DES MOINES, MINNESOTA, MISSOURI BASIN TEAM RECOMMENDATIONS TO PROTECT WATER RESOURCES

WATER PLAN 2000

Water Plan 2000
The Des Moines, Minnesota, and Missouri Basin Team
Recommendations

This document is a complementary plan to the State Water Plan 2000. The following pages contain goals and objectives generally consistent with the statewide plan. Indicators for measuring progress in improving the quality of water resources in the Minnesota, Des Moines, and Missouri watersheds were developed by state and federal agencies working in these watersheds. They are reflective of information provided by watershed management organizations and local water plans.

Strategies related to the indicators will be developed by this interagency Basin Team as well. Focus for implementing the strategies will include education and information concerning the quality of Minnesota water resources, data management systems including periodic interagency and partnership updates on significant assessment and land management indicators, opportunities for citizen involvement, regulation and enforcement requirements, and ongoing planning monitoring and evaluation processes to ensure progress is being made in addressing water issues.

Beneath Goals and Objectives in this plan are Assessment Indicators and Land Management Indicators. Assessment Indicators are things that relate directly to the quality of a particular water resource. Land Management Indicators are those human practices and management approaches that influence the quality of water resources. The text for each indicator references ways that the indicator can be monitored.

****PRIORITY INDICATORS, which will be the Team's work focus for the next ten-years, are indicated by an asterisk(*) next to the Indicator and are written in CAPS.***

Goal: Minnesotans will improve the quality of water resources

As the only state whose waters flow to three major North American drainage basins, Minnesota has a unique responsibility to protect water quality. However, clean and clear water resources are too easily taken for granted. Changing land uses, increased industrial activity and the ever-expanding population create the need for constant vigilance in protecting the state's waters. Pollutants are threatening lakes, streams and ground water.

Water resources are inter-related to each other and to the watersheds from which they flow. While the condition and quality of our water resources is found within lakes, streams, rivers and groundwater, it is how we mange our land, not only the riparian regions and lakeshores but also upland areas in communities and rural areas that determines the quality of our water.

To improve the quality of water resources, we must determine and track the sources of nutrients, bacteria, and pollutants that pose the most severe threat to water resources and to the ecosystems of which they are a part, and therefore to human health and safety. Understanding the source of nutrients, solids, bacteria and pollutants that threaten water resources and changes in human activity and land management practices that will enact the greatest improvement in the quality of

water resources are equally important. Water quality improvement or protection measures will require adequate funding on state and local levels to achieve the objectives and subsequent implementation activities of this goal.

The following objectives emphasize streams, lakes, and groundwater resources. The objectives include indicators which can be used to better understand how nutrients, bacteria, and pollutants affect water quality and biological systems in water resources, and help track the progress being made in management practices and development decisions over time to improve water quality in streams and river, lakes and groundwater. The objectives clarify the relationship between water quality and land management practices and how effectively land and water management practices are being used to improve water quality.

Objective A. Protect and improve water quality in rivers, streams and other water courses

Threats to water quality come from a variety of sources. Nutrients, solids, bacteria and other common pollutants can negatively influence the health of humans and animals and can cause aesthetic problems, inhibiting the use and enjoyment of streams and rivers for recreational purposes**.**

Wetlands and wet prairies dominated part of Minnesota's landscape in the 1800s. There were small sub-watersheds that were effective in keeping water within the watersheds of streams and rivers. But this landscape has been severely altered with complex results to water quality.

Wetlands have been drained. A network of drainage tile and ditches have changed how water moves through the system. This drainage has allowed water and pollutants to move faster and greater distances. Sediments, nutrients, pesticides, animal and human waste now degrade entire water systems.

In metropolitan areas and small cities, development patterns have also created problems. Acres of pavement and impermeable surfaces allow rain and snow to be deposited untreated through storm sewers to streams and river. Pollutants including dust and dirt, animal waste, sediment from construction, plant matter and chemicals all find their way into these water resources.

Assessment Indicators:

***1. PHOSPHORUS IN WATERCOURSES**

Phosphorus is the key nutrient directly responsible for causing algae to grow in surface water. While a combination of nutrients are needed for algae to grow, excess phosphorus leads to blooms of algae, some of which can produce gases that are toxic to animals. Algae blooms prevent swimming and other enjoyment of Minnesota waters. As such, the amount present in water greatly effects the amount of algae and other aquatic plants present in streams.

***2. NITROGEN AND AMMONIA IN WATERCOURSES**

Nitrogen is another nutrient that can harm water resources. The Pollution Control Agency measures nitrate plus nitrite nitrogen as an indicator of nitrogen amounts in streams.

Ammonia is a compound of nitrogen that in some forms can be toxic to fish and other aquatic life. Chemical changes in ammonia can use up oxygen in the water and can kill fish.

Nitrate and ammonia are forms of nitrogen related through a complex cycle. For example, nitrate is the most common form of nitrogen in oxygenated ground water and surface water; however, when little or no oxygen is present, the ammonium ion can remain stable and nitrate can be reduced to nitrogen gasses.

The Pollution Control Agency measures unionized ammonia. Changes in its concentration can result from changes in pollutant amounts, bacterial breakdown of organic matter and oxidation of ammonia and are affected by the type and location of pollutant source, temperature, season and other factors.

*3. CARBONACEOUS BIOCHEMICAL OXYGEN DEMAND

Biochemical oxygen demand measures the oxygen that is used by microscopic organisms such as bacteria when organic matter decomposes. This can cause unpleasant odors from the bacteria and kill fish by depleting oxygen.

The Pollution Control Agency measures biochemical oxygen demand to get an indication of its impact on oxygen supplies in surface waters.

*4. TOTAL SUSPENDED SOLIDS

Suspended solids are particles of things like dirt, plants and animals that cause water to be cloudy or less transparent. Solids decrease the amount of light available for aquatic plants and make it difficult for fish, clams and other aquatic animals to breathe and feed. Pesticides, nutrients, metals and bacteria can attach to the solids and bring contaminants into the water.

*5. FECAL COLIFORM

Biological organisms that cause waterborne diseases are among the oldest health threats to drinking-water quality. Waterborne diseases can be caused by a number of different bacteria, viruses and protozoa. These disease-causing organisms live in the intestines of warm-blooded animals and can be spread to water by contact with animal feces. Potential sources of contamination include sewers, septic systems, feedlots and manure spreading.

Symptoms of waterborne diseases include gastrointestinal illnesses such as severe diarrhea, nausea and possibly jaundice, with associated headache and fatigue. These symptoms also result from other factors or diseases. Generally, young children and the elderly are more susceptible to waterborne disease.

The Pollution Control Agency measures fecal coliform to determine the presence of and the potential for disease-causing organisms. The measurement of fecal coliform is affected by sunlight, nutrient levels, temperature, stream flow and other factors. Public water supply systems routinely test for total coliform, fecal coliform, and escherichia coliform (E. coli).

While fecal coliform bacteria are not harmful to humans, they indicate contamination from sewage and do suggest the possible presence of disease-causing organisms.

***6. TRANSPARENCY READINGS**

Water clarity in a stream is affected by human activities as a result of point and nonpoint sources of pollution. A citizen stream monitoring network is being developed and implemented by the MPCA. A citizen monitoring network will expand our understanding of how human activities such as land use affect water quality, and in turn, how human activities affect the benefits we gain from clean water such as swimming and fishing. Increased stream monitoring will help identify problems, develop strategies and prioritize actions for improving water quality, and track progress toward improvement. A transparency tube is used to measure the clarity of the water in the stream at regular intervals and/or during runoff events.

7. ***HYDROLOGY (Trends in Stream Flow)**

Monitoring programs must include provisions for surface flow, ground water flow, and precipitation measurements in addition to physical, chemical, and biological monitoring. Without this hydrologic information, concentration data obtained in a monitoring program cannot be fully used. Adequate flow and precipitation information allows for the calculation of sediment, nutrient, and water quantity loadings to surface waters. Several federal, state, and local agencies use utilize hydrologic information as part of their monitoring programs.

7. *STREAM MILES MEETING HEALTH STANDARDS FOR SWIMMING

In order to meet the goals of the Clean Water Act (CWA), the Minnesota Pollution Control Agency focuses on whether streams meet swimmable or fishable uses. As schemes are developed to prioritize streams for monitoring, protection, and/or restoration, both aspects of use-support should be considered. Initially, though, they will be addressed separately. The primary reason that streams in Minnesota are impaired and not suitable for swimming is the accelerated aging (cultural eutrophication) which occurs as a result of excess nutrient, bacterial, and sediment loading because of human activities in the stream and watershed. Minnesota state agencies currently use the "Recommended Standards for Bathing Beaches" as guidelines for meeting health standards for swimming uses of public waters. The water quality standards include the following categories: bacteriological, chemical, physical, and biological quality.

Land Management Indicators:

***1. ACRES OF RESTORED FLOODPLAINS INCLUDING RE-ESTABLISHMENT OF VEGETATIVE BUFFER.**

Floodplains currently used for agricultural production and development do little to help stabilize the flow of water across the land, allowing nutrients and sediments to be carried directly into receiving waters. Floodplains are subject to flooding, which results in the loss of crops and structures.

Restoration of floodplains through re-establishment of vegetated riparian corridors along rivers and streams allows them to function once again in a more natural way + filtering flood water and stabilizing soil to help safeguard these systems. Acreage removed from production and restored to a more natural vegetated state through state and federal conservation easement programs is one way to monitor changes in the quality of our streams and rivers. The removal of permanent structures from floodplain areas can also be monitored for our progress in returning floodplains to their natural function. The Board of Water and Soil Resources and the Department of Natural Resources can provide assistance in monitoring these indicators.

2. *ACRES OF RESTORED AND PRESERVED TARGETED WETLANDS

The drainage of all types of wetlands in rural and urban areas has dramatically altered the surface and subsurface hydrology in watersheds. Minnesotans recognize that wetlands perform many important functions, such as reducing peak flow during runoff events, recharging groundwater aquifers, slowing the movement of surface water, trapping sediment and nutrients, and providing habitats for fish and wildlife. The preservation of existing wetlands should be a high priority. Agencies such as the USFWS, NRCS, BWSR, MNDNR, and SWCD can provide financial and technical assistance to landowners for wetland restoration and preservation projects. These agencies can provide the tracking, monitoring and reporting of wetland implementation activities.

As society becomes more educated about wetlands, emphasis has been placed on restoring and/or constructing wetlands. Towns and cities are constructing wetlands to use in conjunction with their waste treatment system to act as a filter. Other wetlands are being restored or constructed in order to recreate habitat of specific animals whose population has started to decline.

Federal and state agencies (NRCS, COE, DNR, BWSR, USFWS) are providing assistance in the restoration/construction of wetlands on private and public land.

The implementation of No Net Loss of wetlands, looks for ways to decrease the acres of wetlands being drained or destroyed. Federal and state agencies (COE, NRCS, USFWS, and DNR) are looking for ways to lessen the impact of wetland losses when working with the urban and the rural farming community. Wetland mitigation banks were established to assist with the loss of wetlands. Landowners can drain a wetland and replace the drained acres with another area on their property.

3. ACRES ENROLLED IN WETLAND CONSERVATION PROGRAMS (CREP)

There are several wetland conservation programs (Wetland Reserve Program, Reinvest in Minnesota, Conservation Reserve Program, etc.) that are voluntary and offer landowners the opportunity to protect, restore, and enhance wetlands on their property. Eligible participants will receive financial incentives to enhance wetlands in exchange for removing marginal agricultural land from production. These programs allow wetland functions and values to be restored by providing fish and wildlife habitat, improving water quality by filtering sediments and chemicals, reducing flooding and recharging groundwater.

Some counties have concerns that too many long term easements will reduce the tax base. Presently each county decides the taxes on long term easements. The FSA, BWSR and SWCD agencies monitor the acres accepted into the programs

4. ESTABLISHMENT OF FILTER STRIPS, RIPARIAN BUFFERS (GREEN WAYS) AND NATURALLY VEGETATED SHORELAND AREAS USING CONSERVATION EASEMENT PROGRAMS.

The Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP) (federal and state program) encourage and help farmers to voluntarily plant long-lasting areas of ground cover on environmentally sensitive cropland. Both programs promote the establishment of filter strips and riparian buffers, which are planted to protect streams, lakes, and rivers from sedimentation and pollution from agricultural chemicals.

Federal, state, and local agencies (FSA, SWCD, BWSR) are responsible for administering the programs.

5. Management of drainage ditches, tile, and storm sewers as tributaries

The flow of water in agricultural and urban watersheds has been significantly altered over the past century due to extensive ditching and tiling. Formerly landlocked areas are now connected to tributaries resulting in downstream delivery of water, sediments, and nutrients that otherwise would not have reached the river. The story is similar in urban areas. Water that formerly soaked into the ground is now transported from roofs, roads, and parking lots to storm sewers that drain into streams and rivers. Two management strategies need to be considered if water quality is expected to improve in streams and rivers.

First, revise the state drainage code. The Minnesota Drainage Code currently promotes activities that are in direct conflict with other state laws which aim to preserve and protect wetlands, reduce nonpoint source pollution, save endangered species of plants and animals, and protect groundwater supplies. The state drainage laws are outdated and in need of significant revision. The Board of Water and Soil Resources and the University of Minnesota Extension will coordinate and assist with the review of the drainage code activities.

Second, require treatment of urban storm water. In many instances drainage waters from urban areas are discharged directly into lakes and rivers. This has a serious negative impact on water quality and aquatic life. All storm water from cities and towns should be treated before it is discharged into public waters. As part of this approach, all state agencies, especially the Minnesota Department of Transportation, should be required to include effective storm water management as an integral part of every construction project. The Metropolitan Council requires cities in the metropolitan area seeking sewer extensions to adopt and enforce a storm water management ordinance. The ordinances require contractors, developers, and others to adopt best management practices to control storm water runoff. This requirement should be enacted for all cities and towns. The MPCA requires and regulates storm water permits.

*6. IMPLEMENTATION OF EROSION CONTROL PRACTICES

Meeting swimmable and fishable goals can only be accomplished when we recognize that the quality of the water is determined by what we do on the land. Widespread adoption of responsible land use practices on the part of homeowners, farmers, developers, businesses, and government agencies will significantly reduce polluted runoff to surface waters. Resources need to be devoted to assist in the development and implementation of land management practices that protect and improve water quality. There are a number variety of best management practices that are designed to prevent and control sediment and nutrients from entering surface waters. The Board of Water and Soil Resource, Natural Resource Conservation Service and Soil and Water Conservation Districts can provide assistance to landowners and provide the tracking and reporting of these activities.

7. Upgrade septic systems, wastewater treatment facilities, and unsewered communities.

There are many individual failing septic systems, bypasses from wastewater treatment facilities, and unsewered communities that discharge untreated or partially treated sewage to surface waters. The effluent contains solids, phosphorous, nitrogen, chloride, bacteria, viruses, and organic chemicals. Under low flow conditions, these point sources have a significant impact on water quality and environmental health risk concerns.

***8 SUSTAINABLE FEEDLOT AND MANURE MANAGEMENT PRACTICES**

Livestock manure is a major source of potential phosphorus, bacterial, and nitrate pollution. All feedlots are required to obtain a permit from the MPCA or delegated county when there is a change of ownership, expansion, construction activities, or a pollution problem exists and that enough land is available to apply manure at agronomic rates according to Minnesota Rules chapter 7020. It is recommended that each county adopt the state-delegated feedlot program and develop a 10 year plan for bringing nonconforming feedlots into compliance. The University of Minnesota (U of M) published a set of best management practice recommendations for nutrient (manure and fertilizer) management. Continued educational efforts by the U of M Extension Service and other agencies should be utilized in local planning efforts.

***9. NUTRIENT AND PESTICIDE MANAGEMENT - AGRICULTURAL AND URBAN LANDS (ACRES COVERED BY PLAN)**

Commercial fertilizers (nitrogen, potassium, and phosphorus) have become an essential part of many farming operations. The demand for greater efficiency and increasingly high yields has increased the production per acre of many crops. Urban uses of fertilizers have also become an essential part of lawn care for residential, commercial, and recreational properties. Fertilizers can be a source of pollution to surface and groundwater if not applied properly and according to recommended rates. Soil tests should be taken to determine the present levels of nutrients and to determine application rates of additional fertilizer if needed for the intended uses for both crops and turf care. The University of Minnesota and Department of Agriculture can provide assistance for monitoring and tracking fertilizer usage.

10. Source water protection

Source water protection is a means of safeguarding public water supplies by preventing contaminants from entering the area that contributes water to the wells or surface waters that a public water suppliers rely on for drinking water supply.

The long term goal is to implement wellhead protection measures for all public water supply wells. Public water well systems that are considered vulnerable to contamination will receive highest priority to complete wellhead protection plans. Ground water based water supply systems deemed vulnerable and surface water based systems will have a MDH source water assessment completed by 2003.

Wellhead protection plans will be developed and implemented by public water suppliers over the next decade. Those systems determined to be vulnerable to contamination will be considered a higher priority to complete a wellhead protection plan. MDH is the lead agency for source water protection.

Objective B. Protect and improve lake water quality

Generally, the clearer the water of a lake, the more suitable it is for recreation. The more a lake is polluted by nutrients like phosphorus or solids such as soil from erosion, the more algae will grow in the lake and the less desirable the water will be. High levels of algae or solids decrease transparency; however, some natural materials such as tannic acid from bogs and calcium carbonates discolor water and can reduce transparency as well.

Lakes receive the waters of ditches, streams, and rivers as they flow across the land. How we change our land management practices to improve water quality in our rivers and streams will indirectly relate to improvements in the water quality of our lakes. There are also direct impacts to water quality and aquatic communities from land management practices. Pressure on lake resources are increasing from shoreland development, urban and agricultural runoff, reduction in near shore aquatic vegetation and increased recreation use.

Assessment Indicators:

*1. SECCHI TRANSPARENCY IN LAKES

The expected clarity of lakes varies from place to place in Minnesota due to natural features and characteristics of the landscape and changes in land use and cover.

Some solids and nutrients in lakes come from runoff from farm fields and lawns, lakeshore erosion, failing septic systems, wastewater treatment plants, feedlots, and natural sources like leaves.

Water clarity is measured using a method called Secchi transparency. This method involves dipping a disk into the water and gauging how deep the disk can be seen. Secchi disk readings are taken all over the state by volunteers and reported to the Pollution Control Agency, providing an indirect measure of algae amounts. Detecting trends requires taking a minimum of four readings each summer for eight to 10 years. The summer mean-transparency of a lake can vary annually in response to changes in amounts of algae, watershed runoff, precipitation and other factors.

2. *DISSOLVED OXYGEN LEVELS IN LAKES

Adequate dissolved oxygen concentrations are needed for the growth and reproduction of fish and other aquatic fife. A dissolved oxygen concentration of 5 mg/l is considered to be the critical threshold to sustain aquatic life. Dissolved oxygen plays an important role in the chemistry and natural degradation of pollutants in a water body. Low dissolved oxygen concentrations can lead to taste and odor problems in water.

2. *CHLOROPHYL IN LAKES

Algal biomass measurements provide estimates of the amount of algae present in a lake. Chlorophyll *a* is the most commonly used parameter for measuring algal biomass. Chlorophyll consists of a group of green pigments found in all photosynthetic organisms, including algae. Chlorophyll *a* is a type of chlorophyll found in all types of algae. It is used as a measure of algal biomass, because it is often present in direct proportion to the biomass of algae in the water. Average summer chlorophyll *a* concentrations are used as indicators of the severity of algal problems in lakes.

2. *FISH, INVERTEBRATE, AND MACROPHYTE POPULATIONS IN LAKES

Information on a lake’s biota, primarily fish, invertebrates (microscopic animals without backbone), and macrophytes (rooted aquatic plants) is very important to assess the health of a lake's ecosystem. They play a vital part in the lake's food web.

A lake's fish population often receives more attention than any other biological element. The management of fish populations in a lake is dependent on sound information concerning the age and sex distribution of each species. Fish are counted using gill nets, trap nets, seines, electro-fishing, and angler surveys.

Invertebrates (zooplankton) include crustaceans and other microscopic animals without backbones. They are secondary consumers that feed upon bacteria and algae (phytoplankton) and are, in turn, consumed by fish. Because of their role as grazers they play an important part in the lake's food web. Invertebrates (zooplankton), such as *Daphnia Pulicaria*, can intensively increase water clarity by severely grazing on algae (phytoplankton).

Macrophytes (rooted aquatic plants) provide important habitat for fish and aquatic life. They play a unique role in maintaining healthy lakes with good water clarity and abundant fish and wildlife populations. These plants stabilize bottom soils and prevent shoreline erosion. They

play an important role in filtering nutrients from the water and provide a place for small snails, immature insects, and tiny crustaceans to feed and live. Macrophytes are important biological indicators of ecological health. Monitoring the species composition, density, and depth of aquatic plants provides important insight into a lake's quality.

2. *LAKE ACRES MEETING HEALTH STANDARDS FOR SWIMMING

In order to meet the goals of the Clean Water Act (CWA), the Minnesota Pollution Control Agency focuses on whether lakes meet swimmable or fishable uses. As schemes are developed to prioritize lakes for monitoring, protection, and/or restoration, both aspects of use-support should be considered. Initially, though, they will be addressed separately. The primary reason that lakes in Minnesota are impaired and not suitable for swimming is the accelerated aging (cultural eutrophication) which occurs as a result of excess nutrient, bacterial, and sediment loading because of human activities in the lake and watershed. Minnesota state agencies currently use the "Recommended Standards for Bathing Beaches" as guidelines for meeting health standards for swimming uses of public waters. The water quality standards include the follow categories: bacteriological, chemical, physical, and biological quality.

Biological organisms that cause waterborne diseases are among the oldest health threats to drinking-water quality. Waterborne diseases can be caused by a number of different bacteria, viruses and protozoa. These disease-causing organisms live in the intestines of warm-blooded animals and can be spread to water by contact with animal feces. Potential sources of contamination include sewers, septic systems, feedlots and manure spreading.

Symptoms of waterborne disease include gastrointestinal illnesses such as severe diarrhea, nausea and possible jaundice, with associated headache and fatigue. These symptoms also result from other factors or diseases. Generally, young children and the elderly are more susceptible to waterborne disease.

The Pollution Control Agency measures fecal coliform bacteria to determine the presence of and the potential for disease-causing organisms. The measurement of fecal coliform is affected by sunlight, nutrient levels, temperature, stream flow and other factors. Public water supply systems routinely test for total coliform, fecal coliform, and escherichia coliform (*E. Coli*). While fecal coliform bacteria are not harmful to humans, they indicate potential contamination from sewage and do suggest the presence of disease-causing organisms.

Phosphorus is a key nutrient in the growth of almost all plants, whether on land or water. As such, the amount present in water greatly affects the amount of algae and other aquatic plants present in lakes or streams. Phosphorus concentration is of particular concern in lakes where it is often the limiting nutrient in algal productivity. Phosphorus is present in the environment in several forms. The analysis for total phosphorus (TP) provides a measure of the total concentration of phosphorus present in a water sample. Only a portion of the TP is readily available for use in algae growth; however, TP does give an indication of the total amount of phosphorus contained in the various forms of phosphorus.

Land Management Indicators:

1. *THE NUMBER OF COMPREHENSIVE LAKE MANAGEMENT PLANS DEVELOPED

In most instances, developing a lake management plan will precede any meaningful restoration or protection efforts. The plan will guide efforts and gain buy-in of local government officials and state agencies. In this planning process, information on the lake and its watershed is assembled, goals for the lake and its watershed developed, and management options discussed. It may also serve as a basis for seeking funding to carry out your proposed projects. The manual "Developing a Lake Management Plan" and "A Citizens Guide to Lake Protection" should be helpful resource and are available from the MPCA. As guidelines, the MPCA's method to track the status of lakes is the "Use Support Classification for Swimming Relative to Carlson's Trophic State Index by Ecoregions".

Preserving the quality of lakes is essential to state and local economics. It is wise and less costly to protect and preserve lake conditions whenever possible than it is to restore them. Activities in the shoreland and riparian areas are an important part of an overall protection effort. Second and third-tier developments should be considered for inclusion in these efforts as well. Special efforts should be made to reduce the amount of impervious area and maintain vegetative buffer zones to minimize the disturbance or removal of aquatic vegetation near shore. Recreational uses of the lake need to be considered as development occurs to maintain those uses for future generations. The local county environmental office monitors to oversee the management and enforcement of shoreland activities with support of the Department of Natural Resources.

*2. IMPLEMENTATION OF EROSION CONTROL PRACTICES IN THE WATERSHED (ACRES BUFFERED)

Meeting swimmable and fishable goals can only be accomplished when we recognize that the quality of the water is determined by what we do on the land. Widespread adoption of responsible land use practices on the part of homeowners, farmers, developers, businesses, and government agencies will significantly reduce polluted runoff to surface waters. Resources need to be devoted to assist in the development and implementation of land management practices that protect and improve water quality. There are currently a variety of best management practices that are designed to prevent and control sediment and nutrients from entering surface waters. The Board of Water and Soil Resource, Natural Resource Conservation Service and Soil and Water Conservation Districts can provide assistance to landowners and provide the tracking and reporting of these activities.

3. Re-establishment of aquatic vegetation

Aquatic plants are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. In lakes, life depends directly or indirectly on water plants. They are the primary producers in the aquatic food chain, converting the basic chemical nutrients in the water and soil into plant matter, which becomes food for all other life. As human activities have increased in the lake and watershed, and introduction of exotic plants, native aquatic plants have decreased in many cases. The Department of Natural Resources has developed several guidance

documents on aquatic plants and management of aquatic plants. One recommended document is "A Guide to Aquatic Plants, Identification, and Management." The Department of Natural Resources monitors aquatic vegetation activities.

*4. UPGRADE SEPTIC SYSTEMS, WASTEWATER TREATMENT FACILITIES, AND UNSEWERED COMMUNITIES

There are many individual failing septic systems, bypasses from wastewater treatment facilities, and unsewered communities that discharge untreated or partially treated sewage to surface waters. The effluent contains solids, phosphorous, nitrogen, chloride, bacteria, viruses, and organic chemicals. Under low flow conditions, these point sources have a significant impact on water quality and environmental health risk concerns. The University of Minnesota Extension Service provides training and education for the Individual Sewage Treatment System (ISTS) program. The Minnesota Pollution Control Agency provides for the licensing and tracking of the ISTS program. The MPCA is also responsible for the permitting, monitoring, enforcement, and tracking of wastewater treatment facilities and assisting unsewered communities to become compliant.

*5. RESTORATION AND PRESERVATION OF WETLANDS

The drainage of all types of wetlands in rural and urban areas has dramatically altered the surface and subsurface hydrology in watersheds. Minnesotans recognize that wetlands perform many important functions, such as reducing peak flow during runoff events, recharging groundwater aquifers, slowing the movement of surface water, trapping sediment and nutrients, and providing habitat for fish and wildlife. The preservation of existing wetlands should be a high priority. Agencies such as the USFWS, NRCS, BWSR, MNDNR, and SWCD can provide financial and technical assistance to landowners for wetland restoration and preservation projects. These agencies can provide the tracking, monitoring and reporting of wetland implementation activities.

*6. SOURCE WATER PROTECTION

Source water protection is a means of safeguarding public water supplies by preventing contaminants from entering the area that contributes water to the wells or surface waters that a public water suppliers rely on for drinking water supply.

The long term goal is to implement wellhead protection measures for all public water supply wells. Public water well systems that are considered vulnerable to contamination will receive highest priority to complete wellhead protection plans. Ground water based water supply systems deemed vulnerable and surface water based systems will have a MDH source water assessment completed by 2003.

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Objective C. Protect and improve ground water quality

Ground water is a vital source of drinking water for more than 70 percent of Minnesotans and 98 percent of the state's nearly 1,000 community water systems. Identifying trends in ground-water quality is difficult due to the typically long response times of aquifers to changes in activities at the land surface. There is presently no single data set that identifies trends in ground-water.

Ground and surface water must be treated as a single resource. Land, waste, and water management practices that affect surface water will ultimately affect groundwater as well. Point and non-point sources of contaminants must be properly managed to eliminate their infiltration into groundwater systems.

Assessment Indicators:

*1. NITRATE IN GROUND WATER

Nitrate is the most common contaminant found in ground water in Minnesota and is used nationally as an indicator of overall quality. Nitrate in ground water comes from people and some comes from nature. Nitrate is not a principal component of surface water or ground water unless the water has been affected by human activities. To prevent degradation of ground-water quality, it is necessary to understand how water moves in the subsurface. Nitrate is a good tracer of ground-water movement since elevated nitrate levels in ground water can be used to identify where aquifers have been influenced by activities at the land surface.

The Pollution Control Agency conducted a statewide baseline assessment of groundwater quality in Minnesota by sampling approximately 1,000 private wells between 1992 and 1996. The agency is redesigning its Ground Water Monitoring and Assessment Program to monitor trends in areas of the state where water quality is affected by activities at the land surface. Other data sources include Minnesota departments of Health, Agriculture and Natural Resources, and regional, federal and local sources.

*2. CHLORIDE IN GROUND WATER

Chloride, like nitrate, can be introduced into ground water by activities at the land surface. Sources of chloride include community and individual sewage treatment systems and road salt. In addition, chloride can be used to identify the influx of deeper or more naturally saline waters into freshwater aquifers due to excessive pumping. Unlike nitrate, chloride is chemically stable in conditions typical of deeper aquifer settings. In this way it can identify impact of land use on ground-water quality in areas where nitrate no longer exists. The presence of elevated chloride and nitrate in ground water does not necessarily mean that there are other, potentially harmful chemicals in the ground water; rather, by analogy, where there is smoke, there may be fire.

Natural levels of chloride in ground water are higher in some state areas than others. Data from the Pollution Control Agency, Department of Natural Resources and U.S. Geological Survey helps distinguish natural levels of chloride from those introduced by land surface activities.

*3. VOLATILE ORGANIC COMPOUNDS IN GROUND WATER

Volatile organic compounds are chemicals that evaporate rapidly from water into air at normal air temperatures. These chemicals are contained in a wide variety of commercial, industrial and household products, such as fuel oils, gasoline, solvents, cleaners and de-greasers, paints, inks, dyes, refrigerants and pesticides. Most volatile organic compounds found in the environment result from human activity.

Volatile organic compounds vary considerably in their harmful effects. The Minnesota Department of Health has developed drinking water standards for many of these compounds. Some of these compounds are known or suspected to cause cancer; others can be harmful to the central nervous system, the kidneys, or the liver; or cause irritation to the skin or mucous membranes.

The Minnesota Department of Health requires public water suppliers to test for volatile organic compounds based on the type of water supply system and on previous analytical results. This information is collected and is available in department databases.

*4. TOTAL ATRAZINE (ATRAZINE PLUS METABOLITES) IN GROUND WATER

Pesticides vary widely in their effects. Each behaves uniquely as it moves in the water, soil and air, and the rate it breaks down into other compounds; therefore, no one pesticide is a good indicator of the concentration of pesticides in ground water and potential risks to the environment or human health.

Atrazine is suggested as an indicator because it is the only pesticide in Minnesota currently in *common detection status*, which means it is a serious concern for Minnesotans. An advisory committee has determined that detection of atrazine is not due to misuse or unusual or unique circumstances.

The Minnesota Department of Agriculture has sampled more than 425 wells since 1985, representing 13 aquifers. Monitoring efforts have focused on the sandy soils in central Minnesota and the karst bedrock in the southeast part of the state. In these places, ground water is considered susceptible to contamination. Normally, 70 percent or more of samples collected contain no detectable pesticide. Five pesticides alachlor, atrazine, cyanazine, metolaclor and metribuzin - represent over 95 percent of detections from ground-water monitoring.

Atrazine is detected most commonly, and typically represents more than 90 percent of the detections in any given year. Detections commonly fall between 0. I and 0.5 parts per billion, with less than 5 percent reported above 1.0 parts per billion. Generally, average atrazine concentrations in the sand plain have been declining in wells monitored over time. In karst areas, atrazine concentrations are remaining about the same.

Land Management Indicators:

*1. SOURCE WATER PROTECTION (NUMBER OF SYSTEMS WITH PLANS)

Source water protection is a means of safeguarding public water supplies by preventing contaminants from entering the area that contributes water to the wells or surface waters that a public water suppliers rely on for drinking water supply.

The long term goal is to implement wellhead protection measures for all public water supply wells. Public water well systems that are considered vulnerable to contamination will receive highest priority to complete wellhead protection plans. Wellhead protection plans require a drinking water supplier to have a contingency plan to address disruption of the water supply due to mechanical failure or contamination. Ground water based water supply systems deemed vulnerable and all surface water based systems will have a MDH source water assessment completed by 2003.

Wellhead protection plans will be developed and implemented by public water suppliers over the next decade. Those systems determined to be vulnerable to contamination will be considered a higher priority to complete a wellhead protection plan. MDH is the lead agency for source water protection.

Vulnerability assessments must be conducted for all recharge areas for ground water-based drinking water suppliers. A vulnerability assessment will: 1.) determine the degree of risk that land uses may have on the quality of the ground water entering the public water supply well, 2.) guide the amount of effort needed to conduct an inventory of potential contaminants in the recharge area, and 3.) help define measures for controlling potential contaminant sources so they do not present a threat to public water supplies.

*2. MANURE AND NUTRIENT MANAGEMENT.

In vulnerable ground water recharge areas around the state, ground waters are susceptible to nitrate-nitrogen contamination. Animal feedlots are frequently found in source water protection areas and may pose a risk to ground and surface water-based drinking water systems. Runoff from feedlots may percolate into groundwater or enter surface waters from overland flow. Implementation of nitrogen fertilizer and manure BMPs are important to reduce the impacts manures and fertilizers may have on drinking water resources. Education should be a component of any manure or nutrient management plan

*3. WATER QUALITY CHANGES IN SHALLOW AQUIFERS

Monitored water quality changes in shallow ground water systems are a function of susceptibility of the aquifer to contaminants. Susceptibility is defined as the likelihood that a contaminant will enter a public water supply at a level which may result in an adverse human health impact. A full understanding of the hydrogeology of Minnesota's ground water systems is required to

determine which aquifers are susceptible to surface connected contamination. Ground water monitoring should be conducted to determine if levels of contaminants are changing.

4. Well management

Improperly constructed or maintained wells, or wells that are unused or improperly sealed, can provide a direct pathway for contaminants at the land surface to reach an aquifer. This is particularly important for confined aquifer settings. Confined aquifers are generally protected from potential sources of contamination by overlying layers of low permeability materials such as clay or shale. This natural protection can be bypassed by wells which are improperly constructed, maintained, or unused and unsealed**.**

If total coliform and coliform or E. coli are detected in ground water, there is strong evidence that fresh sewage is present. As of 1999, all community water suppliers are required to publish an annual consumer confidence report on the quality of their drinking water. In addition to information collected by public water suppliers, the Minnesota Department of Health requires that new wells be tested for total coliform before the well can be used as a source of drinking water.

*5. UPGRADE OF INDIVIDUAL WASTEWATER TREATMENT SYSTEMS

There are many individual failing septic systems, by passes from wastewater treatment facilities, and unsewered communities that discharge untreated or partially treated sewage to surface waters. The effluent contains solids, phosphorous, nitrogen, chloride, bacteria, viruses, and organic chemicals. Under low flow conditions, these point sources have a significant impact on water quality and environmental health risk concerns. The University of Minnesota Extension Service provides training and education for the Individual Sewage Treatment System (ISTS) program. The Pollution Control Agency is for the Licensing and tracking of the ISTS program. The MPCA is responsible for the permitting, monitoring, enforcement, and tracking of wastewater treatment facilities and assisting unsewered communities to become in compliance.

6. Improved compliance and elimination of unsafe storage tanks

Leaks from storage tanks can result in contamination of public and private water supplies. The MPCA estimates that there are more than 50,000 above and underground storage tanks in Minnesota. Above ground tanks are used for storing crude oil and petroleum products, chemicals and food products such as molasses and vegetable oil. Underground tanks most commonly store petroleum products and hazardous substances. Currently, state and federal law and state or local fire marshals already require certain standards for those tanks that are regulated. These standards are primarily designed to prevent leaks resulting from corrosion, spills and improper installation. Leaking tank detection and removal and remediation of contaminated soils should be a high priority in ground water recharge areas.

7. Safe hazardous waste disposal and solid waste management practices

Improper management of waste causes environmental problems, ranging from human illness to environmental pollution to ecosystem damage. Businesses, governmental agencies, institutions, and other organizations can use or store hazardous materials. In addition, although not usually considered hazardous materials, salt/sand mixtures, street sweepings, and residue from vehicle washing and storage sites are similar waste materials that need proper management. Efforts by state and local government are important to provide education, service based programs, monitoring, grants and loans to solid waste, livestock composting and hazardous waste generators for the purpose of providing improved management practices.

8. Underground injection wells

Underground disposal of commercial, agricultural and industrial wastewater can cause serious soil and ground water contamination if not carefully controlled. Injection wells are regulated by the United States Environmental Protection Agency in order to protect underground sources of drinking water. In source water protection areas a high priority is given to the removal or sealing of disposal wells that inject motor vehicle waste, industrial wastes, agricultural drainage waters, and sewage wastes into ground waters.

9. Regulation

Controlling the usage and management of certain pollutants can be done by a local unit of government. There are a variety of regulatory categories that a community may chose from to control or manage materials or substances that may impact the public drinking water supply. Typically public water suppliers can work closely with state and local regulators, including the fire marshal on regulatory efforts.

10. Stormwater management

Stormwater management methods in urban or rural landscapes are typically designed to protect and improve surface water quality and to control flooding. In source water protection areas, careful consideration of the type of stormwater structures used is needed to protect a drinking water supply. The type of structure chosen will depend on characteristics of the watershed, goals of the source water protection plan, local and regional geologic and hydrogeologic conditions and characteristics of potential contaminant sources within the source water protection area.

Goal. Minnesotans will conserve water supplies and maintain the diverse characteristics of water resources to give future generations a healthy environment and a strong economy.

Minnesotans take water for granted in planning for development; they expect to find it available everywhere in a quantity and quality that meets their demands. However, supply in some areas is inadequate and elsewhere, contamination has harmed the supply or the natural quality prevents the use of water. Competing users can strain local water supplies. Individual demands for water either stay the same or increase with the decrease in supply during droughts. High water levels that may happen only once a decade need to be considered when planning construction so floods do not cause unnecessary and costly damage.

The impact of development and redevelopment and changing uses of water resources will impact the ability to meet this goal. Water supply must be planned. Communities must clarify uses of water that are essential and non-essential to help assure a continued supply of water in emergency situations. Water conservation and a shared philosophy of water use is needed. Economic incentives must support conservation practices.

Objective D. Maintain ground-water levels to sustain surface water bodies such as lakes, wetlands, fens and rivers and provide water supplies for human development.

Minnesota is increasingly tapping into ground water. The use of ground water for public water supplies surpassed surface water in about 1980 and continues to grow. Irrigation, drawing mainly on ground water, doubled between 1986 and 1996. Using too much water from a vulnerable supply could cause lakes, rivers or wells to dry up.

Many of Minnesota's shallow aquifers have been compromised. This has forced the increased use of deeper aquifers. Minnesotans are using more water and they are also increasing the use of groundwater as their main water source. Groundwater supply is threatened by demands of public consumption, industrial and commercial use, and irrigation. Using too much water from a vulnerable supply could impact lakes, rivers, fens and wells and increase the rate of contaminant movement. Conservation of groundwater and assurance that the quality of groundwater remains high are both related to land management indicators.

Assessment Indicators:

1. *WATER LEVELS IN WELLS

The need to acquire groundwater will increase as human activity increases. More wells will be dug and the added pumping may draw down other wells in the vicinity. This will result in complaints from existing well users.

New wells will need permitting prior to drilling. These could be monitored for domestic consumption. Industrial and municipal wells would be permitted as well and pumping rates and well draw-downs could be monitored closely. In some areas, the practice of dewatering an aquifer for industrial purposes needs to be monitored closely. In rural areas the growing number of large confinement facilities pose a real concern as they tend to have larger water consumption than normal domestic use. MDH or DNR could monitor these permits.

2. Community and rural water systems expansions

The lack of water quantity and quality in some parts of the state has led many rural farms and communities to develop rural water systems. These systems provide potable water to farms and communities that would otherwise face a large investment that may or may not result in a good supply of water. The Lincoln-Pipestone Rural Water System, for example, has more than 2800 farmers and 24 small communities on its current system with plans for expansion. Most of these systems rely on shallow aquifers to supply their water. Groundwater contamination and the possibility of a prolonged drought are a real possibility. As these rural water systems either

expand to address economic growth needs, or maintain their current network, they utilize a very limited resource which should be managed on a regional basis.

The rural water systems would be the indicator source. The Dept. of Health monitors all public water suppliers for water quality. The Dept. of Natural Resources monitors water usage. Increases in the number of customers would be an indicator of change.

Communities utilize both surface and groundwater to supply their water needs. Most communities rely solely on groundwater for use. When the need arises, the city may be required to dig new wells due to new industry within city limits. This added consumption may strain existing wells. If adequate sources are not located nearby, it may result in business and industry moving to communities where an adequate water supply is available. This would result in a loss of jobs.

***3. PER CAPITA USE OF WATER**

Municipalities keep data on water use based on per capita consumption. Trends could indicate increased usage. In addition, the Department of Natural Resources monitors municipal well use.

Land Management Indicators:

***1. NUMBER OF COMMUNITIES THAT ENACT WATER CONSERVATION PLANS AND DEVELOP STRATEGIC USE PLANS WITH ALL CUSTOMERS (NUMBER OF PLANS ENACTED, IMPLEMENTED)**

Population trends show that rural area numbers are decreasing and community numbers are increasing. This varies from region to region with people migrating to larger metro and regional centers. As water appropriation becomes critical in some communities it will be important that they enact strategies to conserve water, provide use information, develop contingency plans in times of prolonged drought and emergency situations.

Local community water conservation and strategic use plans should be developed over time.

2. Implementation of water retention conservation practices

The construction of farm ponds may furnish a source for the recharge of groundwater. Although this is limited, care must be taken to provide for a non-contaminated water source.

Individual counties could inventory number of constructed ponds and dams. The DNR has records of permitted larger dams that meet Dam Safety requirements.
Protection of groundwater can be partially accomplished by the implementation of conservation practices. Crop rotation, conservation tillage, ag. waste utilization, and buffer strips are a few of the agronomic practices that could be used to aid in groundwater recharge. Engineered practices such as blind tile intakes, ditch plugs, farm ponds and small dams could be used as well.

Trends in applying conservation practices could be monitored by the National Resource Inventory. This is administered by the USDA Natural Resources Conservation Service. The inventory is done every 5-10 years and would be reliable on a major watershed basis. Local field offices of the Soil and Water Conservation District and USDA NRCS have county specific data.

*3 NUMBER OF IDENTIFIED AND PROTECTED GROUNDWATER RECHARGE AREAS

Groundwater recharge varies throughout the state based on watershed size, amount of rainfall and surface and subsurface composition of the aquifer. In some parts of the state these recharge areas occur in geologically sensitive areas. Karst topography in SW MN has shallow topsoil over fractured limestone, extensive peat deposits in Northern MN, Anoka Sand Plains, Shallow topsoil over bedrock and the red clay deposit in NE MN are just a few of these sensitive areas. Each of these areas need special management to protect the groundwater.

Resource maps would indicate these areas. The MN Geological Survey would be able to provide maps of these sensitive areas. County soil surveys would provide smaller areas that may not be covered by the Minnesota Geologic Survey.

The state has enacted a “No Net Loss” policy for wetlands. In addition several State and Federal programs encourage the restoration of wetlands. Wetlands serve as a recharge site for our groundwater.

Wetland restorations and constructed wetlands could be monitored by local Soil and Water Conservation Districts, USDA agencies, DNR, and US Fish and Wildlife Service for programs that each administer.

*4 WATER LEVELS IN AQUIFERS

The quantity of water available in each aquifer is important information for development of new wells. Pumping tests are needed to determine draw-down in wells and recharge rates Users need this information to determine placement of new wells as well as potential problems that may arise as a result of over-pumping from an aquifer.

Groundwater studies in some aquifers are available. The DNR has an observation well program and other well records are available. The MN Geologic Survey and USGS have aquifer studies for use.

5. Impervious surfaces in recharge areas

Each year thousands of acres are developed to provide housing, roads, industrial development, and parking lots. These impervious surfaces alter the amount of recharge that aquifers receive. In addition it may add to the degradation of water quality by adding road deicer salts, lawn fertilizers, etc. to the aquifer. Planning and Zoning Commissions may need to consider urban expansion and its effect on their water supply. Sensitive aquifers are more vulnerable to this.

Communities can monitor trends in impervious surfaces by analyzing building permits. They can also monitor the effect of laws or building codes that try to reduce the amount of impervious surface per development. In rural settings this may be more difficult to track. Building permits and regulations may provide a means to monitor.

5. Irrigation

There is 380,394 acres in irrigated land in Minnesota according to the 1997 USDA Census of Agriculture. Most of these acres occur in sand deposits and the aquifers range from small to large and shallow to deep. Contamination by pesticides and fertilizers are a concern. Appropriation is permitted through the DNR.

Trends in irrigation could be monitored by the DNR through the permit process. The other source of information is the USDA Census of Agriculture that is conducted every 10 years.

5. Diversion of water between watersheds

Groundwater recharge relies on rainfall for its source of water. One or more surface watersheds may overlay an aquifer. In some instances these watersheds have had activities such as ditching and tiling that has diverted water from one watershed to another. If the aquifer you are trying to protect has a limited area for recharge, any loss of surface water by the above actions could have a dramatic effect on the viability of that aquifer. Limiting activities that divert water would be beneficial

Individual counties need to monitor requests for public drainage systems that cross watershed boundaries. They need to make the public aware of any potential problems.

5. Sand and gravel surficial mining

Removal of sand and gravel by mining in a shallow aquifer that is used for wells in an area needs to be monitored. The mining activity itself could contaminate the aquifer. In some operations de-watering is used to get to sand and gravel deposits. The pumping may have an effect on local wells. If mining is carried out for several years, the aquifer's water supply could be reduced.

Permits for de-watering could be monitored by the DNR and trends in this activity could be tracked. The potential contamination of the aquifer could be monitored by the Dept. of Health through complaints or municipal well data.

5. * ACRES OF CALCAREOUS FENS PROTECTED.

Calcareous fens are the rarest wetland plant community in Minnesota and Wisconsin, and probably one of the rarest in North America. These are plant communities of wet, seepage sites that have an internal flow of groundwater rich in calcium and magnesium bicarbonates, and sometimes calcium and magnesium sulfates as well (Curtis 1971). The calcium and magnesium bicarbonates and sulfates precipitate out at the surface, creating a harsh, alkaline soil condition.

Only a select group of calcium-tolerant plants, referred to as **calciphiles,** can tolerate these conditions. Characteristic species include shrubby cinquefoil, sterile sedge, wild timothy, beaked spike-rush, Ohio goldenrod, common valerian and lesser fringed gentian. Also included are species disjunct from the tundra, alpine meadows, and salt marshes. Therefore, calcareous fens have been referred to as a hybrid community by Curtis (1971).

Calcareous fen communities in general have a disproportionate number of rare, threatened, and endangered plant species compared to other plant communities in the Great Lakes Region. Trout streams are often associated with calcareous fens because of the cold, pure water provided by the springs and seepages. Active springs are frequently associated with calcareous fens.

Calcareous fens should be mapped and monitored via the DNR County Biological Survey and programs such as DNR's Protected Waters Inventory and WCA.

Objective E. Maintain the hydrologic characteristics of surface water that support beneficial uses

Drinking is a priority use of surface water. Twenty-six community water supplies use water from lakes and rivers. Besides the use of water for drinking water purposes, the other priority water use is habitat for fish and wildlife.

Habitat changes as natural conditions of riverine systems change. The changes help keep the overall system healthy for plants and animals. When changes in the hydrology of a water system occur, the delicate balance of the system is jeopardized. High flows destroy habitat. Low flows may not support plant and animal communities.

The availability of water supply has to first meet priority needs. Other uses must depend on alternative supplies when conditions result in depleted resources. Demand must reflect the natural variation of water supplies. When water use increases during drought, it can threaten human, fish and wildlife needs. Costs increase as flood-prone lands are developed. Efforts to control flooding through control structures has altered the natural flow conditions and disrupted ecosystem balance. Flood damage reduction measures can help reduce social/economic impacts in floodplain areas while supporting natural systems.

To maintain a natural range of variation in surface waters, two options for management exist. The water supply can be managed more effectively or the demands placed on the water supply must be managed. Urban and rural runoff can be better managed to hold water on the landscape. This will allow more infiltration to sustain base flows year around and retard contributions to help reduce the severity and frequency of flooding.

Wetlands are important because of how they function in hydrologic and ecological systems. Regional differences in Minnesota can be attributed to the quantity of wetlands existing now and historically. Today there is greater understanding about the value of wetlands for habitat, water quality, flood mitigation and recreation.

Most lakes in Southwest Minnesota are shallow prairie pothole lakes. These lakes are greatly influenced by hydrologic changes. Water levels in these lakes are an issue of concern to citizens and to resource management agencies. Still, they contribute aesthetics to communities and a sense of well-being to their citizens. Lakes draw people to an area and add economic value through their recreation and tourism potential. They are an important source of water supplies.

Assessment Indicators:

*1. TRENDS IN STREAM FLOW

Minnesota's water consumption is increasing even in years with plenty of precipitation. During drought, decreased flows can affect the ecological health of a stream. Power production and industrial processing are major users of surface water.

Stream flow is measured at approximately 96 continuous gauging stations and numerous measurement sites maintained by the U.S. Geological Survey. The Department of Natural Resources measures stream flow at 38 flood warning gauge sites. Additional measurements are taken by permit holders and researchers for high or low flow documentation. Models and statistical analyses describe the frequency and magnitude of flows and forecast high or low flows. Water users or property owners in the path of the water can then take appropriate action.

*2. DRAINAGE PROJECTS (DITCH & TILE IMPROVEMENTS; FEET OF TILE PURCHASED)

Drainage projects improve agricultural production and convey water to a downstream location. This process, while good for crop yield, does cause a shorter, steeper and higher hydrograph often referred to as “bounce.” This artificially caused bounce causes increased erosion of streambanks and ditch banks adding sediment to the stream or ditch. Flooding may also be a negative outcome of drainage projects depending on the soils, landscape and conveyance system. Smaller frequency storms cause water to rise with cumulative impacts to downstream flooding and streambank erosion.

Drainage authorities are responsible for tracking these systems with agencies such as the USGS monitoring flow at various locations throughout the watershed. Presently U of M Extension Service is doing research. Institutions such as the U of M St. Anthony Falls Hydraulics Laboratory and in the future Minnesota State University Water resources Center could begin to model complex artificial drainage systems to provide accurate information regarding impacts of drainage.

*3. WETLAND ACRES

Despite wetland gains from federal, state and private restoration efforts and regulatory programs such as the Wetland Conservation Act, it is unlikely that Minnesota has reached its goal of no-net-loss of wetlands. Significant wetland losses occur from activities that do not require approvals or permits, making them impossible to accurately track. As difficult as it is to estimate wetland gains and losses on an acreage basis, it is even more difficult to measure the functional gains and

losses resulting from wetland projects. Quantitative information on wetland functions, which is more relevant than total acreage, is not available.

Minnesota currently has approximately 8.7 million acres of wetlands. Using the National Wetland Inventory database, eight different wetland types have been identified in the State (Source: Circular 39 Classification). Recent estimates of wetland trends on non-federal land indicate a loss rate of 70 to 90 thousand acres annually. Drainage of wetlands for agricultural purposes has continued to decline, while development accounts for a large percentage of losses. In addition to these losses, many other wetlands have suffered degradation of functions. Calculating the magnitude of the degradation, however, would be difficult. (Source: EPA- Status and Trends)

The DNR, BWSR, and USFWS will track the wetland changes as they occur.

*4. PLANT BIODIVERSITY

The result of draining wetlands and/or altering the hydrology is a change in species composition. As a result of disturbance and habitat degradation, wetlands are being invaded by aggressive, highly tolerant, non-native vegetation, such as purple loosestrife, water hyacinth, and salvinia, or being dominated by a monoculture of cattails or common reeds.

The DNR and local county governments use the biological survey to monitor the changes that are occurring in the wetlands.

*5. LAKESHORE DEVELOPMENT PRESSURE (NUMBER OF NEW RESIDENCES AND SUB-DIVISIONS)

The development of lake shore varies by region and county. All permits must be issued by the planning and zoning commission in the county. All development must comply with county ordinances. In some areas, the county ordinance is more stringent than the state's.

The County planning and zoning commission would track the growth rate of lake shore development.

Approximately 70 to 75 percent of the privately owned lakeshores are altered for aesthetic purposes. Only federal and state owned lands have not been altered. The State of Minnesota provides financial assistance to owners to restore the lakeshore back to its original habitat or to leave property in its natural state.

State agencies providing financial assistance would track number of lakeshores being altered.

Variances may be granted in accordance with Minnesota Statutes. Conditions may be imposed in the granting of variances to ensure compliance and to protect adjacent properties and public interest. Townships with shoreland management controls must provide information granting variances to the zoning official of the county.

Land Management Indicators:

1. Water supply demand reduction and increased storage capacity

Cities and water utilities should plan and design water storage and retention systems to minimize instantaneous demand rates. Water storage and retention allows water to be appropriated at lower, more sustainable rates as surface waters become more limited. Storage, coupled with demand reduction and water conservation, will provide more sustained flows for downstream uses. Construction of additional water storage systems, the requirement of water demand reduction measures for large users and the adoption of water conservation plans and measures by communities and water utilities will be accurate measures of efforts to better manage limited supplies. Cities monitor and manage water supply.

1. *IMPLEMENTATION OF LAND MANAGEMENT PRACTICES WHICH HELP HOLD WATER ON THE LANDSCAPE.

Not only must we educate about the need to hold water on the land, programs such as RIM and CREP must continue to be funded at adequate levels so that water holding areas will actually be put on the ground. Road retention structures including downsizing bridges and culverts, rock inlets, restoration of small ponds and dams are all ways to ease impacts to drainage systems. DNR hydrologists can teach improvements from these efforts.

Under MN Statutes 103A.205, it is the policy of the state to promote the retention and conservation of all water precipitated from the atmosphere in the areas where it falls, as far as practicable. It is also the goal to encourage the construction of small upstream retarding structures for the conservation of water in natural water basins and watercourses, consistent with any overall plans for the affected watershed area. These practices will enhance groundwater recharge and more stable base flows for our rivers and streams. Construction of water retarding structures (that are not barriers to fish movement), wetland and drained lakebed restorations, reclamation of our natural floodplains and other environmentally sound methods of holding water on the landscape are measures of progress.

Unfortunately, there is no single or direct data, or monitoring of how we comprehensively or collectively manage water on our landscapes. Drainage activity is not regulated or tracked and water retention programs and implementation efforts are scattered among many state, federal, local, public and private non-profit groups. Determining trends is possible but will be difficult to compile from the many public and private sources of data. Local drainage authorities are in the best position to track maintenance and improvement of drainage systems and to report their information. DNR and BWSR can track losses and gains of wetlands via the PWI and WCA while gains in storage areas can be tracked by BWSR.

1. *REMOVAL AND PROTECTION OF FLOOD PRONE USES (DOLLARS INVESTED, STRUCTURES REMOVED)

Floodplain ordinance adoption and enforcement and relocation of flood-prone structures are key to providing adequate space for flood waters. Unrestricted use of the floodplain will lead to

higher peak flows, reduced water quality and rising costs of disaster recovery. DNR is the state agency charged with oversight of floodplain management.

1. Restoration of free flowing, natural river and stream systems

Flow restoration of rivers and streams done in an environmentally friendly manner is important to relieve flooding pressure on upstream lands. This action should be done as part of a comprehensive approach to flood damage reduction which also emphasizes storage of water on the land. Instead of stream and ditch straightening natural systems should be left to meander and restoration of straightened streams should be pursued. DNR and local drainage authorities are best suited to monitor stream straightening trends. Projects involving protected waters are required to obtain permits from the DNR while local drainage authorities are responsible for drainage projects.

1. Management of business and industrial uses as non-essential uses

Community planning must prioritize consumptive use so that basic potable water is available for human health and hygiene. Municipalities should be doing this with oversight by DNR.

Not only must communities prioritize consumptive use, they must educate on and promote water conservation so that water is efficiently consumed depending on the climatic conditions. During drought, restrictions on consumption may be needed to provide adequate water supplies.

1. ***MANAGEMENT AND MONITORING OF DRAINAGE SYSTEMS**

Aging drainage systems are in need of repair. As this is done, drainage authorities must seize the opportunity to integrate wetland restoration and blind inlets in the systems. Understanding of drainage via research done by educational institutions and other experts is critical to providing accurate information to all people regarding the impacts of drainage. A pilot program funded through the Board of Innovation would be a start to this challenge.

Stormwater management methods in urban or rural landscapes are typically designed to protect and improve surface water quality and to control flooding. In source water protection areas, careful consideration of the type of stormwater structures used is needed to protect a drinking water supply. The type of structure chosen will depend on characteristics of the watershed, goals of the source water protection plan, local and regional geologic and hydrogeologic conditions and characteristics of potential contaminant sources within the source water protection area.

1. Dredging-use of fill and spoils disposal

River dredge spoil should be placed in upland areas to allow for flood flows to pass and to eliminate the PCB threat to water quality. DNR should provide oversight to local government as this is monitored via floodplain management.

8. Establishment of lake monitoring programs

Towns and cities in Minnesota have established monitoring programs for their lakes. Aquatic plants and algae respond quickly to small changes in the amount of nutrients present in the water. Too much fertilizer (nitrogen and phosphorous) causes too much plant and alga growth. This can result in growth of dense beds of aquatic plants and blooms of blue green alga that create scums and foul odors. These negatively impact the physical appearance and recreational suitability of the lake. Lakes are monitored regularly for nitrogen and phosphorous levels. In Minnesota, phosphorous is considered more critical than nitrogen because there is less of it available to the lakes and may be easier to control.

9. Development of comprehensive lake management plans

In most instances, developing a lake management plan will precede any meaningful restoration or protection efforts. The plan will guide your efforts and gain buy-in of local government officials and state agencies. In this planning process, information on the lake and its watershed is assembled, goals for the lake and its watershed developed, and management options discussed. It may also serve as a basis for seeking funding to carry out your proposed projects. The manual "Developing a Lake Management Plan" and "A Citizens Guide to Lake Protection" should be helpful resource and are available from the MPCA. As guidelines, the MPCA's method to track the status of lakes is the "Use Support Classification for Swimming Relative to Carlson's Trophic State Index by Ecoregions."

10. Organization of lake associations

Lakeshore residents have formed Lake Associations on a voluntary basis. Forming the associations has helped in protecting and preserving the quality of water in the lakes. The associations establish goals and initiate projects and programs of long-term significance that will help maintain the lake's health.

11. Sustainable development approaches in communities with lakes and wetland areas

People are connected to the land, water, air and life forms that surround them. Balance among these things must occur if each is to be sustained in a healthy manner. When relationships between people and their ecosystems are not balanced, social, economic and environmental problems emerge. How effectively communities are balancing these elements is seen in the quality of life found within communities. The quality of life of our communities must be evaluated.

Community development is a major factor in the quality of community life. Community development must be consistent with and in accordance with a balanced approach to social, economic and environmental health. This balance is especially critical where resources that contribute significantly to the survival of people, plants and animals, such as water resources, are at stake. Communities through long-term comprehensive plans can help to assure sustainable approaches to development. Indicators need to be incorporated into comprehensive plans in order to measure how effectively quality of life is being sustained. Indicators can help to set community policy priorities.

The state, through Minnesota Planning, consistent with recommendations contained in proceedings from the 1994 Minnesota Congress on Sustainable Development, should develop sustainability measures and data bases that integrate social, economic, and environmental elements to support local community planning efforts.

Goal: Minnesotans will restore and maintain healthy aquatic ecosystems that support diverse plants and wildlife

People do not only affect natural resources, people are a mutually interdependent part of all ecosystems. The health of people depends upon the health and diversity of plant and animal communities. We must manage natural resources in ways which will support sustainable use, including recreational use, economic stability, and well being of plants and animals, including humans.

Managed ecosystems in which plant and animal diversity closely resemble that of undisturbed systems tend to be more resilient and stable, as well as more healthy. Because the natural environment can be modified by people's activities, the diversity of plants and animals is a commonly used measure of ecosystem health. Naturally diverse systems have a variety of species, a variety of habitats, and a complex food web. As habitats or species are eliminated, relationships between species change and the system becomes more susceptible to decline and collapse. Exotic plants and animals tend to displace native species and may reduce diversity and disrupt normal ecosystem processes.

Objective F. Ensure aquatic environments have conditions suitable for the maintenance of healthy self-sustaining communities of plants and animals

Several species are suggested to track the health of the ecosystem. Fish, frogs and some species of birds rely on water environments for food, cover and nesting areas. Variability of some species at a statewide scale may mask local areas where conditions have deteriorated for a species because of loss of habitat or overuse. If pollution affects food sources, it can affect reproduction, as was the case with the bald eagle's decline due to DDT, a pesticide now banned but commonly used before the 1970s.

Although the health of selected species can be used to gauge the health of an ecosystem, an ecosystem based management approach relies on management of habitat rather than management of a species. Degradation and fragmentation of habitat negatively affects plant and animal communities. The watersheds that support Minnesota River systems also provide habitat for aquatic plant and animal species. Better management of watersheds will lead to healthy plant and animal communities.

The inter-relationship between natural resource management and water quality and recreational use can be accommodated by “smart growth” in Minnesota’s cities, urbanizing communities and rural communities. The establishment of green corridors, especially surrounding our lakes and along our rivers and streams, helps to insure protection of water resources, connectivity of habitat

areas, and multi-use recreation areas. The result is habitat improvement, clean water for drinking, fishing and outdoor enjoyment.

Assessment Indicators:

*1. BLUE-WINGED TEAL AND MALLARD BIRD POPULATIONS

These indicators were chosen because both the teal and mallard breed and reside in Minnesota waters and are highly dependent on ponds and wetlands that provide suitable food and cover. Population trends in waterfowl populations are related to many factors such as weather, predator populations and hunting mortality. However, land use decisions that affect the number of wetlands and quality of associated habitat are a primary determinant of waterfowl reproductive success. Changes in water quality that reduce the growth of waterfowl food plants and production of invertebrate foods in ponds and wetlands are also critical. Stable, resident, breeding populations of these two waterfowl species are indicative of the quantity and quality of the water resource. The trends in annual harvest of these species by hunters in particular geographic areas is a behavioral indicator that may have value for assessing environmental quality.

Data is available from the Department of Natural Resources. The increase of teal populations appear to be slowing possibly due to loss of habitat with decline of Conservation Reserve Program land. Mallards are less sensitive to habitat loss than many other species. Natural fluctuation in populations combined with favorable spring weather, mild winters and light harvest rates are some factors that can cause an increase. Trends in the prairie pothole region in western Minnesota are most significant.

2. Percent of lakes where loons reproduce successfully

Loons are sensitive to disturbance and tend to favor northern lakes where disturbance is low, with abundant small fish for food and water clear enough that feeding can occur underwater. Reproductive success declines as disturbance increases and water clarity decreases.

Loons are counted on more than 600 lakes in eight counties by the Department of Natural Resources. Most Minnesota counties are in southern index areas containing marginal habitat for loons. The proportion of lakes on which juvenile loons were seen in 1995 to 1997 was fairly stable and slightly higher than in 1994.

*3. NUMBER OF TERRITORIES OCCUPIED BY BALD EAGLES

Bald eagles are sensitive to environmental contaminants and need a habitat of healthy Minnesota waters. Their populations were decimated when reproduction was impaired by pesticides that accumulated in aquatic food chains. By eliminating the use of DDT pesticide, their numbers have increased slowly. At present, populations in Minnesota are healthy and continuing to increase but concern for their welfare is widespread. Because the bald eagle's primary food is large fish, they are still at risk for exposure to contaminants in fish.

Data for 1973 to 1992 are available. In the future, surveys likely will be conducted every five years by the Department of Natural Resources. Both the number of territories occupied and the number of nests that successfully produced at least one young have increased steadily since 1975. The number of young produced per nest is adequate for a long-lived species.

*4. FROG AND TOAD POPULATIONS

Frogs and toads depend on a combination of water and land habitats and may be particularly sensitive to habitat degradation, acid rain and snow, and toxic chemicals in the environment. Changes in the number and location of amphibians, such as frogs and toads, are an indirect measure of overall environmental quality.

There is little statewide information on the population status of frogs and toads. The state of Wisconsin's shoreland management program, however, found drastic reductions in the abundance of green frogs on developed shorelands. In Minnesota, recent widespread frog malformations signal a change in environmental quality.

*5. AQUATIC INVERTEBRATE POPULATION

Aquatic invertebrates are sensitive to environmental stressors such as changes in the chemical composition of sediment and water, increases in silt and pollutants, alterations in habitat and introduction of exotic species. These pressures cause changes in community structure and species composition and consequently, are indicators of biological quality at a particular site. Repeated sampling over the years can show trends in environmental quality.

Aquatic invertebrates species respond relatively rapidly to changes in their environment. Invertebrates collected from streams or wetlands provide data to calculate an *index of biotic integrity*. This index combines data on various measures such as species richness, predator composition and tolerance to pollution. The Minnesota Pollution Control Agency is developing indexes for both invertebrates and fish and has launched a biological monitoring program for rivers and streams across the state.

*6. INDEX OF FISH DIVERSITY

The structure and diversity of fish communities can be good indicators of water quality and the general health of a watershed. Human activities have greatly accelerated the natural process of eutrophication (increasing nutrient loading over time) within the Minnesota and Missouri River watersheds. This has and will continue to change both structure and diversity of fish communities. The Minnesota Department of Natural Resources, Section of Fisheries, surveys fish populations in lakes and streams on a regular basis. These surveys are used as an index for monitoring changes in fish populations over time. This index makes it possible to compare and identify changes in both structure and diversity of fish communities.

7. Breeding bird surveys

Breeding bird populations are excellent indicators of the health and productivity of natural communities, from native grasslands, to riparian woodlands to forests. The wide diversity of

species found in Minnesota, coupled with their conspicuousness, their growing public constituency, and the vital ecological role they serve in the functioning of ecosystems, makes them an ideal indicator.

Breeding bird population trends have been monitored by the federal Breeding Bird Survey (BBS, U.S. Geological Survey) since 1966. A system of over 2000 routes, each 25 miles in length and randomly located throughout the United States and southern Canada, are monitored once each year during the breeding season by experienced volunteers. Every half mile along the route, the volunteers record all the birds they hear and see for a period of three minutes. A total of 82 routes are located in Minnesota. Designed to monitor statewide and national population trends, the BBS has become the best source of information on species population trends. Species that are difficult to detect (by song or sight), that have a limited distribution, or that are very rare, are not adequately monitored by the survey.

*8. MUSSEL COMMUNITY INDEX

The life history and ecology of freshwater mussels makes these animals promising indicators of river health. Mussels typically spend their entire life in a small portion of a river or stream, where they filter food and oxygen from the water column. This sedentary habit makes mussels vulnerable to disturbances to the water and substrate that comprise their habitat, and useful indicators of such disturbances. Further, many mussels rely on the presence of a specific fish host species for successful reproduction. The mussels' vulnerability to pollution, over harvesting, changes in hydrology, zebra mussel infestation, and loss of host fish species is reflected in the fact that 30 of Minnesota's 48 mussel species are currently listed as endangered, threatened, or of special concern.

Because mussel shells persist in the streambed long after the animal dies, mussel surveys can reveal both the species surviving in a stream, and the species now represented only by dead shells. Further, because some of Minnesota's rivers and streams support a diverse array of mussel species, changes in species diversity and abundance may also serve as a useful indicator of river health. Creation of an effective mussel index will require careful planning and research. DNR has performed mussel surveys on selected rivers and streams and, provided that funding continues, we will collect additional information over time that will help us assess the health of these indicator species

*9. STATUS OF THREATENED AND ENDANGERED SPECIES

Although there are other reasons for species to become listed as threatened or endangered, many of the listed aquatic species have become so for water quality reasons. A primary example would be mussels. A majority of the species of mussels in Minnesota are listed species because of water quality reasons. Improvements in water quality should cause at least some species to recover to the point of taking them off the list.

Data exists on mussel populations on many of our major rivers, however, the data is somewhat scattered in a temporal and spatial context. Nearly all of the recent surveys when compared to historical data have shown drastic declines of many species of mussels. Although the emphasis in

the future will be to survey streams which have no historical data, future data will look at repeating surveys at locations done in the past.

10. Number and location of major fish barriers

The amount of river and stream fish habitat, and the viability and productivity of the fishery has been impacted by the construction of fish barriers. While the creation of fish barriers has been intentional in some cases to restrict re-introduction of exotic species, in many other cases, the construction of dams and culverts has restricted or prevented natural migration and fish movement in significant portions of many watersheds. Elimination of unintentional fish barriers will increase species diversity and habitat by restoring fish access to larger portions of their natural range within the watersheds. Progress toward this objective can be measured by elimination of identified fish barriers as dams become obsolete and as culverts are replaced

11. Nesting for colonial water birds and other aquatic species

Populations of colonial nesting species are sensitive to poor water quality. Because they nest in compact colonies, impacts to water quality in the vicinity of these colonies has a great potential to impact nesting success of a large proportion of the population of these species. Many of the species negatively affected by use of DDT in the 1950's and 1960's were colonial fish eating birds such as white pelicans, double-crested cormorants and some species of egrets. These species were at or near the top of the food chain and accumulated quantities of DDT that affected reproductive success and declines in populations. With the banning of DDT in the US in 1972, many of these species have recovered to the point of being considered nuisances in some places. In addition, other aquatic species such as osprey also serve the same roll as a species at the top of the food chain that will be quick to respond to positive or negative changes in water quality.

Since the early 1980's, systematic surveys of colonial water birds as well as bald eagle and ospreys, have been conducted by the MN Nongame Wildlife Program. Some colonies are surveyed every year while some of the smaller colonies may only be surveyed every 5 years. Information on colony size, reproductive stage and success are some of the parameters collected. This data is kept in a central database in St. Paul by the Natural Heritage Program.

12. Non-game fish species

The normal focus of Minnesotans is on the game species, such as walleye, northern, bass and panfish. These species are near the top of the food chain and their success depends on providing habitat and protection of the aquatic plants and animals that make up the food chain which supports them. The ability of Minnesotans to recognize the value and importance of the aquatic ecosystem, as a whole, is essential if we expect our lakes and rivers to produce a healthy, sustaining population of game species. Information to characterize the health of the plants and animals of our aquatic ecosystems is scarce however, DNR fish population assessments of our lakes and rivers is available. Comparisons of the number and diversity of non-game species over time would be a reasonable indicator of the overall health of our aquatic ecosystems.

*13. AERATION SYSTEMS FOR FISH MANAGEMENT

Aeration systems are tools to provide over-wintering populations of fish in lakes that would be lost due to oxygen depletion. Systems are installed in lakes that are no longer able to sustain fish populations year around due to accelerated eutrophication from watershed land management practices, and also in marginal lakes that otherwise would not naturally be able to sustain fish populations. A goal of reducing the number of aeration systems needed on lakes that are potentially capable of naturally sustaining fish communities would be an indicator of improved watershed and water quality management. DNR maintains a record of lake aeration systems through a permit process which can be used to measure trends.

14. Fish Consumption Advisories

Angling is a favorite recreational activity for many Minnesotans. Fish are low in fat, high in protein, and may have substantial health benefits when eaten in place of high fat foods. While the quality of sport fish taken in Minnesota is good, chemicals like mercury, polychlorinated biphenyls (PCBs), toxaphene, and dioxin have been found in some fish from certain waters. The levels of these chemicals are usually low and in Minnesota there are no known cases of illness from these contaminants. To ensure the continued good health of Minnesota anglers, the Minnesota Department of Health (MDH) has guidelines for how often these fish can be safely eaten. A publication is published annually entitled "Minnesota Fish Consumption Advisory" by the MDH. The advisory is not intended to discourage anglers from eating fish, but should be used as a guide for choosing fish which are low in contaminants. This information may be useful in detecting long term trends on surface water in relation to mercury and PCBs. In ten years we can look back to see if the number of mercury and PCB Fish Consumption Advisories are increasing or decreasing.

Land Management Indicators:

*1. PRESERVATION OF EXISTING NATURAL HABITATS AND RESTORATION OF DEGRADED HABITATS (ACRES RESTORED)

In southwest Minnesota, conversion of the vast majority of pre-settlement natural ecosystems to urban and agricultural uses has severely limited and fragmented remaining natural habitats. Plant and animal communities and species diversity have been significantly impacted by this intensive conversion. Continued growth, development pressure and conversion further threatens these remaining natural habitats, such as native prairies, wetlands, shoreland buffers, wooded areas, bluff and steep slope areas and other natural areas. Policies and ordinances to protect agricultural lands from development intensifies development pressure to other areas. High demand for lands having natural resource values and the lack of policies or ordinances to protect the few remaining natural areas places them at great risk for uncontrolled development.

The adoption of county comprehensive plans and ordinances that recognize how these areas contribute to the quality of life of their citizenry will be a good measure of efforts to recognize, manage, restore and protect these areas.

Willing landowners and local, state and federal government priority support of conservation retirement programs that permanently support, protect and enhance natural or degraded natural habitats will be a direct measure. The BWSR tracks a variety of state-funded conservation easements which can be used for monitoring trends.

*2. ADOPTION OF SUSTAINABLE AGRICULTURE CONCEPTS (ACRES)

The way that each person manages and uses their land has a direct link to the environment and a direct or indirect link to their neighbors. The cumulative effects of our land management practices has a direct link on the health and diversity of most plants and animals. To lessen the impacts, we will need to manage our lands more carefully to improve water quality, quantity and associated habitats. Many educational programs have been developed to promote soil and water land use management practices that are environmentally and generally economically sound. The willingness of landowners to change management practices however, has been slower than desired. Land use within these three major watersheds is predominantly agricultural and significant improvements in water and soil conservation will not occur until landowners are effectively implementing best management practices.
Federal, state and local governments and institutions must develop more coordinated, effective outreach efforts and implementation strategies that encourage best management practices. The measure of our effectiveness will be seen in more adoptions of farm management plans, tillage transects surveys which show increased levels of conservation tillage, and feedlot and manure management permit compliance. University of Minnesota Extension, BWSR and MPCA have data bases which will track trends.

*3. FLOODPLAIN DEVELOPMENT RELOCATION; NATURAL HABITAT CORRIDORS (ACRES RETIRED)

Historic settlement of many Minnesota communities was near rivers and streams. Rivers and streams provided transportation and commerce routes, water supply and a source of energy to power industry and therefore encouraged growth in the floodplain. Floodplain development subjects people to recurring safety risks and property to recurring damages at great cost to the state and federal government. We have long since surpassed our need for any development to occur or exist in the floodplain. Returning our floodplains to low damage open space uses and, natural environmental and recreational corridors will reduce economic losses and costs, improve public safety and improve water quality and quantity problems that plague our rivers and streams.

The Department of Natural Resources administers and tracks floodplain management activities and coordinates a Flood Damage Reduction program. Progress toward re-location, acquisition and other non-structural flood damage reduction measures, and conversion of floodplains to natural values for wildlife management, passive recreational corridors, and vegetated natural buffers and water storage areas will be an indicator of progress. State and federal legislative funding of flood damage reduction measures and conservation-based grant programs (i.e. CREP, CRP, WRP etc.) will be the most significant measure of progress toward this goal.

4. Multi-use areas providing non-conflicting recreation opportunities and enhanced habitat.

The diverse needs of communities and individuals must be addressed in planning for recreational activities. Minnesota's population continues to change. It is becoming older and more diverse. Agencies, local governmental units, private providers and the public in cooperation must ensure a base of natural resources and habitats which support a diverse range of recreation opportunities that are non-conflicting. People who use public land, water and recreational facilities should have a safe and satisfactory recreational experience. Limited availability of natural resources, habitat or public land may necessitate that open space areas which are available for recreation, support multiple uses, allow year round use, and are durable and flexible in their use.
The natural resource base upon which recreational activities depend must not be impaired. The number and acreage of multi-use recreation areas can be monitored. Acreage, location and ownership of natural communities within or adjacent to multi-use recreation areas and affected water resources can be measured or monitored to determine impacts occurring from recreation use.

5. Planned green space in community development decisions which provides access to water resources.

Natural areas must also be protected if they are to be sustained for future generations. Public involvement in development decisions allows for awareness of recreational and environmental values and provides valuable input into planning of sensitive areas and appropriate recreational activities. There is a suggested trend away from facility based activities and toward natural environment based recreation activities. Community plans which include protection, preservation, enhancement and sustainable development of natural resources is an indicator of the extent to which communities are recognizing the need to provide opportunities for common natural space and access to natural resources.

Objective G. Limit geographic range of exotic species.

As ecosystems are degraded by unwise, excessive use and the introduction of exotic species, desired native species of plants and animals are reduced or eliminated and economic losses are likely.

Examples of wetland and lake exotic species include: Eurasian water milfoil, zebra mussels, gobies, and roughies which may impact other native fishes, habitat, and shellfish species. Examples of exotic grasses, forbs and trees which impact ecological quality include: Canadian thistle, curly leaf pondweed, reed canary grass, buckthorn, purple loosestrife, and leafy spurge

Land and water management practices may contribute to conditions which support exotic species. Technology must be evaluated for long term consequences. Protection of ecological health and integrity must play a role in decision about when, where, and how technology is used.

Assessment Indicators:

***1. NUMBER OF WATER BODIES WITH EURASIAN WATERMILFOIL**

The number of water bodies with Eurasian watermilfoil is an indicator of the rate of spread and potential disturbance to natural aquatic communities. It is also an indicator of the effectiveness of

education and enforcement efforts that are designed to prevent accidental spread by anglers and boaters. Preventing the spread of Eurasian watermilfoil is crucial because eradication is usually not feasible. The Department of Natural Resources collects trend information.

*2. MILES OF WATERWAYS AND NUMBER OF LAKES AND RESERVOIRS WITH ZEBRA MUSSELS

Zebra mussels are small shellfish that have spread rapidly in Minnesota water since 1992. The miles of waterways with zebra mussels is an indicator of the rate of spread and potential disturbance to natural aquatic communities. The number of lakes and reservoirs with zebra mussels is also an indicator of potential spread of this species. Because the zebra mussel has a free-floating larval stage, it reproduces only where lakes or reservoirs are available. Education and enforcement efforts are designed to control the spread by anglers, boaters and commercial navigation interests. The zebra mussel displaces native species but also clogs city and industrial water intake pipes. The economic strain on certain industries and communities can rapidly occur.

There is no trend data on zebra mussels. Known zebra mussel populations are located in Lake Superior; the Mississippi River, downstream of St. Anthony Falls; and the St. Louis River, downstream of the Fond du Lac dam. Densities of up to 20,000 per square meter have been measured in Lake Pepin. Expansion of zebra mussels occurs at a very rapid rate. Zebra mussels made their way out of Lake Michigan into the Mississippi River basin via the Chicago Sanitary Shipping Canal in 1992. By the end of the season in 1992, zebra mussels had become established in isolated populations as far north as Minneapolis.

3. *CONTROL OF INVASIVE GRASSES FORBS AND TREES (SPURGE/BUCKTHORN)

Land and water management practices may contribute to conditions that support exotic species. Technology must be evaluated for long term consequences. Protection of ecological health and integrity must play a role in decisions about when, where, and how technology is used. Research is important to arrive at methods to control exotics. Biological control is being used for Leafy Spurge with some success. Others need more research

The DNR and University of MN may be able to monitor trends and provide input into success of any developmental Research taking place.

Land Management Indicators:

*1. PASTURES AND RIGHT-OF-WAYS MANAGED PROPERLY (RANGE OF INVASIVES REDUCED)

The improper management of pastures and right-of-way can result in spread of exotic species. As a result, exotic species may be able to compete in the ecosystem and displace desirable species. Monitoring is necessary as well as research to minimize the impact of some exotics. The MnDNR and county weed inspectors would provide trend data in this area.

***2. USE OF WATERSHED RESTORATION AND PROTECTION INSTEAD OF DAMS TO MANAGE HIGH FLOW VARIATIONS (NUMBER OF DAMS ON CHANNELS).**

Natural water resource systems have a natural range of variation. When naturally functioning systems are destroyed or altered, they can no longer deal with external conditions effectively. Storms and resulting floods are more severe. In an effort to control the problem, dams and other structures are built. While flooding problems may be lessened, other problems can emerge.

Stabilizing flows by dams results in native fish species that are less resilient. Flow variations inhibit establishment of exotic species. Stabilization of flow through dams may be favorable to exotic species and eliminate native species.

The use of impounding and/or altering hydrology may result in a change of specie composition. A disturbance or habitat degradation may result in wetlands being invaded by aggressive, highly tolerant, non-native vegetation, such as purple loosestrife, or water hyacinth. It may also result in an area being dominated by a monoculture such as cattails or reeds canary grass.

Goal: Minnesotans will have reasonable and diverse opportunities to enjoy the state's water resources.

Social and community needs are part of the human element of an ecosystem management approach. Availability of natural resources for recreational use is a strong need for many Minnesotans. A recent study completed by the Minnesota Department of Natural Resources and the Minnesota River Basin Joint Powers Board reflected the need that people in the Minnesota River Watershed have for expanded recreational opportunities, but it also revealed the deep awareness people have for the relationship between recreation and the quality of natural resources. Improvement in the quality of the Minnesota River was the priority goal of the citizens, businesses, agencies and organizations that participated in the study. Inventories of recreational resources and the promotion and enhancement of recreational resources within each river basin are integral to continued public investment in the quality of Minnesota's water resources.

Minnesota has a long tradition and policy of public access to state water resources, promoting use and enjoyment by all citizens, including those who do not own waterfront property. The number of public access sites and fishing piers reflect the state's abundant recreational opportunity; however, there is a pressing need to balance recreational use and water protection. Registered boats in the state have increased from 157,767 in 1959 to 780,680 in 1998. Registration of personal watercraft has grown from 55 in 1974 to 30,013 in 1998. Despite level sales of fishing licenses since 199 1, fishing demands have continued to increase statewide.

Objective H. Provide access to water recreation sites.

The inter-relationship between natural resource management and water quality and recreational use can be accommodated by "smart growth" in Minnesota's cities, urbanizing communities and rural communities. The establishment of green corridors, especially surrounding our lakes and

along our rivers and streams, helps to insure protection of water resources, connectivity of habitat areas, and multi-use recreation areas. The result is clean water for drinking, fishing and outdoor enjoyment. A cooperative blend of public and private recreational facilities is needed, particularly in areas where public land, and therefore public access to water resources is limited. The number of recreational areas provided and how effectively they are utilized, and managed are an indication of and may impact the quality of water resources on which recreation opportunities are based.

Water access sites include boat accesses, fishing piers, shore fishing areas and stream corridor easements. In addition to these sites, the public also has access to shorelines **in** other settings including state parks, state forests, national forests, national parks, local parks and other public holdings. The Department of Natural Resources collects trend information for all indicators under this objective.

Assessment Indicators:

1. *NUMBER OF CANOE AND BOAT ACCESS SITES

The number of sites for canoe and boat launching is an indicator how well the state is meeting its policy of providing access to pubic waters. The number of sites has grown from 1,000 in 1979, to 1,250 in 1989, to 1,550 in 1999. Minnesotans rely heavily on public water access sites. 73 percent of Minnesotans used a public access in 1977. Of that number, 78 percent were canoe or kayak owners. Approximately 1/4 of registered water craft are registered canoes. About 75 percent of state boat owners launch at public access sites at least once a year. The long-term goal is to provide access to all significant recreational waters of the state.

*2. NUMBER OF PUBLIC FISHING PIERS

Providing angling opportunity to children, people with disabilities, senior citizens and people who do not have the means to fish from boats is especially important in urban areas that have fishing lakes. The number of public fishing piers is an indicator of how well this need is being met. In 1979 there were few public fishing piers on Minnesota waters; the number climbed to 60 in 1989, and reached 415 in 1999. Most of these piers are built through a cooperative local-state effort.

*3. MILES OF STREAM CORRIDOR EASEMENTS

Stream corridor easements give the public the right of way to streams. Fishing on smaller streams, and in particular on trout streams, is best from in the stream, or the corridor. In addition to providing the necessary access for angling, stream corridor easements allow habitat management to protect valuable vegetation on stream banks. The number of miles of easements is an indicator of angling opportunity on smaller streams. For example, Minnesota currently has 216 miles of easements on trout streams, but nearly 1,000 miles of trout streams lack access.

*4. AMOUNT OF SHORE FISHING AREA

Public use of river systems is expected to increase in the future. Fishing is one of the major recreational uses of water resources. Over 22% of people who travel to Minnesota, come because of opportunities for outdoor recreation including hunting, fishing and hiking. To avoid potential conflicts with private property owners, shoreland areas must be provided to meet the need for public access to water resources for shore fishing and other recreation needs. Number of river miles accessible for shore fishing and other recreational pursuits can be monitored as an indicator of ability and capacity to meet recreation use needs. Public lands are currently identified by the DNR in publications including Public Water Access Maps and PRIM Maps. Tracking private lands made accessible for public use by landowners must also be monitored.

Land Management Indicators:

***1. CONSERVATION CONNECTIONS & SMART GROWTH PRINCIPLES APPLIED TO COMMUNITY DEVELOPMENT DECISIONS THAT AFFECT WATER RESOURCES.**

Natural areas must also be protected if they are to be sustained for future generations. Public involvement in development decisions allows for awareness of recreational and environmental values and provide valuable input into planning of sensitive areas and appropriate recreational activities. There is a suggested trend away from facility based activities and toward natural environment based recreation activities. Community plans which include protection, preservation, enhancement and sustainable development of natural resources is an indicator of the extent to which communities are recognizing the need to provide opportunities for common natural space and access to natural resources.

Investment in the environment through provision of open green space and access to water resources in residential areas, leads to increased property values. This provides a valuable way to gain increased tax revenue and an incentive for more open space provision for recreation purposes. Recreational areas and facilities not only attract people who are looking for areas in which to locate their homes, they also attract tourists enhancing the opportunity for economic growth through tourism dollars. Growth and sustainability of rural communities is dependent upon the ability of each community to attract and keep residents and businesses. Quality of life has been found to be more important than business-related factors in attracting new businesses to an area. Provision of recreational and natural resources contributes to community value and quality of life. Assisting rural communities through smart growth and development offers a partial solution to problems associated with larger urban areas. However, the natural resource and recreation features that attract people to a community or area must be maintained if they are to be sustainable and continue to function as positive motivation for economic growth. Demographic studies can be used to follow population growth patterns statewide. Rural growth areas can be assessed to determine linkage with expanded recreational use.

Providing reasonable use of resources while insuring that the resources are sustained and will be available for use far into the future is a challenge all resource management agencies must face. New recreation areas and facilities are planned and funding is provided for acquisition and development. Often funding is not available for long term management of facilities or facilities are managed in ways that result in destruction of the natural resources upon which they area

based. Plans for recreational facilities must be long range and must include provision for maintenance and eventual rehabilitation and possible redevelopment in order to protect associated natural resources. Plans must address sustainable use of the resource including management goals and strategies. Use of an Environment-Recreation Interaction Model can assess positive and negative impacts of use.

***2. ENHANCED OPPORTUNITIES FOR WATER RECREATION ACCESS ON PRIVATE LANDS THROUGH COOPERATIVE VENTURES AMONG PUBLIC AGENCIES, LOCAL GOVERNMENT, LANDOWNERS AND THE OUTDOOR RECREATION COMMUNITY.**

The land, including land bordering water resources, of Southwest Minnesota is largely in private ownership. Public access to lakes, rivers, streams and wetlands is greatly restricted. Landowners fear litigation, vandalism and other abuses from the public. They often post their land against trespassing. Only through efforts to engage private landowners in making their land available for various recreational uses can existing and future recreational needs be met. Conservation easement programs are available as an alternative resource for landowners wishing to receive dependable income from marginal lands. Often these lands border water resources, have potential as excellent habitat, and could provide much needed access for the public for water based recreation. Payment received for opening private land for public recreational use may provide additional incentive to landowners to enroll their acreage in conservation programs. Although landowners who allow access to their land are protected from liability. However, if landowners charge a fee to allow access to their property, they are not protected. Liability issues may discourage some landowners from opening their land for public use. Water quality will continue to improve through protective buffers, recreation needs can be met, and landowners receive alternative sources of income. There may be opportunities for private entrpreneurial investments in public recreation areas consistent with public recreation goals. Partnerships between agencies and between the public and private sectors can be fostered to enhance recreation opportunities. The DNR working with BWSR and the Farm Service Agency can monitor the amount of private land being made available for recreation use and can work to remove restrictions to public use of conservation and other public lands.

***3. ACCESS TO WATER RESOURCES FOR PEOPLE OF ALL ABILITIES.**

People of all abilities should have access to outdoor recreation opportunities. People with mobility, sight, and learning problems may have difficulty accessing recreational sites and facilities. Transportation to accessible water resources also is problematic for individuals who have no private or public means of reaching the resource. Facilities should be built using standards that provide accessability. Communities must address ways to provide transportation options to make water resource recreation available to all citizens. Public recreation sites that are accessible to persons with disabilities can be measured. The availability of transportation to water resource areas can be measured.

Objective I. Improve or maintain the quality of water recreation.

A balance of resource use and resource protection focuses recreational development on areas that are most suitable. People depend on water resources for a wide range of recreational purposes.

Fish and boating are commonly thought of as mainstay recreational water activities, but many other people enjoy swimming, picnics adjacent to rivers and lakes, trails along rivers or lakeshores, birdwatching, hunting or viewing scenic areas. Recreation planning and resource management must be combined to ensure a balanced, coordinated environmentally sustainable approach to meet current and future recreational needs.

Enjoyment and safety decline on waters subject to heavy recreational use. In recent years the Department of Natural Resources has conducted surveys of boaters to measure their satisfaction and levels of use. Fishing surveys are also conducted to determine the amount and rate of fish harvest. To prevent recreational-use conflicts, surface water use regulations now apply to about 300 separate waters. Fish harvest regulations address the management needs of about 100 lakes and 30 rivers.

Opportunities for recreational use of water resources is being lost through development, inadequate funding and coordination among providers, private land issues, and subdivision of large acreage that once allowed access and facilities for water recreation use. Continued deterioration of the state's lands and waters will negatively impact the natural resources that support outdoor recreation. People depend on water resources for a wide range of recreational purposes. Fishing and boating are commonly thought of as mainstay recreational water activities, but many other people enjoy swimming, picnics adjacent to rivers and lakes, traveling trails along rivers or lakeshores, birdwatching, hunting or viewing scenic areas. Recreation planning and resource management must be combined to ensure a balanced, coordinated environmentally sustainable approach to meet current and future recreational needs.

Assessment Indicators:

1. *WATERCRAFT SATISFACTION SURVEYS

The satisfaction of boaters and canoeists is an indicator of the recreational quality of state lakes and rivers and helps define specific problems. Surveys allow the state to compare regions and to track recreation over time in regions where studies have been repeated. 51-percent of households surveyed in 1989 wanted additional river accesses statewide. Over 47-percent requested more canoe routes.
Existing surveys concentrate on boat and canoe use in lakes. Some canoeists are surveyed in this process. Canoeists surveys which concentrate on rivers and streams, would assist in determining access location, and user needs. The Department of Natural Resources would be in the best position to conduct these surveys.

*2. ANGLER SATISFACTION BY SURVEYS

Angler surveys are conducted by the Department of Natural Resources to determine the amount of fishing activity and level of harvest on individual waters. This information helps the department determine if harvest is sustainable. Some of the larger, more important lakes such as Mille Lacs are continually surveyed for fishing pressure and harvest. The state's 11 largest lakes are usually surveyed annually and other waters are checked less frequently. This data also helps measure ecosystem health.

Recreational fishing pressure on Minnesota waters is highly variable. In general, fishing pressure per acre is low on very large and on remote lakes. Conversely, fishing pressure is high on smaller lakes and lakes near metropolitan areas. Fishing pressure on walleye lakes has increased steadily since the 1950s. For walleye, the number and weight of fish caught has remained steady as fishing pressure increased, but the amount of time needed to catch a fish has increased. For northern pike, the number and weight of fish caught and the time needed to catch a fish tends to decrease as fishing pressure increases.

Of approximately 5,000 lakes managed for sport fishing, 918 lakes were surveyed from 1935 to 1994. Most angler surveys have been conducted on lake trout lakes and walleye lakes. Relatively few lakes have multi-season (summer and winter) repetitive surveys.

*3. LAKESHORE AND RIVER PARKS--SIZE AND NUMBER

River use surveys and analysis of canoe licenses show growing participation in river recreation sites help distribute use to avoid overcrowding and ensure public access to waters. Scenic easements protect sensitive areas on wild and scenic rivers from development while keeping them under private ownership and on the tax rolls. DNR's Accelerated River Acquisition Program will address these issues and can be monitored as an indicator for successful efforts to maintain quality recreation experiences. The DNR maintains information on state managed campsites along waterways. Additional campsite information is available from counties. River recreation sites which exist must be maintained. Additional sites may be needed for some types of recreation. The DNR has found, however, that river campgrounds are not being full utilized. DNR administers a Water Access and River Recreation Maintenance and Operations Program for existing and future accesses and recreation sites which can provide information on current use and facility needs. Lakeshore parks provide another opportunity for the public to access water resources. These parks are commonly developed and maintained by communities in accordance with shoreland regulations and local ordinances.

*4. HUNTER SATISFACTION SURVEYS

Land Management Indicators:

*1. NUMBER OF MULTI-USE AREAS PROVIDING NON-CONFLICTING RECREATION OPPORTUNITIES AND ENHANCED HABITAT

The diverse needs of communities and individuals must be addressed in planning for recreational activities. Minnesota's population continues to change. It is becoming older and more diverse. Agencies, local governmental units, private providers and the public in cooperation must ensure a range of natural resource based outdoor recreation opportunities that are non-conflicting. Active and passive recreational uses of water resources must be addressed. People who use public land, water and recreational facilities should have a safe and satisfactory recreational experience. Limited availability of natural resources or public land may necessitate that open space areas which are available for recreation, support multiple uses, allow year round use, and are durable

and flexible in their use. The natural resource base upon which recreational activities depend must not be impaired.

The number and acreage of multi-use recreation areas can be monitored. Acreage, location and ownership of natural communities within or adjacent to multi-use recreation areas and affected water resources can be measured or monitored to determine impacts occurring from recreation use. Surveys can be used to measure public satisfaction with multi-use recreation areas. Multi-use areas can be assessed to make sure separation of conflicting recreational is occurring. Number of accidents or fatalities by persons recreating in multi-use areas can be documented.

2. Provision of support for enforcement consistent with recreational opportunities provided.

For quality water recreation use to exist, people must be able to enjoy and use water and land resources in safe and responsible ways. There are many opportunities for citizens to learn about safe outdoor recreation. DNR and other organizations promote safe outdoor recreation experiences through training and education. However, in some cases this is not enough. Rules and regulations have been promulgated to ensure that everyone uses public land, water, and recreation facilities in safe and responsible ways and that the rights of others to enjoy the outdoors is protected. Increased recreation use necessitates increase in enforcement. The number of local and state enforcement officers assigned by geographic areas or populations and funding for positions are indicators of how well enforcement is supported.

3. *NUMBER OF COOPERATIVE VENTURES (BETWEEN PUBLIC AND PRIVATE PROVIDERS) IN PLANNING AND MANAGING LAKES, STREAMS, AND WETLAND RECREATIONAL AREAS

Involving citizen groups in recreation planning and policy development facilitates interaction between recreation providers and users. Communities learn to work together to determine priority water recreation resource areas, common recreational needs and how to allocate resources to address them. Cooperative working relationships between federal, state, and local government and the private sector are needed to acquire land, especially in areas where there is a heavy recreation demand. Through cooperative efforts, open space can be acquired for future use and/or protection from encroachment, development or other incompatible land use. Opportunities exist to link providers and recreation users more effectively. Sharing of information about facilities and programs at all levels is lacking. More broad sharing of information among recreation providers and between providers and the public is needed on recreation programs, recreation facilities, and funding options. Better coordination could reduce duplication and allow programs to reinforce and complement each other. Alliances can overcome differences within the recreation community and form strong partnerships in pursuing common goals. Recreation programs and facilities can be monitored for partnership efforts and shared opportunities. The DNR can provide information on partnership efforts involved in acquisition, planning, and management of recreation areas in the basins. Major public and private sector providers and their mission, role and responsibilities can be identified. Agreements can be developed to clarify roles and responsibilities of providers. Recreation needs and priorities are communicated to local decision

makers through organizations such as the Association of Minnesota Counties, the Minnesota Recreation and Parks Association and the League of Minnesota Cities.

4. Economic growth trends related to water resource tourism opportunities

Water recreation benefits personal, social, cultural, and economic interests at the state and community level. There are economic benefits from recreation expenditures at the state and local level. Travel and non-travel related expenditures provide economic benefit to communities. $10 billion is generated annually in Minnesota from domestic and international travel and tourism. Tourism is a key part of Minnesota's economy, comparable to agriculture in its contribution to the gross state product. More than one out of every three travelers to Minnesota participates in outdoor recreation. International, out-of-state, in state tourism as well as community use places demands on private and public recreational facilities and programs and upon the resources that support recreational use. Festivals and special events centered upon water resources also generate revenue, increase tourism, and foster an appreciation of the resource and the surrounding community. Agro-tourism focuses upon resources available to local farmers as an alternative source of income to farm production. Many of these alternative options build upon water and land resources which are under private ownership but which may be made available to the public. Areas of the basins which are experiencing economic growth or stability as a result of recreation associated with water resources may also have enhanced land and water management strategies and plans in place to protect those resources. Resorts and associated businesses grow as the quality of recreational experience increases. Existing models can be used to measure outdoor recreation benefits to social, cultural, environmental and economic interests.

The Department of Trade and Economic Development monitors tourism trends across the state.

*5. NUMBER OF NATURAL RESOURCE PROTECTION, DEVELOPMENT, AND MANAGEMENT PLANS THAT INCLUDE RECREATION PLANNING CONCEPTS

Integration of recreation planning and resource management is needed to ensure a balanced, coordinated and environmentally sustainable approach to meet future needs of for outdoor recreation. An ecosystem management approach recognizes that all parts of natural systems are interdependent and connected. Positive or negative changes to one part will impact all other parts and will ultimately change the entire system. It is important that plans for natural resource management address plans for social or recreational use and economic elements of an ecosystem as well. Recreation use plans, as well as other land-use and development plans, which meet social and economic needs must consider impacts to natural resources. The result is sustainable outdoor recreation that satisfies recreation needs without compromising the basic character, and quality or productivity of the natural systems upon which outdoor recreation depends. It is a balance between resource use and protection which focuses recreation development on areas most suitable for that use. Intensive recreation use, especially when the use may result in serious impact to natural resources, should be directed to areas that are more suited to higher use levels. Plans can be reviewed for cooperative approaches between landowners, business and commercial interests, local citizens' groups and resource management perspectives. Measure of public

recreation experience and benefits can be used to gauge long term sustainability of recreation policies, programs and management actions. The Recreation Opportunity Spectrum can monitor unacceptable or irreversible changes in recreation settings.

6. *MILES OF CORRIDOR LINKING NEW AND EXPANDED RECREATIONAL FACILITIES AND AREAS WITH EXISTING RECREATIONAL OPPORTUNITIES

Concentrating on land acquisition toward completing existing outdoor recreation sites and facilities should become the priority for recreational development and may be critical to continued use and access of recreation facilities and areas. Recreational facilities could be linked together more effectively. Natural open space areas preserve resources while providing corridors to connect recreational opportunities. The Minnesota River Valley Scenic Byway provides a corridor which connects natural, recreational, historic and cultural sites and areas along 300 miles of the Minnesota River. The Office of Tourism and Chambers of Commerce have data indicating the impact of a travel route such as the byway to economic growth and development and associated development of new recreational opportunities. Trails within the Minnesota, Des Moines, and Missouri River Basins provide another unique opportunity to provide linkages to water and other recreational resource opportunities while furthering the concept of an open or green space corridor that connects biological communities and habitat areas as well as buffering water resources. Miles of trail and number of recreational areas being accessed through the Scenic Byway and amenity or support facilities being developed in association with expanding trails or Byway efforts can be measured.

The Department of Natural Resources maintain maps of trail information but has no data concerning trail use. The Minnesota River Valley Scenic Byway Alliance, Chambers of Commerce, and Tourism Associations are sources of information about activity resulting from the Scenic Byway.

FUNDING RESOURCES

Funding must be provided in sufficient amounts to assure success for high priority water resource projects.

Increasingly, local units of government are implementing watershed based management strategies at the urging of federal and state level agencies. The rate of implementation is partially a function of the amount of funding available to actually put management strategies “on the ground”. Presently, financial requests to the state or federal government to fund water resource related projects far out outstrip the actual dollars allocated for such projects. If Minnesotans have stated water resources are of high importance to the quality of life, then higher levels of funding are necessary to assure protection and improvement of our water resources.

Indicators that should be monitored to determine whether sufficient funds are being allocated to support work within the Minnesota, Missouri, and Des Moines watersheds are as follows:

1. Yearly state lottery allocation for the Environmental Trust Fund

***2. AMOUNT OF LCMR FUNDING TARGETED BIANNUALLY TO WATER RESOURCE PROJECTS**.

Amount of state funding received by local units of government for monitoring and implementation of water resource projects. (BWSR grants, RIM, WCA, DNR shoreland, PCA CWPS, MDA BMP loans, etc.). County Water Planning base grant funding has not changed since the beginning of local water planning.

***3. AMOUNT OF FEDERAL FUNDING RECEIVED BY MINNESOTA TARGETED FOR MONITORING AND IMPLEMENTATION OF WATER RESOURCE PROJECTS.**

***4. AMOUNT OF HIGH PRIORITY GRANT/LOAN APPLICATIONS BY LGUS THAT ARE UNFUNDED EACH CYCLE**

OUTREACH PROCESS

Outreach efforts in the three river basins focused on local government, citizens, and water professionals. Information was presented and passed out at a number of meetings and also was publicized in other materials.

In the Minnesota River Basin, the Minnesota River Basin Joint Powers Board's County Commissioners and Technical Advisory Committee reviewed the document. The Technical Advisory Committee is composed of water planners, and staff from SWCDs and watershed projects. The public was invited to participate in this process through the Minnesota River Public Input Committee, in which several citizens shared their vision of the State's Water Plan. Additionally, two public meetings were held (February 8 and 9) to gather any additional comments.

In the Des Moines and Missouri River Basins, County Water Planners were invited to meetings to comment. The meeting was held on November 30, 1999 in Slayton.

The suggested changes to the goals, objectives, and indicators contained in this document came from comments and from review of the county water plan priorities. Water Plan 2000, being the state water plan, should be worked in to other planning processes. Similarly, Water Plan 2000 needs to reflect other plans (local, state, and federal).

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