesticide-related water quality problems and public health risks difficult to describe:

- a. Physical and chemical mechanisms influencing pesticide movement and fate in soils and ground water are complex and not completely understood;
- b. Pesticides found in water from indirect sources of contamination (i.e. normal farming practices) are usually observed in trace amounts. The presence of low levels of pesticides is significant but the public health/environmental implications are not always clear;
- c. Except for 2,4-D, water quality/drinking water standards have not been established for the most commonly used pesticides in Minnesota;
- d. Laboratory capabilities for detection and verification of potentially significant trace amounts of pesticides are improving but still limited, and analytical costs are high.

Fertilizer

The three primary plant nutrients applied to crops are nitrogen, phosphate and potassium. For the year ending June 1984, Minnesota consumption of primary plant nutrients in fertilizer totaled 1.65 million tons. Past attention addressed phosphorus runoff to lakes and its associated eutrophication.

Serious and occasionally fatal blood disorders (commonly called "blue baby syndrome" or methemoglobinemia) have occurred in infants less than 6 months of age following ingestion of well waters containing nitrate at concentrations greater than 10 milligrams per liter as nitrate-N. As a result, a maximum contaminant level of 10 milligrams per liter as nitrate-N has been established for nitrate in public drinking water supplies. The same number is a recommended action level for private suppliers.

High nitrate levels in ground water have usually been associated with septic tank/drainfields or feedlots. Historically, nitrogen has been applied for crop production purposes at rates to achieve maximum net economic return. Some studies have pointed to fertilizer and manure nitrogen as sources of elevated nitrate concentrations in rural ground water supplies.

Urban Runoff/Infiltration and Construction

Urban Runoff/Infiltration

Urban runoff pollution is caused by rain and snowmelt runoff picking up pollutants from an urban area. In some cases snowmelt or storm water runoff

carries a pollutant load equal to or exceeding sanitary sewage. Five factors which influence the generation of runoff, the rate at which it flows, and the pollutant load are: precipitation, antecedent conditions, the percentage of impervious surface area, soil characteristics, and topography. Other activities in urban areas affecting the quality of runoff/infiltration include: traffic density; littering; fertilizer and pesticide use; atmospheric deposition; construction; animal wastes; landfills/dumps; surface impoundments; on-site sewage disposal; municipal/industrial sludge disposal; hazardous material/waste/spillage or leakage during generation, handling, storage and transportation; hazardous material/waste disposal; unauthorized waste disposal; salt application/storage, etc.

The pollutants present in urban runoff and infiltration impact both surface and ground water quality. The general impacts they have on water quality if deposited in excessive quantities include:

- Toxics: Heavy metals and many complex organic compounds are toxics to both humans and aquatic life. These compounds can also accumulate in bottom materials and in fish tissue where they may produce other chronic effects. The same substances may infiltrate and contaminate ground water/drinking water.
- Nutrients: High phosphorus levels can lead to excessive plant growth and poor water conditions. Some nitrogen compounds, such as ammonia, which is very toxic, and nitrate which may lead to fatal conditions in infants, are also very harmful nutrients.
- Bacteria: Fecal coliforms are present in animal wastes and may indicate the presence of other organisms harmful to humans.
- Suspended Solids: High levels of suspended solids contribute to turbid conditions, which retards plant growth and limits the use of waters by humans for recreation and consumption. Suspended solids may also smother habitat critical to aquatic life and carry other absorbed pollutants.
- Oxygen-Consuming Materials: Adequate oxygen levels are essential to maintaining healthy aquatic systems. Wastes that are biologically or chemically active can deplete oxygen to very low levels.

Construction

Construction activities contribute significantly to water pollution by erosion, sedimentation and harmful materials that are moved from the construction site and enter water bodies by way of runoff. Housing, industry, commerce, recreation and transportation are the major categories of land use that involve new construction.

Construction activities can have an impact on water quality in three ways. First, disturbance of the natural land cover accelerates the process of erosion, which results in an increase in sediment pollution of water. The second potential area of water quality impact is caused by substances used on the construction site. These substances are carried away by runoff or adsorbed onto sediment which washes into surface waters. Examples are construction chemicals (paints, glues, preservatives, acid, cleaning solutions and solvents) oils,

greases, petroleum products or residues of construction activities. The third type of potential water quality impact is the long term erosion problem caused by the inability of the completed development to adequately convey storm water runoff through or from the site. This may be caused by inadequate drainage design or the lack of water quality management practices.

Vegetation, climate, soils, and topography all interact in a complex way to make each site unique in its potential to generate pollutants. Soil erosion rates during the active construction phases of urban developments are often many times greater than on farmlands. Typical annual soil losses on croplands range from 3 to 10 tons per acre, while losses from construction sites may range from 30 to 750 tons per acre. The extremely high erosion rates usually occur on limited areas where surface runoff becomes concentrated.

Sediment lowers water quality for municipal, industrial and recreational uses and reduces the storage capacity of lakes and reservoirs. Sediment can pose serious health hazards by carrying potentially toxic substances such as petroleum products, pesticides and heavy metals to our water supplies. Sediments and toxic materials not only destroy fish and wildlife habitats, but also reduce values of streams and lakes which in turn reduce the value of adjacent property, especially in residential areas. Taxpayers and downstream property owners pay for the carelessness of construction site practices when sediment fills ditches, storm sewers and culverts, which must be cleaned at great expense. In addition, the loss of soil from the site causes increased costs of service roads, loss of fill material, and need to replace topsoil, which increases development cost and delays project completion.

Water quality damages and associated costs are needless and wasteful since practical and effective management practices can be used to avoid them.

On-Site Sewage Systems

Currently, 28% of Minnesota households use on-site sewage treatment or disposal systems. This includes over 230 Minnesota municipalities and numerous developed lakeshore and suburban areas without municipal sewer systems. Many of the homes in these areas have holding tanks, individual sewage treatment systems, or use some other means of sewage disposal. For example, it has recently been estimated that many small, unsewered communities dispose of untreated sewage through local agricultural drainage systems. In some parts of the State, as many as 75 percent of the residences dispose of sewage in this way. One county even assesses homeowners for connection to agricultural drainage systems. The full extent of this problem has not yet been documented. In addition, many seasonal homes are being converted to permanent residences without consideration of the capabilities of their existing sewage handling system.

Holding tanks simply hold domestic wastes and must be pumped regularly. Individual sewage treatment systems, commonly referred to as septic systems, function by the natural decomposition of wastes on the site where they originate. Properly designed, sited, and operated, these systems will have a life span of 20 to 50 years. Improper design, siting and operation or the improper disposal of wastes removed from septic systems or holding tanks can lead to the contamination of the ground and surface water, threatening the public health and the quality of Minnesota's water resources. Individual sewage

treatment systems are the source of many waterborne disease outbreaks cited by public health officials.

Septic systems are relatively simple, consisting of two components, an underground septic storage tank and drainfields. Wastewater first flows to the storage tank where it separates into solids and liquids. Bacteria decompose the solids in the tank creating a sludge that settles to the bottom or forms a scum and floats on the surface. The liquid portion flows from the tank to the drain field where it undergoes treatment by filtering and biological decomposition. Properly functioning septic systems rely on some dilution in the ground water. In improperly functioning systems, sludge may build up and untreated wastes may flow to the drain field and clog the soil pores. This results in the failure of the entire system. If the drain field is undersized or too close to the water table or if the soil is too coarse, there may be little or no attenuation of the contaminants in the liquid.

Both septic systems and holding tanks must be periodically pumped or cleaned to remove solids and other materials. The solids from septic systems have undergone some treatment and can be disposed of by proper land spreading. Care must be taken to prevent excessive loading of the land and the spread of disease. Wastes from holding tanks generally have not undergone extensive breakdown and additional treatment may be required for proper disposal of these materials.

Even systems that are properly designed and pumped at recommended intervals can cause water quality problems if homeowners place materials down the drains that kill the organisms providing biological decomposition of the wastes in the septic tank or the soils beneath the drain field. These materials include paints, solvents and cleaning agents, pesticides, and some so-called septic tank cleaners. Besides damaging the system, the materials themselves are potential ground water contaminants and may affect drinking water supplies.

Nitrate contamination of the ground water will occur even with a properly functioning system. In isolated areas nitrates from on-site sewage systems can generally be assimilated by the aquifer and will not exceed acceptable levels, i.e. the drinking water standard. There are, however, certain factors and combinations of factors that can easily result in nitrate contamination of local shallow wells beyond levels that are considered safe for human consumption. These factors include soil type, hydrogeologic setting, hydraulic gradient and development density. Development density is particularly important because of the cumulative addition of nitrate loading to a unit area.

On-site sewage systems may also be responsible for the addition of other nutrients to the ground or surface water. Along heavily developed lakeshore areas these nutrients may enter the lake via ground water discharge, surface breakout, and septic tank leakage. Once in the lake the nutrients can degrade lake quality through accelerated eutrophication.

Hydrologic Modification

Wetlands

Wetlands protect water quality by reducing peak runoff and trapping sediment and nutrients. They also provide islands of aesthetic diversity in landscapes that

may otherwise be dominated by uniform land use, such as row crops or urban development. Wetlands also are recognized for their importance in providing vital habitat for fish and wildlife.

Most of these beneficial aspects of wetlands have gone unquantified for two reasons: a) they are difficult to evaluate in terms of dollars and cents; and b) they are often cumulative, that is, the destruction of an individual wetland may appear inconsequential unless considered along with other similar actions.

Public benefits are often diffuse and harder to define than the direct economic benefit realized by an individual converting a marsh or wetland into agricultural and or a building site. Therefore, the public benefit of wetland preservation often is lost. As a result, wetland losses between 1964-1974 revealed destruction of approximately 40% of the potholes in certain counties in western Minnesota.

Between 1974-1979, approximately 860 basins in several western Minnesota counties were drained (over 16% of all existing water basins in those areas). Despite continued efforts at improvement in the existing regulatory program over the last several years, a significant number of isolated wetlands, especially prairie potholes, peatlands, and type 1, 2, 6, 7 and 8 wetlands remain unregulated.

At the present time there are inconsistencies in the Minnesota statutes (106, 105 and 116) and programs and policies related to wetlands.

Drainage Activities

Modernization of the state drainage code is in order. The recent modification of Minnesota Statutes, Chapter 106 did much to make the Drainage Code easier to understand. However, the changes did not address the environmental concerns. The Minnesota Legislature has gone on record to include environmental concerns in drainage proceedings, but these have been largely ineffective. The process, as it currently exists, has raised questions dealing with equitable assessments; equitable representation at proceedings; determination of damages and benefits; wetland destruction and preservation; environmental concerns like those of flooding, water quality, erosion, sedimentation, land conversion and ground water recharge; and accountability for overseeing system facilities and performance of annual inspections. These issues have been raised above and beyond the question of consistency with environmental procedures and policies of the state.

Dredge and Fill

Dredge and fill activities affect both water quality and the overall aquatic environment. The traditional pollutants of concern, to water quality include suspended solids which may have associated chemicals. These chemicals may have potential for bioaccumulation and other toxic effects. The most prevalent impacts of dredge and fill activities are physical disruption of waters and wetlands and potential effects of resuspended polluted sediment in aquatic ecosystems. These activities can be grouped into two classifications: (1) maintenance, and 2) new dredge and fill activities. Activities classified as maintenance range from small projects by individuals to maintenance dredging

undertaken by the U.S. Army Corps of Engineers. The extent of maintenance dredge and fill activities over the state has not been quantified, but the Corps of Engineers dredges about 1.5 million cubic yards annually in the navigation channels of the Mississippi, St. Croix, and Minnesota Rivers, and the Duluth Superior Harbor. New dredge and fill activities have an incrementally larger, more lasting impact. A major impact is from drainage ditch construction and reconstruction in the state. In addition, harbors and other dredging projects have secondary effects from development. Dredging also can have beneficial effects, such as those associated with lake restoration projects.

Forestry

The study of the relationship of forestry activities to water quality in Minnesota indicates that water pollution is not generally severe in forested areas, however an extremely high proportion of highly classified waters occur in forested areas. Therefore, whenever pollution does occur from forest activities, it is likely to harm a high-quality environment.

While forestry and other activities common to forested lands in Minnesota do not appear to constitute a frequent or widespread threat to water quality, certain practices, if done carelessly or improperly can cause localized detrimental effects on the valuable and relatively sensitive ecosystems common to most Minnesota forested areas.

Forestry activities in Minnesota identified as potential causes for water quality degradation include:

- construction of roads in forest land
- recreational activities
- clearing for fire breaks
- timber harvest operations including skidding of logs and development of landing areas
- mechanical site preparation
- prescribed burning for site preparation
- application of pesticides for site preparation

There are known effective management practices for controlling and preventing pollution from forestry activities. Forested lands in Minnesota are sixty-three percent public, managed by the United States Forest Service (USFS), MDNR, or counties, and thirty-seven percent under private ownership. The USFS, MDNR and counties have sufficient authority to protect water quality by regulating activities occurring within public forested lands. Establishing effective forestry management practices on private land is the primary concern for continued water quality protection from forestry activities.

Mining Runoff

Mining has been, and probably will continue to be, a major industry in Minnesota. A variety of minerals and other substances including ferrous metallic minerals (natural iron ore, taconite), sand and gravel, building stone, non-ferrous metallic mineral ores (copper, nickel, gold...), peat, and uranium ore have the potential to be mined. Mining includes all or any part of the process of removing, stockpiling, processing, storing, transporting, and

reclaiming any material in connection with the commercial production or extraction of minerals or other substances (MDNR, 1977).

Sand and gravel excavation is Minnesota's most widely occurring mining activity. Sand, gravel and building stone mining operations may generate significant amounts of suspended solids, which may have direct adverse water quality effects or contribute to turbidity. In 1977, the Metropolitan Council conducted a water quality management study of sand and gravel mining in the Twin Cities Metro Area which has a concentration of these operations. While this study found that rainfall runoff from these operations is not a significant source of pollutants, there is a need to develop a consistent approach to assist local units of government in regulating these operations.

Natural iron ore and taconite mining occur primarily on the Mesabi range. The principal water pollutants which result from active taconite and iron ore mining are suspended solids (which also contribute to turbidity). In certain areas, fibers are also a pollutant of concern. These pollutants may be released during the mining operation, during processing, or from tailings basins and waste rock or lean ore stockpiles. All of these pollutants are potentially harmful to aquatic life at certain levels.

Left behind by past iron mining operations, there are many abandoned iron ore piles and tailings ponds containing surface, overburden rock, lean ore, and tailings in northeastern Minnesota. Some of these sites may become operative again. Others will probably remain abandoned. If disturbed, these wastes could be sources of suspended solids and dissolved metals.

Non-ferrous metallic mineral deposits of possible commercial significance extend across the northern part of the state. Prospecting and exploration has been limited by the thick layer of surface overburden covering much of the potentially mineralized rock. If these ores are discovered and mined, there may be adverse effects on the water quality of this area. These ores contain substances, such as heavy metals, which cause toxic conditions and sulfides which can seriously alter the acidity of receiving waters. Examples of heavy metals which can be associated with this type of mining include cadmium, copper, zinc, lead, cobalt, nickel, arsenic and mercury. In addition, certain mining wastes can cause impacts due to the presence of processing additives. An additive of particular concern is cyanide. While there is existing knowledge about what type of pollutants could be expected and what the water quality effects could be, further information is needed with respect to what control technologies should be utilized to abate adverse effects on water quality.

Minnesota contains an estimated 7.5 million acres of peatland, the largest peat area of any of the lower 48 states. The state owns or administers an estimated 50% of these peatlands and is therefore in a strong position to influence any development (SPA, 1978). Monitoring data have indicated the potential for water quality impacts resulting from the drainage of peatlands. The pollutant of primary concern is suspended solids. However, for the drainage of sphagnum peatlands, acidity is also of concern.

Highway De-Icing Chemicals

The stockpiling and application of highway de-icing chemicals, primarily sodium chloride, can have detrimental impact on surface and ground water quality.

Evidence indicates that intensive or concentrated application of salts to roadways can cause water quality problems, particularly in small lakes and streams. There are no known cases of ground water contamination in Minnesota from de-icing application. Application of de-icing salts to roads in rural areas appears unlikely to cause water quality problems. The potential for pollution occurring from the application of de-icing chemicals is more difficult to determine than the potential of pollution from stockpiles. There have been numerous documented cases of surface and ground water contamination caused by runoff from inadequate stored stockpiles of salt and sand mixed with salt. One study estimated if all storage inadequacies were eliminated, over 80 percent of the reported cost to the environment from the use of de-icing chemicals could be eliminated.

In 1977, the Minnesota Department of Transportation (MnDOT) established a policy regarding their storage of salt and sand/ salt mixtures in order to reduce the potential for surface and ground water contamination near its stockpile sites. This policy is based on recognized best management practices and requires that:

- a. all salt and sand/salt mixtures be placed on bituminous pads which must be sloped to prevent surface water from draining through the stockpiles;
- b. all salt piles be covered with polyethylene if not stored in a shed, and all sand/salt mixtures be moved to empty salt sheds or covered during spring and summer;
- c. any runoff from the stockpiles be contained.

There are currently 213 sites to which MnDOT has salt delivered during the fall and winter. Of the 213 sites, 208 have some type of storage sheds. At the remaining 5 sites, the salt piles are kept covered with polyethylene at all times and the sand/salt mixtures are kept covered during the non-use months.

A survey conducted by the Minnesota House Committee on Transportation, Science and Technology revealed the following about county and municipal storage practices:

	Counties Responding		Storage Method (%)		
	%	(No.)	In. Bldg.	Under Tarp	In Open
County	77	(66)	51	13	36
Municipal	54	(52)	38	11	51

The pollution potential from county and municipal storage should be considered high because of the large percentage of open uncovered sites. The Minnesota Legislature enacted Statute 160.215 in 1971 in an attempt to minimize damage from application of de-icing chemicals. This statute established guidelines for the application of de-icing chemicals. MnDOT believes that their current application rates and procedures are in compliance with the established guidelines and cannot be significantly improved given current technological and fiscal constraints without detrimental decrease in the level of service provided. MnDOT does continue research in an attempt to improve its ice removal practices.

Based on available information, it appears that efforts to assess and minimize the potential for surface and ground water contamination due to highway de-icing chemicals would be best directed towards improving storage practices at those state, county and municipal storage facilities where they are found to be inadequate.

Special Problems

Roadside Erosion

Roadside erosion is occurring along many established roads in Minnesota. A 1973 study estimated that 4.3 million cubic yards of soil have eroded from road ditches in Minnesota. Areas of the state with the most serious roadside erosion problems generally have high concentrations of lakes and streams. Roadside erosion was found to be caused by:

- Inadequate design for drainage from land adjacent to roadsides (drainage from parking lots, county and judicial ditches, agricultural drainage, open ditches etc.)
- Poor maintenance practices -Use of roadsides by recreational vehicles (four wheel drive vehicles, dirt bikes, snowmobiles, and other all terrain vehicles or off the road vehicles);
- Use of roadsides for utilities construction, livestock moving or crop planting; and
- Lack of vegetation established during construction.

The full extent of the roadside erosion problem is difficult to assess at any one time because new erosion sites are developing continually. Sediment lowers water quality for municipal, industrial and recreational uses and reduces the storage capacity of lakes and reservoirs. Sediments not only destroy fish and wildlife habitats, but also reduce values of streams and lakes, which in turn reduce the value of adjacent property. Roadside erosion also causes excessive maintenance costs and produces unsafe highway conditions.

A number of road authorities exist in Minnesota: the MnDOT, counties, municipalities, and townships. Each is responsible for setting maintenance policies for roads under its authority. Local units of government lack adequate financial and physical resources to correct the existing roadside erosion problems. Therefore, the existing management structure does not adequately address the roadside erosion problem.

Streambank and Lakeshore Erosion

Many human activities contribute to accelerated streambank and lakeshore erosion. A 1978 study estimated 1524 miles of eroded streambanks and 165 miles of eroded lakeshore in the state. Streambank and lakeshore erosion are accelerated when activities increase water volume and velocity or destroy the actual bank and the vegetative cover which acts to limit erosion. Streambank and lakeshore erosion are significant since the sediment directly enters water resources.

Often as a part of urban and rural development, stream channels are realigned and straightened, resulting in a steeper stream gradient which increases the velocity and flow of potential erosive action. Urban and rural development may also increase volume and velocity of water entering a stream resulting in more streambank erosion. Livestock with direct access to waters trample the bank and stream bottoms and destroy vegetation exposing bare soil to erosion during rainfall and increase water temperature.

Shaping of banks and replacing trees, shrubs and grass can be effective treatment techniques for less severely eroding streams or lakeshores. More structural controls may be used in areas with severe erosive forces. Fencing is often needed to keep cattle and other livestock away from banks and out of water.

Fish Tissue Contamination

Fishing is an important recreational activity in Minnesota. Part of the enjoyment of fishing is eating the catch. Unfortunately, some of the waterways in Minnesota are contaminated with chemicals which accumulate in fish and may be toxic to human and animal consumers. For these waterways, the designated uses are partially or not supported.

The Minnesota Department of Natural Resources (MDNR) collects fish to be analyzed for contaminants. The MPCA processes the fish, contracts for their analyses, and prepares environmental reports from the data. Fish consumption advisories are issued by the Minnesota Department of Health (MDH). MDH annually reviews the toxicological literature to determine the appropriate fish consumption advice.

Fish consumption advisories are issued each spring by MDH through the news media and booklets that are sent upon request.

Sediment Contamination

There are no specific programs for sediment assessment in Minnesota. Sediment problems are addressed on a case-by-case basis through cooperative efforts between local, state, and federal agencies. In the past, sediment problems have been identified based on fish consumption advisories, bulk sediment chemistry and benthic macroinvertebrate structure. Once a sediment problem has been identified, the appropriate course of action is determined based on the source, responsible party, and effects on human health, fish and water quality.

Acid Rain

Since the late 1970's, acid rain has been recognized as a serious threat to aquatic and terrestrial ecosystems in northeast Minnesota. In response to the potential environmental and economic damage from acid deposition, the Legislature passed the Acid Deposition Control Act in 1982. This Act was the first of its kind in the nation and required the MPCA to 1) identify the areas of the state containing resources sensitive to acid deposition; 2) develop a standard to protect these resources; 3) adopt a plan to control acid rain, addressing both in-state and out-of-state emission sources; and 4) ensure that all Minnesota sources subject to the Control Plan are in compliance by January 1, 1990.

The Agency completed the first three directives when the MPCA's Citizens Board adopted Minnesota Rules 7005.4010-7005.4050 Relating to an Acid Deposition Standard and Control Plan in July 1986. Adoption of these Rules made Minnesota the first state to promulgate an acid deposition standard.

The Acid Rain Rules establish an acid deposition standard of 11 kilograms per hectare per year in the sensitive area, require reductions in sulfur dioxide from two power plants in the state, place a cap on system-wide sulfur dioxide emissions from Northern States Power at 93,500 tons per year and from Minnesota Power at 40,300 tons per year, respectively, and reduces statewide sulfur dioxide emissions to 194,000 tons per year by 1994 (60,000 ton per year reduction from 1980 levels).

Since the adoption of the Acid Rain Rules in 1986, the Agency has focused its efforts on a) monitoring deposition in the sensitive areas; b) developing and formalizing a process to track statewide and utility sulfur dioxide emissions and modify permits for the two coal-fired power plants required to reduce their sulfur dioxide emissions; c) seasonal long-term monitoring of low alkalinity lakes to detect subtle chemical changes; d) addressing the uncertainties of snowmelt impacts on trout streams along the North Shore of Lake Superior and assisting in the investigation of the relationship between mercury contamination and acid rain; and e) continuing the lobbying effort for federal acid rain control legislation. These activities provide for monitoring compliance with the acid deposition standard and control plan and for the continued assessment of acid deposition impacts on Minnesota resources.

II. THE ASSESSMENT

BACKGROUND

Assessing the impact of NPS pollution on the water resource is difficult because this resource is abundant, diverse, and our understanding of the environmentally complex NPS pollution problem is limited. However, by combining existing water quality data with the experience of local water resource management groups, those waterbodies where NPS pollution is obvious and waterbody uses threatened or limited can be identified.

The MPCA, through an evaluation of existing water quality data, a survey of local water resource managers, and a mapping exercise, has identified waterbodies potentially threatened or impaired by NPS pollution. In identifying threatened or impacted waterbodies every attempt was made to eliminate from consideration those waterbodies that were impacted solely by point sources. The following are the lake, stream, ground water and wetland assessments of NPS pollution problems in Minnesota.

INLAND LAKES, RESERVOIRS AND PONDS

Background

Minnesota, "Land of 10,000 Lakes" is really the land of 12,034 lakes. These lakes encompass 3,411,200 acres. Of this number less than 1% (62) have surface areas greater than 5,000 acres. A majority of the lakes (70%) have surface areas between 10 and 100 acres.

The nature of runoff from a lake's watershed, both its quantity and content, and the morphometry of a lake determine its water quality. Generally, runoff from cultivated and urban areas carries more nutrients and sediments to lakes than that from forested or wetland areas. In terms of lake morphometry, depth and surface area provide an indication of a lake's ability to assimilate nutrients and sediments that arise within the its watershed. Lake morphometry also determines the likelihood of maintaining thermal stratification during the growing season and the likelihood of internal sources of nutrients contributing to the production of algae and rooted vegetation.

To assess lake water quality for NPS impacts, the MPCA used the "ecoregion" framework developed by the U.S. Environmental Protection Agency's Environmental Research Laboratory in Corvallis, Oregon. Ecoregions provide a framework to identify regional patterns in land use, lake morphometry and water quality. Once these patterns are identified data from representative minimally impacted lakes in each ecoregion can be used to assess use support. This comparison formed the basis for the MPCA's assessment of lake quality data for NPS impacts.

Ninety-eight percent of Minnesota's lakes occur in four of the seven ecoregions: Northern Lakes and Forests (NLF), North Central Hardwood Forest (NCHF), Northern Glaciated Plains (NGP), and Western Corn Belt Plains (WCBP). The Northern Lakes and Forests is dominated by forests - with some water and marsh, while the Northern Glaciated Plains and Western Corn Belt Plains are primarily cultivated with some pasture and open land. The North Central Hardwood Forest ecoregion consists of a mixture of various land uses. The MPCA lake data assessment focused on these four ecoregions. Approximately 42 percent of the State's lake acres are included in the assessment. By number, this represents about twelve percent of Minnesota's lakes.

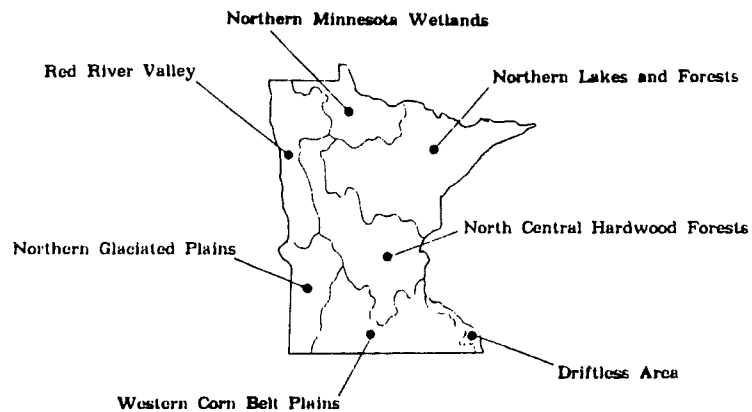


FIGURE 1. ECOREGIONS IN MINNESOTA. Ecoregion boundaries were delineated by Omernik (1987). A complete description of the ecoregions in Minnesota and the surface water quality within these ecoregions is presented in Fandrei et al. (1988).

Assessment Procedures

Lake data collected during the past eleven years (1977 - 1987) and accessible through the U.S. Environmental Protection Agency's computer data storage and retrieval system, STORET, were used for the lake assessment. The primary focus was on lake trophic state and its relationship to support and nonsupport of designated swimming and aesthetic uses. The variables used for assessing trophic state were epilimnetic total phosphorus, chlorophyll-a and Secchi transparency. Lakes were categorized as either monitored or evaluated as follows:

Monitored: Lakes with summer data collected between calendar years 1982 through 1987, inclusive. Summer was defined as the time period between June 24 and September 11. Summer data were used because the data 1) generally corresponds to maximum productivity of a lake, 2) yields the best agreement between trophic variables, and 3) reflects the period of maximum use of the resource.

Evaluated: Lakes with data collected between 1977 and 1987 but not meeting the summer season criterion for total phosphorus. For total phosphorus data the seasonal requirement was expanded to include the open water season from May through November. Expanding the season for total phosphorus measures allowed for the inclusion of a large number of lakes in northern Minnesota which were sampled only during spring or fall turnover as part of an acid rain lake monitoring effort. The summer season criterion was applied to chlorophyll-a and Secchi transparency measurements.

Trophic status was assessed for each lake using Carlson's Trophic State Index (TSI). This index was developed from the interrelationships of summer Secchi transparency and epilimnetic concentrations of chlorophyll-a and total phosphorus. The four TSI calculations used for the NPS assessment were:

- 1) Secchi disk TSI (TSIS) = $60 - 14.41 \ln (SD)$;
- 2) Total phosphorus TSI (TSIP) = $14.42 \ln (TP) + 4.15$;
- 3) Chlorophyll-a TSI (TSIC) = $9.81 \ln (Chl-a) + 30.6$;
- 4) Average TSI = TSIS + TSIP + TSIC

Chlorophyll-a and total phosphorus are in ug/l and Secchi disk is in meters.

The index values resulting from these equations generally range from 0 to 100 with increasing values indicating more eutrophic conditions. For the NPS assessment the average TSI value (equation 4) was used to evaluate use support.

The MPCA selected the following TSI categories as a basis for assessing the level use support in terms of aesthetics and swimmable conditions. See Heiskary and Wilson (1988) and MPCA (1988) for more information on status of use support in terms of aesthetics and swimmability. The lake assessment did not deal with the fishable status of water.

1. Fully supporting - lakes with an average TSI ≤ 50 were classified as fully supporting swimmable and aesthetic uses.
2. Supporting-threatened - lakes with an average TSI between 51 and 59 were classified as supporting, but threatened.
3. Partial support-impaired - lakes with an average TSI between 60 and 65 were classified as partially supporting, but impaired.
4. Non-support-impaired - lakes with an average TSI > 65 were classified as non-supporting.

Lakes fully supporting uses exhibit impaired conditions less than ten percent of the time and exhibit aesthetically unacceptably high algal levels less than ten percent of the time. Lakes with threatened uses exhibit impaired swimming conditions 11 to 25 percent of the time. Lakes with partial use support exhibit impaired swimming 26 to 50 percent, no swimming less than ten percent of the time and high algal levels 26 to 50 percent of the time. Non-supporting lakes exhibit no swimming conditions greater than 25 percent of the time, no recreation possible on occasion, and high algal levels greater than 50 percent of the time.

The list of lakes assessed for NPS impacts and identified as supporting but threatened, partially supporting but impaired, or non-supporting aesthetic and swimming uses are presented in Appendix A. This list identifies each lake by name and Minnesota Department of Natural Resources identification number, the ecoregion the lake occurs in, and the use support category assigned by the assessment.

The Northern Lakes and Forest ecoregion contains approximately 5,550 lakes or about 46% of Minnesota's lakes. The lakes are generally small and deep. Based on the 793 assessed lakes, surface areas are typically 100 to 550 acres, while maximum depths are typically 20 to 60 feet. A majority of these lakes thermally stratify during the summer.

Based on the assessment, lake trophic state in the region ranges from oligotrophic to hypereutrophic. More than 50% of the lakes are considered oligotrophic or mesotrophic and less than 5 percent of the lakes are considered hypereutrophic. The vast majority (92%) of the assessed lakes in the Northern Lakes and Forests ecoregion fully support swimmable uses, while less than 2 percent do not support swimmable uses.

A review of the 15 nonsupport lakes reveals that 5 are receiving (or have received) point source discharges from municipal wastewater treatment facilities either directly or from upstream sources. The point source impacted lakes are not listed in Appendix A. The nonsupport lakes tend to be shallower with maximum depths in the 13 to 34 feet range. In contrast, supporting lakes maximum depths generally range from 23 to 58 feet. For lakes not impacted by point sources potential causes of impairment related to NPSs of pollution are pockets of agriculture in the watershed, feedlots, pasturing near the waterbodies, onsite septic systems, and ditching which may affect the quantity and quality of runoff to the lake. Overall, it seems reasonable to expect either full support or at least partial support of swimmable uses for all lakes in this ecoregion.

The North Central Hardwood Forests ecoregion contains approximately 4,760 lakes or about 40% of Minnesota's lakes. In terms of morphometry and thermal stratification these lakes are quite similar to those of the Northern Lakes and Forests ecoregion.

A wide range in trophic status is evident in the lakes of this region. Typically North Central Hardwood Forest lakes are characterized as eutrophic in nature. The remainder are rather evenly divided between mesotrophy and hypereutrophy. Of the 533 assessed lakes, 51% support swimmable uses. However, over one-half of these lakes are considered threatened based on the use support criteria applied for this assessment. More than one-third of the assessed lakes do not support swimmable uses.

Point source discharges are a major cause of nonsupport in 41% of the 185 lakes assessed as nonsupporting. NPSs of pollution are considered the major cause for nonsupport in the remainder. In the rural areas the NPSs are believed to be related to cultivated land uses, feedlots and pasture uses. On-site septic systems may also be an important NPS factor for lakes with extensive recreational development in their immediate watershed and urban land uses an important consideration in developed areas.

Achievement of full support or at least partial support of swimmable uses appears to be a realistic goal for most of the lakes in the ecoregion. However, it may not be a realistic goal for some of the shallow lakes in the ecoregion.

The Western Corn Belt Plains ecoregion contains approximately 570 lakes or about 5% of Minnesota's lakes. In general these lakes are quite shallow and have larger surface areas than the lakes in the Northern Lakes and Forests and North Central Hardwood Forests ecoregions. Typical surface areas range from 250 to 1,000 acres and maximum depths range from 5 to 20 feet. Very few lakes in this region are deep enough to retain thermal stratification during the summer.

All 58 assessed lakes in this region are eutrophic. More than 75% are considered hypereutrophic. Less than 10% support a swimmable use. Of the lakes supporting a swimmable use, all are considered threatened or impaired.

Point source discharges were noted for 5 of the 47 nonsupporting lakes. For the remainder, the high degree of agricultural land use, natural fertility of the soils and the shallowness of the lakes likely limit the ability of these threatened lakes to support the same quality of use as lakes in the northern ecoregions. Partial support of swimmable uses or a reduction in the frequency of nuisance algal blooms are reasonable goals for many of the lakes of this ecoregion.

The Northern Glaciated Plains ecoregion contains approximately 850 lakes or about 7 percent of Minnesota's lakes. Lakes in this region are all quite shallow and rather large in size. Based on the assessed lakes, surface areas are typically 250 to 900 acres and maximum depths are 6 to 12 feet. All lakes in this region are considered well mixed.

The lakes in the Northern Glaciated Plains ecoregion are very fertile, based on their phosphorus concentrations. Virtually all are considered hypereutrophic. As a result of this fertility the majority (85%) of the assessed lakes do not support swimmable uses.

High nutrient concentrations from NPSs in conjunction with the shallowness of the lakes, are the primary causes of nonsupport in this ecoregion. Extensive agricultural development and feedlots are the likely NPSs. Only one of the 21 assessed lakes in this ecoregion was impacted by a point source.

At best, partial support or a reduction in the frequency of nuisance algal blooms are reasonable goals for lakes in the Northern Glaciated Plains ecoregion. The shallowness of lakes in this area may make full support of swimmable conditions an unrealistic goal.

STREAMS

Background

Within the State of Minnesota there are nine major river basins with water flowing in three geographic directions. Rivers and streams flow north to Hudson Bay, east through the Great Lakes to the Atlantic Ocean, and south to the Gulf of Mexico. With a total of nearly 92,000 miles, Minnesota's stream resource is both abundant and diverse.

To promote the proper management of Minnesota's stream resource, the State has operated, with periodic adjustments, a Routine Water Quality Monitoring Program since 1953. With this sampling program the MPCA annually monitors about 1,250 stream miles, less than 2% of the state's total stream resource. Currently water quality data are available for approximately 5% of Minnesota's stream miles. (Minnesota's Surface Water Quality Management Plan, Point Source Element, MPCA, 1987). The Routine Water Quality Monitoring Program formed the basis for an assessment of nonpoint source impacts to streams.

Any assessment procedure is only as good as the components that make up that procedure. For this assessment the components are the water quality data and the criteria against which the data are compared. The stream water quality data collected by the MPCA are maintained in STORET, the U.S. Environmental Protection Agency's computerized national water quality data bank. Several other water management agencies also store data in STORET. STORET data was used for the stream NPS assessment. These data meet U.S. Environmental Protection Agency approved guidelines and are considered good data.

In terms of the criteria component, water quality standards are often used as the basis for comparison. Minnesota has established stream water quality standards. These standards are designed to maintain and protect water quality uses, particularly from degradation by point sources of pollution. Minnesota's water quality standards can serve as criteria for assessing water quality impacts, however, they do not provide a complete basis for an assessment of NPS pollution. Criteria for water quality variables not represented by Minnesota's standards must also be considered when assessing NPSs of pollution. To complete the stream water quality assessment an estimate of NPS criteria for these other water quality variables was required.

Omernik (1987) proposed that ecoregions be used as a framework to segregate spatially variable water quality data and to establish water quality standards that are in tune with regional patterns. A preliminary review of Minnesota's stream water quality data suggested a regional variation in water quality. Ecoregions (Figure 1) were selected as the framework for the stream NPS assessment.

Assessment Procedures

To assess stream water quality, the MPCA reviewed the stream monitoring sites maintained in STORET and selected 149 to define, by ecoregion, the typical water quality. The stream monitoring sites that were selected for the assessment have:

1. at least 4 years of data;
2. data collected monthly for at least nine months each year; and
3. data that provides a reasonable representation of the ecoregion; that is, the drainage area contributing to a monitoring site does not include large areas of more than one ecoregion.

Ten water quality parameters representing over 15,000 water quality samples and 120,000 observations were reviewed to describe typical stream water quality by ecoregion. A summary of this information, presented in Figure 2, showed regional differences for several water quality parameters.

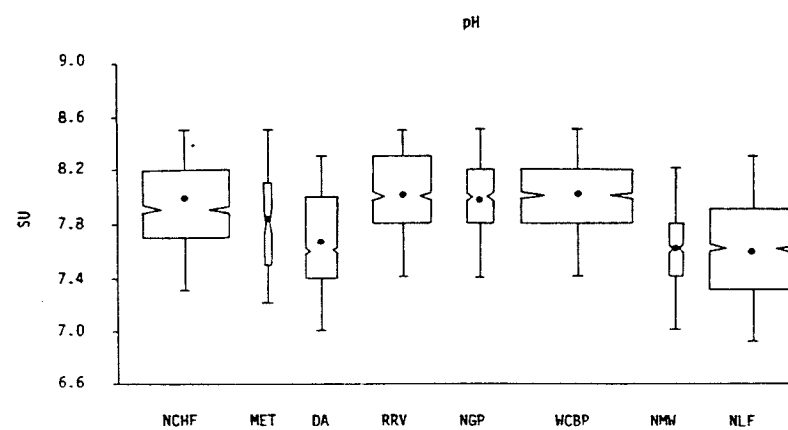
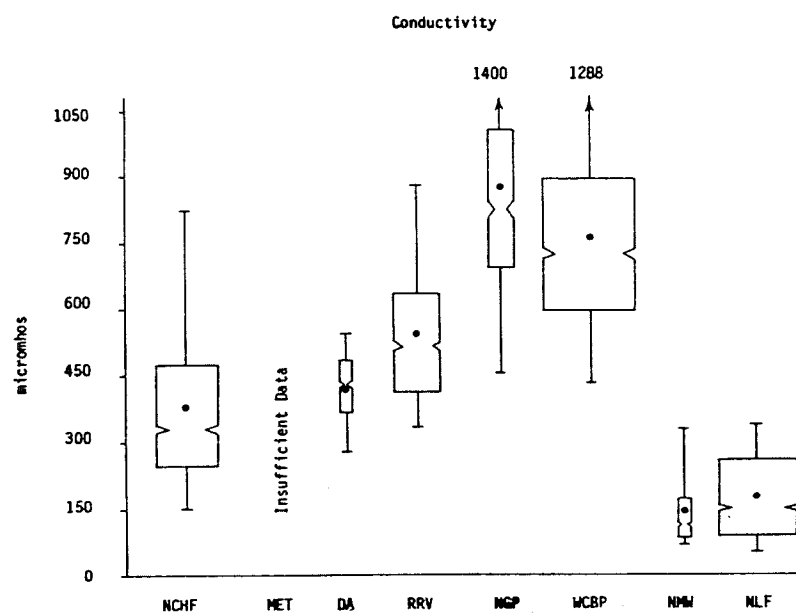
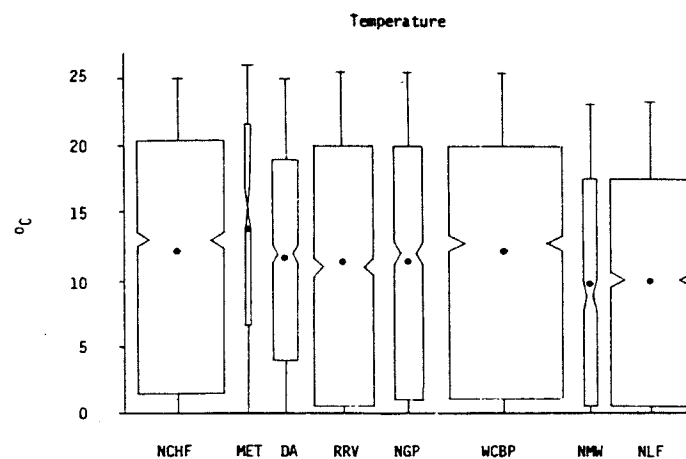
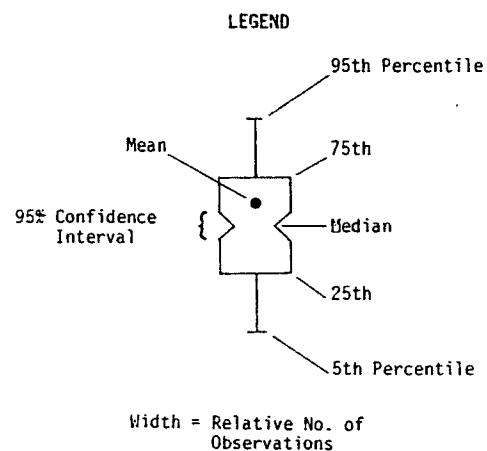


FIGURE 2. STREAM WATER QUALITY FOR THE SEVEN MINNESOTA ECOREGIONS. Period of Record.

FIGURE 2. (cont'd)

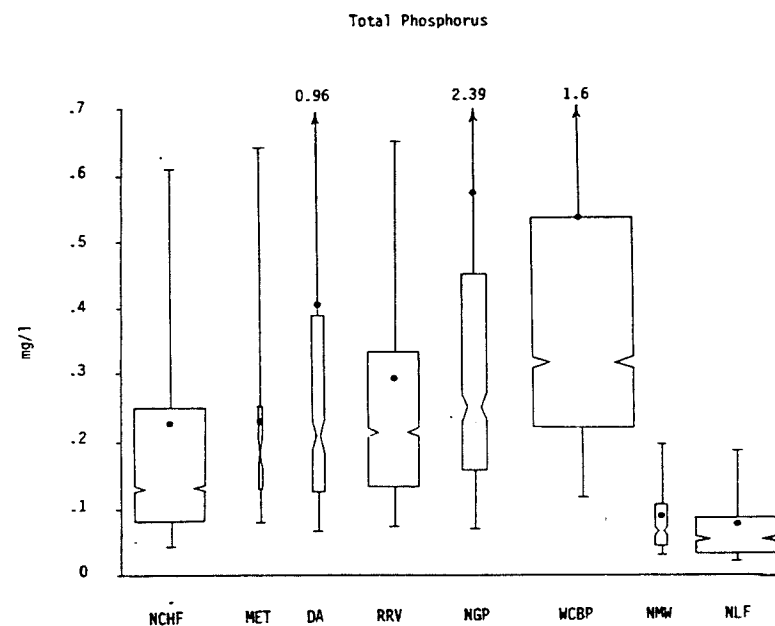
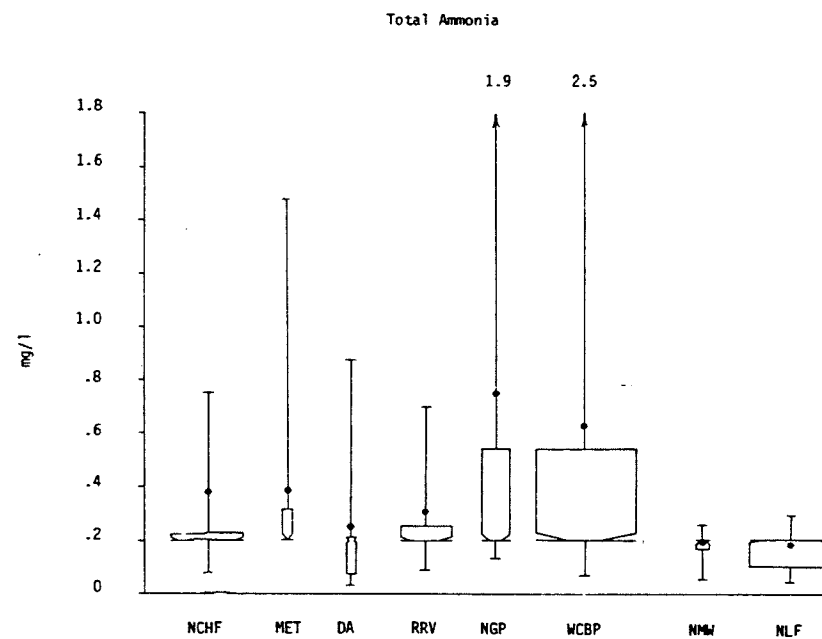
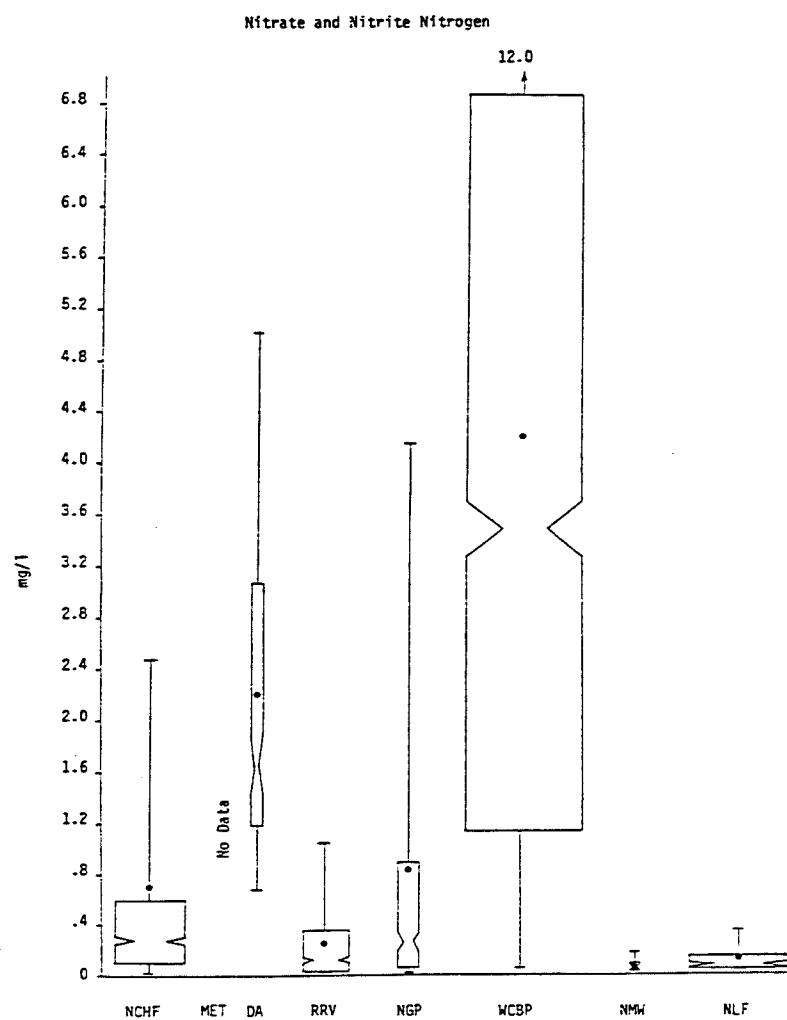
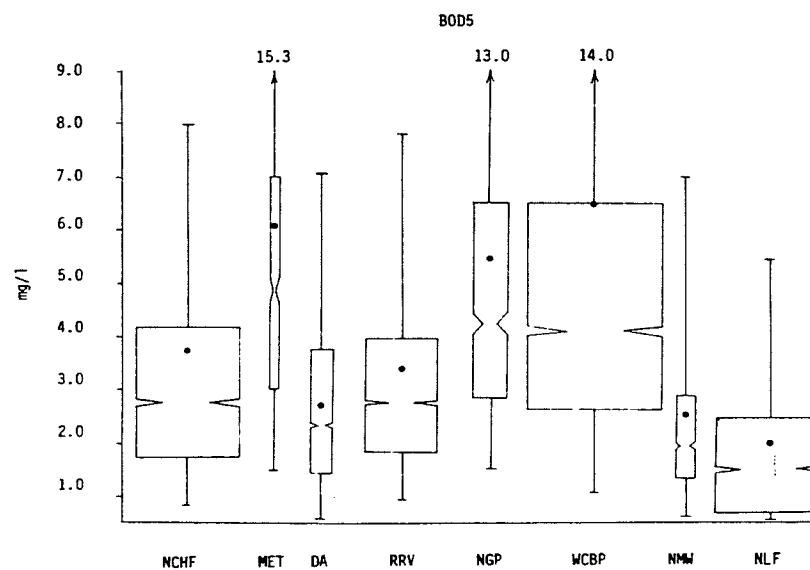
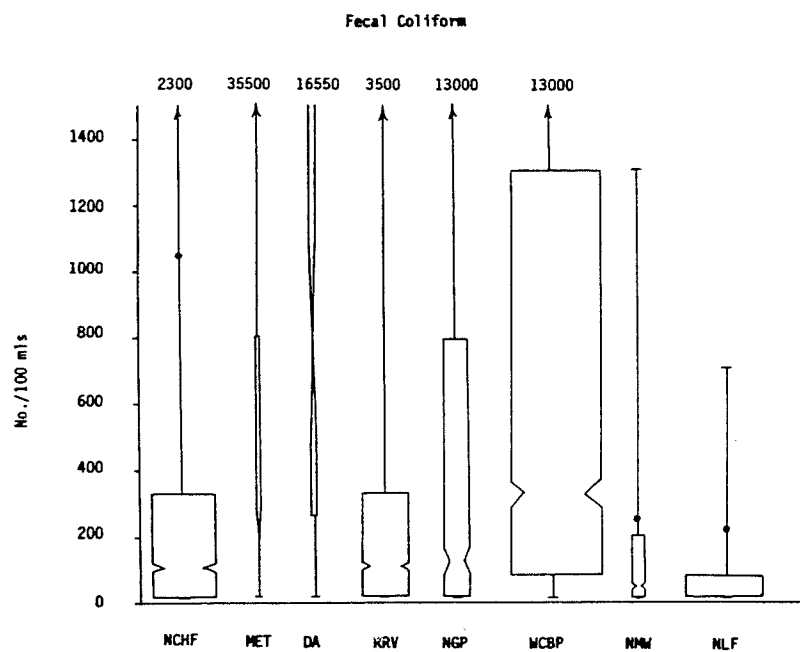
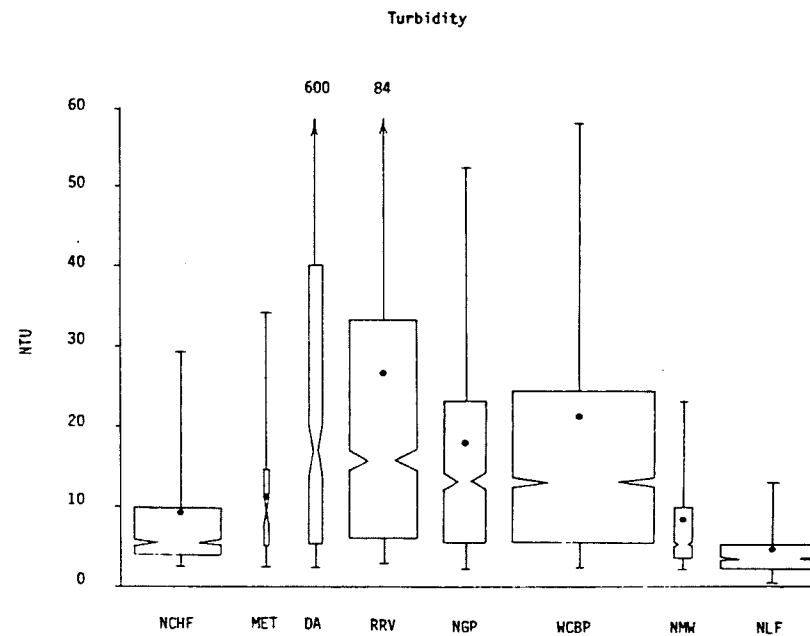
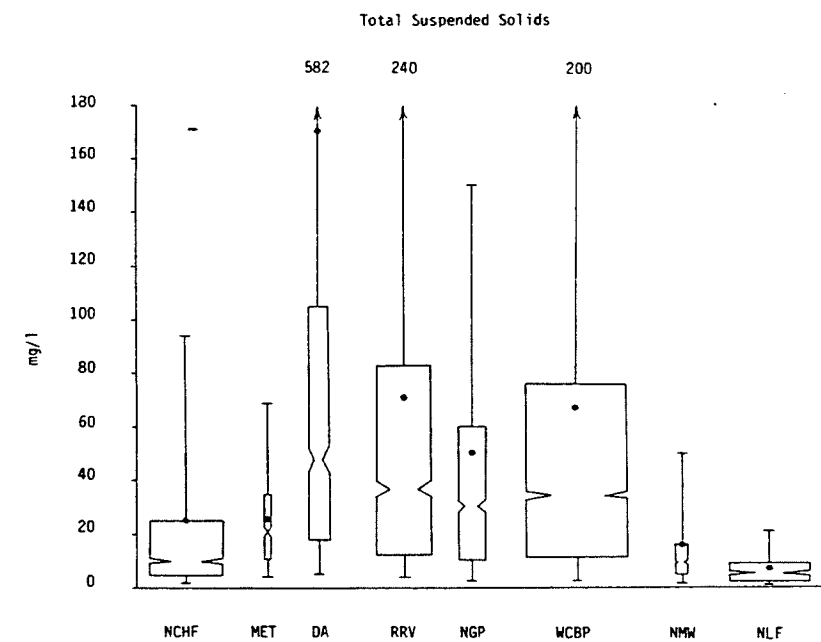


FIGURE 2. (cont'd)



To address the question of which parameters to use for a NPS assessment, the MPCA reviewed STORET water quality data for a 12 year time period; 1973 - 1985. This review, summarized in Table 2., clearly showed temporal changes in regional water quality. Of particular interest are the pollutants nitrate plus nitrite nitrogen ($\text{NO}_2 + \text{NO}_3$), total suspended solids (TSS), and ammonia nitrogen (NH_3).

TABLE 2. TRENDS IN STREAM WATER QUALITY FOR THE 1973-1985 TIME PERIOD.
Statistically significant changes are indicated by an asterisk.

	Nitrate + Nitrite ($\text{NO}_2 + \text{NO}_3$)	Total Suspended Solids (TSS)	Ammonia (NH_3)
NCHF	Decrease	Increase*	No Trend
DA	Increase*	No Trend	Decrease
NGP	Increase*	Increase	No Trend
NLF	No Trend	Increase	Decrease
NMW	No Trend	No Trend	Decrease
RRV	Increase	Increase*	No Trend
WCBP	Increase	Increase*	Decrease

Ammonia nitrogen levels decreased or remained constant in each ecoregion during the 12 year time period. Ammonia nitrogen levels are believed indicative of point source pollution and its decline is reflective of successful point source control efforts.

In contrast to ammonia nitrogen, nitrate plus nitrite nitrogen and total suspended solids have increased in concentration in several ecoregions. Nitrate plus nitrite nitrogen and total suspended solids are associated with NPSs. Nitrate plus nitrite nitrogen and total suspended solids are useful for the assessment process.

In addition to streams there are numerous lakes in Minnesota and lakes are influenced by nutrients, particularly phosphorus. Total phosphorus (TP) may be a good parameter to use for assessing NPS impacts in streams. While TP is generally not considered a problem in lotic systems the delivery of TP to lakes by streams can lead to increased lake eutrophication as noted in the lake assessment. As such it seems reasonable to conclude that stream levels of TP can also be used to assess NPS impacts.

In addition to the aforementioned water quality variables, the ability of a stream to assimilate pollutants, particularly oxygen demanding substances, is also an important consideration for assessing both point and nonpoint sources of pollution. Therefore, the level of oxygen demanding substances, measured as BOD_5 , can be considered an indication of NPS impacts.

The question now becomes what level or criteria should be used to assess stream NPS impacts. To address this question, the MPCA further reviewed the 149 stream monitoring sites selected for ecoregion analysis. The monitoring sites were reviewed to identify the least impacted sites in each ecoregion. For some ecoregions, those with relatively good water quality, selection of least impacted sites was quite easy. For other ecoregions selection was more difficult because NPS impacts are widespread. In these areas even those sites considered least impacted may have considerable NPS impacts.

Ecoregions recognize the natural spatial variability of Minnesota's streams, however, some variability still exists within ecoregions. It is important to recognize this variability when establishing NPS criteria. To establish NPS criteria and recognize this variability the 75th percentile of the least impacted site water quality data was selected as the NPS assessment criteria for streams. In addition to recognizing spatial variability within an ecoregion there is a need to recognize temporal variability. To recognize temporal variability a monitoring site was considered NPS impacted only if more than 10% of the samples collected during a given year exceed the 75th percentile concentration.

In summary, the water quality data from the least impacted sites provide a reference point from which to estimate the best attainable water quality for an ecoregion. The data from the least impacted sites, presented in Table 3, represents the best estimate of stream NPS water quality criteria.

Table 3. ESTIMATED BEST ATTAINABLE WATER QUALITY FOR EACH ECOREGION.
Concentrations are the 75th percentile of data collected from
least impacted sites from 1973 to 1985.

	NLF	NMW	RRV	NGP	WCBP	DA*	NCHF
TSS (mg/l)	6.4	17.2	56.5	65.5	57.5		16.1
TP (mg/l)	0.052	0.092	0.322	0.271	0.340		0.170
NO ₂ +NO ₃ (mg/l)	0.09	0.08	0.2	0.52	5.62		0.29
BOD ₅ (mg/l)	1.7	2.2	4.2	4.5	5.6		3.4

* No data available, use estimates of best attainable water for the NCHF ecoregion.

The portion of the Driftless Area ecoregion that occurs in Minnesota is very small and does not contain many monitoring sites. Because the number of monitoring sites was limited no least impacted sites were identified for this region. For the NPS water quality data assessment data for the North Central Hardwood Forests, an ecoregion with similar land use characteristics, was used as a surrogate to provide criteria for the assessment of NPS impacts in the Driftless Area ecoregion.

It is important to note that these criteria are presently the best estimates available to assess NPS impacts. As more information is collected on least impacted sites, particularly in the agricultural areas of southern and western Minnesota, adjustments in best attainable water quality will occur.

For the evaluation of NPS impacts, water quality data from sampling sites with at least ten observations for each of the NPS indicators; TSS, NO₂ + NO₃, TP and BOD₅, were compared, by ecoregion, to the best attainable water quality data. The following categories of stream NPS impact were defined based on the frequency a stream's water quality exceeded the attainable water quality.

- No Impact: <10% of the water quality samples collected in a given year exceed the best attainable concentration.
- Partial Impact: $\geq 10\%$, but $\leq 25\%$ of the water quality samples collected in a given year for any NPS indicator exceed the best attainable concentration.
- Full Impact: >25% of the water quality samples collected in a given year for any NPS indicator exceed the best attainable concentration.

For the stream NPS assessment of STORET water quality data, 117 stream sites representing 1588.8 stream miles were evaluated. Of the evaluated stream miles only 12.9 miles (0.8%) were considered non-impacted, 107.4 miles (6.8%) were considered partially impacted, and 1468.5 miles (92.4%) were considered fully impacted.

A high percentage of fully impacted stream miles were identified by the NPS data assessment. It should be noted that this percentage cannot be projected statewide. The water quality monitoring program in Minnesota has many objectives which includes the monitoring of problem areas. These areas are over emphasized in the MPCA's monitoring efforts which likely produced the biased results presented here. In some areas, such as the Red River Valley ecoregion, it may be true that more than ninety percent of the streams are NPS impacted, but in other areas, such as the Northern Lakes and Forests ecoregion, it is unlikely that a high percentage of streams are impacted.

Stream segments with water quality data that were assessed for NPS impacts are presented in Appendix B.

GROUND WATER

Background

Both lakes and streams are abundant surface water resources that can be assessed within the two-dimensional ecoregion framework. There is, however, a three-dimensional water resource that may also be impacted by nonpoint sources.

Ground water, the abundant freshwater resource that lies under our feet, provides drinking water for nearly 75% of Minnesotans and provides numerous other uses such as livestock watering, irrigation, and manufacturing. To protect these uses we must be aware that what we do to the land's surface can impact the water resource beneath our feet. As much as 30 percent of the precipitation that falls on the land's surface infiltrates and becomes part of the extensive ground water system. Ground water must be assessed for NPS impacts to protect this valuable resource.

The U.S. Geological Survey in their Water-Supply Paper 2275 (pages 261-8) provides a good description of the ground water resource in Minnesota. Table 2, of this report describes the general aquifer characteristics. Water-Supply Paper 2275 is presented in Appendix C.

Assessment Procedures

The assessment of NPS impacts on ground water proceeded in two directions; through a mapping exercise and through data evaluation. Both of these procedures are described in existing reports attached as Appendices D, E and F. These reports serve as the assessment of NPS impacts on ground water. The following is a brief synopsis of their results.

In a study of ground water quality (Appendix D) the MPCA has evaluated water quality data collected by the MPCA and the U.S. Geological Survey (USGS) between 1978 and 1986 to observe spatial trends in water quality. In selecting well sites for evaluation, attempts were made to minimize hydrogeologic difference surrounding sampled wells by limiting the evaluation to wells greater than ten feet deep and to wells developed in surficial sand aquifers. Evaluated wells were classified as having intense, moderate or limited agriculture based on the percentage of acres in cultivation and row crop production of the county in which the well occurred (intense >80 percent cultivated, moderate 30-60 percent cultivated, limited <5 percent cultivated).

Mean, median and maximum nitrate plus nitrite nitrogen, chloride and total phosphorus concentrations were calculated for each land-use region. The median proved to be the more useful statistic because of the skewed distribution of the ground water quality data.

Since nitrite nitrogen concentrations in ground water are usually negligible compared to nitrate nitrogen concentrations, the drinking water standard of 10 mg/l nitrate nitrogen can, in most instances, be applied to the measured nitrate plus nitrite nitrogen concentration. In the intense and moderate agricultural regions over 25 and 18 percent of the respective wells exceeded a concentration of 10 mg/l nitrate plus nitrite nitrogen. The limited agriculture region had no wells with nitrate plus nitrate nitrogen exceeding 10 mg/l.

Mean and median chloride concentrations showed an increasing trend from the limited agriculture region to the intense agriculture region. For total phosphorus the opposite trend may exist. It appears that the highest concentrations for total phosphorus occurred in the limited agriculture region, however, there is insufficient data in both the limited and intense agriculture regions to confirm this apparent trend.

In addition to the apparent trends in the surficial drift aquifers, the upper carbonate aquifers also show serious stress signs from agricultural land use. In instances where conduits exist, deeper aquifers are being cross contaminated.

From this study of nitrite, nitrate, chloride and total phosphorus ground water quality, it appears that the upper carbonate and surficial sand and gravel aquifers of the 14 principal aquifer types in Minnesota show NPS land use related problems. Another study (Appendix E) conducted by the Minnesota Department of Health and Agriculture investigated pesticide contamination of Minnesota's ground water.

Between July 1985 and June 1987, the Minnesota Department of Health (MDH) and Agriculture (MDA) conducted cooperative surveys of water wells for selected pesticides. Pesticides were selected for survey consideration based on an evaluation of existing information related to use, toxicology and environmental

transport and fate. Emphasis was placed on those pesticides which were commonly used in the State and/or which appeared to be more likely to adversely impact ground water and public health. Only one of the selected pesticides, 2,4-D, had a Federal or State drinking water standard. In order to address the public health concerns presented by the detection of pesticides in drinking water, the MDH established recommended allowable limits (RALs) for the other pesticides considered in the survey.

In general, wells were selected for sampling in agricultural regions of the State and, within those regions, from areas where the local or regional soils and hydrogeologic conditions make the ground water especially susceptible to pesticide contamination. Karst aquifers and shallow sand and gravel aquifers overlain by coarse-textured soils were viewed as particularly sensitive and most likely to show evidence of ground water contamination by pesticides. Some wells were also selected outside of these sensitive areas to provide a real coverage of the State's agricultural regions and diverse cropping patterns.

The MDA sampled 100 observation, irrigation, and private drinking water wells and five drain tiles on a time-series or repetitive basis (typically, four samples per site). The MDH collected a single sample at each of 400 public drinking water wells. A second sample was collected from each well in which pesticides were detected in the initial sample.

The results of the surveys indicated that several pesticides were present in ground water, especially in hydrogeologically sensitive areas of the State. One or more pesticides were detected in 165 (33 percent) of the 500 wells sampled. Pesticides were observed more frequently in observation and private drinking water wells than in public drinking water wells. This difference is most likely attributable to the shallower depths of many of the observation and private drinking water wells and to their closer proximity to fields receiving pesticide applications.

Fifteen pesticides, including thirteen herbicides, one insecticide and one wood preservative, were detected in the surveys. Atrazine, the most commonly detected pesticide in each survey, was found in 154 (31 percent) of the 500 wells sampled and in over 90 percent of the wells which tested positive for pesticides. Alachlor, the next most commonly occurring compound in each survey, was found in 17 wells. Each of the remaining thirteen pesticides was detected in seven or fewer wells.

Although the percentage of wells with detectable levels of pesticides was relatively high, the concentrations detected were usually low. Eighty-four percent of all pesticide occurrences were at concentrations less than 1.0 ug/l. Levels exceeding the RALs were observed in samples collected from ten wells, including four public drinking water wells and one private drinking water well.

At the low concentrations typically observed in these surveys, the public health concerns focus on potential chronic health effects. Chronic toxicity information for many pesticides is limited. Although this body of information has improved significantly in recent years, it is difficult to associate specific health effects with exposure to low levels of pesticides in drinking water.

Pesticides were detected in wells in 51 counties, but were most commonly found in wells completed in the karst formations in southeastern Minnesota, the shallow, outwash and gravel aquifers in central Minnesota and the shallow, alluvial sand and gravel aquifers in southwestern Minnesota. Few pesticide occurrences were observed in northwestern and southcentral Minnesota.

The widespread occurrence of pesticides, primarily atrazine, at low concentrations in certain areas, and the presence of pesticides in observation wells located near field application sites, indicate that ground water contamination may result from normal pesticide use as well as from spills, leaks, backsiphonages and other point sources.

Significant vertical differences in pesticide and nitrate-nitrogen occurrence and concentration were observed in adjacent observation wells in certain central Minnesota sand and gravel aquifers. The nature of this vertical stratification varied from site to site.

While pesticides were observed more frequently in wells in certain areas of the State, the potential for contamination in a specific well is determined by a complex set of factors, including the contaminant source, chemical properties, local ground water vulnerability, local agricultural practices and well construction. These factors vary considerably from area to area and from well to well.

Nitrates were analyzed to determine if there was a relationship between nitrate and pesticide occurrence and concentration in ground water and to evaluate nitrate testing as a surrogate for pesticide testing. Nitrates were not found to be a reliable indicator of pesticide occurrence or a quantitative predictor of pesticide concentration.

The baseline information generated in these surveys has significantly expanded the knowledge of pesticide contamination in Minnesota ground water and drinking water. Nevertheless, it is important to recognize the limitations of the surveys. A limited number of wells and pesticides were studied during a relatively short time frame under unusual precipitation conditions. As a result, these surveys do not provide a comprehensive statewide assessment of the extent of ground water contamination of pesticides. Additional monitoring, research, regulatory and educational efforts will be needed to minimize the impact of pesticides on ground water quality and public health.

To expand the baseline information on Minnesota's ground water, the MPCA initiated a mapping project with the goal to design and implement a method of assessing relative ground water contamination susceptibility in the State of Minnesota. Using the Minnesota Land Management Information Center's (LMIC) Prime computer, data from digitized base maps were combined and ranked to provide an evaluative tool to highlight those areas of the state most vulnerable to contamination from land surface and near-surface activities. A preliminary map of ground water contamination susceptibility was developed which delineates a variety of ground water contamination susceptibility regions across the state. This mapping exercise is included in Appendix F.

Base maps used for the mapping exercise include an aquifer materials map created for the project, a vadose zone materials map also created for the project, a soil materials map modified from existing statewide soils data, and a recharge

potential map derived from hydrologic soils groups listed in the Minnesota's Soils Atlas Series. Ranking of the factors within each component map was modified from the National Water Well Association's DRASTIC system for evaluating ground water pollution potential. All the parameters were combined in a computer file with each sequence of factors being a unique four or five digit number. There were more than 1,000 unique combinations of physical characteristics for the state.

Each digit was subsequently assigned a relative rank and then the ranks were summed to give the final relative rating for each unique area of the State. The preliminary product, a map of the relative ratings, delineates the areas of lowest ground water contamination susceptibility as those areas where the aquifers are nonexistent or low-yielding, and recharge potential is very low. In general, areas of the State which received high ratings are those which are dominated by sand and gravel deposits and those areas in the southeastern corner of the State which have karstic bedrock near the land surface.

There are problems with the current version of the ground water susceptibility map. These problems include areas of the state information was insufficient to properly rank susceptibility; as well as the lack of digitized depth-to-water information. In addition, buried unconsolidated aquifers were frequently not well-defined, and therefore were poorly illustrated on maps. Future refinements planned (based on the availability of funding) include addressing these problems, and the building of cultural factors into the data base, such as land use, population density, sources of potential impact, etc. The goal is to develop a product which will be useful in prioritizing agency programs and raising public awareness of environmental vulnerability in the State.

From these studies, it appears that ground water is subjected to NPS pollution and that several areas are showing serious signs of stress. The pollutants of main concern are nitrate nitrogen and pesticides. Areas likely to be contaminated with these pollutants are areas of surficial sand and gravel aquifers in central and southwestern Minnesota and the Karst area of southeastern Minnesota.

WETLANDS

According to Minnesota Statutes, [Minnesota Statutes 105.37 subd. 15 (1987)] wetlands are defined as all types 3, 4, 5 wetlands (U.S. Fish and Wildlife Service Circular No. 39, 1971) not included in the definition of public waters. In unincorporated areas, this includes wetlands which fulfill the above criteria, and are 10 acres in size. In incorporated areas, the wetland must be 2½ acres. This definition was intended to apply to the regulation of wetlands by Minnesota Department of Natural Resources (MDNR) permits. The definition provides a regulatory framework, but it has essentially been replaced by the concept of "protected waters" which MDNR currently uses in its regulatory programs. Protected waters are those that are on the protected water inventory.

In Minnesota there are approximately six million acres of wetlands or marsh. These areas are considered an important natural resource that requires special consideration from all types of impacts. An evaluation for NPS impacts of every wetland in Minnesota is a monumental task beyond the scope of any single agency.

In the past the largest single activity affecting wetlands has been drainage. In Minnesota it is estimated that approximately two-thirds of all wetlands have been lost to drainage or filling (Minnesota Soil and Water Conservation Board, 1982). A review of the U.S Army Corps of Engineers permit actions indicates that approximately 1,300 acres may have been drained in water years 1986-1987. Many of the recent drainage projects fall outside the Corps of Engineers' jurisdiction and projects can be segmented to avoid regulation. Because of these jurisdictional gaps, there are no accurate estimates for total acreage drained in the State of Minnesota. Also, there are no state or federal agencies that regulate all drainage of wetlands in the State. However, there are numerous agencies including the U.S. Army Corps of Engineers and the MDNR, that can exert influence on drainage decisions through their respective planning and regulatory programs.

By examination of U.S Army Corps of Engineers permit actions it is also estimated that approximately 1,200 acres of wetlands have been filled through regulated activities during water years 1986-1987. Additional fill activities have undoubtedly occurred and there is a potential that these fill activities could be significant, especially in urbanized areas, but there is no comprehensive information to evaluate these impacts.

All wetlands have the potential to be impacted by drainage and filling activities. Other NPS impacts are also likely, but best evaluated at the local level by local resource managers. In Minnesota, all wetlands are considered threatened by NPS impacts. The U.S. Fish and Wildlife Service is completing an inventory of the State's wetlands which will identify these sensitive areas. In addition, a Wetland Evaluation Task Force was recently formed in Minnesota.

The Wetland Evaluation Task Force reviewed many wetland evaluation procedures and developed the Minnesota Wetland Evaluation Methodology for the North Central United States (Kittelson, 1987). This procedure, based on the U.S. Department of Transportation's Method for Wetland Functional Assessment (Adamus et al., 1982), evaluates wetlands for their functional benefits to flooding, water quality, shoreline anchoring, aesthetics, fish and wildlife. It does not provide an evaluation of NPS impacts, however, many of the functional benefits mitigate downstream NPS impacts. The Minnesota Wetland Evaluation Methodology can be used to assess individual wetlands, but is inappropriate for a statewide evaluation of all wetlands.

LOCAL WATER RESOURCE MANAGERS

Background

Minnesota has over 12,000 lakes, nearly 92,000 stream miles, 14 principle aquifers and 6 million acres of wetlands. The abundance of the water resource far exceeds the ability of Minnesota's water quality data base to identify all NPS impacts. Therefore, a NPS assessment must rely on the first-hand experience of local resource managers.

In the spring of 1986 the MPCA requested Minnesota Department of Natural Resources fishery managers and county zoning administrators to address several questions relating to NPS pollution in their management area. These questions were presented in a survey format and solicited a list of NPS impacted waterbodies, their uses, and the causes and types of pollution affecting the

waterbodies. The local resource managers were provided one month to respond to the survey.

Based on the results of the 1986 survey, the MPCA, in the fall of 1987, requested that the Minnesota Department of Natural Resources hydrologists, wildlife managers, and foresters, Watershed Districts, Soil and Water Conservation Districts, and Rural Development Commissions complete a similar NPS survey. The county zoning administrators and the fishery managers were also asked to update their 1986 survey response.

Approximately 50% of the surveys were returned covering every county in the state (Figure 3). All the waterbodies identified as NPS threatened or impaired by the local resource managers, the NPS effects on the waterbodies, likely causes, and the waterbody uses have been tabulated and are presented in Appendix G. The following is a brief synopsis of the results of the survey. The results, when assessed regionally, clearly show where the NPS problems occur what they are and their effects (Table 4).

Results

Statewide over 4,100 threatened or impaired waterbodies were identified. Most of these waterbodies were lakes or streams (55 and 40 percent, respectively). Wetlands and aquifers were also identified, but much less frequently (4 and 0.5 percent, respectively).

Regionally, the most waterbodies identified occurred in the North Central Hardwood Forest ecoregion (38 percent). Most of these waterbodies were lakes. The Western Corn Belt Plains ecoregion was also well represented by the number of threatened or impaired waterbodies identified (29 percent). A fairly even mixture of lakes and stream reaches were identified here. Stream reaches were more frequently identified as impacted or threatened by NPSs in the Driftless Area and Red River Valley ecoregions. Approximately even ratios of lakes and streams were identified for the Northern Glaciated Plains, Northern Lakes and Forests, and Northern Minnesota Wetlands ecoregions.

The local resource managers also identified categories of NPSs that threaten or impair the waterbodies identified. The majority of these categories reflect agricultural activities (56 percent). Urban (13 percent), land disposal (11 percent) and hydromodification (10 percent) activities were also frequently cited. The most frequently cited subcategories of NPSs reflect cropping activities (17 percent), agricultural chemical application (17 percent), animal management (8 percent) and on-site septic systems (8 percent).

The Northern Lakes and Forests ecoregion, located in northeastern Minnesota, is the largest of Minnesota's seven ecoregions. Although lakes, streams and wetlands are relatively abundant in this area, (the Northern Lakes and Forests ecoregion contains 46 percent of Minnesota's lakes) only 13 percent of the NPS threatened or impaired waterbodies identified by resource managers were from the Northern Lakes and Forests. This suggests that NPS problems are not widespread in the area.

Most of the waterbodies identified by Northern Lakes and Forests resource managers were lakes and streams. A few wetlands, but no aquifers were also identified as threatened or impaired by NPS.

Table 4. Results of the NPS Survey of Local Resource Managers

	State	Ecoregions						
		Forested		Mixed		Agriculture		
		NLF	NMW	NCHF	DA	RRV	NGP	WCBP
Percent of Water Bodies Identified	100	13	4	38	2	6	8	29
Dominant Type of Water Body Identified*								
Lake	1	1	2	1	2	2	2	2
Stream	2	2	1	2	1	1	1	1
Wetland	3	3		3		3		3
Aquifer	4			4	3			4
Major NPS Effects*								
Sedimentation	1			2	1	2	1	1
Eutrophication	2	1	2	1		3		
Turbidity	3			3			2	2
D.O.							3	
Toxics		2	1		3	1		3
Habitat Modification					2			
Bacteria		3						
Unknown			3					
Other								
Major NPS Categories*								
Agricultural	1	1	1	1	1	1	1	1
Urban	2			2		2		2
Land Disposal	3	2	2	3	2		3	
Hydromodification		3			3	3	2	3
Construction			3					
Forestry								
Mining								
Other								
Unknown								
Major NPS Subcategories*								
Crop Production	1			1	2	1	1	2
Agricultural Chemicals	2			2	1	2	2	1
On-site Septic Systems		1	2					
Pasturing		2	1					

* The numbers indicate the relative number of responses received.

The main NPS categories affecting Northern Lakes and Forests waterbodies were related to agriculture, land disposal, hydromodification or urban land use activities. The main subcategories were on-site septic systems followed by pasturing and agricultural chemical application. These NPS categories were believed to result in eutrophication, toxics and sedimentation problems for the identified waterbodies.

The Northern Minnesota Wetlands ecoregion, similar to the Northern Lakes and Forests ecoregion, is heavily forested and located in northern Minnesota. In contrast to the Northern Lakes and Forests, this area is characterized by extensive wetlands. Although wetlands are abundant, only lakes and stream reaches were identified as NPS threatened or impaired. About 4 percent of the waterbodies identified statewide were from the Northern Minnesota Wetlands. Based on the number of waterbodies identified, it appears that NPS problems are not extensive in this ecoregion.

The main NPS categories affecting Northern Minnesota Wetlands lakes and streams were related to agriculture, land disposal, construction and hydromodification activities. Pasturing, on-site septic systems, crop production, agricultural chemical application and land development were the main NPS subcategories identified in the Northern Minnesota Wetlands, these NPSs were believed to result in toxics, eutrophication bacteria and unknown water quality problems.

The North Central Hardwood Forests ecoregion is located immediately south of the Northern Lakes and Forests and Northern Minnesota Wetlands ecoregions. This area, like the Northern Lakes and Forests, is characterized by an abundant lake resource.

Most of the waterbodies (38 percent) identified as NPS threatened or impaired were reported from areas within the North Central Hardwood Forests ecoregion. This suggests that local resource managers feel that NPS problems are widespread in this ecoregion. Many of the waterbodies identified were lakes which also suggests that lakes are an important resource in the Northern Central Hardwood Forests.

The main NPS categories affecting North Central Hardwood Forests waterbodies were related to agriculture, urban and land disposal activities. The main subcategories were crop production, agricultural chemical application and on-site septic systems. These NPS categories were believed to be associated with eutrophication, sedimentation and turbidity problems.

The Driftless Area ecoregion located in southeastern Minnesota is the smallest of Minnesota's seven ecoregions. This area is characterized by few lakes and an abundant ground water resource. Only about 2 percent of the waterbodies identified statewide were from this ecoregion. Most of these waterbodies were streams.

The main NPS categories affecting Driftless Area waterbodies were agriculture, land disposal and hydromodification activities. The main subcategories were agricultural chemical application and crop production. The NPS categories were believed related to problems associated with sedimentation, habitat modification and toxics.

With respect to the NPS concerns in the Driftless Area ecoregion, it is interesting to note that local resource managers made only one reference to ground water. Recent water quality monitoring suggests that southeastern Minnesota is showing signs of ground water contamination by nitrates and pesticides. Although this information has been widely publicized, local resource managers did not express this concern by identifying ground water in their survey responses. Reference to agricultural chemical application as the main subcategory of NPS, however, may suggest that pesticides and nitrates are a concern.

The Red River Valley ecoregion is an intensively cultivated area located along the Minnesota and North Dakota border. This ecoregion, like the Driftless Area, has few lakes. Streams, lakes and wetlands were identified as NPS threatened or impaired.

The main NPS categories affecting Red River Valley waterbodies were agriculture, urban and hydromodification activities. The main subcategories of NPS identified by the local resource managers were crop production and agricultural chemical application. These NPS categories were believed to be associated with toxic, sedimentation and eutrophication problems observed in the Red River Valley.

The Northern Glaciated Plains ecoregion is another intensively farmed area located in the southwestern corner of Minnesota. Approximately 8 percent of all NPS threatened or impaired waterbodies identified by local resource managers were from this area. This area does provide a good mixture of lake, stream and wetland surface waters.

Wetlands and aquifers were not identified as NPS threatened or impaired waterbodies. About equal numbers of lakes and streams were identified.

The main NPS categories identified by the resource managers were agriculture, hydromodification and land disposal. Similar to the Red River Valley ecoregion the main NPS subcategories were crop production and agricultural chemical application. These NPS categories were believed to be associated with eutrophication, turbidity and dissolved oxygen problems observed in the ecoregion. It is interesting to note that the Northern Glaciated Plains and Red River Valley ecoregions are both intensive agricultural areas with similar NPS categories. However, the effects of these NPS categories differs. In the Northern Glaciated Plains, there are more lakes and more lake associated concerns were identified.

The Western Corn Belt Plains ecoregion is located in the south central part of Minnesota, an area noted for intensive agricultural activities. The number of NPS threatened or impaired waterbodies identified by local resource managers for this ecoregion (29 percent of the statewide total) is second only to the North Central Hardwood Forest ecoregion. This response suggests that NPS problems are widespread and that many resource managers are concerned about water quality.

Most of the waterbodies identified by Western Corn Belt Plains resource managers were lakes or streams, however, a substantial proportion of the aquifers and wetlands identified by resource managers were also from this area.

The main NPS categories affecting Western Corn Belt Plains waterbodies were related to agriculture, urban and hydromodification activities. The main subcategories were agricultural chemical application and crop production. These NPS categories were believed to be associated with eutrophication, turbidity and toxic NPS problems.

ASSESSMENT OF SPECIAL PROBLEMS

Fish Tissue Contamination

The fish consumption advisory issued in May, 1987 was used as a basis to determine the use support category for contaminants in Minnesota waterways. The advisory is comprehensive, using data from the inception of the program in 1975 to 1985. Since this advisory was issued, tissue samples from fish collected in 1986 have been analyzed and are included. Data from 1975-1982 was considered "evaluated" data. Data from 1983-1986 was considered "monitored" data. A waterbody was considered monitored if data from both time periods was used. At this time, 2,941 fish fillet samples have been analyzed for one or more contaminants. Of these, 41 - 2,3,7,8 tetrachlorodibenzo-a-dioxin (TCDD) samples, 1,236 polychlorinated biphenyls (PCBs) samples, and 2,140 mercury (Hg) samples in fish fillets were used to determine advisories and were used for this assessment. Fish tissue samples have not been analyzed for the other International Joint Commission (IJC) pollutants of concern.

There are four categories of advice in the MDH fish consumption advisory ranging from "unrestricted" to "no consumption advised." Waterbodies where all of the samples were placed in the "unrestricted consumption" group were listed in the "fully supporting and not threatened" use category. Waterbodies where at least one sample was placed in one of the two intermediate groups were listed in the "partially supporting" use category. Waterbodies where at least one of the samples were in the "no consumption advised" group were listed in the "not supporting and impaired" use category. No waterbodies were placed into the "fully supporting but threatened" use category.

Contaminant levels for each interval are listed in Table 5. These levels are similar to those used in Minnesota's 1986 305(b) report. This assessment does not take into account the variability in contaminant levels due to fish size (i.e., waterbodies with large fish sampled may be placed in a worse category than waterbodies with small fish). In addition, it does not distinguish between locations with different levels of sampling effort.

Table 5. FISH CONTAMINANT CONCENTRATIONS FOR EACH USE CATEGORY.

	Contaminant		
	TCDD (ng/kg)	PCB (ug/g)	Hg (ug/g)
Fully supporting (unrestricted consumption)	0.0-0.5	0.0-0.14	0.0-0.21
Partially supporting (moderate consumption)	0.6-5.1	0.15-1.99	0.22-2.95
Not supporting (no consumption advised)	5.2-over	1.0-over	2.96-over

The lake surface area, Great Lake shoreline length, and stream reach length which was represented by each station was listed and summed by use category (Appendix H). For each station the entire surface area, shoreline length, or reach length was listed and summed irrespective of the number of stations or samples. For lakes, the surface area of the entire lake or bay was listed in acres. For streams, the main channel length (i.e., no tributaries) represented by each station was determined by: 1) mileage between fish barriers (falls or dams), 2) mileage between major sources of contaminants, 3) mileage between major tributaries or 4) best professional judgement. These reaches generally correspond to river boundaries established for the fish consumption advisory. For example, the Cedar River is divided into a background reach (upstream of a fish barrier and a major discharger) and into an impacted reach (downstream of a fish barrier and a major discharger). If two or more stations represent the same reach, the data was combined and assessed as one station. One of the stations within the reach was assigned to be a "principal station" and the others were designated "associated stations." The mileage for the entire reach was assigned to the principal station.

The waterbodies used for this section of the report may not be representative of all Minnesota waters. The fish samples used in this analysis are generally collected from waters that 1) have a history of contamination; 2) are near suspected sources; 3) have characteristics similar to contaminated waters or 4) are heavily fished. Waterways not suspected of being contaminated are not sampled as often or as frequently. Also, large lakes (over 5,000 acres) are not sampled as intensively as small lakes (under 5,000 acres) due to logistical difficulties of obtaining the samples.

Assessing NPS pollution problems through an evaluation of fish tissue contaminant levels is difficult because fish tend to be mobile and there is no direct way to positively identify the source of the contaminants. The waters identified through this assessment do not distinguish the source of the pollutant problem. It is likely that the waters identified here (Appendix H) are impacted by both point and nonpoint sources.

Lakes

From 1975 through 1986, 228 lakes representing 1,367,131 acres, or 40 percent of Minnesota's 3,411,200 acres were sampled for contaminants in fish. The majority of the lakes (184), representing 91 percent of the acreage, have been sampled since 1983 and are considered "monitored." Fewer lakes (44), representing nine percent of the total acreage, were sampled before 1983 and are considered "evaluated." Most of the lakes in Minnesota (99 percent) are smaller than 5,000 acres. Likewise, most of the lakes (198) sampled for contaminants were less than 5,000 acres. However, they represented only 13 percent of the total acres assessed. Lakes larger than 5,000 acres (30) represent the majority (87 percent) of the acres assessed. Small and large lakes will be discussed separately to avoid any bias created by the extensive area of the large lakes.

Nearly one-half of Minnesota's large lakes (30 of 62) representing 1,185,384 acres, have been sampled for contaminants in fish. Of these, four large lakes representing 85,464 acres (seven percent) fully supported fish consumption uses. Twenty-five lakes representing 1,091,030 acres (92 percent) partially supported fish consumption uses. This was primarily due to mercury contamination of several northeastern Minnesota lakes. The sources of mercury to the region may

be determined in a state sponsored study. One lake, Minnetonka (lower lake), partially supported fish consumption uses due to PCB contamination. One lake, Sand Point Lake in northeastern Minnesota, representing 8,890 acres (one percent) did not support fish consumption uses due to mercury contamination.

A small number of lakes with surface areas less than 5,000 acres have been sampled for contaminants in fish. These lakes represent 181,742 acres, or 198 of 11,972 small lakes. Of these, 31 lakes representing 35,738 acres (20 percent) fully supported fish consumption uses. One hundred sixty-six lakes representing 145,018 acres (80 percent) partially supported fish consumption uses primarily due to mercury contamination. Some reservoir lakes (Silver Lake and Grays Bay of Lake Minnetonka) and river backwater lakes (Pig's Eye and Snelling) were contaminated with PCBs, presumably due to past disposal practices. Some Minneapolis-St. Paul area lakes (Christmas and Harriet) were also contaminated with PCBs. The sources of PCBs to these lakes are unknown. Fourmile Bay of Lake of the Woods was contaminated with dioxins from upstream papermill sources.

Great Lakes

Fish samples were collected from five locations from Lake Superior. Fish from these locations are thought to represent the whole lake. Lake trout over 30" were collected from one location but were unavailable from the others. These fish had PCB concentrations over 2.0 ug/g. The Wisconsin Department of Natural Resources also collected lake trout over 30 inches (south shore) and measured PCBs over 2.0 ug/g in many of the samples. Based on this information, MDH and the Wisconsin Department of Health decided to issue a lakewide advisory for lake trout over 30 inches. These collections were the first lake trout over 30 inches that were collected for contaminant analyses since the U.S. Food and Drug Administration lowered its guideline for PCBs from 5.0 to 2.0 ug/g. Since all of Lake Superior is under an advisory, the entire shoreline length was classed as not supporting fish consumption uses.

Rivers

Fish from 101 river locations, representing 1855.3 miles, have been analyzed for contaminants in Minnesota. Of these, 13 locations representing 231.9 miles (14 percent) fully supported fish consumption uses. Forty-four locations representing 1121.2 miles (60 percent) partially supported fish consumption uses. Forty-four locations representing 477.2 miles (26 percent) did not support fish consumption uses. The ratio of the average miles represented per station declined from 39:1 for fully supporting, 25:1 for partially supporting and 12:1 for not supporting. These ratios reflect the need to intensively sample areas found to be contaminated to characterize the contamination and help locate sources.

Sediment Contamination

The St. Louis Bay is one area where contaminated sediment has been identified as a major source of contaminants to aquatic life by the International Joint Commission (IJC). This area was identified as partially or not supporting fish consumption uses due to dioxin, PCB and mercury contamination. In this case, the course of action was to initiate a "Remedial Action Plan" (RAP) investigation. The RAP will address and identify the following: (1) define

environmental problem; (2) identify beneficial uses impaired; (3) describe problem causes and identify sources; (4) identify remedial actions to resolve problems and restore uses; (5) schedule for implementation of remedial measures; (6) identify responsible agencies and jurisdictions; (7) describe process for evaluation of RAP effectiveness and, (8) describe surveillance and monitoring activities to track RAP effectiveness. This project requires local, state and federal cooperation to succeed.

Aquatic sediment samples are also used to help locate sources of pollutants. For example, aquatic sediment samples were collected from the Rainy River system to help locate the source of dioxins to fish. (Some reaches of the Rainy River do not support fish consumption uses due to dioxins.) Samples were taken from Rainy Lake, Rainy River above and below International Falls, and from Lake of the Woods. The results showed no contamination above International Falls and immediately below papermill discharges. However, downstream samples showed contamination in Fourmile Bay where the Rainy River enters Lake of the Woods. Samples from Lake of the Woods showed no contamination. These samples, along with papermill sludge and effluent samples, indicate that papermills on the river are a significant source of dioxins to the Rainy River system. Regulatory strategies are being developed at this time by the MPCA to control the dioxin discharges.

Acid Rain

Areas sensitive to acid rain have been identified by the MPCA in a previous document.

This information is available upon request. It will not be presented here because the acid rain problem is addressed through another program. Information related to the acid rain program is included in Appendix I.

III. THE PROCESS FOR DEFINING BMPs

BMP IDENTIFICATION

Background

In order to effectively address nonpoint source pollution, it is necessary to identify those management solutions which are effective and useful as part of the statewide management program. To complete this process, the Minnesota Pollution Control Agency, with funding through the Legislative Commission on Minnesota Resources, established an intergovernmental personnel agreement with the USDA-Soil Conservation Service to develop a process to identify best management practices (BMPs) and prepare handbooks to catalog BMPs for four land uses; urban, agricultural, forestry and mining. Completion of these handbooks is scheduled for the summer of 1989.

The definition of a BMP to be used for the identification process is, practices, techniques, and measures that prevent or reduce water pollution from nonpoint sources by using the most effective and practicable means of achieving water quality goals. Best management practices include, but are not limited to: official controls, structural and nonstructural controls, and operation and maintenance procedures. Because of the very site specific nature of BMPs, the MPCA will not attempt to specify a single practice or set of practices to be used in a given situation. The approach taken is to identify a process where a resource manager can determine what practices are needed for their particular land use.

The BMPs included in the handbooks will be based upon existing technology. Where necessary, practices will be tailored to conditions in Minnesota. As technology changes BMPs will be updated through a handbook maintenance procedure.

These handbooks will be used as an informational and educational tool for Minnesota's nonpoint source (NPS) pollution control program. Funding under Minnesota's NPS pollution control program will not be restricted to BMPs identified in these handbooks. The BMP identification process referenced in the handbooks will be used for this program.

The Process

The first step in the process is to identify the impacted water body and set reasonable goals for water quality. An impacted waterbody could be identified either by an impaired use or by violation of water quality standards. In the case of an aquifer or Outstanding Resource Value Water, BMPs may be needed to protect for nondegradation even if it has not been impacted. Water quality goals will vary from one part of the state to another. For example, a reasonable water quality goal in the Northern Lakes and Forest ecoregion of Minnesota would probably not be attainable in the Western Corn Belt Plains ecoregion.

The second step is to identify nonpoint source pollutants responsible for water quality problems and the delivery processes (availability, detachment, transport). This is an important process to understand because some pollutants are best controlled at certain stages. For example, sediment is always available for loss as soil and nothing can be done to reduce this in most situations. Sediment is best controlled by preventing detachment with erosion

control practices. Nitrogen, on the other hand, is best controlled at the availability stage and is difficult to control after that.

The third step is to identify BMPs that can be used to prevent pollutants from entering a waterbody. The term "BMP" insinuates that there is one practice that will solve a particular problem. However, if the previously mentioned definition of BMP is scrutinized one can see that it involves a combination of practices or a "system." This "system" approach using several individual practices will be stressed.

In selecting the practices that constitute a BMP, there are many factors that must be considered other than water quality alone. The practice selection considerations include, but are not limited to, the following:

- Will the BMP achieve the desired level of water quality?
- Will the BMP solve a water quality problem or shift it to another waterbody? For all surface water BMPs, what are the effects on ground water?
- Are the costs such that a reasonable economic return can be expected from the land use where applicable? This includes both implementation costs as well as operation and maintenance costs.
- Does the practice meet the land users needs and operation?
- Is the practice well suited to the individual site?
- Are there proven standards or criteria with known results?
- Are there detrimental effects to the environment such as destruction of wildlife habitat, etc.
- If a practice is an educational program, will it be implemented so it is effective?
- If a practice is a local official control, will uniform enforcement be implemented along with it?

The Handbooks

The practices that are included in the handbooks will be evaluated based upon a very broad consideration of the factors for BMP selection. It would be impossible to try to make detailed evaluations for all situations. In the handbooks, the practices will be described in such a manner that the planners can make their own decisions on practice suitability.

Each handbook will be slightly different based upon the intended audience. In handbooks such as Agriculture and Forestry, the practices and principles will be described in layman terms and the reader will be referred to appropriate technical experts for planning assistance, such as the USDA Soil Conservation Service. In the urban handbook, the material will be more technical and will include information such as recommended design criteria. The criteria will only be recommendations and not standards. It is anticipated that local units of

government may refer to these recommendations and make appropriate changes or develop ordinances which would change the recommendations to requirements for their purposes.

The following is a brief description of the handbook status to date.

Agricultural Handbook

An advisory committee has been established for the preparation of the Agricultural handbook. This advisory committee has representatives from various governmental and industry groups such as the Soil Conservation Service, the Board of Water and Soil Resources, Minnesota Department of Agriculture, Minnesota Department of Health, Minnesota Association of Soil and Water Conservation Districts, Minnesota Pollution Control Agency, Farm Bureau, and the University of Minnesota. The committee met at the beginning of the project and made recommendations on the content and format of the handbook. As a result, the handbook will be written for the farmer and layman and will cover the following topics:

1. What are the common nonpoint source pollutants from agriculture?
2. What are the water quality impacts of these pollutants?
3. What are the BMPs that can be used?
4. How are BMPs combined into a "system" to control NPS pollution.
5. Where is assistance, services, and further information available from?

A draft copy of this handbook is being reviewed by the advisory committee. When their comments are incorporated, the draft will be available for review by anyone interested party.

Urban Handbook

There is considerable interest in the urban handbook in the metropolitan area. An advisory committee has been established with representatives from the following groups: Metropolitan Council, Metropolitan Association of Soil and Water Conservation Districts, Consulting Engineers Council, League of Minnesota Cities, Associates General Contractors, Soil Conservation Service, Minnesota Department of Transportation, Pollution Control Agency, Department of Natural Resources, Minnesota Association of Watershed Districts, University of Minnesota, and the Board of Water and Soil Resources.

This handbook will contain the technical criteria necessary to size structural measures. The recommendations will be based upon criteria developed by the national urban runoff program (NURP).

The handbook will have three major sections. They are 1) sediment and erosion control, 2) practices to prevent urban pollutants from entering water, and 3) practices to remove urban pollutants from water.

For the sediment and erosion control section, the MPCA is working with the Board of Water and Soil Resources. They have been working with several Soil and Water

Conservation Districts in the metro area to develop uniform sediment and erosion control guidelines. In cooperation, the MPCA is preparing the practice descriptions and engineering examples. The section on preventing pollutants from entering water will deal with management practices such as street sweeping and proper fertilizer application. The section on removal of pollutants from storm water will describe practices such as detention ponds, oil separators, etc.

A draft copy of this handbook is being reviewed by the advisory committee. When their comments are incorporated, the draft will be available for review by any interested party.

Forestry Handbook

The MPCA is working closely with the Minnesota Department of Natural Resources (MDNR), Division of Forestry in the preparation of this handbook. MDNR has discussed the handbook with various governmental and industry land managers. They are all very receptive to being involved in the preparation of the handbook. The MPCA will meet with this group in the near future to get input on the handbook format and content.

Mining Handbook

The MDNR, Minerals Division has agreed to assist the MPCA with the preparation of the mining handbook. The MPCA is in the process of making contacts with industry groups to serve on an advisory committee. The exact content of the handbook has not been decided.

IV. LOCAL, STATE AND FEDERAL PROGRAMS

BACKGROUND

Achievement of Minnesota's water quality goals will require a comprehensive water quality program, implemented through a coordinated local, state and federal partnership. In Minnesota, this will be accomplished through a coordinated two tier strategy for controlling nonpoint sources of pollution.

Tier 1: Implementation of comprehensive water quality protection and improvement projects on a hydrologic unit basis through two programs; 1) the Clean Water Partnership (CWP) Program and 2) the federal Clean Lakes Program. Both programs are administered by the MPCA. These programs provide for comprehensive study and implementation projects which focus on protecting and improving the water quality of specific waterbodies - lakes, streams, wetlands and aquifers.

Tier 2. Implementation of best management practices through other local, state and federal programs, to protect resources from degradation by nonpoint sources of pollution on a broad statewide basis.

The two-tiered strategy is supported by a structure that includes:

1. Ongoing monitoring and research to provide data and information, so water quality trends and facts guide NPS management program implementation;
2. Information and education efforts integrated into water quality projects and programs, so individual land managers have current and factual information on management practices;
3. Local Water Planning
4. Technical Assistance and Local Program Delivery System
5. State water planning, coordination and evaluation.

TIER I: COMPREHENSIVE WATER QUALITY PROJECTS

The Clean Water Partnership Program

In 1987, the Minnesota Legislature established the Clean Water Partnership Program (CWP) (Minn. Stat. § 115.091 to 115.103, Supp. 1987) to protect and improve surface and ground water in Minnesota, through financial and technical assistance to local units of government for the control of water pollution from nonpoint sources.

The Clean Water Partnership Program provides financial assistance through matching grants and technical assistance to local units of government to lead nonpoint source pollution control projects. The MPCA has adopted permanent rules (Minn. Rules Chapter 7076) to establish the administrative criteria and procedural conditions under which the MPCA may award grants to local units of government. The legislation and permanent rules establishing the Clean Water Partnership Program are presented in Appendix J.

The rules provide separate grants for fifty percent of the eligible costs of project development and project implementation. The project development grant is to complete a diagnostic study and implementation plan which meet the requirements defined in the rules. The project development activities identify the specific water quality problems and sources of pollution and the combination of best management practices, activities and protective measures that will be necessary to solve the identified problems. The project implementation grant is to install the best management practices and carry out educational and other activities identified in the implementation plan completed through the project development grant.

The rules also include the procedures and conditions for administration of the program. This includes the application requirements that provide the MPCA with the information necessary to rank the projects in order of priority for funding. The rules spell out the criteria and procedures to be used by the MPCA in ranking projects to receive funding, the allocation of funds between project development grants, project implementation grants and the continuation of ongoing projects. The rules also identify costs that are eligible for reimbursement, requirements for contracts between the MPCA and project sponsor and procedures for reimbursement of grant eligible costs.

The CWP establishes the authority and mechanism for Minnesota to implement projects on a watershed by watershed basis using funds that become available through the federal Nonpoint Source Management Program.

The Clean Lakes Program

Since the inception of the Clean Lakes Program, the MPCA has been designated as the state agency to administer grants awarded to the state from the U.S. EPA. The purpose of the program is to preserve and protect Minnesota's lakes to increase and enhance their public use and enjoyment. This is done by providing federal matching grants to eligible local units of government to conduct specific lake water quality projects.

The Program has been and continues to be an important part of the MPCA's efforts to address lake water quality problems. To date, the MPCA has completed nine Clean Lakes projects and currently has 17 projects underway. Three of the ongoing projects are nonpoint source demonstration projects. The success of these demonstration projects has been instrumental in establishing the state's Clean Water Partnership Program.

The Agency's existing Clean Lakes projects include a variety of work ranging from limited dredging, hypolimnetic aeration, treatment of bottom sediments, biomanipulation and other in-lake measures to wetland restoration, artificial wetland creation, stream bank erosion control and other watershed management measures. While in the past the program emphasized in-lake measures, the MPCA has reassessed the program's focus, shifting the emphasis from in-lake restoration measures to watershed management and nonpoint source pollution abatement. This approach concentrates on reducing the pollutants entering a lake prior to implementation of in-lake restoration measures.

The MPCA anticipates continuing its active participation in the Clean Lakes Program to the extent that federal funding allows.

TIER II: STATEWIDE IMPLEMENTATION OF BEST MANAGEMENT PRACTICES.

The following is a listing of authorities and programs in Minnesota that are effective for controlling nonpoint sources of pollution. The list is organized by the topical areas of Agricultural Crop Production, Animal Waste Management, Pesticide and Fertilizer Application, Urban Runoff/Infiltration, Construction, On-site Wastewater Treatment, Hydromodification, Silviculture, Mining, Highway De-icing Chemicals, Special Erosion Problems, Land Disposal, Atmospheric Deposition, In-place Pollutants,

Agricultural Crop Production

Minnesota Cost Share Program

The Minnesota Cost Share Program provides cost-sharing contracts for erosion control and water management through the 91 Soil and Water Conservation Districts (SWCD) throughout the state.

Minn. Stat. Sec. 40.036 . . . authorizes Soil and Water Conservation Districts, with grants from the Board of Water and Soil Resources (BWSR), to contract for cost-sharing with land occupiers and state agencies for permanent non-production oriented systems for erosion control and water quality improvement. . .

In providing financial incentives to land owners throughout Minnesota for the installation of permanent non-production oriented soil and water conservation practices, the Board of Water and Soil Resources and the SWCDs will follow these steps:

1. SWCDs apply to the state for funds. The BWSR, within priorities established in their program plan, provides grants to SWCDs. These grants are used for providing cost-sharing assistance to land occupiers. In addition, grant monies are provided to assist SWCDs in the technical and administrative aspects of the program. The grants provided to SWCDs must be used in accordance with the needs and priorities reflected in their annual and long-range plans.
2. Upon receipt of grant monies, and within guidelines established by the BWSR, SWCDs are responsible for making all local decisions concerning the program. SWCDs, after approving a project, are responsible for issuing payment.
3. All projects must be designed and constructed according to USDA Soil Conservation Service standards and specifications or plans approved by a registered engineer.
4. All installed practices will be monitored by SWCDs to insure that they will be properly maintained for a minimum of ten years.

Board of Water and Soil Resources rules provide that at least 70 percent of the cost-sharing funds available statewide for conservation practices be used to address high priority erosion, sediment or water quality problems.

Soil Loss Limits

The Excessive Soil Loss Limits (Minn. Stat. §§ 40.19-40.28), provides local units of government with authority to adopt and administer an ordinance to reduce the amount of soil erosion on Minnesota land, to decrease the amount of off-site damages from sediment, retain the productivity of the soil and improve water quality. To date only one county has adopted an excessive soil loss ordinance.

Reinvest in Minnesota Reserve Marginal Agricultural Lands Program

The Reinvest in Minnesota Reserve Marginal Agricultural Lands Program (RIM Reserve) acquires marginal cropland for conversion to permanent grass or trees. The program offers landowners two payment options, a 20 year or perpetual easement discounted lump sum payment based on cash rent for cropland in the area. The program also provides perpetual easements for restoring wetlands on previously drained cropland. RIM Reserve also provides up to 100 percent of the expense of establishing permanent cover.

The state law sets up minimum enrollment requirements of landowners and their land, and designates the soil and water conservation district boards as the agents who administer the program locally using state guidelines.

The landowner is responsible for the operation and maintenance of the vegetative cover and for ensuring that all easement restrictions are followed. Should the landowner fail to install or maintain the practices or comply with easement restrictions during their effective life, the landowner may be subject to penalties including repayment of financial assistance, mandatory court-imposed injunctions, or other actions directed at correcting the maintenance violation.

To date, over 25,000 acres have been idled through this program. RIM Reserve is part of a program administered by the Department of Agriculture and the Department of Natural Resources. The Board of Water and Soil Resources administers RIM Reserve via an agreement with the Department of Agriculture.

USDA Conservation Reserve Program

The Conservation Reserve Program authorized by the 1985 Food Security Act was established as a voluntary program to help farmers control erosion on marginal cropland by taking it out of annual crop production and put it into perennial grass, wildlife plantings, windbreaks or trees. USDA enters a 10 year contract with the farmer and provides annual rental payments in cash or commodities. USDA also provides half the expense of establishing permanent cover on the land and provides technical assistance to land owners.

In Minnesota, over 1.5 million acres have been taken out of production and permanent cover established. There are potentially over five million acres eligible for the program in Minnesota.

USDA Agricultural Conservation Program (ACP)

The Agricultural Conservation Program, provides financial assistance (cost-sharing) to farmers, ranchers, and woodland owners and tenants who wish to voluntarily apply soil, water, woodland, and wildlife conservation practices to

their land. Soil erosion and nutrient runoff due to agricultural production is a major emphasis of the program. The Agricultural Conservation Program was authorized by the Soil Conservation and Domestic Allotment Act of 1936, as amended. The program is carried out by USDA Agricultural Stabilization and Conservation Services (ASCS) through a system of state and county committees.

USDA Soil and Water Conservation Loan Program

The Farmers Home Administration conducts a large number of credit programs for the rural community, one of which is the Soil and Water Conservation Loan Program. This program provides either insured or guaranteed loans to farmers for the purpose of improving the management of their soil and water resources. The loans may be made to partnerships or corporations as well as to individual farmers.

USDA Resource Conservation and Development (RC&D)

The Resource Conservation and Development Program administered by USDA Soil Conservation Service, primary objective is the improvement of rural areas including natural resources, economic development, and social measures. The particular objectives and the level and scope of activity are determined by the leadership and sponsorship of the county boards' soil and water conservation districts, tribal councils, and community groups. RC&D can provide financial assistance for soil and water management for agricultural- related pollution control in approved RC&D areas.

USDA Watershed Protection and Flood Prevention (P.L. 566)

The Watershed Protection and Flood Prevention Program administered by USDA - Soil Conservation Service provides technical assistance, including project planning, design, and construction assistance to the watershed project sponsor. Funds are available to share the cost of watershed protection, flood prevention, irrigation, drainage, sedimentation control and public water based fish and wildlife and recreation purposes.

River Basin Surveys

River Basin Surveys are carried out by the Soil Conservation Service in cooperation with federal, state and local agencies to inventory, analyze, and develop alternative solutions to resource problems. River Basin Surveys can provide a recommended course of action to be implemented by survey sponsors, or produce technical information that is needed to assist in carrying out existing or new programs. Multi-disciplinary planning assistance is provided.

Animal Waste Management

Feedlot Permit Program

In 1971, the MPCA established a feedlot permit program. Revised in 1979, the feedlot rules (Minn. Rules Chapter 7020) require a farmer to apply for a permit when any of the following conditions exist:

- a. a new animal feedlot is proposed; or
- b. a change in operation, modification, or expansion of an existing animal feedlot is proposed; or

- c. ownership of an existing animal feedlot is changed; or
- d. a National Pollutant Discharge Elimination System (NPDES) permit is required under state or federal rules.

A farmer must also apply for a feedlot permit when an inspection by the MPCA staff or a county feedlot pollution control officer determines that the animal feedlot creates or maintains a potential pollution hazard. At the present time, an estimated 15,000 feedlots are permitted.

Approximately 400 feedlot permit applications are processed per year. Certificates of Compliance are issued for feedlots which are not identified as potential pollution hazards. Approximately 90 percent of the applications processed receive certificates. Feedlots with a potential pollution hazard which can be corrected within one construction season (10 months) receive an Interim Permit. This permit is replaced with a Certificate of Compliance when the work is complete and the pollution problem resolved. Sites on which the corrective work takes more than one construction season due to economics or technical problems receive state feedlot permits. These permits are issued for a period of five years and contain special operating conditions and a schedule of compliance.

By requiring a farmer to apply for a permit whenever he is starting or purchasing animal facilities or investing in changes to his existing operation, the program can prevent the creation of new pollution problems from feedlots. Also, if a pollution problem does exist, the most appropriate time to ask for corrective action to be taken by the land owner is when an investment is being made in the operation.

The feedlot program rules provide for a cooperative program between counties and the MPCA, which allows the County Board to request authority to issue most feedlot permits. This provides an excellent mechanism to coordinate local zoning with the feedlot rules. The cooperative county-state program is effective because it enables local involvement and insight on problems, and provides close coordination between state and local programs. At the present time, 22 counties participate.

For the feedlot permit program to be effective, it requires not only good county-state cooperation, but also close coordination between other state and federal agencies involved in feedlot pollution control. The Agricultural Stabilization and Conservation Service (ASCS), Soil Conservation Service (SCS), Board of Water and Soil Resources (BWSR), and MPCA have entered into an interagency agreement to coordinate their animal waste control programs so that federal and state cost-share funds, technical assistance programs, and the state permit program will work together efficiently. The ASCS and BWSR each have cost-share programs to provide incentives to install pollution control equipment. The SCS and Soil and Water Conservation Districts (SWCD) provide technical assistance. The MPCA permit program acts as a catalyst to bring farmers into these programs by adding a regulatory incentive.

National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES Permit Program is administered by the MPCA and applies to all facilities containing over 1,000 animal units (i.e. 1,000 beef cattle, 700 dairy cattle, 2,500 hogs) and to smaller facilities it wastes are discharged directly

into water through manmade conveyance or, if water passes through a facility so that animals may come in direct contact with the water. As of January 1988, nine confined animal facilities have NPDES permits.

Minnesota Cost Share Program

The Minnesota Cost Share Program provides cost-share contracts for pollution control systems for animal waste management through the 91 Soil and Water Conservation Districts throughout the state.

Minn. Stat. Sec. 40.036 authorizes cost-share assistance, to a maximum of 75% of the total cost of the pollution control systems for; confined animal facilities which are within shoreland areas, for facilities which have been cited by the MPCA, or are otherwise considered to be potential pollution hazards.

USDA - Agricultural Conservation Program (ACP)

The Agricultural Conservation Program, provides financial assistance (cost-sharing) to farmers who wish to install animal waste control facilities. The program is carried out by USDA. Agricultural Stabilization and Conservation Service (ASCS) through a system of state and county committees. Animal waste control facilities within shoreland areas, that have been cited by MPCA or are considered to be a potential water pollution hazard, are high priorities for receiving ACP assistance. The program has a set maximum amount that can be spent for any one practice of \$3,500.

Farm Ownership, Farm Operating and Soil and Water Conservation Loan Programs

The Farmers Home Administration provides loans which may be used by land owners to improve confined animal facilities, including water pollution control practices.

Pesticide and Fertilizer Application

Federal Insecticide, Fungicide, and Rodenticide Act and the Minnesota Pesticide Control Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) establishes procedures for classification, registration, sale, use, research, monitoring, and disposal of pesticides. The U.S. EPA is required to promulgate regulations for registration of pesticides and certification of applicators. Upon weighing the benefits of use against the risk, EPA may deny or cancel registration or place restrictions on use of pesticides which cause unreasonable adverse effects on humans or the environment. Until recently, pesticides were reviewed on the basis of their toxicity to humans exposed through application or food consumption. EPA now considers ground water to be a potential source of human exposure to pesticide residues and is requiring leaching data for new pesticide registration as well as pesticide re-registration.

The Minnesota Department of Agriculture (MDA) is responsible for regulation of the distribution, use, storage, handling, and disposal of pesticides, rinsates, and pesticide containers. MDA is responsible for registration of pesticides and administration of certification, licensing, and training programs for pesticide applicators under FIFRA. Approximately 7,900 pesticides are registered for use

in Minnesota. The department is authorized to collect fees for registration of pesticides and for applicator and dealer licenses. MDA has the authority to deny or cancel registration or restrict use of pesticides in addition to those restricted or banned by EPA; in the past, this authority was used to ban DDT and other pesticides prior to EPA action. In addition, in 1987 the Minnesota Legislature passed legislation banning chlordane and heptachlor. MDA does not have a formal procedure for evaluating pesticide registrations with respect to the potential for ground water contamination; at present, the state relies upon EPA review.

MDA is the lead agency for response to a release of pesticides, fertilizers and soil or plant amendments. MDA must notify MPCA if the release may cause pollution of state waters.

The 1987 Pesticide Control Law gives MDA authority to recover the costs of cleanup from the party(ies) responsible for the release. MPCA is responsible for incidents involving pesticide wastes. At present, the two agencies do not have a formal procedure or agreement for responding to pesticide incidents, however, both agencies are involved in negotiating a Memorandum of Understanding regarding pesticide incidents and other issues of mutual concern. Currently, MDA, MPCA, MDH, MDNR, Minnesota Department of Public Safety (Division of Emergency Services) and Minnesota Department of Transportation has responsibilities for emergency response in the event of a hazardous materials release.

The Minnesota Department of Natural Resources (MDNR) approves registered aquatic herbicides and algicides for use in protected waters. MDNR also issues aquatic nuisance control permits for application of herbicides and other chemicals to protected waters; the Minnesota Department of Health (MDH) approves these permits when the treatment of public drinking water is involved. Under a Memorandum of Understanding (53) with the MDA, MDNR enforces regulations for use of pesticides in public waters. Although MDA administers exams for certification of pesticide applicators, MDNR prepares written exams for aquatic pesticide applicators and the Minnesota Department of Transportation prepares a portion of the exam for aerial applicators.

Federal Safe Drinking Water Act (SWDA) and Minnesota Safe Drinking Water Act

Minnesota Department of Health regulates public drinking water supplies for the purpose of protecting public health. MDH has authority under the federal and Minnesota Safe Drinking Water Acts to set maximum contaminant levels and monitoring frequencies for public water supply systems which are at least as stringent as the federal requirements under the Safe Drinking Water Act. To date, EPA has set standards for only six pesticides. Of these, only 2,4-D is commonly used in Minnesota. In a survey of wells located primarily in areas of Minnesota which are vulnerable to contamination, atrazine was detected in more than 35 percent of the wells, while alachlor was detected in approximately five percent. Maximum contaminant levels have not been established for either of these pesticides.

Congress amended the SWDA in 1986, making several significant changes for public water supply and ground water quality protection. Amid concern over the paucity of drinking water standards set by EPA, Congress specified eighty-three contaminants which EPA must regulate by June of 1989, including twenty-one

pesticides. Prior to amendment, monitoring was required for only 23 regulated contaminants. The 1986 amendments require EPA to promulgate regulations requiring monitoring of public water supply systems for certain unregulated contaminants, these provisions should provide for the expansion of the presently limited database on the scope and severity of ground water contamination.

A new provision of the SDWA authorizes states to establish wellhead protection areas around public drinking water wells on a voluntary basis. The new legislation also authorized, but did not appropriate, funding to states for the development and implementation of plans for the protection of ground water quality in critical areas within designated Sole Source Aquifers.

Minnesota Water Well Construction Code

The Minnesota Department of Health administers the water well construction and abandonment program. Proper siting, construction, and maintenance of water wells can reduce the potential for drinking water contamination by nonpoint sources of pollution. Sealing abandoned wells can eliminate potential routes of contaminant movement between aquifers.

The Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act authorizes EPA to regulate hazardous wastes "from the cradle to the grave" as well as solid waste disposal. Ground water monitoring is required at disposal sites. Regulatory authority is delegated to states with approved programs.

The MPCA regulates storage and disposal of waste (discarded) pesticides under RCRA and Minnesota statute. Farmers are exempt from hazardous waste regulations as long as they triple-rinse each empty pesticide container and dispose of pesticide residues according to label instructions and on their own farm. The rinsate must be used and not discarded.

Household Hazardous Waste Management

Legislation enacted in 1987 requires MPCA to establish a household hazardous waste management program. The program must include the establishment and operation of waste collection sites, and information, education, and technical assistance regarding the proper management of household hazardous wastes, including pesticides.

The same act established a Waste Pesticide Collection Pilot Project, to be implemented by MPCA, in cooperation with MDA.

Regulation of Fertilizers, Soil and Plant Amendments

Under the Fertilizer, Soil Amendment and Plant Amendment Law, MDA has authority to regulate registration, storage, and handling of fertilizers. Applicants for liquid fertilizer storage permits must provide information on the distance from the facility to surface water and to wells. Adequate containment in the event

of a leak must be assured; a dike is required in most cases. Dry fertilizer storage piles are prohibited in locations where surface water runoff could enter storm or sanitary sewers, and surface or ground water.

Urban Runoff/Infiltration

National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES Permit Program is administered by the MPCA and is applied to discrete, identifiable sources of water pollutants. NPDES Permit requirements have been applied to certain instances to urban storm sewers in Minnesota.

Local Ordinances, Planning and Zoning Controls

Counties may develop planning and zoning programs, which include countywide zoning, subdivision controls, sanitary code, shoreland ordinances, and floodplain ordinances. These ordinances and subdivision regulations serve to regulate land use within the county and may require and control the development of urban runoff management practices. Development of shoreland management and floodplain management ordinances are required of each county. Counties bordering streams designated as Wild and Scenic Rivers by the Department of Natural Resources must also develop ordinances which give special protection to such streams. These ordinance may be more restrictive of land use activities within the designated areas. Most Minnesota counties have also established countywide zoning programs. These county planning and zoning programs serve to regulate development within the county, and control the location of land-using activities.

Many Minnesota municipalities have established planning programs which include provisions for official maps, zoning ordinances, and subdivision regulations. These provisions control development and establish standards and guidelines for land use. Municipal ordinances may establish controls for urban runoff.

Urban townships (1,200 or more people in platted portions) or other townships which obtain voter approval may establish township planning and zoning programs. The authority of a township is similar to that of a municipality -- the only difference being that where a county has established ordinances and regulations, a township cannot implement less restrictive ordinances and regulations.

By state law, SWCDs, may construct, maintain, and operate any facilities necessary for carrying out their legislated functions. Under this authority, SWCDs may be able to construct urban runoff control facilities.

Watershed Districts are authorized to adopt rules that provide for public health and prevent pollution of waters within the district. These rules may apply to the construction of urban runoff facilities and other land disturbances within the district. Watershed Districts may take enforcement action against violators of their rules; or they may refer violations to other agencies, such as the MPCA.

Watershed Districts may construct drainage ditches, sewers, or any other facility related to urban runoff within the district.

Construction

Shoreland and Flood Plain Management Program

Minn. Stat. sec. 105.485 and 104.01-104.08 requires the Minnesota Department of Natural Resources to promulgate regulations, implemented through county and municipal land use control ordinances, which provide minimal dimensional and performance standards to protect and enhance the quality of surface waters and conserve the economic and natural resource values of shorelands of public water. These ordinances control some aspects of construction activities near public waters.

Work in Beds of Public Waters

Minn. Stat. sec. 105.42 authorizes the Minnesota Department of Natural Resources to require permits for changing the "course, current, or cross-section of public waters." Examples of projects requiring these permits are filling, excavation, breakwaters, retaining walls, certain types of riprap, bridge crossings, and storm sewer outfalls.

Although the physical jurisdiction of M.S. 105.42 permits extends only from the ordinary high water mark to the bed of a public water, upland activities of the permitted project which result in adverse effects on the beds of the public waters may also be regulated. Bridge construction, for example, would be subject to a permit under Chapter 105 not only to minimize direct effects on the streambed but also to ensure that proper erosion control techniques are used. Erosion and sedimentation control in situations like this are concerns of the program.

National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES Permit Program is administered by the MPCA and is applied to discrete, identifiable sources of water pollutants. Certain types and sizes of construction projects are defined as point sources and discharge permits may be required. This MPCA program also responds to pollutant spills and supervises the cleanup and recovery of spilled pollutants. If violations of water quality regulations occur, the MPCA will take appropriate enforcement action, which could include litigation, to obtain compliance by the violator.

Local Ordinances, Planning and Zoning Controls

Watershed Districts are legally authorized to issue rules and construction permits with conditions to control activities on and uses of lands that may adversely affect public waters. About three-fourths of the districts have adopted rules, and some of these have provisions requiring permits for construction activities.

By law, all such permits must be coordinated with other state, county, and local agencies having environmental control authority.

All counties are required to adopt and enforce shoreland and floodplain management ordinances. The DNR may use its authority and resources to assist, if necessary.

Each county may also develop a planning and zoning program which may include countywide zoning, subdivision controls. Provisions of these ordinances may require some measures of erosion control for construction activities.

In addition, counties are required to administer the Uniform Building Code. The Code contains provisions for some erosion control measures when buildings are being constructed.

All municipalities are required to adopt and enforce shoreland and floodplain management ordinances. The provisions and requirements are similar to county ordinances.

Municipalities may also adopt comprehensive land use plans and local zoning and subdivision ordinances. Provisions of these ordinances may require some measures of erosion control for construction activities.

In addition, municipalities are required to administer the Uniform Building Code. The Code contains provisions for erosion control measures when building construction is carried out.

Urban townships (1,200 or more people in platted portions), or other townships that obtain voter approval, may establish township planning and zoning programs. Township zoning programs would regulate the location of new developments and can include provisions that require measures for erosion control during construction activities. Township zoning ordinances may be more restrictive, but not less restrictive, than county zoning ordinances.

Individual Sewage Treatment Systems

Standards and Criteria for Individual Sewage Treatment Systems

The improper design, location, installation, use, and maintenance of individual sewage treatment systems adversely affects the public health, safety, and general welfare by discharge of inadequately treated sewage to surface and ground waters. Minnesota Rules Chapter 7080 provide the minimum standards and criteria for the design, location, installation, use and maintenance of individual sewage treatment systems (ISTS). The Minnesota Pollution Control Agency administers Minn. Rules Chapter 7080, which are then voluntarily adopted and administered by local units of government. At the present time, approximately 40 counties have adopted Minn. Rules 7080. There is growing public support for making these standards mandatory statewide. Limited administrative resources hamper the effectiveness of these rules.

Training and Technical Assistance

The MPCA and the Minnesota Extension Service cooperatively present a number of three day onsite sewage treatment workshops throughout the state each year. The workshops are designed for people involved in the site evaluation, design, construction, inspection and maintenance of individual sewage treatment systems. Over 500 people attend the workshops each year and the demand for these workshops is growing. The MPCA staff also offers technical assistance to the public on questions regarding individual sewage treatment systems. Staff receive over 100 such requests each month.

Certification for Installers of Individual Sewage Treatment Systems

The MPCA administers a voluntary certification program for persons involved in the site evaluation, design, installation, inspection and maintenance of individual sewage treatment systems. This program is designed to promote the employment of knowledgeable and experienced personnel in these practices as a means to prevent the water quality and public health problems that can be associated with the improper design, location, installation, or maintenance of these systems. The MPCA does not require that such persons be certified, however, a growing number of counties and cities do.

Hydromodification

State Waterbank Program

The Waterbank Program, administered by the Minnesota Department of Natural Resources, is designed to compensate farmers for not converting qualifying wetland to cropland. Payments, based on appraised land values, provide incentives to help keep qualifying wetlands in their natural state. For protected wetlands, the landowner must have been denied permission to drain the wetland and must show that drainage of the areas would not violate any property agreements, that outlet rights can be obtained, that the proposed drainage would be profitable and that the area, if drained, would make high quality cropland.

Federal Waterbank Program

The Federal Waterbank Program administered by the USDA-Agricultural Stabilization and Conservation Service (ASCS) provides ten year lease contracts with landowners to protect qualifying wetlands. The landowners must agree not to drain, burn, fill or otherwise destroy the wetland character of such areas nor to use the areas for agriculture. Thirty-eight Minnesota counties are eligible for this program. Payment rates typically are \$10 per acre per year for wetland and may range from \$20 to \$55 per acre for adjacent upland. Upland payment rates are based on cropland capability classes and a percent of the documented corn yield. Upland acres are planted to permanent grass-legume cover.

Wetland Acquisition Program (WAP)

The federal Wetland Acquisition Program administered by U.S. Department of the Interior, Fish and Wildlife Service, uses two methods of acquisition, fee title and easement. Specified counties in northwestern, west central and southern Minnesota are eligible for this program. Eligible wetlands are primarily wetlands with associated uplands managed to provide water fowl habitat.

RIM Reserve - Wetland Restoration Program

The RIM Reserve - Wetland Restoration Program pays landowners to restore their previously drained wetlands. It offers landowners perpetual easements, reimburses the cost of cover seeding and helps pay for any structures needed to restore the wetlands.

Silviculture

Minnesota Forestry Incentives Program (MFIP)

The Minnesota Forestry Incentives Program administered by Soil and Water Conservation Districts provides cost sharing for forestry related practices not covered by other state and federal programs such as pest control, fire break establishment, forest road construction, etc.

Private Forest Management (PFM)

The Private Forest Management Program provides technical assistance to land owner participants in state and federal cost-share program and state tax laws. This assistance includes inventory, multiple use management planning, timber harvesting and restoration.

USDA - Agricultural Conservation Program

The Agricultural Conservation Program administered by USDA - Agricultural Stabilization and Conservation Service provides financial assistance to woodland owners who wish to voluntarily apply soil, water, woodland and wildlife conservation practices to their land. Soil erosion and nutrient runoff are major emphasis of the program.

Protected Waters and Wetland Permit Program

The Minnesota Department of Natural Resources administers a program regulating works in the beds of protected waters. Protected waters are those lakes, wetlands and watercourses specifically identified on county maps by an inventory procedure specified by statute. All activities require a permit except for certain types of projects, if constructed under specified guidelines. Activities subject to the permit program include dredging, filling, installation of permanent structures, water level control structures, bridges and culverts and intakes and outfalls.

U.S. Forest Service (USFS)

The USFS regularly conducts timber sales in which stands of timber of varying sizes (usually less than 40 acres) are harvested by wood products corporations, small independent businesses, and private individuals. Harvesting must be done according to a contract; conditions may include such requirements as leaving an uncut buffer at shorelines, leaving aesthetic buffers at road edges, slash disposal requirements, specifications for logging road construction, culvert construction, and stream crossing prohibitions. Water quality preservation is one consideration addressed in this policy. Many contract conditions are based on evaluations made at selected timber sale sites by a USFS forest hydrologist and a wildlife biologist. The sites are occasionally inspected during the course of the harvesting project; the discovery of failure to observe requirements may result in immediate closing of the project.

State Lands

Minnesota Statutes require notification of intent to cut timber on any state-owned lands. A contract is then written that contains extensive conditions similar to those outlined for the USFS. Requirements may include specific management practices, setbacks from roads, and slash disposal techniques. DNR

district foresters are assigned to inspect timber-cutting operations on state land and may halt work if contract conditions are not being met. These contract harvesting guidelines are mainly for aesthetic purposes, but, by their nature, also contribute to water quality maintenance.

Mining

National Pollutant Discharge Elimination System (NPDES) Permit Program and State Disposal System (SDS) Permits

The NPDES and SDS Permit Programs are administered by the MPCA and applies to all discrete, identifiable sources of water pollutants related to mining. NPDES Permit requirements are applied to mine pit dewatering, stock pile runoff, tailings basin construction, operation and discharges, drainage from peat operations and mine deactivation.

Mineland Reclamation

The Mineland Reclamation Program administered by MDNR provides for reclamation of lands disturbed by mining after August 1980. This includes the activities associated with the siting, design, construction, operation and deactivation of all mining facilities.

Work in Beds of Public Waters

The MDNR program regulating works in the beds of public waters requires a permit for any alteration of public waters.

Highway De-icing Chemicals

In 1977, MnDOT established a policy regarding their storage of salt and sand/salt mixtures in order to reduce the potential for surface and ground water contamination near stockpile sites. This policy is based on recognized best management practices and requires that:

- a. all salt and sand/salt mixtures be placed on bituminous pads which must be sloped to prevent surface water from draining through the stockpiles;
- b. all salt piles be covered with polyethylene if not stored in a shed, and all sand/salt mixtures be moved to empty salt sheds during spring and summer;
- c. any runoff from the stockpiles be contained.

The Minnesota Legislature enacted Statutes 160.215 in 1971 in an attempt to minimize damage from application of de-icing chemicals. This statute established guidelines for the application of de-icing chemicals. MnDOT believes their current application rates and procedures are in compliance with the established guidelines and cannot be significantly improved given current technological and fiscal constraints without detrimental decrease in the level of service provided.

The MPCA has no explicit authority to directly regulate the highway de-icing operations of state or local road authorities. The application and storage of de-icing salts have not generally been subject to MPCA permit requirements which are aimed at controlling point sources of wastewater. The MPCA does have general authority to investigate water pollution problems and to take appropriate action against those responsible for specific water pollution problems when the responsible parties can be clearly identified. Violations of water quality regulations which are clearly and directly attributable to application of de-icing chemicals have not yet been identified and prosecuted by the MPCA. However, the MPCA has received and investigated several complaints of ground and surface water contamination caused by the storage of de-icing chemicals. MPCA regulations (WPC-22) prohibit depositing any pollutant in such a manner that it would reach ground waters and actually or potentially preclude their use as drinking water. The MPCA may direct the party responsible for such sources of potential pollutants to monitor ground water quality at its own expense. The MPCA has responded to de-icing chemical storage problems as such problems have been reported to the MPCA. In those cases where water quality problems have been identified, the MPCA has required corrective measures be taken.

Special Problems

Streambank, Lakeshore, and Roadside Sediment and Erosion Control Program

The Streambank, Lakeshore, and Roadside Sediment and Erosion Control Program is administered by the Board of Water and Soil Resources through Soil and Water Conservation Districts. Through this program, funds are available to provide grants to assist soil and water conservation districts and local units of government in solving sediment and erosion control problems. Grants may not exceed 50 percent of the total cost or 50 percent of the local share if federal funds are used. Priority is given to projects eligible for federal matching funds and projects designed to solve streambank, lakeshore, and roadside erosion. Although the funding of a project is done on a case by case basis by the Soil and Water Conservation Board, soil and water conservation districts are responsible for all local administration, including issuance of checks.

Resource Conservation and Development Program (RC&D)

The RC&D Program administered by USDA Soil Conservation Service may provide up to 65% of actual costs of approved roadside erosion control programs, with 35% local match. Costs are determined through the RC&D Measure Plan. As much as \$23 million of RC&D funds have been used for roadside erosion control programs.

While no agency has specific authority for regulating erosion on roadsides, road authorities are responsible for construction, stabilization and maintenance of roadsides under their control. In addition the FHWA, in providing funds for state and local highway construction, does require the receiving agency (in Minnesota the MnDOT) or local unit of government to follow standard construction specifications. In general, these specifications are based upon the American Association of State Highway and Transportation Officials (AASHTO) model specifications. MnDOT design specifications and local highway department specifications are very similar though each may be modified to meet specific or unusual problems. All highway design specifications are intended to promote stable and safe highways. Any resulting roadside erosion pollution abatement is

generally the result of efficient design and planning, with protecting the environment a concern rather than a response to a regulatory act.

The MnDOT has established several procedures within its highway construction and maintenance programs to ensure control of roadside erosion. During the preliminary stages of a highway construction project, a Pre-Design Environmental Impact Statement (EIS) is prepared. The potential for erosion is one of the topics studied. The MnDOT's construction manual, design manual, and construction specifications book contain procedures for both permanent and temporary erosion control. For normal maintenance on geological erosion, the MnDOT has a manual on maintenance repair.

Land Disposal

State Disposal System (SDS) Permits

The State Disposal System Permit Program is administered by the MPCA and requires the issuance of permits for the disposal of wastes on land. Certain residual wastes fall under the SDS permit program. The permits are supported by a compliance and enforcement program which investigates complaints about water quality problems.

SUPPORTING EFFORTS

The Clean Water Partnership and other state programs are supported by: ongoing monitoring and research, information and education, local water management planning and program delivery system and state water planning, coordination and evaluation.

Monitoring

Minnesota Pollution Control Agency (MPCA)

The Minnesota Pollution Control Agency conducts a variety of monitoring programs under the authorities granted by federal and state legislation. These programs collect and evaluate data which define the water quality of the state. The data are used to identify pollution, assess abatement programs, enforce environmental regulations, and report the changes in the state's water quality.

The Routine Water Quality Monitoring Program was the first monitoring program established, and it continues to be the cornerstone of the monitoring efforts conducted by the Agency. The program began in 1953 and monitors surface water quality throughout the state. In addition to this fixed ambient network, a variety of special monitoring programs also exist. Lake monitoring is conducted in conjunction with special lake studies, the Clean Lakes Program, a Lake Assessment Program, and a volunteer Citizen Lake-Monitoring Program. Additional stream information is collected by the Intensive Survey Program, the Border Waters Program, and the Nonpoint Source Pollution Program. Specialized data are collected by the Toxic Substances Monitoring Program, the Acid Rain Program, the Biomonitoring Program, and the Dredge and Fill Program. Data on permitted dischargers is collected by the Compliance Monitoring Program. Because much of this information is related and important to more than one program, a Data Management Program was established to computerize the data and make it available in a usable format to everyone. A Quality Assurance-Quality Control Program

insures that the samples are collected, preserved, shipped, and analyzed by approved methods.

All water quality data are entered in STORET, the U.S. EPA computerized national water quality data bank.

Minnesota Department of Health

The Minnesota Department of Health (MDH) routinely monitors public water supplies for up to 23 different parameters. The list of parameters will be expanded to 83 over the next two years. MDH requires that all new wells have samples collected and analyzed for nitrogen and total coliform bacteria.

Minnesota Department of Agriculture

The Minnesota Department of Agriculture monitors designated well locations within agricultural production areas to determine effects of pesticide and fertilizer use on ground water. The Environmental Quality Section conducts pesticide area and problem specific monitoring to provide information on trends for possible regulatory response. Surface water studies are anticipated to assess pesticide impacts of erosion, runoff and ground water.

Metropolitan Council

The Metropolitan Council (MC) monitors approximately 100 lakes on a three- to five-year rotating basis. The lakes are sampled for physical, biological and chemical character semi-monthly throughout the open water season. On occasion, lakes are sampled more intensively; for example, several cooperative diagnostic studies with year-round sampling have been done on select, high interest lakes. Data from the lake studies are maintained in data management systems, including STORET, and analyzed for regional trends, as well as lake-specific uniqueness.

The MC is currently focusing its surface water monitoring on the water quality effectiveness of runoff management practices. The program underway is sampling on an event basis the runoff into, and out of, five detention and/or wetland treatment systems. Samples are analyzed for solids, nutrients, oxygen demand and lead.

The MC has sampled the effects of nonpoint source pollution on a watershed level. The programs were designed to obtain data on the nature and effects of nonpoint source pollution. The Metropolitan Waste Control Commission, in cooperation with the Metropolitan Council, has begun a long-term monitoring program of the major creeks discharging to the Minnesota River within the Metropolitan Area. This program is designed to identify the pollution load discharged by each of these creeks.

Minnesota Department of Natural Resources

The MDNR's Division of Fish and Wildlife, Ecological Services Section, conducts special surveys and investigations to determine the effects of various activities upon fish and wildlife. The Section also conducts routine water quality sampling at selected lakes. MDNR Regional and Area Offices also monitor fish populations.

Minnesota Department of Transportation

The MnDOT operates a water quality monitoring program intended to establish the relationship of highway construction projects and highway runoff to water quality. One portion of this program is collecting water quality samples from streams and lakes, both above and below the sites of new highway projects. This sampling is done to assess the existing background conditions of the stream or lake. Sampling is conducted over a period of 1-2 years, and the results of the analysis are reported in the draft environmental impact statement required for highway projects.

The second part of the MnDOT water quality monitoring program is the sampling of highway runoff from selected highway locations. This program, which began in 1976, is seeking to establish the flow and quality of highway runoff under various climatic conditions.

U.S. Department of the Interior, U.S. Geological Survey (USGS)

The general objectives of the USGS are to perform surveys, investigations, and research covering topography, geology, and the mineral and water resources of the United States; to classify land as to mineral character and water and power resources; to enforce departmental regulations applicable to oil, gas, and other mining leases, permits, licenses, development contracts, and gas storage contracts; and to publish and disseminate data about these activities.

The USGS has an office in Minnesota and conducts several water monitoring programs in cooperation with various state, federal, and local agencies. The principal agencies working with or providing financial support to the USGS efforts are the MDNR, the MnDOT, the MPCA, and the U.S. Army Corps of Engineers.

The USGS maintains a stream water quality monitoring network of _____ stations sampled on a quarterly or monthly basis and a stream sediment monitoring network of _____ stations sampled on a daily, periodic, or monthly basis. These monitoring networks are designed to give a broad overview of water quality and sediment conditions in the streams of the state.

U.S. Department of Interior, U.S. Fish and Wildlife Service (USFWS)

The USFWS conducts field investigations as needed to determine the nature, extent, and causes of localized pollution problems involving fish and wildlife. Some field investigations are joint studies with other federal or state agencies.

U.S. Forest Service (USFS)

As a normal procedure, the USFS monitors water quality at all sites prior to the commencement of a timber harvest and again upon completion of the project. Monitoring has been continued for five years after one such cut and the data used to refine cutting and land management policies. Also, national forest hydrologists are responsible for having a general understanding of the nature of water quality in their areas. Lakes and streams are monitored to meet this need.

Research

University of Minnesota (U of M) - Agricultural Experiment Station

The Agricultural Experiment Station has a mission to organize and support basic and applied research in agriculture, forestry, home economics, veterinary medicine and related areas for the benefit of the states' economy and the well-being of its citizens. A major area of research is the production, processing, marketing and distribution of food and other agricultural products. Research is also directed at examining and improving public policies, at forests and forest products, other natural resources, human nutrition, family life, rural development, recreation and tourism and overall environmental quality. The program of the station is closely integrated with that of the Minnesota Extension Service, with the latter serving as a primary disseminator to the public of the applied research results.

The special appropriation, entitled "General Agricultural Research," from the State of Minnesota to the Agricultural Experiment Station is the station's major funding source. Combined with federal formula funds, gift, grant and contract funds (federal, state, and private), and income and fees, this funding permits the station to conduct research to address both the short- and long-term needs of Minnesota and its citizens.

University of Minnesota (U of M) - Center for Agricultural Impacts on Water Quality

The Center for Agricultural Impacts on Water Quality was formed to provide a coordinated interdisciplinary research approach to the impacts of agricultural management practices on water quality. The Center is within the Institute of Agriculture, Forestry, and Home Economics at the University of Minnesota. Funding is provided from research grants and a line item in the Agricultural Experiment Station budget.

University of Minnesota (U of M) - Water Resources Research Center

The Water Resources Research Center funds research projects to faculty at academic institutions in Minnesota on a wide range of subjects related to the state's natural waters, including transport and fate of pollutants from nonpoint sources to surface and ground waters.

U.S. Department of Agriculture (USDA) - Agricultural Research Service (ARS)

The ARS conducts basic, applied, and developmental research on a wide variety of topics related to agriculture. One of the ARS's primary concerns is the relationship between agricultural production and soil erosion and nutrient runoff. The SEA-AR has conducted research on the basic processes that control soil erosion and nutrient runoff. That research has included developing models for evaluating and prioritizing the pollution potential for livestock feedlots in the state and routing sediment and nutrients through a watershed.

Minnesota Department of Transportation (MnDOT)

The MnDOT conducts in-house staff research, administers research contracts, enters into cooperative research agreements, and provides financing for research

related to highway de-icing chemicals, roadside erosion, and other road water quality projects.

U.S. Department of Interior - U.S. Fish and Wildlife Service (USFWS)

In its management of the nation's fish and wildlife resources, the USFWS carries out such operations as biological monitoring, ecological studies, environmental impact review, area planning and preservation, game law enforcement, fish stocking, operation of wildlife refuges, educational programs, and research in a number of different areas. The USFWS conducts diverse research on pollutants in relation to fish, wildlife, and their environments.

U.S. Forest Service (USFS)

There are two national forests in Minnesota: the Chippewa and the Superior. These forests are divided into nine areas, each of which may field-test forest management techniques. All Forest Service experimental work in Minnesota is coordinated and supervised by the North Central Forest Experiment Station.

In general, the Experiment Station evaluates and improves forest management practices. Attention is largely focused on timber-harvesting techniques, including forest road construction, use of heavy machinery, and disposal of logging residuals. Also included is fire control, which may also imply soil structure maintenance and hence prevention of sediment effects on water. Other studies have been conducted to determine the effects of clear-cutting on water quality and to correlate changes in water quality with seasonal changes and storms.

Information and Education

Minnesota Extension Service

The Cooperative Extension Service is the educational arm of the national land grant University system. It is a cooperative effort relying on funding from federal, state, and local sources.

The primary role of the Minnesota Extension Service (MES) is to provide research-based educational information on subjects related to agriculture, home economics, natural resource management, and community economic development. Educational programs are carried out in cooperation with universities; federal, state, and local agencies; public and private organizations and cooperatives.

University of Minnesota, Center for Agricultural Impacts on Water Quality

The Center for Agricultural Impacts on Water Quality was formed to promote and coordinate interdisciplinary approach to research and education on the impacts of agricultural management practices on water quality. The Center is within the Institute of Agriculture, Forestry and Home Economics at the University of Minnesota. Funding is provided to the research and education programs through research grants and a line item in the agricultural Experiment Station budget.

University of Minnesota, Water Resources Research Center

The Center supports graduate education in water resources through a grant program and is active in information dissemination by sponsoring conferences and publishing reports related to water quality.

Board of Water and Soil Resources

The Board of Water and Soil Resources has responsibility for developing and implementing a comprehensive public information program of the Soil and Water Conservation Districts (SWCDs) and the problems and preventive practices related to erosion, sedimentation, and agriculturally-related pollution.

Soil and Water Conservation Districts

The SWCDs, in cooperation with the SCS, distribute information (brochures, pamphlets, exhibits) and conduct educational programs (talks, tours, workshops) on the subject of soil erosion and agriculturally related pollution as a regular part of their operations. The amount and type of activity that is conducted depends on the desires and resources of the individual district.

U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS)

The SCS develops and distributes a wide variety of information on soil and water conservation to individuals, SWCDs, and the news media throughout the state. SCS personnel, often in conjunction with SWCDs, conduct workshops and make presentations to schools, at 4-H meetings, and to other interested groups. Educational tours are also periodically conducted by SCS personnel.

Minnesota Department of Agriculture

The Minnesota Department of Agriculture provides information and education through its pesticide training and certification programs. These training programs are currently being revised to include ground and surface water sections.

Local Water Planning

Comprehensive Local Water Management

In 1986, the Minnesota Legislature enacted the Comprehensive Local Water Management Act (Minn. Stat. section 110B.01 (1986)). Under this Act, each county outside the Metro area is encouraged to develop and implement a comprehensive water plan. The county is responsible for preparing, adopting, and assuring implementation of the Comprehensive Water Plan, but may delegate all or part of the preparation to a local unit of government, a regional commission, or a resource conservation and development committee. The county may not delegate its authority for the exercise of eminent domain, taxation, or assessment to a local unit which does not possess those powers.

Each county will be responsible for coordinating local and inter-county efforts to resolve water resource problems. They will incorporate existing plans and rules adopted by a watershed district or Intercounty Joint Powers Board into their own comprehensive water plan.

After a plan is completed, but before it is adopted, it must be submitted for approval to local governments, the regional development commission, any contiguous county or watershed management organization, and any other governmental unit affected by the plan's proposals. These governmental units will then review the plan and relate any possible conflicts to their own plans. After a local review period and hearing, the Board of Water and Soil Resources will review the plan. If the plan is adopted, the affected local governments must conform to the county's plan.

When a county develops a plan, it must address several requirements established in Minn. Stat. § 100B. A local water plan must:

1. cover the entire area within a county;
2. address problems within the context of watershed units and ground water systems;
3. be based upon principles of sound hydrologic management of water, effective environmental protection and efficient management;
4. be consistent with comprehensive water plans prepared by counties and watershed management organizations wholly or partially within a single watershed unit or ground water system; and
5. apply to every year through the year 1995 or any later year that is evenly divisible by five, and be updated before the period covered expires.

Fifty-four counties outside the Metro area are currently in the process of developing local water plans.

Metropolitan Surface Water Management Act

The Metropolitan Surface Water Management Act of 1982 (Minn. Stat. 473.878), assigned water resources planning and management responsibilities to local government units in the Minneapolis/St. Paul Metropolitan area.

The legislature's philosophy that prevention of water problems through sound planning and management is better public policy than allowing water problems to develop. Therefore, the act requires that stormwater management plans shall be prepared and implemented over the seven county metropolitan area. To effectuate the purposes of the Act, the Board of Water and Soil Resources requires the watershed management organizations responsible for preparing the watershed plans do the following:

1. assess existing water quantity and quality problems;
2. assess potential water problems and opportunities for natural resource enhancement in view of projected watershed development;
3. and formulate practical strategies correct existing problems, to prevent potential problems, and to take advantage of opportunities to enhance water related natural resources.

The Act recognizes that management of a body of water or water course requires control of the contributing drainage area. Therefore, the Act requires, as a first step the preparation of a water management plan for each and every watershed unit in the metropolitan area.

After a watershed management organization or county has drafted a watershed plan, it must submit the plan for review and comment to every affected soil and water conservation district, county, city and township.

The Metropolitan Council must review the plan for compatibility with other local plans, and consistency with other metropolitan plans. The Department of Natural Resources and Pollution Control Agency review and comment on the plan's consistency with state laws and rules. The Board of Water and Soil Resources reviews the watershed plan for conformance with the following requirements of the Act.

1. description of existing and proposed physical environment and land use;
2. definition of drainage areas and the volumes, rates and paths of stormwater runoff;
3. identification of areas and elevations for stormwater storage adequate to meet performance standards established in the watershed plan;
4. definition of water quality and water quality protection methods adequate to performance standards established in the watershed plan;
5. identification of regulated areas; and
6. an implementation program, outlining a description of official controls and, as appropriate, a capital improvement program.

Forty-six water management organizations in the metropolitan area have completed or are developing a plan.

Local Program Delivery System and Technical Assistance

Counties

Counties are general purpose land units with broad authorities to implement nonpoint source pollution control programs. Most of Minnesota's 87 counties have comprehensive land use planning programs and ordinances controlling land use and development. Within established state requirements, counties can organize their comprehensive land use planning programs according to local circumstances and the judgement of local officials.

As the legislative branch of county government, the county board establishes the land use planning program. The county board appoints members of the planning commission and hires a county planning staff. The county board has five commissioners elected to four-year terms from five separate districts that are approximately equal in population. The county board has authority to prepare, and adopt by ordinance, a comprehensive land use plan that is the basis for county zoning ordinances.

Since county boards have many other responsibilities, state law encourages them to appoint planning commissions to advise them in formulating, implementing, and administering land use policies. If appointed, the planning commission must have from 5 to 11 regular members. The responsibilities delegated to the planning commission by the county board generally fall into four categories:

1. helping to develop a comprehensive land use plan;
2. recommending specific ordinances and amendments for adoption by the county board;

3. conducting hearings on proposed ordinances and amendments, and transmitting findings and conclusions to the board; and
4. being actively involved in land use control programs, including the review of applications for conditional use permits.

Each county, through the county extension committee appointed by the county board and in cooperation with the Minnesota Extension Service, establishes a county extension service program and hires the county extension director and county extension agents. The county extension director and agents spend a great deal of time providing one-to-one counseling services, ranging on a variety of water quality and land use issues.

Watershed Districts

Watershed Districts are public corporations, created to assist in the conservation of Minnesota's natural resources, and to protect public health and welfare, and natural resources.

A watershed district may be established to control flooding, improve stream channels for drainage or navigation, reclaim or fill wet or overflowed lands, and provide irrigation water. A district may be formed to regulate stream flow and conserve stream waters, divert water courses, provide and conserve water supply for domestic, industrial, recreational, agricultural or other public use. It may provide for sanitation and regulation of waterbodies. Furthermore, a district may regulate improvements by riparian landowners, generate hydroelectric power, protect or enhance water quality, and regulate ground water.

To establish a watershed district, a nominating petition must be filed with the Minnesota Board of Water and Soil Resources. The petition must be signed by at least half of the counties within the proposed District, or by a county with at least fifty percent of the area within the proposed District, or a majority of cities within the proposed District. Alternatively, the petition must have the signatures of at least fifty freeholders in the proposed District, exclusive of the resident freeholders within the corporate limits of any city on whose behalf the authorized official has signed the petition. This is significant because it allows groups of concerned citizens an opportunity to organize with significant authority, where the general purpose units of government are not responsive to their concerns.

The Board of Managers has power to make necessary land and water surveys and cooperate or contract with other governmental bodies. It may regulate, conserve, control, and change waterways, waterbodies and water uses. The Board may acquire by gift or eminent domain real and personal property within the District or outside the District, if necessary, for a water supply system. The Board of Managers may take over county drainage systems when directed by the county board. It may provide for sanitation, and borrow funds from federal, state or county governments. Finally, the Board may mandate flood controls and preserve open spaces and greenbelts.

Because of its public corporation status, a district has perpetual existence with the power to sue and be sued, and incur debts, liabilities, and obligations. A district may exercise the power of eminent domain, provide for assessments, and issue certificates, warrants and bonds. It may also levy

taxes. Violations of Chapter 112 or rules, orders or permits issued by a board of managers of a watershed constitute misdemeanors. Violations may be enforced through criminal prosecution, injunction, action to compel performance, restoration, abatement or other appropriate action.

Soil and Water Conservation Districts

Soil and Water Conservation Districts are created to conserve soil and water resources through the implementation of practices which prevent erosion, sedimentation, siltation, and agriculturally related pollution. The conservation practices will preserve natural resources and wildlife, insure continued soil productivity, control floods, prevent impairment of dams and reservoirs, assist in maintaining the navigability of rivers and harbors, and protect public lands. SWCDs prepare and implement erosion control and soil and water conservation plans and practices on individual properties. SWCD programs and suggestions are implemented by affected persons on a voluntary basis.

Originally formed to address soil erosion problems for the purpose of sustaining productivity, SWCDs are currently giving increased emphasis and attention to off-farm impacts including water quality protection, especially from agricultural sources. The strength of SWCD is their expertise and experience in addressing soil and water management, especially on agricultural lands. The primary limitations are they have neither taxing authority nor the authority to initiate official controls.

SWCDs have close relationships with county boards, the Board of Water and Soil Resources (BWSR), and the United States Department of Agriculture-Soil Conservation Service (SCS). The board of the county in which the SWCD is located may provide the SWCD with funds to operate district programs. BWSR reviews annual plans prepared by SWCDs and must approve the plans before SWCDs can receive operation assistance funds from BWSR. SWCD employees work closely with SCS employees in identifying soil and water conservation needs and in encouraging implementation of soil and water conservation control practices.

The annual budgets of SWCDs vary greatly. Funds for SWCD programs generally come from the county board, BWSR, and from income from local projects, such as tree planting.

SWCDs have broad responsibilities to encourage and assist in implementing soil and water conservation practices by landowners. They may provide analysis, data, and design assistance to landowners upon request. Prevention of soil erosion and water quality management is strongly emphasized in these programs.

USDA-Soil Conservation Service (SCS)

SCS programs are directed towards the achievement of the construction and wise use of soil, water, and related land resources. Priority program goals are; 1) to reduce the damage caused by excessive soil erosion and 2) protect the quality of ground and surface water against contamination by nonpoint sources of pollution.

SCS provides, through its Soil and Water Conservation Operations Program, technical assistance to individuals, groups, and units of government through local Soil and Water Conservation Districts, including the planning and

application of Land Management Systems, providing for quality assurance of installed practices and BMPs, technology development to assure that the latest research and methodology is utilized in addressing priority concerns, and training in the application of existing and newly developed techniques for addressing soil and water resource problems and concerns.

The Metropolitan Council

The Metropolitan Council, a regional agency created under the laws of Minnesota, is charged with the authority to coordinate the planning and development of the seven county metropolitan area. The metropolitan area generally includes the counties of Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington. The Metropolitan Council is authorized by state and federal laws to plan for highways and transit, sewers, parks and open space, airports, land use, air and water quality, waste management, health, housing and aging. The Metropolitan Council will continue to collect data on lakes, document nonpoint source pollution problems with the assistance of the Metropolitan Waste Control Commission, and the effectiveness of commonly used management practices. It provides this information to municipalities, governmental agencies and watershed management organizations. The Metropolitan Council prepares and implements policy for watershed management organizations on nonpoint source pollution and reviews activities that are likely to cause an increase in nonpoint pollution loading. Such reviews include environmental assessment worksheets, environmental impact statements and watershed plans prepared under the Metropolitan Area Surface Water Management Act.

Regional Development Commissions (RDCs)

Authorized by the Regional Development Act of 1969, RDCs were established for all areas of Minnesota. Three of the twelve RDCs have been dissolved.

The nine remaining RDCs are authorized to:

1. receive grants from various state and federal programs that provide funds for multi-county planning, coordination, and development purposes;
2. prepare and adopt, after study and public hearings, a comprehensive development plan for the region;
3. review and comment upon any comprehensive plan prepared by any local unit of government within the region;
4. review applications for state or federal assistance made by any local government unit, and comment upon the relationship of the application to the comprehensive plans and priorities of the region;
5. conduct special studies of programs and problems relevant to the region, including water pollution programs and problems; and
6. contract with local units of government to assist them with local planning and development activities.

Most RDCs form executive committees. Subject to approval by the entire commission membership, these committees conduct much of the RDCs' business. RDCs may also appoint special advisory committees to assist them in specific subject areas or planning programs.

The RDC chairman is responsible for recommending an executive director for appointment by the commission. The executive director is responsible for supervising the commission staff and for implementing commission programs.

RDCs were required to develop Comprehensive Development Plans for their respective regions; these plans included land use-related policies and objectives. RDCs follow these policies when assisting local government planners and when reviewing federally financed local projects for consistency with the Comprehensive Development Plan.

Townships

A township may develop a planning and zoning program if it is an urban town or if the township's residents vote to develop such a program. Townships which choose to exercise zoning authority may undertake planning programs in order to develop zoning ordinances and to ensure orderly development within the townships. The town board may appoint an advisory planning and zoning commission and employ a planning staff when necessary. Zoning programs developed to implement township plans regulate land use, including development of confined animal facilities.

Community Health Services

The Minnesota Department of Health provides funding to community health service (CHS) agencies which can be used for environmental health related activities at CHS discretion. These activities may include private well testing, public non-community water well supply testing and inspection, on-site sewage disposal system permitting and inspection, water well construction and water well abandonment.

State Water Planning, Coordination and Program Evaluation

Minnesota Environmental Quality Board (MEQB)

The principal function of MEQB is to review and coordinate the environmental policies and programs of state agencies.

MEQB is composed of the heads of nine state agencies (State Planning, Pollution Control, Health, Natural Resources, Agriculture, Public Service, Transportation, Board of Water and Soil Resources and Waste Management Board), plus a representative of the governor's office and five members from the general public.

By Minnesota Statute, the Environmental Quality Board is charged with:

1. Determining environmental problems of interdepartmental concern and initiating interdepartmental investigations;
2. Reviewing and coordinating state agency programs that are interdepartmental in nature and ensuring compliance with state environmental policy;
3. Reviewing environmental regulations and criteria for granting and denying permits by state agencies and resolving interagency conflicts with regard to programs, regulations, permits and procedures;
4. Evaluating proposed legislation and reporting findings to the governor and legislature;

5. Coordinating public water resources management and regulation activities among state agencies;
6. Initiating, coordination and continuing to develop comprehensive long-range water resources plans;
7. Coordinating water planning activities of local, regional and federal bodies with state planning; and,
8. Administer federal water resources planning with multiagency interests.

MEQB established the Water Resources Committee (WRC) in 1985 to assist it in carrying out the water resources aspects of its charge. WRC is composed of five MEQB agency members, or their designees (Agriculture, Health, Natural Resources, Pollution Control and Board of Water and Soil Resources), two MEQB citizen members, and a representative from the University of Minnesota. The Waste Management Board will be added on 7/1/88. WRC is assisted by an interagency technical committee.

WRC's primary purpose is to provide the focus necessary for effective integration of water programs and policies through monitoring water-related activities of MEQB and other agencies engaged in public water management and advising MEQB on a comprehensive water strategy for the state. Specific responsibilities of WRC include:

1. Review of legislative initiatives to ensure interagency discussion, coordination, elimination of duplication, and responsiveness to and consistency with the state's water resources strategies and priorities;
2. Review agency budget requests to ensure coordination, eliminate duplication and identify areas of highest funding priority;
3. Prepare and recommend to EQB a comprehensive water resources strategy for the state, including biennial water resources priorities and a ten year agenda for meeting the goals of the strategy; and,
4. Coordinate and facilitate activities necessary to achieve the goals of the strategy.

State strategies development involves:

1. Water Resources Strategy for Control of Pests and Management of Nutrients - WRC is leading an interagency effort to evaluate Minnesota's current activities related to pesticide and nutrient contamination and developing a state strategy to ensure that pests are controlled and nutrients managed in a manner that safeguards Minnesota's water resources. The strategy will be finalized for adoption by MEQB in 1988 (Appendix K).
2. Minnesota Ground Water Protection Strategy - Development of this strategy by the Pollution Control Agency is being coordinated through WRC and MEQB. The strategy will be finalized for adoption by MEQB in 1988 (Appendix K).
3. A Control Strategy for Nonpoint Source Ground Water Pollution - Development of this strategy by the Pollution Control Agency is being coordinated through WRC and MEQB (Appendix K).
4. Minnesota Nonpoint Source Assessment Report and Management Program - Pollution Control Agency development of this program is being coordinated through WRC and MEQB.

Minnesota Pollution Control Agency

The MPCA was established to address the various complex problems relating to water, air and land pollution and to achieve for water, air and land resources a degree of quality consistent with maximum public enjoyment and use.

Minn. Stat. 115.101 requires the MPCA to coordinate the programs and activities used to control nonpoint sources of pollution to achieve Minnesota's water quality goals, by:

1. developing a state plan for the control of nonpoint source water pollution in order to meet the requirements of the federal Clean Water Act;
2. working through the environmental quality board to coordinate the activities and programs of federal, state, and local agencies involved in nonpoint source pollution control and, where appropriate, develop agreements with federal and state agencies to accomplish the purposes and objectives of the state nonpoint source pollution control plan; and
3. evaluating the effectiveness of programs in achieving water quality goals and recommend to the legislature, under section 3.195, subd. 1, any necessary amendments to sections 115.091 to 115.102.

To date, several memoranda of agreement have been completed (Appendix L). These include:

1. A Strategy for Planning the Abatement of Nonpoint Sources of Pollution in the Metropolitan Area - MPCA, Metropolitan Council, Metropolitan Waste Control Commission.
2. Control of Nonpoint Sources - MPCA, MDNR.
3. Procedures for Cooperative Involvement in Regulation of Mining Industries - MPCA, MDNR.
4. Coordination and Cooperation of Activities and Programs Related to Protection, Management and Conservation of Lake Associated Natural Resources - MPCA, MDNR.

Minnesota River Strategy. The Minnesota Pollution Control Agency is leading an interagency effort focusing on development of a strategy for control of nonpoint source pollution in the Minnesota River. The activities associated with this effort involved the following:

- Twenty-four of thirty-seven counties in the Minnesota River Basin are involved in Comprehensive Local Water planning. Staff at the Minnesota Pollution Control Agency have been very active in assisting in the development of these plans including staff attendance at approximately fifty local meetings.
- A comprehensive monitoring program between the Minnesota Pollution Control Agency, the U.S. Geological Survey, the U.S. Environmental Protection Agency ERL-Duluth, the U.S. Fish and Wildlife Service, the Board of Water and Soil Resources, the South Central Minnesota Planning Project, and Mankato State University is being developed. The proposed program will establish a monitoring network throughout the entire Minnesota River basin.

- A demonstration effort between the U.S. Environmental Protection Agency ERL-Duluth, the Minnesota Pollution Control Agency, the Minnesota Department of Natural Resources, and Mankato State University is also being developed. The goal of this project is to demonstrate and evaluate the application of land use and habitat management alternatives to enhance water quality and other environmental objectives in a designated watershed.
- The Metropolitan Council and the Metropolitan Waste Control Commission are doing detailed studies of seven tributaries to the Minnesota River near the Metropolitan area. This effort started in 1988 will continue for at least five years.

State Planning Agency, Land Management Information Center (LMIC)

The LMIC provides information about land and its characteristics to state agencies, RDCs, and local governments. Information such as soil type and erodibility, soil nutrient factors, water resources, and land-use patterns can be used in the analysis of potential for NPS pollution problems.

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