sediment load from eroding uplands is estimated to make up 92 percent of the total sediment load in the subwatershed.

Only one-half of the uplands are estimated to be contributors of this sediment load to surface waters. This is due in part to the extensive internal drainage in the subwatershed, and partly due to the buffering effects of riparian wetlands. The riparian wetlands trap an estimated 44 tons of sediment per year. Wetland vegetation within internally-drained areas receives an estimated 124 tons of sediment per year. The effects of this sediment deposition on these wetlands is unknown, but expected to vary widely, as does the sensitivity and value of the wetlands themselves.

Streambank degradation was found to be severe at four sites. Erosional sediment from two of these sites, both located on the Milwaukee River, accounts for five percent of the estimated sediment load delivered to the surface waters. The two remaining sites, one on the Milwaukee River and one above Highway 28 on the East Branch, are significant primarily because of cattle access that results in trampling of the streambed and banks.

Urban Sources: Diffuse urban runoff contains a wide array of pollutants that can lead to the degradation of surface waters. Each urban pollutant is associated to varying degrees with specific types of urban land uses. The pollutants, therefore are generated wherever these land uses occur, regardless of the size of the community. The nature of the stormwater conveyance system, however, can have a dramatic effect on the transport and delivery to surface waters of these pollutants generated in urban areas.

Three pollutants were chosen to represent the pollution potential of this urban area. Phosphorus was chosen because it is commonly associated with surface water enrichment, and is also a pollutant generated by rural land uses. Suspended solids was chosen for the same reasons. In addition, many urban pollutants attach themselves to suspended solids in runoff, and therefore suspended solids can be used as a general indicator of other particulate pollutants generated and transported from urban areas. Lead was chosen because of its toxicity, and because it, along with many other heavy metals, are the most commonly detected priority pollutants in urban runoff (USEPA, 1983).

Estimated urban loads in the Kewaskum Study Area for suspended solids and phosphorus are 140,000 pounds 380 pounds respectively. The urban contribution of these materials is insignificant compared to other sources within the subwatershed. Established urban areas contribute only six percent of the subwatershed suspended sediment load. These same areas are estimated to contribute only five percent of the subwatershed phosphorus load. The significance of these contributions are even less for the Milwaukee River mainstem, which receives a considerable pollutant load from upstream.

Consequently other urban pollutants are the primary concern for these urban lands. These include: heavy metals, typified by lead; pathogens; oils and greases; and a wide array of hazardous materials that can make their ways into urban storm sewer systems and surface waters.

Table 32 shows the relative pollution potential of the major urban land uses in the study area. Commercial, industrial, and institutional lands, all which have a high capability of generating urban pollutants, produce most of the lead load. Although these lands make up only 24 percent of the urban area, they contribute 83 percent of the lead load. Residential lands in the study area combine to produce a significant portion of the lead load (14 percent), but these lands cover nearly 50 percent of the urban area. The residential lands take on a greater significance as sources of pesticides, human disease causing pathogens, and a wide array of chemicals often improperly used or disposed. (Draft State Plan, NURP Rpt).

Map 6 shows the anticipated urban land use in the study area for the year 2000. Table 33 shows the nature and extent of the proposed development. A total of 1,016 acres of new development are anticipated over the next 12 years. Commercial and industrial land uses will increase by 149 percent and 126 percent respectively. Institutional land use will increase by almost 100 percent. Residential land use will continue to dominate the urban landscape, growing by 161 percent and making up 55 percent of the urban land use in the year 2000.

The water quality implications of future development are two-fold. First is the pollution potential attendant to construction site erosion if not properly controlled. Second is the pollution potential of new urban impervious surfaces, if appropriate stormwater control practices are not used.

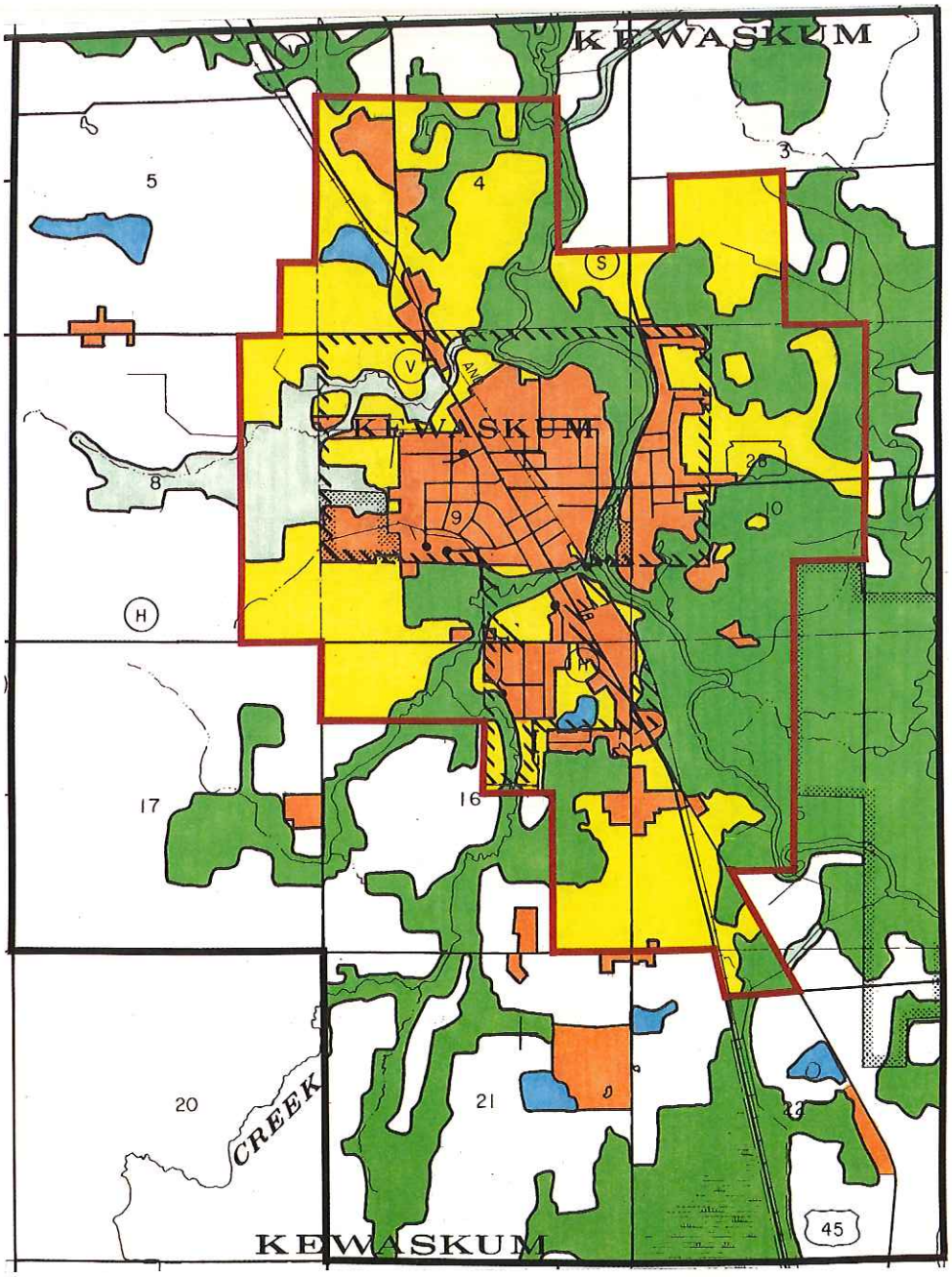
Potential construction erosion impacts are dramatic. The construction site erosion potential for 1,016 acres of development is about 28,000 tons of sediment, or about 2,300 tons of sediment per year. This is equivalent to double the existing annual estimated sediment load from all sources within the entire subwatershed. Even if only 25 percent of the potential eroded sediment is delivered to surface waters, the annual sediment load would equal about one-half of the existing subwatershed sediment load. Water resources impacts from construction site erosion are potentially catastrophic, with many examples within the East-West Watershed.

The increase in lead load from new urban areas is estimated to be 150 percent if control practices are not used. The relative significance of commercial, industrial, and institutional lands as sources of lead and other similar pollutants would remain high.

It is important to note that some of this development will occur outside of the Kewaskum Village limits, in the town of Kewaskum. As mentioned in the discussion for the Smith Lake Subwatershed, a small portion of anticipated urban expansion for the Kewaskum Study Area occurs in the Smith Lake Subwatershed in an area draining to the East Branch of the Milwaukee River.

Map 6

EXISTING AND PLANNED URBAN AREAS IN THE KEWASKUM STUDY AREA



LEGEND

- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- EXISTING URBAN LANDS
- PLANNED ADDITIONAL URBAN LANDS
- URBAN SERVICE AREA BOUNDARY
- STUDY AREA BOUNDARY

Source: SEWRPC.

GRAPHIC SCALE

0 2000 4000 FEET

Water Resources Objectives

Rural nonpoint source pollution is a significant contributor to the factors limiting the quality of existing uses in Kewaskum Creek and the Milwaukee River. Fairly extensive controls for both sediment and animal waste are needed. The impact from existing urban runoff is not fully known, although the potential from future construction erosion is significant if it goes on uncontrolled. The pollution potential from new urban land uses is significant, but the water quality implications are not fully understood, although long-term degradation can generally be expected.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Enhance the quality of the existing biological and recreational uses for Kewaskum Creek, the un-named perennial tributary, and the Milwaukee River downstream of the millpond.

b. Protect the existing uses in other surface waters within the subwatershed.

c. Protect sensitive and valuable wetlands from impacts of sedimentation and barnyard runoff, where the pollutant attenuation capacity of these areas is overloaded.

d. Protect sensitive groundwater resources from barnyard runoff where necessary.

SMITH LAKE SUBWATERSHED

WATER RESOURCE CONDITIONS

The main water resources in this subwatershed include the lower reach of the East Branch of the Milwaukee River, from the New Fane Dam to the confluence with the Milwaukee River Mainstem, and a two mile stretch of the Milwaukee River between the Kewaskum and West Bend subwatersheds.

Milwaukee River East Branch: Habitat and other physical features in this part of the East Branch of the Milwaukee River are capable of supporting a diverse and abundant warmwater sport and forage fish community throughout the year, as well as partial body contact. The stream is only partially meeting its potential due primarily to livestock pasturing practices.

Habitat in the river is generally good for sportfish. Important gamefish populations include northern pike, largemouth bass and sunfishes. There are also many important intolerant forage fish species, in abundant numbers. Benthic macroinvertebrates showed good to very good water quality.

Aquatic plant growth is well-balanced with low to moderate abundance in riverine sections. The mean summer baseflow phosphorus concentration (at Valley View Drive) is sufficiently low to prevent nuisance growths of macrophytes. This is supported by low measured plant biomass.

There are a number of factors limiting uses in this river section. Streambank and streambed degradation associated with cattle access is a primary limitation. Elevated bacteria counts were also measured at State Highway 28. Obstacles to canoeists include the dam at New Fane.

NONPOINT SOURCES OF POLLUTION

General Land Use: The rural land use distribution is shown in Table 30. Woodlands and grasslands make up a major portion (67 percent) of the land use. Much of this well protected land is part of the Kettle Moraine State Forest which borders most of the East Branch within this subwatershed. Croplands make up 31 percent of the rural land use, with nearly all of this cropland rotated.

Rural Sources: Table 34 shows the results of the rural nonpoint source inventory for this subwatershed.

Three of the four barnyards draining to surface waters have moderate to high pollution potential. Two of these drain to the East Branch near State Highway 28, and one drains to the Milwaukee River Mainstem. The other barnyards in this subwatershed are of no concern.

Eroding croplands are estimated to deliver 269 tons of sediment per year to the Milwaukee River and the East Branch. This is estimated to account for approximately 95 percent of the sediment load to the waterways within this subwatershed.

Only one-half of the uplands are estimated to be contributors of this sediment load. This is due in part to the fact that about one-half of the lands in the subwatershed are internally-drained. Neither riparian nor non-riparian wetlands receive appreciable sediment loads in this subwatershed.

Streambank degradation was found to be severe at four sites. Erosional sediment from two of these sites, both located on the Milwaukee River, accounts for five percent of the estimated sediment load delivered to the surface waters. The two remaining sites, one on the Milwaukee River and one above Highway 28 on the East Branch, are significant primarily because of cattle access that results in trampling of the streambed and banks.

Urban Sources:

The village of Kewaskum is immediately adjacent to the East Branch of the Milwaukee River. However, most of the existing urban runoff from the village is directed towards the Milwaukee River in the Kewaskum Subwatershed.

The urban growth anticipated in the Kewaskum Study Area, and the attendant increase in urban pollution potential, was discussed in the analysis for the Kewaskum Subwatershed where most of the existing and anticipated growth occurs. Map 6 shows, however, that some of the future anticipated urban growth in the Kewaskum Study Area is expected to occur to the northeast of the village in the drainage to the East Branch of the Milwaukee River.

The nature of this future urban land use within the Smith Lake Subwatershed in not known, and consequently the significance of the urban runoff from newly created impervious areas cannot be predicted. However, the potential for construction erosion on wetlands in streams close to the potential development is considerable.

WATER RESOURCES OBJECTIVES

Most of the problems and threats to the surface waters in this subwatershed are from nonpoint sources. Although limitations on the existing uses are few, a good deal of protection can be achieved through controlling the critical sources identified.

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect the existing aquatic life and recreational uses of the East Branch and the Mainstem of the Milwaukee River.

b. Decrease pollutant loads to downstream water resources.

West Bend Subwatershed

Water Resources Conditions

There is one major stream, two minor perennial streams, and six intermittent streams in the West Bend Subwatershed. In addition, the subwatershed contains three natural lake basins and four impoundments which have been formed along the Milwaukee River.

Milwaukee River and Impoundments: The Milwaukee River is the only major perennial stream located in this subwatershed, and constitutes its principal surface water resource. The segment of the Milwaukee River within this subwatershed is approximately 16.3 miles long and has an average gradient of 5.5 feet per mile.

The river is impounded at four locations. Three dams impound the river above and within the city of West Bend. These include: the Young America Millpond, a small linear impoundment located about .5 miles upstream of the city of West Bend; the Barton Millpond, an 18 acre impoundment managed for hydroelectric power generation located just upstream of State Highway 144 within the city of West Bend; and the West Bend Pond, a 67 acre impoundment located just upstream of State Highway 33 within the city of West Bend. The fourth impoundment is located several miles downstream in the village of Newburg. The Woolen Mills Pond, a 68 acre impoundment formed just upstream of County Highway G in the city of West Bend, was replaced with a free flowing stream reach in 1988 with the permanent removal of the Woolen Mills dam.

Habitat and other physical and chemical features along free-flowing reaches of the Milwaukee River are suitable for sustaining a diverse and abundant warmwater sport and forage fish community. Notably, the Greater Redhorse, a fish contained on the Wisconsin State Watch Species list, was collected during 1986 from the free-flowing reaches located between the Young America Pond and the Barton Pond, and just below the former Woolen Mills Pond dam. These free-flowing reaches of the river are also capable of supporting full body contact types of recreation.

The free-flowing portions of the Milwaukee River are only partially meeting their full potential uses. Sedimentation, excessive macrophyte growth and high bacteria counts are the most limiting problems. Nonetheless, these segments can be considered to have high resource value. The free-flowing reach located below the West Bend Millpond is of particular note. This reach was recently extended by removal of the Woolen Mills Dam in 1988. The city of West Bend is planning to expand its Riverside Park onto the site of the former millpond, providing canoe access, recreational fields, trails, and walkways. The Department has plans to re-establish a high quality sport fishery in this part of the river through improvement of habitat and fish stocking.

Habitat and physical-chemical features along impounded reaches of the Milwaukee River are suitable for sustaining more tolerant forms of forage fish and other aquatic life and limited numbers of warmwater sport fish. Sedimentation, limited habitat, poor water quality (ie. elevated water temperatures, turbidity, low dissolved oxygen levels) and polluted sediment are the most limiting problems. Factors and pollutants responsible for these problems include sediment, toxic materials, nutrients, greater retention time, abundant carp populations, filling of wetlands, shallow water depths, and respiration by excessive amounts of macrophytes and planktonic algae.

Millponds in the city of West Bend are known to contain contaminated sediments. Analysis of sediments from the former Woolen Mills Impoundment, for example, show that sediments were "heavily polluted" according to USEPA sediment pollution classification criteria for a variety of materials. These include copper, lead, cadmium, mercury, oil and grease. Sediments were shown to be "moderately polluted" for arsenic and chemical oxygen demand. This level of contamination is not expected to pose a human health hazard in the new parklands created by removal of the dam (ITT Corporation Report, 1987).

Long-term exposure of fish to elevated concentrations of toxic materials found in these impoundments may also be affecting the fish populations. For example, fish collected from the former Woolen Mills Impoundment during 1986 showed frequent occurrences of parasites, bacterial or fungal infections, and tumors. Fish tissue analysis showed detectable concentrations of PCB's, dieldrin, chlordane, and DDT, although all were below the FDA consumption standards. No detectable levels were found in fish tissue for metals including arsenic, cadmium, chromium, or lead. Detectable levels of copper and mercury were found, but these did not exceed the consumption standards.

Perennial Streams: Perennial streams include Myra Creek and an un-named stream tributary to the Milwaukee River in the southeast quarter of Section 17, Trenton Township.

Habitat, biological and other physical features along Myra Creek and its impoundments are suitable for sustaining intolerant forage fish and aquatic life and limited numbers of warmwater sport fish. Water depths present within the impoundments provide for a variety of full body contact types of recreation. Sedimentation is the greatest threat to maintaining the existing uses of Myra Creek.

Habitat and other physical and biological features of the un-named perennial stream are suitable for sustaining more tolerant forms of forage fish and aquatic life. Wetlands present along tributaries and headwaters of this stream may provide suitable spawning habitat for northern pike populations indigenous to the Milwaukee River. Recreational uses include partial forms of body contact.

Sedimentation and limited habitat are the most important problems impacting this stream. Factors and pollutants responsible for these problems include sediment, channelization and draining of wetlands.

Intermittent Streams: There are six intermittent streams in this subwatershed. Their respective confluences with the Milwaukee River are concentrated in Sections 16 and 17 of Trenton Township, where four enter the Milwaukee. The other streams are tributary to the Milwaukee River in Section 2 of West Bend Township and in Section 11 of Trenton Township.

Habitats along these intermittent tributaries are rated "fair" to "poor" and are capable of sustaining tolerant to very tolerant forms of forage fish and aquatic life and partial body contact types of recreation. In all instances, these streams are only partially meeting their full potential use.

Sedimentation, limited habitat, and "natural" low-flow characteristics are the major problem impacting their use. Factors or pollutants responsible for these problems include sediment, channelization and draining of wetlands.

Biological and recreational uses of all of the perennial and intermittent tributaries are closely tied to adjoining wetlands and seasonal high flow. The development of a balanced fish and aquatic life community along the Milwaukee River will be dependent on maintaining suitable spawning habitat provided by many of these tributary streams and reducing the amounts of pollutants exported to the Milwaukee River.

Lakes: Fish habitat and existing fish stocks indicate that Radtke and Proschinger lakes support a variety of fishable populations of warmwater sport and forage fish species. No public access is provided.

Nonpoint Sources of Pollution

General Land Use: This subwatershed is predominantly rural. Rural land uses cover 77 percent of the area, while urban lands cover the remaining 23 percent. Most of the urban land use (85 percent) is in and immediately adjacent to the city of West Bend. The remainder is concentrated in and adjacent to the village of Newburg. It is important to note that significant additional urban acreage is contained within the Quaas Creek and Silver Creek subwatersheds which are tributary to the Mainstem of the Milwaukee River in and just below the city of West Bend.

Table 30 shows the distribution of rural lands in the West Bend Subwatershed. Croplands make up 53 percent of the 11,898 rural acres. Most of this cropland is in rotation. Wetlands, grasslands, and woodlands are also important, each constituting about 15 percent of the rural land use.

Urban land use in the portions of the West Bend Study Area located in this subwatershed covers 2,981 acres. Low intensity land uses such as medium and low density residential areas, open space, parkland, and cemeteries cover about 60 percent of this urban acreage. Higher intensity land uses such as commercial strip, industrial, institutional, and high density residential areas cover the remainder.

Urban land use in the Newburg Study Area cover 528 acres. Most of this acreage is residential, which covers 80 percent of the urban area. Commercial, industrial, and institutional land uses are limited to eight percent of the existing urban land use.

The entire course of the Milwaukee River, Myra Creek, and the unnamed perennial stream are contained in the "primary" environmental corridor (SEWRPC, 1970 and 1985). The open space lands along these streams provide a variety of recreational use activities including swimming, boating, canoeing, fishing, hunting and site seeing.

Rural Sources: Any discussion of nonpoint sources must recognize that the Milwaukee River within the West Bend Subwatershed receives pollutants from the East, West, and Upper Mainstem Regions of the East-West Watershed as well as from the West Bend Subwatershed. In addition, the Quaas Creek and Silver Creek subwatersheds are tributary to the Milwaukee River at West Bend.

Table 35 shows the results of the rural nonpoint source inventory for this subwatershed.

Barnyards are a relatively insignificant source of pollution to surface waters. Of the 17 barnyards draining to surface waters, one is a significant source and four are of marginal concern. The significant barnyard drains to the Milwaukee River via the intermittent stream tributary to the Milwaukee River in Trenton Township. Barnyards draining to pocket wetlands have low pollution potentials, and those draining to deep soils are of no concern. The hazard posed by barnyards draining to shallow soils is not known.

Eroding uplands are estimated to deliver 719 tons of sediment per year to surface waters. About 90 percent of this comes from croplands in rotation and five percent comes from row cropland. This sediment load from eroding uplands is estimated to make up about 55 percent of the sediment load coming from this subwatershed. About two-thirds of the agricultural uplands are estimated to be contributors of this sediment load to surface waters.

The remaining agricultural areas do not deliver eroded sediment to surface waters partly because of internal drainage and partly because of the buffering effects of all lands, including riparian wetlands. It is estimated that riparian wetlands trap an estimated 270 tons of sediment per year that would otherwise have entered surface waters. Wetland vegetation within internally-drained areas receives an additional 248 tons of sediment per year. The effects of this sediment deposition on these wetlands is unknown, but expected to vary widely, as does the sensitivity and value of the wetlands themselves.

Significant streambank degradation occurs at 10 sites in the subwatershed, affecting nearly 3,000 feet of streambank and delivering an estimated 229 tons of sediment directly to surface waters. Overall, streambank erosion accounts for about 17 percent of the sediment delivered to surface waters from this subwatershed.

Eight of these streambank sites are located on the Milwaukee River, with seven of these significant sediment producers. None of these have cattle access. Two sites are on tributary streams. One of these,a significant sediment producer, is located on the intermittent stream tributary to the Milwaukee River in Section 11 of Trenton Township. The other is significant primarily because of the extensive streambank trampling caused by cattle.

Urban Sources: Diffuse urban runoff contains a wide array of pollutants that can lead to the degradation of surface waters. Each urban pollutant is associated to varying degrees with specific types of urban land uses. The pollutants, therefore are generated wherever these land uses occur, regardless of the size of the community. The nature of the stormwater conveyance system, however, can have a dramatic effect on the transport and delivery to surface waters of these pollutants generated in urban areas.

Three pollutants were chosen to represent the pollution potential of this urban area. Phosphorus was chosen because it is commonly associated with surface water enrichment, and is also a pollutant generated by rural land uses. Suspended solids was chosen for the same reasons. In addition, many urban pollutants attach themselves to suspended solids in runoff, and therefore suspended solids can be used as a general indicator of other particulate pollutants generated and transported from urban areas. Lead was chosen because of its toxicity, and because it, along with many other heavy metals, are the most commonly detected priority pollutants in urban runoff (USEPA, 1983).

The discussion of urban pollution sources in the West Bend Subwatershed is divided into two subsections. The first covers the city of West Bend, and complements similar subsections for the city contained in the Quaas Creek and Silver Creek subwatershed discussions. The second subsection covers the village of Newburg.

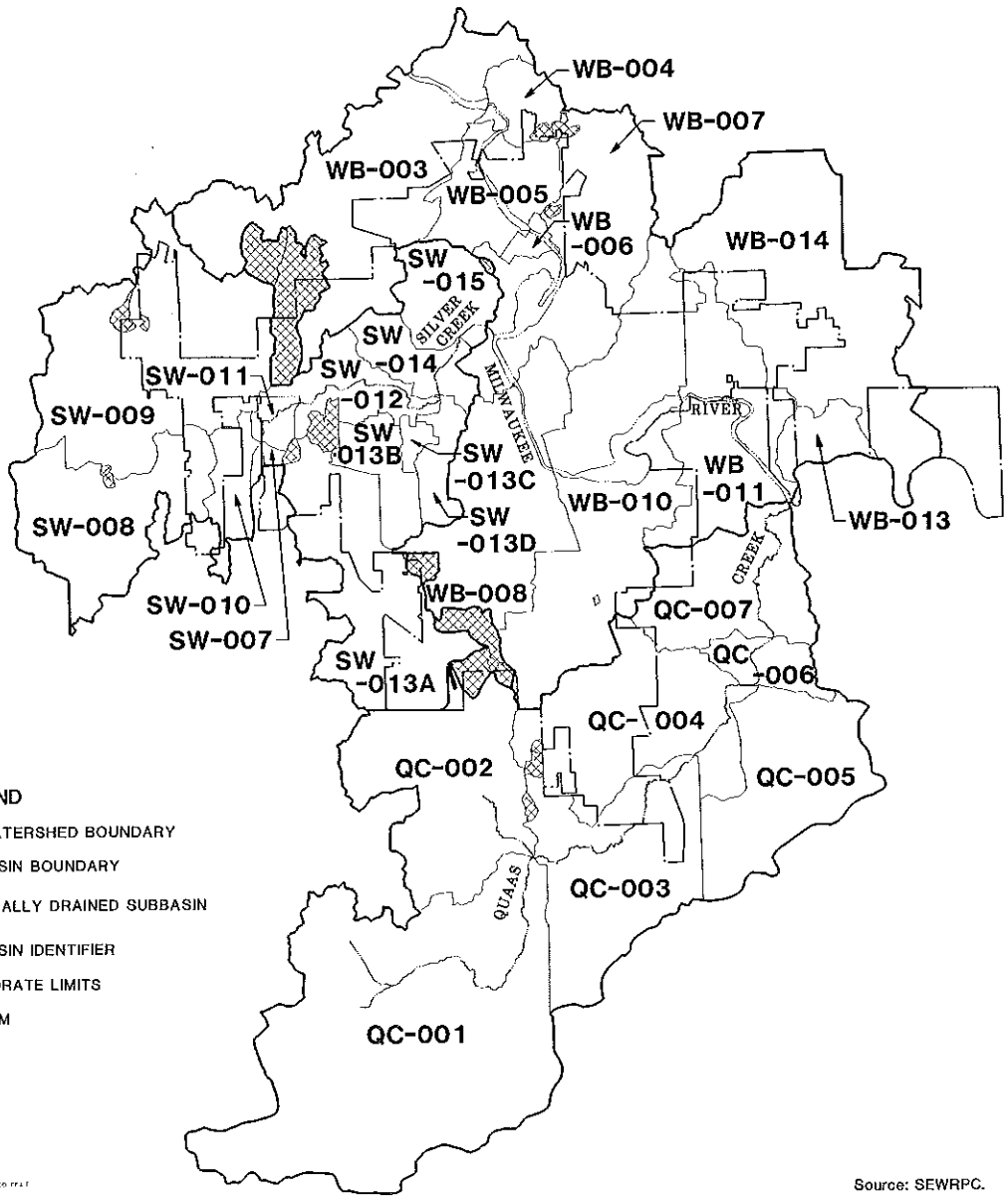
City of West Bend: The main purpose of this analysis is to focus on the critical source areas within the urban areas of the West Bend Subwatershed.

The analysis of urban nonpoint pollutant loadings in the city of West Bend is approached in two ways. First, pollutant loads from individual urban sub-basins are identified. This allows an assessment of where the highest pollution loads are entering the surface water network. In conjunction with water resources information, this sub-basin approach allows us to focus on storm sewer discharges endangering high priority water resources. The second approach is to look at the pollutant loads based on the land uses which generate them. This allows an assessment of high priority source areas that are producing the pollutants within each sub-basin. Map 7 shows the urban sub-basin delineation for the entire city of West Bend. Map 8 shows the existing distribution of generalized land use categories within the city of West Bend Study Area.

Table 36 shows the annual urban nonpoint pollutant loadings from the city of West Bend Study Area. Urban lands within the West Bend Subwatershed contribute a significant portion of the urban pollutant load coming from the

MAP 7

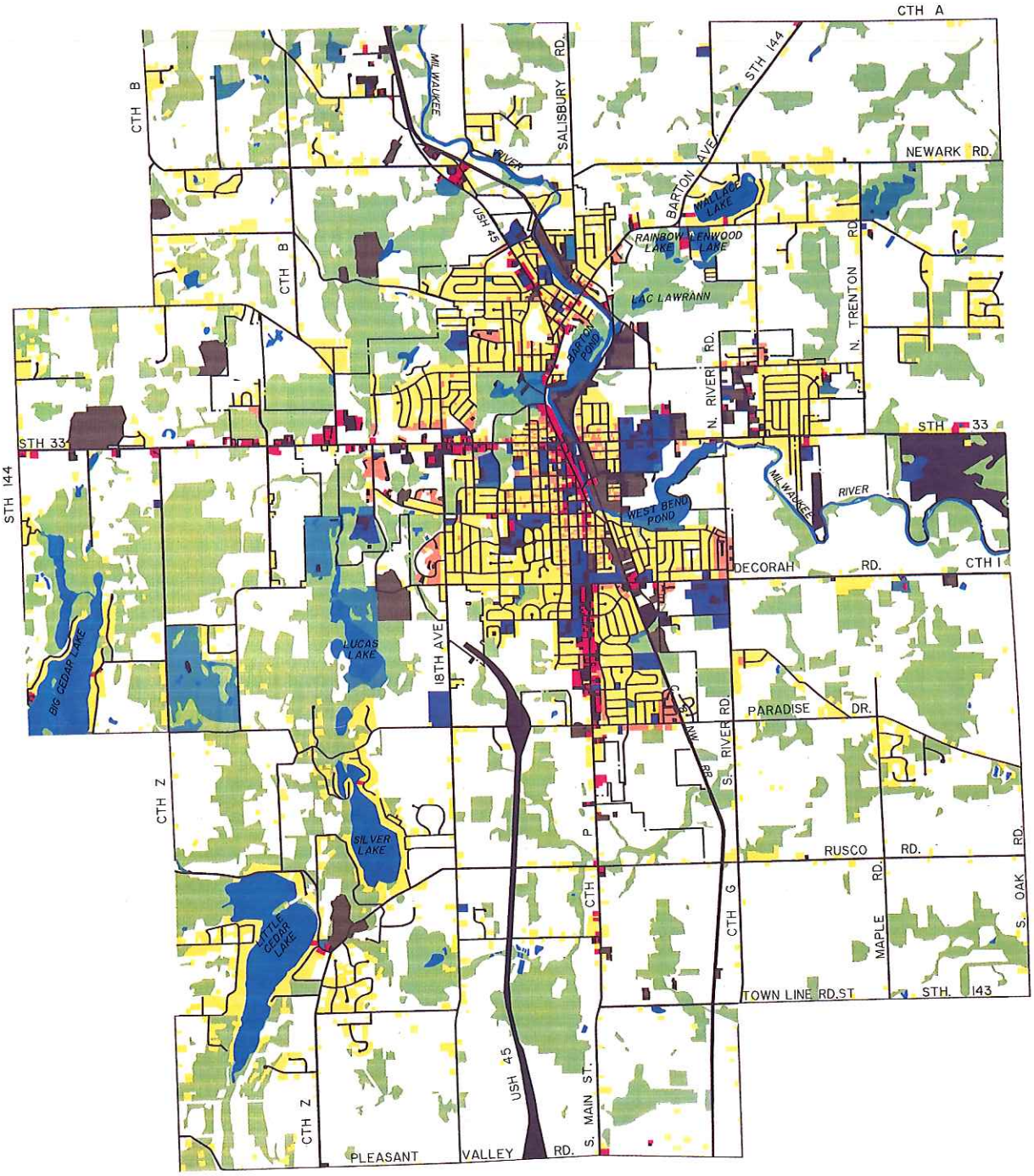
WEST BEND STUDY AREA



Source: SEWRPC.

MAP 8

EXISTING LAND USE IN THE
WEST BEND STUDY AREA: 1985



LEGEND

- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATION AND UTILITIES
- GOVERNMENTAL AND INSTITUTIONAL
- RECREATIONAL
- WATER
- WETLANDS AND WOODLANDS
- AGRICULTURAL AND OTHER OPEN LAND
- CITY OF WEST BEND CORPORATE LIMITS (1987)

Source: SEWRPC.

GRAPHIC SCALE
0 2000 4000 6000 FEET

West Bend Study Area. For example, the urban portions of the West Bend Study Area contained within this subwatershed contribute between 66 percent and 73 percent of the urban pollutant loading, while the urban lands within Silver Creek and Quaas Creek subwatersheds contribute about 20 percent and 10 percent respectively. This importance is not due solely to the fact that the West Bend Subwatershed contains more urban lands within the study area than do the Quaas Creek or Silver Creek subwatersheds. It is partly due to the fact that a large portion of the critical urban land uses are found here. This is evident by the fact that this portion of the study area contains 55 percent of its urban land use, yet contributes 70 percent of its pollutant load.

Control of critical urban areas within the West Bend Subwatershed portion of the West Bend Study Area is therefore a necessary component of reducing urban pollutant loads to the Milwaukee River in the vicinity of West Bend. It is also an important consideration in reducing overall sediment loadings to the River, since the urban portion of the West Bend Study Area contributes about 28 percent of the total suspended sediment loading from all land uses, including rural.

The need for controls in the Silver Creek and Quaas Creek Subwatershed are discussed elsewhere.

The relative importance of urban sub-basin discharges to the West Bend Subwatershed from the city of West Bend Study Area are shown in Table 37. The relative pollution potentials of urban sub-basins WB010, WB008, and WB007 stand out as highly significant, contributing about 70 percent of the urban pollutant loading. Urban Sub-basin WB010, having the highest pollution potential, and WB008, having the second highest potential, both discharge via storm sewer pipes immediately upstream or directly into the Woolen Mills Park renovation project area described in the previous section. This is recognized as a high value water resource by both the Department and the city of West Bend. WB007 discharges via storm sewers to the West Bend Pond. Although the pond has limited resource value, the discharge from the dam, and any pollutants it may carry, feeds directly into the renovation project area.

Table 38 shows the relative importance of different urban land use types as pollutant sources in the subwatershed. The analysis is restricted to lead, since the major source of suspended sediment and phosphorus in the Milwaukee River is the rural contribution. Four land uses stand out as significant pollutant contributors. Commercial strip, medium industrial, light industrial, and miscellaneous institutional lands contribute 70 percent of the pollutant load while making up only 22 percent of the urban land use in this part of the West Bend Study Area. These four land uses represent a focal point for control of urban runoff at its source. Other land uses either contribute relatively little, or make moderate contributions only because of the large acreage as in the case of the residential land uses.

Further focusing can be achieved by looking at the contribution of the four critical land uses only where they occur within the three critical urban sub-basins. Table 39 shows that a significant portion of these critical land uses in fact occur within these critical urban sub-basins. Nearly three-fourths of

the commercial strip, light industrial, and miscellaneous institutional lands within the subwatershed occur within sub-basins WB007, WB008, and WB010; nearly two-thirds of the medium industrial lands within the subwatershed occur in these sub-basins. Table 40 shows the portion of the urban pollutant load for this subwatershed represented by the critical land uses lying within the four critical sub-basins. A total of 50 percent of the subwatershed urban pollutant load is coming from these lands, which represent only 12 percent of the subwatershed urban area.

In summary, by focusing on the critical urban sub-basins affecting the high quality segments of the Milwaukee River in the West Bend area, 70 percent of the urban pollutants can be accounted for by looking at 50 percent of the urban subwatershed area. By focusing on critical land uses, 70 percent of the pollutant load can be accounted for by 22 percent of the urban lands in the subwatershed. By focusing on critical land uses within critical sub-basins, 50 percent of the pollutant load can be accounted for by 12 percent of the subwatershed urban lands.

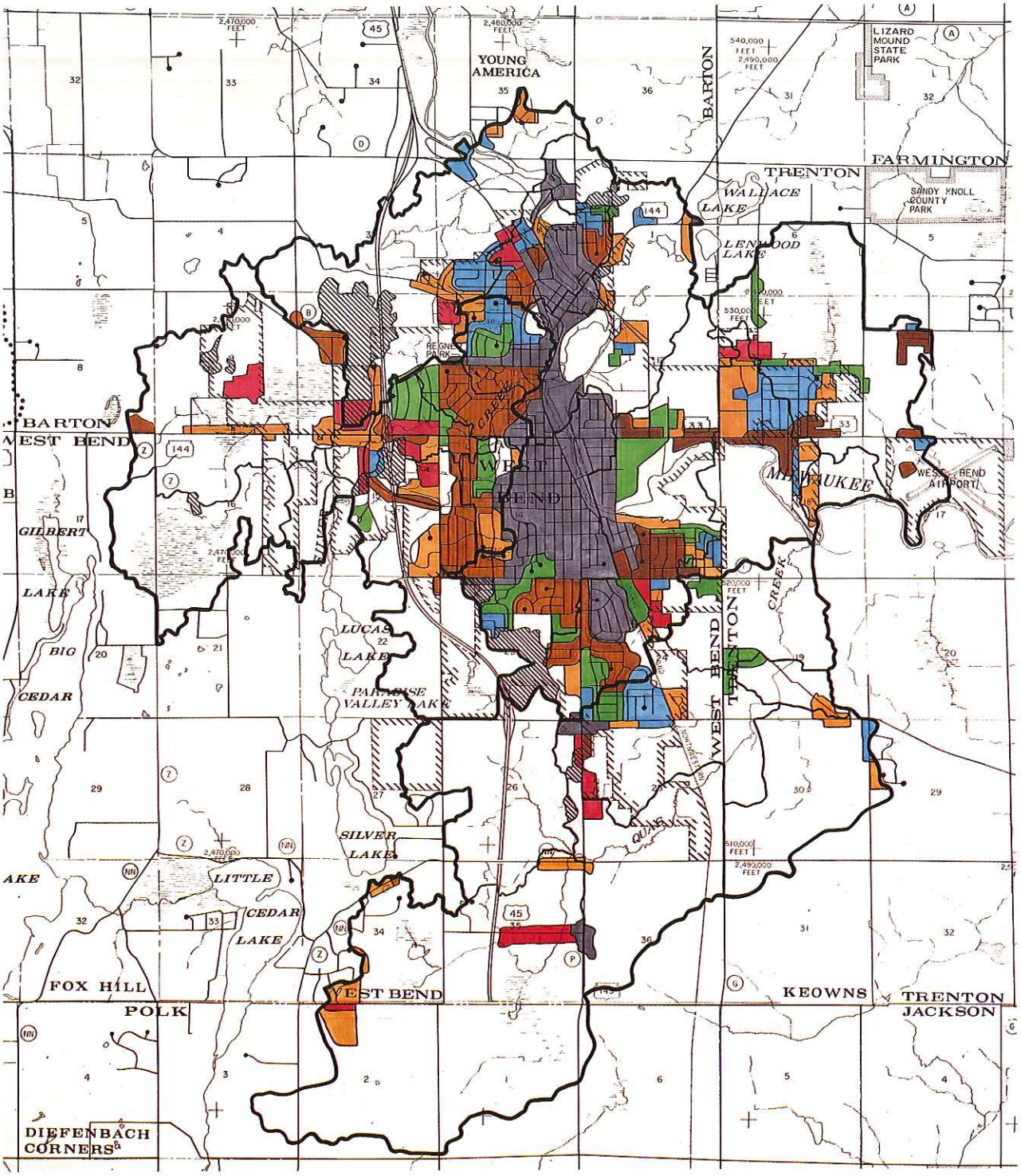
There has been a considerable pollution potential associated with past construction activities, although the actual sediment loading to surface waters from this activity is not known. It is estimated that between 1963 and 1985, urban land uses in the entire city of West Bend Study Area increased by 1875 acres, or about 85 acres per year. Map 9 shows the pattern of historic development in the study area. About 75 percent of this development occurred within the city of West Bend, where a total of 1404 acres were converted to urban land uses during this period for an annual average of 64 acres. The remaining development occurred in areas within the study area outside of the city limits. This amounted to 470 acres over the 22 year period, or an average annual conversion rate of 21 acres. The development in both the city and outlying areas consisted mainly of residential areas, followed in importance by development of transportation, communication, and utility land uses.

The potential construction erosion from 1874 acres of development is considerable, about 53,000 tons in total or about 2,400 tons per year. This annual erosion potential is equal to two times the existing estimated annual sediment load from all sources in the subwatershed, and to about one-half of the estimated annual load from all sources within the entire region. Even if only a portion of the potential historic construction erosion made its way to surface waters, the loading would have been considerable.

Map 10 shows the anticipated urban land use in the city of West Bend Study Area for the year 2000. Table 41 shows the distribution of future urban land use for that portion of the West Bend Study Area located in the West Bend Subwatershed. The total urban land use is expected to increase from the existing 2,981 acres to 5,069 acres, or an increase of 70 percent. About 70 percent of the anticipated growth is expected to be residential. Commercial and industrial land use growth is anticipated to account for an additional 20 percent of the increase. Minor increases are expected in the remaining land uses. A significant portion of this development will occur outside of the existing city limits in the town of West Bend and Trenton.

MAP 9

HISTORIC URBAN DEVELOPMENT IN THE WEST BEND STUDY AREA



LEGEND

URBAN GROWTH

- 1950
- 1963
- 1970
- 1975
- 1980
- 1985

SUBWATERSHED BOUNDARY

SUBBASIN BOUNDARY

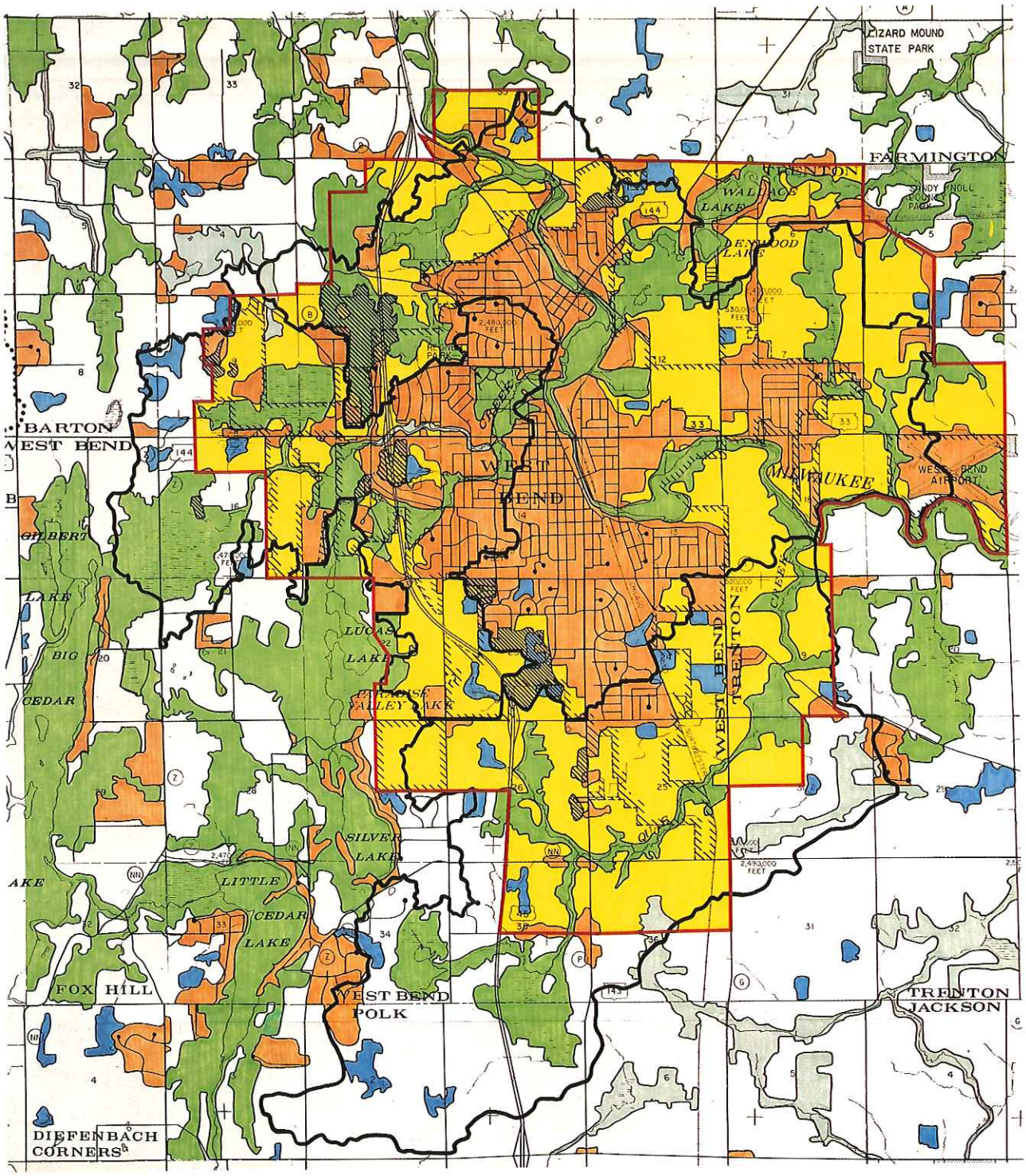
INTERNALLY DRAINED SUBBASIN

Source: SEWRPC.

GRAPHIC SCALE 0 2000 4000 FEET

MAP 10

EXISTING AND PLANNED URBAN AREAS IN THE WEST BEND STUDY AREA



LEGEND

- PRIMARY ENVIRONMENTAL CORRIDOR
- SECONDARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- EXISTING URBAN LANDS
- PLANNED ADDITIONAL URBAN LANDS
- URBAN SERVICE AREA BOUNDARY
- SUBWATERSHED BOUNDARY
- INTERNALLY DRAINED SUBBASIN

Source: SEWRPC.

GRAPHIC SCALE 0 2000 4000 FEET

The water quality implications of future development are two-fold. First is the pollution potential attendant to construction site erosion if not properly controlled. Second is the pollution potential of new urban impervious surfaces, if appropriate stormwater control practices are not used.

Potential construction erosion impacts are dramatic. The construction site erosion potential for 2,088 acres of development is about 63,000 tons of sediment, or about 4,200 tons of sediment per year. Even if only a small portion of the eroded sediment is delivered to surface waters, the annual sediment load would be significant and the potential impact on water resources potentially catastrophic. The city of West Bend has a construction site erosion control ordinance which, if adequately enforced, will minimize the impact of construction activities within the city.

The pollution potential of the future urban area in the West Bend Subwatershed portion of the city of West Bend Study Area is shown in Table 41. Using lead as an indicator, if the anticipated development is not served by stormwater runoff control measures, the estimated pollutant loading will increase from the existing 1,600 pounds of lead to an expected 2,800 pounds of lead. This represents an increase of about 75 percent. Commercial, industrial, and miscellaneous institutional lands would continue to produce a significant portion of the lead load (70 percent) while making up only 20 percent of the urban land use.

Village of Newburg: Estimated urban loads in the Newburg Study Area for suspended solids and phosphorus are 47,000 pounds and 168 pounds respectively. The urban contribution of these materials is relatively low compared to other sources within the subwatershed. The established urban areas of the village contribute less than one percent of the suspended sediment load generated within the subwatershed. This percentage becomes even less significant when the contributing sediment sources in upstream subwatersheds are considered. The urban nonpoint source contribution to the phosphorus load to the Milwaukee River is also considered to be relatively insignificant.

It should be noted that although existing urban areas are overshadowed by rural sources in the production of suspended sediment, there has been a considerable pollution potential associated with past construction activities. It is estimated that between 1963 and 1985, urban land uses in the study area increased by 258 acres, or about 12 acres per year. About 20 percent of this development occurred within the village limits where 47 acres were converted to urban land uses for an annual average conversion of about two acres. Most of this development was residential, with smaller acreage of industrial and transportation land uses also created. About 80 percent of the development occurred outside the village, in the town of Trenton. In these outlying areas, 211 acres have been developed for an average annual rate of about 10 acres. Most of the development in these outlying areas has been residential with associated transportation.

The potential construction erosion from 258 acres of development is considerable, about 7,700 tons in total or about 350 tons per year. This

annual erosion potential is equivalent to about one-fourth the estimated annual sediment delivery to water resources in the subwatershed. Even if only a small portion of this erosion made it to surface waters, the impacts would have been considerable.

Urban pollutants of primary concern for the established urban land uses in the Newburg Study Area include: heavy metals, typified by lead; pathogens; oils and greases; and a wide array of hazardous materials that can make their ways into urban stormsewer systems and surface waters (DNR Publication Brochure).

Map 11 shows the existing urban land use distribution in the village of Newburg Study Area, and Table 42 shows the relative pollution potential of these land uses. The total existing urban lands cover 528 acres, and produce an estimated annual lead load of about 100 pounds. Commercial, non-quarry industrial, and institutional lands, all which have a high capability of generating urban pollutants, produce the majority of the lead load. Although these lands make up only eight percent of the urban area, they contribute nearly 70 percent of the lead load. All of these industrial non-quarry lands and the institutional lands are within the village; most of these commercial lands are within the village as well. The industrial lands shown outside the village limits on Map 11 are quarry lands which do not produce urban runoff.

Residential lands, which have a relatively low capacity for producing lead loads, nonetheless combine to produce 32 percent of the lead loading. This large contribution is the result of the large amount of this land use, which makes up 80 percent of the urban acreage. The residential lands are also important sources of pesticides, human disease causing pathogens, and a wide array of chemicals often improperly used or disposed. Most of these residential areas are outside of the village limits.

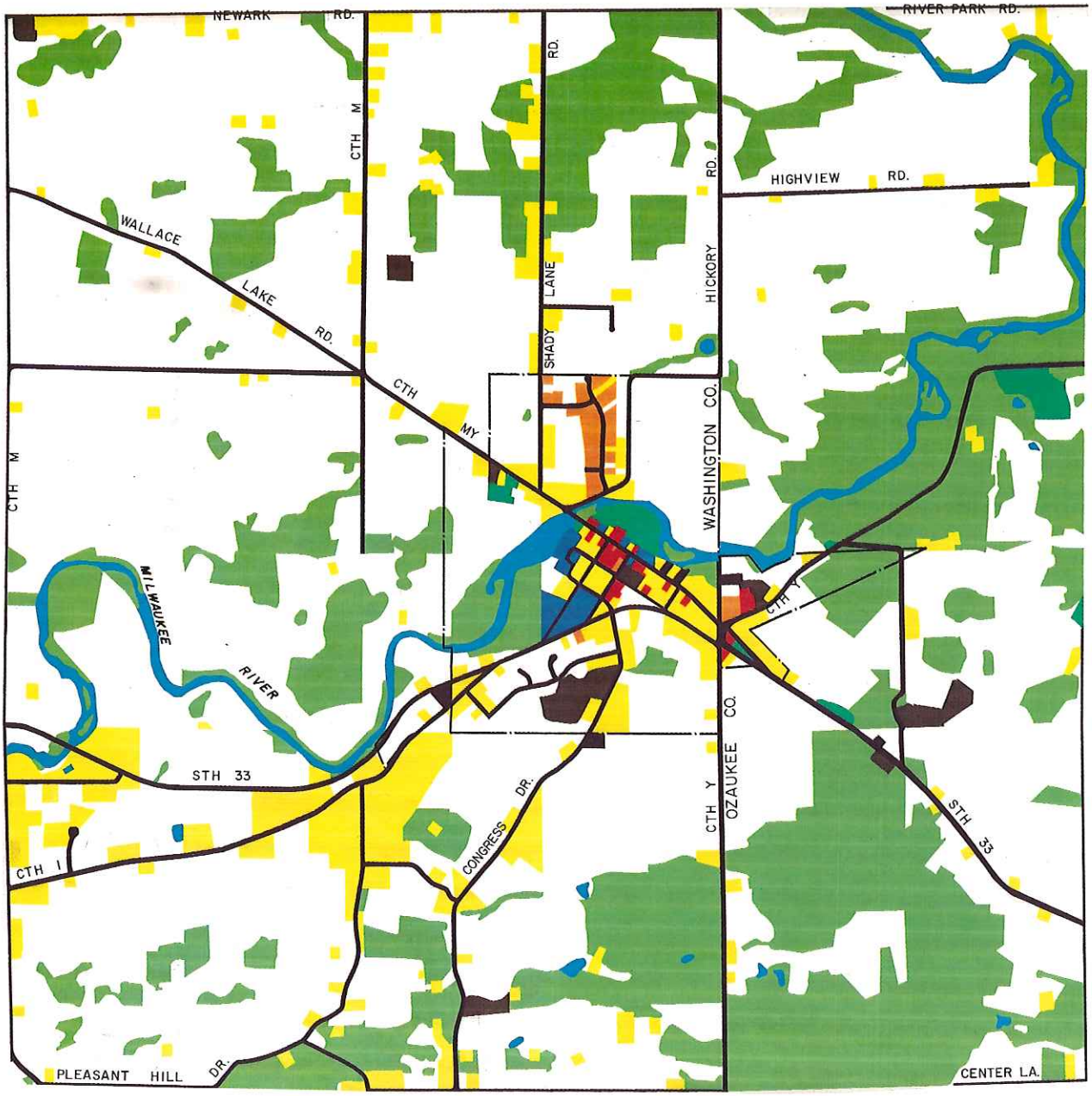
Map 12 shows the anticipated urban land use distribution in the village of Newburg Study Area for the year 2000, and Table 43 shows the relative pollution potential of this future urban area.

The existing urban area is projected to expand from 528 to 1,241 acres. This represents an increase of 713 acres, which would more than double the urban land use over the next 12 years. Most of the projected urbanization will occur in the industrial land use category, which is projected to increase by 478 acres. This represents nearly two-thirds of the total anticipated urban growth. Residential areas are anticipated to grow by 205 acres, which represents 29 percent of the projected growth. A small addition (16 acres) of commercial land use is also anticipated to occur. Significant portions of this development are anticipated to occur both within and outside of the existing village limits.

The water quality implications of future development are two-fold. First is the pollution potential attendant to construction site erosion if not properly controlled. Second is the pollution potential of new urban impervious surfaces, if appropriate stormwater control practices are not used.

Map 11

EXISTING LAND USE IN THE
NEWBURG STUDY AREA: 1985



LEGEND

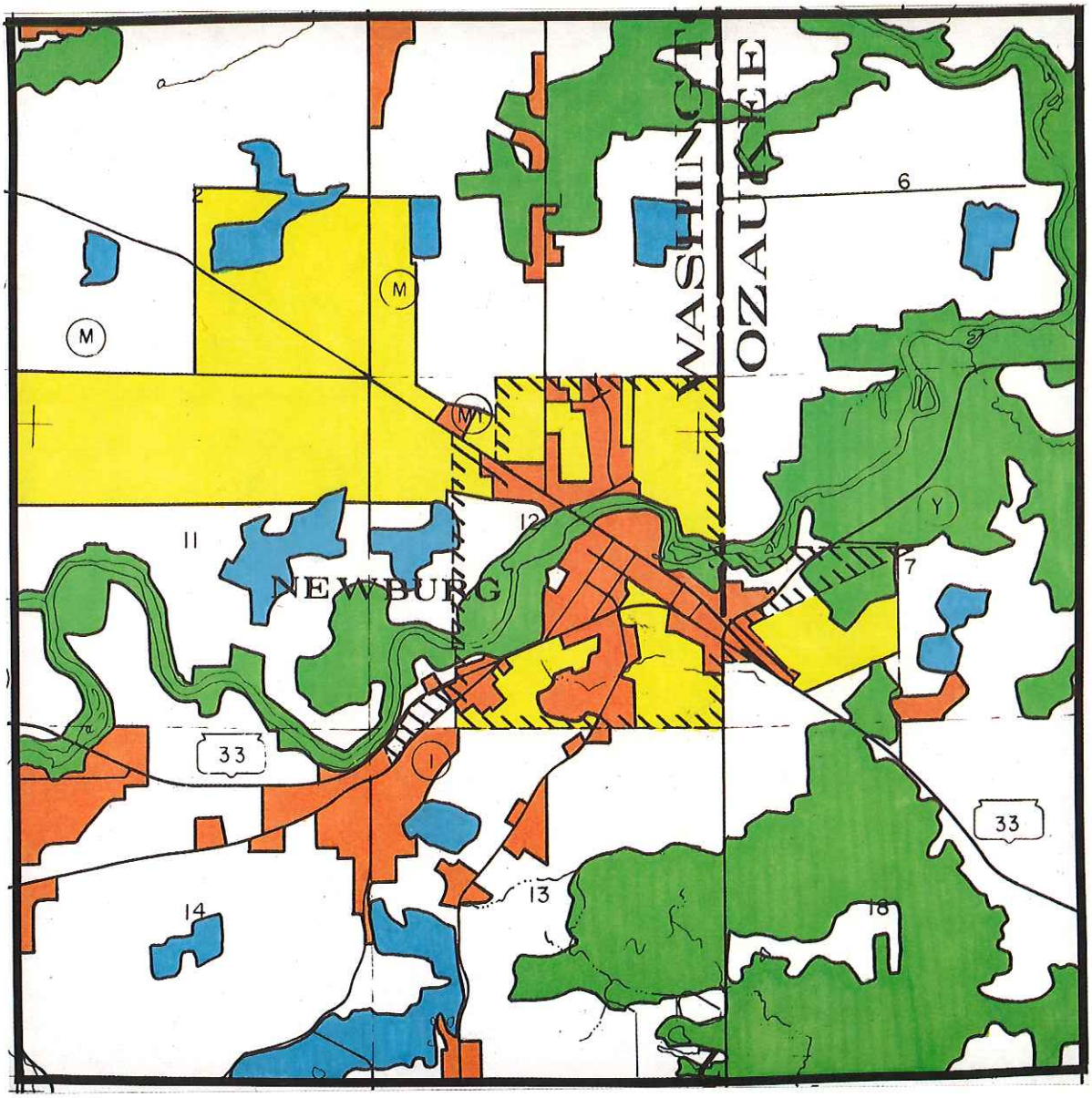
- SINGLE-FAMILY RESIDENTIAL
- MULTI-FAMILY RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- TRANSPORTATION, COMMUNICATION AND UTILITIES
- GOVERNMENTAL AND INSTITUTIONAL
- RECREATIONAL
- WATER
- WETLANDS AND WOODLANDS
- AGRICULTURAL AND OTHER OPEN LAND
- VILLAGE OF NEWBURG CORPORATE LIMITS (1986)

Source: SEWRPC.

GRAPHIC SCALE
0 1000 2000 3000 FEET

Map 12

EXISTING AND PLANNED URBAN AREAS
IN THE NEWBURG STUDY AREA



LEGEND

- PRIMARY ENVIRONMENTAL CORRIDOR
- ISOLATED NATURAL AREA
- EXISTING URBAN LANDS
- PLANNED ADDITIONAL URBAN LANDS
- STUDY AREA BOUNDARY

Source: SEWRPC.

GRAPHIC SCALE
0 1000 2000 FEET

Potential construction erosion impacts are dramatic. The construction site erosion potential for 713 acres of development is about 21,000 tons of sediment, or about 1,700 tons of sediment per year. This is approximately equivalent to the existing annual estimated sediment load from all sources within the entire subwatershed. Even if only a portion of the potential eroded sediment is delivered to surface waters, the potential impact would be significant.

The potential increase in lead load from new urban areas is estimated to be ten-fold, from about 100 pounds to about 1,100 pounds. The expected increase in industrial land use would be responsible for most of this increase. A small increase in lead load is also expected due to the increase in commercial land use. The relative importance of different land uses as pollutant contributors will shift dramatically, as industrial lands are projected to produce 86 percent of the lead load as opposed to 23 percent currently.

Water Resources Objectives

Rural nonpoint source pollution is a significant contributor to the factors limiting the quality of existing uses in the Milwaukee River and its tributaries, and is the principal source of nutrient and sediment pollution in the subwatershed. The impact from existing urban runoff is not fully known, but the existing water resource conditions in impoundments located in West Bend indicate that toxic materials known to be present in urban runoff are finding their way into the aquatic environment and are contributing to the degradation of these resources. Unfortunately, these impoundments may not respond to urban runoff controls because of their serious problems. The urban pollution potential is also high for some of the free-flowing reaches of the Milwaukee River within the West Bend area. These reaches have a high resource value.

The water resources objectives for the Nonpoint Source Control Program are in the West Bend Subwatershed are to:

a. Protect the quality of the existing recreational and aquatic life uses for the impounded reaches of the Milwaukee River (including the Young America, Barton, West Bend, and Newburg impoundments) and for the free-flowing reaches below the Young America, Barton, and Newburg impoundments.

b. Enhance the existing recreational and aquatic life uses for the free-flowing stream reaches below the West Bend Pond, particularly the newly created reach at the site of the former Woolen Mills Dam.

c. Enhance the existing recreational and aquatic life uses of the perennial and intermittent tributaries to the Milwaukee River.

d. Protect sensitive and valuable wetlands from impacts of sedimentation, where the pollutant attenuation capacity of these areas is overloaded.

e. Protect sensitive groundwater areas from animal waste runoff, where necessary.

SILVER CREEK SUBWATERSHED

WATER RESOURCES CONDITIONS

Silver Creek is the major stream located in this subwatershed. It discharges to the Milwaukee River just upstream of the West Bend Pond Dam. Two smaller perennial streams, Engmann Creek and Washington Creek, discharge to Silver Creek in the city of West Bend. Washington Creek joins Silver Creek near its headwaters, just downstream of Lucas Lake. Engmann Creek, sometimes known as Silverbrook Creek, is tributary to Silver Creek about .5 miles from its mouth.

There are three natural lakes and six impoundments contiguous with Silver Creek. The natural lakes include Silver, Lucas, and Paradise Valley (Hackbarth) lakes, which range in size from 9-118 acres and in depth from 15-47 feet. There is no public access to the natural lakes. The six impoundments are small and shallow, yet provide for extensive recreational uses. The most notable of the impoundments are the Regner Park Swimming Pond and the Regner Park Fishing Pond. The Regner Park swimming pond was created adjacent to Silver Creek, and discharges to it just upstream of the Regner Park Fishing Pond. The Regner Park Fishing Pond is formed by a low head dam on Silver Creek near its mouth. This dam currently is a barrier to upstream fish migration from the Milwaukee River.

Silver Creek: Habitat and other physical features along Silver Creek are suitable for sustaining intolerant forms of forage fish and other aquatic life, and partial body contact types of recreation.

Sedimentation, turbidity, and hydraulic loading are the most important problems impacting Silver Creek. When recent fishery survey information was compared to fishery survey information collected during 1976-78, there has been a decrease in the number of intolerant species and their relative abundance compared to other more tolerant species. The least darter, which is currently listed on the state of Wisconsin's Watch Fish List, was collected from Silver Creek during 1976-78 but not during 1986-88. The change in the fish community is coincidental with channelization and urbanization of the surrounding watershed. As such, these factors continue to limit water quality and habitat conditions in Silver Creek and are preventing it from meeting its full biological and recreational use potential."

Factors which currently or potentially limit Silver Creek's use objectives and supporting water quality and habitat include sedimentation from upland

sources, sedimentation from channel and bank scour due to excessive hydraulic loadings and channelization, pollutants associated with urban runoff and loss of valuable instream, and riparian habitat as a result of channelization and development within the environmental corridor.

Regner Park pond is a shallow and heavily silted impoundment located near the mouth of Silver Creek. Habitat is suitable for only the most tolerant forms of fish and aquatic life. Sedimentation, nuisance macrophyte growth and other pollutants associated with urban runoff such as heavy metals, nutrients and debris, are important factors limiting its biological and recreational use. The pond is reportedly used regularly by children and adults teaching children to fish.

In addition there is an unsubstantiated but probable discharge of chlorine from the Regner Park Swimming Pond to Silver Creek. The concentration of chlorine in the pond outlet and the associated chlorine toxicity are unknown, although this is a potential water quality concern for the lower reaches of Silver Creek.

It is expected that most of Silver Creek would respond favorably to urban stormwater controls. The Regner Park Fishing Pond however, would need intensive rehabilitation to support healthy fish populations. Rehabilitation would entail shoreline protection, dredging, and increasing the height of the impounding dam.

Engmann Creek: Engmann Creek originates in Section 15 of West Bend Township and is tributary to Silver Creek about .5 miles above its confluence with the Milwaukee River. Habitat and other physical features along Engmann Creek are suitable for sustaining intolerant to tolerant forms of forage fish and aquatic life (FAL-C), and partial body contact types of recreation. The creek currently supports a somewhat unique "coldwater" forage fish community including species intolerant to very tolerant of poor water quality and degraded habitat conditions (FAL-C). Prior to 1963, fishery surveys documented natural reproducing populations of brook trout. A local resident stated that he caught "trout" as recently as 1982. Since then, surveys conducted in 1986-88 indicate that natural trout populations have been extirpated from the stream. This change is coincidental with channelization and urbanization of the surrounding watershed.

Although trout populations are now absent, natural populations of mottled sculpin have recently been collected. The presence of this "coldwater" and intolerant forage species may indicate that at the least, marginal water temperatures for trout may still exist along localized reaches, including the pond at Bicentennial Park. In addition, channelization has reduced but not necessarily eliminated marginal habitat requirements for salmonids."

Factors which currently or potentially limit Silver Brook's use objectives and supporting water quality and habitat include sedimentation from upland sources, sedimentation from channel and bank scour due to excessive hydraulic loadings and past channelization, elevated water temperatures and other pollutants associated with urban runoff, and the loss of valuable instream and

riparian habitat as a result of channelization and development within the environmental corridor.

Streambank erosion is evident from the intersection of Eighteenth Avenue and Chestnut Street downstream to Sixteenth Avenue. A large stormsewer pipe enters the creek near the intersection of Chestnut and Seventeenth Avenue. Streambank erosion and channel scour is particularly evident from this point downstream to Sixteenth Avenue.

Washington Creek: Washington Creek originates in Sections 9 and 16 of West Bend Township, and is tributary to Silver Creek in Section 15, upstream of State Highway 33. Habitat and other physical features along this stream are suitable for sustaining a warmwater forage fish and aquatic life community tolerant to very tolerant of poor water quality and degraded habitat conditions. The stream also has the potential to support partial body contact types of recreation.

Factors which limit water quality and habitat include channelization, sedimentation from upland sources, sedimentation from channel and bank scour due to hydraulic loadings and other pollutants associated with urban runoff.

Lakes and Impoundments (excluding Regner Park Swimming Pond): Habitat and other physical and chemical characteristics of the three natural lakes present in this subwatershed are suitable for sustaining a diverse and abundant warmwater sport and forage fish and other aquatic life, and full body contact types of recreational uses. Planktonic algae growth is not a problem for Lucas or Silver lakes and present phosphorus loadings are low.

All of the six man-made impoundments along Silver Creek are capable of supporting a variety of forage fish species and lesser numbers of warmwater sport fish. Generally, water depths are suitable for supporting a variety of partial and full body contact types of recreational uses.
Sedimentation, excessive macrophyte growth, and shallow water depths are the most limiting problems. Pollutants and factors responsible for these problems include sediment, excessive nutrients, and shallow basins. Inundated upland soils may be an important source of aquatic plant nutrients.

Regner Park Swimming Pond: The Regner Park Swimming Pond is a small artificial pond created in 1932 and is operated solely as a municipal swimming facility. During the swimming season, the water is treated with the addition of chlorine and algicides. The pond is drawn down in the spring and fall to reshape the sand bottom and beaches. In the winter, the pond is maintained for ice skating. The swimming pond is located adjacent to Silver Creek and discharges to it just upstream of the Regner Park Fishing Pond.

Nonpoint Sources of Pollution

General Land Use: This subwatershed contains 3,062 rural acres and 1,428 urban acres, making it approximately one-third urban and two-thirds rural.

Table 30 shows the distribution of rural lands in the Silver Creek Subwatershed. Only 29 percent of the rural lands are cropped. Within this cropped portion, there are roughly equal acreage in continuous and rotated row crops. The remaining rural lands are predominantly grassland, ungrazed woodlot, and wetland. Low intensity urban land uses such as residential, recreational, and undeveloped open space cover about 80 percent of the urban area within the Silver Creek portion of the West Bend Study Area. High intensity land uses such as commercial institutional land uses cover the remainder.

The entire course of Silver Creek, its tributaries, lakes, and impoundments are contained in "primary" or "secondary" environmental corridor (SEWRPC, 1985). In addition, Silver Creek flows along adjoining wetlands, and the city of West Bend's Regner Park and Washington County's Ridge Run Park. As such, the stream and riparian lands provide open "green space" for sight-seeing, fishing, and wildlife observation.

Rural Sources: Table 44 shows the results of the rural nonpoint source inventory for this subwatershed. In general, eroding uplands are the only rural source of concern, since the streambank erosion site identified by the inventory is only of marginal concern. The eroding uplands are estimated to deliver 95 tons of sediment to surface waters. About one-half of this comes from croplands in rotation and the other half comes from continuous row cropland. This rural source makes up 40 percent of the estimated sediment delivered to surface waters in the Silver Creek Subwatershed.

It is estimated that about 50 percent of the rural uplands in this subwatershed are responsible for delivering sediment to surface waters. The remaining agricultural areas do not deliver eroded sediment to surface waters partly because of internal drainage and partly because of the buffering effects of all lands, including riparian wetlands. It is estimated that riparian wetlands trap an estimated 35 tons of sediment per year that would otherwise have entered surface waters. Wetland vegetation within internally-drained areas receives an additional 207 tons of sediment per year. The effects of this sediment deposition on these wetlands is unknown, but expected to vary widely, as does the sensitivity and value of the wetlands themselves.

Urban Sources: Urban areas are the principal source of sediment and a wide variety of toxic and hazardous materials affecting surface waters in this subwatershed. Significant sediment sources include not only construction sites, but runoff from existing urban lands within the subwatershed which contribute about 60 percent of the existing annual sediment load. In addition, hydraulic scour of the streambed and banks along portions of Silver Creek are caused by urban stormwater flows.

The main purpose of this analysis is to focus on the critical urban areas in the Silver Creek Subwatershed portion of the city of West Bend Study Area, using the same approach as that used for portions of the study area in the West Bend Subwatershed. The important urban sub-basins will be identified based on sub-basin pollutant loadings, and the importance of land uses as pollutant-generating sources within these areas will also be identified.

Map 7 shows the urban sub-basin delineation for the entire city of West Bend. Map 8 shows the existing distribution of generalized land use categories within the city of West Bend Study Area.

Table 36 shows that the urban pollutant loading from the entire Silver Creek Subwatershed represents 20 percent of the urban pollutant loading from West Bend to the Milwaukee River. Consequently, the urban pollutant load is important not only to Silver Creek, Washington Creek, and Engmann Creek, but to the Milwaukee River as well.

Table 45 shows the relative importance of the 12 urban sub-basins draining to surface waters. Sub-basins SW008-10 drain to Washington Creek, sub-basins SW013A-D drain to Engmann Creek, and the remainder drain to Silver Creek.

Sub-basins SW009 and SW012, stand out based on their relative pollutant loadings to Silver Creek. Together, these sub-basins contribute 51 percent of the urban pollutant load to portions of Silver Creek that could be expected to respond to urban stormwater controls. Sub-basin SW014 is marginal in importance, but could be considered for pollution control in the event that an adequate level of control in higher priority sub-basins cannot be achieved.

Sub-basins SW013A, SW013B, and SW013D are relatively less significant when viewed in light of their contributions to the Silver Creek Subwatershed. For example, taken together they are roughly equivalent in pollution potential to either SW009 or SW012. However, since Engmann Creek is a resource worthy of protection in its own right, these sub-basins take on a new significance. All are important contributors to Engmann Creek.

Sub-basin SW015 is directly tributary to the Regner Park Fishing Ponds. Although SW015 is relatively less significant as a source of urban pollutants to the pond than the other urban sub-basins which contribute pollutants to it, the presence of stormsewer pipes into this highly accessible pond may warrant further consideration.

Table 46 shows the relative importance of different urban land use types as pollutant sources in the subwatershed. Three land uses stand out as significant pollutant contributors, based on their contribution of total lead. Commercial strip, multi-family residential and institutional lands, including hospitals, schools, and miscellaneous institutional uses, combine to produce 79 percent of the lead load while comprising only 19 percent of the urban land use within the subwatershed. Although medium density residential areas contribute significantly to the lead loading as well, this is primarily because this land use covers nearly one-third of the existing urban acreage in this subwatershed.

Further focusing can be achieved by looking at the contribution of these critical land uses only where they occur within the critical urban sub-basins. Table 47 shows that a significant portion of these critical land uses in fact occur within these critical urban sub-basins, and is a primary reason why these sub-basins are so critical. Nearly all of the commercial strip lands, and most of the multi-family and institutional land uses are contained within

these sub-basins. Table 48 shows the portion of the urban pollutant load for this subwatershed represented by the critical land uses lying within the four critical sub-basins. A total of 65 percent of the subwatershed urban pollutant load is coming from these lands, which represent only 15 percent of the subwatershed urban area.

In summary, by focusing on the critical urban sub-basins within the Silver Creek Subwatershed, 76 percent of the urban pollutants can be accounted for by looking at 55 percent of the urban subwatershed area. By focusing on critical land uses, 76 percent of the pollutant load can be accounted for by 19 percent of the urban lands in the subwatershed. By focusing on critical land uses within critical sub-basins, 65 percent of the pollutant load can be accounted for by 15 percent of the subwatershed urban lands.

Map 10 shows the anticipated urban land use in the city of West Bend Study Area for the year 2000. Table 49 shows the distribution of future urban land use for that portion of the West Bend Study Area located in the Silver Creek Subwatershed.

The total urban land use is expected to increase from the existing 1,384 acres to 2,151 acres. The additional 767 acres represents an increase in urban area of 55 percent. About 78 percent of the anticipated growth is expected to be residential. Most of this residential development is anticipated to be medium density. Other major development is anticipated to occur in commercial land use, which is anticipated to make up 24 percent of the future growth. Map (West Bend Future) shows that the areas anticipated to experience growth will occur in sub-basins draining to Washington Creek, Engmann Creek, and Silver Creek. Development is anticipated both in the city of West Bend and in the adjacent unincorporated parts of West Bend Township.

There are many water quality implications of future development if not properly controlled. First is the pollution potential attendant to construction site erosion if not properly controlled. Second is the pollution potential of new urban impervious surfaces, if appropriate stormwater control practices are not used. Third is the potential hydraulic impact of too much runoff into the stream, which can result in streambank erosion and streambed scour. Finally, as more rainfall is converted to surface runoff, infiltration is decreased. This can seriously reduce the amount of groundwater needed to maintain the baseflow in surface waters.

Potential construction erosion impacts are dramatic. The construction site erosion potential for 765 acres of development is about 23,000 tons of sediment, or about 1,900 tons of sediment per year. Even if only a small portion of the eroded sediment is delivered to surface waters, the annual sediment load would be significant and the potential impact on water resources potentially catastrophic. The city of West Bend has a construction site erosion control ordinance which, if adequately enforced, will minimize the impact of construction activities within the city.

The pollution potential of the future urban area in the Silver Creek Subwatershed portion of the city of West Bend Study Area is shown in Table 49,

using lead as an indicator. If the anticipated development is not served by stormwater runoff control measures, the estimated pollutant loading will increase from the existing 425 pounds of lead to an expected 860 pounds of lead. This represents an increase of about 100 percent. Commercial strip lands would increase in relative importance, contributing over 60 percent of the lead load while making up only 11 percent of the urban land cover. Multi-family land use would maintain a high significance, producing 13 percent of the lead load while making up only nine percent of the area. Medium density residential areas would also be important as a pollutant source, but only by increasing to 42 percent of the urban land cover.

The hydraulic impacts on Silver Creek, Washington Creek, and Engmann Creek of uncontrolled development have not been quantified, but it is expected that they would be dramatic. Streamflow would become more flashy, streambank erosion and streambed scour would increase, base flows would be reduced, and stream temperatures might rise. These streams should be considered at a turning point. If the trend of unabated stormsewer discharges into these streams continues in the face of increasing urbanization, these streams will become unmanageable for biological, recreational, or aesthetic uses. Instead, they will function merely as open storm sewers.

Water Resources Objectives

Engmann and Silver creeks are heavily impacted by urban and rural runoff. Future urbanization threatens further degradation. With stringent nonpoint source controls, primarily aimed at reducing sediment loads, hydraulic impacts, and general impacts from other urban pollutants, these streams can be expected to show a marked improvement. Although Engmann Creek may actually improve to the point where it could support a limited trout population, Silver Creek will not likely improve significantly enough to change the uses it is capable of supporting.

The water resources objectives for the Nonpoint Source Control Program in the Silver Creek Subwatershed are to:

a. Enhance the existing recreational and aquatic life uses in the rural portions of Silver Creek, Washington Creek, and Engmann Creek, and to protect the urban portions of these creeks from further degradation. Although the preliminary objective for urban impacted reaches of these creeks was to enhance their existing uses, recent work by the Southeast Wisconsin Regional Planning Commission indicates that the pollutant load reductions needed to bring this about are not realistically achievable (SEWRPC, 1988). Consequently, the objective for urban stream reaches has been modified.

b. Protect sensitive and valuable wetlands from impacts of rural and urban runoff, where the pollutant attenuation capacity of these areas is, or may become, overloaded.

QUAAS CREEK SUBWATERSHED

WATER RESOURCES CONDITIONS

Quaas Creek is the only perennial stream present in this subwatershed. The stream is formed by the combined flow of the north and south branches as seepage from wetlands and moraines. Quaas Lake is a small, shallow lake which discharges to the south branch of Quaas Creek. No public access is provided.

Quaas Creek: Habitat and other physical and chemical characteristics along Quaas Creek are suitable for sustaining diverse and abundant populations of intolerant forage fish and other aquatic life. In addition, the stream currently supports a class II brook trout fishery from CHY G upstream to its headwaters. Stream depth and size are suitable for supporting partial body contact types of recreational uses. Bacteria levels, though elevated, do not exceed recommended water quality standards for protecting partial body contact uses.

Sedimentation, loss of habitat, and bacteria are the most important problems impacting Quaas Creek. Factors or pollutants responsible for these problems include sediment, bank failure and scour as a result of past channelization and livestock access, drainage or filling of wetlands, and fecal material.

Quaas Lake: Habitat in Quaas Lake has been rated "good" for northern pike spawning and "fair" for bass and panfish, however bullhead and "minnows" are the only reported fish species present. Depth and size are suitable for supporting full body contact types of recreation.

Sedimentation and winterkills are the most important problems limiting the lake's current uses. Erosion from past highway construction projects and shallow water depths are the factors most responsible for these problems.

NONPOINT SOURCES OF POLLUTION

General Land Use: This subwatershed contains 5,015 rural acres and 1,020 urban acres, making it approximately 85 percent rural and 15 percent urban.

Table 30 shows the distribution of rural lands in the Quaas Creek Subwatershed. About 62 percent of the rural lands are cropped, primarily in rotation. The remaining rural lands, predominantly grassland, ungrazed woodlot, and wetland, make up one-third of the rural land use.

Low intensity urban land uses such as residential, recreational, and undeveloped open space cover about 80 percent of the urban area within the subwatershed. High intensity land uses such as commercial, industrial, and institutional land uses cover nine percent of the urban area.

Rural Sources: Table 50 shows the results of the rural nonpoint source inventory for this subwatershed. Eroding uplands and streambank erosion are important sediment sources. Eroding uplands deliver an estimated 648 tons of sediment annually to Quaas Creek. This represents about 82 percent of the sediment load to the stream. Although sediment is delivered to most parts of the stream network from adjacent uplands, 85 percent of the sediment in this subwatershed is delivered to the upstream segments that support trout. Eroding streambanks, occurring primarily below the section of stream supporting trout, produce 96 tons of sediment to the stream. This represents about 12 percent of the sediment load to the stream.

It is estimated that about 85 percent of the rural uplands in this subwatershed delivering sediment to surface waters. This is the highest percentage anywhere in the East-West Watershed. The remaining agricultural areas do not deliver eroded sediment to surface waters partly because of internal drainage and partly because of the buffering effects of all lands, including riparian wetlands. It is estimated that riparian wetlands trap an estimated 268 tons of sediment per year that would otherwise have entered surface waters. Wetland vegetation within internally-drained areas receives an additional 399 tons of sediment per year. The effects of this sediment deposition on these wetlands is unknown, but expected to vary widely, as does the sensitivity and value of the wetlands themselves.

Urban Sources: The existing urban lands in the Quaas Creek Subwatershed are the primary source of many toxic materials entering the stream. These lands are also the source of approximately five percent of the sediment loading to the creek.

The main purpose of this analysis is to focus on the critical urban areas in the Quaas Creek Subwatershed portion of the city of West Bend Study Area, using the same approach as that used for portions of the study area in the West Bend Subwatershed. The important urban sub-basins will be identified based on sub-basin pollutant loadings, and the importance of land uses as pollutant-generating sources within these areas will also be identified. Map 7 shows the urban sub-basin delineation for the entire city of West Bend. Map 8 shows the existing distribution of generalized land use categories within the city of West Bend Study Area.

Table 36 shows that the urban pollutant loading from the entire Quaas Creek Subwatershed represents 10 percent of the urban pollutant loading from West Bend to the Milwaukee River. Consequently, the urban pollutant load to the Milwaukee River from this subwatershed is less significant than loads from either the West Bend Subwatershed or the Silver Creek Subwatershed.

Table 51 shows the relative importance of the seven urban sub-basins draining to surface waters.

Sub-basins QC003, QC004, and QC007 stand out based on their relative pollutant loadings to Quaas Creek. Together, these sub-basins contribute 84 percent of the urban pollutant load to Quaas Creek. QC003 and QC004 discharge to the

portion of the Creek that supports brook trout, while QC007 discharges to the section of Quaas Creek that supports a high quality forage fish community.

Table 52 shows the relative importance of different urban land use types as pollutant sources in the subwatershed. The land uses contributing the highest portion of the pollutant load include commercial strip (27 percent), industrial (20 percent), and institutional (22 percent). These land uses combine to produce 69 percent of the lead load while comprising only nine percent of the urban land use within the subwatershed.

Further focusing can be achieved by looking at the contribution of these critical land uses only where they occur within the critical urban sub-basins. Table 53 shows that a significant portion of these critical land uses in fact occur within these critical urban sub-basins, and is a primary reason why these sub-basins are so critical.

Table 54 shows the portion of the urban pollutant load for this subwatershed represented by the critical land uses lying within the four critical sub-basins. A total of 63 percent of the subwatershed urban pollutant load is coming from these lands, which represent only nine percent of the subwatershed urban area.

In summary, by focusing on the three critical urban sub-basins within the Quaas Creek Subwatershed, 84 percent of the urban pollutants can be accounted for. By focusing on critical land uses, 69 percent of the pollutant load can be accounted for. By focusing on critical land uses within critical sub-basins, 63 percent of the pollutant load can be accounted for by focusing in on only nine percent of the subwatershed urban lands.

Map 10 shows the anticipated urban land use in the city of West Bend Study Area for the year 2000. Table 55 shows the distribution of future urban land use for that portion of the West Bend Study Area located in the Quaas Creek Subwatershed. The total urban land use is expected to increase from the existing 1,020 acres to 2,879 acres. The additional 1,859 acres represents an increase in urban area of 182 percent. About 75 percent of the anticipated growth is expected to be residential. Most of this residential development is anticipated to be low density. Other major development is anticipated to occur in the industrial land use category, which is anticipated to make up 10 percent of the future growth.

Map 10 shows that the areas draining to both the trout and forage fish portions of Quaas Creek are anticipated to experience growth. Development is anticipated both in the city of West Bend and in the adjacent unincorporated parts of West Bend Township.

There are many water quality implications of future development if not properly controlled. First is the pollution potential attendant to construction site erosion if not properly controlled. Second is the pollution potential of new urban impervious surfaces, if appropriate stormwater control practices are not used. Third is the potential hydraulic impact of too much runoff into the stream, which can result in streambank erosion and streambed

scour. Finally, as more rainfall is converted to surface runoff, infiltration is decreased. This can seriously reduce the amount of groundwater needed to maintain the baseflow in surface waters.

Potential construction erosion impacts are dramatic. The construction site erosion potential for 1,859 acres of development is about 52,000 tons of sediment, or about 4,300 tons of sediment per year. Even if only a small portion of the eroded sediment is delivered to surface waters, the annual sediment load would be significant and the potential impact on water resources potentially catastrophic. The city of West Bend has a construction site erosion control ordinance which, if adequately enforced, will minimize the impact of construction activities within the city.

The pollution potential of the future urban area in the Quaas Creek Subwatershed portion of the city of West Bend Study Area is shown in Table 55, using lead as an indicator. If the anticipated development is not served by stormwater runoff control measures, the estimated pollutant loading will increase from the existing 300 pounds of lead to an expected 972 pounds of lead. This represents an increase of about 225 percent. Commercial strip lands would increase in relative importance, contributing about one-third of the lead, while industrial land uses would increase in importance by producing 42 percent of the future pollutant load.

The hydraulic impacts on Quaas Creek of uncontrolled development have not been quantified, but it is expected that they would be dramatic. Streamflow would become very flashy, streambank erosion and streambed scour would be expected to increase dramatically, base flows would be seriously reduced, and stream temperatures would rise.

Water Resources Objectives

Quaas Creek is primarily influenced by rural pollution sources at this time, although future urbanization can be expected to cause serious problems if not controlled by good stormwater management practices. It is unlikely that urban pollutant loads can be maintained at current levels if the planned urban growth takes place, although the pollutant loads and other urban impacts on stream hydrology can be minimized with extensive implementation of controls.

The water resources objectives for the Nonpoint Source Control Program in the Quaas Creek Subwatershed are to:

a. Enhance the existing recreational and aquatic life uses for Quaas Creek.

b. Protect sensitive and valuable wetlands from impacts of sedimentation, where the pollutant attenuation capacity of these areas is overloaded.

DALY LAKE SUBWATERSHED

WATER RESOURCES CONDITIONS

Water resources include the lowermost reaches of the Milwaukee River within the East-West Watershed, two minor unnamed perennial streams, and three intermittent streams. In addition, there are three small and shallow lakes in the subwatershed. These include Daly Lake and two unnamed lakes. None of these lakes provide for public access.

Milwaukee River: The section of the Milwaukee River in this subwatershed reaches 6.2 miles from the impoundment at Newburg to the confluence of the Milwaukee River with the North Branch.

Habitat and other physical features along the Milwaukee River are suitable for sustaining a diverse and abundant warmwater sport and forage fish community and full body contact types of recreation. Current water borne recreational activities or opportunities along the Milwaukee River include full and partial body contact forms such as swimming, fishing, canoeing, site-seeing and wading.

Excessive macrophyte growth, sedimentation, and high bacteria levels are the most important problems impacting the use of the Milwaukee River in this subwatershed. Factors or pollutants responsible for these problems include sediment, nutrients, and fecal material. Abatement of these pollutant sources will improve the existing quality and diversity of the biological and recreational uses.

Unnamed Perennial Streams: Perennial Stream A is tributary to the Milwaukee River in Section 36 NESW, Farmington Township. Habitat was rated "fair" and is capable of supporting intolerant forms of fish and aquatic life throughout the water year. A spring discharges to this stream at CHY M, providing an important source of stream flow. Physical features provide for partial body contact types of recreational uses.

Perennial Stream B (Riveredge Creek) is tributary to the Milwaukee River in Section 6 SWSE, Saukville Township, Ozaukee County. Habitat was rated "fair" and is capable of supporting intolerant forms of fish and aquatic life throughout the water year. Approximately 20 percent of the watershed is located within the Riveredge Nature Center property. While physical features provide for partial body contact types recreational uses, the Center uses the environs of this stream for environmental and conservation education and frequent body contact occurs.

Sedimentation and limited habitat are the most important problems which limit the existing uses of these two perennial streams. Factors or pollutants responsible for these problems include sediment, channelization, and natural

low flow characteristics. Abatement of sediment sources and regulating channelization will improve existing biological and recreational uses.

Unnamed Intermittent Streams: Intermittent Stream A is tributary to the Milwaukee River in Section 31 NWSW of Fredonia Township, Ozaukee County, and Intermittent Stream B is tributary to the Milwaukee River in Section 36 NENW of Farmington Township, Washington County. In both of these streams habitat was rated "fair" to "poor" and is capable of supporting more tolerant forms of fish and aquatic life throughout the water year.

Physical features present in all of the intermittent tributaries provide for partial body contact types of recreational uses.

Sedimentation, excessive algae growth, and limited habitat are the most important problems which limit the existing uses of these intermittent streams. Factors or pollutants responsible for these problems include sediment, nutrients, channelization, and natural low flow characteristics. Abatement of sediment and nutrient sources, regulating channelization, and creation of vegetated corridors along the stream banks will improve existing biological and recreational uses.

Existing and potential biological uses of all of the perennial and intermittent streams present in the Daly Lake Subwatershed are closely tied to the adjoining wetlands of these streams. The maintenance of a balanced warmwater sport and forage fishery in the Milwaukee River may be aligned to successful spawning habitat provided by these streams and wetlands. In addition, these streams are conduits for the transport of pollutants to the Milwaukee River. As such, control of pollutant sources tributary to these streams will enhance the quality and use of the Milwaukee River.

Daly Lake: Fish habitat was rated "favorable" for sportfish species (Daly Lake File Report, 1962; Wirth, 1950, and Fols, 1962). The lake is susceptible to winter kill due to shallow depths.

Unnamed Lakes: Unnamed Lake A is located in Section 5 of Saukville Township, Ozaukee County. Habitat information for this lake is limited. Observations indicate that the shallow and marsh-like lake characteristics of the lake "prohibits fish survival" because of winter freeze-out.

Unnamed Lake B is located in Section 17 of Saukville Township. Habitat information is very limited for this lake. Observations indicate that the shallow and bog-like nature of this lake limits the recreational fishery.

Nonpoint Sources of Pollution

General Land Use: The general land use is 96 percent rural. The urban land use is primarily scattered low density residential.

The rural land use composition is presented in Table 30. Cropland, most of which is in rotation, makes up 60 percent of the rural land use. Low intensity land uses, including ungrazed woodlot, wetlands, and grasslands make up most of the remainder.

The entire course of the Milwaukee River and the unnamed tributary (Riveredge Creek) are contained in a "primary" environmental corridor. The corridor along the Milwaukee River in the Daly Lake Subwatershed was rated as having "high value" for potential park site development (SEWRPC,1970).

The riparian lands along the remaining tributaries are listed by SEWRPC (1970) as being "secondary" environmental corridors. As secondary environmental corridor, they provide the same natural resource values as primary environmental corridors, but are not as extensive in area.

Rural Sources: Table 56 shows the results of the rural nonpoint source inventory for this subwatershed.

Of the ten barnyards draining to surface waters, one has a high pollution potential and two are of moderate concern. One of the three barnyards draining to pocket wetlands is of concern; the other two have very low pollution potentials. The pollution hazard posed by the barnyard internally-drained to shallow soils is not known. The remaining barnyards internally-drained to deep soils are not of concern.

Sediment delivered to surface waters from rural land uses is estimated to be 518 tons per year. This constitutes the major source of sediment from this subwatershed impacting surface waters. Ninety-five percent of this upland sediment comes from rotated cropland, with the remainder scattered amongst the other rural land uses. Sediment loading from uplands is fairly even in distribution along the Milwaukee River. The unnamed perennial stream located in Section 36 of Farmington Township carries a substantial sediment load delivered from eroding uplands. The intermittent streams and Riveredge Creek carry lesser amounts of sediment from this source.

It is estimated that 70 percent of the rural lands deliver eroded soil to surface waters. The remaining lands do not deliver eroded soil because they are buffered from the stream channel system. Part of this buffering is due to riparian wetlands, which trap an estimated 71 tons of sediment per year that would normally have reached surface waters. The remainder of the buffering is due to internal drainage, which affects about 60 percent of all lands in the subwatershed. Some of these internally-drained lands support wetland vegetation. These areas together receive an estimated 203 tons of sediment per year. The effects of this sediment loading on riparian and non-riparian wetlands is not known, but can be expected to vary based on the value and sensitivity of the wetland.

Streambank degradation occurs at 15 sites in this subwatershed, affecting 840 feet of streambank and delivering an estimated 17.5 tons of sediment directly into surface waters. All sites are located on the Milwaukee River. This sediment burden constitutes about three percent of the sediment load

originating in the subwatershed. Streambank erosion is considered serious at one of these sites, and of marginal concern at the remainder. Only one of these sites is associated with cattle access.

Water Resources Objectives

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect and enhance the existing recreational and aquatic life uses in the Milwaukee River and its perennial and intermittent tributaries.

b. Protect sensitive and valuable wetlands from impacts of sedimentation and barnyard runoff, where the pollutant attenuation capacity of these areas is overloaded.

c. Protect sensitive groundwater resources from barnyard runoff where necessary.

GREEN LAKE SUBWATERSHED

WATER RESOURCES CONDITIONS

Green Lake: Habitat and other physical and chemical characteristics of Green Lake are suitable for sustaining a variety of warmwater sport, forage fish and other aquatic life, and full body contact types of recreational uses. Planktonic algae growth is not a problem, however the potential for future algae problems may exist. Annual phosphorus loading rates exceed by 30 percent the phosphorus loading rate estimated to be acceptable for the long-term maintenance of good water quality. Public access is available.

NONPOINT SOURCES OF POLLUTION

General Land Use: The general land use in this small subwatershed is about 80 percent rural and 20 percent urban. The rural land use composition is presented in Table 30. Rotated cropland makes up about one-third of the rural land use. Low intensity land uses including woodland, wetland, and grassland combine to form the other two-thirds of the rural land use. The existing urban land use is primarily residential lakeshore development; a substantial amount of land was under development during the land inventory.

Rural Sources: Table 57 shows the results of the rural nonpoint source inventory for this subwatershed.

The only rural pollution potential is associated with sediment delivered from upland sheet and rill erosion. It is estimated that 50 tons of sediment are delivered annually to surface channels in the subwatershed that eventually drain to Green Lake. This represents about two-thirds of the estimated sediment load to the surface channel system. The only rural land use of concern as a sediment source is rotated cropland.

It is estimated that 76 percent of the rural lands deliver eroded soil to surface waters. The remaining lands do not deliver eroded soil because they are buffered from the stream channel system. Part of this buffering is due to riparian wetlands, which trap to internal drainage. Some of these internally-drained lands support wetland vegetation. These areas together receive an estimated seven tons of sediment per year. The effects of this sediment loading on riparian and non-riparian wetlands is not known, but can be expected to vary based on the value and sensitivity of the wetland.

Urban Sources: The existing urban lands, consisting primarily of residential lakeshore development, are estimated to produce about 10 percent of the sediment delivered to surface waters. Developing areas that were noted during the land use inventory are expected to have contributed about 20 percent of the sediment load. These lakeshore residential areas also pose a pollution hazard through the misuse and improper disposal of many household materials used for automotive maintenance, lawn and garden projects, etc.

Water Resources Objectives

The water resources objectives for the Nonpoint Source Control Program are to:

a. Protect and enhance the existing recreational and biological uses in Green Lake.

b. Protect sensitive and valuable wetlands from impacts of sedimentation, where the pollutant attenuation capacity of these areas is overloaded.

CHAPTER IV

NONPOINT SOURCE CONTROL NEEDS

INTRODUCTION

The nonpoint source pollution control needs for this watershed are presented in three sections.

The first section identifies the in-stream pollutant load reduction that must be achieved in order to meet the water resources objectives that are presented in Chapter III. The primary pollutants evaluated include sediment and phosphorus for rural water resources, and sediment, phosphorus, and lead for urban water resources. It is important to note that limiting factors other than those related to nonpoint source pollutants affect water resources in this watershed. Management actions outside the scope of the Nonpoint Source Control Program that are needed to remove or reduce these additional limitations are presented in the integrated resource management plan for this watershed (WDNR, 1988b).

The second section of this strategy identifies the level of rural nonpoint source controls needed to meet the required in-stream pollutant load reductions. This section addresses sources including barnyard runoff, runoff of winterspread manure, eroding uplands, and streambank degradation. Quantitative management decision criteria are developed for each of these sources. These criteria identify which sources are considered critical to control, which sources are of moderate importance to control, and which sources are relatively insignificant. These determinations are in turn used to identify sources eligible for financial and technical assistance through the Nonpoint Source Control Program. These decision criteria are important not only in identifying the importance of sources as currently evaluated, but will be used to re-evaluate sources for which inventory data change as well as to evaluate sources missed by the original inventory.

The third section addresses the needed level of urban nonpoint source control. It addresses needs for urban sources in and immediately adjacent to the villages of Campbellsport, Kewaskum, and Newburg, and the city of West Bend. Urban source reductions are presented for existing urban areas, areas planned for new development, and for construction site erosion.

POLLUTANT LOAD REDUCTION GOALS

Two factors are considered in setting the levels of in-stream pollutant load reduction for this watershed project. The primary consideration is the reduction needed to meet the water resources objectives for surface waters located within the project area. A secondary consideration is the level of reduction that is needed in the Milwaukee River at the North Avenue Dam, located in the city of Milwaukee, in order to fulfill the nonpoint source control element of the management plan for the Milwaukee Harbour Estuary (SEWRPC, 1987).

SUBWATERSHED POLLUTION REDUCTION GOALS

SEDIMENT AND PHOSPHOROUS

Assessment of Resource Problems: Sediment and phosphorus impacts on beneficial uses of surface waters were analyzed for water resources in the project area.

Reduction goals: Table 58 shows the in-stream sediment and phosphorus reduction goals established for each subwatershed in the East-West Watershed. These reduction goals were developed based on reduction goals established for specific water bodies, and then generalized to the subwatershed level. In six subwatersheds, the reduction goals were adjusted based on a subjective assessment of the importance of the subwatershed pollutant loading to water bodies in downstream subwatersheds. As a consequence, sediment or phosphorus reduction goals are made more stringent for Parnell Creek, Headwaters, Wayne Marsh, Kettle Moraine, Auburn Creek, and Quaas Creek subwatersheds.

Use in Rural Areas: The sediment and phosphorus reduction goals presented in Table 58 are the basis of the agricultural pollution control strategy included in this section. The control strategy will be based on reducing existing pollutant loads sufficiently to meet the instream reduction goals.

Control of sediment being delivered to surface waters will also result in a decrease in agricultural nutrients and pesticides that may be attached to sediment and transported with it.

Use in Urban Areas: The sediment reduction goals in Table 58 are also important in developing the pollution control strategy for urban areas.

Where the urban area is a significant sediment source, the urban strategy will focus on achieving a reduction in existing pollutant loads by the year 2000. For example, if the subwatershed reduction goal identified for sediment is 50 percent and the urban area is a significant sediment contributor, then the

pollution control strategy will be to reduce the present pollutant loads by 50 percent by the year 2000. This reduction may need to be achieved in the face of increasing urbanization.

If the urban area is not a significant contributor, then the strategy will be to assure that there is no increase in urban pollutant loads over the planning period as the area urbanizes.

In addition, there is an assumed need to adequately control erosion from construction sites.

Bacteria and Pathogens

Assessment of Resource Problems: Limited bacteriological testing was conducted in the watershed area to determine the compliance of surface waters with the bacteria standards established by Wisconsin Law for recreational uses.

Reduction Goals: The instream goal is to achieve compliance of surface waters with their respective bacteria standards.

Use in Rural Areas: The water quality goal for bacteria reduction was not considered separately in developing the pollution control strategy for animal waste, one of the predominant agricultural sources of bacteria and pathogens. The control strategy for nutrients will effectively target the animal waste sources which have the highest potential for contributing bacteria.

Use in Urban Areas: Stormwater monitoring conducted nationwide, including Wisconsin, shows that urban stormwater is heavily contaminated by a wide variety of bacteria and pathogens. Pet wastes and wildlife feces are generally considered to be primary sources of these materials.

Land uses and sub-basins in urban areas within this watershed were not specifically evaluated for potential bacterial contributions. There is a need for better identification of problem stormsewer discharges so that an evaluation can be made of how practices recommended for control of sediment, toxins, and flow will affect bacteria discharges to these streams.

Other Urban Stormwater Pollutants

Toxic and Hazardous Materials: In general, there was little monitoring of the impacts these substances are having on recreational and aquatic life uses of surface waters in urban areas. Consequently, the instream pollutant load reductions for these materials in urban streams is more subjectively determined based on the general condition of the urban stream, and the significance of urban runoff as a potential contributing source.

Three streams in the East-West Watershed are considered to be heavily influenced by existing urban runoff. These include Silver Creek, Engmann Creek, and portions of the Milwaukee River Mainstem, all located in the West Bend Study Area. In addition, Kewaskum Creek in the village of Kewaskum may fall into this category. For these surface waters, the goal is to achieve a high level of reduction of urban stormwater pollutants. This is interpreted to mean reducing the 1988 urban pollutant loading in the stream, using total lead as an indicator, by 40 to 60 percent by the year 2000. A secondary goal of maintaining urban pollutant loads at 1988 levels at least through the year 2000 is established to prevent further degradation in streams where the primary goal cannot be achieved.

The remaining urban streams including the West Branch of the Milwaukee River at Campbellsport, the Mainstem of the Milwaukee River at Kewaskum and Newburg, and Quaas Creek in the city of West Bend do not appear at this time to be heavily impacted by these types of pollutants. For these surface waters, the goal is to maintain urban pollutant loads at 1988 levels at least through the year 2000 to prevent further degradation.

Flow: Streams in the East-West Watershed that can be expected to experience the most pronounced changes in hydrology as a result of increasing urbanization include Silver Creek, Engmann Creek, Washington Creek, Quaas Creek, and Kewaskum Creek. Urbanization can lead to significant changes in runoff volumes and peak discharges, and can also lead to a decrease in stream baseflows. The changes in peak runoff and baseflow are of particular interest from a water quality standpoint.

Past studies show that the peak discharges associated with the mean annual flood, which occurs on the average of once in every 2.33 years), are important in shaping stream channel characteristics. Increases in peak discharges associated with this frequency flood will tend to destabilize the streambed and streambank until a new equilibrium is reached. This will result in increased streambed scour and streambank erosion (Krug & Goddard, 1986). The goal for these streams is to maintain post-development runoff peak discharges for the year 2000 development conditions at existing levels for this design storm so that destabilizing hydraulic changes in streamflows will not occur. In some instances, such as along portions of Silver Creek and Engmann Creek, further reductions may be needed since streamflows are already considered a causative factor in streambank erosion and streambed scour.

Stream baseflow characteristics suitable for sustaining fish and aquatic life are a critical component of habitat suitability. Not only must water volumes capable of sustaining fish and aquatic life be maintained, but water temperatures must also be protected at levels that allow for survival and reproduction. Urbanization can lead to significant decreases in groundwater recharge that in turn result in inadequate base flow volumes and water temperatures too high to support cold water sport and forage fish species. The goal for these streams is to protect to the stream baseflows and temperatures at levels capable of supporting their potential beneficial uses. This is particularly important for the portions of Quaas Creek that supports trout.

WATERSHED POLLUTANT REDUCTION GOALS

Nonpoint source control measures will contribute to attainment of the objectives for the Milwaukee Harbour Estuary, and as such constitute one of five primary elements in the plan to reduce pollutant loads to the estuary (SEWRPC, 1987).

The cumulative effect of the nonpoint source controls in the Milwaukee River Basin upstream of the North Avenue Dam must attain an overall reduction of approximately 25 percent for sediment and phosphorus in order to provide a level of control consistent with the management plan for the Milwaukee Harbour Estuary. Control of 25 percent of these pollutants coming from the East-West Watershed is therefore used as a minimum goal for control. This level of control will serve as a check to assure that the subwatershed control plans will together provide the cumulative level of control necessary for this watershed to contribute effectively to meeting the estuary objectives. In addition, the plan to manage the estuary assumes that there will be a high degree of erosion control (75 to 90 percent) on all construction activity.

Although control of rural nonpoint sources in the East-West Watershed is important to the management of the estuary, the water quality benefits of controlling existing urban area runoff in the watershed will be limited to the water resources within the project area. This is based on projections that urban nonpoint source controls in the East-West Watershed would provide only marginal improvement in the estuary above and beyond the principle elements of the estuary management plan (SEWRPC, 1987).

RURAL POLLUTION CONTROL GOALS AND DECISION CRITERIA

This section presents the level of control sought through the Nonpoint Source Control Program for major categories of agricultural nonpoint sources. In addition, management decision criteria are presented for each source type so that as data on existing sources is updated or new sources are inventoried a determination can be made as to the significance of the source and its eligibility for cost-sharing under this program.

Reference is made to "management categories" throughout this chapter. These categories are established for most sites generating nonpoint source pollutants, such as individual barnyards, individual cropland fields, or specific streambank erosion sites. The most serious pollution sources are placed in Management Category I, and are considered essential to control. Sources in Management Category II are less severe. Although they are considered worthy of control efforts, their control is not considered essential. Sources in Management Category III are considered insignificant from a water quality standpoint, and efforts will not be made through the Nonpoint Source Control Program to control them. However, efforts through other programs such as ACP, Farmland Preservation, or Federal Food and

Security will be coordinated within the watershed to address some of these sources in Management Category III that are important for these other resource conservation programs.

BARNYARD RUNOFF

Barnyards are divided into four groups for management. These are presented below. In each presentation, the pollutant load reduction targeted for the entire group is presented, along with the portions of the pollutant load reduction targeted for each management category. The phosphorus mass load limitations that correspond to each management category are presented in Table 59, which should serve as an easy reference for decision-making.

BARNYARD RUNOFF TO SURFACE WATERS

Each barnyard was ranked twice, once based on its significance relative to all other barnyards in the watershed, and again based on its significance relative to other barnyards in the same subwatershed. Management categories were then assigned to each barnyard based on the two rankings. Where the two management categories for a barnyard were different, the most stringent one was assigned.

The total pollutant load reduction being sought from this source is 90 percent for the watershed as a whole. Sixty percent is associated with high priority pollution sources, and 30 percent is associated with lesser priority sources.

The pollutant load reduction sought on a subwatershed basis varies. High priority sources include those where controls can meet the phosphorus reduction goals shown in Table 58.

The intended pollutant load reductions and corresponding management categories are:

Management Category I: This includes the barnyards that contribute either the top 60 percent of the watershed phosphorus loading from barnyards, or contribute the portion of the subwatershed load equivalent to the subwatershed target reduction goal for phosphorus presented in Table 58.

A barnyard may not be assigned to this category if its mass loading is less than 10 lbs.

Management Category II: This includes the barnyards that contribute either the next 20 percent of the watershed phosphorus loading from barnyards, or contribute one-half of the remaining subwatershed phosphorus load from barnyards.

Barnyards that do not meet either requirement for placement in this category, but which produce at least five pounds of phosphorus, are placed in this category with restrictions on the amount of cost-sharing for control of the pollution source. A barnyard may not be assigned to this category if its mass loading is less than five pounds.

Management Category III: All other barnyards draining to surface waters are placed in this management category. These comprise approximately the lower 10 percent of the watershed phosphorus load coming from barnyards, and are relatively insignificant on a subwatershed basis.

Barnyard Runoff Internally Drained To Pocket Wetlands

This is a site-specific management approach. Hence, there is no overall pollutant reduction goal that determines management categories.

Management Category I & II: For barnyards producing at least 10 lbs. phosphorus, a joint field investigation involving district staff from the Land Conservation Department and the Department will be made to subjectively determine the need for controls. Where controls cannot be justified based upon existing or potential long-term damage to the wetland, the barnyard will be placed in Management Category III.

Management Category III: Barnyards producing less than 10 pounds phosphorus are placed in this category. In addition, barnyards producing at least 10 pounds, but found through the joint field investigation to pose little concern to the health of the wetland community, will be placed in this category.

Barnyard Runoff Internally Drained To Soils Over Shallow Bedrock or Groundwater

This is a site-specific management approach. Hence, there is no overall pollutant reduction goal that determines management categories.

Management Categories I, II, & III: All barnyards in this group will be investigated further during implementation to determine the threat posed to groundwater.

A preliminary screening using file information and possibly a site visit by county Land Conservation Department district staff will be made. Information that will be used in the screening will include, but not be limited to, a mechanical analysis of the soil, depth to bedrock or groundwater, location of the lot with respect to groundwater recharge areas, animal herd size, and current lot surface management such as scraping frequency. Table 60 lists preliminary site characteristics to be

used in determining the threat to groundwater from barnyards and associated animal waste sources. If available, information concerning well contamination may also be used.

Following verification of site conditions by Land Conservation Department staff and the evaluation of any additional information collected during a site visit, the Land Conservation Department staff will contact the Department and a joint determination of a management category will be made for the source.

Lesser cost alternatives to reduce the groundwater contamination hazard may be cost shared based on the hazard potential as determined by the information presented above. However, if site conditions require use of high cost practices, the feasibility and cost of groundwater monitoring to substantiate the existence of groundwater contamination will be investigated prior to making a determination of cost share eligibility.

Barnyard Runoff Internally Drained To Deep Mineral Soils

This is a site-specific management approach. Hence, there is no overall pollutant reduction goal that determines management categories.

Management Category III: All barnyards in this group are assigned to this management category, and consequently are ineligible for cost share assistance to control barnyard runoff.

Manure Spreading Runoff

The pollutant load reduction and management decision criteria for this source was determined only on a watershed basis, since data was not available to perform a subwatershed analysis. This information is presented below. The phosphorus mass load limitations that correspond to each management category and that will be used during this project are presented in Table 59

The total pollutant load reduction being sought from this source is 75 percent for the watershed as a whole. Fifty percent is associated with high priority livestock operations, and 25 percent is associated with lesser priority sources.

Management Category I: This includes those livestock operators who contribute to the top 50 percent of the critical acres spread during winter It also includes livestock operators who spread manure in sensitive wetlands, or who spread manure in areas sensitive to groundwater contamination.

Management Category II: This includes those livestock operators who contribute the next 25 percent of the critical acres spread during winter.

Management Category III: The remaining livestock operators are placed in this management category.

A preliminary analysis was done for each livestock operation in the watershed, and a contact priority list generated based on criteria parallel to those above. Assignment of a management category for purposes of determining eligibility will be based on the determination of the actual number of critical acres winterspread each year. This determination will be made during implementation. This number of actual critical acres spread will be compared to the acreage limits in Table 59 to determine the final management category.

UPLAND EROSION

Chapter III presents information that shows the need to carefully target eroding uplands for water resources management purposes. About one-half of the eroding uplands in the watershed do not deliver any of the eroded sediment to the stream channel system because of buffering effects. Of the soil eroded from agricultural lands in the watershed, only about four percent reaches the stream channel system.

Eroding uplands in this watershed project are consequently targeted for management based on the rate of soil delivery to the stream channel system, not on the soil loss rates as determined using the Universal Soil Loss Equation (USLE).

The portion of the delivered sediment targeted for reduction in this project varies by subwatershed. The reduction goal for each subwatershed is consistent with the reduction goals for sediment shown in Table 58. The sediment delivery rates to which parcels in each subwatershed should be controlled in order to meet these sediment reduction goals are presented in Table 59.

The effect that this subwatershed strategy will have on the watershed as a whole will be to reduce by approximately 50 percent the sediment delivered to surface waters from upland erosion.

The intended pollutant load reductions and corresponding management categories are:

Management Category I: This includes all eroding parcels that deliver sediment above the rate targeted for control. The resultant pollutant load reduction will be consistent with the sediment reduction goal for the subwatershed.

If the Department and the county Land Conservation Departments jointly conclude that a field having very low soil loss but delivering soil above the target level cannot feasibly be controlled, the field may be placed in Management Category II.

Once selected for management through the Nonpoint Source Control Program, additional controls above and beyond those needed to meet the sediment delivery reduction objective may be eligible for cost-sharing through the Nonpoint Source Program if necessary to bring the field into compliance with soil loss reduction objectives under Farmland Preservation or Federal Food and Security Programs. This applies only where the additional control is low to moderate cost. High cost practices, such as terraces, are not eligible under the Nonpoint Source Control Program in order to attain the additional control.

Management Category II: This includes those fields that are delivering soil above the acceptable sediment delivery rate for the subwatershed, but which cannot be feasibly controlled to a greater degree.

Management Category III: All fields that deliver soil at a rate below the target delivery rate for the subwatershed are placed in this management category, regardless of the soil erosion rate.

It is important to note that the sediment delivery data developed for this plan reflects the sediment delivered to the surface channel system. In many instances, riparian wetlands or pocket wetlands effectively buffer the channel system from sediment delivery, as was shown in Chapter III. Fields contributing sediment to these areas were not identified as needing control, since they deliver little or no sediment to the stream system. However, in some cases these buffering wetland areas may be receiving too much sediment and damage may be occurring. These specific sites were not sought out during the water resources appraisal process. However, where they are found to occur, it is the intent of this project to target the contributing uplands for control. Sites found during implementation will be reviewed jointly by the Department and the county Land Conservation Department to determine the need for sediment control.

STREAMBANK DEGRADATION

Streambank degradation is not a significant sediment source in the watershed as a whole. Consequently, sites are evaluated based on their localized impacts. The potential exists for site-specific impacts as a result of either sediment production, or as the result of general habitat degradation associated with loss of streambank cover and trampling of the substrate by cattle.

Management categories are as follows. The mass loadings associated with each management category are repeated in Table 59.

Management Category I: This includes those sites that either produce in excess of one ton of sediment per year, or that have been jointly identified by the county Land Conservation Department staff and the Department's district field staff as being significantly degraded.