Glossary

ALGAE:
A group of microscopic, photosynthetic water plants. Algae give off oxygen during the day as a product of photosynthesis and consume oxygen during the night as a result of respiration. Therefore, algae affect the oxygen content of water. Nutrient-enriched water increases algae growth.

AQUIFER:
A rock or soil formation that can store and transmit water efficiently.

ARTESIAN WELL:
A well that has punctured a confining rock layer resulting in a water well continuously flows at the surface.

AMMONIA:
A form of nitrogen (NH_3) found in human and animal wastes. Ammonia can be toxic to aquatic life.

BACTERIA:
Single-cell, microscopic organisms. Some can cause disease, but others are important in organic waste stabilization.

BASE FLOW:
The water which flows in a stream during times of no precipitation or snow melt. Much, if not all, of this water is derived from groundwater discharge to the streambed.

BASIN:
A large area of land that drains to a major river or lake. Wisconsin is divided into about 20 basins, which are defined partially on drainage boundaries and partially on political boundaries, such as county lines. Each basin contains a number of watersheds (see Watersheds).

BASIN PLAN:
A plan that documents water quality conditions in a drainage basin and makes recommendations to protect and improve basin water quality. Each basin in Wisconsin must have a plan prepared for it, according to section 208 of the Clean Water Act.

BEDLOAD:
The sediment in the bottom of a stream that is continually pushed, rolled and moved downstream by the turbulent forces of flowing water.

BEST MANAGEMENT PRACTICE (BMP):
The most effective, practical measures to control nonpoint sources of pollutants that runoff from land surfaces.

BIODIVERSITY:

A shortened form of the term "biological diversity". It is the entire spectrum of life forms and the many ecological processes that support them. Biodiversity includes genetic diversity, species diversity, community diversity and ecosystem diversity.

BIOLOGICAL COMMUNITIES:

Areas that are defined and described based on a variety of factors including geographic location, species composition, topography, moisture, temperature, soils and climate. Biological communities in the Bad Axe - La Crosse Basin include: northern forests, southern forests, oak savannas, oak and pine barrens, grasslands, wetlands, and aquatic systems.

BIOLOGICAL USE CLASSIFICATION:

Description of fish species and other aquatic organisms which a stream system can support. A water body is *designated* as being in a biological use class based on the ability of a stream to provide suitable habitat and water quality conditions for fish and other aquatic life. See *Cold Water Communities (COLD), Warm Water Sport Fish Communities (WWSF), Warm Water Forage Fish Communities (WWFF), Limited Forage Fish Communities (LFF).*

BOULDER:

Rock averaging greater than 9.5" in diameter.

BROOD STOCK:

Adult fish collected from streams which are transported to a fish hatchery for collection of eggs and milt to produce a wild strain of offspring.

BUFFER STRIPS:

Strips of grass or other erosion-resisting vegetation between disturbed areas and a stream or lake.

CARRYOVER:

The survival of fish from one year to the next. Successful carryover is the result of enough food, suitable habitat and adequate water quality conditions in a stream.

CATEGORICAL LIMITS:

All point source discharges are required to provide a basic level of treatment. For municipal wastewater treatment plants this is secondary treatment (30 mg/1 effluent limits for SS and BOD). For industry the level depends on the type of industry and the level of production. More stringent effluent limits are required, if necessary, to meet water quality standards.

CLASS I TROUT STREAM:

High quality stream where trout populations are sustained by natural reproduction. See "Biological Use Classification".

CLASS II TROUT STREAM:

Trout stream with some natural reproduction but may need stocking to maintain a desirable trout fishery. See "Biological Use Classification".

CLASS III TROUT STREAM:
Trout stream with no natural reproduction and requires annual stocking of legal-size fish to provide sport fishing. See "Biological Use Classification".

CLEAN WATER ACT:
See "Public Law 92-500."

COBBLE:
Rock averaging 2.5" to 9.5" in diameter.

COLD WATER COMMUNITY (COLD):
Includes surface waters capable of supporting a community of coldwater fish and other aquatic life or serving as a spawning area for coldwater fish species. Within the COLD biological use classification, trout streams are further classified. See Class I, Class II and Class III.

CONSUMPTION ADVISORY:
A health warning issued by DNR that recommends people limit the fish they eat from some rivers and lakes based on the levels of toxic contaminants found in the fish.

CONTAMINANT:
Some material that has been added to water that is not normally present. This is different from a pollutant, which suggests there is too much of the material present.

COST-EFFECTIVE:
A level of treatment or management with the greatest incremental benefit for the money spent.

DEPARTMENT OF LAND CONSERVATION:
Every county in Wisconsin has a Department of Land Conservation that is under the direction of each County's Land Conservation Committee. The County Conservationist heads a staff of professionals who provide landowners with the direction and assistance they need to improve, manage, and protect the natural resources of the land they own. The County Department Land Conservation implements farmland preservation, conservation programs, and priority watershed projects, among other programs.

DESIGNATION:
Identification of a waterbody as belonging to a specific use classification. See "Biological Use Classification".

DETRITUS:
Decomposing leaves and small branches found in streams.

DISSOLVED OXYGEN (DO):
Oxygen dissolved in water. Low levels of dissolved oxygen cause bad smelling water and threaten fish survival. Low levels of dissolved oxygen often result from inadequate wastewater treatment. The DNR considers 5 ppm DO necessary for fish and aquatic life.

DRAINAGE AREA:
An area of land defined by the surrounding topography that drains to a lake or stream. Drainage areas can be defined on a scale ranging from very small to very large. See "Watershed".

DOLOMITE:
A rock similar to limestone in composition except that it also contains magnesium in addition to calcium carbonate. Since any water stored in this rock formation is found in cracks or caves, little to no filtering of groundwater occurs.

ECOLOGICAL LANDSCAPE:
A *geographic area* that has similar land uses and ecological themes throughout. The Bad Axe - La Crosse River Basin lies entirely within the Western Coulee and Ridges Ecological Landscape.

ECOSYSTEM:
The interacting system of biological community and its nonliving surroundings.

EFFLUENT:
Solid, liquid or gas wastes (byproducts) that are disposed on land, in water or in air. Effluent generally means wastewater discharges.

EFFLUENT LIMITS:
The DNR issues WPDES permits establishing the maximum amount of pollutant to be discharged to a receiving stream. Limits depend on the pollutant and the water quality standards that apply for the receiving waters.

ENVIRONMENTAL PROTECTION AGENCY (USEPA):
The federal agency that is responsible for enforcing federal environmental regulations. The Environmental Protection Agency delegates some of its responsibilities for water, air and solid waste pollution control to state agencies.

EROSION:
The wearing away of the land surface by wind or water.

EUTROPHIC:
Refers to a nutrient-rich lake or stream. Large amounts of algae and weeds characterize a eutrophic lake (see also "Oligotrophic" and "Mesotrophic").

EUTROPHICATION:
The process of nutrient enrichment of a lake leading to increased production of aquatic organisms. Eutrophication can be accelerated by human activity such as agriculture and improper waste disposal.

FINGERLING:
Small immature fish, generally at least 1" long and less than 12 months old. The term "Young of Year" also applies.

FORAGE FISH:
A general term applying to numerous small-sized fish species consumed by larger predatory fish.

GRADIENT:
The change in altitude (expressed as feet) over the length of a stream (expressed as mile). A high gradient stream has a large drop in altitude over a certain stream length versus a shallow gradient stream which drops which has a smaller drop in altitude over the same length of stream. Gradient is expressed in feet per mile.

GRAVEL:
Rock averaging 0.8" to 2.5" in diameter.

GROUNDWATER:
Underground water-bearing areas generally within the boundaries of a watershed, which fill internal passageways of porous geologic formations (aquifers) with water that flows in response to gravity and pressure. Often used as the source of water for communities and industries.

HABITAT:
The place or type of environment where a plant or animal needs to live and grow.

HAZARDOUS WASTE:
Waste that has been found to be fatal to humans or animals in low doses, or is otherwise capable of causing or significantly contributing to an increase in serious irreversible, or incapacitating reversible, illness.

HEAVY METALS:
Metals present in municipal and industrial wastes that pose long-term environmental hazards if not properly disposed. Heavy metals can contaminate ground and surface waters, fish and other food stuffs. The metals of most concern are: arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium and zinc.

HERBICIDE:
A type of pesticide that is specifically designed to kill plants and can also be toxic to other organisms.

HIGH CAPACITY WELL:
A well pump or total well pumps on one property which equal or exceeds 70 gallons per minute of water.

HYDRAULIC DREDGING:
The removal of sediment by hydraulic disturbance, conveyance of the water/sediment slurry, and then re-settlement of the sediment in another location.

KARST:
A comprehensive term applied to limestone areas which possess a topography peculiar to and dependent upon underground solution by water and the diversion of surface waters to underground routes. Karst features include sinkholes, underground caverns and sinking streams.

LANDFILL:
A conventional sanitary landfill is "where solid waste is disposed on land by utilizing the principles of engineering to confine the solid waste to the smallest practical area, to reduce

it to the smallest practical volume, and to cover it with a layer of earth or other approved material as required." Hazardous wastes frequently require various types of pretreatment before they are disposed of, i.e., neutralization, chemical fixation, or encapsulation. Neutralizing and disposing of wastes should be considered a last resort. Repurifying and reusing waste materials or recycling them for another use may be less costly.

LEACHATE:

The contaminated liquid which seeps from a pile or cell of solid materials and which contains water, dissolved and decomposing solids. Leachate may enter the groundwater and contaminate drinking water supplies.

LIMESTONE:

A rock similar to dolomite in composition in that it contains calcium carbonate however magnesium is not present. Since any water stored in this rock formation is found in cracks or caves, little to no filtering of groundwater occurs.

LOESS:

Wind-blown fine-grained soil derived from high winds generated during the previous glacial period.

LUNKERS:

Refers to the acronym Little Underwater Neighborhood Keepers Encompassing Rheotactic Salmonids. It is a wooden structure, installed underwater on a streambank which provides overhead cover for trout.

MACROPHYTE:

A rooted aquatic plant.

MARL:

Off-white, clayey substance derived from lime-rich, chalky soil. This calcium carbonate mineral is found in some streams and wetlands.

MESOTROPHIC:

Refers to a moderately fertile nutrient level of a lake between the oligotrophic and eutrophic levels. (See also "Eutrophic" and "Oligotrophic.")

MILLIGRAMS PER LITER (mg/1):

A measure of the concentration of substance in water. For most pollution measurement this is the equivalent of "parts per million".

MITIGATION:

The effort to lessen the damages caused by a project, providing alternatives, compensating for losses or replacing lost values.

MUNICIPAL SLUDGE

The residual of the wastewater treatment process. Sludge generally contains substantial levels of nitrogen and organic material as well as phosphorus, potassium, and nutrients.

NONPOINT SOURCE POLLUTION (NPS):

Pollution whose sources cannot be traced to a single point such as a municipal or industrial wastewater treatment plant discharge pipe. Nonpoint sources include eroding farmland and

construction sites, urban streets, and barnyards. Pollutants from these sources reach water bodies in runoff, which can best be controlled by proper land management.

OLIGOTROPHIC:
Refers to an unproductive and nutrient-poor lake. Such lakes typically have very clear water. (See also "Eutrophic" and "Mesotrophic.")

OUTFALL:
The mouth of a sewer or drainpipe where effluent from a wastewater treatment plant is discharged.

OUTSTANDING RESOURCE WATER (ORW):
Rivers, streams or lakes that have been designated as valuable fisheries, hydrologically or geologically unique features, outstanding recreational opportunities or unique environmental settings that are not affected significantly by human activities. In designated ORW waters, effluent from all new permitted discharges must be of a quality equal to or better than the water receiving the discharge. A listing of these designated waters occurs in NR 102, Wisconsin Administrative Code.

PARTNERSHIP TEAM:
Individuals and organizations with an interest or stake in natural resources in the basin. The La Crosse - Bad Axe Partner Team consists of individuals from the four counties in the La Crosse - Bad Axe basin and includes individuals representing businesses, non-profit organizations, local or state governments, and universities.

PESTICIDE:
Any chemical agent used to control specific organisms, such as insecticides, herbicides, fungicides, etc.

PH:
A measure of acidity or alkalinity, measured on a scale of 0 to 14 with 7 being neutral, 0 being most acid, and 14 being most alkaline.

PHOSPHORUS:
A nutrient that, when reaching lakes in excess amounts, can lead to over-fertile conditions and algae blooms.

PLANKTON:
Tiny plants and animals that live in water.

POINT SOURCES:
Sources of pollution that have discrete discharges, usually from a pipe or outfall.

POLLUTION:
The presence of materials or energy whose nature, location, or quantity produces undesired environmental effects.

POLYCHLORINATED BIPHENYLS(PCBs):
A group of 209 compounds, PCBs have been manufactured since 1929 for such common uses as electrical insulation and heating/cooling equipment, because they resist wear and chemical breakdown. Although banned in 1979 because of their toxicity, they have been

detected on air, land and water. Recent surveys found PCBs in every section of the country, even those remote from PCB manufacturers.

PRIORITY WATERSHED:
A drainage area selected to receive Wisconsin Fund money to help pay the cost of controlling nonpoint source pollution. Because money is limited, only watersheds where problems are critical, control is practical, and cooperation is likely are selected for funding.

PRODUCTIVITY:
A measure of the amount of living matter which is supported by an environment over a specific period of time. Often described in terms of algae production for a lake.

PUBLIC LAW 92-500 (CLEAN WATER ACT):
The federal law that sets national policy for improving and protecting the quality of the nation's waters. The law set a timetable for the cleanup of the nation's waters and stated that they are to be fishable and swimmable. This also required all dischargers of pollutants to obtain a permit and meet the conditions of the permit. To accomplish this pollution cleanup, billions of dollars have been made available to help communities pay the cost of building sewage treatment facilities. Amendments in the Clean Water Act were made in 1977 by passage of Public Law 95-217, and in 1987.

PUBLIC PARTICIPATION:
The active involvement of interested and affected citizens in governmental decision-making.

RIPARIAN:
Belonging or relating to the bank of a lake, river or stream.

RIPRAP:
Broken rock, cobbles, or boulders placed on the bank of a stream to protect it against erosion.

RUNOFF:
Water from rain, snowmelt, or irrigation that flows over the ground surface and returns to streams. Runoff can collect pollutants from air or land and carry them to receiving waters.

SANDPOINT WELL:
A water well which terminates in sand. Generally a sandpoint well is not deeper than 40 feet and approximately 2" in diameter.

SANDSTONE:
Sand grains cemented together to form rock. Water stored in sandstone formations is in small pores between sand grains, thus allowing filtering of groundwater to occur.

SEDIMENT:
Soil particles suspended in and carried by water as a result of erosion.

SEPTIC SYSTEM:
Sewage treatment and disposal for homes not connected to sewer lines. Usually the system includes a tank and drain field. Solids settle to the bottom of the tank. Liquid percolates through the drain field.

SEPTAGE:
The solids or wastewater generated by private on-site wastewater systems and treatment.

SOLID WASTE:
Unwanted or discharged material with insufficient liquid to be free flowing.

STORM SEWERS:
Systems of sewers that collect and transport rain and snow runoff. In areas that have separated sewers, such stormwater is not mixed with sanitary sewage.

SUSPENDED SOLIDS (SS):
Small particles of solid pollutants suspended in water.

TOTAL MAXIMUM DAILY LOADS (TMDLs):
The maximum amount of a pollutant that can be discharged into a stream without causing a violation of water quality standards.

TOXIC:
An adjective that describes a substance which is poisonous, or can kill or injure a person or plants and animals upon direct contact or long-term exposure. (Also, see toxic substance.)

TOXIC SUBSTANCE:
A chemical or mixture of chemicals which, through sufficient exposure, or ingestion, inhalation or assimilation by an organism, either directly from the environment or indirectly by ingestion through the food chain, will, on the basis of available information cause death, disease, behavioral or immunologic abnormalities, cancer, genetic mutations, or development of physiological malfunctions, including malfunctions in reproduction or physical deformations, in organisms or their offspring.

TROPHIC STATUS:
The level of growth or productivity of a lake as measured by phosphorus content, algae abundance, and depth of light penetration. (See also "Oligotrophic," "Mesotrophic," "Eutrophic..")

TURBIDITY:
Lack of water clarity. Turbidity is usually closely related to the amount of suspended solids in water.

UNIVERSITY OF WISCONSIN-EXTENSION (UWEX):
A special outreach and education branch of the state university system.

USE CLASSIFICATION:
See "Biological Use Classification".

WASTEWATER:
Water that has become contaminated as a byproduct of some human activity. Wastewater includes sewage, washwater and the water-borne wastes of industrial processes.

WASTE:

Unwanted materials left over from manufacturing processes, refuse from places of human habitation or animal habitation.

WATER QUALITY STANDARDS:

The legal basis and determination of the use of a water body and the water quality criteria, physical, chemical, or biological characteristics of a water body, that must be met to make it suitable for the specified use.

WATERSHED TABLE CODES:

See codes in Appendix 6: Watershed Tables

WATERSHED:

The land area that drains into a lake or river. Watersheds can be defined on scales ranging from very small to very large, such as the Mississippi River drainage basin. For management purposes the state of Wisconsin has 333 identified watersheds.

WETLANDS:

Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a variety of vegetative or aquatic life. Wetland vegetation requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas.

WISCONSIN ADMINISTRATIVE CODE:

The set of rules written and used by state agencies to implement state statutes. Administrative codes are subject to public hearing and have the force of law.

WISCONSIN NONPOINT SOURCE WATER POLLUTION ABATEMENT GRANT PROGRAM:

A state cost-share program established by the State Legislature in 1978 to help pay the costs of controlling nonpoint source pollution. Also known as the nonpoint source element of the Wisconsin Fund or the Priority Watershed Program.

WISCONSIN POLLUTANT DISCHARGE ELIMINATION SYSTEM (WPDES):

A permit system to monitor and control the point source dischargers of wastewater in Wisconsin. Dischargers are required to have a discharge permit and meet the conditions it specifies.

YEARLING:

Fish between 13 and 24 months old. Not necessarily sexually mature adults.

YOUNG OF THE YEAR:

Fish that have hatched in the current calendar year.

Preface

Just as nature is a complex web of interconnections and interdependencies, so must be the understanding and management of each component in that web. The use and care of land resources in a drainage basin can greatly influence the interdependent ground and surface waters. To that end, the Wisconsin DNR has produced the State of the Bad Axe - La Crosse River Basin Plan, which describes the condition, issues and threats to the land and water resources of the basin. The issues and threats that face the natural resources of this basin are in some ways unique, but in other ways also reflect general statewide trends. Due to jurisdiction, workload issues, and a variety of other constraints, the Wisconsin DNR staff cannot completely address every issue or threat that faces the natural resources of this basin. Thus, the Bad Axe - La Crosse River Basin Team was formed in 1998 to identify the major issues facing the resources of the basin and coordinate holistic inclusive solutions to land and water resource threats. These issues and threats to the natural resources of this basin are discussed throughout the document and then organized by issue at the end of this report.

The purpose of the State of the Bad Axe - La Crosse River Basin Report includes the following five reasons:

1) Report to the people of Wisconsin the state of the natural resources in the Bad Axe - La Crosse River Basin.

2) Discuss and organize the priority issues facing the natural resources of the basin for the Bad Axe - La Crosse River Basin Team to systematically address over the ensuing six years.

3) Engage the Bad Axe - La Crosse River Basin Partners in a process of issue identification, shared prioritization and development of a framework for implementation of projects to improve the basin's ecological health.

4) Report to the U. S. Environmental Protection Agency the status of waterbodies in the basin for reporting to the U.S. Congress and to determine funding levels the Wisconsin DNR receives under the Clean Water Act.

5) Report to the U. S. Federal government the purpose and use of grant money received by the Wisconsin DNR from the U. S. Fish and Wildlife Service.

The following chapters describe the basin in detail, including the historical and existing condition of the land and water resources. The report ends with recommendations on how the Wisconsin DNR and basin partners can address the issues and threats to the land and water resources of the Bad Axe - La Crosse River Basin.

Executive Summary

The Bad Axe - La Crosse River Basin, located in southwest Wisconsin, contains numerous scenic vistas from the many hilltops and beautiful stream valleys. This basin is characterized by steep forested hillsides with agricultural activities located mainly in the relatively level valleys. The last glaciers to flatten Wisconsin did not reach this part of the state. Consequently, this basin is drained by a highly dendritic network of primarily cold, groundwater fed streams. In fact, the Bad Axe - La Crosse River basin contains 400 hundred miles of trout streams. Portions of Crawford, La Crosse, Monroe, and Vernon Counties lie within the Bad Axe - La Crosse River Basin.

This basin is rich in cold water streams. Many of these streams are in good shape, but many others are threatened by both urban and agricultural non-point source pollution. Stormwater runoff from urban areas, barnyard runoff and inadequate sod cover on streambanks top the list of problems. An extensive effort to restore in-stream habitat for trout and purchase streambank easements for fishing access has been very successful in the Bad Axe - La Crosse River Basin.

Groundwater provides drinking water to all citizens of the basin. This precious resource is at risk simply due to the prevalence of fractured dolomite, which acts as a conduit, rather than a filter of groundwater. Knowing this risk is pervasive throughout the basin, residents, business and municipalities must take great care in disposing of wastes that could potentially contaminate their drinking water supply.

The picturesque hills, valleys, and sandstone cliffs bring many visitors to the basin, some of whom decide to make it their home. Consequently, many farmers parcel their land and sell acreage to people who want to build homes in the hills. Even though many hills are too steep for crops or grazing, some new landowners simply carve out a hillside to create a flat building area for their home. These actions threaten surface water quality if erosion results as well as the integrity of the hillsides. The forests of the Bad Axe - La Crosse River Basin contain primarily oak species; however, oak wilt is taking its toll in the basin. The steep topography of this basin is not conducive to many acres of wetlands; however, large expanses still exist near the mouths of the Bad Axe River, Coon Creek, and the La Crosse River.

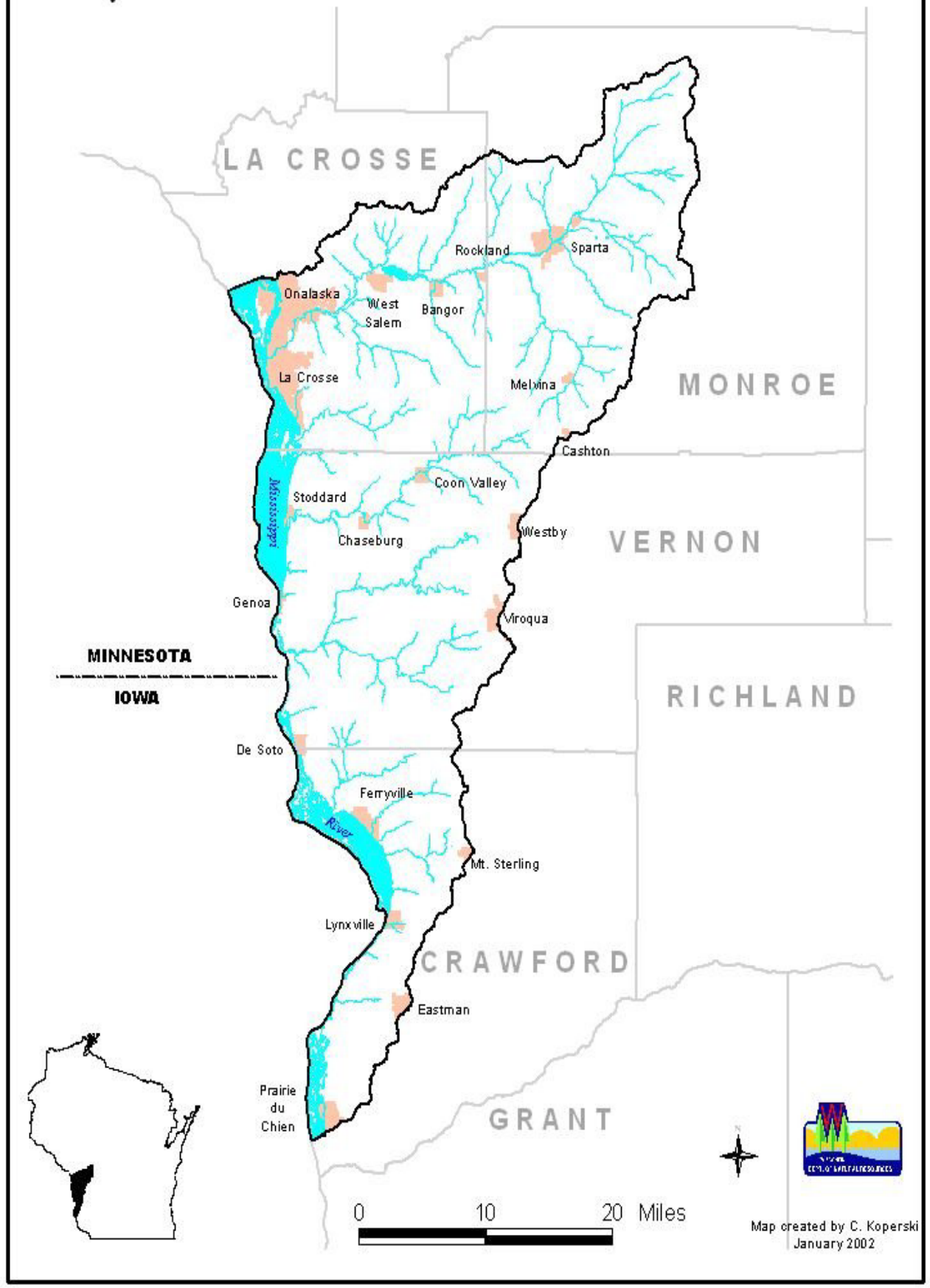
Major Bad Axe - La Crosse River Basin Issues

- Threats to land, forest and water quality from urbanization.
- Changing agricultural practices and the effect on surface and groundwater quality as well as forests.
- Land use changes and threats to the basin's many sensitive and unique plant and animal species and their associated habitats.
- Improvement in the availability of recreational opportunities.
- Need for coordinated management of forest ecosystems.
- Enhance public education regarding the basin's unique resources and how to protect them.

Efforts by people from many different walks of life are required to successfully meet the challenges to the natural resources of this basin. The Bad Axe - La Crosse River Basin Partnership Team was created by the Wisconsin DNR to bring people and agencies together to collaborate on priority natural resource issues in this basin. A list of natural resource issues unique to this basin and actions that can be taken by DNR and others are listed at the end of this

report. Narratives throughout the plan explain the issues in more detail and provide a good understanding of the problems.

Map 1. Bad Axe - La Crosse River Basin



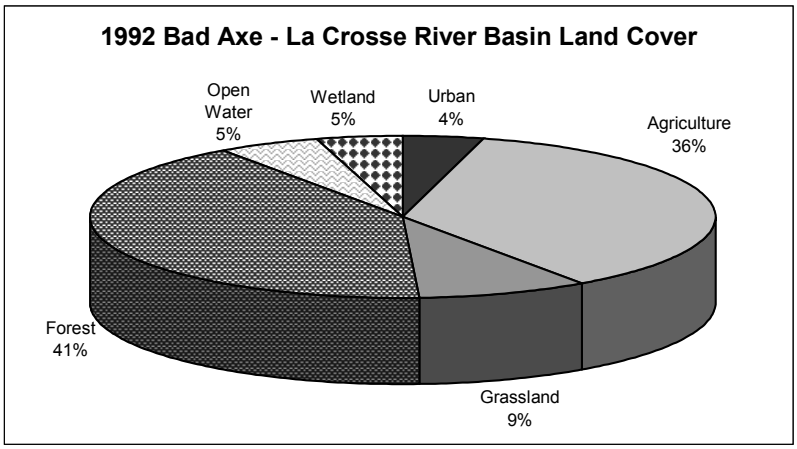
CHAPTER 1: THE BAD AXE - LA CROSSE RIVER BASIN

The Bad Axe - La Crosse River Basin encompasses approximately 1,000 square miles in southwest Wisconsin. This basin lies entirely within the portion of Wisconsin that was not flattened by the glacial ice drifts, also known as the *driftless area*. Another term commonly used to describe the driftless area is *coulee region*. Coulee was used by French voyageurs, the first Europeans to visit the area, to articulate the hills and valleys they observed. The basin is divided into six watersheds for water resource management purposes. Three watersheds drain to the La Crosse River, while the other three drain directly toward the Mississippi River.

Figure 1. Unglaciated portion of Wisconsin

The basin includes parts of Crawford, La Crosse, Monroe, and Vernon Counties. Major cities and villages in the basin include La Crosse, Onalaska, Sparta, Prairie du Chien, Viroqua, Westby, Genoa, Chaseburg, Coon Valley, Cashton, DeSoto, Stoddard, Rockland, Bangor, and Fort McCoy. Approximately 106,000 people live in the Bad Axe - La Crosse River Basin, La Crosse County being the most populous. The basin population increased an estimated 8% between 1990 and 2000, a little higher than the state average of 7.3%.

Figure 2. Current Land Cover in the Bad Axe - La Crosse River Basin



Current land cover in the basin is approximately equal between forest and agricultural lands. Many steep hillsides in the basin are forested, with agricultural activity limited to valleys or wide ridgetops. Many barns and animal feedlots in the basin are located immediately adjacent to streams. As seen statewide, many new homes and subdivisions are being built further away from major population centers in the Bad Axe - La Crosse River Basin, putting growth pressures on rural townships and changing historical land ownership patterns.

The Bad Axe - La Crosse River Basin contains over 700 miles of streams and rivers, with 57% classified as trout water. Due to the steep topography, no natural lakes exist in the basin; however, a fair number of man-made impoundments can be found. Again, due to the steep topography, isolated wetlands are rare, but some relatively large expanses of wetlands are located adjacent to larger rivers in the basin.

Geology

The entire Bad Axe-La Crosse River Basin is located within the unglaciated region of Wisconsin. The basin consists not of uprising hills, but rather of a deeply dissected bedrock plateau with as much as 700 feet of relief near the Mississippi River. Massive sandstone formations with interbedded shale layers are visible from the lowest elevations upward to about 1000 feet above sea level. Dolomite forms a resistant cap rock on ridge tops and is exposed in the bluffs along the Mississippi River. The surface of the dolomite was highly eroded and deeply incised before the next layer of sand was deposited, blanketing the surface and filling the valleys, caves and fractures in the dolomite. Although erosion has removed much of this sandstone, isolated outcrops and bedrock knobs can be found along the eastern basin boundary in Vernon County. On the north end of the basin and south into Crawford County, this sandstone lies just beneath the ground's surface.

Although the basin was not glaciated, there were glacial influences, such as wind-blown silt, also known as loess, deposited on ridge tops. These deposits may be up to 40 feet thick over the bedrock. Where thin layers of loess cover the bedrock, surface activities have direct access to the rocks beneath, and consequently, to underlying groundwater aquifers. Thicker accumulations of loess may inhibit the vertical and lateral migration of some contaminants. Soils developed in loess and/or weathered residuum of the dolomite, are productive as cropland, but are less well suited to the purifying needs of septic absorption fields. Such soils are moderately to poorly drained, with low to moderate permeability, and have high available water capacity. When dried thoroughly though, for example by plowing, the soil can become rock-hard.

Some valleys contain heavy clay, deposited at a time when rivers were larger and quiet bays or overbank deposits were made possible by additional water flowing from melting glaciers. Clay deposits north of La Crosse have been mined for use as landfill liners and landfill cover material. A similar low permeability clay material can be found in isolated valleys in Crawford County.

Sandy soils are found in the northern part of the basin and are likely to be excessively to well drained, with high permeability and low available water capacity. Again, surface activities in areas of this soil type may impact groundwater quality.

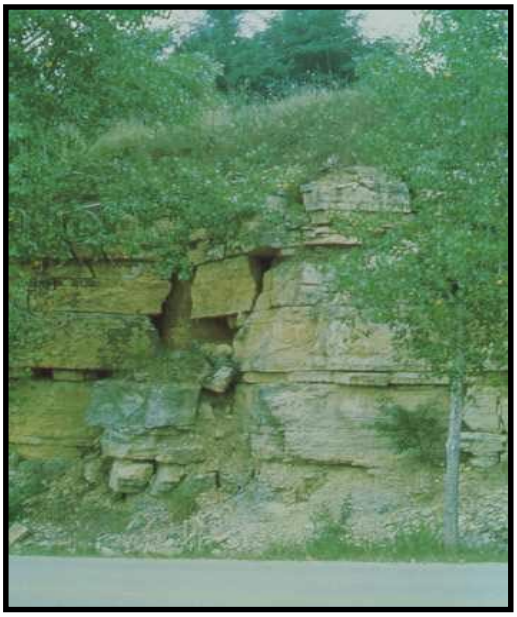


Figure 3. Fractured dolomite covered with less than five feet of soil on hilltop in Bad Axe - La Crosse River Basin.

Rock types have an impact on the quality and quantity of groundwater. Caves and cavities in the dolomite provide a way in which groundwater can move fairly rapidly over long distances. Predicting flow directions is sometimes difficult, since localized flow can become a function of bedrock weathering and may or may not conform to anticipated regional flow directions. Additionally, the sand-filled incised valleys mentioned earlier may divert groundwater in unexpected directions. Sink holes (basically a cave with a collapsed roof), a common development in dolomite, can act as a

conduit to carry surface run-off and contaminants into the rock formations and groundwater.

Seeps and springs are common in the basin and occur naturally where groundwater finds a less resistant path by flowing laterally, between two rock layers, rather than percolating vertically from one rock layer into another. The groundwater discharges where the rock layers intersect the ground surface. Both springs and seeps have been and still are used to provide water for older farmsteads in the basin. Springs and seeps are also a critical component of the quality trout streams in the area, providing a constant supply of cool, clear water with very little temperature variation throughout the year.

Artesian, or flowing wells, occur when a confining layer of rock is perforated, allowing the water accumulated under the formation to surge upward. Historically, flowing wells were also used in many parts of the basin to provide potable water for farms and homes. Some artesian wells are visible from STH 35 between Stoddard and Ferryville.

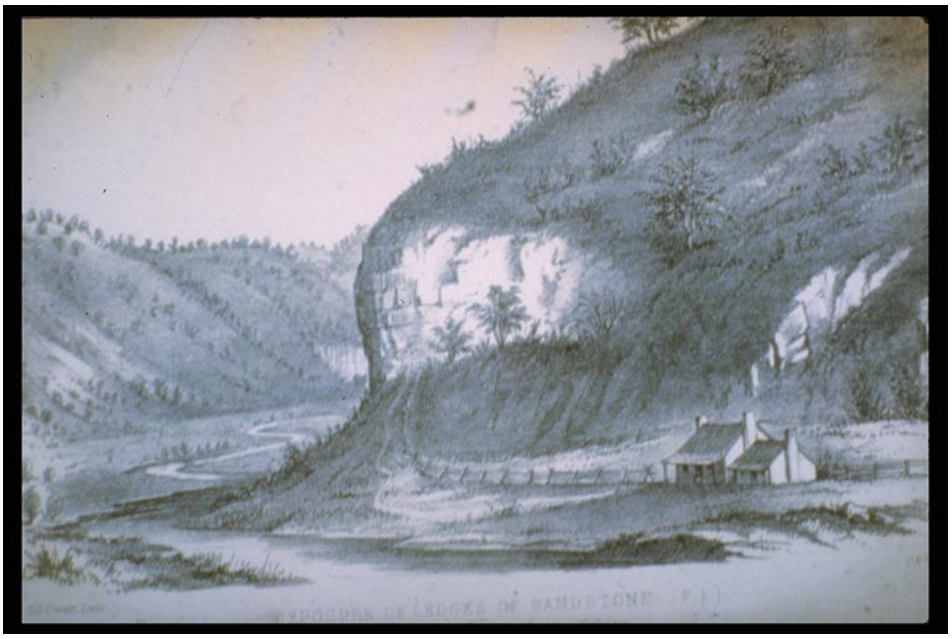
Groundwater is available from several aquifers in the basin. For example, wells on French Island near the city of La Crosse, tend to be shallow and draw groundwater from river sand and gravel deposits. Wells drilled on the ridges may terminate in the dolomite formation at 150-200 feet below the surface, while others extend hundreds of feet downward into the Cambrian sandstones below the dolomite. Although the sandstones provide the best supply of water, in terms of quantity and quality, some locales experience high iron as well as other hardness problems due to minerals dissolved from rock formations through which the water moves.

Historical Perspective

Pre-European Settlement

Before European settlement of the basin, the area was inhabited by many different Indian tribes for more than 2,000 years. The Ho-Chunk people (also known as Winnebago) were the most

Figure 4. Painting of typical coulee region land cover in the early 1800's.



recent and numerous, many of which still reside in the basin. The Bad Axe - La Crosse River Basin is rich in archeological sites from early Indian cultures. Many pictographs (paintings) and petroglyphs (carvings) are found in caves of the driftless area. Early Indian settlements have been confirmed along the Mississippi River by the discovery of large concentrations of discarded mussel shells. Some effigy mounds also exist in the basin.

Oak-dominated forests and prairies, usually on south facing hillsides, were recorded by the early surveyors. Prairies were kept treeless by periodic fires, some set by the indigenous people. Large expanses of high quality wetlands were found adjacent to the La Crosse River, the Bad Axe River and the Mississippi River. The streams were cold, clear, narrow and deep and contained abundant numbers of the only inland trout native to Wisconsin - brook trout. The streams also remained clear after rainstorms as water levels rose and fell slowly. Deer, black bear, wild turkeys, ruffed grouse, squirrels, wolves, elk, bison, and songbirds were present throughout the area.

Post-European Settlement

European settlers began arriving in the basin by the early 1800's. People of various ethnic backgrounds settled in the basin, but Germans and Norwegians are the major ethnic groups residing in the basin today. By the 1850's, at least 50% of the basin was in agricultural production.

The unique hill and valley characteristics of the driftless area influenced many cultural features of the region. For instance, roads do not follow section lines, rather wind through valleys or along ridgetops. Some township boundaries and other governing boundaries sometimes follow a river rather than man-made section lines. Conversely, property boundaries conformed to survey sections, which forced a square or rectangular farm onto very irregular topography. Much of the future soil erosion problems stemmed from this unfortunate choice of land parceling that did not follow land contours. Farmers cropped in square and rectangular shaped fields, as they had done in their homelands, with little regard for the steep slopes of the region. Some row crops were plowed up and down hills, creating an easy route for water to scour soil from hillsides.

Wetlands were drained, grazed and disturbed to fit whatever the landowner's preference was at the time. Many streams in the basin contained small dams used to turn wheels for grist mills or saw mills. Burns Creek, Dutch Creek, Mormon Coulee Creek and many more contained these type of structures.

Figure 5. Typical streambank erosion in coulee region circa 1920.

The first major crop in the basin was wheat, but by the 1870's, the majority of agricultural income was derived from dairy. When the first farmers arrived in the basin, the land supported small numbers of livestock and the soil still retained the rich, water absorbing humus that had accumulated from centuries of forest and prairie vegetation. As the agricultural

economy changed to dairy, trees were removed from steep hillsides and more cows were allowed to graze them. The rich humus valley soils were drained of their nutrients and soil absorbing capacity by constant plowing and cropping. As the hillside soils compacted under the constant weight of grazing livestock and vegetation became sparse, rains began to quickly run off the hills rather than soak into the once spongy soil. Water carved massive gullies into hillsides, which moved tons of soil to the valley floor. Large amounts of runoff originating from ridge top fields also carved gullies into hillsides. Aldo Leopold once referred to rain on the hillsides of the coulee region as water running off a tin roof. By the 1930's, after nearly eighty years of cultivation and grazing, virtually every rainstorm resulted in flash floods. By this time, farming in the Bad Axe - La Crosse River Basin developed into a frustrating venture with every new rainstorm washing away valuable crops, pasture and soil. An average of 12 to 15 feet of soil was added to many valleys. This much additional soil buried bridges and roads causing many to be raised and rebuilt.

The once crystal clear streams which held brook trout were now shallow, wide, warm and full of silt. The tons of sediment that reached the valley floor buried many springs and seeps, causing many perennially flowing streams to become intermittant, flowing only after rainstorms. Streams became braided meanders with their channel lost to the massive amounts of sediment now in the valley. In-stream fish habitat was lost and the cold water brook trout were replaced by warmwater species such as suckers, carp, chubs and other minnows.

Figure 6. Installation of a field terrace on a coulee region farm circa 1934.

In 1934, the Federal Soil Erosion Service, later called the Soil Conservation Service and now named the Natural Resource Conservation Service, launched the Coon Valley Erosion Project in the Coon Creek Watershed. They asked farmers to allow men from the newly founded Civilian Conservation Corp (C.C.C.) to enter their land and plant trees, fence livestock off steep slopes, reconfigure fields to follow the hills' contours, plant grassed waterways, and stabilize gullies. Efforts to restore streams were also attempted by the addition of brushmats to eroding banks, wood and rock deflectors to force floodwaters away from streambanks toward the stream's center, and revegetation of raw streambanks. These land management practices were successfully adopted and are still in use today not only by farmers in the Coon Creek watershed, but others in the Bad Axe - La Crosse River Basin as well as the entire driftless area, including parts of Minnesota, Iowa, and Illinois.

Changes throughout the 20th Century

After eighty years of farming, the Bad Axe - La Crosse River Basin was in as poor shape as any person had witnessed. To see immediate improvement after soil conservation measures were added to the land was expecting too much. Even with these measures, flash floods continued to damage land and property in the basin. Major floods occurred in 1951, 1961 and again in 1965. It was about this time that state biologists remarked that "because of watershed management problems…trout stream fishing in the coulee region may practically disappear in the future".

From the 1940's to the 1960's, farms on marginal land in the basin did not survive and the land reverted back to more natural conditions. Drastic changes in the farming community did not occur again until the 1970s, when many farming operations were encouraged to expand and consequently went deeply into debt. When overvalued land values fell and interest rates remained high in the early to mid 1980's, many producers were forced to financially dissolve their farms. Large amounts of agriculturally worked land was purchased by hobby farmers, interested only in getting back to nature - not raising livestock or growing crops as their sole source of income.

Inconspicuously, the Food Security Act of 1985 enabled further improvement of the land and water resources of the driftless area. This act contained a component which required compliance with farm specific Conservation Plans in order to receive any kind of government subsidy. From 1983 to 1988, land under conservation tillage in the area increased over 700%. Wisconsin also began promoting Farmland Preservation Program conservation plans as a tool to keep valuable soil on farm fields. The Conservation Reserve Program (CRP) also was a financial incentive to remove highly erodable land from crop rotation and replace with perennial vegetative cover.

Figure 7. A coulee region stream containing watercress in 1997.

Infiltration of rain and snowmelt into the ground increased approximately fifty years after trees were planted by the CCC, marginal cropland was converted to perennial vegetative cover and fewer livestock numbers grazed the hillsides. By the 1980's, springs reappeared, effectively cooling streams and causing intermittent streams to once again flow perennially. Watercress, an aquatic plant indicative of groundwater inflow to a stream, was documented not only at springheads, but also further downstream on many small and medium sized streams.

In 1978, money became available from the Wisconsin state trout stamp fund to allow installation of in-stream habitat structures designed to improve trout streams around the state. Restoration efforts occurred on stream sections owned by the state or where streambank easements had been acquired. Brown trout were stocked in many streams beginning in the 1960's, but carryover from year to year and natural reproduction was lacking. As streambanks became more stable, flood events less frequent, and infiltration of rain to groundwater increased, the streams of the Bad Axe - La Crosse River Basin held more water during dry periods and began to produce self-sustaining brown trout populations. Beginning in the mid-1990's, fishery surveys of streams in the basin revealed not only self sustaining brown trout streams but also streams capable of supporting native brook trout, absent from the basin for nearly 100 years. Stocking of wild brook trout fingerlings in some streams has since resulted in self-sustaining populations of brook trout.

After the land and water resources of the Bad Axe - La Crosse River Basin had reached their worst conditions in the 1930's, nearly 60 years of changes and improvements in land management

were necessary for the resources to recover to near pre-European settlement conditions. Since millions of tons of soil moved from the hilltops and hillsides to the valley floor, the Bad Axe - La Crosse River Basin will never look or act like it did before Europeans settled the area, but an equilibrium has been reached where many streams which drain agricultural lands are once again narrow, deep, clear, cold and contain healthy trout populations.

Current Land and Water Resource Issues

Even with the good news of recovering streams, challenges to water quality still exist in the Bad Axe - La Crosse River Basin.

➢ Beach closings due to unsafe bacterial levels in rivers and in some impoundments are of concern. Due to the topographic constraints of many farms in the basin, many barnyards and feedlots are immediately adjacent to streams. If not properly managed, these areas can contribute large amounts of bacteria laden manure to a stream.

➢ Increased runoff volumes from expanding urban areas in the basin threaten not only the quality but also the future existence of adjacent trout streams. The change in stormwater runoff volume as well as when and how much of it reaches an adjacent stream can degrade the in-stream habitat and water temperatures necessary for trout survival.

➢ A trend in the agricultural community of increased dairy herd size threatens both surface and groundwater quality in the basin if the manure generated at these large dairy operations is not properly managed. It is crucial to build manure storage facilities according to the proper design specifications in order to protect groundwater. Another crucial component of proper manure management is having enough land to spread these large volumes of manure. Since many fields in the coulee region are located adjacent to streams, coordinating the proper day and time to spread liquefied manure is extremely important. Frozen ground conditions, impending rainstorms, and the ability to immediately incorporate manure into the ground must all be seriously considered when determining when, how and where to spread.

➢ Just as easily as the National Farm Bill can improve the natural resources of the Bad Axe - La Crosse River Basin, it also has the potential to bring about drastic changes in how land in the basin is farmed. Changes in monetary compensation programs can cause a farmer to change a field rotation or grow one crop exclusively. Depending on the crop, the land may not be able to sustain itself, or on the other hand it may be a crop best suited to conditions in the basin. In any case, the economics of farming dictate how farmland is used. Since farming in the coulee region is unique to the rest of the State, area farmers and legislators must endorse those programs that help both farmers and the natural resources of the driftless area.

➢ Nutrient enrichment of the Mississippi River and impoundments in the basin, causing nuisance algae blooms, originates from the lands draining to them. Due to the topographic constraints of many farms in the basin, many barnyards, feedlots and cropped fields are immediately adjacent to streams. If not properly managed, these areas can contribute large amounts of nutrient laden manure and chemical fertilizer to a stream.

➢ Streambank erosion is a common sight in the Bad Axe - La Crosse River Basin. Some eroding streambanks are raw vertical banks created by the past accumulation of sediment in the valley and the stream naturally cutting into the bank. Other eroding streambanks result from unrestricted access of large animals which trample sloped streambanks and consume the soil retaining plants.

The addition of sediment to streams in the basin threatens to eliminate existing in-stream habitat for fish and aquatic insects.

- Disturbance of steep slopes in the basin for building single family homes is becoming more common. The destabilization of already fragile hillsides can lead to movement of soils off site to nearby streams or wetlands. Landslides, which can contain extremely large rocks, have occurred on destabilized slopes during heavy rains.

- Development encroaching into the extensive lower La Crosse River wetland complex threatens not only the flood control function, but also the diversity of plant and animal species residing within. Requests to fill one acre here and a half acre there of the La Crosse River marsh contributes to the cumulative reduction in total area.

- An increase in absentee landowners and their lack of historical perspective relating to land use issues of the basin threaten past land management mistakes to be repeated. Whether building on a hill or adjacent to a stream, newcomers to the area haven't seen how high that beautiful stream can get or how fragile the hillside soils are when it rains. The permitting, design and construction of stream crossings is often met with resistance since the crossing must be designed to pass large stream flows. New landowners to La Crosse County are mostly unaware of the building restriction on slopes steeper than 30% in the county. People living in the Bad Axe - La Crosse River Basin should have a good understanding of why these and other restrictions are necessary. Unfortunately fewer and fewer elderly 'locals' with first hand knowledge of problematic land management practices are around to share their insights with residents new to the basin.

- Increased development pressures in rural townships not adequately prepared for the accompanying decisions and long range implications of changing land use patterns has taxed some township staff and elected officials. Local officials must seriously consider what their township should look like in the future and what it will look like based on current land ownership and land use trends.

- If new markets for cranberries are created, expansion of new cranberry operations into the La Crosse River Basin is expected. The need for impounded water in a cranberry operation will likely affect any coldwater streams in the basin by the release of warm water. A closed water system where no stream is impounded would have the least impact to the basin's trout streams.

- The splitting of large land parcels into smaller subdivisions sometimes requires numerous stream crossings in a short length of stream. If these crossings are improperly designed or constructed, they have the potential to exacerbate flooding upstream of the crossing and/or inhibit upstream fish migration.

- Invasion of the exotic purple loosestrife threatens the plant and animal diversity that currently exists in the extensive wetland complex of the La Crosse River and many other waterbodies and wetlands in the basin. When purple loosestrife becomes established, it out competes native wetland vegetation, which in turn reduces biological diversity of plants, animals and insects.

- The practice of grazing livestock in some wooded areas of the basin was resumed recently due to a change in tax codes. This grazing practice was proven not only inadequate for the support of livestock but also destructive to the absorptive capacity of soils in the driftless area.

It is crucial to educate legislators, landowners and farmers about the unique qualities, problems, and solutions of living and working on the land in the basin in order to guard against repeating

past mistakes. Resolving other threats will involve partnerships with communities, units of government, individual farmers and citizens concerned about the land and water resources of the Bad Axe - La Crosse River Basin.

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