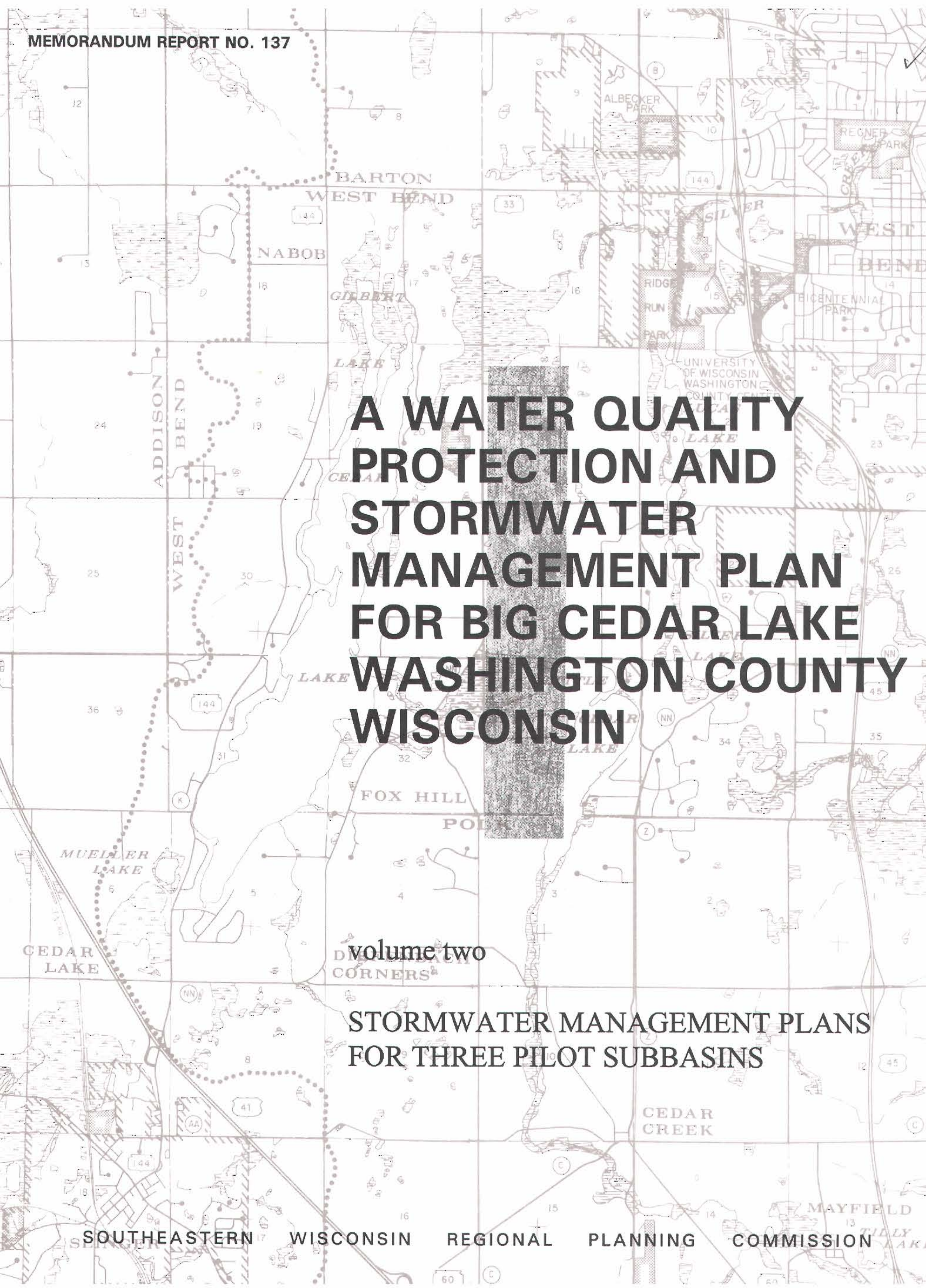
MEMORANDUM REPORT NO. 137

A WATER QUALITY PROTECTION AND STORMWATER MANAGEMENT PLAN FOR BIG CEDAR LAKE WASHINGTON COUNTY WISCONSIN

volume two

STORMWATER MANAGEMENT PLANS FOR THREE PILOT SUBBASINS



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Big Cedar Lake Protection and Rehabilitation District
Cedar Lakes Conservancy Foundation
Southeastern Wisconsin Regional Planning Commission
Washington County Land Conservation Department

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Prepared by the

Southeastern Wisconsin Regional Planning Commission

In cooperation with the

Washington County Land Conservation Department
Big Cedar Lake Protection and Rehabilitation District
Cedar Lakes Conservation Foundation

August 2001

Inside Region $ 5.00
Outside Region $10.00

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Chapter I

INTRODUCTION

This report is the second volume of a report setting forth a water quality protection plan for Big Cedar Lake. It is part of the ongoing commitment of the Big Cedar Lake Protection and Rehabilitation District, the Towns of Barton and West Bend,[1] and Washington County to sound planning with respect to this lake. Volume One presented inventory findings regarding water quality conditions, identified lake water quality problems and issues, and set forth alternative and recommended lake protection measures designed to maintain and improve water quality within Big Cedar Lake. This volume sets forth stormwater management plans and water quality protection recommendations for each of the three pilot subbasins in which urban incipient development is expected or known to be occurring. The three subbasins are shown on Map 1.

The development of stormwater management plans for the pilot subbasins is consistent with the stormwater issue action plan set forth in the August 2000 draft *Washington County Land and Water Resource Management Plan: 2000-2005.* That plan calls for the County Land Conservation and Planning and Parks Departments and the Regional Planning Commission to advise and assist Lake Districts on "plans and projects related to water quality protection and regional stormwater management, including implementation."

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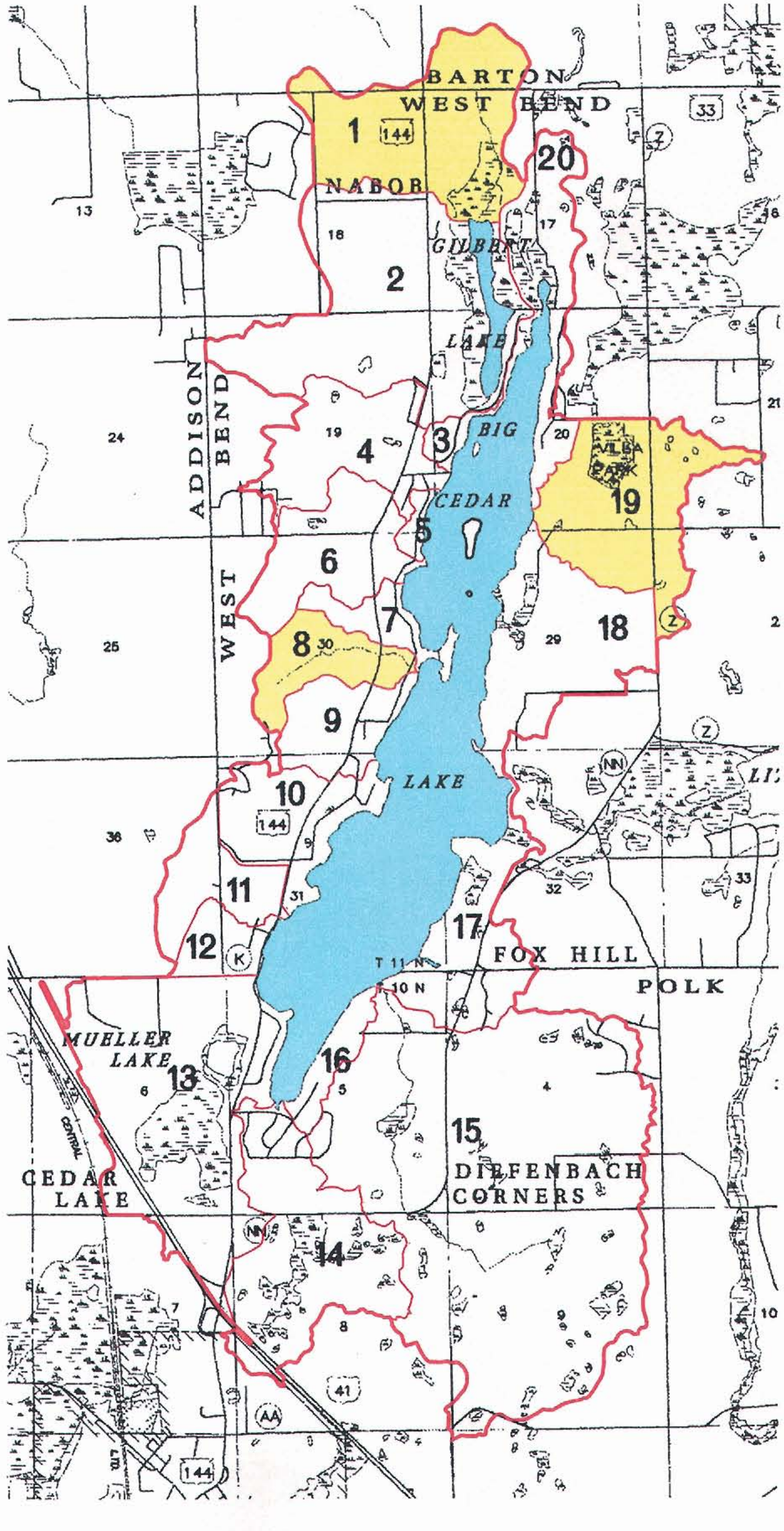
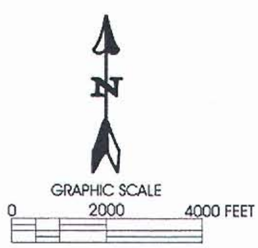
[1]*Although the Big Cedar Lake subwatershed includes portions of the Village of Slinger and the Towns of Addison, Barton, Polk, and West Bend, the pilot subbasins considered in this stormwater management plan are located only in the Towns of Barton and West Bend.*

Map 1

SUBBASINS IDENTIFIED FOR DETAILED STORMWATER MANAGEMENT PLANNING



STORMWATER MANAGEMENT PLANNING AREAS



Source: SEWRPC.

Chapter II

STORMWATER MANAGEMENT OBJECTIVES AND STANDARDS

The formulation of objectives and standards is an essential task in the development of a stormwater management plan. Appendix A of this volume sets forth a set of objectives and standards that should be applied in the development of stormwater management systems within the Big Cedar Lake tributary area. Those objectives and standards were also considered in the development of the stormwater management plans set forth in this report. The following standards, as listed in Appendix A, are most pertinent to the stormwater management plans presented in this report:

- Objective No. 1, Standards 5a and 5b

  All new and replacement bridges or culverts over waterways should be designed so as to accommodate, according to the categories listed, below, the designated flood events without overtopping of the related roadway.

  a. Minor and collector streets used or intended to be used primarily for access to abutting properties: a 10-year recurrence interval flood discharge.

  b. Arterial streets and highways, other than freeways and expressways, used or intended to be used primarily to carry heavy volumes of through traffic: a 50-year recurrence interval flood discharge.

- Objective No. 3, Standard No. 1

  Stormwater management facilities should promote the achievement of existing water use objectives and supporting water quality standards for Big Cedar Lake, and should not degrade existing habitat conditions for fish and aquatic life.[1]

- Objective No. 4, Standards No. 1 and 2

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[1] *The recommended water use objective for Big Cedar Lake as set forth in SEWRPC Memorandum Report No. 93,* A Regional Water Quality Management Plan for Southeastern Wisconsin: An Update and Status Report, *March 1995, calls for maintenance of a warmwater sport fish community in the Lake.*

Stormwater management systems shall be designed to minimize disruption to primary and secondary environmental corridors, including the incorporated woodlands, wetlands, and wildlife habitat areas.

Stormwater management systems should be designed to protect valuable and sensitive wetlands from the adverse impacts of stormwater runoff.

Chapter III

HYDROLOGIC AND HYDRAULIC MODELS AND ANALYSES

The hydrologic analysis for the development of flood flows and volumes was based on a model developed by the Commission staff using the U.S. Army Corps of Engineers (USCOE) Hydrologic Engineering Center HEC-HMS (Hydrologic Modeling System) computer program. Regional rainfall depth-duration-frequency data set forth in SEWRPC Technical Report No. 40, *Rainfall Frequency in the Southeastern Wisconsin Region*, April 2000, were used to determine rainfall totals for the storms analyzed. Those rainfall data were developed from analysis of rainfall records from 1891 through 1998 and they represent the most current information available for the Region. The rainfall depths were distributed using the 90th percentile rainfall distribution as recommended in Technical Report No. 40.[1] Rainfall depths for various recurrence intervals and durations are set forth in Table 1 and the 90th percentile distribution is set forth in Table 2.

Additional input parameters for the hydrologic and hydraulic models were determined from the following sources: 1) one inch equals 200-foot scale, two-foot contour topographic maps prepared in 1976 for the Regional Planning Commission: 2) Commission one inch equals 400-foot scale orthophotographs dated April 1995; 3) the U.S. Geological Survey (USGS) 7.5 minute Allenton and West Bend quadrangle maps, both compiled at a scale of one inch equals 2,000 feet and a 10-foot contour interval in 1959 and revised in 1971[2]; 4) Wisconsin Department of Transportation as-built plans for STH 33; 5) hydraulic structure surveys obtained by the staffs of the Washington County Land Conservation Department and the Commission (Table 3); and 6) field observations by the Commission staff.

Discharges were determined for two-, 10-, 50-, and 100-year recurrence interval storms occurring under both existing 1995 land use conditions and future conditions that reflect the zoning districts established in the pilot subbasins. In order to determine the critical storm durations for the development of peak flood flows, storms with durations ranging from one to 24 hours were analyzed.

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[1]*Chapter 17 of the Washington County Code, entitled "Erosion Control and Stormwater Management" (adopted December 9, 1997), was consulted during preparation of this plan. The methods of analysis are generally consistent with the technical requirements of the County Code except that this plan employs more-detailed hydrologic modeling approaches than required under the Code and this plan also utilizes more current rainfall depth-duration-frequency and rainfall distribution data.*

[2]*The West Bend quadrangle map was also revised in 1976.*

Table 1

RECOMMENDED DESIGN RAINFALL DEPTHS FOR THE SOUTHEASTERN WISCONSIN REGION

	Recurrence Interval and Depths (inches)					
Storm Duration	Two Years[a]	Five Years[a]	10 Years[a]	25 Years	50 Years	100 Years
5 Minutes	0.40	0.48	0.54	0.62	0.68	0.74
10 Minutes	0.64	0.76	0.85	0.98	1.08	1.19
15 Minutes	0.83	0.98	1.07	1.21	1.31	1.41
30 Minutes	1.07	1.29	1.45	1.68	1.85	2.02
60 Minutes	1.31	1.60	1.84	2.20	2.50	2.82
2 Hours	1.54	1.93	2.23	2.73	3.16	3.64
3 Hours	1.68	2.07	2.40	2.93	3.39	3.89
6 Hours	1.95	2.40	2.79	3.44	4.03	4.70
12 Hours	2.24	2.74	3.17	3.89	4.53	5.25
24 Hours	2.57	3.14	3.62	4.41	5.11	5.88
48 Hours	3.04	3.71	4.20	4.94	5.53	6.13
72 Hours	3.29	3.94	4.40	5.09	5.63	6.17
5 Days	3.77	4.42	4.84	5.43	5.86	6.26
10 Days	4.68	5.42	5.89	6.55	7.03	7.46

[a]*Factors presented in U.S. Weather Bureau TP-40 were applied to the SEWRPC 2000 annual series depths with recurrence intervals of two, five, and 10 years, converting those depths to the partial duration series amounts set forth in this table. The annual series depths were adjusted as follows:*

Two-year: multiplied by 1.136; five-year: multiplied by 1.042; and 10-year multiplied by 1.010.

Source: Rodgers and Potter and SEWRPC.

As shown by a comparison of Maps 7 and 17 in Volume One of this memorandum report, lands in the Town of West Bend that are shown as agricultural and rural land under the regional land use plan for 2020[3] are within the R-1R Rural Residential District of the Town Zoning Ordinance. That district specifies a maximum density of 3.5 acres per dwelling unit, with wetlands, primary environmental corridors, and wildlife habitat areas excluded from the density calculations. The hydrologic analyses were made assuming residential density conditions as permitted under the zoning ordinance.

The three pilot subbasins designated for analysis in Volume One of this report were further subdivided into catchment areas using the best available topographic maps as described above. The subbasin and catchment area boundaries were digitized and the Commission geographic information system was used to determine the distribution of existing and future land uses by hydrologic soil group in each catchment area. That information was used to compute U.S. Natural Resources Conservation Service (NRCS) runoff curve numbers for each catchment area. Those runoff curve numbers were input to the HEC-HMS model for calculation of rainfall losses,

[3]*SEWRPC Planning Report No. 45,* A Regional Land Use Plan for Southeastern Wisconsin: 2020, *December 1997.*

Table 2

SEWRPC 90TH PERCENTILE RAINFALL DISTRIBUTIONS

Hour	Cumulative Percent of Total Storm Rain 90th Percentile Distribution
0	0.0
1	0.3
2	0.9
3	1.9
4	3.2
5	4.9
6	7.0
7	9.4
8	12.2
9	15.3
10	18.8
11	22.7
12	26.9
13	31.5
14	36.4
15	41.7
16	47.4
17	53.4
18	59.8
19	66.5
20	73.6
21	81.1
22	87.8
23	94.5
24	100.0

Source: Camp Dresser & McKee, Inc.

including an initial abstraction and infiltration losses. The difference between the rainfall losses and the total precipitation is the excess rainfall that would run off from the land surface. The rainfall excess was converted to runoff hydrographs, or records of flow versus time, using catchment area times of concentration and NRCS unit hydrograph or kinematic wave procedures within HEC-HMS. The NRCS unit hydrograph approach was applied to the existing, generally rural, land use conditions in the study area and the kinematic wave procedure was applied to future, predominantly suburban-density, development in the area.

The HEC-HMS model was used to develop, combine, and route flood hydrographs throughout each of the three pilot subbasins. Kinematic wave routing and modified Puls procedures were used to route hydrographs through the drainage networks of each pilot subbasin.

The hydraulic capacities of culverts at key existing road and highway crossings were determined using the U.S. Department of Commerce Hydraulic Engineering Circular No. 5, *Hydraulic Charts for the Selection of Highway Culverts*. The USCOE HEC-RAS (River Analysis System) computer model was used by the Commission staff to develop discharge ratings for road overflow.

Table 3

HYDRAULIC STRUCTURE INFORMATION FOR BIG CEDAR LAKE PILOT SUBBASINS

Structure Number	Structure Identification	U. S. Public Land Survey Section	Structure Type and Size	Structure Length (feet)	Upstream Invert Elevation (feet NGVD)	Downstream Invert Elevation (feet NGVD)
Subbasin 1						
1	STH 144	NE 1/4, NE 1/4, Section 18	36-inch-diameter corrugated metal pipe	209	1093.03	1082.41
2	STH 144	NE 1/4, NE 1/4, Section 18	24-inch-diameter corrugated metal pipe	48	1094.15	1091.9
Subbasin 8						
3	STH 144	NW 1/4, SE 1/4, Section 30	66-inch-wide by 48-inch-high corrugated metal pipe arch	56	1064.13	1060.06
4	West Lake Drive	NE 1/4, SE 1/4, Section 30	Two 18-inch-diameter corrugated metal pipe	30	1030.59	1030.27
Subbasin 19						
5	Hacker Drive	NE 1/4, SE 1/4, Section 20	24-inch-diameter corrugated metal pipe	43	1046.5	1046.47
6	CTH Z	NW 1/4, SW 1/4, Section 21	24-inch-diameter corrugated metal pipe	77	1079.03	1071.95
7	Paradise Drive	NW 1/4, NE 1/4, Section 29	12-inch-diameter corrugated metal pipe	22	1033.46	1032.53
8	Paradise Drive	NW 1/4, NE 1/4, Section 29	15-inch-diameter corrugated metal pipe	36	1032.11	1032.11
9	Paradise Drive	NE 1/4, NE 1/4, Section 29	24-inch-diameter corrugated metal pipe	- -	1071.34	1067.76
10	CTH Z	SW 1/4, SW 1/4, Section 21	24-inch-diameter corrugated metal pipe	56	1098.17	1096.75
11	Paradise Drive	NW 1/4, NW 1/4, Section 28	18-inch-diameter corrugated metal pipe	44	1099.85	1098.36

Source: Washington County and SEWRPC.

Chapter IV

NONPOINT SOURCE POLLUTION ANALYSES

The nonpoint source pollutant loads to Big Cedar Lake occurring under existing (1995) land use conditions for the three pilot subbasins were set forth in Volume One of this report. Those loads were calculated using unit area loads in pounds per acre per year that are characteristic of Southeastern Wisconsin. In addition, phosphorus loads were calculated using the Wisconsin Lake Model Spreadsheet program (WILMS), developed by the Wisconsin Department of Natural Resources. For the more-detailed analyses presented here, the pollutant loads occurring under future land use conditions, based on the zoning districts shown on Map 17 in Volume One, were calculated using the Source Loading and Management Model (SLAMM), Version 8.1 for Windows, as developed by Robert Pitt and John Voorhees. The model has the ability to analyze the effectiveness of various pollutant control measures and it can evaluate changes in nonpoint source loads under different development scenarios. The Wisconsin Department of Natural Resources (WDNR) promotes the use of SLAMM for nonpoint source analyses.

SLAMM makes extensive use of empirical data collected from field observations made during the U.S. Environmental Protection Agency (USEPA) Nationwide Urban Runoff Program (NURP) in the early 1980s, as well as considerable additional data compiled since that time. The model focuses on small storm hydrology and the pollutant washoff processes associated with such storms. That is appropriate because, on an annual basis, most of the nonpoint source pollutants are transported to waterbodies during such small storms. Information input to SLAMM includes land use and land cover, the type of drainage system (curb and gutter or roadside swales), and the nature of impervious area connections to the drainage system (directly connected or draining to a pervious area). For this analysis, SLAMM was applied to compute pollutant concentrations and total loads for the annual series of storms that occurred in 1981 at the National Weather Service station at General Mitchell International Airport in the City of Milwaukee. That set of storms is considered to represent a typical year.

In addition to modeling nonpoint source pollutant loads, SLAMM can also be used to evaluate the pollutant removal effectiveness of outfall control measures such as wet detention basins with permanent ponds. For this analysis, it was assumed that the suburban-density residential areas that may be developed under future conditions were served by roadside swales that would promote the infiltration of runoff, thereby reducing nonpoint source pollutant loads to Big Cedar Lake. In addition, alternative plans were developed to evaluate the effectiveness of wet detention basins in reducing nonpoint source loads.

The nonpoint source pollutants analyzed with SLAMM for this study are: total solids, particulate phosphorus, total copper, and total zinc.

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Chapter V

ALTERNATIVE STORMWATER DRAINAGE AND NONPOINT-SOURCE POLLUTION CONTROL PLANS

EXISTING DRAINAGE AND NATURAL RESOURCE FEATURES

Subbasin 1

This 379-acre area is shown on Map 2. The subbasin includes portions of both the Towns of Barton and West Bend located in Sections 7, 8, 17, and 18, Township 11 North, Range 19 East. Under existing (1995) land use conditions 57 percent of the area is in agricultural use, 4 percent is open land, 6 percent is residential, 5 percent is commercial and industrial, 9 percent is wetlands, 10 percent is woodlands, and the remaining 9 percent is in miscellaneous other uses.

The existing stormwater management system consists of overland flow, agricultural or natural drainageways, roadside swales, and culverts. With the exception of Subbasin 1H, runoff from this subbasin is conveyed to a large wetland complex immediately north of Gilbert Lake. Runoff from Subbasin 1H is conveyed to a depression area located in a woodland just west of STH 144. The only outlet for runoff collected in this depression area is through overtopping of STH 144. Under existing land use and drainage conditions and for storms with durations through 24 hours, STH 144 would overtop at this location during rainfall events with a recurrence interval of 10 years or greater. Once over the road, the runoff would eventually drain to the wetland complex north of Gilbert Lake. Additional details of the existing stormwater management system are shown on Map 2. Peak rates of runoff at various locations in Subbasin 1 under existing land use and drainage conditions and future land use and existing drainage conditions are set forth in Table 4.

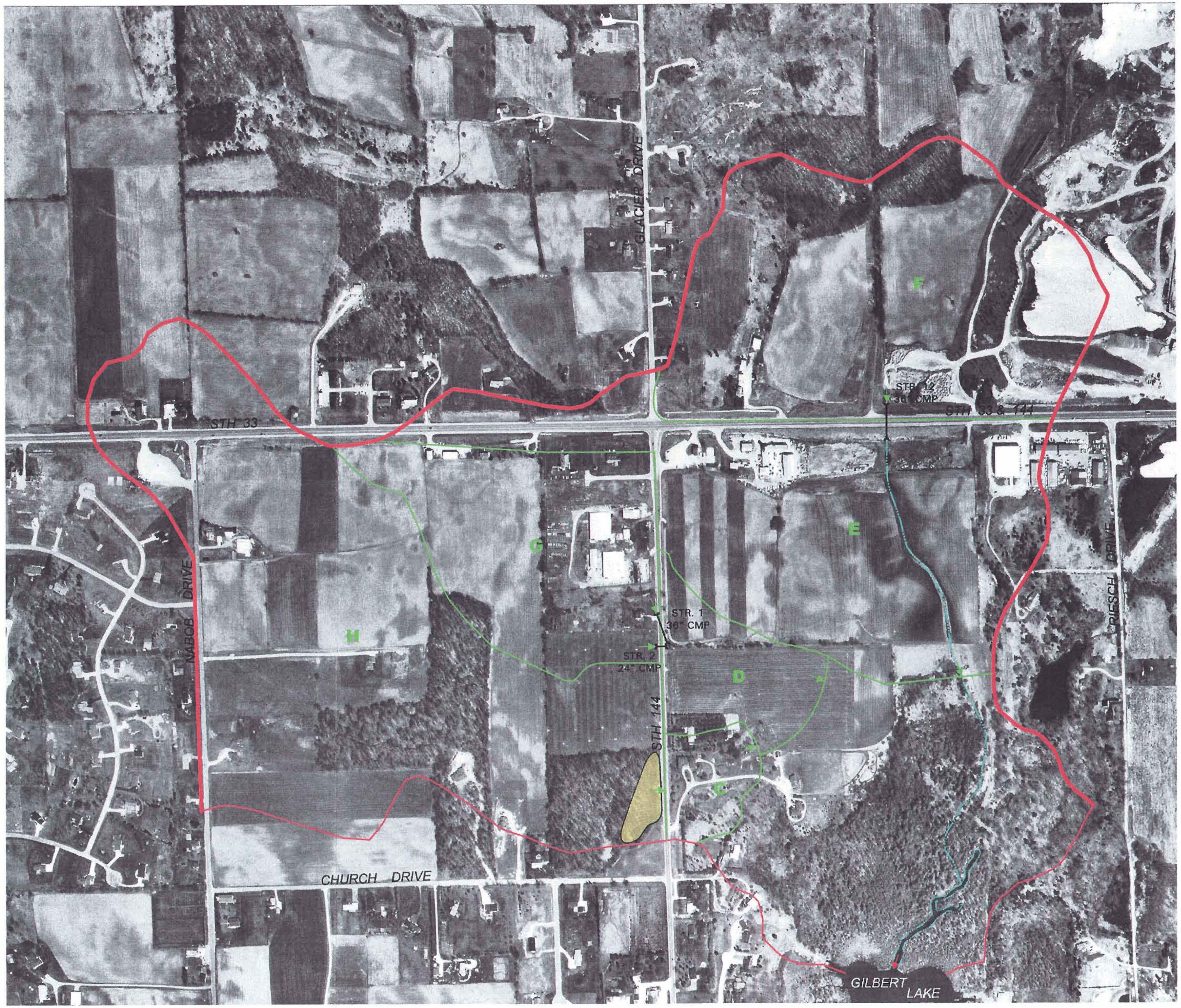
Subbasin 8

This 125-acre area is shown on Map 3. The subbasin is located entirely within the Town of West Bend in Section 30, Township 11 North, Range 19 East. Under existing (1995) land use conditions 82 percent of the area is in agricultural use, 8 percent is woodlands, 6 percent is residential, and the remaining 4 percent is in various other uses.

The existing stormwater management system consists of overland flow, agricultural or natural drainageways, roadside swales, and culverts. Runoff from the entire watershed is conveyed to two 18-inch corrugated metal pipe (CMP) culverts under West Lake Drive, which drain directly to Big Cedar Lake. Additional details of the existing stormwater management system are shown on Map 3. Peak rates of runoff at various locations in Subbasin 8 under existing land use and drainage conditions and future land use and existing drainage conditions are set forth in Table 4.

Map 2

SUBBASIN 1 EXISTING 1995 DRAINAGE FEATURES



BIG CEDAR LAKE SUBWATERSHED BOUNDARY

SUBBASIN 1 BOUNDARY

CATCHMENT AREA BOUNDARY

G CATCHMENT AREA IDENTIFICATION

SUBBASIN OUTLET

CATCHMENT AREA OUTLET

INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)

DEPRESSION AREA

EXISTING CULVERT (SIZE IN INCHES)

STR. 2 STRUCTURE IDENTIFICATION

CMP CORRUGATED METAL PIPE

N

GRAPHIC SCALE 0 300 600 FEET

Source: SEWRPC.

Table 4

PEAK FLOWS UNDER EXISTING AND FUTURE LAND USE CONDITIONS[a]

Location	Recurrence Interval (years)	Existing (1995) Land Use Conditions	Future Conventional Development Conditions without Drainage Modifications		Future Cluster Development Conditions[b] without Drainage Modifications and Alternative 1a and Alternative 8		Alternative 1[c]		
		Flow (cfs)	Flow (cfs)	Percent Change Relative to Existing	Flow (cfs)	Percent Change Relative to Existing	Flow (cfs)	Percent Change Relative to Existing	Percent Change Relative to Future Cluster Conditions without Drainage Modifications
Subbasin 1									
STH 144 Structure 1 and Structure 2 Catchment 1G Outlet	2	5	12	140	12	140	12	140	0
	10	20	33	65	33	65	33	65	0
	50	42	47	12	47	12	47	12	0
	100	54	55	2	56	4	56	4	0
STH 144 Catchment 1H Outlet	2	0[d]	0[d]	- -	0[d]	- -	12	- -	- -
	10	8	14	75	14	75	22	175	57
	50	44	64	45	65	48	37	-16	-43
	100	78	97	24	100	28	66	-15	-34
STH 33/144 Structure 12 Catchment 1F Outlet	2	10	10	0	10	0	10	0	0
	10	40	40	0	40	0	40	0	0
	50	87	87	0	87	0	87	0	0
	100	110	110	0	110	0	110	0	0
Subbasin 1 Outlet	2	28	48	71	48	71	57	104	19
	10	110	130	18	130	18	140	27	8
	50	230	220	-4	220	-4	250	9	14
	100	300	310	3	330	10	340	13	3
Subbasin 8									
STH 144 Structure 3 Catchment 8C Outlet	2	9	5	-44	6	-33	- -	- -	- -
	10	40	23	-43	24	-40	- -	- -	- -
	50	92	70	-24	71	-23	- -	- -	- -
	100	120	110	-8	110	-8	- -	- -	- -
West Lake Drive	2	10	7	-30	7	-30	- -	- -	- -
	10	46	28	-39	28	-39	- -	- -	- -
	50	110	83	-25	83	-25	- -	- -	- -
	100	140	130	-7	130	-7	- -	- -	- -
Subbasin 8 Outlet at Big Cedar Lake	2	10	7	-30	7	-30	- -	- -	- -
	10	46	28	-39	28	-39	- -	- -	- -
	50	110	83	-25	83	-25	- -	- -	- -
	100	140	130	-7	130	-7	- -	- -	- -

[a] *Up to and including storm durations of 24 hours.*

[b] *With density bonus.*

[c] *Does not apply to Subbasin 8.*

[d] *Stormwater runoff does not overtop STH 144 during this event.*

Source: SEWRPC.

Map 3

SUBBASIN 8 EXISTING 1995 DRAINAGE FEATURES

- BIG CEDAR LAKE SUBWATERSHED BOUNDARY
- SUBBASIN 8 BOUNDARY
- CATCHMENT AREA BOUNDARY
- B — CATCHMENT AREA IDENTIFICATION
- SUBBASIN OUTLET
- CATCHMENT AREA OUTLET
- INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)
- EXISTING CULVERT (SIZE IN INCHES)
- STR. 3 — STRUCTURE IDENTIFICATION
- CMP — CORRUGATED METAL PIPE
- CMPA — CORRUGATED METAL PIPE ARCH

GRAPHIC SCALE
0 200 400 FEET

Source: SEWRPC.

Subbasin 19
This 222-acre area is shown on Map 4. The subbasin is located entirely within the Town of West Bend in Sections 20, 21, 28, and 29, Township 11 North, Range 19 East. Under existing (1995) land use conditions 33 percent of the area is in agricultural use, 9 percent is open land, 13 percent is residential, 7 percent is recreational, 13 percent is wetlands, 17 percent is woodlands, and the remaining 8 percent is in various other uses.

The existing stormwater management system consists of overland flow, agricultural or natural drainageways, roadside swales, culverts, and several natural depression areas. Detailed hydrologic modeling determined that a significant portion of the subbasin is in the Washington Creek subwatershed and ultimately drains to Silver Creek and then the Milwaukee River. Also, almost all of the remaining area was determined to be internally drained during rainfall events up to and including the 24-hour, 100-year recurrence interval storm. As a result, the only area within Subbasin 19 that drains to Big Cedar Lake is the small area immediately adjacent to the Lake. These various areas are shown on Map 4.

FUTURE (ZONED) LAND USE

The future land use conditions analyzed for this study were based on the existing zoning districts for each of the subbasins. There are two zoning districts that represent a significant change from the existing (1995) land use. As shown on Map 17 in Volume One of this report, the first is an area zoned for commercial development along STH 33 in Subbasin 1 in both the Towns of Barton and West Bend. The majority of this area is currently in agricultural use. The second is the rural-density residential zoning in the Town of West Bend. This district covers essentially all of the land currently in agricultural use within Subbasins 8 and 19 and the portion of Subbasin 1 in the Town of West Bend that is not in the commercial zoning district.

Conventional Subdivision Development Alternative
The Town of West Bend's rural residential zoning district calls for densities not to exceed one single-family dwelling unit per 3.5 acres of land. This calculation excludes wetlands, primary environmental corridors, and SEWRPC mapped wildlife habitats. This conventional development was considered as one future development alternative scenario for the rural residential district.

Cluster Development Alternative
Cluster development is an alternative to the conventional subdivision development approach. Cluster development is a means of preserving open space and natural resource features in a residential development by grouping the dwellings on only a portion of the development site. The Town of West Bend Zoning Ordinance provides for a cluster development density bonus that allows the developer to provide a greater number of dwelling units than with a standard cluster development, while still preserving open space on the site.[1] Cluster density bonuses result in a higher overall density than standard cluster development. Cluster development with density bonuses was considered as one future development alternative for the rural residential district.

Comparison of Conventional and Cluster Development Approaches
The key issue in the comparison of the conventional development to the cluster development scenario as it relates to the development of both the hydrologic and nonpoint source pollution control models is the quantification of the impervious areas resulting under each scenario. Table 5 shows a breakdown of the impervious areas of a typical lot under both development conditions. One of the benefits of "clustering" may be a significant reduction in the overall street length needed for a development when compared to conventional methods. However, based on Appendix E - Residential Cluster Development Study of SEWRPC Community Assistance Planning Report No. 209, *A Development Plan for Waukesha County*, August 1996, it was determined that for a typical cluster

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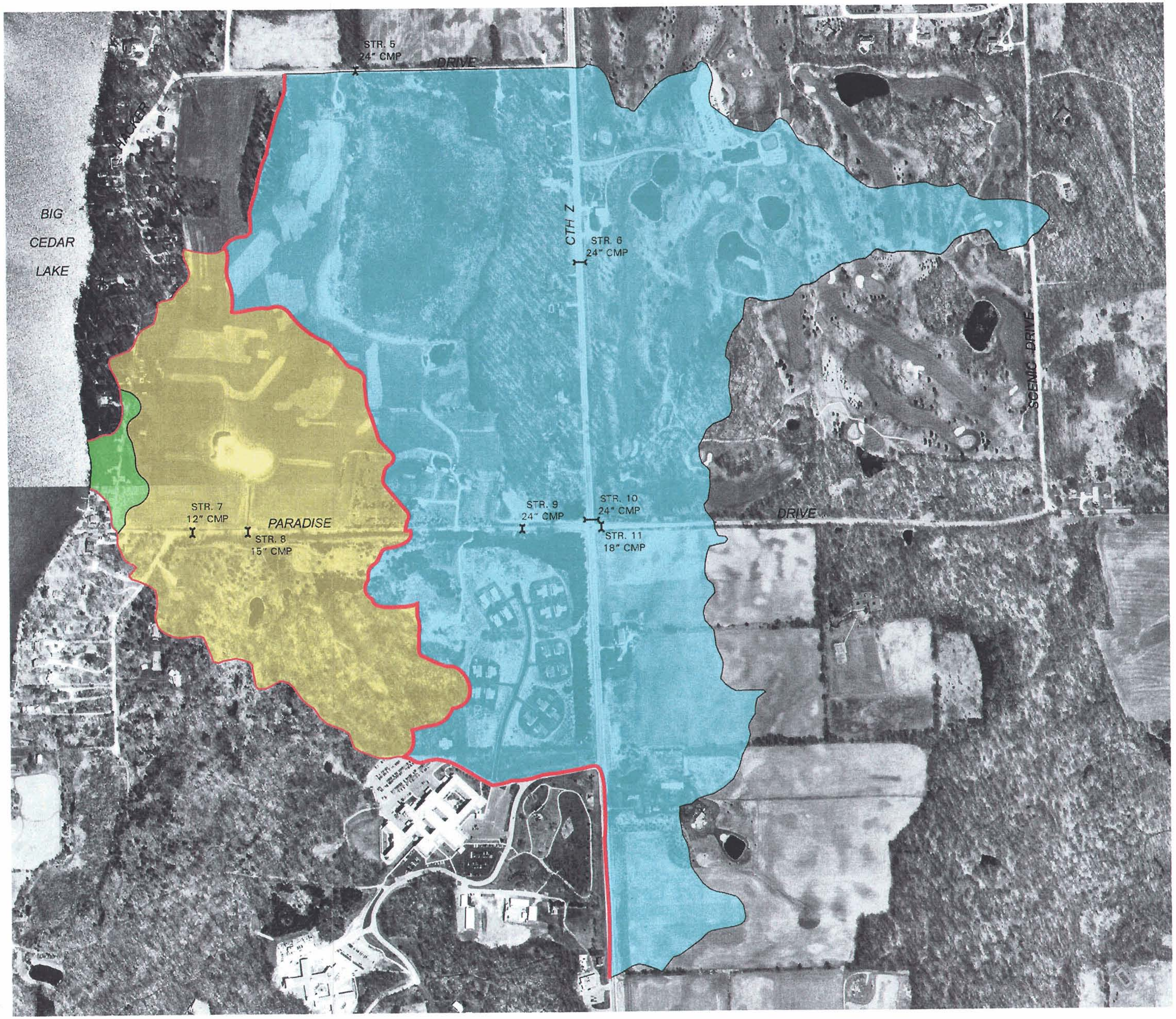
[1]*Details of the cluster development density "bonus" and the rural residential district can be found in the Town of West Bend Zoning Ordinance.*

Map 4

SUBBASIN 19 EXISTING 1995 DRAINAGE FEATURES



- BIG CEDAR LAKE SUBWATERSHED BOUNDARY
- SUBBASIN 19 BOUNDARY
- INTERNALLY DRAINED AREA
- WASHINGTON CREEK DRAINAGE AREA
- AREA TRIBUTARY TO BIG CEDAR LAKE
- EXISTING CULVERT (SIZE IN INCHES)
- STR. 8 STRUCTURE IDENTIFICATION
- CMP CORRUGATED METAL PIPE

N

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

Table 5

TYPICAL LOT IMPERVIOUS AREAS

Development Type	Conventional	Cluster	
Minimum Lot Size	3.5 acres	1.5 acres	
Source	Impervious Area (square feet)		Percent Change
House	2,500	2,500	0
Garage	720	720	0
Patio	375	375	0
Driveway	2,250	1,500	-33
Street	4,400	3,950	-10
Total	10,245	9,045	-12

Source: SEWRPC.

development minimum lot size of 1.5 acres (as is specified in the Town of West Bend Zoning Ordinance) the effective street length per lot would only be reduced by 10 percent when compared to the conventional 3.5-acre minimum size lot. On the other hand, the same study showed that a 0.85-acre minimum size cluster lot reduced the effective street length per lot by 35 percent when compared to the same 3.5-acre lot. As can be seen in Table 5, the only other reduction in impervious area attributed to the type of cluster development allowed under the Town Zoning Ordinance is a 33 percent reduction in driveway length. As a result, the overall reduction in impervious area for the cluster development scenario is 12 percent per lot. However, when the additional lots allowed in the cluster development scenario due to the density bonuses are included, the total impervious area of the cluster development is found to be similar to, or slightly greater than, that of the conventional development. These results are detailed in the following sections.

STORMWATER MANAGEMENT ALTERNATIVES

Subbasin 1

Under a conventional future development scenario, a maximum of 34 3.5-acre rural residential lots would fit within the boundaries of Subbasin 1. The total impervious area of the entire subbasin, including residential, industrial, and commercial development, would be about 64 acres, or 17 percent of the entire 379-acre subbasin. Under a cluster development scenario, with the density bonus, a maximum of 49 1.5-acre lots would fit within the boundaries of Subbasin 1, and the total impervious area of the subbasin would be about 66 acres, or also 17 percent of the subbasin.

Under the conventional development scenario, the peak rates of runoff for the entire subbasin for the two-, 10-, and 100-year recurrence interval storms would be expected to increase by 71, 18, and 3 percent, respectively, relative to existing conditions. However, the peak rate of runoff for the 50-year recurrence interval storm would decrease by 4 percent. Under cluster development with density bonuses, the peak rates of runoff for the entire subbasin for the two-, 10-, and 100-year recurrence interval storms would be expected to increase by 71, 18, and 10 percent, respectively, relative to existing conditions. However, the peak rate of runoff for the 50-year recurrence interval storm would again decrease by 4 percent. Complete comparison results are set forth in Table 4. In relation to the entire Big Cedar Lake subwatershed area, these increases would result in no significant adverse impacts on flood stages of Big Cedar Lake. That is the case because the volume of inflow from the subbasin is small relative to the large storage volume above the normal lake level, thus, the surcharge storage volume in the Lake is quite effective in attenuating peak flows.

Under existing, conventional, or cluster development conditions, all existing culverts located at outlets of the catchment areas that comprise the subbasin were found to have adequate capacity to meet the road overtopping standard set forth in Chapter II. However, as described below, the potential exists for overtopping of STH 144, in violation of the overtopping standard, at one location where there is currently no culvert installed.

Estimated annual nonpoint source pollutant loadings, under both conventional and cluster development conditions without runoff controls are set forth in Table 6. Relative to existing conditions, solids (sediment) loads would increase by 13 and 14 percent under conventional and cluster development conditions, respectively. Phosphorus

Table 6

NONPOINT SOURCE POLLUTANT LOADINGS UNDER EXISTING AND FUTURE LAND USE CONDITIONS

		Existing (1995) Land Use Conditions	Future Conventional Development Conditions without Drainage Modifications or NPS[a] Pollution Controls		Future Cluster Development Conditions without Drainage Modifications or NPS[a] Pollution Controls		Alternative 1[b]			Recommended Plans		
Area	Pollutant	Load (pounds per year)	Load (pounds per year)	Percent Change Relative to Existing	Load (pounds per year)	Percent Change Relative to Existing	Load (pounds per year)	Percent Change Relative to Existing	Percent Change Relative to Future Cluster Conditions without Drainage Modifications or NPS[a] Pollution Controls	Load (pounds per year)	Percent Change Relative to Existing	Percent Change Relative to Future Cluster Conditions without Drainage Modifications or NPS[a] Pollution Controls
										Alternative 1a		
Subbasin 1	Total Solids	128,100	144,200	13	146,500	14	123,000	-4	-16	81,000	-37	-45
	Particulate Phosphorus	150	105	-30	106	-29	96	-36	-9	64	-57	-40
	Total Copper	1.3	2.9	123	2.9	123	2.0	54	-31	0.69	-47	-76
	Total Zinc	46	124	170	124	170	85	85	-31	2.8	-94	-98
										Alternative 8		
Subbasin 8	Total Solids	49,000	20,600	-58	26,300	-46	- -	- -	- -	15,800	-68	-40
	Particulate Phosphorus	92	20	-78	27	-71	- -	- -	- -	16	-83	-41
	Total Copper	0.03	0.22	633	0.42	1,300	- -	- -	- -	0.24	700	-43
	Total Zinc	1.7	11	547	12	606	- -	- -	- -	6.8	300	-43
										Alternatives 1a and 8		
Subbasins 1 and 8 Combined	Total Solids	177,100	164,800	-7	172,800	-2	- -	- -	- -	96,800	-45	-44
	Particulate Phosphorus	242	125	-48	133	-45	- -	- -	- -	80	-67	-40
	Total Copper	1.33	3.12	135	3.32	150	- -	- -	- -	0.93	-30	-72
	Total Zinc	47.7	135	183	136	185	- -	- -	- -	9.6	-80	-93

[a] *Nonpoint source.*

[b] *Does not apply to Subbasin 8 or Subbasins 1 and 8 combined.*

Source: SEWRPC.

loads would decrease by 30 and 29 percent under conventional and cluster development conditions, respectively. Copper loads would increase under both conventional and cluster development conditions by 123 percent. Zinc loads would increase under both conventional and cluster development conditions by 170 percent.

The increase in solids loads under both development scenarios can be attributed to the possible future conversion of some land from agricultural to commercial use. Although agricultural contributes relatively large amounts of solids to runoff, the modeling showed that the commercial development would produce over four times the amount of solids per acre as would agricultural land. Even though a significant amount of agricultural land would be converted to residential use, which would reduce solids loads by nearly 50 percent per acre, that would not be enough to compensate for increases due to the commercial development.

Similarly, the commercial development would account for the large increases in copper and zinc loadings. Agricultural land generally does not contribute significant amounts of these metals to runoff. Commercial and industrial areas and, to a much lesser extent, residential areas are the main sources of heavy metals.

Phosphorus loads, however, would decrease under developed conditions. Even though results show that commercial areas produce larger phosphorus loads than agricultural areas, the results also reveal that the decrease in phosphorus loads per acre from residential areas, compared to agricultural land, is greater than the increase per acre from commercial areas. This, and the fact that more acres of agricultural land would be converted to residential uses than to commercial development, accounts for the significant reduction in phosphorus loadings. It is possible that the phosphorus reductions could be somewhat less than indicated by the model if increasing trends in the application of nutrients to lawns continue. Public information and education programs should be implemented to promote proper application of fertilizers and other chemicals on residential lawns.

Under existing conditions, catchment area 1H is internally drained during events with durations up to 24 hours and recurrence intervals less than 10 years. That is, all runoff from the area tributary to the wooded depression that is located in an isolated natural resource area on the west side of STH 144 would pond without overtopping the roadway for all such storm events. This area currently functions as a natural storage and infiltration area and, based on the Washington County Soil Survey, consists of moderately to well drained soils that have a depth to the seasonal high water table of greater than five feet. The ponded runoff, eventually infiltrates into the soil, or is removed through evapotranspiration. There are two main effects of the catchment area being internally drained: 1) during storms with recurrence intervals less than ten years and durations up to 24 hours, runoff from catchment area 1H does not reach the east side of STH 144 and 2) since the vast majority of nonpoint source pollutants are produced during more-frequent storms, such as those with recurrence intervals less than 10 years, significant amounts of nonpoint source pollutants generated in catchment area 1H do not reach Big Cedar Lake.

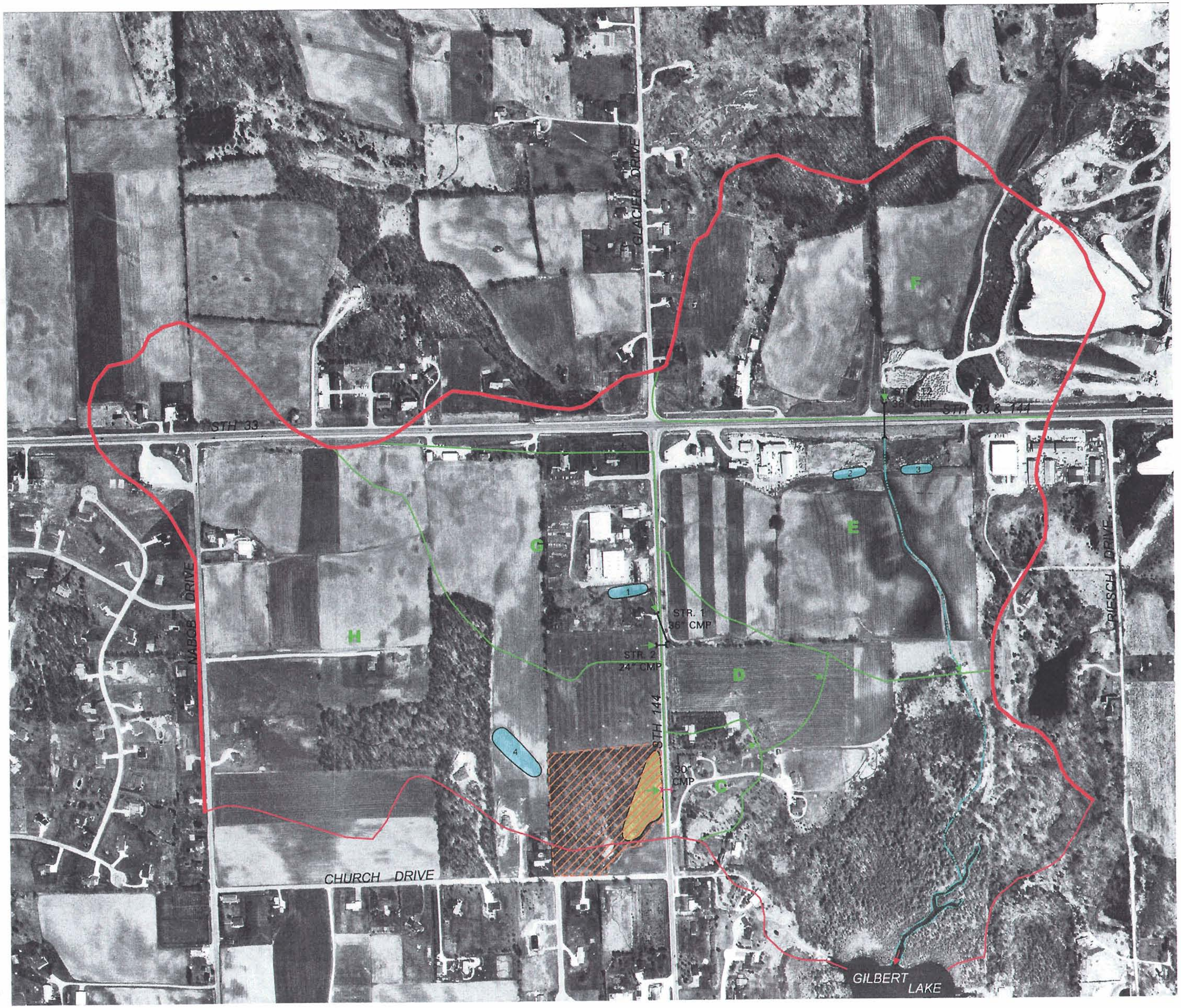
All peak flow rates and nonpoint source pollutant loadings under cluster development conditions with the density bonus are either similar to, or slightly higher than, those under conventional development conditions. Therefore, the choice of residential development approach does not have a significant effect on peak rates of runoff or pollutant loadings. Because of the advantages of cluster development for preservation of open space and of environmentally significant lands, each alternative was analyzed under only the cluster development scenario.

Alternative Plan No. 1: Conveyance under STH 144 and Wet Detention Basins

As shown on Map 5, Alternative Plan No. 1 calls for 1) installing one 60-foot-long, 30-inch-diameter corrugated metal pipe (CMP) culvert under STH 144 adjacent to the natural depression area located in the woodland west of STH 144 in catchment area 1H; 2) constructing a single purpose wet detention basin with a permanent pond area of one acre just west of the woodland; 3) purchasing the woodland on the west side of STH 144; and 4) constructing single purpose wet detention basins with permanent pond areas of 0.25, 0.33, and 0.35 acres to control runoff from commercial and industrial development. The detention basins would control nonpoint source pollution, but they would not have a significant water quantity control function. Each basin would have an average pond depth of five feet. The woodland downstream of proposed detention basin No. 4 stores runoff under existing conditions and would continue to do so, although to a lesser degree, under planned conditions.

Map 5

ALTERNATIVE 1: CONVEYANCE UNDER STH 144 AND WET DETENTION BASINS



- BIG CEDAR LAKE SUBWATERSHED BOUNDARY
- SUBBASIN 1 BOUNDARY
- CATCHMENT AREA BOUNDARY
- G — CATCHMENT AREA IDENTIFICATION
- SUBBASIN OUTLET
- CATCHMENT AREA OUTLET
- INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)
- DEPRESSION AREA
- 2 — PROPOSED WET DETENTION BASIN AND IDENTIFICATION
- WOODLAND TO BE PURCHASED
- EXISTING CULVERT (SIZE IN INCHES)
- PROPOSED CULVERT (SIZE IN INCHES)
- STR. 2 — STRUCTURE IDENTIFICATION
- CMP — CORRUGATED METAL PIPE

N

GRAPHIC SCALE
0 300 600 FEET

Source: SEWRPC.

The culvert under STH 144 would be installed to prevent overtopping of the roadway during storms with recurrence intervals up to and including 50 years, as specified under the road overtopping standard for arterial highways (see Chapter II). The upstream invert elevation of the proposed culvert was assumed to be the same as that of the existing low point in the depression (1,074 feet above National Geodetic Vertical Datum, 1929 adjustment (NGVD29)).

All roads in areas of future development would be constructed with roadside grassed swales for stormwater drainage and control of nonpoint source pollution.

As set forth in Table 4, implementation of this alternative plan would be expected to increase peak rates of runoff from the **entire** subbasin for the two-, 10-, 50-, and 100-year recurrence interval storms by 104, 27, 9, and 13 percent, respectively, relative to existing conditions. When compared to future land use conditions without additional drainage modifications, the peak rates of runoff for the two-, 10-, 50-, and 100-year recurrence interval storms would increase by 19, 8, 14, and 3 percent, respectively. These latter increases are the result of the proposed culvert under STH 144 which would allow flows to leave catchment area 1H during any storm and not just those with recurrence intervals of 10 years or greater.

As shown in Table 6, when compared to existing land use conditions, solids and phosphorus loads would decrease by 4 and 36 percent, respectively, while copper and zinc loads would increase by 54 and 85 percent, respectively. When compared to future land use conditions without additional nonpoint source pollution controls and without drainage modifications, solids, phosphorus, copper, and zinc loads would decrease by 16, 9, 31, and 31 percent, respectively.

Under existing conditions, the drainage system downstream from catchment area 1H consists of the roadside swale along the east side of STH 144 and a series of backyard swales that discharge to the wetlands along the north end of Gilbert Lake. This system may require some modification to convey the increased flows expected if this alternative plan were implemented.

As set forth in Table 7 the capital cost of this alternative is estimated to be $397,000. That cost consists of approximately $6,000 for the installation of the new culvert, $10,000 to modify the open drainage system downstream from STH 144, $255,000 for the construction of the wet detention basins, $36,000 for the acquisition of land needed for the basins, and $90,000 for acquisition of the woodland west of STH 144. The annual operation and maintenance cost is estimated to be $13,100. Based on a 50-year project life and an interest rate of 6 percent, the annualized cost of this alternative plan would be about $38,300.

Alternative Plan No. 1a: Preservation of Existing Storage and Wet Detention Basins

As shown on Map 6, Alternative Plan No. 1a calls for 1) purchasing and preserving the woodland runoff storage area that is located in an isolated natural resource area in catchment area 1H on the west side of STH 144; 2) constructing three single purpose wet detention basins with permanent pond areas of 0.25, 0.33, and 0.35 acres to control runoff from commercial and industrial development; 3) relatively minor modification of the drainage system downstream from catchment area 1H; and 4) the provision of roadside grassed swales that would reduce nonpoint source pollution through infiltration and filtering of runoff.

As under Alternative Plan No. 1, the detention basins would control nonpoint source pollution, but they would not have a significant water quantity control function. Each basin would have an average pond depth of five feet.

Table 7

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 1
CONVEYANCE UNDER STH 144 AND WET DETENTION BASINS

Component Description	Estimated Cost[a]	
	Capital[b]	Annual Operation and Maintenance
1. 60-foot-long, 30-inch-diameter CMP culvert under STH 144	$ 6,000	$ 100
2. 0.33-acre wet detention basin No. 1	50,000	2,200
3. 0.35-acre wet detention basin No. 2	52,000	2,200
4. 0.25-acre wet detention basin No. 3	43,000	2,000
5. One-acre wet detention basin No. 4	110,000	3,600
6. Land acquisition for basins	36,000	- -
7. Land acquisition for existing natural storage area	90,000	3,000
8. Modification of the drainage system downstream from catchment area 1H	10,000	- -
Total	$397,000	$13,100

[a]*Costs based upon 2000* Engineering News-Record *Construction Cost Index = 7,230.*

[b]*Includes 35 percent for engineering, administration, and contingencies.*

Source: SEWRPC.

With this alternative plan implemented, the peak rates of runoff for catchment area 1H for the two-, 10-, 50-, and 100-year recurrence interval storms would be expected to increase by 0,[2] 75, 48, and 28 percent, respectively, relative to existing conditions. However, the total runoff volumes for the two-, 10-, 50- and 100-year recurrence interval storms would only be expected to increase by 20, 11, 8, and 8 percent, respectively, relative to existing conditions. The increases in the rate and volume of runoff would be solely attributable to land use changes.

The peak rates of runoff for the **entire** subbasin for the two-, 10-, and 100-year recurrence interval storms would be expected to increase by 71, 18, and 10 percent, respectively, relative to existing conditions. However, the peak rate of runoff for the 50-year recurrence interval storm would decrease by 4 percent.

Implementation of this plan could result in overtopping of STH 144 during storms with recurrence intervals slightly less than 10 years. Under existing conditions, overtopping would not be expected for storms with recurrence intervals less than 10 years. Thus, the highway could be overtopped more frequently under future conditions than under existing conditions. However, the depression area would still store all runoff during the smaller storms that are most critical for the generation of nonpoint source pollution. Therefore, if undisturbed, the depression should continue to function to control nonpoint source pollution in a manner similar to existing conditions.

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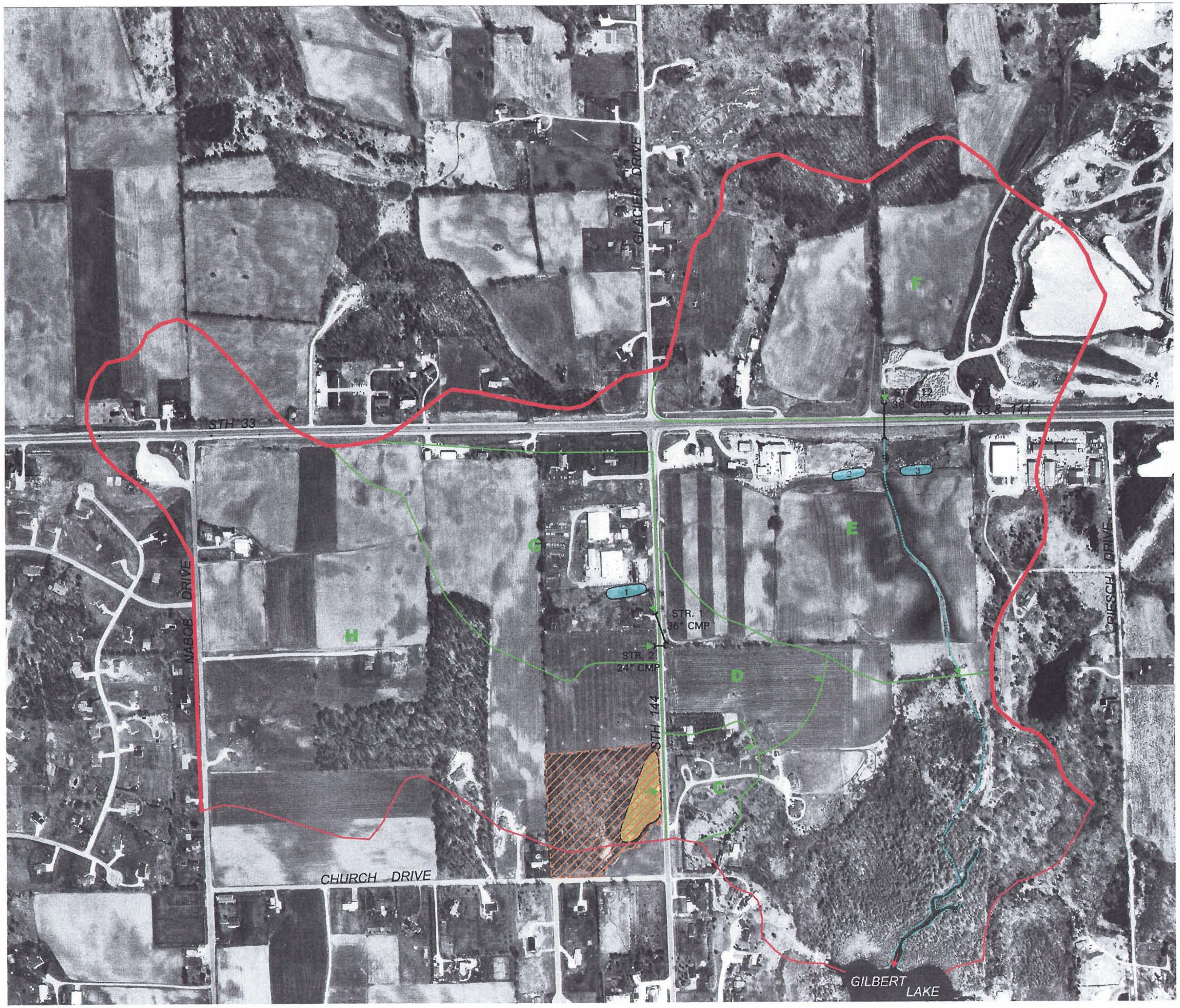
[2]*The two-year, 24-hour storm would be completely stored in the depression area under both existing land use and drainage conditions and future land use and alternative drainage conditions. Thus, the outflow for that storm would be zero for both conditions.*

Map 6

ALTERNATIVE 1a: PRESERVATION OF EXISTING STORAGE AND WET DETENTION BASINS



BIG CEDAR LAKE SUBWATERSHED BOUNDARY

SUBBASIN 1 BOUNDARY

CATCHMENT AREA BOUNDARY

G CATCHMENT AREA IDENTIFICATION

SUBBASIN OUTLET

CATCHMENT AREA OUTLET

INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)

DEPRESSION AREA

2 PROPOSED WET DETENTION BASIN AND IDENTIFICATION

WOODLAND TO BE PURCHASED

EXISTING CULVERT (SIZE IN INCHES)

STR. 2 STRUCTURE IDENTIFICATION

CMP CORRUGATED METAL PIPE

N

GRAPHIC SCALE

0 300 600 FEET

Source: SEWRPC.

As shown in Table 6, when compared to existing land use conditions, solids, phosphorus, copper, and zinc loads from the subbasin would decrease by 37, 57, 47, and 94 percent, respectively. When compared to future land use conditions without additional nonpoint source pollution controls, solids, phosphorus, copper, and zinc loads would decrease by 45, 40, 76, and 98 percent, respectively.

Under existing conditions, the drainage system downstream from catchment area 1H consists of the roadside swale along the east side of STH 144 and a series of backyard swales that discharge to the wetlands along the north end of Gilbert Lake. This system may require some modification to convey the increased flows that would be expected solely due to future urban development, not as a result of any measures provided under the alternative plan.

As set forth in Table 8 the capital cost of this alternative is estimated to be $257,000. That cost consists of approximately $5,000 to modify the open drainage system downstream from STH 144, $145,000 for the construction of the wet detention basins, $17,000 for the acquisition of land needed for the basins, and $90,000 for acquisition of the woodland west of STH 144. The annual operation and maintenance cost is estimated to be $9,400. Based on a 50-year project life and an interest rate of 6 percent, the annualized cost of this alternative plan would be about $25,700.

Subbasin 8

Under a conventional future development scenario, a maximum of 29 3.5-acre rural residential lots would fit within the boundaries of Subbasin 8. The total impervious area of the entire subbasin would be about 6 acres, or 5 percent of the entire 125-acre subbasin. Under a cluster development scenario, with the density bonus, a maximum of 37 1.5-acre lots would fit within the boundaries of Subbasin 8, and the total impervious area of the subbasin would be about 7 acres, or 6 percent of the subbasin.

Under the both conventional and cluster development scenarios, the peak rates of runoff for the entire subbasin for the two-, 10-, 50-, and 100-year recurrence interval storms would be expected to decrease by 30, 39, 25, and 7 percent, respectively, relative to existing conditions. The decreases in the peak rates of runoff can be attributed to the conversion of agricultural land, often with exposed soil, to rural residential land, with significant grassed areas. The grassed areas, which provide greater resistance to stormwater runoff than bare soil, slow the velocity of the runoff and increase infiltration. Complete comparison results are set forth in Table 4. Also, under existing, conventional, or cluster development conditions, the existing culvert located under STH 144 within the subbasin was found to have adequate capacity to meet the road overtopping standard set forth in Chapter II. However, as described below, the potential exists for overtopping of West Lake Drive during a 10-year storm, in violation of the overtopping standard.

Estimated annual nonpoint source pollutant loadings, under both conventional and cluster development conditions are set forth in Table 6. Relative to existing conditions, solids (sediment) loads would decrease by 58 and 46 percent under conventional and cluster development conditions, respectively. Phosphorus loads would decrease by 78 and 71 percent under conventional and cluster development conditions, respectively. Copper loads would increase under conventional and cluster development conditions by 633 and 1,300 percent, respectively. Zinc loads would increase under conventional and cluster development conditions by 547 and 606 percent, respectively.

The decrease in solids loads under both development scenarios can be attributed to the possible future conversion of land from agricultural to residential use, which would reduce solids loads by about 50 percent per acre. Similarly, phosphorus loads would decrease significantly under developed conditions due to the possible future conversion of land from agricultural to residential use. Once again, it is possible that the phosphorus reductions could be somewhat less than indicated by the model if increasing trends in the application of nutrients to lawns continue. Public information and education programs should be implemented to promote proper application of fertilizers and other chemicals on residential lawns.

Table 8

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 1A
PRESERVATION OF EXISTING STORAGE AND WET DETENTION BASINS

Component Description	Estimated Cost[a] Capital[b]	Estimated Cost[a] Annual Operation and Maintenance
1. 0.33-acre wet detention basin No. 1	$ 50,000	$2,200
2. 0.35-acre wet detention basin No. 2	52,000	2,200
3. 0.25-acre wet detention basin No. 3	43,000	2,000
4. Land acquisition for basins	17,000	- -
5. Land acquisition for existing natural storage area	90,000	3,000
6. Modification of the drainage system downstream from catchment area 1H	5,000	- -
Total	$257,000	$9,400

[a]*Costs based upon 2000* Engineering News-Record *Construction Cost Index = 7,230.*

[b]*Includes 35 percent for engineering, administration, and contingencies.*

Source: SEWRPC.

The conversion of land to residential uses accounts for the increases in copper and zinc loadings. Agricultural land does not contribute significant amounts of these metals to runoff, and residential areas do contribute heavy metals.

All peak flow rates and nonpoint source pollutant loadings under cluster development conditions were either similar to, or higher than, those under conventional development conditions. Because of the advantages of cluster development for preservation of open space and environmentally significant lands, each alternative was analyzed under only the cluster development scenario.

Alternative Plan No. 8: Increased Conveyance under West Lake Drive and Wet Detention Basin

The issues of providing adequate stormwater drainage and control of nonpoint source pollution for this subbasin are clear and can be addressed adequately, and in a cost-effective manner, through the plan described below. The evaluation of additional alternatives is not considered to be necessary because of the straightforward nature of the problems to be solved.

As shown on Map 7, Alternative Plan No. 8 calls for 1) installing two 30-foot-long, 43-inch-wide by 27-inch-high corrugated metal pipe arch (CMPA) culverts under West Lake Drive, 2) raising a 230-foot stretch of West Lake Drive up to one foot in the vicinity of the proposed new culverts, and 3) constructing a single purpose 0.9-acre wet detention basin with a five-foot pond depth between STH 144 and West Lake Drive. The detention basin would control nonpoint source pollution, but it would not have a significant water quantity control function.

The culverts under West Lake Drive would be installed to prevent overtopping of the roadway during storms with recurrence intervals up to and including 10 years, as specified under the road overtopping standard for minor and collector streets (see Chapter II). The upstream invert elevation of the proposed culverts would be the same as that of the existing culverts they are to replace. West Lake Drive would also be raised to prevent overtopping of the roadway due to backwater from Big Cedar Lake with the Lake at its 10-year recurrence interval flood stage.

Map 7

ALTERNATIVE 8: INCREASED CONVEYANCE UNDER WEST LAKE DRIVE AND WET DETENTION BASIN

- BIG CEDAR LAKE SUBWATERSHED BOUNDARY
- SUBBASIN 8 BOUNDARY
- CATCHMENT AREA BOUNDARY
- B — CATCHMENT AREA IDENTIFICATION
- SUBBASIN OUTLET
- CATCHMENT AREA OUTLET
- INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)
- PROPOSED WET DETENTION BASIN
- PROPOSED ROAD GRADE RAISE
- EXISTING CULVERT (SIZE IN INCHES)
- PROPOSED REPLACEMENT CULVERT (SIZE IN INCHES)
- STR. 3 — STRUCTURE IDENTIFICATION
- CMPA — CORRUGATED METAL PIPE ARCH

Source: SEWRPC.

All roads in areas of future development would be constructed with roadside grassed swales for stormwater drainage and control of nonpoint source pollution.

As set forth in Table 4, implementation of this alternative plan would be expected to decrease peak rates of runoff for the subbasin for the two-, 10-, 50-, and 100-year recurrence interval storms by 30, 39, 25, and 7 percent, respectively, relative to existing conditions. As shown in Table 6, when compared to existing land use conditions, solids and phosphorus loads would decrease by 68 and 83 percent, respectively, while copper and zinc loads would increase by 700 and 300 percent, respectively. Also, under this alternative, solids, phosphorus, copper, and zinc loads would be expected to decrease by 40, 41, 43, and 43 percent, respectively, when compared to cluster development conditions without any pollutant controls.

As set forth in Table 9 the capital cost of this alternative is estimated to be $124,000. That cost consists of approximately $10,000 for the installation of the new culverts, $14,000 to raise West Lake Drive, and $100,000 for the construction of the wet detention basin.[3] The annual operation and maintenance cost is estimated to be $3,500. Based on a 50-year project life and an interest rate of 6 percent, the annualized cost of this alternative plan would be about $12,500.

Subbasin 19
As explained above in the section of this chapter that describes existing drainage and natural resource features, only a very small portion of Subbasin 19 drains to Big Cedar Lake under existing conditions. That area contributes negligible amounts of nonpoint source pollutants to the Lake. Based on the hydrologic and hydraulic modeling of rates and volumes of runoff under future land use conditions, it was found that it would be possible to accommodate that runoff under the existing drainage conditions. Thus, it is recommended that the drainage patterns of Subbasin 19 be maintained under future conditions.

NONPOINT SOURCE POLLUTION REDUCTION GOALS

In 1978, the Wisconsin Department of Natural Resources developed a set of recommended management measures for the protection of the Lake's water quality.[4] These measures included both urban and rural pollution control measures.[5] In 1979, the Southeastern Wisconsin Regional Planning Commission completed a regional water quality management plan for Southeastern Wisconsin.[6] That plan contained specific recommendations for reduction in nonpoint source pollutants from both rural and urban lands tributary to Big Cedar Lake which were needed to achieve the adopted water use objectives for the Lake. That plan recommended that a reduction of about

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[3]*The land on which the basin would be constructed is owned by the Lake District. Thus, there is no cost for land acquisition.*

[4]*Wisconsin Department of Natural Resources, Office of Inland Lake Renewal,* Big Cedar Lake, Washington County, Management Alternatives, *1978.*

[5]*Urban pollution control measures were recommended to include limitation of sediment transport to the Lake, control of runoff from urban development to pre-development levels, use of settling basins and grassed waterways to minimize nutrient transport to the Lake, and location of onsite sewage disposal systems at least 100 feet from the ordinary high water mark of the Lake. Rural pollution control measures were recommended to include proper management of barnyards and manure storage facilities. In-lake pollution control measures were recommended to include aquatic plant harvesting.*

[6]*SEWRPC Planning Report No. 30,* A Regional Water Quality Management Plan for Southeastern Wisconsin: 2000; *Volume One,* Inventory Findings, *September 1978; Volume Two,* Alternative Plans, *February 1979; and Volume Three,* Recommended Plan, *June 1979*

Table 9

COMPONENTS AND COSTS OF ALTERNATIVE PLAN NO. 8
INCREASED CONVEYANCE UNDER WEST LAKE DRIVE AND WET DETENTION BASIN

	Estimated Cost[a]	
Component Description	Capital[b]	Annual Operation and Maintenance
1. Two 30-foot-long, 43-inch-wide by 27-inch-high CMPA under West Lake Drive	$ 10,000	$ 100
2. Grade raise along 230-foot-long section of West Lake Drive	14,000	- -
3. 0.9-acre wet detention basin	100,000	3,400
Total	$124,000	$3,500

[a] *Costs based upon 2000* Engineering News-Record *Construction Cost Index = 7,230.*

[b] *Includes 35 percent for engineering, administration, and contingencies.*

Source: SEWRPC.

25 percent in both the rural and urban nonpoint sources, plus streambank erosion control, construction site erosion control, and onsite sewage disposal system management be achieved in the drainage area tributary to Big Cedar Lake. Subsequently, a nonpoint source pollution abatement priority watershed program plan[7] was prepared by the Wisconsin Department of Natural Resources and its partners. The Cedar Creek priority watershed project established nonpoint source pollutant loading reduction goals of 30 percent for sediment and nutrients. The plan did not specifically establish reduction goals for metals in the Big Cedar Lake subwatershed, because the subwatershed was not considered as an area that would experience significant urban development. The nonpoint source pollutant recommendations set forth in these plans have been partially implemented by the Big Cedar Lake Protection and Rehabilitation District in cooperation with Washington County and the WDNR during the intervening period. The nonpoint source pollution reduction goals described above were considered in the evaluation of the alternative plans presented herein.

The priority watershed study also made the following two recommendations regarding streamflow in urbanizing areas:

- The peak flow from a two-year, 24-hour storm should be maintained at a level consistent with pre-development conditions.[8]
- Infiltration of stormwater runoff should be promoted to maintain stream baseflows, but should not be allowed to contaminate groundwater.

[7] *Wisconsin Department of Natural Resources,* Nonpoint Source Control Plan for the Cedar Creek Priority Watershed Project, *August 1993.*

[8] *This recommendation relates specifically to avoiding increases in flows that would negatively affect streams by potentially increasing streambank erosion and streambed scour and altering stream morphology.*

EVALUATION OF ALTERNATIVE STORMWATER MANAGEMENT PLANS

Subbasin 1

The alternative plans developed for Subbasin 1 were evaluated based on cost; nonpoint source pollution control effectiveness; and the ability to thereby meet the water quality, roadway overtopping, and primary environmental corridor preservation standards set forth in Chapter II.

On an annual basis, Alternative Plan No. 1, Conveyance under STH 144 and Wet Detention Basins, is about 50 percent more costly to implement than Alternative Plan No. 1a, Preservation of Existing Storage and Wet Detention Basins. Implementation of Alternative Plan No. 1 would result in a greater increase in the peak rate of runoff from a two-year storm than would Alternative Plan No. 1a. For each pollutant analyzed, Alternative Plan No. 1 achieves a lesser degree of control of nonpoint source pollution than Alternative No. 1a. Alternative No. 1 does not meet the 30 percent target reduction in sediment, but does meet the 30 percent target for phosphorus. Alternative No. 1a meets, and actually exceeds the target for both sediment and phosphorus reductions.

Alternative No. 1 provides culverts under STH 144 to meet the 50-year flood overtopping standard. Alternative No. 1a does not meet the standard. Under Alternative No. 1a, the potential frequency of overtopping of STH 144 would increase slightly relative to existing conditions because of increases in runoff volume due to residential development in the tributary subbasin.

Alternative Plan No. 1a, Preservation of Existing Storage and Wet Detention Basins, is selected as the recommended plan for Subbasin 1 because it provides the highest level of control of peak rates of runoff and of nonpoint source pollution.

Subbasin 8

The single alternative plan developed for this subbasin, Increased Conveyance under West Lake Drive and Wet Detention Basin, is recommended to be implemented.

Subbasin 19

It is recommended that the existing drainage patterns in this subbasin be maintained. There is no need to evaluate alternatives.

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Chapter VI

RECOMMENDED STORMWATER MANAGEMENT PLAN

RECOMMENDED PLAN

Consistent with the evaluation set forth in Chapter V of this volume, it is recommended that the Preservation of Existing Storage and Wet Detention Basins plan be implemented in Subbasin 1, that the Increased Conveyance under West Lake Drive and Wet Detention Basin plan be implemented in Subbasin 8, and that the existing drainage patterns in Subbasin 19 be preserved such that all but a small portion of that subbasin drains away from Big Cedar Lake. The recommended plans for each subbasin are shown on Maps 8, 9, and 10. The recommended plan costs and the components of the recommended plan are set forth in Table 10.

Subbasin 1

The recommended plan for this subbasin calls for 1) purchase and preservation of the wooded depression that is located in an isolated natural resource area in catchment area 1H on the west side of STH 144; 2) relatively minor modification of the drainage system downstream from catchment area 1H; 3) construction of three wet detention basins to control runoff from areas of existing and/or future commercial and industrial development;[1] and 4) the provision of roadside grassed swales that would reduce nonpoint source pollution through infiltration and filtering of runoff.

Implementation of this plan could result in overtopping of STH 144 during storms with recurrence intervals slightly less than 10 years. Under existing conditions, overtopping would not be expected for storms with recurrence intervals less than 10 years. Thus, the highway could be overtopped more frequently under future conditions than under existing conditions. However, the depression area would still store all runoff during the smaller storms that are most critical for the generation of nonpoint source pollution. Therefore, if undisturbed, the depression should continue to function to control nonpoint source pollution in a manner similar to existing conditions.

The peak rates of runoff for the entire subbasin for the two-, 10-, and 100-year recurrence interval storms would be expected to increase by 71, 18, and 10 percent, respectively, relative to existing conditions. However, the peak rate of runoff for the 50-year recurrence interval storm would decrease by 4 percent.

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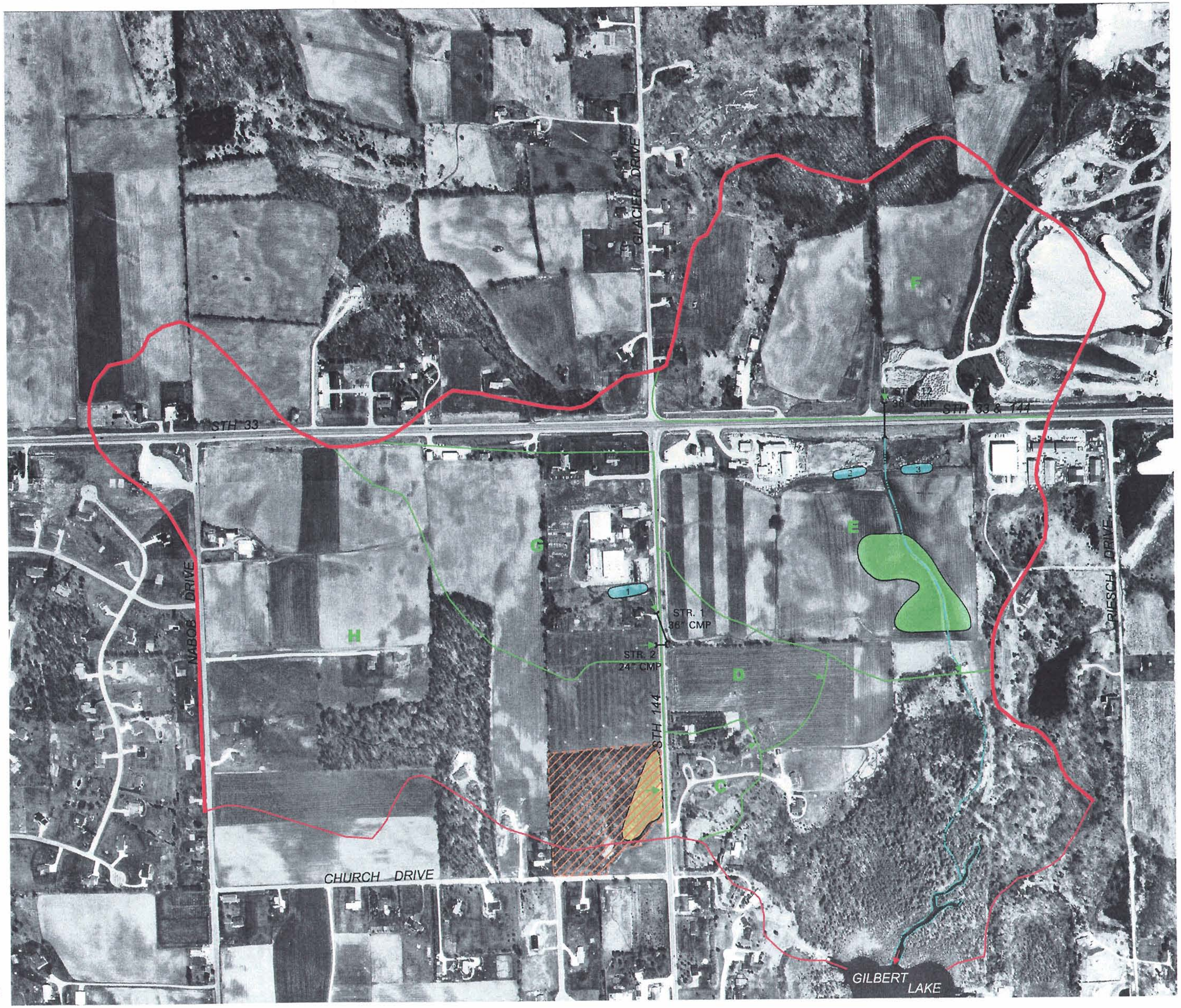
[1] *The Lake District plans to construct a wet detention basin with a permanent pond area of about three acres at the location shown on Map 8. That basin would control runoff from a greater land area than the three basins called for under the recommended plan. It is an appropriate refinement of the recommended plan that would eliminate the need for the three individual basins.*



Map 8

RECOMMENDED PLAN FOR SUBBASIN 1

BIG CEDAR LAKE SUBWATERSHED BOUNDARY

SUBBASIN 1 BOUNDARY

CATCHMENT AREA BOUNDARY

G CATCHMENT AREA IDENTIFICATION

SUBBASIN OUTLET

CATCHMENT AREA OUTLET

INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)

DEPRESSION AREA

2 PROPOSED WET DETENTION BASIN AND IDENTIFICATION

ALTERNATE SITE TO CONSOLIDATE PROPOSED WET DETENTION BASINS 1, 2, AND 3 AND TREAT RUNOFF FROM ADDITIONAL AREAS

WOODLAND TO BE PURCHASED

EXISTING CULVERT (SIZE IN INCHES)

STR. 2 STRUCTURE IDENTIFICATION

CMP CORRUGATED METAL PIPE

N

GRAPHIC SCALE

0 300 600 FEET

Source: SEWRPC.

Map 9

RECOMMENDED PLAN FOR SUBBASIN 8

- BIG CEDAR LAKE SUBWATERSHED BOUNDARY
- SUBBASIN 8 BOUNDARY
- CATCHMENT AREA BOUNDARY
- B — CATCHMENT AREA IDENTIFICATION
- SUBBASIN OUTLET
- CATCHMENT AREA OUTLET
- INTERMITTENT STREAM (FROM USGS ALLENTON 7.5-MINUTE QUADRANGLE MAP)
- PROPOSED WET DETENTION BASIN
- PROPOSED ROAD GRADE RAISE
- EXISTING CULVERT (SIZE IN INCHES)
- PROPOSED REPLACEMENT CULVERT (SIZE IN INCHES)
- STR. 3 — STRUCTURE IDENTIFICATION
- CMPA — CORRUGATED METAL PIPE ARCH

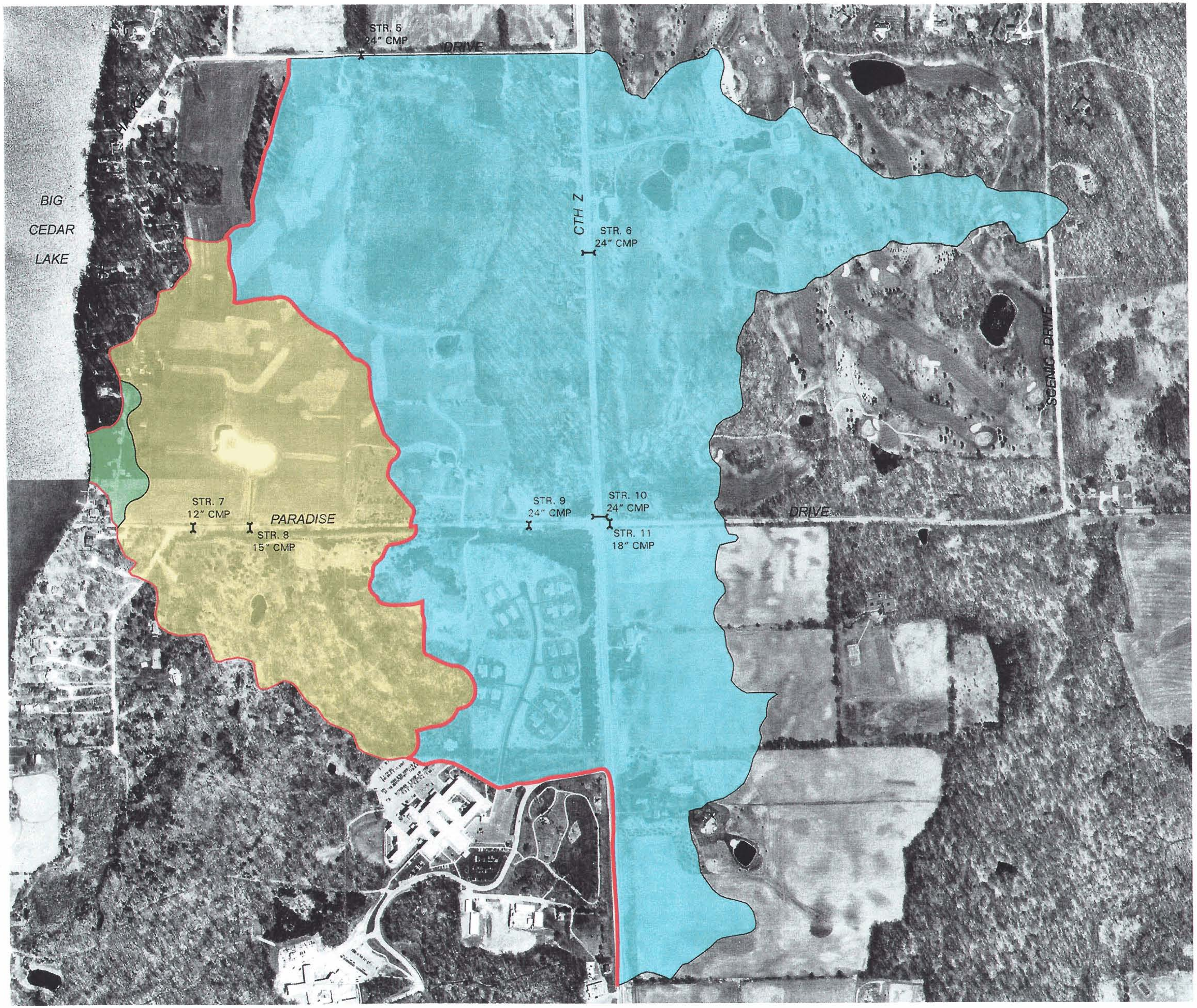
N

GRAPHIC SCALE
0 200 400 FEET

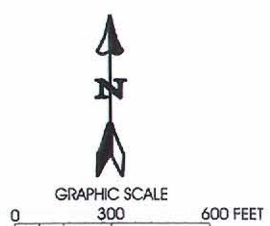
Source: SEWRPC.

Map 10

RECOMMENDED PLAN FOR SUBBASIN 19



- BIG CEDAR LAKE SUBWATERSHED BOUNDARY
- SUBBASIN 19 BOUNDARY
- INTERNALLY DRAINED AREA
- WASHINGTON CREEK DRAINAGE AREA
- AREA TRIBUTARY TO BIG CEDAR LAKE
- EXISTING CULVERT (SIZE IN INCHES)
- STR. 8 — STRUCTURE IDENTIFICATION
- CMP — CORRUGATED METAL PIPE



Source: SEWRPC.

Table 10

COMPONENTS AND COSTS OF THE RECOMMENDED STORMWATER MANAGEMENT PLAN FOR THREE PILOT SUBBASINS IN THE BIG CEDAR LAKE SUBWATERSHED[a]

Component Description	Estimated Cost[b]	
	Capital[c]	Annual Operation and Maintenance
Subbasin 1		
1. 0.33-acre wet detention basin No. 1[d]	$ 50,000	$ 2,200
2. 0.35-acre wet detention basin No. 2[d]	52,000	2,200
3. 0.25-acre wet detention basin No. 3[d]	43,000	2,000
4. Land acquisition for basins	17,000	- -
5. Land acquisition for existing natural storage area	90,000	3,000
6. Modification of the drainage system downstream from catchment area 1H	5,000	- -
Subtotal	$257,000	$ 9,400
Subbasin 8		
1. Two 30-foot-long, 43-inch-wide by 27-inch-high CMPA under West Lake Drive	$ 10,000	$ 100
2. Grade raise along 230-foot-long section of West Lake Drive	14,000	- -
3. 0.9-acre wet detention basin	100,000	3,400
Subtotal	$124,000	$ 3,500
Total	$381,000	$12,900

[a] *There are no costs associated with the recommendations for Subbasin 19.*

[b] *Costs based upon 2000 Engineering News-Record Construction Cost Index = 7,230.*

[c] *Includes 35 percent for engineering, administration, and contingencies.*

[d] *The Lake District plans to construct a wet detention basin with a permanent pond area of about three acres at the location shown on Map 8. That basin would control runoff from a greater land area than the three basins called for under the recommended plan. It is an appropriate refinement of the recommended plan that would eliminate the need for the three individual basins.*

Source: SEWRPC.

As shown in Table 6, when compared to existing land use conditions, solids, phosphorus, copper, and zinc loads from the subbasin would decrease by 37, 57, 47, and 94 percent, respectively. When compared to future land use conditions without additional nonpoint source pollution controls, solids, phosphorus, copper, and zinc loads would decrease by 45, 40, 76, and 98 percent, respectively.

Under existing conditions, the drainage system downstream from catchment area 1H consists of the roadside swale along the east side of STH 144 and a series of backyard swales that discharge to the wetlands along the north end of Gilbert Lake. This system may require some modification to convey the increased flows that would be expected solely due to future urban development, not as a result of any measures provided under the alternative plan.

As set forth in Table 10, the estimated total capital cost of the recommended plan for this subbasin is $257,000 and the estimated annual operation and maintenance cost is $9,400.

Subbasin 8

The recommended plan for this subbasin calls for 1) installing two 30-foot-long, 43-inch-wide by 27-inch-high corrugated metal pipe arch (CMPA) culverts under West Lake Drive, 2) raising a 230-foot stretch of West Lake Drive up to one foot in the vicinity of the proposed new culverts, and 3) constructing a single purpose 0.9-acre wet detention basin with a five-foot pond depth between STH 144 and West Lake Drive.[2] The detention basin would control nonpoint source pollution, but it would not have a significant water quantity control function.

The culverts under West Lake Drive would be installed to prevent overtopping of the roadway during storms with recurrence intervals up to and including 10 years, as specified under the road overtopping standard for minor and collector streets (see Chapter II). The upstream invert elevation of the proposed culverts would be the same as that of the existing culverts they are to replace. West Lake Drive would also be raised to prevent overtopping of the roadway due to backwater from Big Cedar Lake with the Lake at its 10-year recurrence interval flood stage.

All roads in areas of future development would be constructed with roadside grassed swales for stormwater drainage and control of nonpoint source pollution.

As set forth in Table 4, under recommended plan condition, peak rates of runoff from the subbasin for the two-, 10-, 50-, and 100-year recurrence interval storms would decrease by 30, 39, 25, and 7 percent, respectively, relative to existing conditions.

As shown in Table 6, when compared to existing land use conditions, solids and phosphorus loads would decrease by 68 and 83 percent, respectively, while copper and zinc loads would increase by 700 and 300 percent, respectively. Also, under this plan, solids, phosphorus, copper, and zinc loads would be expected to decrease by 40, 41, 43, and 43 percent, respectively, when compared to future land use conditions without any pollutant controls.

As set forth in Table 10, the estimated total capital cost of the recommended plan for this subbasin is $124,000 and the estimated annual operation and maintenance cost is $3,500.

Subbasin 19

It is recommended that the existing drainage patterns in this subbasin, including runoff storage areas, be maintained. No additional stormwater management facilities are needed.

TOTAL COST OF RECOMMENDED PLAN

The estimated total capital cost of the recommended plan for all three pilot subbasins is $381,000 and the estimated annual operation and maintenance cost is $12,900.

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[2]*The Lake District intends to begin construction in 2001 of a smaller wet detention basin at the general location shown on Map 9. That facility should perform some of the water quality functions of the recommended wet basin, but it may be necessary to augment the proposed basin with wet basins serving existing residential development in the upstream part of the subbasin. Those developments are served by dry detention basins that might be retrofitted to include permanent ponds for control of nonpoint source pollution.*

ABILITY OF RECOMMENDED PLAN TO MEET OBJECTIVES AND STANDARDS

The key standards for evaluation of the recommended plan are set forth in Chapter II of this volume. Additional standards intended to guide the development of stormwater management systems in the subwatershed are provided in Appendix A.

The recommended plan can only be evaluated on a subbasin basis, because the overall effects on the Big Cedar Lake subwatershed cannot be determined until stormwater management plans are completed for the remaining subbasins.

Nonpoint Source Pollution Control Standards

The priority watershed plan established reduction goals for sediment and phosphorus of 30 percent relative to existing conditions in the Big Cedar Lake subwatershed.[3] The plan did not specifically establish reduction goals for metals, because the subwatershed was not considered as an area that would experience significant urban development.

Subbasin 1

The recommended plan provides a high level of control of nonpoint source pollution. The sediment and phosphorus reduction goals would be met and actually exceeded. Metals loads would be expected to decrease under future conditions, relative to existing conditions.

The road overtopping standard for STH 144 is not met. However, the decision to not meet the standard was made in order to maximize the control of nonpoint source pollutants and downstream rates of runoff through maintenance of the existing depression storage area west of the highway.

The priority watershed study recommendation to maintain peak the two-year flood flow at its pre-development level is not satisfied for all of the 0.7-mile-long intermittent stream in the subbasin. The upper 0.3-mile reach is apparently a modified agricultural drainage channel. The expected increase in two-year flows would occur in that reach. The lower 0.4-mile reach is a natural channel that flows through a wetland adjacent to Gilbert Lake. The large amount of floodwater storage available in the wetland would be expected to reduce peak flows, significantly reducing the increase in the peak two-year flow and mitigating negative effects in that reach.

Subbasin 8

The recommended plan provides the greatest level of control of nonpoint source pollution that is feasible. Almost all runoff from the subbasin is recommended to be treated with a wet detention basin and grassed roadside swales. The sediment and phosphorus reduction goals are met and actually exceeded. Metals loadings would still increase relative to existing conditions. However, when the recommended plan loadings for Subbasins 1 and 8 are combined, solids, phosphorus, copper, and zinc loads from the total area would all decrease as described below.

The priority watershed study recommendation that the peak two-year flood flow be no more than the pre-development peak flow is satisfied for the intermittent stream in the subbasin.

The road overtopping standard for West Lake Drive is met.

Subbasin 19

The recommendation for this subbasin calls for maintenance of existing drainage patterns to avoid increasing runoff to the Lake. The portion of this subbasin that drains to the Lake is now, and is recommended to remain,

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[3] *This reduction goal is similar to the 25 percent reduction goal established under the regional water quality management plan.*

quite small, and it does not represent a significant contribution of nonpoint source pollution or runoff volume to the Lake.

Overall Effectiveness of Recommended Plan

As shown in Table 6, when the recommended plan loadings for Subbasins 1 and 8 are combined, solids, phosphorus, copper, and zinc loads from the total area would decrease by 45, 67, 30, and 80 percent, respectively, relative to existing land use condition loads. Thus, the overall plan more than meets the 30 percent sediment and phosphorus reduction goal and it also results in significant reductions in metals relative to existing conditions.

ADDITIONAL RECOMMENDATIONS

In addition to the specific stormwater management recommendations set forth above, the following recommendations are made relative to management of stormwater and of the natural resource base in areas tributary to Big Cedar Lake:

- It is recommended that primary environmental corridor lands, as identified on Map 14 of Volume One of this report, be preserved in essentially natural, open space use. Those corridors include most of the wetlands and other ecologically valuable lands in the Big Cedar Lake subwatershed.

- It is recommended that the Town of West Bend construction erosion control ordinance be strictly enforced and that the Washington County ordinance be enforced in the Town of Barton.

- Existing zoning permits suburban-density residential development on lands in the Town of West Bend that are recommended for agricultural and rural use under the 2020 regional land use plan. In the interim period between conversion of those lands to urban use, it is recommended that upland erosion from agricultural and other rural lands be reduced to the target level of three tons per acre per year, as identified on the Washington County agricultural soil erosion control plan as the tolerable level that can be sustained without impairing productivity. This reduction should be accomplished through the preparation of detailed farm plans for individual farm units with the assistance of the NRCS and County Land Conservation department staffs.

- It is recommended that good urban "housekeeping" practices to control nonpoint source pollution be encouraged through public education programs. Such practices include selecting building and construction materials that reduce the runoff contribution of metals and other toxic pollutants, judicious application of fertilizers and pesticides, improved pet waste and litter control, proper disposal of motor vehicle fluids, increased leaf collection, and the reduced use of street deicing salt.

- It is recommended that Washington County, the Lake District, and the Town of West Bend monitor and guide proposed urban development to ensure that it does not threaten to destroy or degrade natural resources located within the primary environmental corridor. If urban development not proposed or envisioned under the regional land use plan threatens primary environmental corridors, the Lake District, in conjunction with the Cedar Lakes Conservation Foundation, should consider the acquisition of such lands for resource and open space preservation purposes.

- As currently written, the Town of West Bend zoning ordinance calls for minimum residential lot sizes of 1.5 acres for cluster developments in the R-1R Rural Residential District. That minimum lot size, when combined with the cluster density bonus provisions of the ordinance, significantly limits the potential stormwater management benefits of cluster development because the percent impervious area is not reduced relative to traditional development.[4] It is recommended that the Town of West Bend monitor cluster development proposals to determine whether the proposals are resulting in impervious areas greater than the areas that would be expected from traditional development approaches. If it is found that greater impervious areas are resulting from application of the Town cluster development requirements, it is recommended that the Town work with developers to limit the amount of impervious area and that the Town also consider amending the ordinance requirements, including the density bonus provisions, to achieve lower impervious areas and the resultant stormwater management benefits.

- It is recommended that large-scale topographic maps be obtained for the following areas in the subwatershed where no such maps are currently available: Township 10 North, Range 19 East, Section 9, Town of Polk; Township 11 North, Range 18 East, Section 36, Town of Addison; and Township 11 North, Range 19 East, Sections 7 and 8, Town of Barton, and Sections 17 and 18, Town of West Bend. These maps would greatly facilitate future stormwater management planning in the areas of the subwatershed outside the pilot subbasins that are the subject of this report. The maps would also be valuable in the conceptual design and layout of the facilities recommended in this plan.

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[4]*Rates and volumes of stormwater runoff are directly related to the amount of impervious area and studies have shown that increases in impervious area are correlated with degradation of streams.(See* Site Planning for Urban Stream Protection, *prepared by the Center for Watershed Protection for the Metropolitan Washington Council of Governments, December 1995.)*

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Chapter VII

PLAN IMPLEMENTATION

INTRODUCTION

The recommended stormwater plans for the three pilot subbasins are designed to attain the objectives and standards set forth in Chapter II and Appendix A of this volume to the greatest degree feasible. In a practical sense, however, the plans are not complete until the steps to implement them, that is to convert the plans into action policies and programs, have been specified.

Implementation of the plans will require a long-term commitment to the plan objectives and coordination and cooperation among the Big Cedar Lake Protection and Rehabilitation District, Washington County, the Towns of West Bend and Barton, the Wisconsin Department of Natural Resources (WDNR) staff, the Cedar Lakes Conservation Foundation, developers, and concerned citizens. This chapter describes the actions necessary to implement the recommended plans, including adoption or endorsement of the plans and possible funding sources.

PLAN ADOPTION

An important first step in plan implementation is formal adoption of the recommended plan by the Big Cedar Lake Protection and Rehabilitation District and the Towns of Barton and West Bend and endorsement of the plan by Washington County and the WDNR.[1] Upon such adoption, the plan becomes the official guide to making stormwater management decisions in the pilot subwatersheds.

PLAN IMPLEMENTATION AGENCIES

The Lake Protection and Rehabilitation District should be the lead agency for the implementation of best management practices such as construction and maintenance of wet detention basins or, if necessary, acquisition of conservation easements. The Cedar Lakes Conservation Foundation should play a major role in the acquisition of land for construction of best management practices or conservation easements.

The Town of West Bend should be responsible for the recommended culvert installation under West Lake Drive and the associated road grade raise and for maintenance of the recommended culverts.

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[1] *The Commissioners of the Big Cedar Lake Protection and Rehabilitation District voted to adopt this plan at their August 9, 2001, meeting.*

The Washington County Land Conservation Department along with the U.S. Natural Resources Conservation Service should be responsible for development of farm plans to limit soil erosion and nutrient washoff from agricultural lands in the period prior to possible residential development of those lands.

The Lake District and the County Land Conservation Department should continue and expand their public existing education programs to promote good urban "housekeeping" practices.

Washington County should be responsible for obtaining the recommended large-scale topographic maps within the Big Cedar Lake subwatershed.

FUNDING SOURCES

Best Management Practices

The end date for implementing nonpoint source pollution control projects in the Cedar Creek Priority Watershed was March 2000. Thus, funding from the State of Wisconsin is no longer available under the priority watershed program. State of Wisconsin Targeted Runoff Management (TRM) urban grants as currently provided for under Chapter NR 120 of the *Wisconsin Administrative Code* are intended to be used for projects to control nonpoint source pollution from areas of existing urban development.[2] The urban nonpoint source control projects recommended under this plan are generally intended to control runoff from areas of future development. Therefore, the TRM grant program may not be a significant source of funding for plan implementation.

Land acquisition for construction of wet detention basins, or, if necessary, purchase of conservation easements for protection of primary environmental corridors, is possible through the Chapters NR 50 and 51 Stewardship Grant Program or the Chapter NR 191 Lake Protection Grant Program, all of which are promulgated in the *Wisconsin Administrative Code.* Lands proposed for purchase must be appraised using standard governmental land acquisition procedures as established by the WDNR, and must be subject to a land management plan setting forth the process and procedures for their long-term maintenance and development. The Chapter NR 191 grant program provides 75 percent State cost-share funding up to a maximum State share of $200,000. The Chapters NR 50 and 51 grant program provides 50 percent State cost-share funding up to a maximum State share of $100,000.

Funds for construction of wet detention basins could be obtained 1) through private developer contributions that would be required by the Town of West Bend and Washington County as a condition of approval for a given development, 2) through the Lake District's tax levy, or 3) through a combination of those two approaches. Depending on the size of individual developments that are tributary to recommended wet detention basins, it may be necessary for the third approach to be utilized whereby the Lake District and a given private developer would share the cost of detention basin construction with costs being divided proportional to the area of development relative to the total tributary area. When additional development occurs in the tributary area, the Lake District, working with the Town and the County, may be able to recover the remainder of its initial contribution from the developers of the additional areas.

Road and Highway Improvements

Road and highway improvements would be funded by the Town of West Bend.

Practices to Reduce Soil Erosion and Nutrient Washoff from Agricultural Lands

State of Wisconsin TRM grants as provided for under Chapter NR 120 of the *Wisconsin Administrative Code* may be available to implement agricultural conservation practices in the interim period prior to residential development of existing agricultural land in the Town of West Bend.

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[2]*The State has proposed transferring the urban nonpoint source provisions of Chapter NR 120 to Chapter NR 153, which is currently being considered for adoption.*

PROPOSED STATE OF WISCONSIN ADMINISTRATIVE RULES RELATED TO STORMWATER MANAGEMENT

The Wisconsin Department of Natural Resources has proposed creation of *Wisconsin Administrative Code* Chapters NR 151, "Runoff Management"; NR 152, "Model Ordinances for Construction Site Erosion Control and Stormwater Management;" NR 153, "Runoff Management Grant Program;" and NR 154 "Best Management Practices, Technical Standards and Cost-Share Conditions," and Chapter NR 155, "Urban Nonpoint Source Water Pollution Abatement and Stormwater Management Grant Program." The State intends that the draft model stormwater management ordinance that is part of Chapter NR 152 be voluntarily adopted by local units of government. The draft ordinance recognizes that stormwater management plans are preferable to site-by-site requirements and it provides for the substitution of plans for site-by-site requirements. Chapter NR 153 sets forth funding programs for implementation of agricultural and urban nonpoint source controls. Those programs may have some applicability to the projects recommended under this plan; however, until the Administrative Rules are finally adopted, their applicability cannot be determined with certainty.

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APPENDIX

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Appendix A

OBJECTIVES AND STANDARDS FOR STORMWATER MANAGEMENT IN THE BIG CEDAR LAKE SUBWATERSHED

OBJECTIVE NO. 1

The development of a stormwater management system which reduces the exposure of people to drainage-related inconvenience and to health and safety hazards and which reduces the exposure of real and personal property to damage through inundation resulting from inadequate stormwater drainage.

STANDARDS

1. In order to prevent significant property damage and safety hazards, the major components of the stormwater management system and the floodland management system should be designed to accommodate runoff from a 100-year recurrence interval storm event.

2. In order to provide for an acceptable level of access to property and of traffic service, the minor components of the stormwater management system should be designed to accommodate runoff from a 10-year recurrence interval storm event.

3. In order to provide an acceptable level of access to property and of traffic service, the stormwater management system should be designed to provide two clear 10-foot lanes for moving traffic on existing arterial streets, and one clear 10-foot lane for moving traffic on existing collector and land access streets during storm events up to and including the 10-year recurrence interval event.

4. Flow of stormwater along and across the full pavement width of collector and land access streets shall be acceptable during storm events exceeding a 10-year recurrence interval when the streets are intended to constitute integral parts of the major stormwater drainage system.

5. Plan components shall be designed to comply with the requirements of Chapter NR 116 of the *Wisconsin Administrative Code.*

6. All new and replacement bridges and culverts over waterways shall be designed so as to accommodate, according to the categories listed below, the designated flood events without overtopping of the related roadway or railway track.

   a. Minor and collector streets used or intended to be used primarily for access to abutting properties: a 10-year recurrence interval flood discharge.

   b. Arterial streets and highways, other than freeways and expressways, used or intended to be used primarily to carry heavy volumes of through traffic: a 50-year recurrence interval flood discharge.

   c. Freeways and expressways: a 100-year recurrence interval flood discharge.

   d. Railways: a 100-year recurrence interval flood discharge.

7. All new and replacement bridges and culverts along waterways shall be designed so as not to inhibit fish passage in areas which are supporting, or which are capable of supporting, valuable recreational sport and forage fish species.

OBJECTIVE NO. 2

The development of a stormwater management system which will effectively serve existing and planned future land uses.

STANDARDS

1. Stormwater drainage systems should be designed assuming that the layout of collector and land access streets for proposed urban development and redevelopment will be carefully adjusted to the topography in order to minimize grading and drainage problems, to utilize to the fullest extent practicable the natural infiltration, drainage, and storage capabilities of the site, and to provide the most economical installation of a gravity flow drainage system. Generally, drainage systems should be designed to complement a street layout wherein collector streets follow valley lines and land access streets cross contour lines at right angles.

2. Stormwater drainage systems should be designed assuming that the layouts and grades of collector and land access streets can, during major storm events, serve as open runoff channels supplementary to the minor stormwater drainage system without flooding adjoining building sites. The stormwater drainage system design should avoid midblock sags in street grades, and street grades should generally parallel swale, channel, and storm sewer gradients.

3. Street elevations and grades, and appurtenant site elevations and grades, shall be set to provide overland gravity drainage to natural watercourses so that positive drainage may be effected during major storm events and in the event of failure of piped stormwater drainage facilities.

4. Stormwater management systems shall utilize rural street cross-sections with roadside swales and culverts.

5. The stormwater management system shall be designed to minimize the creation of new drainage or flooding problems, or the intensification of existing problems, at both upstream and downstream locations.

6. Stormwater management systems should utilize the existing storage capacity of wetlands and open spaces to the extent practicable.

OBJECTIVE NO. 3

The development of a stormwater management system which will abate nonpoint source water pollution and help achieve the recommended water use objectives and supporting water quality standards for surface waterbodies.

STANDARD

1. Stormwater management facilities should promote the achievement of recommended water use objectives and supporting water quality standards for Big Cedar Lake, and should not degrade existing habitat conditions for fish and aquatic life.

2. Stormwater management practices should promote the attainment of sediment quality criteria for toxic substances.

OBJECTIVE NO. 4

The development of a stormwater management system which will maintain or enhance existing terrestrial and aquatic biological communities, including fish and wildlife.

STANDARDS

1. Stormwater management systems shall be designed to minimize disruption to primary and secondary environmental corridors, including the incorporated woodlands, wetlands, and wildlife habitat areas.

2. Stormwater management facilities should be designed to protect valuable and sensitive wetlands from the adverse impacts of stormwater runoff.

3. Stormwater management facilities shall be designed to control sedimentation in receiving streams and lakes and to prevent the loss of fish and aquatic life habitat through streambank erosion and streambed scour.

4. To the extent practicable, stormwater drainage facilities should be designed to avoid enclosure of tributary streams identified as having significant and valuable biological and recreational uses.

OBJECTIVE NO. 5

The development of a stormwater management system which will be flexible and readily adaptable to changing needs.

STANDARDS

1. Stormwater management facilities should be designed for staged, or phased, construction so as to limit the required investment in such facilities at any one time and to permit maximum flexibility to accommodate changes in urban development, in economic activity growth, in the objectives or standards, or in the technology of stormwater management.

2. Where practicable and advantageous to the achievement of the objectives of this plan, multipurpose stormwater storage facilities should be provided. Such facilities should serve two or more of the following functions: water quantity control, water quality control, active or passive recreation, and aesthetic enhancement.

OBJECTIVE NO. 6

The development of a stormwater management system which will not pollute groundwater aquifers.

STANDARD

1. Where practicable, wet detention basins and infiltration devices shall not be located within the boundary of a recharge area to a wellhead identified in a wellhead area protection plan; within 100 feet of a private well; 100 feet of a transient, noncommunity public water system;[a] or within 400 feet of a well serving a public water system other than a transient noncommunity system.

2. Where, of necessity, wet detention basins are located in areas where contamination of the groundwater is possible, the basins should be provided with an impermeable liner.

3. Stormwater discharges to infiltration devices should be pretreated to avoid groundwater contamination and to assure proper long-term functioning of the infiltration device.

OBJECTIVE NO. 7

The development of a stormwater management system which will efficiently and effectively meet all of the other stated objectives at the lowest practicable cost.

STANDARDS

1. The sum of stormwater management system capital investment and operation and maintenance costs should be minimized.

2. Maximum feasible use should be made of all existing stormwater management components, as well as the natural storm drainage system. The latter should be supplemented with engineered facilities only as necessary to serve the anticipated stormwater management needs generated by existing and proposed land use development and redevelopment.

3. To the maximum extent practicable, the location and alignment of new storm sewers and engineered channels and storage facilities should coincide with existing public rights-of-way to minimize land acquisition or easement costs.

4. Stormwater storage facilities—consisting of retention facilities and of both centralized and onsite detention facilities—should, where hydraulically feasible and economically sound, be considered as a means of reducing the size and resultant costs of the required stormwater conveyance facilities downstream of the storage sites.

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[a]*Chapter NR 809 of the* Wisconsin Administrative Code, *which sets forth rules regarding safe drinking water, defines a transient, noncommunity public water system as a system for the provision to the public of piped water for human consumption, if such system serves at least 25 people at least 60 days of the year. Examples of such systems include those serving taverns, motels, restaurants, churches, campgrounds, and parks.*

Source: SEWRPC.