Washington County

Quaas Creek Watershed Protection Plan

Preserving • Protecting • Enhancing

"To Preserve and Enhance
the Quality and Function
of the Natural Resources
of Quaas Creek Watershed"

Quaas Creek Watershed Protection Committee

QUAAS CREEK WATERSHED PROTECTION PLAN
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GLOSSARY

Baseflow - The minimum amount of water (usually groundwater contributed) that fills the stream channel during even the dry times. Baseflow is essential to the health of the aquatic community in any stream.

Baseline monitoring - The act of establishing certain stream parameters that are used to assess future collected data.

Best management practices - The most effective practice or combination of practices for reducing nonpoint source pollution to acceptable levels, where environmental harm may occur if no action is taken.

Biofiltration - The use of biological substances, living or dead, to filter impurities out of water.

Biological assessment - A strategy used to measure the type, amount, and diversity of living things in a specific area.

Biological community - All living things that dwell interdependently in a specific place and share the available resources.

Celsius (Centigrade) - 1.8º C + 32 = Fahrenheit or 5/9 (Fº -32) = Celsius.

Channelization - The artificial enlargement or straightening of a stream channel in order to maintain navigability.

Channel stability - The amount that a streambed is resistant to change by environmental or human caused forces.

Class II - A waterbody that has the objective of maintaining the waterbody due to the reason that it has limited development. Class II waterbodies are determined by average width, average depth, and type of fish population.

Dissolved oxygen (DO) - The amount of oxygen dissolved into water at a given temperature and atmospheric pressure. Generally, higher amounts of oxygen are found in cold water versus warm water streams. DO affects the health of all aquatic life.

Dry detention basin - An engineered basin designed to slow and pond stormwater runoff for a short period of time before allowing the water to exit back into the environment, thereby reducing peak flooding levels.

Ecology - The study of the interactions between living things and their environment.

Ecosystem - All the living and nonliving things found in a given area, such as plants, animals, sunlight, water, and soil.

Entrenchment ratio - Interrelationship between the stream to its valley or landform features. Streams can be deeply contained (incised) in their valley or not. Measurement of the stream's relationship to its floodplain. Generally, Quaas Creek is not entrenched.

Environmental corridor - Areas of land that contain undisturbed concentrations of natural and scenic resources. Corridors serve as natural areas, wildlife refuges, surface water drainageways, stormwater retention areas, and other valuable ecological resources.

Ephemeral stream - Stream that flows over highly permeable land surfaces and exists for a short time usually only after a rain.

Erosion -The wearing away or gradual removal of soil, rock, and other land surfaces by wind, water, ice and/or gravity.

Grassland - Land capable of supporting prairie grass or other native species of vegetation other than trees.

Groundwater - Water found below the surface of the land in the soil spaces and pores and/or bedrock cracks and fissures.

Groundwater recharge area - Landscape area that collects stormwater runoff and allows it to infiltrate into the ground.

Hydric soil - Type of soil that has groundwater found at or slightly below the soil surface for a period of time. Usually associated with floodplains, wetlands, and groundwater recharge areas.

Hydrology - The branch of science that studies the distribution of the earth's waters, located above and below the ground.

Impervious surfaces - Natural or artificial landscapes that do not allow water to seep into the ground, usually concrete, asphalt, or rooftops.

Infiltration basin - An engineered basin designed to pond stormwater runoff before allowing the water to soak into the ground, thereby pre-treating polluted runoff and eliminating or reducing peak flooding levels.

Intermittent stream - Stream that recharges the groundwater and flows during the wet seasons and after heavy rainfall.

Intolerant species - Organisms intolerant to external stresses such as pollution or environmental change. Not adaptable to change.

Loading - Process of suspension and deposition of an amount of materials into another area, i.e. Pollutant loading to a stream.

Macroinvertibrates - Organisms without a backbone that live in association with the stream bottom (benthic) and can be seen without the help of a microscope. They are good indicators of stream health and pollution levels and serve as food for some fish.

Native species - Species of plants or animals historically found within a specific geographic area and assumed to be the original inhabitants from pre-European settlement time. Conversely, nonnative species have been introduced into a specific area by human activity.

Natural area - Tracts of land or water not significantly modified by human activity and contain intact native plant and animal communities believed to be representative of the pre-European settlement landscape, i.e. tallgrass prairie, oak savanna, old growth forest.

Navigable - In Wisconsin, a waterbody is considered such if it has a defined bed and bank and is capable of floating a watercraft (canoe) on a regular recurring basis (once a year).

Nonpoint source pollution - Pollution from any small or diffuse sources, not originating from one specific location, i.e. snow deicer and oil from a parking lot or sediment from a construction site finding its way into a stream and causing water pollution.

PAH's - Polycyclic aromatic hydrocarbons usually associated with gas stations and vehicle maintenance areas. Considered cancer causing.

Perennial stream - Stream that normally flows year-round because it is constantly replenished by groundwater or runoff.

Point source pollution - Pollution discharged from any identifiable point, such as a pipe, ditch, sewer, channel, tunnel, or container, i.e. a sewage pipe discharging raw sewage into a stream and causing water pollution.

Pool - A slow, but deep portion of the stream where water flows smooth and is not noticeably disturbed. Good fish habitat.

Porous pavement - Surfaces that allow rainwater to pass through them and infiltrate into the soil and groundwater.

Recovery potential - Ability of a stream to recuperate from external disturbances such as stormwater runoff pollution.

Riffle - A shallow area in the stream where water flows unevenly and turbulently producing noticeable waves.

Riparian buffer strips - Areas of land surrounding a stream that remove runoff pollutants and sediment and provide wildlife habitat.

Riparian corridors - Area of land adjacent to the banks of a stream and directly influenced by the stream. Good wildlife habitat.

Run - A length of the stream whose surface is choppy due to uneven streambed surface. Good macroinvertebrate habitat.

Sedimentation - The deposition of soil or pollutant particles from a state of suspension (erosion) into a stream and/or low spot in the landscape.

Sinuosity - Measurement of the stream channel pattern, which can range from straight to winding (meandering).

Slope - Elevation change divided by distance between two points in the stream, expressed as feet/mile or percent.

Stormwater runoff - Water that does not infiltrate into the ground after a rainstorm, but instead travels over the land surface picking up pollutants along the way, eventually depositing them into the stream. Primary source of nonpoint pollution.

Stream morphology - The origin, function, form, and structure of a stream. Includes slope, sinuosity, entrenchment ratio, etc.

Stream reach - A length of stream determined by similar characteristics or through management zones.

Streambed scour - A process where fine sediment and substrate is removed from the streambed exposing larger coarse substrate more suitable for aquatic habitat and fish spawning. This process aids in removing pollutants trapped in the streambed.

Subdivision plat - A paper document showing land division that meets County Code Chapter 23.

Subwatershed / Subbasin - A smaller watershed found within a larger watershed, i.e. Quaas Creek is a subwatershed of Lake Michigan.

Thermal pollution - Pollution that occurs when dissimilar temperatures of water mix together causing stress to fish and other aquatic organisms. i.e. warm water flowing into a stream system that normally contains cold water.

Tolerant species - Organisms tolerant to external stresses such as pollution or environmental change. Adaptable to change.

Turbidity - The amount of solid particles suspended in water that causes water cloudiness, chokes fish gills, and inhibits photosynthesis.

Watershed - The geographic land area from which surface water runoff drains into a particular river, stream, or waterbody, also called a drainage area or tributary area. Identified by tracing the highpoints in a landscape; Water flows from high to low points.

Watershed Protection Plan - A commitment to action by local governments and other stakeholders to preserve the quality of a lake or stream. It combines the principles and practices of land conservation, stormwater management, nonpoint pollution control, and good stewardship, each custom-tailored to the specific needs of a particular resource. Developing and implementing the plan requires not only intergovernmental cooperation, but also citizen participation. Helps preserve water for use by future generations.

Wet detention basin - An engineered basin designed as a permanent pool of water constructed to collect, detain, and treat polluted stormwater runoff. Water can absorb heat from the sun during detainment and upon release contributes to the thermal pollution of the stream.

Wetland - Land where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities. Usually associated with hydric soils and groundwater recharge areas.

Woodland - Area of land with more than seventeen trees per acre that are four inches in diameter or greater.

Zoning - Regulation of land into various districts to separate conflicting uses. i.e. Commercial zoning, agricultural zoning, residential zoning, floodplain zoning, shoreland zoning.

CHAPTER I - INTRODUCTION

PLAN BACKGROUND AND PURPOSE

Quaas Creek and its major tributaries are a unique water resource located in the heart of Washington County, within the Towns of Polk, Trenton, Jackson, West Bend and the City of West Bend (Map 1). The system is a high quality warm water stream, sustained by groundwater recharge, seepage from wetlands and moraines, and precipitation runoff from an 8.3 square mile (5,312 acre) watershed. Eventually, Quaas Creek discharges into the Milwaukee River at the eastern edge of the City of West Bend (Map 2).

Quaas Creek has unique aesthetic value: The majority of the stream and adjacent riparian corridors exhibit a rural character within a rapidly urbanizing watershed. Recreational opportunities are also present within Quaas Creek. Utilized for fishing, wading, and wildlife watching, it provides ecological and recreational benefits for adjacent landowners and other users. The potential to support a warm water sport fishery is present throughout the watershed. In the cool temperature headwaters, extending from the main channel at CTH G upstream to the North and South Branches, Quaas Creek has the potential to support a Class II brook trout fishery. Brook trout have been historically reported to occur here by the Wisconsin Department of Natural Resources. While the most recent fishery studies indicate that the abundance and diversity of fish have increased, Quaas Creek has experienced an apparent loss of thirteen native fish species, including brook trout (Figure 1) since 1983.

Figure 1: Brook Trout-coldwater gamefish species

(*Photo courtesy* of *John Lyons, WDNR)*

Limited aquatic habitat, sedimentation, and water quality, as related to dissolved oxygen content and water temperature, may continue to limit the maintenance and potential development of a high-quality warmwater sport fishery throughout this stream system, as well as a brook trout fishery in the headwaters. Generally, these limitations are related to changing land use conditions, namely urbanization, within the watershed. From the early 1900's through the 1980's, the most significant factors impairing the Quaas Creek system had been nutrient loading and sedimentation from cropland, streambank erosion and streambed scour from stream channel straightening and modification, and the draining and/or filling in of wetlands.

More recently, construction site erosion and stormwater discharge from urban development have superceded agriculture impacts and have become the primary pollution concern in the watershed. Urbanization increases the amount of impervious surfaces that contribute nonpoint source pollution (Figure 2) and increases the loss of wetlands, groundwater recharge areas, and natural riparian corridors.

Figure 2: Oil, grease, and sediment runoff from impervious surfaces to storm sewers, which drain into surface water.

(*Photos courtesy* of *Lizhu Wang, WDNR)*

Despite an increase in urbanization, land immediately surrounding Quaas Creek and its major tributaries remains relatively undeveloped and primarily consists of woodlands, grasslands, and wetlands (Figure 3). These adjacent riparian corridors help protect water quality, offer ecological and aesthetic benefits for recreational enjoyment, and provide the opportunity to protect and restore critical habitat for fish and wildlife.

Figure 3: Natural vegetative buffers along Quaas Creek, stream at CTH I and CTH G.

(Photos courtesy of Washington County LWCD)

PLAN DEVELOPMENT PROCESS

Based upon issues identified by the public in the process that led to the *Washington County Land and Water Management Plan*,[1] the Quaas Creek Watershed Protection Committee, created in 1999 by the Washington County Board of Supervisors, was given the responsibility of preparing a watershed protection plan for Quaas Creek. This intergovernmental committee consists of representatives from the Washington County Planning and Parks Department; the Towns of Polk, Trenton, and West Bend; the City of West Bend; the Wisconsin Department of Natural Resources (WDNR); the University of Wisconsin-Extension; the University of Wisconsin-Milwaukee; and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) (Appendix A). Under this planning program, the Committee, with assistance from the Technical Advisory Subcommittee, has refined

[1] Washington County, Washington County Land and Water Resource Management Plan: 2000-2005, 2000.

issues, developed goals, and established recommendations, through numerous meetings over the past five years, that are designed to preserve, protect, and enhance the natural resources within the Quaas Creek watershed.

Purpose and Format

This watershed protection plan complements management actions that are currently implemented in and adjacent to Quaas Creek and represents an ongoing commitment from government agencies and municipalities to diligent land use planning. The Washington County Planning and Parks Department, Land and Water Conservation Division (LWCD) prepared this protection plan in cooperation with the representatives from Quaas Creek Watershed Protection Committee. This plan incorporates land and stream management data and analyses found within the following sources: Washington County Land and Water Resource Management Plan,[2] Washington County Lake and Stream Classification Project,[3] SEWRPC Regional Water Quality Management Plan for Southeastern Wisconsin,[4] Stormwater Management Plan for the City of West Bend, [5] WDNR Nonpoint Source Control Plan for East and West Branches of the Milwaukee River Priority Watershed Project,[6] and SEWRPC Stream Channel Stability and Biological Assessment of Quaas Creek.[7] In addition, this plan incorporates water quality and fishery data collected by the Wisconsin Department of Natural Resources, the University of Wisconsin-Milwaukee, SEWRPC, and the Washington County Land and Water Conservation Division. The Quaas Creek Watershed Protection Plan presents appropriate and feasible watershed management recommendations for enhancing and preserving the water quality of Quaas Creek and for providing the public with opportunities for safe and enjoyable recreation within the Quaas Creek Watershed.

The objectives for the Quaas Creek Watershed Protection Plan were developed in consultation with the Quaas Creek Watershed Protection Committee and the Quaas Creek Technical Advisory Subcommittee. These objectives are as follows:

- Preserve the existing natural vegetative cover in and along perennial, intermittent, and ephemeral water bodies.
- Preserve the existence and hydrological function of wetlands and other high groundwater areas, including hydric soils.
- Preserve the existing natural vegetation in remaining natural areas and enhance their ecological function by reconnecting these areas to the larger riparian corridor.
- Limit the negative water quality and quantity impacts of impervious surfaces associated with urban runoff.
- Reduce the nonpoint pollutant loading and thermal increases from existing urban and rural runoff.

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[2]Washington County. Washington County Land and Water Resource Management Plan: 2000-2005. 2000.

[3]Southeastern Wisconsin Regional Planning Commission. Surface Water Resources of Washington County Wisconsin, Lake and Stream Classification Project: 2000. Memorandum Report No. 139, September 2001.

[4]Southeastern Wisconsin Regional Planning Commission. A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report. Memorandum Report No. 93, March 1995.

[5]Southeastern Wisconsin Regional Planning Commission. A Stormwater Management Plan for the City of West Bend, Washington County, Wisconsin- Alternatives and Recommended Plan for the Quaas Creek Subwatershed. Community Assistance Planning Report No. 173, Vol. 4, July 1996.

[6]Wisconsin Department of Natural Resources. A Non-point Source Control Plan for East and West Branches of the Milwaukee River Priority Watershed Project. PUBL-WR-255-90, March 1992.

[7]Southeastern Wisconsin Regional Planning Commission. Stream Channel Stability and Biological Assessment of Quaas Creek: 2002. Memorandum Report No. 151, July 2002.

- Improve the function and purpose of key natural resource features.

- Increase the awareness and promote environmentally responsible practices and behaviors of residential, business and institutional communities.

- Improve the understanding of the existing and potential physical, chemical and biological conditions of Quaas Creek, and use that understanding to evaluate existing watershed management activities and develop future recommendations and activities.

The Quaas Creek Watershed Protection Plan is designed to assist municipalities in developing strategies that will benefit Quaas Creek's natural assets and protect sensitive habitats within the watershed. By using the planning strategies outlined in this plan, results will be achieved that enrich and preserve the natural environment. In addition, carefully planned urban development can create and maintain open space, groundwater recharge areas, and wildlife corridors for the benefit of Quaas Creek and its residents. This protection plan should serve as a practical guide for the management of the water quality within the Quaas Creek Watershed and for the management of the land surfaces that drain directly and indirectly to this body of water.

RELATED RESOURCE MANAGEMENT PLANS

Washington County Land and Water Resource Management Plan
As indicated in the Washington County Land and Water Resources Management Plan, a top priority for the Washington County Land and Water Conservation Division is the development of recommendations that preserve and improve the Quaas Creek system. This priority, developed through an extensive public participation process, involved more than eighty-five people including individual citizens, representatives of more than five private organizations, six municipalities, and six public agencies. The full proceedings of the public participation process, as well as supporting documentation are available from the Washington County Land and Water Conservation Division. This watershed protection plan represents the ongoing commitment of the Washington County Land and Water Conservation Division to protect and preserve the land and water resources of Washington County.

Washington County Lake and Stream Classification Plan
Incorporated, by reference, into Chapter 23 of the *Washington County Code,* this lake and stream classification report updated surface water resource inventories previously completed by the WDNR and SEWRPC. This plan provides a summary of the water quantity and quality characteristics of both lakes and streams in Washington County. It also includes an assessment of current water-use potentials and water protection methods.

Stream Channel Stability and Biological Assessment of Quaas Creek: 2002
This channel stability and biological assessment, prepared by the Southeastern Wisconsin Regional Planning Commission staff from data collected by SEWRPC and Washington County Land and Water Conservation Division, guides the development of the recommended management actions and identifies potential protection, revitalization, and restoration actions that may be incorporated in the Quaas Creek Watershed Protection Plan. This report also describes in-stream management measures that may be applied to enhance the water quality conditions, biological communities, and recreational opportunities in Quaas Creek. More specifically, this report provides the following: an evaluation of the historical and current status of habitat quality and ecological integrity within Quaas Creek; an identification of the potential limitations to water quality and fishery resources; an analysis of the main channel bank stability; and an identification of management activities that can enhance the ecological, resource, and aesthetic values. Readers interested in the technical details and background information pertaining to the physical, chemical, biological, and natural resource characteristics of the Quaas Creek Watershed are encouraged to obtain a copy of the SEWRPC Memorandum Report No. 151, available from the Washington County Land and Water Conservation Division or the Southeastern Wisconsin Regional Planning Commission.

ONGOING LAND CONSERVATION AND WATER QUALITY MONITORING EFFORTS

Since the formation of the Quaas Creek Watershed Protection Committee in 1999, there have been a variety of activities and projects implemented throughout the watershed that are directly contributing to the preservation and

enhancement of the Quaas Creek watershed. These projects range from the establishment of riparian buffers along the tributaries to Quaas Creek, to retrofitting some existing stormwater management ponds, to the continuing water quality monitoring efforts of UW-Milwaukee and Washington County Land and Water Conservation Division. These continuing monitoring efforts are shown on Map 3 and the projects are briefly described below.

Land Conservation Activities

Working with landowners, the Washington County Land and Water Conservation Division has helped landowners establish riparian corridors in the East Branch through a federal cost-sharing program called the Conservation Reserve Enhancement Program. These buffers will reduce annual sediment loading into the stream by more than eight tons and reduce the annual amount of nitrogen and phosphorus loading by over thirty pounds. Other landowners that own cropland adjacent to the creek have been contacted to discuss the potential of installing riparian buffers. Many lands adjacent to Quaas Creek have riparian buffers large enough to trap and filter sediment from their cropland, but these buffers provide little wildlife habitat or long term flood and water quality protection.

Working with developers, the City of West Bend has preserved, as parkland, numerous acres of riparian land along Quaas Creek. Much of the preserved land is wetland, environmental corridor, and/or floodplain and is now in public ownership for all residents to enjoy.

Runoff Management Activities

To help reduce pollutant loadings, the City of West Bend is in the process of retrofitting one of its existing stormwater ponds, which drains directly to a ditch along the west side of CTH G, south of Quaas Creek (Appendix B). The City received a grant from the DNR to provide 50% of the cost of this project. In addition, the City is constructing a stormwater detention pond along CTH G, north of Paradise Drive, which will significantly decrease the peak flows from the upstream watershed during the 100-year storms. This basin protects water quality through the use of prairie grasses, which filter sediment before it can pollute the stream, and drain tiles located around the pond perimeter, which provide thermal control by allowing the stormwater to infiltrate into the groundwater, instead of directly running into the stream.

Watershed Education and Outreach Activities

The Washington County Land and Water Conservation Division, in cooperation with UW-Milwaukee and West Bend High School, has established a permanent water quality monitoring station on Quaas Creek. This station provides educational opportunities for students and interested citizens. It is also a valuable management tool used to understand water quality trends and the effectiveness of pollution control measures employed throughout the Quaas Creek watershed.

Continuing Monitoring and Analysis

To better understand the relationship between water quality and land management practices, the Washington County Land and Water Conservation Division, with the assistance of local volunteer water monitors, continues to assess water quality at several sites throughout the Quaas Creek watershed.

The Wisconsin Department of Natural Resources continues baseline monitoring on fisheries, macroinvertebrates, and water quality within the upstream areas of the Quaas Creek watershed.

The University of Wisconsin-Milwaukee has been working on several projects in the Quaas Creek watershed. These projects are focused on determining the relationship between stream organisms (fish, macroinvertebrates, etc.) and their in-stream habitat and how that relationship is affected by the changing land use conditions within the watershed.

Map 1: Quaas Creek Watershed within Washington County

Map 2: Quaas Creek Watershed Streams and Waterbodies

Map 3: Quaas Creek Watershed Ongoing Water Monitoring

CHAPTER II – INVENTORY FINDINGS

INTRODUCTION

The Quaas Creek watershed contains four major subwatersheds designated as the East Tributary, South Branch, North Branch, and Main Stem. Quaas Creek, determined to be capable of meeting the warmwater sport fish and full water recreation use objectives, has been designated as a Class II waterbody within the Washington County Lake and Stream Classification System. Between 2000 and 2020, urban land uses in the watershed are expected to more than double with accompanying impacts on the stream system in terms of hydrology, water quality, wildlife habitat, and fisheries.

Geology, Topography and Soils

The Quaas Creek watershed is underlain by Niagara limestone (dolomitic bedrock). Quaas Creek lies to the east of the Inter-Lobate Kettle Moraine and occupies the pitted glacial outwash, rolling ground moraines and glacial lake basin deposits south of the Milwaukee River. The glaciers deposited a wide variety of soil-forming materials and sculpted many different landforms that influence soil type and stream hydrology. Topsoil varies from silty to sandy loam to organic muck; subsoil varies from clay loam to gravelly sandy loam. Most topsoil is deep, but areas throughout the watershed contain a thin mantle of topsoil with groundwater close to the soil surface. Average depth to groundwater throughout the watershed is less than fifty feet and greater than one-half of the watershed has groundwater less than twenty-five feet below ground surface. Most soils are considered well to moderately drained, although some poorly drained soils exist, mainly surrounding wetlands. Soil slope is 2-6% in 67% of the watershed, although steeper slopes of 6-20% exist throughout. Quaas Creek and its tributaries travel a linear distance of over six miles and contain an overall gradient of approximately nineteen feet per mile.

Hydrology

Ten unique stream reaches were defined within the Quaas Creek watershed based upon slope, sinuosity, width, depth, entrenchment ratio, and dominant channel material (Map 4). These characteristics would suggest that Quaas Creek is very sensitive to disturbances within the drainage area, with a fair to good recovery potential from these disturbances. These characteristics also suggest that within this system, the potential for streambank erosion is moderate to very high. Streambank vegetation has a very large influence on moderating this erosion potential. Field surveys, conducted by SEWRPC and Washington County LWCD in the Fall of 2001, indicated that there were more than 130 active erosion sites totaling about 1.5 miles of streambank. Other fish habitat limitations- sedimentation, channelization (Figure 4), and obstructions, namely culverts (Figure 5) and debris jams- were identified and ranked for each reach. As shown in Table 1, all four of these limitations affect fishery habitat.

Table 1: Comparison of Potential Limitations to Fisheries Habitat among Reaches within the Quaas Creek Watershed

River Reach	Potential Limitations to Fisheries Habitat			
	Sedimentation	Channelization	Bank Instability	Obstructions
East Tributary	Low	High	Low	Low
South Branch	High	High	Low	Moderate
North Branch	High	High	Moderate	Low
CTH P	Moderate	Low	Moderate	High
Private Drive	Low	Low	High	Low
Progress Road	Low	Moderate	Moderate	Low
Wisconsin Central Railroad	Low	Moderate	Low	Low
CTH G	High	High	High	High
Sand Drive	High	Moderate	High	Moderate
Decorah Road	Low	Low	High	Low

Source: SEWRPC

Map 4: Quaas Creek Watershed Stream Reaches

Figure 4: Channelization in Quaas Creek

Figure 5: Culvert in Quaas Creek

(Photos courtesy of Thomas Slawski, SEWRPC)

WATER QUALITY

Quaas Creek is a perennial stream with water quality that varies from poor to excellent, depending upon the indicators considered. From 1983 to 2001, the Wisconsin Department of Natural Resources and University of Wisconsin-Milwaukee collected various instantaneous dissolved oxygen and temperature measurements for specific areas within Quaas Creek. These measurements indicated it could support the full fish and aquatic life standards for a warmwater sportfish community. This data also suggested a thermal regime that would not support a coldwater sportfish community.

Coldwater fish, such as brook trout, survive best in 20° Celsius water temperature or less and have been shown to prefer temperatures in the wild ranging from 13.9º C to 15.6°C. Optimum feeding temperature is about 19°C, and temperatures recommended for optimum growth and for spawning are 20°C and 12.8°C, respectively.[8] However, temperatures a few degrees below the lethal limit of 25°C [9] can still cause significant stress that can eventually lead to illness, infection, and ultimately death. Data collected from the main channel at River Mile 0.91 (east of West Bend High School, south of CTH I) during 2000 through 2003 showed that the water temperature often exceeded 20°C, and on several occasions during 2001 exceeded the 25°C lethal limit for trout (Figure 5a).[10]

Dissolved oxygen is a good indicator of water quality. The level of oxygen present in the water determines what types of fish and macroinvertebrates can flourish and survive in the stream system. Dissolved oxygen content in a stream is highly influenced by the temperature of the water (warmer water holds less dissolved oxygen than colder water). In healthy streams, it ranges from six to twelve milligrams per liter, with warm water streams being on the low end and vice versa for cold water streams. During the spring, summer, and fall of 2000, seasonal dissolved oxygen concentrations in the main channel of Quaas Creek rarely dropped below seven milligrams per liter (Figure 5b). In comparison, seasonal dissolved oxygen trends in the main channel of Quaas Creek during 2001, 2002, and 2003 indicated that concentrations are more frequently dropping below six milligrams per liter and in one instance dropping below four milligrams per liter. The apparent increase in the frequency of reduced dissolved oxygen levels may be indicative of a reduced water quality trend. If this trend continues, a serious reduction in the abundance and diversity of the fishery may continue to occur throughout this system.

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[8] G.S. Becker. Fishes of Wisconsin. University of Wisconsin Press, 1983.

[9] Ibid.

[10] Lyons, J., Lizhu Wang and Timothy D. Simonson. "Development and Validation of an Index of Biotic Integrity for Coldwater Streams in Wisconsin." North American Journal of Fisheries Management, 16 (2): 241-256. May 1996. This article distinguishes warmwater habitats that have a maximum daily mean water temperatures in excess of 24°C from coldwater habitats that have a maximum daily mean water temperatures of less than 22°C.

Figure 5a: Average Hourly Water Temperature Readings within Quaas Creek at mile 0.91 from June through October 2000-2003

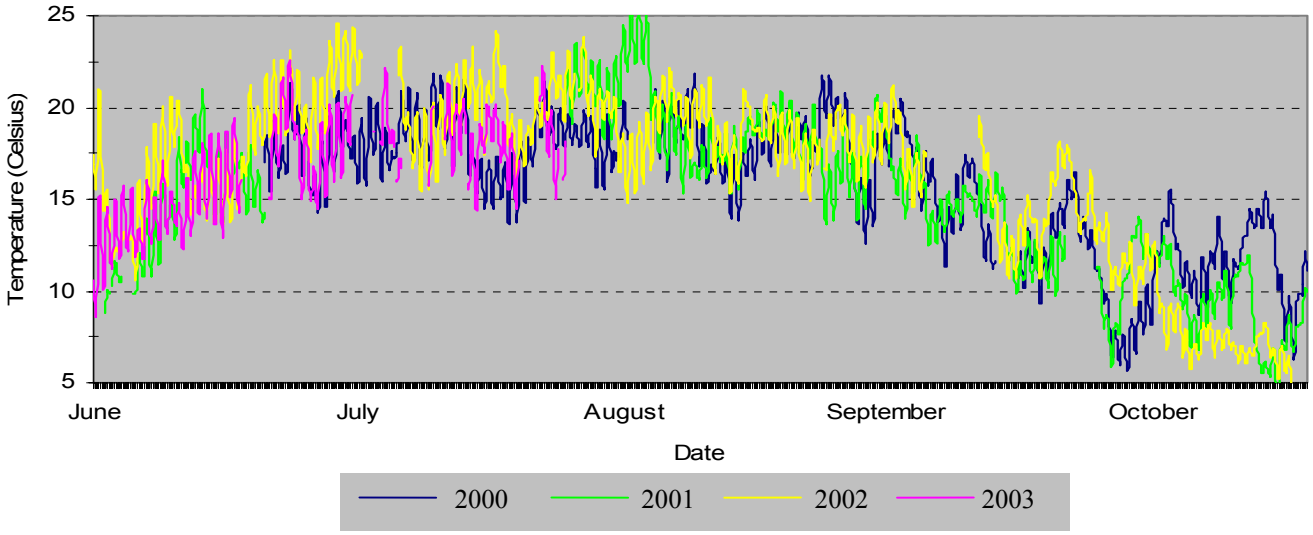
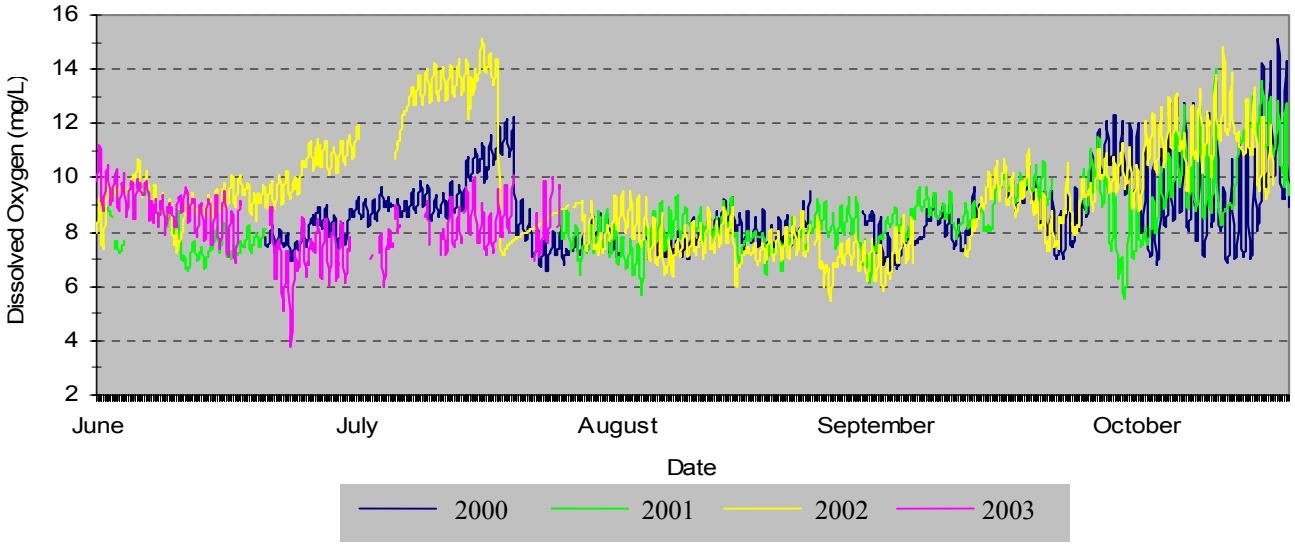


Figure 5b: Average Hourly Dissolved Oxygen Concentrations within Quaas Creek at mile 0.91 from June through October 2000-20003



Source: Washington County Land and Water Conservation Division, UW-Milwaukee, and SEWRPC

HABITAT

Within Quaas Creek, the amount, quality, and diversity of available in-stream fish and macroinvertebrate habitats are generally very good (Figure 6). Quaas Creek also contains a large amount of in-stream cover, characterized by undercut banks, woody debris, and large boulders. The presence and diversity of woody debris within the system is excellent; however, woody debris had been observed to excessively accumulate in some areas causing debris jams (Figure 7). Debris jams can function like a beaver dam and may cause a significant disruption in stream sediment dynamics, leading to localized flooding and bank stability problems. Debris jams, as well as road culverts, may inhibit fish movement to feeding and spawning areas, thereby decreasing reproduction success.

Figure 6: ***Pool-riffle habitat in Quaas Creek***

Figure 7: ***Woody debris jam and streambank erosion***

(Photos courtesy of Thomas Slawski, SEWRPC)

FISHERIES

A fish's habitat must contain all the physical, chemical, and biological features needed for that organism to complete its life cycle. For fish, this includes a variety of parameters such as water temperature regimes, pH, amount and type of cover, substrate type, turbidity, water depth and velocity, inorganic nutrient levels, and accessibility to migration routes. Habitat quality affects the health of individual fish, fish populations, and fish communities. Changes in habitat will usually result in changes to the species composition of a fish community. In Wisconsin, many native species and other intolerant species characterize high-quality warmwater streams. Tolerant fish species are typically present within high-quality warmwater streams, but do not dominate.

A review of the fishery data collected in the Quaas Creek watershed between 1924 and 2001 indicates an apparent loss of thirteen species since the mid-1980s. Most notable were losses of intolerant species such as the brook trout, blackchin shiner, smallmouth bass, and the Iowa darter (Figure 8). This is indicative of a decrease in water quality conditions over the past seventy-five years. Additional species that have not been observed since 1924 include the banded killifish, which is a species of special concern in Wisconsin. When recent survey results are compared to historic conditions, the quality of the fishery in Quaas Creek has made an overall improvement. For example, mottled sculpin (Figure 9), which indicate high quality, coolwater stream systems, are currently abundant throughout Quaas Creek.[11] In addition, aquatic macroinvertebrates within Quaas Creek demonstrate diversity and abundance, indicating good water quality throughout the majority of the watershed.

Figure 8: ***Iowa Darter-Intolerant species***

Figure 9: ***Mottled Sculpin-Coolwater indicator species***

(Photos courtesy of John Lyons, WDNR)

The Quaas Creek watershed maintains a healthy and diverse fishery, which is a manifestation of the relatively good water quality conditions that have historically existed. However, the sportfish component of the creek continues to be limited by water quality conditions. Of the thirty-seven species of fish captured over the period of 1924 to 2001, the following ten species are considered to be of sport fishing value: brook trout, northern pike, grass pickerel, black and brown bullhead, largemouth and smallmouth bass, green sunfish, bluegill, and pumpkinseed. Brook trout, northern pike, largemouth bass, and smallmouth bass have not been recorded in nearly ten, twenty, twenty-five, and seventy-five years, respectively. The apparent loss of these species could be due to a

[11] Lyons, J. and Lizhu Wang. "Development and Validation of an Index of Biotic Integrity for Coldwater Streams in Wisconsin." North American Journal of Fisheries Management. 16: 241-256. 1996.

variety of reasons. For example, the loss of brook trout from this system may be related to elevated water temperatures throughout the watershed. Also, local residents have observed northern pike spawning (Figure 10) in both the East Tributary and South Branch. It is possible that northern pike continue to spawn during the spring in limited areas of the creek, but then migrate back to Milwaukee River before the mid summer and late fall fish populations are surveyed. Since 1983, brown bullhead, bluegill, and green sunfish have been found with limited abundance and continue to be a small component of the existing fishery. Recent occurrences of forage fishes such as the fantail darter, johnny darter, and pumpkinseed (Figure 11) indicate that Quaas Creek has potential for the enhancement of sportfish recreational opportunities.

Figure 10: Northern Pike-Coolwater gamefish

(Photo courtesy of http://www.thecontentwell.com)

Figure 11: Pumpkinseed-Warmwater gamefish

(Photo courtesy of John Lyons, WDNR)

LAND USE

The land use information presented here is derived from inventories and plans developed by the Southeastern Wisconsin Regional Planning Commission. The data available describe the amount, type, and spatial location of land uses under the existing year 2000 and the planned year 2020 conditions. In Figure 12 and Maps 5 and 6, land use data are presented for the entire Quaas Creek drainage area and the major subwatersheds including the East Tributary, South Branch, North Branch, and Main Stem. The land use data shown on Map 5 is based on the year 2000 regional plans and local planning data. In addition, the City of West Bend is currently preparing an updated land use plan that will refine these land use maps in the future. An updated map reflecting growth in the City of West Bend between the years 2000-2003 can be found in Appendix B.

Urban Land Use

As indicated by Figure 12, in 2000, urban land uses, which include residential, commercial, industrial, governmental, transportation, communication, utilities, and recreational lands, encompassed approximately 23% of the total land area in the watershed. Residential land uses comprised the largest urban land use, encompassing more than one square mile, about 14% of the total watershed area. Under year 2020 conditions, about four square miles, nearly 50%, of the watershed area are anticipated to be in urban land uses. Residential development is anticipated to comprise the majority of the increase in urban land use, encompassing about 2.5 square miles, nearly 30% of the total land area in the watershed.

In 2000, urban land uses, when distributed among the East Tributary, South Branch, North Branch, and Main Stem subbasins of the watershed, comprised about 3%, 30%, 19%, and 48% of the total urban land uses, respectively. Residential land uses in 2000 comprised the largest urban land use in the East Tributary, South Branch, and Main Stem subbasins, encompassing about 9%, 14%, and 16% of each, respectively. Between 2000 and 2020, urban land uses in the watershed are anticipated to expand by more than one-half square mile or 170% within the North Branch and by about 1.5 square miles or 150% within the Main Stem.

Map 6A reflects the recommendations of the City of West Bend's Draft 2020 Comprehensive Plan, which was developed to meet the needs and goals of the West Bend community. Map 6A is an enlarged view of the City and

better depicts the City's service area, it also indicates the proposed land uses in the City's Draft 2020 Comprehensive Plan. Map 6A indicates the following recommended goals, which are:

- Preserving the natural resources of the area.
- Preserving as open spaces all wetlands, floodlands, environmental corridors (primary and secondary), and isolated natural resource areas.
- Preserving riparian buffers along all significant streams and rivers.

The proposed 2020 land use depicted on Map 6 was developed through SEWRPC and is not consistent with the City's Draft Comprehensive Plan, it contains some inaccuracies pertaining to previous regional and local approvals. Additionally, Map 6 does not include:

- The boundary agreement between the City and Town of West Bend, dated October 29, 2001; or,
- The City's sanitary sewer service area adopted in 1998.

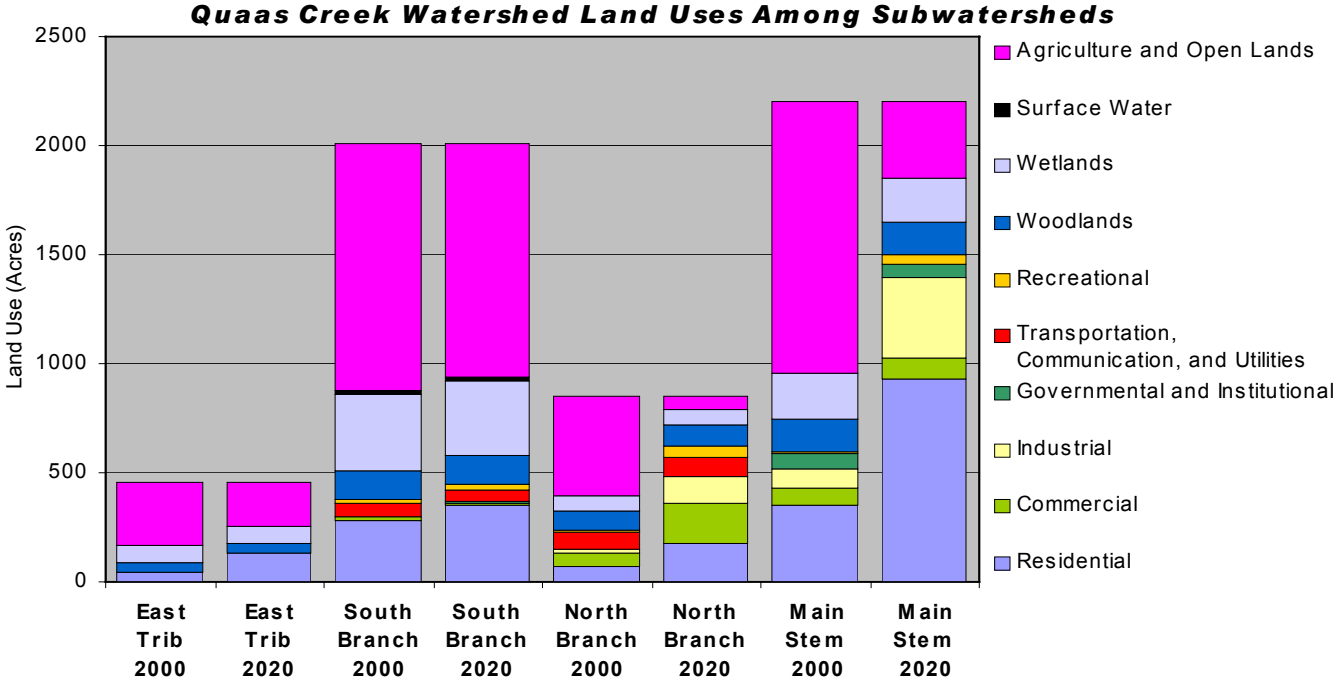
The information and land use as shown on Map 6 was used to calculate the anticipated future pollutant loads in Quaas Creek and to illustrate the potential effect of continued development in the watershed, assuming that <u>no storm water quality or quantity controls were used</u>. The actual anticipated future pollutant load will vary significantly from the values listed in this plan due to the differences between the development patterns shown on Maps 6 and 6A. It should also be noted that storm water management quantity and quality control features have been installed since 1985 throughout the watershed that are capable of removing approximately 80% of the total suspended solids in runoff from developed urban areas.

Rural Land Use

As shown in figure 12, in 2000, rural lands, consisting of woodlands, wetlands, surface water, agricultural croplands and other open lands, comprised about 77% of the total land area in the watershed. Agricultural and other open land uses comprised the largest rural land usage in the watershed, encompassing about 57% of the total land area. Agricultural land use is divided between active cropland and other open lands, which includes farm buildings, pasture, grasslands that have not yet succeeded to a wetland or woodland community, and lands adjacent to cropland, such as treelines and hedgerows. When agricultural land use is dissected even further, of the total 57% of land classified as agricultural land use, only 27% is active cropland, with the remaining 30% comprised of other open lands, mostly unpastured grasslands and treelines. Surface water, wetlands, and woodlands comprised about 20% of the land area in the watershed. Between 2000 and 2020, rural lands in the watershed are anticipated to decrease by approximately 34%, as indicated on Figure 12. The majority of this loss is anticipated to be from the conversion of agricultural cropland and other open lands to urban lands for residential, commercial, and industrial uses. Wetlands, woodlands, and surface water are not anticipated to experience any significant losses due to current zoning ordinances within the watershed. Wetlands and woodlands are primarily located adjacent to Quaas Creek and are largely considered to be Class II wildlife habitat.[12] In addition, the majority of this wildlife habitat is located within the primary and secondary environmental corridors, as well as the isolated natural areas (Map 7).

In 2000, rural land uses, distributed among the East Tributary, South Branch, North Branch, and Main Stem subbasins of the watershed, comprised about 10%, 38%, 14%, and 38% of the total rural land in the watershed, respectively. Agricultural cropland and other open land uses comprised the largest rural land use category in 2000, encompassing about 64% in the East Tributary, 57% in the South Branch, 53% in the North Branch, and 57% in the Main Stem of the total land surface. Wetlands located within the South Branch and Main Stem subbasins account for nearly 80% of the total wetland acreage within the watershed. Woodlands comprised about 7% to 10% of the land surface within each of the four subbasins. Between 2000 and 2020, agricultural and other open lands are anticipated to decrease throughout the watershed by about 31% in the East Tributary, 6% in the South Branch, 88% in the North Branch, and 72% in the Main Stem subbasins.

Figure 12: Comparision of Current 2000 and Predicted 2020 Quaas Creek Watershed Land Uses Among Subwatersheds



Source: Washington County Land and Water Conservation Division and SEWRPC

[12]Washington County. Washington County Land and Water Resource Management Plan: 2000-2005. 2000.

Influence of Land Use on Water Quality

Concerns related to urban development and their detrimental consequences to the water quality of Quaas Creek are primarily related to the increasing density of impervious surfaces (Appendix C). Urban development increases the area of rooftops, roadways, and other "impervious to water" surfaces. When these impervious surfaces increase relative to the total amount of open space, a portion of the precipitation can no longer infiltrate through the pervious soil into the groundwater system. Increasing urbanization has two main impacts on the hydrology of Quaas Creek watershed:

1. Due to the greater area of impervious surface, surface water runoff volumes increase, thereby increasing the proportion of precipitation that runs off the land surface instead of infiltrating into the groundwater. The larger surface runoff volumes, in turn, create higher stream flows that rise, peak, and diminish more rapidly than stream flows that occur under natural, more pervious surface conditions. The larger, more rapid stream flows may increase the water's erosive power causing stream channel erosion and unpredictable flash flooding.

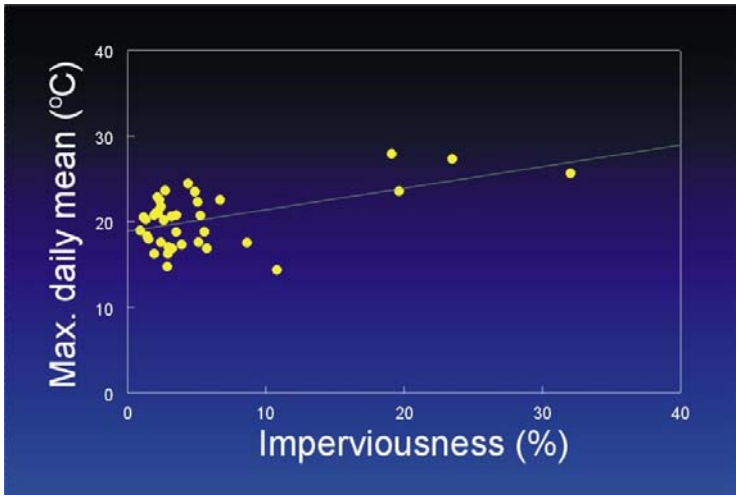
2. Due to the greater area of impervious surface, infiltration is reduced, thereby limiting the volume of groundwater recharge that occurs within the watershed. Localized reductions in infiltration can reduce the amount of groundwater flow into the stream during periods of reduced rainfall. This effectively reduces baseflow water conditions in the stream and negatively affects the temperature regime in the stream. Groundwater flow, which contributes to baseflow conditions, is responsible for keeping the stream's water temperature cool. Any decrease in groundwater flow that corresponds with an increase in surface water runoff will warm the stream's water temperature, potentially impacting the stream's fish and macroinvertabrate diversity.

Of these concerns, the first has a more direct impact on the stability and water quality of the stream; the second has more direct impact on the biology of the stream. Surface runoff is more likely to transfer nonpoint source contaminants into the stream system; nonpoint source contaminants are more likely to be available as a result of increased urban development. Deposition of pollutants from motor vehicle exhausts, residential lawn care practices, and other activities are more readily washed off impervious surfaces (Figure 2).

An additional important concern related to urban development is thermal pollution. Thermal pollution results when storm water flows over heated surfaces, such as roads, rooftops, and parking lots before it enters the stream. The main consequence of thermal pollution is oxygen depletion, because warm water cannot hold as much oxygen as cold water. Rainfall events that occur during the warmer summer months are more stressful on fish and other water dwelling organisms due to sunwarmed impervious surfaces and warmer rainwater. As these oxygen deficit events increase, aquatic organisms living in the stream become more stressed. Any increase in the level of thermal and oxygen stress can lead to decreased growth and reproduction, migration out of the system, or death of the aquatic organisms. When coupled with the chronic affects of reduced infiltration, these events can lead to significantly elevated temperatures. There is a direct relation between a coldwater stream's maximum daily water temperatures and the percent of impervious surfaces (i.e. urban development) in the watershed (Figure 13). Coldwater fish, such as brook trout, survive best in water temperatures less than 20° Celsius: Temperatures a few degrees below the lethal limit of 25°C can still cause significant stress, eventually leading to illness, infection, and death.[13]

[13]Becker, G.S. Fishes of Wisconsin. University of Wisconsin Press, 1983.

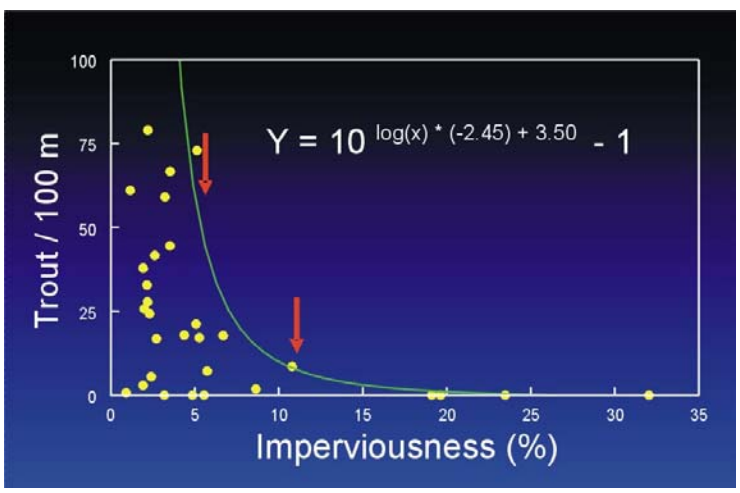
***Figure 13**: Maximum daily water temperatures and percent impervious surfaces among coldwater stream watersheds within Wisconsin.*



Source: Wisconsin Department of Natural Resources

Increases in urban development and impervious surfaces within the Quaas Creek watershed may have lead to the loss of brook trout within this system. Results from work completed by the WDNR indicate watersheds that contain greater than 11% imperviousness can no longer support trout (Figure 14).

***Figure 14**: Trout abundance per 100 meters of linear stream distance and percent impervious surfaces among coldwater stream watersheds within Wisconsin.*



Source: Wisconsin Department of Natural Resources

In the Quaas Creek Watershed, the amount of impervious surface has grown steadily from 5% in 1975 to 16% in the year 2000 (Table 2). Although Quaas Creek currently has a total average of 16% impervious surface, each of the subwatersheds contain different amounts of impervious surface, from 5% in the East Branch to more than 30% in the North Branch. Urban development has proceeded at different rates among each of the subwatersheds and is expected to continue increasing in all of them. The total average of impervious surfaces in the watershed may reach more than 24% by 2020 (Table 2).

Table 2: Estimated Historic, Existing, and Planned Impervious Surface within the Quaas Creek Watershed.

Sub-watershed Area	**Historic 1975**	**Historic 1985**	**Existing 2000**	**Planned 2020**
North Branch	- -	- -	30%	40%
South Branch	- -	- -	9%	13%
East Tributary	- -	- -	5%	14%
Main Stem	- -	- -	19%	29%
Total Average	5%	9%	16%	24%

Source: Wisconsin Department of Natural Resources, Washington County Land & Water Conservation Division, and SEWRPC

Various natural processes and human activities that take place in the drainage area generate pollutant loads that can be delivered to the stream. These loads are transported to the creek through the atmosphere, groundwater, and across the land surface in runoff water. Pollutants transported by the atmosphere are deposited onto the land surfaces and into the stream waters as dry fallout and direct precipitation. Pollutants deposited on land surfaces can be transported across the land surface and enter the creek directly through overland flow and indirectly, as shallow subsurface flow, such as drainage from onsite wastewater treatment systems. Pollutants can also enter the stream through contaminated groundwater.

The absence of identifiable point source pollutant discharges from industries or wastewater treatment facilities suggests that nonpoint source pollutants, generated from human activities within the drainage area, constitute the primary source of pollution to Quaas Creek. The nonpoint source pollutant loads to Quaas Creek were estimated on the basis of year 2000 and planned year 2020 land use inventory data and by using unit area load coefficients that assume no stormwater controls on the land surfaces (Table 3). Total suspended solids, phosphorus, copper, and zinc loads were estimated using a unit area load-based algorithm developed for the Southeastern Wisconsin Region. Annual contaminant loads entering Quaas Creek in year 2000 were calculated to be approximately 787 tons of sediment, 3,149 pounds of phosphorus, 52 pounds of copper, and 374 pounds of zinc. Copper and zinc were used in this analysis as substitutes for metals and other pollutants that are contributed primarily from urban sources. As shown in Table 3, annual planned year 2020 contaminant loads entering Quaas Creek were calculated to be approximately 20% less for sediment and phosphorus loadings and 65% more for copper and zinc loadings. This predicted change in pollutant loadings reflects the anticipated increase in urbanized land (more impervious surfaces delivering copper and zinc) and subsequent decrease in rural land (less cropland eroding sediment and phosphorus) throughout the Quaas Creek watershed.

Table 3: Estimated Annual Pollutant Loadings to Quaas Creek by Subwatershed—2000 and 2020.

Subwatershed	Acres	2000				Planned 2020			
		Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)	Sediment (tons)	Phosphorus (pounds)	Copper (pounds)	Zinc (pounds)
North Branch	785	119.8	461.1	14.3	97.3	111.7	405.8	55.2	375.1
South Branch	2,012	261.1	1,065.4	3.0	23.6	250.7	1,031.8	3.0	23.9
East Tributary	457	65.7	261.9	0.0	0.4	45.1	197.5	0.0	1.1
Main Stem	2,210	340.8	1,361.1	34.4	252.5	245.0	1,017.5	95.5	673.2
Total	5,464	787.4	3,149.5	51.70	373.8	652.5	2,652.6	153.7	1,073.3

Source: SEWRPC

Fortunately, research has shown that good stormwater management practices can help offset some of the effects of imperviousness. Source Loading and Management Model (SLAMM) was developed as a tool to help managers and planners quantify nonpoint source pollutant loadings in urban areas and evaluate remedial measures. This model estimates pollutant loadings to surface waters from land runoff over a series of normal rainfall events. The model also allows for comparison between existing land use and proposed land use scenarios where the implementation of pollution control devices reduces or removes pollutant loadings. The Wisconsin Department of Natural Resources applied SLAMM to the urban areas of the watershed to determine the effect of nonpoint source pollutant loadings in these areas and evaluate the potential for corrective measures (Table 4). This analysis indicates the potential for a reduction in sediment loading through the implementation of urban stormwater management measures as required under the current County, City, and Town ordinances and policies.

Table 4: Potential Control of Total Suspended Solids (TSS) Loadings from the Developed Urban Areas within the Quaas Creek Watershed – 2001.

Subwatershed	Urban Land (acres)	Total Suspended Solids (TSS) - With No Controls (lbs/yr)	Potential Total Suspended Solids (TSS) - With Existing Controls (lbs/yr)	% of Total Loadings	Amount of Control % Control
North Branch	515	963,739	262,870	41	73
South Branch	472	253,756	123,475	19	51
East Tributary	44	25,555	13,245	2	48
Main Stem	1074	1,703,283	238,938	38	86
Total	2105	2,946,333	638,528	100	78

Source: Wisconsin Department of Natural Resources, April 2001 (SLAMM)

Additional stormwater ordinance provisions, such as infiltration basins, street sweeping, dry detention ponds, grass swales, biofiltration, porous pavement, and/or runoff catch basins can control the peak stormwater discharges generated from commonly recurring rainstorms and help to control stream channel erosion and flash flooding. Similar beneficial effects on both flow and water quality are achieved through the use of agricultural best management practices, already widely implemented in the watershed, such as conservation tillage, contour plowing, and through the establishment of riparian buffer strips. Clearly, however, there are further opportunities to mitigate the impacts from existing and projected urban developments, as well as from existing agricultural lands in this watershed. These opportunities form the basis for the recommended actions in Chapter III.

LAND USE REGULATIONS

The comprehensive zoning ordinance represents the most important and significant tool available to local units of government in directing the proper use and development of lands within their areas of jurisdiction. Local zoning regulations include general, or comprehensive, zoning regulations and special-purpose regulations governing floodland and shoreland areas. General zoning regulations may be adopted as a single ordinance or as separate ordinances; they may or may not be contained within a single document. Any analysis of locally proposed land use must take into consideration the provision of both general and special-purpose zoning. In Washington County, general zoning is administered at the municipal level. County zoning oversight is limited to shoreland, wetland, and floodland districts. The ordinances administered by the local units of government in Washington County are summarized in Table 5, and described further in this section.

Table 5: Land Use Regulations among Municipalities within the Quaas Creek Watershed Related to Environmental and Natural Resource Issues.

Community	Type of Ordinance				
	General Zoning	Floodland Zoning	Shoreland and/or Wetland Zoning	Subdivision Control	Erosion Control and Stormwater
City					
West Bend.....	Adopted	Adopted	Adopted	Adopted	Adopted
Towns					
Polk.....	Adopted	County ordinance	County ordinance	County ordinance	Adopted[a]
Trenton.....	Adopted	County ordinance	County ordinance	County ordinance	Adopted[a]
West Bend.....	Adopted	County ordinance	County ordinance	County ordinance	Adopted
Washington County....	--[b]	County ordinance[c]	County ordinance[c]	County ordinance[c]	County ordinance[c]

[a]Intergovernmental agreement between the Town and Washington County. The Town Ordinance is administered through the Washington County Land & Water Conservation Division.
[b]In 1986, Washington County rescinded its general zoning ordinance and all nine towns that were subject to the general county zoning ordinance have since adopted town zoning ordinances.
[c]County ordinance applies to all unincorporated areas, to lands annexed to incorporated areas after the effective date of the ordinance, and provides "overlay" zoning.

Source: Washington County and SEWRPC

General Zoning
Cities in Wisconsin are granted comprehensive, or general, zoning powers under Section 62.23 of the *Wisconsin Statutes.* The same powers are granted to villages under Section 61.35 of the *Wisconsin Statutes.* Counties are granted general zoning powers within their unincorporated areas under Section 59.97 of the *Wisconsin Statutes.* However, a county zoning ordinance becomes effective only in those towns that ratify the county ordinance. Towns that have not adopted a county zoning ordinance may adopt village powers and subsequently utilize the city and village zoning authority conferred in Section 62.23 of the *Wisconsin Statutes*. Town powers, however, are subject to county board approval where a general-purpose county zoning ordinance exists. Alternatively, towns may adopt a zoning ordinance under Section 60.61 of the *Wisconsin Statutes* where a general-purpose county zoning ordinance has not been adopted, but only after the county board fails to adopt a county ordinance at the petition of the governing body of the concerned town. In Washington County, general zoning is in effect in the unincorporated areas of the County, which includes all of the Towns in the Quaas Creek drainage area. County zoning authority in these towns is limited to shoreland-wetland overlay zoning, floodland overlay zoning, and subdivision review. Comprehensive zoning exists in the City of West Bend within the County, including areas within the Quaas Creek drainage area.

Floodland Zoning
Section 87.30 of the *Wisconsin Statutes* requires that cities, villages, and counties, with respect to their unincorporated areas, adopt floodland zoning to preserve the floodwater conveyance and storage capacity of the floodplain areas and to prevent the location of new flood damage-prone development in flood hazard areas. The minimum standards that such ordinances must meet are set forth in Chapter NR 116 of the *Wisconsin Administrative Code.* The required regulations govern filling and development within a regulatory floodplain, which is defined as the area subject to inundation by the 100-year recurrence interval flood event, the event which has a one percent chance of occurring in any given year. Under Chapter NR 116, local floodland zoning regulations must prohibit nearly all forms of development within the floodway, which is that portion of the floodplain required to convey the 100-year recurrence peak flood flow. Local regulations must also restrict filling and development within the flood fringe, which is that portion of the floodplain located outside of the floodway that would be covered by floodwater during the 100-year recurrence flood. Permitting the filling and development of the flood fringe area, however, reduces the floodwater storage capacity of the natural floodplain, and may thereby increase downstream flood flows and stages. The County Shoreland and Floodplain Zoning Ordinance applies in all of the unincorporated areas of the Towns in Washington County, which includes all of the Towns in the Quaas Creek drainage area. The City of West Bend also has an adopted floodland zoning ordinance, however, the County ordinance also applies to lands annexed to incorporated areas of the City after the effective date of the ordinance and provides "overlay" zoning.

Shoreland and Shoreland-Wetland Zoning
Under Section 59.692 of the *Wisconsin Statutes*, counties in Wisconsin are required to adopt zoning regulations within statutorily defined shoreland areas, or, those lands that are within 1,000 feet of a navigable lake, pond, or flowage, or 300 feet of a navigable stream, or, to the landward side of the floodplain, whichever distance is greater, within their unincorporated areas. Minimum standards for county shoreland zoning ordinances are set forth in Chapter NR 115 of the *Wisconsin Administrative Code.* Chapter NR 115 sets forth minimum requirements regarding lot sizes and building setbacks; restrictions on cutting of trees and shrubbery; and restrictions on filling, grading, lagooning, dredging, ditching, and excavating and must be incorporated into county shoreland zoning regulations. In addition, Chapter NR 115 requires that counties place all wetlands five acres or larger and within the statutory shoreland zoning jurisdiction area into a wetland conservancy zoning district to ensure their preservation after completion of appropriate wetland inventories by the Wisconsin Department of Natural Resources. Aside from wetlands within the shoreland zone, wetlands five acres and larger are also placed into conservancy zoning outside of the shoreland zone in the unincorporated areas of the County.

In 1982, the State Legislature extended shoreland-wetland zoning requirements to cities and villages in Wisconsin. Under Sections 62.231 and 61.351, respectively, of the *Wisconsin Statutes,* cities and villages in Wisconsin are required to place wetlands five acres or larger and located in statutory shorelands into a shoreland-wetland conservancy zoning district to ensure their preservation. Minimum standards for city and village shoreland-wetland zoning ordinances are set forth in Chapter NR 117 of the *Wisconsin Administrative Code*.

It should be noted that the basis for identification of wetlands to be protected under Chapters NR 115 and NR 117 of the *Wisconsin Administrative Code* is the Wisconsin Wetlands Inventory. Mandated by the State Legislature in 1978, the Wisconsin Wetlands Inventory resulted in the preparation of wetland maps covering each U.S. Public Land Survey Township in the State. The inventory was completed for counties in Southeastern Wisconsin in 1982, the wetlands being delineated by the Regional Planning Commission on its 1980, one inch equals 2,000 feet scale, ratioed and rectified aerial photographs.

County shoreland-wetland zoning ordinances are in effect in all unincorporated areas of Washington County, which includes all of the Towns in the Quaas Creek drainage area. Section 23.07 (1) of the County shoreland, wetland, and floodplain ordinance requires the Planning, Conservation, and Parks Committee to review land divisions of a parcel that is divided into three or more parcels of five acres each or less in a five-year period. The incorporated City of West Bend has adopted their own shoreland-wetland zoning ordinance pursuant to Sections 61.351 and 62.231, respectively, of the *Wisconsin Statutes*. The Wisconsin Department of Natural Resources has approved the County shoreland ordinance and other local shoreland-wetland ordinances.

Subdivision Regulations

Chapter 236 of the *Wisconsin Statutes* requires the preparation of a subdivision plat whenever five or more lots of 1.5 acres or less in area are created either at one time or by successive divisions within a period of five years. The *Statutes* set forth requirements for surveying lots and streets, for plat review and approval by State and local agencies, and for recording approved plats. Section 236.45 of the *Wisconsin Statutes* allows any city, village, town, or county that has established a planning agency to adopt a land division ordinance, provided the local ordinance is at least as restrictive as the State platting requirements. Local land division ordinances may include the review of other land divisions not defined as "subdivisions" under Chapter 236, such as when fewer than five lots are created or when lots larger than 1.5 acres are created. County ordinance 24.02 (3)(i) requires the review of land divisions and preparation of a subdivision plat whenever an existing parcel is divided into five or more parcels of five acres each or less either at one time or by successive divisions with in a period of five years.

The subdivision regulatory powers of the Towns and the County are confined to unincorporated areas. City and Village subdivision control ordinances may be applied to extraterritorial areas, as well as to the incorporated areas.[14] It is possible for both the County and a town to have concurrent jurisdiction over land divisions in unincorporated areas or for a city or village to have concurrent jurisdiction with a town or the County in the city or village extraterritorial plat approval area. In the case of overlapping jurisdiction, the most restrictive requirements apply. The City of West Bend has adopted its own subdivision control ordinance.

Erosion Control and Stormwater

Section 62.23 of the *Wisconsin Statutes* grants authority to the Cities and Villages in Wisconsin to adopt ordinances for the prevention of erosion from construction sites and the management of stormwater runoff from lands within their jurisdiction. Towns may adopt Village powers and subsequently utilize the authority conferred on the Villages under Section 62.23 to adopt their own erosion control and stormwater management ordinances, subject, however, to county board approval where a county ordinance exists. During 1997, Washington County prepared a model stormwater and construction erosion control ordinance for adoption by the Towns. A construction site erosion control and stormwater management ordinance is in effect for all of the unincorporated areas of the Quaas Creek watershed, and has been adopted and is in effect for West Bend, the only incorporated municipality within the Quaas Creek drainage area. The County maintains oversight of land development activities, including stormwater management and construction site erosion control, in all unincorporated areas of the County where a similar ordinance has not been adopted and within areas annexed to incorporated municipalities as set forth in Section 59.693(10) of the *Wisconsin Statutes*.

[14]Under Section 236.02 of the Wisconsin Statutes, the extraterritorial plat approval jurisdiction is the area within three miles of the corporate limits of a first, second, or third class city and within one and a half miles of a fourth class city or village.

Runoff Management

Performance standards governing urban (newly developed areas, post-construction development, and redevelopment including nonmunicipal property fertilization) and agricultural nonpoint source pollution abatement practices (cropland soil erosion control, manure storage and management, and nutrient management) have been developed by the Wisconsin Department of Agriculture, Trade and Consumer Protection and the Wisconsin Department of Natural Resources. They are set forth in Chapters ATCP 50, NR 151 through NR 155, NR 216, and NR 243 of the *Wisconsin Administrative Code*. For a description of the current protections relevant to infiltration standards for residential and nonresidential developments, stormwater quality and quantity and priority pollutant control, see Appendix D in this document.

WATER USE OBJECTIVES AND WATER QUALITY STANDARDS

The water use objectives for the surface waters of Washington County are set forth in Chapters NR 102 and NR 104 of the *Wisconsin Administrative Code*. Under that code, Quaas Creek is classified as meeting the standards for warmwater sport fish and is fully compliant with the fishable and swimmable goals set for the waters of the United States by the Federal Clean Water Act. The level of pollutant control needed to achieve the established water use objectives was initially identified in the regional water quality management plan[15] and was refined under the City of West Bend stormwater management plan[16] and the Wisconsin Department of Natural Resources nonpoint source priority watershed plan.[17] These plans contained consistent recommendations for the nonpoint source controls needed to achieve water use objectives for Quaas Creek.

SURFACE WATER CLASSIFICATION OF QUAAS CREEK

During 2000, Washington County undertook a revision of Chapter 23 of the Washington County Code, which incorporated waterbody classification into the Code as provided in Section 281.69(5), *Wisconsin Statutes*. The technical basis for this surface water classification system was set forth in a surface water resource report.[18] This system classified the stream resources of the County based upon their physical and biological characteristics. Stream systems classified in accordance with this system are subject to specific performance standards set forth in Chapter 23 of the Washington County Code, including setback requirements, minimum lot size requirements, and density limitations. In accordance with these provisions, Quaas Creek was classified as a Class II stream and is subject to the performance standards outlined on the following page.

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[15]Southeastern Wisconsin Regional Planning Commission. A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report. Memorandum Report No. 93, March 1995.

[16]Southeastern Wisconsin Regional Planning Commission. A Stormwater Management Plan for the City of West Bend, Washington County, Wisconsin- Alternatives and Recommended Plan for the Quaas Creek Subwatershed. Community Assistance Planning Report No. 173 Vol. 4, July 1996.

[17]Wisconsin Department of Natural Resources. A Non-point Source Control Plan for East and West Branches of the Milwaukee River Priority Watershed Project. PUBL-WR-255-90, March 1992.

[18]Southeastern Wisconsin Regional Planning Commission. Surface Water Resources of Washington County, Wisconsin, Lake and Stream Classification Project: 2000. Memorandum Report No.139, September 2001.

Lots within the shoreland zone adjacent to Quaas Creek and within areas served by public sanitary sewerage systems must meet the following standards, among others:

- Minimum lot size of 20,000 square feet;
- Minimum lot width of 85 feet;
- Minimum setback from the ordinary high water mark of 100 feet or 75 feet with mitigation;
- Minimum average setback of principal structures from the ordinary high water mark is 75 feet, or 50 feet with mitigation in those areas where setback averaging is permitted;
- Principal structures are not to exceed 30% of the lot; and
- Total of all impervious surfaces should not exceed 40% of the lot.

Lots within the shoreland zone adjacent to Quaas Creek and within areas served by onsite sewage disposal systems must meet the following standards, among others:

- Minimum lot size of 30,000 square feet;
- Minimum lot width of 125 feet;
- Minimum setback from the ordinary high water mark of 100 feet or 75 feet with mitigation;
- Minimum average setback of principal structures from the ordinary high water mark is 75 feet, or 50 feet with mitigation in those areas where setback averaging is permitted;
- Principal structures are not to exceed 30% of the lot; and
- Impervious surface should not exceed 40% of the lot.

Lots included within areas affected by joint boundaries or intergovernmental agreements must have a minimum lot size of 15,000 square feet and minimum average lot width of 90 feet. Other requirements may also apply and shoreland development in the Quaas Creek watershed remains subject to all applicable Federal, State, County, and local government permitting requirements.

Map 5: Quaas Creek Watershed Existing Land Use

Map 6: Quaas Creek Watershed Planned Land Use

Map 6A: Quaas Creek Watershed Proposed Land Use in the City of West Bend Planning Area: 2020

Map 7: Quaas Creek Watershed Environmental Corridors

Map 8: Lands Currently Protected Under Regulations and Lands Recommended for Protection

CHAPTER III – ISSUES, OBJECTIVES AND RECOMMENDATIONS

INTRODUCTION

Many issues impact the water quality and recreational use of Quaas Creek. Identified in Chapter II, these issues focus on future land development, especially the changing of rural land use to urban land use, and the detrimental effects these land use changes may have on the hydrology, water quality, habitat quality, bank stability, and fisheries within Quaas Creek.

In this chapter, management measures, developed by the Quaas Creek Watershed Protection Committee, have been recommended to address five major issues of concern. These issues include the following:

1. Land Conservation and Management
2. Runoff Management and Pollution Reduction
3. Stream Protection and Enhancement
4. Watershed Education and Outreach
5. Monitoring and Evaluation

Recommended management objectives and actions are described briefly below and also found in Appendix D and on Map 8. The recommendations focus on those measures that are applicable to all landowners and also to the public agencies exhibiting jurisdiction within the watershed. Local units of government are encouraged to adopt these recommendations and implement this protection plan through the use of existing policies, practices, and programs.

LAND CONSERVATION AND MANAGEMENT

The adopted regional, Town of Trenton, and Town and City of West Bend land use plans contain the recommended future land use condition for the Quaas Creek Watershed.[19] These plans recommend that primary environmental corridor lands be preserved in natural, open space land use. The SEWRPC delineated environmental corridors contain most of the ecologically valuable lands located in the vicinity of Quaas Creek. Protection measures include the placement of these lands into appropriate zoning districts, depending upon the type and character of the natural resource features to be preserved and protected. All lakes, wetlands, and woodlands are recommended for placement into conservancy protection districts. The existing zoning and recommended future land use plans adopted by the County, Towns, and City are consistent with these recommendations.

[19] Southeastern Wisconsin Regional Planning Commission. A Regional Land Use Plan for Southeastern Wisconsin: 2020. Planning Report No. 45, December 1997.
Southeastern Wisconsin Regional Planning Commission. A Land Use Plan for the Town of Trenton: 2010. Community Assistance Planning Report No. 238, December 1997.
Town of West Bend. A Land Use Plan for the Town of West Bend. July 1998.
Southeastern Wisconsin Regional Planning Commission. A Land Use Plan for the City of West Bend: 2010. Community Assistance Planning Report No. 167, July 1992.

A key protection element given to the land and water resources is contained within existing county and other local ordinances. Enforcement of these ordinances, summarized in Table 5 in Chapter II, will help address the land conservation related concerns found throughout the watershed. Specifically, enforcement of the construction site erosion control, stormwater management, development control, and onsite sewage disposal system inspection and maintenance ordinances is explicitly recommended in this watershed protection plan.

The recommended land use plans for the Town of Trenton, and for the Town and City of West Bend, suggest a future increase in low-density urban residential development throughout the Quaas Creek watershed. These land use changes have the potential to impact the quantity and quality of groundwater inflows to the creek. This watershed protection plan recommends that additional lands, beyond what current regulations protect, be protected from future development (Map 8). Quaas Creek is at risk due to an increasing density of impervious surfaces associated with urban development activities. Land use activities associated with urban development generate nonpoint source pollution loadings that potentially threaten the water quality within the watershed. Likewise, modification of impervious surfaces to allow for groundwater recharge and inflow into the Quaas Creek system is an important factor that will contribute to the maintenance of good water quality in the future. In order to moderate or mitigate these likely impacts from impervious surfaces and their associated impacts on groundwater, land conservation oriented actions are warranted. Three potential actions are recommended- maintenance of riparian corridors, protection of groundwater recharge and discharge areas, and preservation of natural areas within the watershed. Each action is briefly described below.

Maintenance of Riparian Corridors

Objective:
Preserve the existing natural vegetative cover in and along perennial, intermittent and ephemeral waterbodies within the Quaas Creek Watershed.

Recommended Actions:

- Observe guidelines set forth in the regional and local land use plans, as well as in the Washington County Land and Water Resource Management Plan that protect environmentally sensitive lands as identified by SEWRPC in the regional natural areas and critical species habitat protection and management plan.[20]

- Preserve and/or restore natural vegetation and topography on targeted lands along perennial, intermittent, and ephemeral waterways by seeking voluntary, perpetual conservation easements. Targeted lands are recommended to be designated as open space areas. Lands recommended to be included within such easements:
  - Lie within 100 feet of each stream bank or within the floodplain, whichever is greater;
  - Exhibit high groundwater and/or hydric soils;
  - Are within the Environmental Corridors or Isolated Natural Resource Areas designated by SEWRPC.

- Expand the riparian corridor to a total width of 300 feet, where needed, to form a connection between primary and secondary environmental corridors and otherwise fragmented natural areas.

- Maintain or establish natural vegetation, preferably using native species, within the 100 and 300-foot riparian corridors along the stream courses.

- Update and implement local zoning standards to ensure the preservation of these targeted lands.

[20] Southeastern Wisconsin Regional Planning Commission. A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin. Planning Report No. 42, September 1997.

Protection of Groundwater Recharge and Discharge Areas

Objective:
Preserve the existence and hydrological function of wetlands and other high groundwater areas in the Quaas Creek Watershed.

Recommended Actions:

- ❖ Observe guidelines set forth in the regional and local land use plans, as well as the Washington County Land and Water Resource Management Plan that encourage the clustering of any new development within the drainage area to minimize nonpoint pollution impacts on water quality and the potential loss of groundwater recharge and discharge.

- ❖ Prevent filling, draining or any other alteration of the following:
  - All wetlands as defined by the WDNR and SEWRPC, regardless of owner, size, and location.
  - Areas where water is at, near, or above the land surface long enough to be capable of supporting aquatic vegetation and/or hydric soils indicative of wet conditions.

- ❖ Protect and preserve the quality of water discharging into the high groundwater areas identified above by incorporating runoff management recommendations that pre-treat water before it enters these areas.

- ❖ Maintain groundwater recharge as close to existing rates as possible by incorporating runoff management recommendations for low-impact design standards that promote infiltration.

Preservation of Natural Areas

Objective:
Preserve the existing natural vegetation of remaining valuable natural areas in the Quaas Creek Watershed and enhance their ecological function by reconnecting these areas to the larger riparian corridor.

Recommended Actions:

- ❖ Observe guidelines set forth in the regional and local land use plans, as well as the Washington County Land and Water Resource Management Plan that protect environmentally sensitive lands as identified by SEWRPC in the regional natural areas and critical species habitat protection and management plan.

- ❖ Prevent development within these environmental corridors and isolated natural areas as recommended by SEWRPC.

- ❖ Promote defragmentation of wildlife habitat by reconnecting environmental corridors and isolated natural areas with other larger corridors and natural areas where and when possible as recommended in the regional natural areas and critical species habitat protection and management plan.[21]

RUNOFF MANAGEMENT AND POLLUTION REDUCTION

The adopted regional and local land use and water quality management plans recommend management measures directed at controlling urban and rural nonpoint pollution sources within the watershed.[22] Further management

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[21] Southeastern Wisconsin Regional Planning Commission. A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin. Planning Report No. 42, September 1997.

[22] Southeastern Wisconsin Regional Planning Commission. Sanitary Sewer Service Area for the City of West Bend and Environs. Community Assistance Planning Report No. 35 2nd Ed., June 1998. This report indicates that in the future the majority of the watershed's waste disposal needs will be served by public sanitary sewerage systems. Hence, nonpoint source phosphorus and nitrogen from existing onsite sewage disposal systems may be expected to be controlled under planned year 2020 land use conditions. Only a portion of the South Branch of Quaas Creek is indicated to be outside of the planned sewer service area at this time.

plans, such as the priority watershed plan for the Milwaukee River and the stormwater management plan for the City of West Bend, refined and elaborated these measures. Sediment and total phosphorus load reduction goals, established during this planning process, indicated a 50% reduction in sediment loading and a 25% reduction on phosphorus loading is possible. Heavy metal loadings, recommended by the water quality plans to be maintained at then-current levels, should show no further increases in their amount. Through the use of currently available techniques and technologies, it was determined that sediment loads could be reduced by about 25%, phosphorus loads by about 15%, and heavy metals by about 35%. Two potential actions are recommended- runoff management and pollution reduction. Each action is described briefly below.

Runoff Management

Objective:
Limit the negative water quality and quantity impacts of impervious surfaces associated with urban runoff.

Recommended Actions:

- Maximize post-development groundwater recharge by improving infiltration and implementing the Wisconsin infiltration standards as set forth in NR 151, *Wisconsin Administrative Code*.

- Minimize stormwater pollutant loading, runoff temperature increases, and changes in downstream hydrology that would otherwise result from impervious surfaces created by development and control the quantity and quality of stormwater entering the stream.

- Prevent untreated discharges of runoff water from areas where high concentrations of pollutants such as heavy metals, PAH's, petroleum products, and chlorides are likely to accumulate.

- Encourage developers and landowners to implement practices that exceed the minimum standards identified NR 151, *Wisconsin Administrative Code*.

- Minimize the potential negative consequences of conventional detention ponds, by promoting infiltration basins that minimize the release of warm water into the stream and by utilizing innovative technologies such as porous paving and rain gardens to maximize infiltration and limit the impacts of smaller storm events such as the one-year, two-year, and ten-year recurrence interval storms.

Pollution Reduction

Objective:
Reduce the nonpoint pollutant loading and thermal increases from existing urban and rural runoff within the watershed.

Recommended Actions:
Watershed

- Retrofit existing detention basins, as necessary, to meet the objectives in this plan.

- Install new stormwater basins, where appropriate, to treat runoff from currently untreated developments.

Urban Areas

- Retrofit existing wet and dry detention basins, as necessary, with subsurface outlet structures to promote infiltration and provide water quality benefits.

- Convert existing wet detention basins, where practical, to dry detention facilities with adequate forebay and subsurface discharge systems or infiltration basins, both limit thermal pollution and enhance pollutant filtering.

- Install new stormwater treatment facilities at locations where runoff is currently untreated, or where additional treatment is necessary.

- Work cooperatively with area fueling and automotive service stations to decrease potentially contaminated runoff.

Rural Areas

- Develop state-certified nutrient management plans for cropland within the watershed.

- Develop or update existing conservation plans to resource management plans that plan the farm as a whole resource and focus not only on the cropland, but also the wildlife, forest, and other open land.

- Maintain existing best management practices and install, where needed, new practices, such as grassed waterways, barnyard runoff filter strips, clean water diversions, and other site-specific practices.

- Implement Agricultural Performance Standards found in NR 151, *Wisconsin Administrative Code.*

STREAM PROTECTION AND ENHANCEMENT

Quaas Creek has many important natural resources that are necessary for the continued and sustained function of the stream and watershed ecology. Most of the key resources are biological in nature and include wetlands, woodlands, grasslands, wildlife, fisheries, and native species. Stream protection and enhancement is necessary in order to maintain the function of these resources, for all of these resources serve the purpose of sustaining the ecology of the stream and therefore the watershed.

The maintenance and rehabilitation of the warmwater sport fishery, a key natural resource in this watershed, is an important component of this watershed plan. Based upon an analysis and review of historic and recent fisheries reconnaissance, Quaas Creek is in relatively good condition and is capable of supporting a warmwater sportfish community.[23] However, there are a number of concerning issues that should be addressed to ensure the continued maintenance and future production of this high-quality fishery resource. These issues affect the quality of the fisheries resource in Quaas Creek and are related to the predicted changes in land use, namely an increase in urban development and its associated effects on stream hydrology, water quality, aquatic habitat quality, and streambank stability. This section sets forth the recommended fisheries management plan, which was developed to complement and to be consistent with the other plan recommendations regarding land conservation, pollution control, runoff management, and environmental monitoring. Specifically, these recommendations follow actions recommended by WDNR for habitat improvement of warmwater stream systems.[24] These include the following: 1) enhancement of streambank stability, 2) limitation of instream sediment deposition, 3) implementation of techniques to moderate the effects of channelization, and 4) restoration of instream and riparian habitat.[25] Inherent in these actions is the improvement of water quality, including water clarity and temperature regime, and the improvement of the quality/quantity of food resources and habitat for fish and other aquatic species.

Other key natural resource features located throughout the watershed will need to be maintained and/or enhanced if Quaas Creek is to sustain a viable fishery. In order to sustain the ecology of the watershed, action should not solely focus on the fishery. Action should also focus on the restoration and management of declining habitats

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[23]Southeastern Wisconsin Regional Planning Commission. Stream Channel Stability and Biological Assessment of Quaas Creek: 2002. Memorandum Report No. 151, July 2002.

[24]Wisconsin Department of Natural Resources. A Review of Fisheries Habitat Improvement Projects in Warmwater Streams, with Recommendations for Wisconsin. Technical Bulletin No. 169, 1990.

[25]Ibid.

found not only within the stream, but also within the watershed as a whole. A plan that focuses only on the stream would undermine the interconnection between the watershed's ecosystems. The watershed ecosystem is a continuum including the stream, the wildlife, all the other natural resources, and most importantly, the local citizens who reside there. This section also sets forth the recommended management plan for wetlands, woodlands, grasslands, wildlife, and nonnative species. Where appropriate, wetlands, woodlands, and grasslands should be restored to historic pre-settlement conditions and revegetated with species native to this local region of Wisconsin.

Objective:
Improve the function and purpose of key natural resource features.

Recommended Actions:

- Remove and/or modify woody debris jams causing streambank instability, reducing habitat quality, and potentially impeding fish migration and spawning.

- Stabilize actively-eroding streambanks as identified and prioritized in the SEWRPC Stream Channel Stability and Biological Assessment of Quaas Creek: 2002 Memorandum Report No. 151 through regrading and/or revegetating with native species.

- Increase streambed scour, without exacerbating streambank erosion, and expose the coarse substrate preferred by spawning fish and other aquatic organisms through the use of natural objects, such as boulders and trees cabled to the bank, or other simple structures, such as rock wind deflectors.

- Restore natural flow regime within highly channelized portions of the watershed through stream channel modification or relocation, if appropriate and feasible.

- Preserve, enhance, and/or restore riffle, run, and pool habitats using appropriate bank and instream treatments as identified in the SEWRPC Stream Channel Stability and Biological Assessment of Quaas Creek: 2002 Memorandum Report No. 151.

- Modify and/or remove and replace culvert and bridge installations with the potential for causing hydrological and/or physical obstructions to fish passage.

- Use treatment techniques to stabilize streambanks, reduce sedimentation, and/or modify stream morphology that also increase aquatic habitat and instream cover according to the County, WDNR, and USDA-NRCS Standards.

- Restore undeveloped wetlands that have been converted for agricultural uses in locations where landowner agreements and funding sources are in place according to the County, WDNR, and USDA-NRCS Standards.

- Manage open lands as wildlife habitat according to the County, WDNR, and USDA-NRCS Standards.

- Promote the reforestation of open lands and restore degraded woodlands throughout the watershed according to the County, WDNR, and USDA-NRCS Standards.

- Promote the restoration and management of declining habitats, such as native prairies and oak savannas, according to the County, WDNR, and USDA-NRCS Standards.

- Eradicate and control, to the extent possible, the spread of purple loosestrife, buckthorn, and other nonnative invasive species as determined by WDNR according to the County, WDNR, and USDA-NRCS Standards.

WATERSHED EDUCATION AND OUTREACH

Residents and visitors in the vicinity of Quaas Creek should be educated on the ecological value of Quaas Creek and how their daily behaviors and choices play an important role in determining the health and function of the watershed's ecosystems and, therefore, the community's well-being. Specifically, informational programming should focus on topics such as, but not limited to the following: the need to restore and/or manage declining habitats, such as woodlands, grasslands, and wetlands; the need to protect stream water quality and quantity, through the control of polluted runoff and the use of riparian buffers and environmental corridors; and the need to reduce polluted nonpoint runoff, through implementing good urban housekeeping and yard care practices.

Educational brochures discussing these topics are available from the University of Wisconsin-Extension, the Wisconsin Department of Natural Resources, the Washington County Offices, and many Federal government agencies, such as the Natural Resource Conservation Service and U.S. Fish and Wildlife Service. This information can be provided to homeowners through direct contact distribution, targeted library/civic center displays, and through the use of local media, such as local newspapers and public access cable TV. Many of the ideas contained in these publications can be integrated into ongoing, larger-scale activities, such as anti-littering campaigns, recycling drives, river clean-ups, environment awareness days, and similar community activities.

Public participation is essential in the decision-making processes for public concerns help create the focus of the educational program. Such opportunities for shared decision-making include the creation of citizen advisory committees, completion of memoranda of understanding with lake and river organizations within the Milwaukee River basin, and participation in programs, such as Adopt-A-Waterway, Project WET, Project WILD, Project Learning Tree programs, and other related school-based programming. A sound and vocal base of public support and understanding of the proposed watershed projects will benefit the implementation of the Quaas Creek Watershed Protection Plan.

Establishment of an organization that can promote and coordinate local support for river protection is necessary for implementing the plan's recommendations in a timely and feasible manner. This organization could provide a focal point for private residents and an umbrella under which businesses and other non-profit organizations may participate in a meaningful manner with the watershed projects. The establishment of a private, non-profit watershed protection organization or "Quaas Creek Stewardship Initiative" could provide such a focus for the Quaas Creek community. This organization could play a lead role in coordinating citizen and community support for and participation with the implementation of this watershed protection plan. A watershed protection fund that would help finance activities and projects within the watershed could also be established and managed by this organization.

Objective:
Increase the awareness and promote environmentally responsible practices and behaviors of residential, business, and institutional communities in the Quaas Creek Watershed.

Recommended Actions:

- Create and support a citizen advocacy group that will promote wise resource management and help implement watershed protection activities.

- Develop and distribute educational materials, displays, events:
  - Provide local residents, businesses, developers, and government officials with a basic understanding about the geography, natural resources, and environmental issues within the Quaas Creek Watershed;
  - Educate these same groups about the types of practical actions and behaviors that contribute to the health or destruction of the watershed;
  - Provide opportunities and incentives to make those behavioral changes and actions that protect and preserve the watershed, its river, and its other natural resources.

- Encourage citizen participation in:
  - Storm drain stenciling,

- Litter and pet waste clean ups, and "Clean Sweep" and "River Clean-Up" programs,
- Water quality monitoring,
- Gardening and natural landscaping programs,
- Sound urban housekeeping and yard care practices,
- Use of no or low phosphorus fertilizer,
- The "Quaas Creek Stewardship Initiative."

❖ Encourage business owner participation in:
- Use of grocery bags, posters, and place mats printed with an awareness message,
- Placement of revolving displays,
- Employee education on waste minimization and recycling,
- Activities noted in the Neighborhood Steward Program,
- Natural landscaping and stormwater management in parking areas and green spaces,
- Use of no or low phosphorus fertilizer,
- The "Quaas Creek Stewardship Initiative."

❖ Encourage participation of builders and developers in:
- Workshops on special and alternative design considerations necessary for stream preservation,
- Erosion control and construction site stormwater management practices,
- Environmentally-friendly landscaping,
- Use of no or low phosphorus fertilizer,
- Conservation and/or cluster development,
- Education of people in the process of building new homes to make positive environmental choices,
- Green space preservation,
- The "Quaas Creek Stewardship Initiative."

❖ Encourage participation of local government in:
- Educational programming through workshops, informational packets, etc.,
- Developing stewardship activities for watershed residents,
- Waste minimization and solid and hazardous waste management,
- Stormwater management and prevention of water pollution,
- Street sweeping and leaf pick up programs,
- Use of no or low phosphorus fertilizer,
- Proper use of salt and deicers,
- Proper snow removal and disposal,
- Storm sewer and catch basin maintenance,
- The "Quaas Creek Stewardship Initiative."

MONITORING AND EVALUATION

Environmental monitoring and data evaluation should continue to allow for the participation of all watershed residents in tracking the progress of plan implementation. Citizen participation in monitoring and evaluation provides them an opportunity to gauge the success of their efforts in preserving and protecting Quaas Creek. Consequently, an essential element of this protection plan is the development and implementation of an appropriate, ongoing environmental monitoring and data evaluation program that assess progress in the protection and enhancement of the Quaas Creek watershed. This strategy should include the active participation of all citizens within the watershed, whether they are young or old, business owners or homeowners, live near or far from the creek. These monitoring efforts should include not only water quality assessments, but also fish community surveys, aquatic habitat surveys, wildlife surveys, land use monitoring, and most importantly, the evaluation of urban development projects in meeting community goals. Citizen participation in monitoring programs should be encouraged both through classroom-related activities, such as Champions of the Environment, and other volunteer monitoring initiatives, including the Washington County Adopt-A-Waterway

Program. Data evaluation should be performed on an annual basis by the Washington County Land and Water Division and the WDNR or by others who have the knowledge and background to do so. The evaluation results should be made public at least once every three to five years and should be presented in a manner that all who reside in the watershed can understand the results, irregardless of educational background and level of expertise.

Objective:
Gain a better understanding of the existing and potential physical, chemical, and biological conditions and uses of Quaas Creek, from which existing watershed management activities can be evaluated and future recommendations and activities can be developed and refined.

Recommended Actions:

- Convene and support a multi-agency work group responsible for the following:
  - Implementing the actions identified in the Quaas Creek Watershed Protection Plan,
  - Developing and implementing an environmental monitoring and data evaluation program,
  - Refining these plans, as necessary and appropriate, based upon the outcomes of the foregoing actions.

- Implement a comprehensive environmental monitoring and data evaluation program that:
  - Establishes long term biological, chemical, and physical monitoring goals and objectives,
  - Gathers accurate data for short and long term study of stream health and sustainability,
  - Coordinates sampling efforts between participating organizations,
  - Communicates monitoring results to the community,
  - Determines effectiveness of management measures on a three to five-year review basis.

- Compare the effectiveness and adequacy of existing and proposed watershed management techniques with the agreed upon watershed protection plan's objectives and recommendations.

- Recommend, where appropriate, the modification of existing management measures, as well as the development of new or alternative management measures based upon the monitoring and evaluation program findings.

CHAPTER IV – PLAN IMPLEMENTATION

INTRODUCTION

Quaas Creek is a valuable natural resource in the Southeastern Wisconsin Region. Future increases in population, expendable income, leisure time, and individual mobility are expected to result in additional development pressures within the watershed. Adoption and administration of this watershed protection plan and the recommendations established herein would provide the protection necessary to maintain future water quality conditions that are suitable for the preservation of the function and natural beauty of Quaas Creek.

The recommendations proposed in this watershed protection plan represent an extension of ongoing actions currently being implemented by local public agencies. These recommendations introduce few new initiatives and with respect to the newly proposed recommendations, the water quality, aquatic habitat, and fisheries management programs introduce continuing field surveys that will permit more efficient management of these resources. Public awareness campaigns, such as educating the general public about the unique characteristics of Quaas Creek and why long-term protection of this watershed is vital to the health of the local community are also recommended to continue. Periodically refining performance standards and reviewing current ordinances and land management plans applicable to the Quaas Creek watershed will also contribute to the long-term protection of this valuable resource.

ROLES AND RESPONSIBILITIES

The suggested lead agency is the Land and Water Conservation Division of the Washington County Planning and Parks Department. In general, this division, in cooperation with the appropriate local and state governmental units and agencies, should continue to provide a coordinating role for the community.

For successful implementation of the Quaas Creek Watershed Protection Plan, all those who share an interest in the watershed should be welcomed to participate. Participants include the public entities such as city, town and county governments, as well as, non-governmental private entities such as watershed residents, businesses, and non-profit organizations. Community support, involvement, and cooperation are essential in order to implement the plan's recommendations in a feasible, timely manner and preserve the Quaas Creek Watershed. Appendix D lists the proposed responsibilities for each entity in regards to the plan's recommendations.

TIME FRAME

Implementation speed will be influenced by urban and rural development pressure. Project implementation will also be influenced largely by the success of the county and local municipalities in obtaining financial support from local, state, and federal public sources, as well as private sources. Most of the plan's recommendations are currently being implemented in local wetland, floodplain, and shoreland ordinances and/or regulations. As lands are developed, certain recommendations, such as riparian buffers and groundwater infiltration basins, will be implemented immediately. Other recommendations, such as retrofitting existing stormwater basins or restoring historic wetlands, will be implemented when grant funding becomes available in the near future. Lastly, some recommendations, such as invasive species control and environmental monitoring, will be implemented as ongoing projects.

IMPLEMENTATION COSTS

Implementation of the plan recommendations may require additional capital expenditures for the implementation of stormwater management and water quality management measures within the watershed. These costs are generally viewed as favorable by the landowners and by the community in general, even though the initial costs of developing land within the watershed may be slightly higher than had previously been the case. The main costs of implementation are at the governmental level, where an increased amount of staff time devoted to providing assistance and implementing the protection plan may increase the associated staffing costs for participating municipalities.

Typically, additional land use recommendations, such as watershed protection plans, have little or no impact on the amount of construction activity within the affected area and do not significantly affect the local tax base.[26] Developers may incur additional upfront costs: Voluntary compliance with plan recommendations can potentially increase the initial cost of development. Yet, developers may be able to recoup some of these additional costs by selling lots at a higher price. Studies of the effects of watershed planning on the value of developed land within watershed protection areas have found that land values for developed land can increase by as much as 10%, and the value of vacant land by as much as 20%, as a result of the protection measures.[27] This study notes, "residents benefited from the knowledge that public actions were taken to protect the environmental amenity in which they had already invested." Other studies focusing strictly on stream corridors indicate that properties located adjacent to a stream buffer can increase in value by more than 30% due to the "sense of place" created by water, green space, and forested natural areas.[28] People express a greater willingness to pay more to live near these protected natural resources. Yet, protecting natural resources and their functions can create non-market opportunities that reach beyond market value. Taking a proactive stance, and installing stream buffers before pollutants further degrade water quality, generally means that less money will need to be spent in the future on costly remedial efforts. When these buffers also contain the entire 100-year floodplain, they are a very cost-effective form of flood damage control, both for communities and individual property owners. Conserving streamside vegetation within these buffers, especially trees, not only cools the stream, protects water quality and wildlife habitat, but can save money, up to 25% on energy bills, according to the American Forest Association.

FUNDING SOURCES

Many of these funding sources listed below can provide project funding for more than one category and funds obtained through these sources may be applied toward different projects during the same time period. Most of the funding sources provide cost-share assistance, which is a grant that provides partial funding for the implementation of the stormwater management practice. Funding for the implementation of the various watershed management recommendations may be obtained through the following agencies and funding sources:

Stream Protection and Enhancement

1. River Protection Grant- WI Department of Natural Resources (WDNR)
2. Urban Rivers Grant- WDNR
3. Streambank Protection Grant- WDNR

Runoff Management and Pollution Control

4. Targeted Resource Management Grant- WDNR
5. Urban Nonpoint Source and Stormwater Grant- WDNR

Natural Resource Protection and Enhancement on Agricultural Lands

6. Conservation Reserve Enhancement Program- United States Department of Agriculture (USDA)
7. Conservation Reserve Program- USDA
8. Conservation Security Program- USDA
9. Environmental Quality Incentives Program- USDA

Wildlife, Fisheries, and Habitat Restoration and Protection

10. Wetland Reserve Program- USDA

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[26] Beaton, W.P. "The Impact of Regional Land Use Controls on Property Values: the Case of the New Jersey Pinelands." Land Economics. 67(2):172-94. 1991.

[27] Beaton, W.P. "The Cost of Government Regulations. Volume 2. A Baseline Study for the Chesapeake Bay Critical Area." Chesapeake Bay Critical Area Commission. Annapolis, MD, 216 pp. 1988.

[28] Correll, Mark R., Jane H. Lillydahl and Larry D. Singell, "The Effects of Greenbelts on Residential Property Values: Some Findings on the Political Economy of Open Space." Land Economics. 54(2). 1978.

11. Wildlife Habitat Incentive Program- USDA
12. Partners for Fish and Wildlife- Department of Interior: Fish and Wildlife Service

Forest Restoration and Protection

13. Managed Forest Law- WDNR
14. Wisconsin Forest Landowner Grant Program- WDNR
15. Forest Land Enhancement Program- WDNR

General Resource Funding

16. Land and Water Resource Management Grant- WI Department of Agriculture, Trade, & Consumer Protection
17. Local Units of Government
18. Local Nonprofit Watershed Advocacy Groups
19. Individual, Business, and other Monetary Donations
20. Volunteer Time Commitments from Community Members

Information regarding these potential-funding sources can be obtained by contacting the following:

Washington County Land and Water Conservation Division	262-335-4800	**www.co.washington.wi.us/lcd**
Wisconsin Department of Natural Resources	414-263-8500	**www.dnr.state.wi.us**
Wisconsin Department of Agriculture, Trade & Consumer Protection	608-224-4620	**www.datcp.state.wi.us**
U.S. Department of Agriculture- Farm Service Agency	262-335-4860	**www.fsa.usda.gov**
U.S. Department of Agriculture- Natural Resources Conservation Service	262-335-4800	**www.wi.nrcs.usda.gov**
Town & Country Resource Conservation and Development	262-335-4855	**www.townandcountryrcd.org**
UW-Extension Washington County	262-335-4477	**www1.uwex.edu**
U.S. Department of Interior- Fish and Wildlife Service	608-221-1206	**http://midwest.fws.gov**

CHAPTER V – CONCLUSION

CONCLUSION

Quaas Creek and its tributaries are a unique water resource located at the heart of Washington County. The stream and adjacent riparian corridors exhibit a rural character within a rapidly urbanizing landscape. Tall trees, blue streams, and vast wildlife intermingle with concrete streets, commercial buildings, and urban residents. The babble of water and the smell of green vegetation remain distinct, even when mixed with the drone of engines and the odor of exhaust fumes. Even though urban development is encroaching, Quaas Creek retains a unique aesthetic value that when coupled with the creek's numerous recreational opportunities provide a very desirable and relaxing destination for the community's residents. Recently, construction site erosion and urban stormwater discharge have superceded agricultural impacts on the stream's water quality. Urban development increases the amount of impervious surfaces contributing nonpoint source pollution to the stream. In Quaas Creek, impervious surfaces have increased from 9% in 1985 to over 16% in 2000 and are expected to be more than 24% by 2020. Urban pollution has become the primary concern to Quaas Creek. In order to preserve the ecology of the watershed, the Quaas Creek Watershed Protection Plan was written to provide practical solutions that will address the potential problems associated with urbanization.

Quaas Creek still maintains a healthy, diverse fishery and a large amount of diverse in-stream aquatic habitat. Water quality also remains relatively good. Yet, since 2001, seasonal dissolved oxygen levels in the creek are more frequently dropping below six milligrams/liter and in some instances dropping below four milligrams/liter, a level that is very stressful on aquatic organisms. If this trend continues, a serious reduction in the abundance and diversity of the fishery may continue to occur throughout the stream. Since the mid-1980's, Quaas Creek has lost much of its sport fishery; most notable are the loss of brook trout and smallmouth bass. Although, recent occurrences of forage fishes, such as the fantail darter, johnny darter, and pumpkinseed indicate that Quaas Creek has potential for the enhancement of its recreational sportfishing opportunities. Quaas Creek has a good recovery potential from environmental disturbances occurring within the watershed and this fact makes preservation, restoration, and enhancement all the more feasible and attainable.

Urban development within the Quaas Creek watershed is expected to continue, but the potential negative effects from this development can be alleviated with properly applied and maintained stormwater management and erosion control technologies. This watershed initiative can be a success for the community; the daily behaviors and choices made by residents within this watershed play an important role in determining the health and function of the watershed's ecosystems and, therefore, the community's well-being and sense of place. Community support, involvement, and cooperation are essential if the stream is to be maintained in its current status, with hope of restoring its full beauty in the future. Through increasing the public's knowledge and understanding of the connection between landscape and water, this watershed protection plan's goal is threefold:

- **to preserve** the water quality, riparian and environmental corridors, isolated natural areas, and hydrology of wetlands and groundwater recharge areas;
- **to restore,** where possible, degraded or lost riparian corridors and groundwater recharge areas and other key natural resource features, such as the fishery, wildlife, and the habitat needed for their survival;
- **to enhance** existing and planned stormwater and erosion control practices, so they can better protect the water quality into the future.

The Quaas Creek Watershed Protection Plan is designed to assist communities in developing strategies that will benefit Quaas Creek's natural assets and protect sensitive habitats within the watershed. By using the planning strategies outlined in this plan, results will be achieved that enrich and preserve the natural environment. In addition, carefully planned urban development can create and maintain open space, groundwater recharge areas, and wildlife corridors for the benefit of Quaas Creek and its residents. An opportunity for the community exists in this watershed; the creek can survive additional urban development if action is taken now to preserve, restore, and enhance the ecology of Quaas Creek.

Appendix A: Quaas Creek Watershed Protection Committee Members and Meetings

COMMITTEE MISSION STATEMENT:

"To prepare an intergovernmental watershed protection plan that will result in protecting and improving the water resources of Quaas Creek."

MEMBERS OF THE QUAAS CREEK WATERSHED PROTECTION COMMITTEE:

Daniel Stoffel (Chair), Washington County Board of Supervisors
John Behrens, Town of West Bend
Harold Groth, Town of Polk
Judith Neu, P.E., City of West Bend, Engineering Department
John Norman, Town of Trenton

Former Members:
John Cook, Town of Trenton
James Fritsche, Town of West Bend
Daniel Rodenkirch, Washington County Planning, Conservation & Parks Committee

MEMBERS OF THE QUAAS CREEK WATERSHED TECHNICAL SUBCOMMITTEE:

Robert Biebel, Southeast Wisconsin Regional Planning Commission
Blaine Delzer, Washington County Planning & Parks Department, Land and Water Conservation Division
Judith Neu, P.E., City of West Bend, Engineering Department
Jim Ritchie, Wisconsin Department of Natural Resources, Water Resources Stormwater Program
Herbert Wolf, Washington County Planning & Parks Department, Land Use Division

COMPILED AND EDITED BY:

Thomas Slawski, PhD., Southeast Wisconsin Regional Planning Commission
Matthew Zoschke, Washington County Planning and Parks Department, Land and Water Conservation Division

CURRENT CONTRIBUTORS:

Timothy Ehlinger, PhD., University of Wisconsin – Milwaukee, Biology Department
Phillip Gaudet, Washington County Planning and Parks Department, Land Use Division
Fay Fitts, Washington County Planning and Parks Department, Land and Water Conservation Division
Sue Millin, Washington County Planning and Parks Department, Land and Water Conservation Division
Paul E. Mueller, Washington County Planning & Parks Department
Jeff Muenkel, City of West Bend, Department of Community Development
Paul Sebo, Washington County Planning and Parks Department, Land and Water Conservation Division
Will Wawrzyn, Wisconsin Department of Natural Resources, Inland Fisheries Program

PAST CONTRIBUTORS:

Troy Kuphal - Washington County Land Conservation Department
Perry Lindquist - Washington County Land Conservation Department

MEETINGS OF THE QUAAS CREEK WATERSHED PROTECTION COMMITTEE

Date	Agency	Description
02-19-98	Town of Trenton	Sends letter of support to form Quaas Creek Watershed Protection Committee
02-26-98	City of West Bend	Sends letter of support to form Quaas Creek Watershed Protection Committee
05-10-99	Land Conservation Committee	Sends resolution to County Board in support of forming Quaas Creek Watershed Protection Committee
05-20-99	Land Conservation Department	Information-Input meeting held to discuss formation of Quaas Creek Watershed Protection Committee
07-13-99	County Board of Supervisors	Passage of Resolution # 35-99 to form Quaas Creek Watershed Protection (QCWP) Committee and develop protection plan
08-26-99	QCWP Committee	First meeting of QCWP Committee
09-27-99	City of West Bend	Passage of Resolution # 55-1999-2000 appoints Judith Neu P.E. to QCWP Committee
10-31-99	Land Conservation Department	Tour of Quaas Creek Watershed for involved parties
11-10-99	Town of West Bend	Passage of Resolution # 99-4 appoints James Fritsche to QCWP Committee
11-16-99	Town of Trenton	Passage of Resolution # 11-99-1 appoints John Cook to QCWP Committee
01-25-01	QCWP Committee	Second meeting of QCWP Committee
04-25-01	QCWP Committee	Third meeting of QCWP Committee
06-15-01	QCWP Committee	Fourth meeting of QCWP Committee
12-14-01	QCWP Committee	Fifth meeting of QCWP Committee
06-28-02	QCWP Committee	Sixth meeting of QCWP Committee
01-22-03	QCWP Committee	Seventh meeting of QCWP Committee
11-17-03	QCWP Committee	Eighth meeting of QCWP Committee
12-13-03	QCWP Committee	Quaas Creek Public Informational meeting
12-13-03	QCWP Committee	Ninth meeting of QCWP Committee Passage of Draft Resolution to approve the Quaas Creek Watershed Protection Plan
01-13-04	Washington County Board of Supervisors	Presented 2003 Resolution #62 for consideration approving the Quaas Creek Watershed Protection Plan and forwarding the plan to the affected municipalities for their consideration
02-10-04	Washington County Board of Supervisors	Passage of 2003 Resolution #62

The QCWP Committee meetings mentioned above were all legally posted and the news media notified with an agenda. The public and other concerned parties were invited to participate in the process of forming this plan.

MEETINGS OF THE QUAAS CREEK WATERSHED PROTECTION TECHNICAL SUBCOMMITTEE

Date	Agency	Description
03-08-00	QCWP Technical Subcommittee	First meeting
03-08-01	QCWP Technical Subcommittee	Second meeting
11-15-01	QCWP Technical Subcommittee	Third meeting

OTHER INFORMATIONAL MEETINGS

During the inventory and developmental stages of the QCWP Plan, information updates were presented eight times, twice to each of the three Town Boards and the City Council. These progress reports allowed the cooperating units of government, public, and other concerned parties to comment and assist with the direction and scope of the watershed protection plan.

Appendix B: City of West Bend 2003 Land Uses and Stormwater Basins Proposed for Modifications

Appendix C: Urban Development and Impervious Surfaces

As long as the economy remains strong in the region, population is expected to continue increasing in southeastern Wisconsin. As more people live, work, and raise families in the area, urbanization is also expected to increase. Southeastern Wisconsin has a beautiful landscape that contains many streams and lakes, attractive to live near and recreate in. But, these same streams and lakes change dramatically when urban development begins to encroach upon their shorelands, permanently altering the landscape and associated watercourses. Urbanization, itself, is not the main factor driving the degradation of the local waterbodies. Lakes and streams can survive and flourish in urban settings. The main factors leading to the degradation of local waterbodies are the improper planning of urban development, i.e., the creation of large areas of connected impervious surfaces and zoning favoring small residential lot sizes and/or development in shoreland areas, and hastily performed construction practices that occur before the proper installation and/or maintenance of erosion and stormwater controls. These two factors increase the potential for the occurrence of the negative water quality/quantity effects associated with urbanization. If impervious surfaces were connected to pervious surfaces allowing for water infiltration and if construction activities took place after the establishment of the proper best management practices, urban development would have much less of a potential to negatively effect the surrounding environment.

In the past, when urban development was scattered about the landscape and did not dominant the land use within any one watershed, increases in the amount of impervious surfaces could occur without appreciable change to the water quality and quantity of a stream. Now, since urban developments have converged and become the dominant land use within many southeastern Wisconsin watersheds, any increase in the amount of impervious surfaces can cause noticeable changes to a stream. These current changes can be far greater in magnitude, than if those same increases in impervious surfaces would have occurred sometime in the past. These cumulative effects greatly stress the already impacted aquatic systems, sometimes tipping the balance between the stream's natural ability to recuperate from a major stress episode and its ability to recuperate from any stress episode at all. In Wisconsin, one study examined the cumulative effects of stress on a watershed's ecosystem. When a watershed started out with 40% of its land use in surface water and wetlands and then had that land use decreased by 10%, the result was an increase in flood flows and erosion by approximately 10%. But, when a similar sized watershed, although developed and containing only 10% of its land use in surface water and wetlands, decreased by the same amount, flood flows and erosion increased in this watershed by more than 250%.[29] This shows that a watershed's stress response can be determined by the original condition of the landscape. The reduction in surface water and wetlands, although equal between the watersheds, impacted to a greater degree the already developed and stressed watershed, when compared with the watershed that began in a more natural and unstressed state. This is because the second watershed suffered from a larger cumulative effect. Cumulative effects augment each other. The resilience of the stream was reduced through many stress episodes that occurred not only in the present, but also in the past.

When a new commercial or residential development is built near a stream tributary, driveways, rooftops, sidewalks, and lawns increase, while trees, native plants, and undisturbed soils decrease. The ability of the shoreland area to perform its natural functions (flood control, pollutant removal, wildlife habitat, and aesthetic beauty) is decreased by each of these actions. Urbanization impacts the watershed, not only by altering the ratio between stormwater runoff and groundwater recharge, but also through the changing of stream hydrology (i.e. increasing stormwater peak flow and altering baseflow regime) and through divergence of the seasonal thermal regimes away from their historic patterns. These changes further influence other characteristics of the stream such as channel morphology, water quality/quantity, and biological diversity. When urban development increases, the amount of surfaces impervious to water increases proportionately to the decrease in the amount of surfaces pervious to water. For this reason alone, many researchers throughout the United States, including researchers at the Wisconsin Department of Natural Resources, report that the amount of connected impervious surfaces is the

[29] Novitski, R.P. "Hydrology of Wisconsin Wetlands." Wisconsin Geological and Natural History Survey Circular 40. 1982.

best indicator of the level of urbanization in a watershed.[30] Connected impervious surfaces have a direct hydrologic connection to the stream through a storm sewer, roadbed, and/or other land surface drain. Relatively low levels of urbanization, 8-12% connected impervious surface, can lead to a decline in the biological components of a stream, long before the detection of the physical (increased temperature and turbidity) and chemical (reduced dissolved oxygen and increased pollutant levels) changes that caused them. For example, each 1% increase in watershed imperviousness can lead to an increase in water temperature by about 0.25°C.[31] This temperature increase is small in magnitude, but even this small increase can have significant impacts to fish, such as trout, and other members of the biological community.

One of the unintended results of urban development is the increase in the amount of stormwater, which runs off the land, instead if infiltrating into the groundwater. A parking lot or driveway produces much more runoff than a undisturbed meadow or agricultural hay field. Furthermore, runoff traveling over a parking lot or driveway will pick up more heavy metals, bacteria, pathogens, and other stream pollutants than runoff traveling over surfaces that allow some of the stormwater to infiltrate. Runoff traveling over impervious surfaces bypass the filtering action of the soil particles, soil microbes, and vegetation present above (stems and leaves) and below (roots) the soil surface. Therefore, location of these impervious surfaces determines the degree of direct impact they will have upon a stream. There is a greater impact from impervious surfaces located closer to a stream due to the fact that less time and distance exists where the polluted runoff can be pretreated before entering into the stream. A study of forty-seven watersheds in southeastern Wisconsin found that one acre of impervious surface located less than 100 meters from the stream had the same effect on aquatic communities as ten acres of impervious surfaces located more than 100 meters from the stream.[32] Because urban lands located adjacent to the stream have a greater impact on the biological community, an assumption might be made that riparian buffer strips located along the stream could absorb the negative runoff effects attributed to urbanization. Yet, riparian buffers may not be the complete answer in an urban watershed since most urban stormwater is delivered directly to the stream via a storm sewer or roadbed and, therefore, enters the stream without first being filtered by the buffer. Riparian buffers need to be paired with other management practices, such as infiltration basins and grass swales, in order to gain the full benefits of the stormwater and erosion controls. Combining practices into a "treatment train" can provide a much higher level of pollutant removal, than single stand-alone practices could ever achieve. Stormwater and erosion control treatment practices vary in their function, which in turn influences their level of effectiveness. Location of a practice on the landscape, as well as proper construction and continued maintenance, greatly influences the level of pollutant removal. The following table lists the approximate effectiveness of some engineered stormwater and erosion control practices.

Approximate Pollutant Removal Rates of Engineered Stormwater Practices[33]

Stormwater Practice	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Oil and Grease	Bacteria
Infiltration Basin	95%	80%	5%	Not reported	Not reported
Dry Detention Ponds	50%	20%	10%	5%	45%
Wet Detention Ponds	80%	50%	45%	80%	70%
Wetlands	75%	50%	35%	85%	80%
Grass Swales	80%	35%	10%	60%	Increase
Ditches	30%	Increase	10%	Not reported	0%

[30] Wang, L., J. Lyons, P. Kanehl, and R. Bannerman. "Impacts of Urbanization on Stream Habitat and Fish Across Multiple Spatial Scales." Environmental Management 28:255-266. 2001.

[31] Wang, L., J. Lyons, and P. Kanehl. "Impacts of Urban Land Cover on Trout Streams in Wisconsin and Minnesota." Transactions of the American Fisheries Society 132:825-839. 2003.

[32] Wang, L., J. Lyons, P. Kanehl, and R. Bannerman. "Impacts of Urbanization on Stream Habitat and Fish Across Multiple Spatial Scales." Environmental Management 28:255-266. 2001.

[33] Adapted from: Winter, R. National Pollutant Removal Performance Database for Stormwater Treatment Practices, 2nd Edition. Center for Watershed Protection. Ellicott City, MD. 2000.

If urban land uses and their associated impervious surfaces are compared amongst each other, industrial and commercial land uses create more impervious surfaces than residential land uses. Furthermore, smaller residential lots create more impervious surfaces than larger residential lots. The following table lists the approximate amount of impervious surfaces created by residential, industrial, and commercial development.

Approximate Percentage of Connected Impervious Surfaces Created by Urban Development[34]

Type of Urban Development	Impervious Surface
Two Acre Residential	10-15%
One Acre Residential	15-25%
One-Half Acre Residential	20-30%
One-Third Acre Residential	25-35%
One-Fourth Acre Residential	35-45%
One-Eighth Acre Residential	60-70%
Industrial	70-80%
Commercial	85-95%

During construction, commercial and industrial developments typically have more of their construction area in erosion-prone, bare soil, than when compared to residential developments. Yet, smaller residential lots mean that more construction, in regards to amount and duration, is performed in a specific local area. It is during these construction periods that stormwater runoff events causing erosion and a corresponding reduction in water quality are more likely to occur. One Wisconsin study found that urban construction sediment loads originating from small construction sites can be ten times larger than sediment loads originating from larger urban or rural construction sites.[35] This is because smaller construction sites typically disturb more of the total lot area at one time than the larger construction sites. Even though commercial and industrial developments create more post-construction impervious surfaces, low-density residential developments, where lawns are the single largest use of land area, have different concerns. Lawns are considered pervious, but they do show some similarities to impervious surfaces. When lawns are compared to woodlands and cropland, they are found to contain less soil pore space (up to 15% less than cropland and 24% less than woodland) available for the infiltration of water. Also, lawns typically produce larger runoff volumes that can be higher in nutrients and pesticides than agricultural cropland.[36] Lawn grasses have flat, soft stems comfortable to the bare foot, but more prone to laying flat during runoff events, especially when compared to native grasses, forbs, and sedges. Additionally, most lawns typically have subsoil compaction, which limits water infiltration into the deeper soil levels. This compaction was created by earlier construction activities that stripped the original topsoil off the site and later replaced it with an amount that is less than pre-construction amounts, but sufficient to grow shallow rooting lawn grasses.

When the preceding information is considered, the question may be asked- can the negative effects of impervious surfaces and construction practices be reduced? Of course. If stormwater and erosion control practices are implemented across the entire watershed and adequately constructed and maintained from the beginning, there is no reason to believe that urban developments and streams cannot coexist. In the Quaas Creek watershed, proper urban development design, pre-construction engineering of stormwater and erosion control practices, immediate post-construction stabilization of soils on development sites, post-construction soil compaction alleviation, and establishment of riparian buffers can contribute to reducing the negative impacts to water quality and quantity associated with urbanization. These practices, though, will not provide the necessary pollutant treatment, if they are constructed as stand-alone practices. Rather, each practice must be implemented as part of the "treatment train", each complementing the function of another. Quaas Creek has not lost the opportunity for community action to preserve, restore, and enhance the watershed, even in the face of increasing urbanization.

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[34] Ferguson, B.K. Introduction to Stormwater: Concept, Purpose, Design. New York: John Wiley & Sons. 1998.

[35] Owens, D.W. et al. Soil Erosion from Two Small Construction Sites, Dane County, Wisconsin. USGS Fact Sheet FS-109-00, August 2000.

[36] Center for Watershed Protection. "Impacts of Impervious Cover on Aquatic Systems." Watershed Protection Research Monograph No.1, p.7. March 2003.

Appendix D: Quaas Creek Watershed Protection Plan Recommended Actions

Plan Element	Sub-element	Location	Management Measures[a]	Management Responsibility
Land Conservation and Management	Land Use Zoning	Entire watershed	Observe guidelines set forth in the adopted regional and local land use plans, as well as, the Washington County Land and Water Resource Management Plan that protect environmentally sensitive lands as recommended in the regional natural areas and critical species habitat protection and management plan. Encourage conservation development practices providing for the clustering of any new development within the drainage area to minimize nonpoint pollution impacts on and potential losses of groundwater recharge.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton
	Ordinance Enforcement	Entire watershed	Enforce construction site erosion control, stormwater management, development control, and onsite sewage disposal system inspection and maintenance ordinances and programs as necessary.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, Wisconsin Department of Natural Resources- WDNR
	Riparian Corridors	Along waterways and within designated environmental corridors and natural resource features	Seek voluntary, perpetual conservation easements on targeted lands, within 100 feet of each streambank or within floodplain, whichever is greater. Expand the corridor width to 300 feet, where needed to reconnect an environmental corridor with a fragmented natural area. Include lands into designated open space areas, maintaining or establishing natural vegetation, preferably using native species.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and developers
	Groundwater Recharge and Discharge Areas	High groundwater areas	Prevent filling, draining or any other alteration of wetlands, regardless of owner, size, and location and high groundwater areas, including hydric soils. Protect and preserve quality of water discharging into the high groundwater areas by incorporating runoff management recommendations for pre-treatment. Maintain infiltration and recharge as close to existing rates as possible by incorporating runoff management recommendations for infiltration and low-impact design standards.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and developers
	Natural Areas	Designated environmental corridors and natural resource features	Prevent development within environmental corridor and isolated natural areas as recommended by SEWRPC. Promote defragmentation of wildlife habitat by reconnecting environmental corridors and isolated natural areas with other larger corridors and natural areas where and when possible as recommended in the regional natural areas and critical species habitat protection and management plan.	Washington County; City and Town of West Bend; Town of Polk; Town of Trenton; WDNR; private landowners, developers, and businesses
Runoff Management and Pollution Reduction	Runoff Management	Entire watershed	Update and implement stormwater management ordinances to include the infiltration and other standards located in NR 151, *Wisconsin Administrative Code.* Minimize stormwater pollutant loading, runoff temperature increases and changes in downstream hydrology that would otherwise result from development. Control the quantity and quality of stormwater entering the stream. Maximize post-development groundwater recharge.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR

Plan Element	Sub-element	Location	Management Measures[a]	Management Responsibility
Runoff Management and Pollution Reduction	Runoff Management	Entire watershed	Prevent untreated discharges of runoff from areas where high concentrations of pollutants such as heavy metals, PAH's, petroleum products, and chlorides are likely to accumulate.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private businesses

		New development and redevelopment	Encourage developers and landowners to implement practices that exceed the minimum standards identified in NR 151, *Wisconsin Administrative Code.* Minimum standards are:
			• Construction sites one acre or more: control 80% of sediment load coming off sites.
			• Post construction sites of one acre or more (after Oct. 1, 2004) must have appropriate stormwater management plans addressing:
			  • 80% of the total suspended solids leaving the site,
			  • Maintaining or reducing pre-development peak discharge rates for the 2-year and 10-year, 24-hour storm events,
			  • Infiltration of 90% of pre-development or 25% of the post-development runoff from the 2-year, 24-hour storm on residential land; 60% of the pre-development infiltration or 10% of the post development infiltration from the 2-year, 24-hour storm on non-residential land.
			• Permanent vegetative buffer areas must be maintained around lakes, streams, and wetlands. Sizes range from 50-75 feet depending upon type and classification of waterbody.
			• Establish standards and guidelines for the use of Low Impact Development approaches to stormwater management:
			  • Minimize street pavement widths,
			  • Utilize existing or constructed natural grass channels to convey stormwater, in preference to curb and gutter,
			  • Keep stormwater management facilities outside corridor areas and encourage sheet flow from discharge points,
			  • Retain or infiltrate stormwater on individual lots using infiltration trenches, rain gardens, etc.,
			  • Use combination curb/grass swales, boulevards and roadside ditches versus standard curb and storm sewer designs,
			  • Direct roof drains to grassed areas,
			  • Use other stormwater management "Treatment Train" approaches.
			  • Infiltration Basins:
			  • Use infiltration or tile discharge systems to drain runoff from the 1-year storm within 24 hours and prevent permanent ponding.
			  • Design basins with length to width ratios of at least 3:1 and forebays with areas of 10-24% of the basin's surface area, where practical.
				Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private developers and landowners

Plan Element	Sub-element	Location	Management Measures[a]	Management Responsibility
Runoff Management and Pollution Reduction	Runoff Management	Fueling and maintenance areas	Pre-treat runoff from urban "hotspots" using sand filters before it combines with other runoff - "hotspots" include fueling and vehicle maintenance areas, long-term outdoor vehicle parking areas and industrial storage sites. Work cooperatively with area fueling and automotive service stations to decrease potentially contaminated runoff. Remove all visible sheen from runoff.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, private landowners and businesses
		Highways and roadways	Prevent disposal of snow in areas where melt water will drain directly into a stormwater facility or waterway. Explore possible alternative products and management methods for deicing roads and parking lots.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton
		Urban areas	Implement stormwater management plans that address: • Development and implementation of an intensive street sweeping program for high-traffic streets, parking lots, and storage areas where practical. • Application of nutrients in accordance with a certified nutrient application schedule. • Management of leaves and grass clippings. • Regular removal of sediment, organic matter, and trash from stormwater catch basins, once or twice per year, increasing the frequency of maintenance in industrial or commercial areas. • Assist multi-family, commercial, and industrial areas in identifying proper snow disposal areas. • Detect and eliminate illicit discharges.	City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and businesses
	Pollution Reduction	Entire watershed	Retrofit existing detention basins as necessary to meet the objectives in this plan. Install new stormwater basins, where appropriate, to treat runoff from currently untreated development.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and businesses
		Urban areas	Retrofit existing wet and dry detention basins with surface outlet structures as necessary to promote infiltration and provide water quality benefits. Convert existing wet detention basins, where practical, to dry detention facilities with adequate forebay and subsurface discharge systems or infiltration basins to limit thermal pollution and enhance pollutant filtering. Install new stormwater treatment facilities at locations where runoff is currently untreated, or where additional treatment is necessary.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners, developers, and businesses
		Agricultural areas	Implement Agricultural Performance Standards found in NR 151, *Wisconsin Administrative Code*. Develop state-certified nutrient management plans for cropland within the watershed. Develop or update existing conservation plans to resource management plans. Maintain existing or install new agricultural best management practices, where needed.	Washington County, Natural Resource Conservation Service, WDNR, private landowners

Plan Element	Sub-element	Location	Management Measures[a]	Management Responsibility
Stream Protection and Enhancement	Fisheries	Entire watershed	Remove and/or modify woody debris jams causing streambank instability, reducing habitat quality, and potentially impeding fish movement. Stabilize actively-eroding streambanks as identified and prioritized in the SEWRPC Memorandum Report No. 151 through regrading and/or revegetating with native species. Increase streambed scour, without exacerbating streambank erosion, and expose the coarse substrate by using natural objects, such as boulders and trees cabled to the bank, or other simple structures, such as rock wind deflectors.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and citizens
	Stream	Entire watershed	Restore natural flow regime within highly channelized portions of the watershed through stream channel modification or relocation. Preserve, enhance, and/or restore riffle and pool habitats using appropriate bank and instream treatments. Modify and/or remove and replace culvert and bridge installations with moderate to high potential for causing hydrological and/or physical obstructions to fish passage. Use streambank treatment techniques that stabilize streambanks, reduce sedimentation, and/or modify stream morphology that also increase stream cover.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and citizens
	Declining Habitats	Wetlands	Restore undeveloped wetlands that have been converted to agricultural uses in locations where landowner agreements and funding sources are in place, according to the County, WDNR, and USDA-NRCS Standards.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, private landowners and developers
		Wildlife habitat	Manage open lands as wildlife habitat.	
		Woodlands	Promote the reforestation of open lands and restore degraded woodlots.	
		Native species	Promote the restoration and management of native prairies and oak savannas.	
		Nonnative invasive species	Eradicate and control, to the extent possible, the spread of purple loosestrife, buckthorn, and other species as determined by WDNR.	
Watershed Education and Outreach	Informational Programming	Entire watershed	Create and support a citizen advocacy group that will promote wise management and help implement watershed protection activities. Develop and distribute educational materials, displays, events: • Provide local residents, businesses, developers, and government officials with a basic understanding about the geography, natural resources, and environmental issues of the Quaas Creek Watershed; • Educate local residents, businesses, developers, and government officials about the types of practical actions and behaviors that contribute to the health or destruction of the watershed; • Provide opportunities and incentives to make those behavioral changes and actions that will protect and preserve the watershed, river, and other natural resources.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, UW-Extension, private citizens, local non-profits, and land trusts

Plan Element	Sub-element	Location	Management Measures[a]	Management Responsibility
Watershed Education and Outreach	Informational Programming	Residential areas and private property	Encourage citizen participation in: • Storm drain stenciling, • Litter and pet waste clean ups, "Clean Sweep" programs, river clean ups, • Use of no or low phosphorus fertilizer, • Water quality monitoring, • Gardening and natural landscaping programs, • The "Quaas Creek Stewardship Initiative."	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, UW-Extension, local non-profits, private landowners and citizens
		Businesses and commercial and industrial areas	Encourage business owner participation in: • Use of grocery bags, posters, and place mats printed with an awareness message, • Placement of revolving displays, • Employee education on waste minimization and recycling, • Activities noted in the Neighborhood Steward Program, • Use of natural landscaping and stormwater management in yards and parking areas, • Use of no or low phosphorus fertilizer, • The "Quaas Creek Stewardship Initiative."	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, UW-Extension, local non-profits, private business community
		Building sites and developing areas	Encourage participation of builders and developers in: • Workshops on special and alternative design considerations necessary for the preservation of Quaas Creek, • Use of erosion control and construction site stormwater management practices, • Environmentally-friendly landscaping, • Use of no or low phosphorus fertilizer, • Conservation and/or cluster development, • Education of people in the process of building new homes to make positive environmental choices, • Green space preservation, • The "Quaas Creek Stewardship Initiative."	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, UW-Extension, local non-profits, private landowners and developers
		Civil divisions	Encourage participation of local government in: • Educational programming through workshops, informational packets, etc., • Developing stewardship activities for watershed residents, • Waste minimization and solid and hazardous waste management initiatives, • Stormwater management and prevention of water pollution, • Street sweeping and leaf pick up programs, • Use of no or low phosphorus fertilizer, • Proper use of salt and deicers, • Snow removal and disposal, • Storm sewer and catch basin maintenance, • The "Quaas Creek Stewardship Initiative."	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, UW-Extension, private citizens

Plan Element	Sub-element	Location	Management Measures[a]	Management Responsibility
Monitoring and Evaluation	Comprehensive Monitoring and Evaluation Plan	Monitoring program	Convene and support a multi-agency work group responsible for the following: • Implementing the actions identified in the Quaas Creek Watershed Protection Plan, • Developing and implementing a comprehensive environmental monitoring and data evaluation program, • Refining these plans, as necessary and appropriate, based upon the outcomes of the foregoing actions. Implement a comprehensive monitoring and evaluation plan that: • Establishes long term biological monitoring goals and objectives for watershed, • Gathers accurate data for long term study of stream health, • Coordinates sampling efforts between participating organizations, • Communicates monitoring results to community, • Determines effectiveness of management measures on a three to five-year review basis. Assessment of effectiveness and adequacy of existing and proposed watershed management measures, and alternative strategies against agreed goals and objectives. Evaluation of appropriate, site-specific fish habitat and streambank stability treatment measures in Quaas Creek. Promote the modification of existing and development of new management measures, as necessary and appropriate, based upon the monitoring and assessment program findings.	Washington County, City and Town of West Bend, Town of Polk, Town of Trenton, WDNR, UW-Extension, SEWRPC, private citizens

[a]*Recommended management measures are intended as guidance only and recognize that local ordinances, state requirements, federal regulations, landowner agreements, and site-specific conditions must be thoroughly considered on an individual basis for each application before a measure is implemented.*

Source: Washington County.