INTRODUCTION

This chapter presents the development and evaluation of stormwater management alternatives (structural and nonstructural) which would alleviate the nonpoint source pollution and flooding problems within the project area. These alternatives were incorporated in a plan which addresses the project's water quality and flooding objectives.

NONSTRUCTURAL CONTROL METHODS

Analyzing ways to meet pollutant reduction goals within the project area was the first step in this part of the analysis. Nonpoint source control methods were assessed on a cost basis, with the low cost methods considered first. These included the nonstructural practices of increasing the frequency of street sweeping and utilizing a more efficient street sweeper. Modifications to SLAMM were made to model the impact these changes would have on the pollutant loading conditions of the project area.

Analysis of Increased Street Sweeping Frequency

One common best management practice available to reduce pollutant loading is increased street sweeping frequency. Currently the Village street sweeps on a bi-weekly basis. Results of the SLAMM analysis with weekly street sweeping are shown in Table 6-1. Generally, the less intense land uses (such as residential) showed lower percent control, and the more intense land uses (such as commercial and industrial) showed a higher percent control. According to the analysis, increasing street sweeping from a bi-weekly schedule to a weekly schedule would reduce incremental pollutant loadings by 7 percent for sediment, 1 percent for nutrients (modeled as phosphorus), and 8 percent for heavy metals (modeled as lead).

Costs for the accelerated street sweeping program were based on SEWRPC's Technical Report No. 31: *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Costs for the City of Milwaukee to operate a mechanical street sweeper were reported at $25 per curb mile (1988 dollars). This cost includes labor, equipment depreciation, fuel, maintenance, disposal of street dirt, and indirect/overhead costs. Table 6-2 shows the annual costs estimated for accelerating the street sweeping program in the project area from the present rate of bi-weekly to weekly between April and November. This results in 16 additional street sweeping passes per year.

TABLE 6-1
POLLUTANT LOADING WITH WEEKLY STREET SWEEPING

Basin	Area (acres)	Sediment (tons/yr)	Phosphorus (lbs/yr)	Lead (lbs/yr)
1000	42.9	4.8	44	22
2000	43.1	9.8	72	45
3000	253.6	25.7	243	119
4000	19	1.7	16	8
5000	14.2	0.2	6	2
6000	7.1	1.6	18	4
7000	87.1	2.4	18	7
8000	0.3	<0.1	<1	<1
Total	**467.3**	**46.2**	**417**	**207**
Reduction from Baseline		**3.5**	**4**	**19**

TABLE 6-2
ESTIMATED ACCELERATED STREET SWEEPING COSTS *

Land Use	Future Conditions (acres)	Curb Mi./Acre acre	Cost/Curb Mi. * ($)	Annual Incremental Cost(1)	
				Passes/yr	Cost/yr
Residential	304	0.068	$35.60	16	$11,800
Industrial	9	0.052	$35.60	16	$300
Institutional	38	0.078	$35.60	16	$1,700
Commercial	25	0.078	$35.60	16	$1,100
Parks	86	0.020	$35.60	16	$1,000
Totals:	462				$15,900

* SEWRPC Tech. Rpt. 31, 1991; Updated to 1997 at 4 percent annual rate

(1) 2/MO; April - November

Analysis of High Efficiency Street Sweepers

A new generation of street sweepers were evaluated for their effectiveness in the project area. The street sweeper evaluated is the Enviro Whirl I manufactured by Enviro Whirl Technologies, Inc. of Centralia, Illinois. This sweeper combines mechanical broom sweeping with vacuum action and is more efficient at removing sediment from street surfaces than conventional street sweepers. The vacuum eliminates the need for spraying water for dust control. The elimination of water both improves the ability to pick up dirt, and reduces the amount of time spent filling sweeper water tanks and cleaning the sweeper. The efficiency of this machine at reducing street loads has been measured in western (Nevada, Washington) and Midwestern (Illinois) states. Reduction of sediment was high across a wide range of particle sizes, including those under 10 microns, where a large amount of pollutants are attached. The Wisconsin Department of Natural Resources Stormwater Program has evaluated the data from previous studies of this sweeper. This evaluation concluded that an estimated pollution reduction from street surfaces of 50 percent for suspended solids and 60 percent for lead is reasonable (Pfender, 1996). The WDNR plans to conduct their own field monitoring of this street sweeper in 1997.

Sweeper noise levels are a concern since the Village sweeps at night. An Enviro Whirl sweeper has a noise level of 81 decibels at 50 feet away. A mechanical broom sweeper, such as the Elgin Pelican Series, has a noise level of 77 decibels at 50 feet away and an operating speed of 1,800 rpm. The Elgin Megawind Compact Vacuum Sweeper comes in a silent package, which lowers the decibel levels to the low 70's. Elgin Sweeper Company of Elgin, Illinois, manufactures two similar models, the Whirlwind Series L Vacuum Sweeper and the Megawind Compact Vacuum Sweeper. The efficiencies of the Elgin Vacuum Sweeper are not as well documented as the Enviro Whirl Sweepers.

The SLAMM model does not permit a changing of street sweeping efficiencies, so an Enviro Whirl sweeper was estimated by quantifying the amount of pollution generated in the street areas and reducing it by 50 percent for suspended solids and 60 percent for heavy metals (lead). Results of this evaluation are presented in Table 6-3.

TABLE 6-3
PERCENTAGE OF POLLUTANTS FROM STREET SOURCE AREAS

Land Use	Sediment	Phosphorus	Lead
Commercial	86%	53%	94%
Light Industrial	83%	30%	73%
Multi-Family Residential	78%	53%	50%
High Density Residential	64%	47%	49%

Estimates of pollutant loadings from the project area with weekly sweeping of "critical" land uses (commercial, industrial, multi-family and high density residential) with an Enviro Whirl sweeper and standard bi-weekly sweeping on other land uses are shown in Table 6-4. Results show an incremental pollutant loading reductions of 14 percent for sediment and 25 percent for heavy metals (lead). Nutrient reductions were not calculated due to lack of data.

TABLE 6-4
POLLUTANT LOADING WITH HIGH EFFICIENCY STREET SWEEPING

Basin	Sediment (tons/yr)	Lead (lbs/yr)
1000	4.1	17
2000	10.6	46
3000	22.5	91
4000	1.4	5
5000	0.16	1.5
6000	1.7	3
7000	2.53	7
8000	0.02	<1
Total	**42.9**	**171**
Reduction from Baseline	**6.8**	**55**

Capital cost for purchasing and Enviro Whirl sweeper is approximately $170,000. Capital costs for purchasing and Elgin Whirlwing Series L Sweeper and and Elgin Megawind Compact Sweeper, are approximately $130,000 and $120,000 respectively. Annual operation costs were not estimated, however, they can be expected to be higher than the operating costs for a conventional broom sweeper.

ANALYSIS OF ADDITIONAL CATCH BASIN CLEANING

Increasing the frequency of catch basin cleaning was evaluated as a means of reducing pollutant loading. Storm sewer catch basins collect sediment and debris in the storm sewer inlet before entering the storm sewer. As catch basins fill up, they loose their ability to trap additional sediment and debris. Typically, cleaning catch basins once a year is adequate to prevent the catch basins from becoming full. Currently the Village cleans out catch basisns once a year.

Increasing catch basin cleaning from once a year to twice a year has minor water quality benefits. SLAMM analysis indicates that increasing catch basin cleaning from once a year to twice a year results in a one percent reduction in sediment and lead loading, and less than one percent reduction in phosphorus and zinc. This small reduction in pollution is not worth the added time and expense of increasing catch basin cleaning to twice a year.

STRUCTURAL CONTROL METHODS

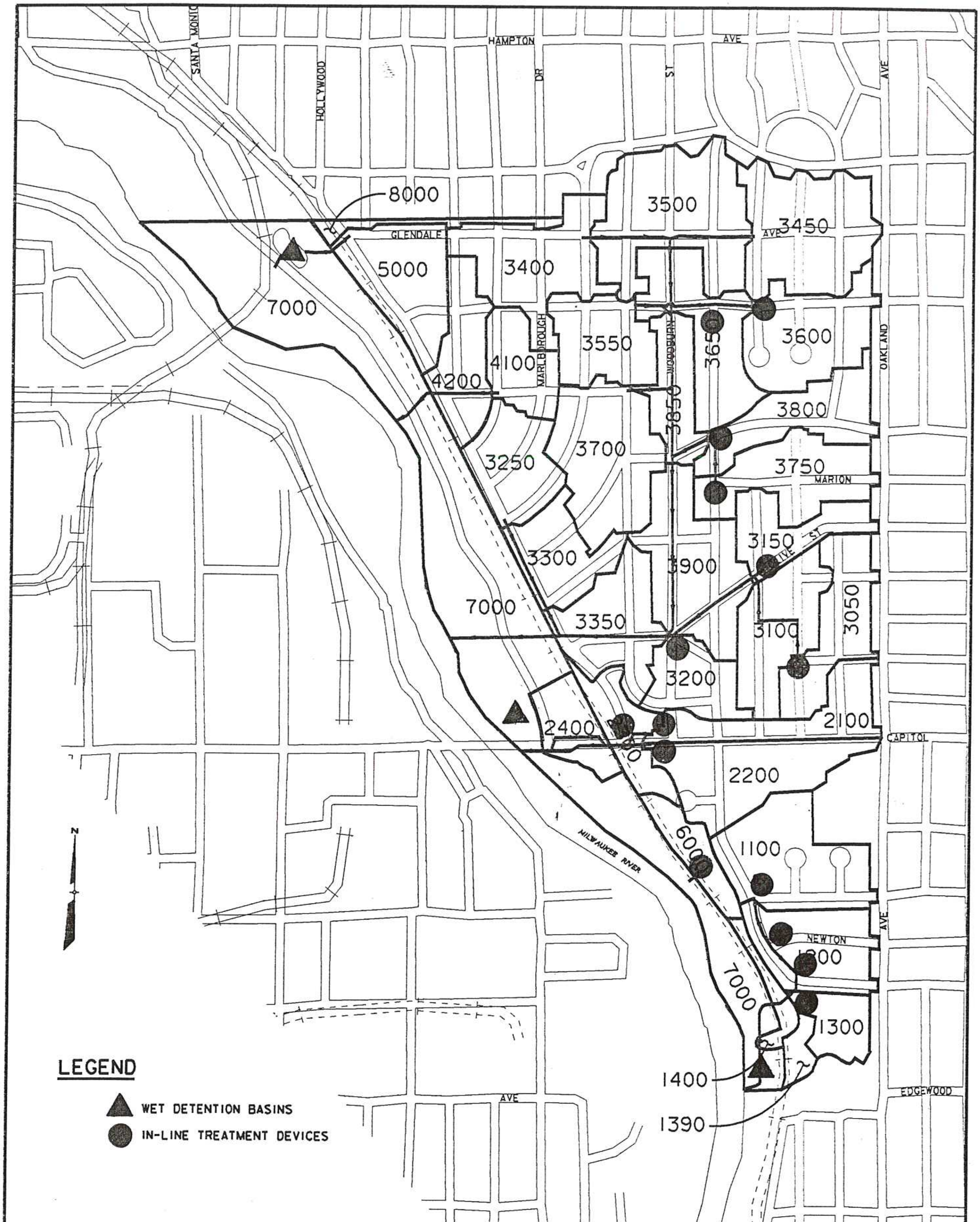
Structural control measures analyzed for this project included three wet detention pond site alternatives and two types of in-line storm sewer treatment devices (Figure 6-1). Pollution reduction performance and costs of these structural measures were estimated in order to determine the best alternatives.

Wet Detention Ponds

Wet detention ponds are sized based on the size and types of land uses of the watershed which it serves. Wet detention pond sizes and maximum outflow rates for the settling of the five micron sediment particle were calculated for the major basins below. For analysis purposes it was assumed that a properly sized wet detention pond has a treatment efficiency of 85 percent for sediment and 60 percent for lead. For pond smaller than the recommended area, the treatment efficiencies were estimated by taking the ratio of the undersized pond area to the recommended pond area and multiplying it by the above treatment efficiencies. For instance a pond 50 percent smaller than the recommended area would have a treatment efficiency of 30 percent for lead.

TABLE 6-5
WET DETENTION POND REQUIREMENTS

Basin	Pond Area (acres)	Maximum Outflow (cfs)
1000	0.4	2.3
2000	0.66	3.8
3000	2.21	12.5
2000 & 3000	2.87	16.3
4000 & 5000	0.3	1.9



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 6-1
STRUCTURAL STORMWATER CONTROL LOCATIONS
VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN

Locations of wet detention basins are limited due to the lack of available land. Three possible locations were identified. 1) Capitol Drive - north of Capitol Drive on the east bank of the Milwaukee River on Milwaukee County Park land. 2) Hubbard Park on the east bank of the Milwaukee River just north of the Shorewood - Milwaukee municipal boundary. 3)Estabrook Lagoon near the east bank of the Milwaukee River on Milwaukee County Park land.

Capitol Drive Site

The Capitol Drive Site is near the current outfalls for basins 2000 and 3000. Alternatives for treating the stormwater runoff from both basins singly and together were investigated. The site consists of a flat floodplain terrace between the river and a steep slope. It is currently vegetated mostly as grass with some trees on the river edge. It is estimated that the largest practical wet detention pond on this site would have a surface area of approximately 1.73 acres (Figure 6-2). This site would be large enough for a properly sized (0.66 acre) pond treating basin 2000 (Figure 6-3). However, the site would be undersized to properly treat stormwater from basin 3000 (or basins 2000 and 3000 together).

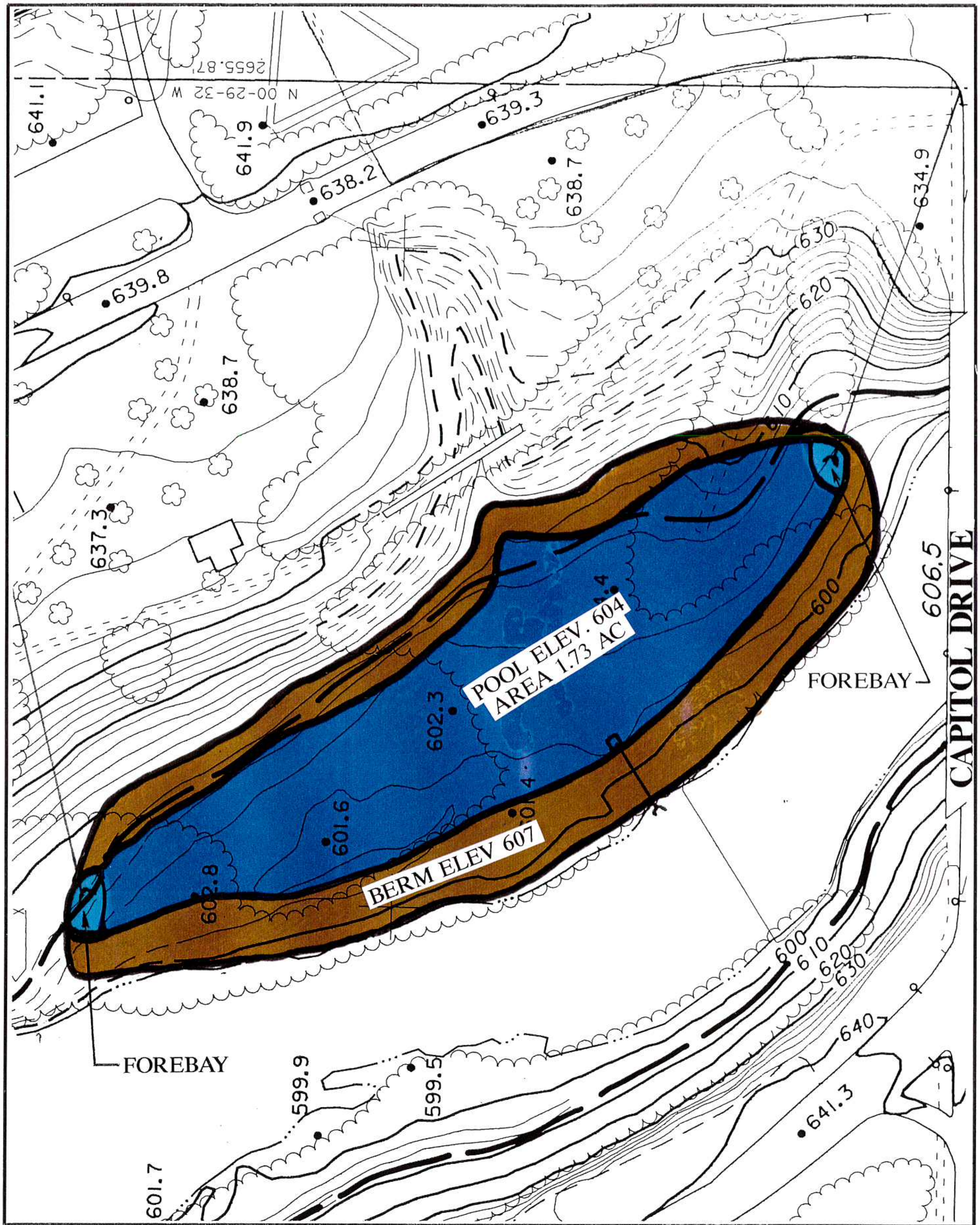
The Capitol Drive site is on Milwaukee County owned Milwaukee River Parkway. The Milwaukee County Parks Department was consulted on constructing a wet detention pond on this site. The Parks Department and County officials did not feel it is appropriate to construct a wet detention pond in the Milwaukee River Parkway for the following reasons:

- The wet detention pond is considered ecologically unacceptable. The site is within a delineated primary environmental corridor. Part of the site may possibly be a wetland, although it is not a delineated wetland. The site is also in the 100-year floodplain. A wet detention pond would diminish or threaten the natural resources in this corridor.

- A wet detention pond at this site would be incompatible with recreational use of the site. The hill to the east of the site is a designated winter sledding and winter recreation area. A wet detention pond at the bottom of the hill would hinder that activity. In addition, a detention pond would be incompatible with recreational activities/pursuits associated with natural areas.

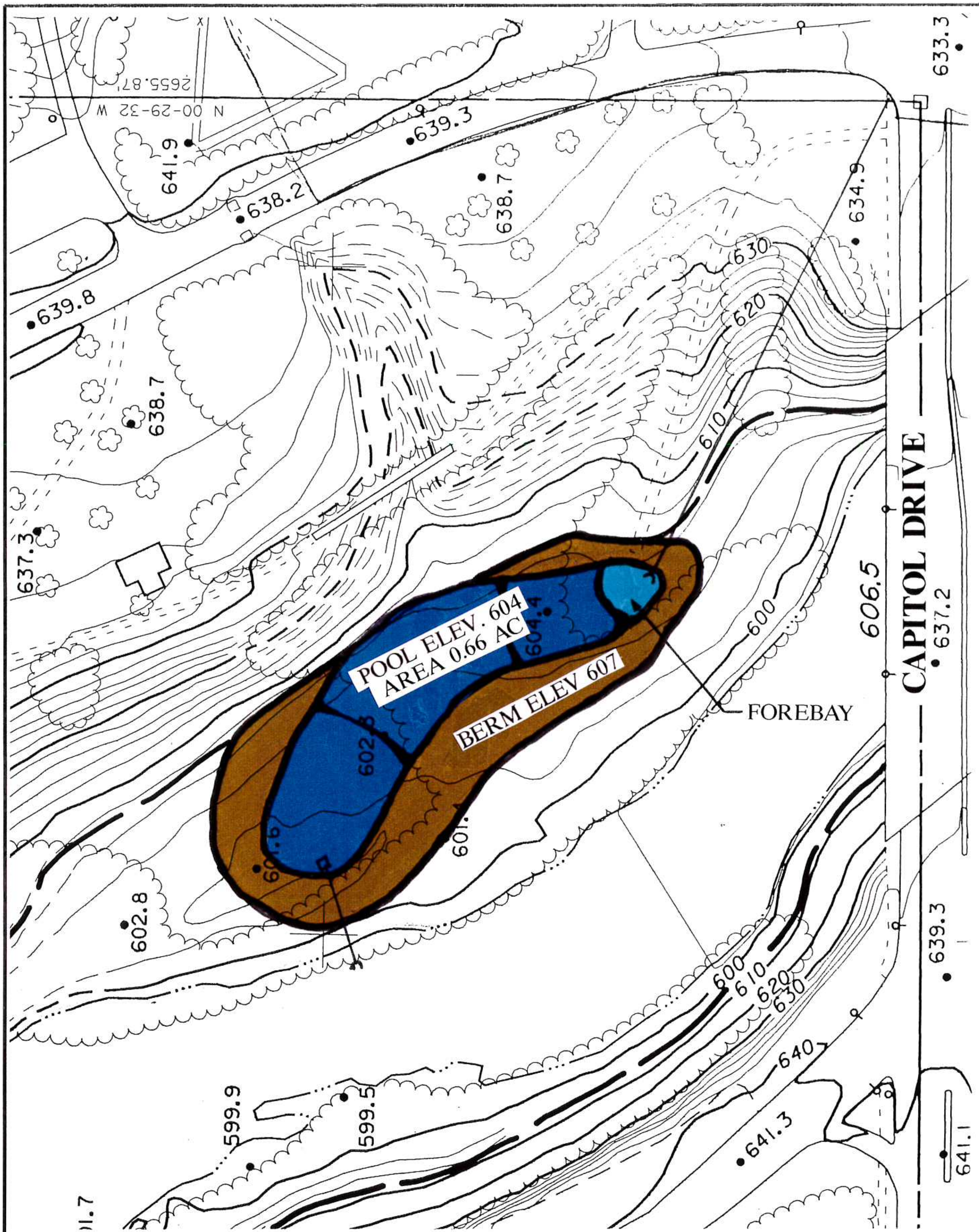
- There are concerns about public access, safety, and liability. Wet detention ponds can pose a safety hazard for young children. Measures to improve the safety of these ponds, such as fencing often seriously detract from the aesthetics of the parkland.

- There are concerns about short and long term maintenance. There are many financial, ecological, and aesthetic concerns related to pond maintenance.



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 6-2
CONCEPTUAL WET DETENTION POND AT CAPITOL DRIVE - MAXIMUM SIZE
VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 6-3
CONCEPTUAL WET DETENTION POND AT CAPITOL DRIVE - BASIN 2000 ONLY
VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN

Hubbard Park Site

The Hubbard Park Site is near the outfall of basin 1000. The site is on a flat floodplain terrace between the river and a steep slope and has two park buildings nearby (Figure 6-4). The maximum practical pond size is estimated to be 0.26 acres. The proper pond size for water treatment is calculated to be 0.4 acres (Table 6-5).

The site is owned by the Village of Shorewood. The Village has expressed interest in possibly constructing an ice skating rink at this site. Combining a stormwater pond with an ice skating rind is feasible if winter stormwater flows were diverted to a bypass to prevent thinning of the pond ice. The site is also in the 100-year floodplain and it would need to be demonstrated that this structure would not significantly alter the 100-year floodplain level. This may be achievable because the volume inside the pond would still act as floodwater storage.

Estabrook Lagoon

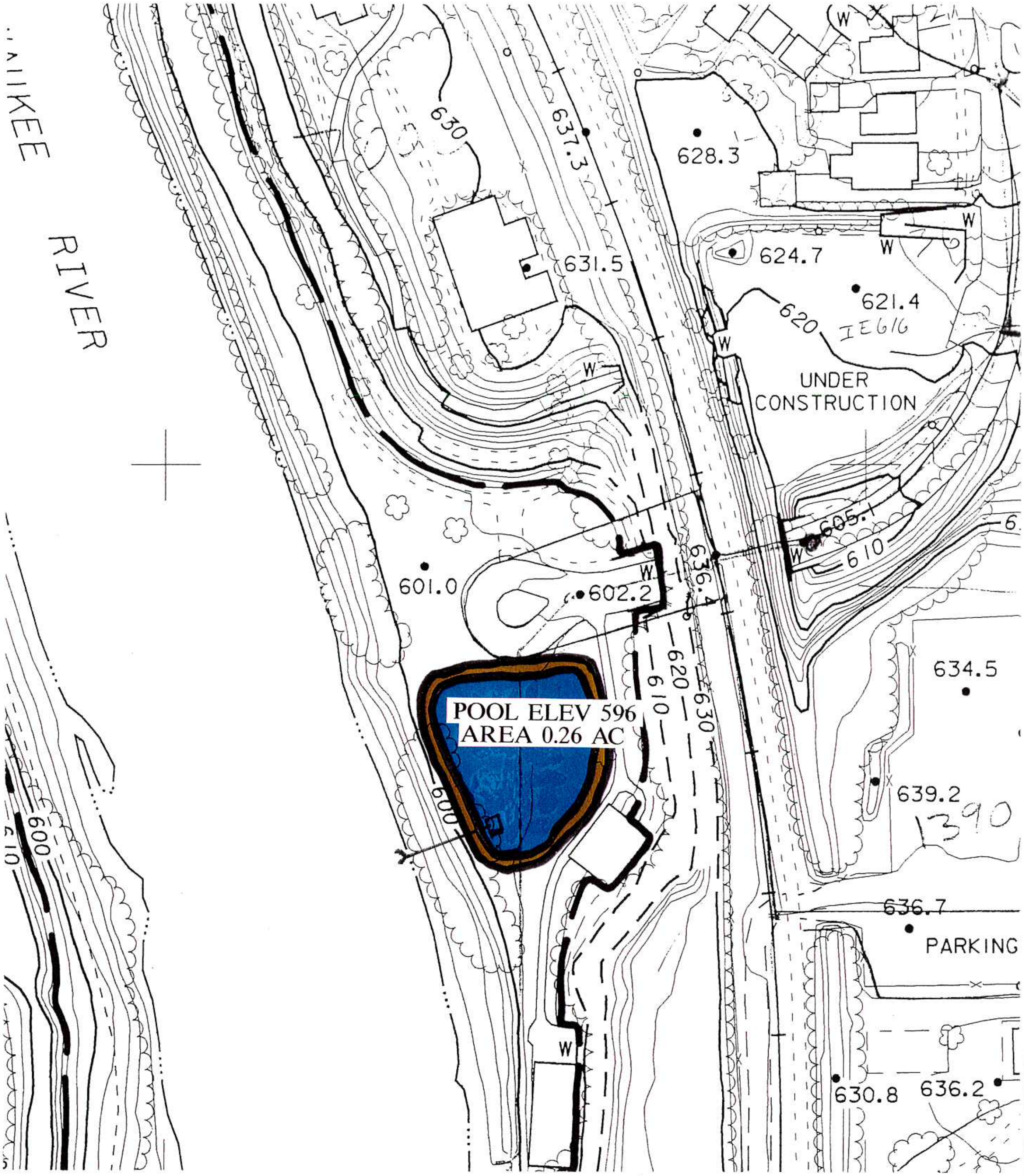
Currently the Estabrook Lagoon receives stormwater from basin 5000. The outfall for basin 4000 is approximately 1,400 feet to the south of the lagoon and could be connected to the lagoon via a storm sewer along Estabrook Parkway (Figure 6-5). Lack of space along the Parkway precludes the construction of an open grass swale. A new pond outlet structure would be recommended since the present outlet would be next to the inlet. Estabrook Lagoon is large enough (1.2 acres) to treat stormwater from basins 4000 and 5000 combined, since the minimum recommended pond area is calculated to be 0.3 acres.

Treatment Efficiencies and Cost Estimates for Wet Detention Ponds

Pollution reductions were based on estimated treatment efficiencies discussed above and the calculated pollution loadings for each basin. Wet detention pond cost estimates were based upon construction costs for recently built ponds. A summary of the estimated costs are below.

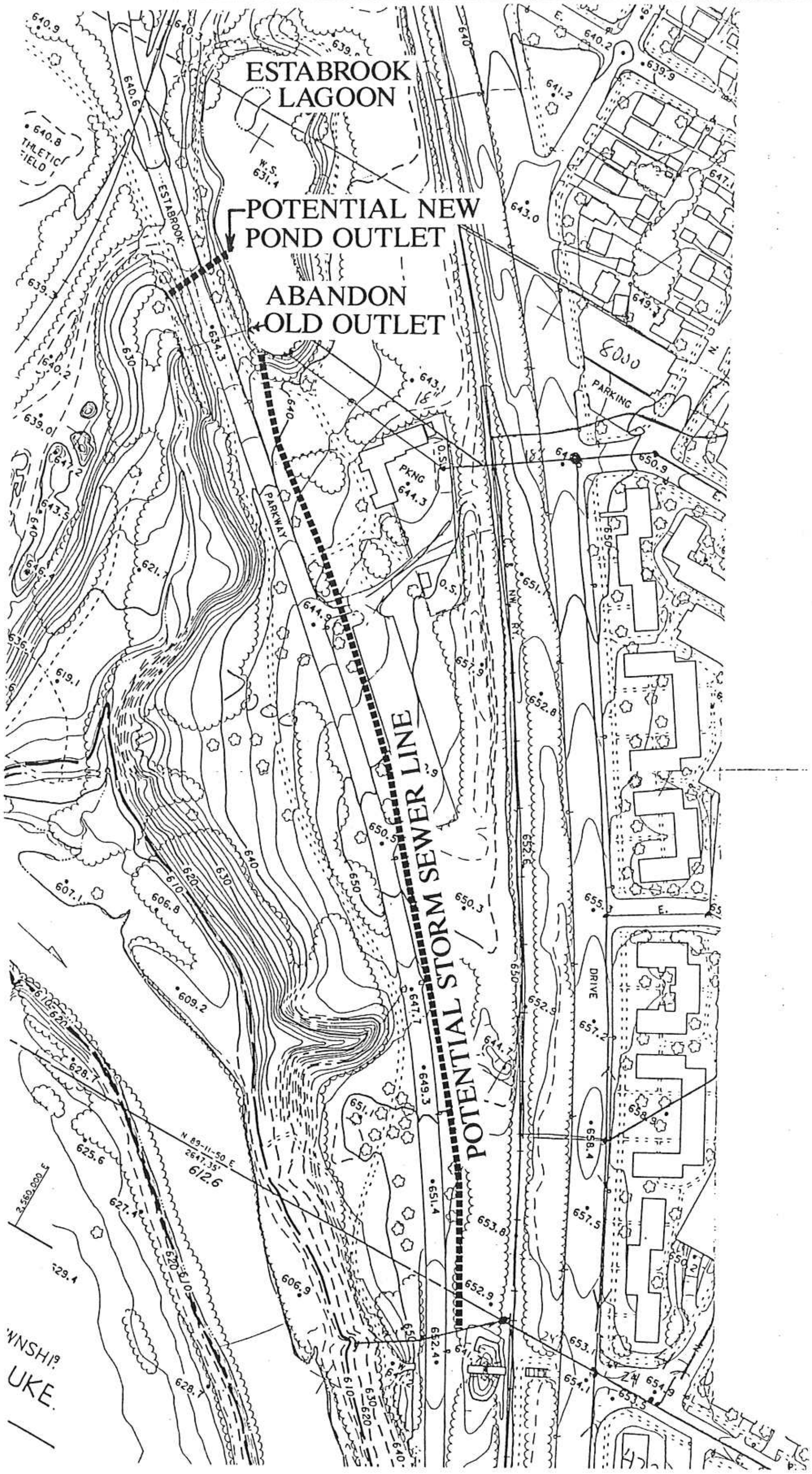
TABLE 6-6
WET DETENTION POND COST ESTIMATES

Alternative	Basin Treated	Pond Area (acres)	Sediment Treatment Efficiency	Heavy Metals Treatment Efficiency	Estimated Cost
Hubbard	1000	0.26	55%	39%	$76,000
Capitol Drive	2000	0.66	85%	60%	$128,000
Capitol Drive	3000	1.73	66%	47%	$370,000
Capitol Drive	2000 & 3000	1.73	51%	36%	$390,000
Estabrook	4000	1.2	85%	60%	$140,000



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 6-4
CONCEPTUAL WET DETENTION POND AT HUBBARD PARK
VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 6-5
ESTABROOK LAGOON RETROFIT

VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN

In-Line Treatment Systems

In-line treatment systems are underground chambers installed in storm sewer lines to settle out pollutants. They resemble oversized manholes or rectangular boxes. They settle out sediment either by gravitational settling or by centrifugal force. A number of manufacturers are constructing these in prefabricated form. Their main advantage is that they require little surface space, since they can be installed below ground.

The manufacturers have published treatment efficiencies for the in-line treatment systems. The WDNR is conducting independent research to validate the performance of the devices. Two in line systems were analyzed for this project, Stormceptor™ and Vortechs™ (Figure 6-6). A new system is the Downstream Defender™ manufactured by H.I.L. Technologies, Inc. At the time of conducting this project, complete information on sizing and treatment efficiencies of the Downstream Defender™ were not available. Therefore, the Downstream Defender™ was not analyzed for this project. It is expected to be a comparable device to the Stormceptor and Vortechs. If the use of in-line treatment systems are pursued, a thorough review of the above system, or any new system, should be done.

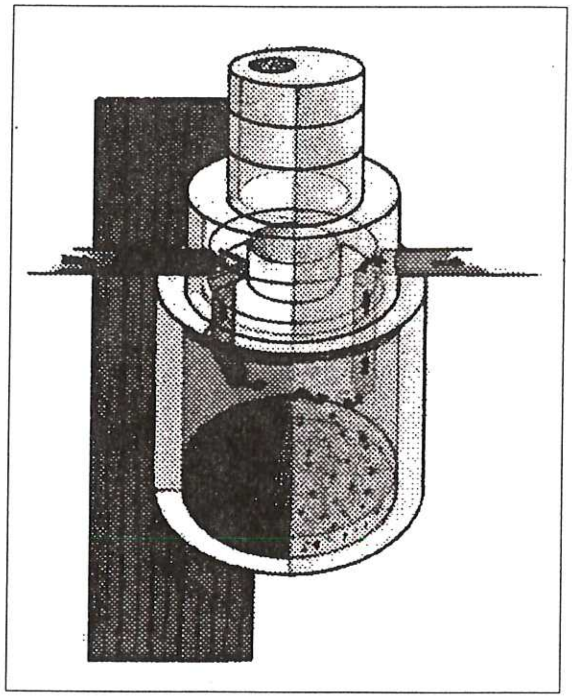
Stormceptor™

Stormceptor, manufactured by Stormceptor Corporation, treats stormwater by settling sediment in a cylindrical, precast concrete chamber. It is designed so that flood flows greater than the treatment capacity of the device are bypassed internally within the unit. The manufacturer claims treatment efficiencies for sediment of upward to 85 percent. The WDNR is monitoring one of these units in the City of Madison, Wisconsin Department of Public Works yard. Monitoring is not yet complete, but preliminary results indicate that the overall sediment treatment efficiency does not approach that claimed by the manufacturer and may instead approach a level of 50 percent treatment. Therefore, it is assumed that these units remove sediment by 50 percent and heavy metals (lead) by 30 percent. It is also assumed that about 20 percent of the storm water is bypassed in flood flows and is untreated.

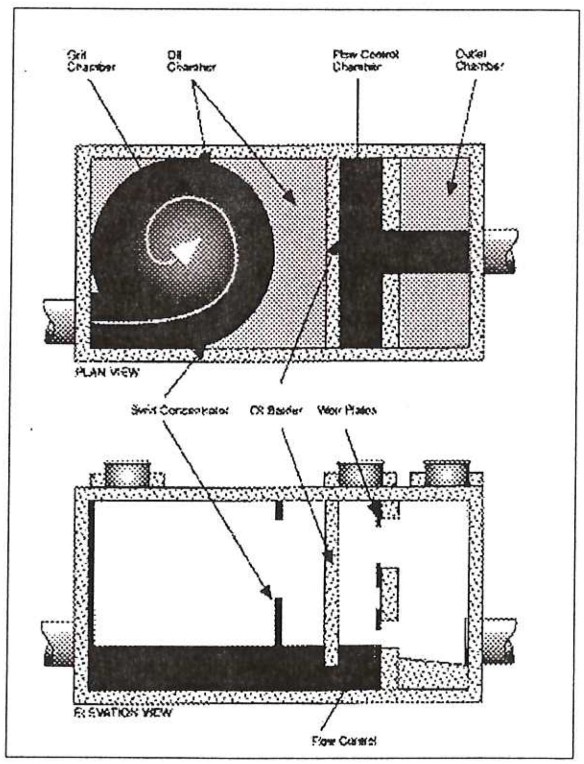
The Stormceptor units come in various sizes and are sized according to how much impervious area the unit serves. The largest impervious area which can be treated at optimum level is 5.5 acres. This limits the placement of these units to treating relatively small sub-basins at the headwaters of storm sewer systems or on lateral storm sewer lines feeding into larger storm sewers. Units placed on main storm sewer lines would probably be overloaded. Analysis of the storm sewer system and sub-basins revealed 15 possible locations for these devices. Some of the units are in sub-basins which are slightly larger than recommended. The treatment efficiencies are adjusted to reflect this. Placement of the units in the project area are located in Figure 6-1.

Estimated sediment removals and costs for each Stormceptor unit are presented in Table 6-7. Estimated costs include installation.

Stormceptor



Vortechs



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 6-6
IN-LINE TREATMENT DEVICES

VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN

TABLE 6-7
STORMCEPTOR TREATMENT EFFICIENCIES
VILLAGE OF SHOREWOOD

Basin i.d.	Basin Area	% Imp.	Imp. Area	Sediment Load tons	Model	Effective Flow Cap.	Flow Vol. Treated	Treatment Efficiency	Sediment Removed	Cost
1100	15.8	50%	7.9	2.2	7200	2.5	57%	29%	0.6	$80,000
1200A	6.9	54%	3.7	0.8	4800	1.8	82%	41%	0.3	$55,000
1200B	4.1	54%	2.2	0.5	3600	1.1	82%	41%	0.2	$45,000
1300	6.4	55%	3.5	0.9	4800	1.8	82%	41%	0.4	$55,000
Subtotal	**33.2**		**17.4**	**4.3**				**35%**	**1.5**	**$235,000**
2100	9.9	86%	8.5	3.6	7200	2.5	53%	27%	0.9	$80,000
2200	17.0	55%	9.4	3.5	7200	2.5	48%	24%	0.8	$80,000
2300A	5.2	70%	3.6	1.4	4800	1.8	82%	41%	0.6	$55,000
Subtotal	**32.1**		**21.5**	**8.4**				**28%**	**2.3**	**$215,000**
3050	13.0	60%	7.8	2.2	7200	1.8	59%	30%	0.6	$80,000
3150	7.9	54%	4.3	1.0	6000	1.8	82%	41%	0.4	$64,000
3200	8.5	54%	4.6	1.1	6000	1.1	82%	41%	0.5	$64,000
3600	14.8	52%	7.7	2.1	7200	1.8	59%	30%	0.6	$80,000
3650A	11.8	50%	5.9	1.5	7200	1.8	76%	38%	0.6	$80,000
3750	13.7	54%	7.4	1.7	7200	1.8	61%	31%	0.5	$80,000
3800	12.7	54%	6.9	2.1	7200	1.8	65%	33%	0.7	$80,000
Subtotal	**82.4**		**44.5**	**11.7**				**33%**	**3.9**	**$528,000**
6000	7.1	69%	4.9	1.8	6000	1.8	82%	41%	**0.7**	**$64,000**
Total									**8.5**	**$1,042,000**

Vortechs™

Vortechs units, manufactured by Vortechnics Inc. treat stormwater by swirling incoming water into a vortex and removing sediment with centrifugal force. The unit is a concrete box containing flow controlling weirs and a cylindrical aluminum swirl chamber. The units have no internal bypass so an external bypass is required for flood flows. The manufacturer claims treatment efficiencies for sediment of upward to 85 percent. Conclusive independent monitoring does not yet confirm this. Therefore the same treatment efficiency of 50 percent for sediment and 30 percent for heavy metals (lead) used for the Stormceptor units was used for the Vortechs units. Again a certain volume of flood flows is bypassed around the units and is accounted for in the overall treatment efficiency.

Vortechs come in various sizes and are sized according to the 2-month flow rate for water quality treatment. For sizing purposes it was assumed that the 2-month flow rate is one fifth of the 2-year flow rate. Like the Stormceptors, placement is limited to storm sewer lines serving smaller areas such as along laterals and at the headwaters of the storm sewer system. Therefore, the same locations are recommended for both Stormceptors and Vortechs units (Figure 6-1).

Estimated sediment removals and costs for each unit are presented in Table 6-8. Estimated costs include installation and external bypass. Comparison of the Stormceptors and Vortechs units show little difference between their cost.

TABLE 6-8
VORTECHNICS TREATMENT EFFICIENCIES
VILLAGE OF SHOREWOOD

Basin i.d.	Basin Area	2-Mo. Flow	Sediment Load (tons)	Model	Effective Flow Cap	Flow Vol. Treated	Treatment Efficiency	Sediment Removed	Cost
1100	15.8	4.4	2.2	11000	4.2	85%	43%	0.9	$70,000
1200A	6.9	2.5	0.8	7000	2.7	85%	43%	0.4	$54,000
1200B	4.1	2.5	0.5	7000	2.7	85%	43%	0.2	$54,000
1300	6.4	1.8	0.9	5000	2.1	85%	43%	0.4	$48,000
Subtotal	**33.2**		**4.3**				**43%**	**1.8**	**$226,000**
2100	9.9	6.7	3.6	16000	6	77%	39%	1.4	$100,000
2200	17.0	5.6	3.5	16000	6	85%	43%	1.5	$100,000
2300A	5.2	4.4	1.4	11000	4.2	85%	43%	0.6	$70,000
Subtotal	**32.1**		**8.4**				**41%**	**3.4**	**$270,000**
3050	13.0	4.1	2.2	11000	4.2	85%	43%	0.9	$70,000
3150	7.9	2.4	1.0	7000	2.7	85%	43%	0.4	$54,000
3200	8.5	4.0	1.1	11000	4.2	85%	43%	0.5	$70,000
3600	14.8	4.5	2.1	11000	4.2	85%	43%	0.9	$70,000
3650A	11.8	3.7	1.5	11000	4.2	85%	43%	0.6	$70,000
3750	13.7	5.1	1.7	16000	6	85%	43%	0.7	$100,000
3800	12.7	5.4	2.1	16000	6	85%	43%	0.9	$100,000
Subtotal	**82.4**		**11.7**				**43%**	**5.0**	**$534,000**
6000	7.1	3.4	1.8	11000	4.2	85%	43%	**0.8**	**$70,000**
Total								**11.0**	**$1,100,000**

Storm Sewer Inlet Filters

Storm sewer inlet filters are inserts which are placed within existing storm sewer inlets. These inserts consist of a trough, which runs aroung the perimeter of the inlet. The trough contains a filter media, which absorbs perto-chemical based pollutants and heavy metals in stormwater as it passes through. These filters are not designed to remove sediment on nutrients.

One type of storm sewer inlet filter is manufactured by Kristar Enterprises, Inc., in Santa Rosa, California. The fossil filter media is composed of amorphous aluminum silicate. The media should be replaced every year or two. The manufacurer claims that the filter removes 98 percent of petroleum based pollutants entering the filter and also removes heavy metals, but this has not been independently verified.

The greatest benefit for these filters would be gained from placing them in parking lots and gas stations where automotive fluids and gasoline tends to concentrate. The number of inlets were tallied off of storm sewer maps for selected parking lots listed in Table 6-9.

TABLE 6-9
STORM SEWER INLET FILTER LOCATIONS

LOCATION	NUMBER OF INLETS
Edgewood Apartments	4
Shorewood High School	4
Gas Station on Capital and Wilson Drive	2
Capital Drive Parking Lots	3
Great Lakes Communication	2
Milwaukee County Parks Department Garage	1
Shorewood DPW Yard	1
Lake Bluff School	1
TOTAL	**18**

The filters cost approximately $1,500 each to install. To install the filters shown in Table 6-9 would cost approximately $27,000. These filters were not compared to other alternatives, since they treat primarily petro-chemical based pollutants and not sediment, heavy metals and nutrients.

COMPARISON OF STORMWATER CONTROL ALTERNATIVES

The pollution control alternatives are summarized in Table 6-10 as "Actions". These include the nonstructural control methods of increased street sweeping and high efficiency street sweeping as well as the structural control methods of wet detention ponds and in-line storm sewer treatment units. The higher costs and pollution reductions calculated for the Vortechnics units in Table 6-8 were used here to represent the cost of the in-line system. This is in no way an endorsement for one product over another.

The cost per ton of sediment reduced, or unit cost, was calculated from the sediment reductions and cost resulting from each "Action". The different "Actions" were grouped into "Alternatives" based upon an increasing unit cost and their feasibility in being implemented (Table 6-11). The pollution reductions for each alternative is graphed in Figure 6-7. The only alternative to achieve the pollution reduction goals of the Priority Watershed plan is Alternative 3 which includes a large wet detention pond at the Capitol Drive site. The alternative's costs are graphed in Figure 6-8. The Alternatives are described below.

- **Alternative 1** consists of Action 2, implementing street sweeping with a high efficiency sweeper such as an Enviro Whirl Sweeper or an Elgin Vacuum Sweeper. Sweeping would occur weekly in critical land use areas (commercial, industruial, multi-family and high density residential) and bi-weekly in other land use areas.

The high efficiency sweeper provides a significantly greater pollution reduction than increasing to weekly street sweeping with a conventional broom sweeper.

- **Alternative 2** consists of Actions 2, 3, and 5 which includes the wet detention pond in Hubbard Park which serves Basin 1000, the smaller wet detention pond at the Capitol Drive site which serves Basin 2000, and the high efficiency street sweeping. These actions were grouped together since they include wet detention ponds, which have greater pollution reduction capability than the in-line treatment systems.

- **Alternative 3** consists of Actions 2 and 9 which includes the large wet detention pond at the Capitol Drive site and the high efficiency street sweeping. This alternative provides the greatest pollution reduction and is the only alternative which achieves the pollution reduction goals of the priority watershed project. The practical feasibility of constructing the large wet detention pond Milwaukee County Park land at the Capitol Drive site is, however, not great.

- **Alternative 4** consists of Actions 2, 6, and 11 which includes the more efficient of the in-line treatment actions but no wet detention ponds.

- **Alternative 5** consists of Actions 2, 3, 6, 11, 10, and 8, which includes all of the in-line treatment actions and the two wet detention pond actions exclusive of the Capitol Drive site. This alternative is an attempt to maximize pollution reduction without the construction of a wet detention pond at the Capitol Drive site. This alternative is the most expensive of the five alternatives and yet does not meet the goals of the priority watershed project.

TABLE 6-10
STORMWATER CONTROL ACTIONS

Action	Treatment Area	Practice	Sediment Treatment Efficiency	Sediment Reduction (tons/yr)	Lead Treatment Efficiency	Lead Reduction (lbs/yr)	Cost	Unit Cost per ton of Sediment
1	Project Area	weekly street sweeping		3.5		19	$15,900*	$4,543
2	Project Area	high efficiency sweepers		6.8		55	$170,000	$25,000
3	Basin 1000	wet detention pond	0.55	2.7	0.39	9	$76,000	$28,148
4	Basin 1000	In-line Treatment (4 units)	0.43	1.8	0.25	5	$226,000	$125,556
5	Basin 2000	wet detention pond	0.85	9.2	0.6	32	$128,000	$13,913
6	Basin 2000	In-line Treatment (3 units)	0.41	3.4	0.25	10.5	$270,000	$79,412
7	Basin 3000	wet detention pond	0.66	18.1	0.47	60	$370,000	$20,442
8	Basin 3000	In-line Treatment (7 units)	0.43	5	0.25	14	$534,000	$106,800
9	2000 & 3000	wet detention pond	0.51	19.5	0.36	65	$390,000	$20,000
10	Basin 4000	route to Estabrook Pond	0.85	1.5	0.6	4.8	$145,000	$96,667
11	Basin 6000	In-line Treatment (1 units)	0.43	0.8	0.25	1	$65,000	$81,250

* Annual incremental cost above existing bi-weekly sweeping.

Note: The pollutant reduction estimates assume that the actions perform independently from one another. Pollutant reductions of several actions performing together are not strictly additive. An action performing downstream from another action will have a reduced treatment efficiency, since the upstream action will have removed the larger particles.

TABLE 6-11
NONPOINT SOURCE POLLUTION CONTROL ALTERNATIVE SUMMARY

Alternative	Sediment Reduction (tons/yr)	Heavy Metal (Lead) (lbs/yr)	Cost
1	6.8	55	$170,000
2	18.7	96	$374,000
3	26.3	120	$560,000
4	11	66.5	$505,000
5	20.2	94.3	$1,260,000
Reduction Goal	24.8	102	

Figure 6-7

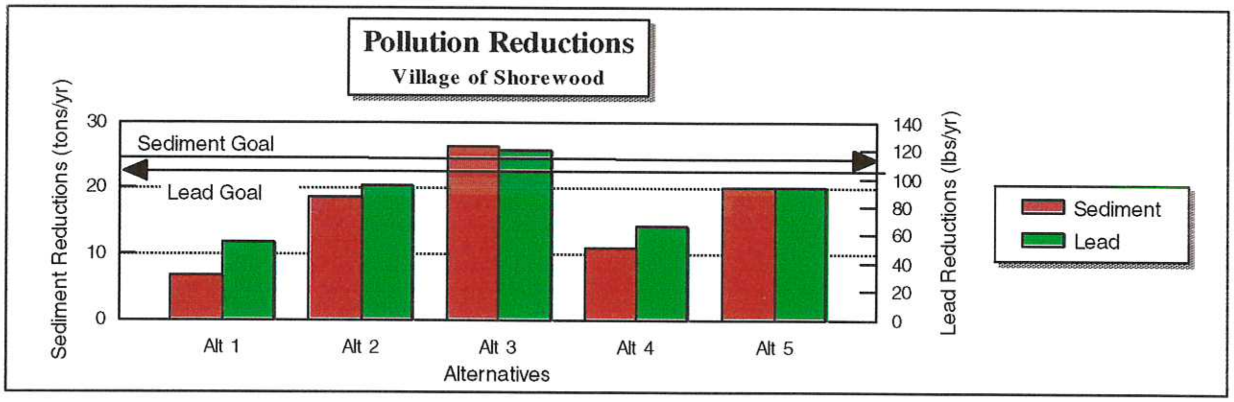
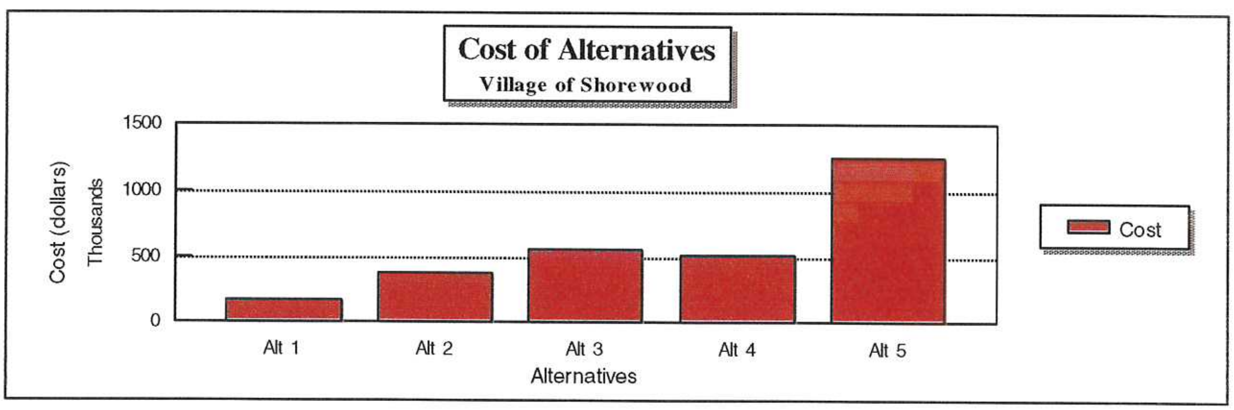


Figure 6-8



FLOODING ALTERNATIVES

Several areas within the storm sewer collection system will either need to be modified to handle expected flows into the system. These deficiencies can be solved in several ways. The use of parallel relief sewers or total replacement sewers are the most common methods of solving these types of capacity deficiencies. Other possible solutions would be a relief sewer using a different route, the use of storage facilities to relieve the capacity problems, and possible combination of the above solutions.

For each sewer improvement alternative, the total replacement option was chosen. This is a planning level study and it is more conservative to use the higher costs of the total replacement option. When the final decision to relieve the flooding is made, more precise quantities of sewer length and manholes will need to be determined. At that time the construct ability of the sewer due to numerous factors, including availability of space for the proposed horizontal and vertical alignment, will also need to be considered.

Costs for all of the sanitary sewer improvement alternatives were calculated from the unit prices. The unit prices were derived by considering size of pipe, backfill material, depth of construction, and type of restoration.

The following potential solutions were investigated to eliminate the identified deficiencies within the Shorewood storm sewer interceptor system. a description of each potential solution, including a summary cost estimate, is presented in this section. Detailed cost estimates for each solution provided in Appendix B.

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1. Total replacement sewers (existing alignment)
2. Parallel relief sewer
3. Storage facilities

Replacement Sewers

The use of parallel relief sewers or total replacement sewers is the most common method of solving the type of deficiencies identified in the Shorewood interceptor system. The parallel sewer alternative is used in areas where there is sufficient room to construct the parallel sewer next to the existing sewer and where the existing sewer is in sound structural condition. The total replacement sewer alternative is generally used in those areas where there is insufficient area to construct a parallel sewer. Therefore, the existing sewer is removed and the larger replacement sewer is constructed. Another reason to use the total replacement alternative is if the existing sewer is in poor condition. Total replacement sewers are larger than parallel relief sewers and, therefore, parallel relief sewers are less expensive to construct than total replacement sewers. Under capacity sewers were replaced in the HYDRA model until the hydraulic gradelines for all modeled pipes were at least 1 foot below the ground elevation. At that point, the storm sewer system is able to handle the flow. The sewers to be replaced for a 10-Year storm are shown graphically on Figure 4-2. The construction cost to replace 39 sewer segments is estimated to be $1,735,000.

Relief Sewer

The second alternative considered was the construction of a relief sewer using a new alignment. This alternative is a major diversion of flows within the system. This alternative is considered when the existing system is in good condition and a constriction or bottleneck is located within the storm sewer system. The relief sewer would be sized to remove enough flow from the existing sewer so that the existing sewer would no longer be under capacity. It was determined that the relief sewer alternative was not economically feasible because of the location of under capacity sewer segments. Therefore, this alternative was not considered further.

Storage Alternatives

The final alternative considered was the use of storage facilities to reduce the peak wet weather flow and store it until the downstream sewer system can handle the flow. This alternative is considered in lieu of the sewer replacement alternative. Storage was added upstream of the under capacity sewers until the hydraulic gradelines for all modeled pipes were at about 1 foot below the ground elevation. At that point, the storm sewer system is able to handle the flow. Storage facilities would be required in basins 1000, 2100, 2200, 3450,3400, 3600, 3250, 3050, 4000, and 5000. The construction cost to construct 10 storage facilities is estimated to be $1,629,000.

ALTERNATIVE SUMMARY

The standard level of protection for area communities for storm sewer systems is a 10-year recurrence level storm. During the design storm, the hydraulic grade line should be one foot or lower below the ground and the storm sewer system should not allow significant street flooding during the design storm. The alternatives described above will meet that criteria and, therefore, provide the storm sewer area in Shorewood with 10-year protection. The costs for the 10-year storm alternatives are shown below:

Replacement Sewers	$1,735,000
Storage Facilities	$1,629,000

7 RECOMMENDED NONSTRUCTURAL AND STRUCTURAL MEASURES

INTRODUCTION

The Village of Shorewood has a number of stormwater management problems that threaten the safety and environment of the Community. The Village has an opportunity to make use of grants from DNR's Priority Watershed Program to help pay for implementing some of the recommended controls. The proposed recommendations will enable the Village of Shorewood to meet the pollution reduction goals discussed in Chapter 5.

SOURCE CONTROLS

Often called "Housekeeping Measures", source controls are procedures or activities that prevent or reduce the amount of stormwater coming into contact with potential pollutant sources. Source controls for the Village of Shorewood range from informing the public on proper use of fertilizers, to spill containment barriers around fuel storage facilities, to routine cleaning of storm sewer inlets and catch basins. It is easier and less costly to prevent pollutants from coming in contact with stormwater than it is to try to remove the pollutants after the fact. Therefore, the Village should emphasize the implementation of source controls. Specific recommendations are described in the following paragraphs.

Public Education

The objective of public education is to make individuals aware of the problems caused by stormwater runoff and the measures that individuals can take to minimize the harmful effects. Audiences must first be identified. There are at least three audiences in the Village of Shorewood, the business community, the general public, and school age children. A tailored message should be developed for each audience. Materials developed by the Village should be coordinated with University Extension Service. Articles could also be written for the local newspaper and Village news letter.

Inlet stenciling is an effective way to discourage the dumping of wastes such as grass clippings, vehicle oil and antifreeze into storm sewers. It also makes urban residents aware of stormwater issues and the connection of storm sewers with area waterways. Installation of informational signs along the Milwaukee River would compliment the stenciling. Signs could educate the public about water quality issues. Topics which could be included are nonpoint source pollution sources, citizen pollution prevention techniques, and recognition of the implementation of best management practices.

A public education program for the Village's recycling program will benefit the Village's stormwater program by providing instruction for the proper disposal of vehicle oil, antifreeze, fertilizers, pesticides, old paint and other house hold hazardous wastes that often find their way into area water ways.

The development of a comprehensive stormwater program targeting school aged children is an excellent way to reach the community. This approach has been very successful in getting participation in the recycling programs. In addition to classroom materials, audio visual materials could also be developed. A portable, interpretive water quality display could be part of the comprehensive program. The University of Wisconsin - Extension Service and the WDNR can provide assistance and information for this type of program.

Operation and Maintenance

Routine maintenance cleaning of streets and storm sewers is essential for reducing the amount of pollutants accumulated on Village streets and sewers that can be washed into area waterways. A fairly good and comprehensive operation and maintenance program has been developed by the Village staff for dealing with nonpoint source pollution. The Department of Public Works yard is well maintained for water quality. The garage has a wash bay and sump connected to the sanitary sewer. The garage flood drains are connected to the sanitary sewer. The yard waste and trash compactors have a roof canopy and their flood drains are connected to the sanitary sewer. Topsoil and mulch are stored in roofed bins. Fuel is stored above ground with concrete retaining walls and floors. The parts cleaner is a self cleaning unit and is serviced by a contractor. Road paint used in the Village is water based. Continued support is needed for the existing program.

Catch Basin Cleaning Monitoring

For water quality purposes, it would be ideal to clean out a catch basin before it is 60 percent full. Once a catch basin is 60 percent full, it can no longer trap the coarse particles in stormwater runoff effectively. Currently, all catch basins in Shorewood are cleaned on an annual basis. It is recommended that the DPW staff record the depth of trapped material in the catch basins prior to being cleaned out. These depths could be recorded in a log as the DPW staff cleans out the catch basins. This log would then be used to identify those catch basins which are greater than 60 percent full after a year of accumulation, and those which are less than 60 percent full after a year. This information would be used to optimize the efficiency of catch basin cleaning. These catch basins which are full after a year, would warrant more frequent catch basin cleaning such as on a six month basis. Those catch basins which are less than 60 percent full after a year, may require less frequent cleaning such as on a biennial basis.

Fall Leaf Pick-up with Paper Bags

It is recommended that the Village collect fall leaves in large paper bags similar to oversized paper grocery bags. The paper bags decompose during composting of the leaves. Currently, the Village collects leaves in the fall from the terraces and gutters with a vacuum. This method of collection leaves a residue of leaf particles which will wash into the storm sewers, adversely affecting water quality. Collecting the leaves in large paper bags is a method of collection which greatly reduces the amount of leaf residue entering the storm sewer system. This not only improves the stormwater quality, but also reduces the amount of DPW staff time required. it is estimated that the staff time required for leaf collection would drop from 240 hrs/wk using vacuum collection to 100 hrs/wk for paper bag collection. In addition, staff time required for catch basin cleaning would be reduced as fewer leaves would be filling up catch basins.

Storm Sewer Inspection

Milwaukee County has emergency procedures that include the Village of Shorewood for responding to the spill of potentially hazardous materials. The Village should review the established procedures to evaluate whether adequate measures would be taken that would prevent pollution of Village storm sewers and area water ways. The Village should establish an inspection program of all storm sewers to locate and eliminate all non-stormwater discharges which are not properly permitted. This would include checking storm sewer outfalls for signs of contamination.

Ordinances

Currently the Village has no ordinance directly pertaining to stormwater quality control. Article eight of the Village ordinance code prohibits discharge of any hazardous material upon or into any public street, alley, or onto the ground, surface water or subsurface waters, or aquifers in the Village. This ordinance does not specify any penalty for committing such an act. It is recommended that the Village institute ordinances with the following provisions:

- specify a penalty for violating Village ordinance Article eight,
- provide the Village with the authority to conduct on-site inspections of sewer systems,
- provide the Village with the authority to require developers to construct stormwater control practices on a redevelopment area such as the Edgewood development.
- expand Article 8 so that it prohibits the discharge of waste materials such as pet waste, yard waste, grass clippings, soil, septage, and litter upon or into any storm sewer, public street, alley, or surface water in the Village.

NONSTRUCTURAL AND STRUCTURAL CONTROL MEASURES

Criteria for selecting structural storm water control measures includes not only pollutant reduction levels, but also concerns regarding a structure's impact on the native ecology and human use of a site. The analysis in Chapter 6 showed that of the five alternatives investigated, only Alternative 3 met the pollution reduction goals of the priority watershed project. Alternative 3 includes constructing a wet detention pond along the Milwaukee River north of Capitol Drive and street sweeping with a high efficiency sweeper on a weekly basis. However, due to the concerns brought up by Milwaukee County regarding the impact to the native ecology and human use of the site as described in Chapter 6, Alternative 3 is not the recommended alternative. **Alternative 1**, which consists of street sweeping with a high efficiency street sweeper, **is the recommended alternative** because of its cost effectiveness and lack of impact on parkland along the Milwaukee River.

The new generation of high efficiency street sweepers combine mechanical broom sweeping with vacuum action and therefore, remove more sediment from street surfaces than conventional sweepers. It is recommended that such a street sweeper be used on a weekly basis in "critical" land use areas (commercial, industrial, institutional, multi-family, and high density residential) and biweekly on other land use areas. The sweeper could be either purchase outright or leased on a five year basis. Weekly street sweeping with a high efficiency street sweeper result in an estimated reduction of 14 percent for sediment loading and 25 percent for heavy metal loading. Phosphorus reductions were not estimated since the phosphorus removal efficiencies for the high efficiency sweepers is not known at this time.

It is maintained that, in terms of nonpoint source pollution control, Alternative 3 is technically the best alternative. Alternative 3 is recommended as the best technical alternative, and should be reconsidered for implementation if the concerns about siting wet detention pond in the Milwaukee River Parkway are alleviated.

In addition to Alternative 1 it is recommended to install storm sewer inlet filters in parking lots and gas stations in the project area to help control petro-chemical based pollutants.

Another possible structural control measure would be the retro-fit of Estabrook Lagoon and the connection of basins 4000 and 5000 to the lagoon. This measure should be pursued jointly with the Village of Whitefish Bay, should Whitefish Bay decide to include the retro-fitting of Estabrook Lagoon as part of its upcoming storm water management plan. Estabrook Lagoon is on the municipal boundary between the two Villages and receives much of its water from Whitefish Bay.

DRAINAGE IMPROVEMENT RECOMMENDATIONS

A number of storm sewers were identified in Chapter 4 that could not convey the runoff for a 10-year recurrence interval design storm. The majority of the drainage/flooding problems identified in Chapter 4 were determined not serious enough to justify their own project. Therefore, it is recommended that the Village make the necessary drainage improvements as part of a larger facility improvement project, such as a road reconstruction project.

COST ESTIMATES FOR PLAN RECOMMENDATIONS

Cost estimates for the recommended nonpoint source pollution control measures are shown in Table 7-1. These costs do not include design costs. The table also shows the levels of state assistance available should the Village fund the recommendations through WDNR's Nonpoint Source Pollution Abatement Program. The state and local shares of construction costs are estimated based on the percent of water runoff from "critical" land uses (medium density residential, open space, and park land are not "critical"). "Critical" land use comprises 81 percent of the area being proposed for street sweeping and 77 percent of the area draining into the proposed wet detention pond. The maximum state cost share rate for construction of eligible structural practices controlling pollution from critical lands is 70 percent. The WDNR funding level for a high efficiency sweeper to variable and dependent on the level of commitment the Village invests in reducing stormwater pollution. The highest level of WDNR funding for a high efficiency sweeper is a 70 percent cost share which may go towards the outright purchase of the sweeper or to a five-year lease. Shoreline erosion protection projects such as at Atwater Park are at a 70 percent cost share rate. The state cost share for public education is 100 percent.

While not a recommended measure of this plan, it should be noted that WDNR funding for in-line treatment systems may not qualify for the full 70 percent cost share. The level of cost share for in-line treatment systems will be determined after the WDNR completes its field evaluation of a demonstration unit later in 1997.

Costs were not estimated for the catch basin cleaning monitoring. The monitoring may result in either a reduction or increase in the amount of time spent on catch basin cleaning dependent on whether overall catch basins need to be cleaned out more or less frequently than once a year.

Costs were not estimated for the fall leaf pick-up with paper bags, since it is expected that this would result in a net reduction of staff time spent on leaf pick-up and catch basin cleaning.

Table 7-1
Recommended Nonpoint Source Control Measures Cost Estimates

Recommended Measure	Estimated Cost	Local Share	State Share	Annual Cost
High Efficiency Street Sweeper	$170,000	$73,600	$96,400	NA
Storm Sewer Inlet Filters	$27,000	$8,100	$18,900	$1,500
Atwater Park Erosion Control Measures[1]	$26,000	$7,800	$18,200	NA
Edgewood Development Stormwater Measures[1]	cost born by developer	--	--	NA
Catch Basin Cleaning Monitoring	--	--	--	--
Fall Leaf Pick-up with Paper Bags	--	--	--	--
Storm Sewer Inspection Program	--	--	--	$12,500
Public Education Program	$5,000	--	$5,000	
Total	**$228,000**	**$89,500**	**$138,500**	**$12,500**

[1] See Appendix A for details

INTRODUCTION

The Village of Shorewood Stormwater Management Plan area is within the "Milwaukee River South Priority Watershed". The Milwaukee River was designated a "priority watershed" under the Wisconsin Nonpoint Source Water Pollution Abatement Program. A planning level study was conducted to address the nonpoint source pollution control needs within the watershed. The plan, "A Nonpoint Source Control Plan for the Milwaukee River South Priority Watershed Project" (WDNR, 1991), identified critical sources of nonpoint pollution and established nonpoint source pollution reduction goals for the watershed. The purpose of this analysis is to estimate the amount of nonpoint source pollution being generated in the study area and to target sub-basins for pollution control measures which may best achieve the pollution reduction goals established in the priority watershed project plan.

SLAMM MODELING OF URBAN AREAS

For water quality simulation of urban stormwater, the *Source Loading and Management Model* (SLAMM version 6.2) (Pitt, 1992), was used. SLAMM was developed by the WDNR for use in the State's Nonpoint Source Pollution Abatement Program. The model has been calibrated with extensive water quality monitoring conducted in southeastern Wisconsin and should characterize the urban runoff in the project area fairly accurately. The model has also been used extensively in stormwater management studies in Wisconsin so this analysis is consistent with previous studies.

Information required as input to SLAMM include:

- Land use
- Hydrologic soil grouping
- Drainage system
- Existing stormwater control practices
- Annual rainfall
- Street conditions

SLAMM data files are used which specifically reflect the source area characteristics of each land use in the watershed. Original files for land use, rainfall, runoff, and pollutant data were obtained from the WDNR. These same files are used in the loading analysis for the Priority Watershed studies. These files were modified as needed to best represent site conditions in the project area and were used to predict annual pollutant loading rates. The rainfall data file for Milwaukee in 1981 provided with the SLAMM model was used in the model simulations. This year of rainfall is considered a typical year for southeastern Wisconsin.

Land Use

Existing land use was determined from the Village of Shorewood Land Use Map, last updated January 1995, and the 1990 Southeastern Wisconsin Regional Planning Commission (SEWRPC) aerial photographs for the project area. Since the Village of Shorewood is essentially completely developed, no change in future land use is anticipated. Land use areas by basin are summarized below (a table of land use by sub-basin is in Appendix C).

TABLE 5-1
LAND USE AREAS
VILLAGE OF SHOREWOOD

Basin i.d.	Residential (acres)			Commercial (acres)	Institutional (acres)	Light Industrial	Open Space (acres)	Park (acres)	Total (acres)
	High Density	Med. Density	Multi-Family						
1000	24.3	0	5.7	1.3	6	0	0	5.6	42.9
2000	4.7	0	2.1	16.2	17.1	1.8	0	1.2	43.1
3000	155.3	64	11.4	7.7	12.8	0	0	2.4	253.6
4000	7.5	4.9	6.1	0	0	0	0	0.5	19
5000	0	0	14.2	0	0	0	0	0	14.2
6000	1.8	0	0	0.1	0	5.2	0	0	7.1
7000	0	0	1.3	0	2.6	2.3	4.9	76	87.1
8000	0	0.3	0	0	0	0	0	0	0.3
Total	193.6	69.2	40.8	25.3	38.5	9.3	4.9	85.7	467.3

Soils

As discussed in Chapter 3, most of the soils in the study area are CD soils. The exception to this are the AB soils in the park land along the Milwaukee River.

Drainage System

The drainage system in the Village of Shorewood is primarily curb and gutter with storm sewers. Roof drains are directly connected to the storm sewers. The areas of park and open space drain primarily via overland flow and channels to the Milwaukee River.

Stormwater Control Practices

Stormwater control practices in the watershed include street sweeping and catch basin cleaning. The Village of Shorewood cleans its catch basins once a year and street sweeps on a bi-weekly basis (James Bartnicki, Shorewood Director of Public Works, personal communication, 1996). Basin 5000 in the northwest corner of the project area drains into Estabrook Park Lagoon, which acts as a wet detention pond. The SLAMM model was run for these conditions. As part of the analysis the SLAMM model was run with the condition of weekly street sweeping to determine if this would be an effective means of pollution reduction.

SLAMM MODELING RESULTS

Stormwater runoff pollution from the study area was calculated for each sub-basin. Water pollution parameters simulated were suspended sediment, nutrients (phosphorus), and heavy metals (lead). While lead was the only heavy metal analyzed, it is considered representative of other heavy metals such as, zinc, cadmium and copper. Total loadings for each major basin and unit area loading rates are summarized in the tables below. The pollution reduction goals are also calculated. The pollution reduction goals in the Priority Watershed Plan are 50 percent for suspended sediment, 50-70 percent for phosphorus, and 45 percent for lead.

TABLE 5-2
EXISTING CONDITIONS POLLUTANT LOADING

Basin	Area (acres)	Sediment (tons/yr)	Phosphorus (lbs/yr)	Lead (lbs/yr)
1000	42.9	5.0	45	23
2000	43.1	10.8	74	53
3000	253.6	27.4	244	128
4000	19	1.8	16	8
5000	14.2	0.25	6	2
6000	7.1	1.8	18	4
7000	87.1	2.6	18	8
8000	0.3	.02	>1	>1
Total	**467.3**	**49.7**	**421**	**226**
Reduction Goal		**24.8**	**210.5**	**102**

TABLE 5-3
EXISTING CONDITIONS UNIT AREA LOADING RATES

Basin	Area (acres)	Sediment (tons/yr)	Phosphorus (lbs/yr)	Lead (lbs/yr)
1000	42.9	0.12	1.0	0.5
2000	43.1	0.25	1.7	1.2
3000	253.6	0.11	1.0	0.5
4000	19	0.10	0.9	0.4
5000	14.2	0.02	0.4	0.2
6000	7.1	0.25	2.6	0.6
7000	87.1	0.03	0.2	0.1
8000	0.3	0.06	0.5	0.2

Subbasin Rankings and Critical Basin Designation

In order to most efficiently reduce the nonpoint pollution loadings from the study area, those sub-basins which contribute a disproportionate share of the total pollutant loadings were identified. For each of the three pollutants simulated, the sub-basins were ranked by the amount of pollution per acre they generated, or their unit area loading rate. In addition, a running total of pollutant loadings, or the cumulative loadings were calculated. The rankings and cumulative totals presented in Table 5-4. were analyzed to determine what level of pollution reductions that would be necessary to meet the goals of the Priority Watershed Plan.

It is stipulated that the most efficient way to achieve the goals of the Priority Watershed Plan is to reduce the pollutant loadings from those sub-basins which generate the most pollutants on a per acre basis. "Critical" sub-basins are identified as those top ranked sub-basins, which, if treated with the best available treatment practices, would meet the goals of the Priority Watershed Plan. For analytical purposes the typical treatment efficiencies for a wet detention basin were considered (85 percent for suspended sediment, 60 percent for nutrients, and 70 percent for heavy metals).

There is considerable overlap among the "critical" sub-basins for each parameter. However, the number of "critical" sub-basis for nutrients is much larger than the other parameters. Of the 33 sub-basins, 23 are "critical" for nutrients, 16 for heavy metals, and 15 for sediment, and 17 for heavy metals and sediment together. If loading reductions for phosphorus are applied to only the 17 "critical" sub-basins for lead and sediment, a total reduction in phosphorus of 39 percent is achieved. Many of the sub-basins which are critical for nutrients but not for heavy metals or sediment consist of medium density land use, which is of lower density than the other critical basins. Due to the less intense land use and lower unit area loadings, it is less efficient to treat pollution in these sub-basins. For purposes here the Village should focus on the 17 "critical" sub-basins for heavy metals and sediment together for nonpoint source pollution control (Figure 5-1).

Table 5-4
Nonpoint Pollution Sub-basin Rankings
Village of Shorewood

Critical Basins

Basin i.d.	Sediment (tons/ac-yr)	Sediment (tons/yr)	Cumulative Total
2100	0.37	3.63	3.63
2300	0.27	2.76	6.39
6000	0.25	1.76	8.14
2200	0.20	3.47	11.61
3050	0.17	2.23	13.84
3800	0.16	2.06	15.90
2400	0.15	0.93	16.83
3600	0.15	2.15	18.98
1100	0.14	2.16	21.14
1300	0.13	0.86	22.01
3650	0.13	2.00	24.01
3200	0.13	1.08	25.09
3750	0.13	1.74	26.82
3150	0.12	0.98	27.80
1200	0.12	1.62	29.43
3100	0.11	1.60	31.02
3900	0.11	2.06	33.08
4200	0.11	1.43	34.51
3850	0.11	0.85	35.35
3350	0.11	1.60	36.96
3400	0.10	1.54	38.50
3450	0.10	1.95	40.44
3300	0.08	0.87	41.31
3250	0.08	0.88	42.19
3500	0.07	1.76	43.95
3550	0.07	0.84	44.79
1400	0.07	0.28	45.07
4100	0.07	0.40	45.47
3700	0.07	1.27	46.74
8000	0.06	0.02	46.76
7000	0.03	2.59	49.35
1390	0.03	0.09	49.44
5000	0.02	0.25	49.69

Total	49.7
50% reduction goal	24.8
Amount to be treated at 85% efficiency	29.2

Critical Basins

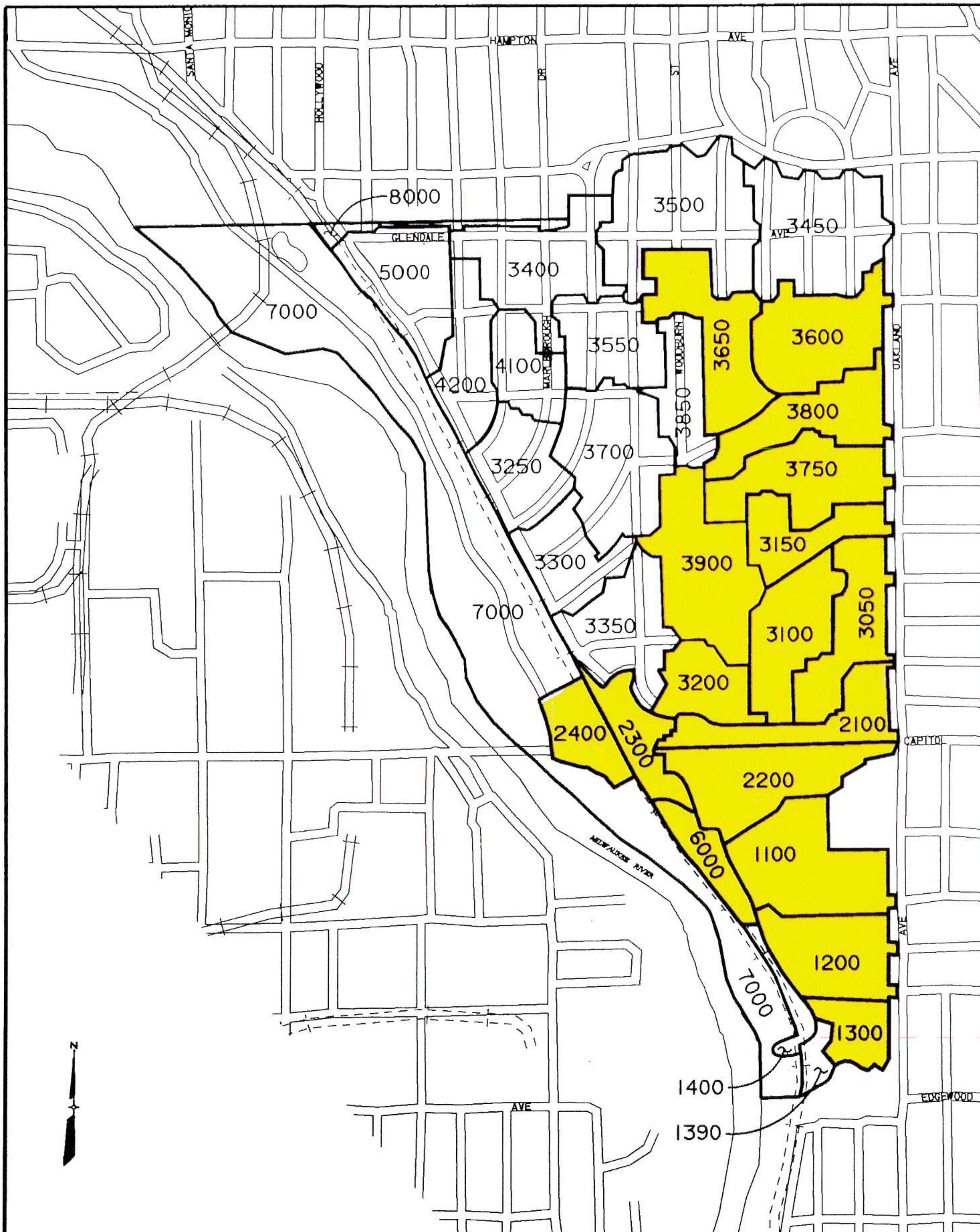
Basin i.d.	Phosphorus (lbs/ac-yr)	Phosphorus (lbs/yr)	Cumulative Total
6000	2.56	18.2	18
2100	1.89	18.7	37
2300	1.87	19.1	56
2200	1.61	27.3	83
2400	1.44	8.6	92
3800	1.37	17.4	109
1100	1.30	20.6	130
3600	1.30	19.2	149
3050	1.27	16.5	165
3650	1.22	19.2	185
3750	1.12	15.4	200
3200	1.12	9.5	210
3150	1.12	8.8	218
1200	1.10	14.7	233
3100	1.08	15.2	248
3900	1.07	20.0	268
3850	1.05	8.2	277
3350	1.00	15.0	292
4200	1.00	13.0	305
1300	0.98	6.3	311
3400	0.96	14.7	326
3450	0.82	16.4	342
3300	0.68	7.4	349
3500	0.66	15.7	365
3550	0.66	7.5	373
3250	0.65	7.3	380
1400	0.64	2.6	382
4100	0.58	3.5	386
3700	0.57	11.0	397
8000	0.47	0.1	397
5000	0.40	5.7	403
7000	0.21	17.9	421
1390	0.18	0.6	421

Total	421.1
50% reduction goal	210.6
Amount to be treated at 60% efficiency	351.0

Critical Basins

Basin i.d.	Lead (lbs/ac-yr)	Lead (lbs/yr)	Cumulative Total
2100	2.13	21.1	21
2300	1.27	13.0	34
3050	0.93	12.1	46
2200	0.90	15.3	61
3800	0.75	9.5	71
1300	0.70	4.5	75
3600	0.66	9.8	85
3200	0.65	5.5	91
3750	0.65	8.9	100
3150	0.64	5.0	105
1200	0.62	8.2	113
6000	0.60	4.3	117
3100	0.57	8.0	125
1100	0.57	9.0	134
3650	0.56	8.8	143
3900	0.55	10.3	153
3850	0.54	4.2	158
4200	0.54	7.0	165
2400	0.53	3.2	168
3350	0.52	7.8	175
3400	0.48	7.4	183
3450	0.44	8.9	192
1400	0.34	1.3	193
3300	0.33	3.6	197
3250	0.32	3.5	200
3500	0.29	6.9	207
3550	0.29	3.3	210
4100	0.24	1.4	212
3700	0.23	4.5	216
5000	0.17	2.4	219
8000	0.17	0.0	219
1390	0.11	0.4	219
7000	0.09	7.8	227

Total	226.9
45% reduction goal	102.1
Amount to be treated at 70% efficiency	145.8



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE 5-1
CRITICAL POLLUTANT SOURCES
VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN

IMPLEMENTATION SCHEDULE

Although all the recommendations included in this report are important components of the overall watershed plan, some recommendations have priority over others. For this reason, an implementation sequence was developed and is presented here.

Three factors influence the ranking or prioritizing of the recommendations:

1. Technical: This factor recognizes that the functioning of certain components of the stormwater system is dependent on the existence of other components. For example, a stormwater detention facility will not function as intended unless the tributary storm sewers have adequate capacity to convey water to the storage area.

2. Cost-effective: The cost-effective factor means that higher priority should be given to those recommended facilities most likely to provide the greatest reduction in non-point source pollution or flood danger, damage, and disruption.

3. Timing: This factor recognizes that some recommendations can be effectively implemented only if quick and decisive action is taken to capitalize on other conditions.

Therefore, after consideration of the technical, cost-effective, and timing factors, we recommend the implementation priority presented as a bar graph in Table 8-1. Included in Table 8-1 are all the structural and nonstructural recommendations set forth in Chapter 7.

RESPONSIBLE PARTIES

Responsibility for taking the lead in implementing various portions of the stormwater management plan reside with local and state government, and private entities. The recommended lead and support implementors are presented in Table 8-1.

TABLE 8-1
RECOMMENDED PLAN IMPLEMENTATION SCHEDULE AND RESPONSILBLE PARTIES

Recommendation	**YEAR**						**RESPONSIBLE PARTY(S)**		
	1997		**1998**		**1999**		**Village of Shorewood**	**WDNR**	**Developer**
Non-Structural									
High Efficiency Street Sweeping			■	■	■	■	●	○	
Enforce Construction Erosion Ordinance	■	■	■	■	■	■	●		○
Enact Stormwater Management Ordinance		■	■				●		
Public Education Program		■	■	■	■		●		
Storm Sewer Inspection Program		■	■	■	■	■	●		
Catch Basin Cleaning Monitoring			■	■	■	■	●		
Paper Leaf Pick-up Bags		■	■	■	■	■	●		
Continue Operation and Maintenance	■	■	■	■	■	■	●		
Structural									
Storm Sewer Inlet Filters			■	■			●	○	
Atwater Park Erosion Control		■	■				●	○	
Edgewood Stormwater Measures *							○		●

* This will be started when a development plan is determined
Note: The Milwaukee River South Priority Watershed Prject ends in 1999.

● Primary Responsibility

FINANCING THE PLAN

Introduction

There are a number of funding mechanisms that can be used to finance the Village's stormwater management program. Table 8-2 contains a list of these funding options and a summary of the appropriate activities each funding source can be used for. These mechanisms can be used individually or in combination. Descriptions of funding sources used to finance stormwater management programs are discussed below. Advantages and disadvantages associated with each alternative are also discussed, as well as an indication of the activity (e.g., administration services, operation/maintenance, renewal/replacement, capital improvements, and water quality monitoring) for which the funding source is best suited.

TABLE 8-2
ALTERNATIVE FUNDING METHODS STORMWATER MANAGEMENT ACTIVITIES

Funding Alternative	Functional Program Elements			
	Stormwater Management Administration and Design	Capital Improvement Program	Operation and Maintenance	Water Quality Monitoring
Stormwater Utility	☆	☆	☆	☆
General Fund	☆	☆	☆	☆
Special Taxing District	☆	☆	☆	
State WDNR Grants	☆	☆		☆
Homeowners Association		☆	☆	☆
Local Option Sales Tax		☆		
Bonds		☆		
Pay-as-you-go Sinking Fund		☆		☆
Subdivision Exactions		☆		
Developer Incentives		☆		
Betterment Charge		☆		

Alternatives

General Fund: In most communities, funds for stormwater management are provided from the General Fund. This source can be best considered a "bank" into which revenues are placed and from which most programs are funded. The major income source for the General Fund is ad valorem (property) taxes. This income is based primarily upon the assessed valuation of property within the Village. This revenue source can be used for funding for administration, renewal/replacement, construction, maintenance, and water quality monitoring.

Special Taxing/Assessment Districts: Income from a special taxing district or special assessment district is generally dedicated to that district. That is, the area that is designated as "special," for whatever reason, would pay an additional tax or have an increased assessment. The funds from the additional tax or assessment are returned to that area. For example, if stormwater management facilities are constructed to benefit a particular drainage basin within the Village then that area could be designated a special taxing district and an additional tax levy could be assigned to the property within the area.

Local Option Sales Tax: The County could impose a local option sales tax if approved by the voting public. The revenue would be distributed to each of the local governments and could be used for infrastructure capital improvements.

Clearly, stormwater management Capital Improvement Projects (CIP) can be funded using this source. However, by law, the funds can only be used for capital improvements--the funds cannot be used for management services and operation and maintenance (O&M) activities. In addition, sales tax revenues can be unreliable, since they vary from year-to-year depending on the ups and downs of the economy. Therefore, it is not sufficient to form the foundation of the financial plan for the stormwater management program.

Homeowners Association: The homeowners association concept is often used with new development. It is similar to the special assessment district in that a relatively small area would receive an additional levy. This method is generally available only for residential parcels. In the case where no special district could be established, or where a private entity is responsible for the maintenance of a stormwater facility, a homeowners association fee may be a reasonable approach. Assessments are specific depending on the needs and desires of each association. Capital improvements, operation and maintenance, and water quality monitoring for the residential development can be funded by this method.

Bonds: General obligation, revenue, or special assessment bonds are normally used by governments to pay for large capital improvement programs. Repayment of a bond is normally through the General Fund (i.e., ad valorem tax income); however, special assessment district income, as well as utility revenues, can be used to pay the debt service. Bonds would allow large-scale capital improvement programs to be initiated when the facilities are needed rather than waiting until the funds are accumulated.

Pay-As-You-Go Sinking Fund: As an adjunct to revenue bond financing, this type of stormwater funding is most common. Essentially, a separate account is formed to receive revenues from numerous sources such as ad valorem taxes or stormwater utility income. The fund accumulates revenues until sufficient money is available for an identified project. Then the total project amount is removed from the fund and the fund "sinks" in size and the growth stage starts over. This method is generally associated with capital improvement programs where it is not advantageous to incur long-term debt.

Subdivision Exactions: As a condition of approval for a redevelopment, the Village can require the developer to construct stormwater management facilities and dedicate them to the Village upon completion. In addition, developers could be required to donate drainage easements or other types of partial rights to the Village for stormwater management purposes. Thus, the developer would be responsible for funding the capital program while the Village would be responsible for funding the operation and maintenance. It is possible, however, to find that stormwater facilities designed, constructed, and transferred to the Village may not have been properly designed or that its discharge may aggravate downstream flooding problems.

Developer Incentives: Incentives could be offered to induce developers to use proper stormwater management planning techniques during the redevelopment of lands in the Village. Such incentives, for example, could include waiving maximum allowable residential densities if land is dedicated to the Village for stormwater management purposes. This method would still require the construction of the stormwater facility by the Village; however, the land costs for the stormwater management facility would be reduced. The two significant concerns regarding the implementation of this method are: (1) to review the compatibility of developers' plans with respect to the goals and objectives of the land use element of the Village's land use plan; and (2) to assess the magnitude of nonpoint source pollution problems due to higher intensity level of development.

Betterment Charges: When a stormwater management facility is constructed to deal with a problem near a community, the property within the community will tend to increase in value. For example, if a drainage system is installed along a street where no stormwater management system had previously existed, then the control of flooding increases the value of property next to the road. The capital cost for such improvements could therefore be apportioned to the property owner(s). This apportionment of charges provides that the benefactors of the stormwater management system improvements would fund the program. The increase in property values resulting from such improvements is hard to estimate and this value may be less than the construction cost, thus limiting recovery.

WDNR Grants: Grants are available through the WDNR to help local communities implement nonpoint source pollution control programs. Two types of grants are available: the Local Assistance Grants and Nonpoint Source Grants.

- Local Assistance Grants are intended to keep the administrative costs for the implementation of the priority watershed plans from becoming a burden for local communities. The state will pay up to 100 percent of the cost of additional staff, professional services, training, travel expense, and additional office space.

- Nonpoint Source Grants provide technical and financial help to implement nonpoint source pollution control practices. Nonpoint source grants require between 30 percent to 50 percent of the cost of the project to be paid by the local community. Part or all of the local share may be "in-kind" match.

Stormwater Utility: Using revenues from a user charge system to fund stormwater management programs is relatively new in Wisconsin. To date, six Wisconsin communities (Appleton, Lake Delton, Sheboygan, West

Allis, Grafton, and Glendale) have evaluated user fees as an alternative for financing stormwater management. The Village of Lake Delton and Glendale have operational stormwater utilities.

The concept of the stormwater utility was developed in the western U.S. in the mid 70's. Since this time, several other municipal governments (Bellevue, Washington; Miami, Florida, Sarasota, Florida; Louisville, Kentucky; Denver, Colorado; New Orleans, Louisiana; Sacramento, California; Tulsa, Oklahoma; and Austin, Texas, are just a few examples) have adopted ordinances to initiate a stormwater utility.

Fairness and equity for all rate payers is an advantage of the stormwater user fee system. Historically, communities have paid for stormwater management from the general fund. The general fund is financed by and large by ad valorem taxes based on property value and the status of the property owner (exempt/nonexempt) which are not related to stormwater runoff or the water quality of runoff. Stormwater user fees, on the other hand, are based on a property's relative stormwater contribution. The stormwater customers who generate larger amounts of stormwater runoff pay proportionally more than other customers. There is a high correlation between impervious area, which was used to establish the rate structure for a stormwater user fee system, and the quantity and quality of stormwater runoff.

Under the user fee system, the majority of the costs of stormwater management is redistributed from the single family home owner to the commercial, industrial, and exempt customers. This more accurately reflects the second group's greater contributions to the problems of stormwater management. Table 8-3 shows how the costs of stormwater management are being reallocated in the Cities of Appleton and West Allis by converting to a stormwater utility program. In these two cases, with a stormwater user fee system, the burden on home owners, as a group, is reduced 30 to 40 percent.

TABLE 8-3
COMPARISON OF TAX BASE AND UTILITY FEE COSTS

Funding Method	Percentage of Cost - West Allis			Percentage of Cost - Appleton		
	Residential	Non-Residential	Exempt	Residential	Non-Residential	Exempt
Property Tax	64%	36%	0	75%	25%	0
Utility User Fee	42%	51%	5%	46%	41%	13%
% change	-32%	42%		-39%	64%	

The stormwater utility provides funding for the five significant aspects of a comprehensive stormwater management program (administration, operation and maintenance, renewal/replacement, capital improvements, and monitoring). The income can also be used to pay the debt service for a stormwater capital improvement program, thereby leveraging the utility's annual revenue into a major program.

Summary of Alternatives

Meeting the goals established by this plan and WDNR's stormwater permitting program will require the Village to significantly increase expenditures for stormwater management. The Village should consider funding annual expenses, such as operation/maintenance, through user fees instead of property taxes.

The General Fund and a stormwater utility are the only two funding sources capable of addressing a stormwater management program on a community-wide basis. The major distinction between the two alternatives is the method of allocating the costs for stormwater management. The General Fund is made up of revenues generated from ad valorem taxes. Ad valorem taxes are based on property value, which do not correlate with the runoff contribution of the property nor to the benefits received from the stormwater management system. Competition from other municipal programs for General Fund revenues often results in less than adequate funding for the stormwater management program.

A stormwater utility would provide an "umbrella" organization which would allow the Village substantial latitude in designing a comprehensive funding program. The funding program could include user fees, special assessments, and connection fees/impact fees. Together, these various funding mechanisms enable the Village to fairly and equitably allocate the cost of providing stormwater management services and facilities to its customers. The stormwater utility offers clear advantages for funding a comprehensive stormwater management program. It is the most fair and equitable means of allocating the costs associated with all facets of stormwater management to all of the users of the facilities based on their contribution to stormwater runoff.

APPENDIX A

ATWATER PARK AND EDGEWOOD DEVELOPMENT
EROSION CONTROL

INTRODUCTION

Two sites outside of the project area were addressed specifically for this project. These sites were Atwater Park on the Lake Michigan shoreline and the Edgewood Development site on the southern border of the Village. The concern at the Atwater Park site is hillslope erosion on the lake bluff. The concern at the Edgewood development is potential construction site erosion.

ATWATER PARK HILLSLOPE EROSION STABILIZATION

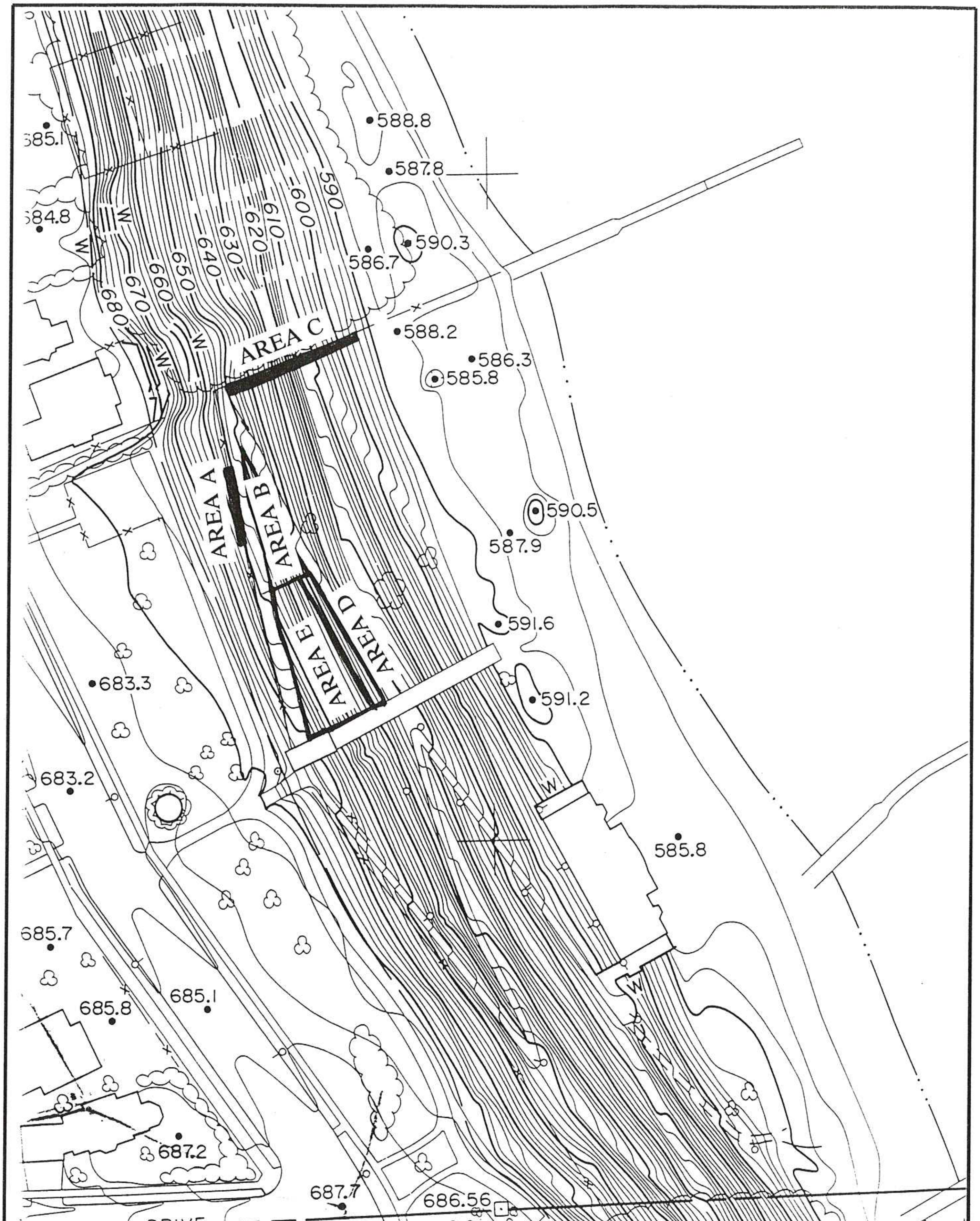
Atwater Park and Beach is located on Lake Drive, north of Capitol Drive. The park has a recreation area on the top of the Bluff and two walkways going down to the beach area. See Figure A-1 for schematic of the area. One walkway is a series of stairs from the top of the bluff to the beach. The other walkway is a sloping path that runs north from the top of the bluff to a landing and then south to a second landing and finally north to the beach. The erosion problem is occurring along the upper part of this bituminous path (Figure A-1). The most severe erosion is occurring near the first or north landing and between the paths.

The first segment of erosion (Area A) is located east of the path before the first landing. It appears that this erosion maybe caused by people entering the park from under the fence. The second area (Area B) is the area along the path by the first landing. The slope in this area is very steep, and although the area is partially vegetated, the amount of exposed soil at the ground level is significant. The third area (Area C) is an eroded gully along the north property line. The fourth area (Area D) is south of Area B and is similar to Area B, except the slope is not as steep. The final area (Area E) is west and upslope of Area D. This area has poor vegetative ground cover but is not eroding as severely as the other areas. These areas are shown on Figure A-1.

Slope Face Stabilization Techniques

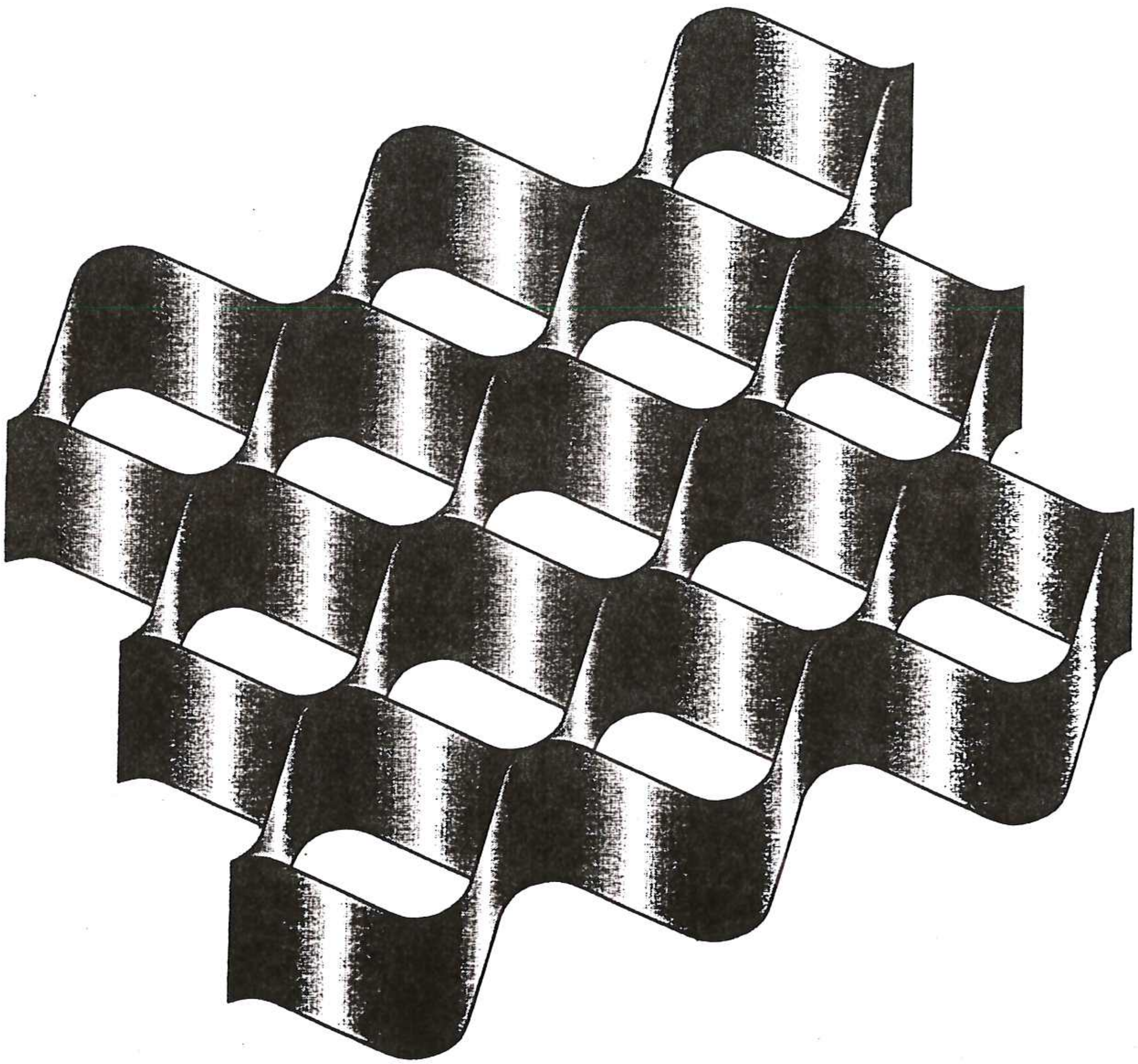
1. **Concrete Block Retaining Wall**. Concrete blocks such as Keystone blocks could be used to construct a retaining wall along the bituminous trail. The wall would be backfilled with soil to achieve a 3:1 slope and vegetated. The height of the wall would be dictated by the existing slope with a maximum suggested height of five feet. Two tiers of retaining walls may be necessary for longer slopes. Granular fill with a drain tile would be placed behind the wall. During an on site inspection, it was noted that the shorter Keystone block in place by the landing is beginning to buckle forward. Therefore, the use of a deeper Keystone block for this application is recommended. A prairie seed mix interspersed with trees for a deeper root system is suggested for vegetation. Straw matting should be spread over the area after seeding.

2. **Cellular Confinement System Slope Protection (cellular web mats).** The cellular confinement system (such as Geo-Web) consists of flexible web mats of polyethylene honeycomb cells which are filled with soil backfill (Figure A-2). The cellular web mats which are anchored to a slope with long pins or wooden stakes are filled with soil and vegetated. The cells confine and reinforce the vegetation and soil structure. This system is good for protecting against surface erosion on steep slopes, but does not provide protection against large scale slope failure. The maximum slope is dependent on the soils, but it has been used on slopes as steep as 1:1. It may be possible to use the cellular web mats on this site



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE A-1
ATWATER PARK
EROSION CONTROL AREAS
VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN



RUST ENVIRONMENT & INFRASTRUCTURE

FIGURE A-2

CELLULAR WEB MAT

VILLAGE OF SHOREWOOD
STORMWATER MANAGEMENT PLAN

without changing the slope. Little additional soil would be required on the site. This would limit any additional loadings on the slope.

All topsoil and easily degraded soil should be removed before laying down the cellular sheets. A loamy soil is recommended for the fill. The cellular web mats with notches between cells for drainage are recommended. A bedding layer of sand or a non-woven geo-textile is recommended between the mats and the native soil. The geo-textile may impede rooting of plants. Suggested vegetation would be a prairie mix with a deep rooting system. A few small scale trees or shrubs may be planted in large spaces in the web by cutting the dividers between a couple of cells. After seeding a straw matting should be placed to hold in soil and seed before sprouting. It may be more aesthetically pleasing to dress the bottom edge of the mat along the trail with a row of concrete block or treated timbers.

3. **Vegetation Management.** For some of the shallower slopes it may be feasible to prevent surface erosion by enhancing the ground cover vegetation. Currently the site is well shaded by black locust trees and burdock. If the black locust trees were thinned out and the existing weedy ground cover was removed and treated with herbicide, a thicker and more desirable ground cover could be established. Leaving the larger trees and pruning the lower branches is suggested since the deep root systems are providing slope stability. A prairie seed mix is also suggested for this site. More desirable tree species may be planted in place of the black locust trees.

Site Preparation and Revegetation

Before the construction of any of the structural alternatives (techniques 1 and 2), the vegetation should be removed. The tree stumps and root systems should be left for soil stabilization where possible. The stumps should be treated with herbicides to prevent suckering. Replant trees, shrubs and ground cover vegetation. Planting of trees and shrubs should take place in the fall or in the spring.

The suggested shrubs, common juniper, red cedar, and gray dogwood provide spreading ground cover, similar root depth to black locust, and provide good wild life habitat. They are also well adapted to the harsh conditions prevalent on lake bluffs. The existing under story does not provide very good ground cover. Plants like burdock have only one stem and have large leaves which shade out other plants. Good ground cover plants ideally spread and have many stems. The suggested plants are native open woods and prairie plants which would tolerate the harsh conditions on the site and provide good wildlife habitat. The list in Table A-1 is representative of the types of plants to use and does not include all possibilities. Several nurseries provide seed mixes blended for different conditions. It is recommended that a nursery be contacted for further advice on plant selection. Potential nurseries include: McKay nursery in Waterloo, WI (414) 478-2121, for shrubs; Prairie Nursery in Westfield, WI (608) 296-3679; Prairie Ridge Nursery in Mt. Horeb, WI (608) 437-5245); and Taylor Creek nursery in Brodhead, WI (608) 897-8641.

Table A-1
Suggested Planting List

Woody Species	Partial Sun Ground Cover	Full Sun Ground Cover
Common Juniper	Switch Grass	Big Bluestem Grass
Red Cedar	Bird's Foot Trefoil	Indian Grass
Gray Dogwood	Northern Bedstraw	Little Bluestem
Black Willow	Pussy Toes	Side Oats Gramma
Honey Locust	Harebell	Lead plant
	Wild Strawberry	Butterfly Milkweed
	Downy Phlox	Pale Purple Cone flower
	Cynthia	Ox eye sunflower
	Common Wood Violet	Prairie Dock

ATWATER PARK RECOMMENDED AND ALTERNATE SOLUTIONS

A solution was recommended for each area. An alternate solution is discussed for each area except for Area A which had one clear solution. Cost estimates for the recommended and alternate solutions are shown in Table A-2.

Area A

This area is experiencing erosion along the chain link fence. The eroding face is relatively short (~ 2 feet high). The cement foundations for the fence posts are exposed. Given the tight confines of the eroded area the recommended solution is to build a short concrete block wall as described above. The area of backfill would be minimal. The fence line would be temporarily removed and then reinstalled, leaving no gaps for people to take a short cut through.

Area B

This area has the steepest slopes and the most erosion. Slopes are approximately 1.5:1. Either the installation of the cellular web mats or a concrete block retaining wall and backfilling to 3:1 slopes may be appropriate. Additional evaluation may be required to determine whether or not the cellular web mats can hold the existing slopes. The total retaining wall total wall height at the south end of the area would be around 11 feet. The wall would probably be in two tiers. The effect of the additional weight of the backfill on slope stability should be considered.

The recommended solution, installing a cellular web mat is less costly and requires the addition of less backfill on the slope, than the alternate solution of constructing a concrete block retaining wall.

Area C Gully Erosion

Area C is an eroded gully along the north property line caused by the runoff coming off of the trail landing and from a 4" PVC drain tile outfall. The drain tile originates at the keystone walls at the first landing. It is recommended that the curb at the landing be rebuilt so that surface runoff does not overtop it. There are two approaches to alleviating the gully erosion. One is to extend the drain tile sub-surface to the sand beach at the base of the hill. The other is to carry the surface flow down a series of terraces constructed out of treated timbers filled with gravel.

The recommended solution, the extension of the drain tile to the bottom of the hill, is less costly and disruptive than the installation of a series of timber terraces.

Area D

The strip of land immediately adjacent to the trail in Area D is steep and prone to erosion. Slopes within 10 feet of the trail are approximately 1.5:1. As in Area B both the use of the cellular web mats and a concrete block wall were considered. The matting could be installed in 8 - 10 foot widths along the trail if the slopes are suitable. A short (1 foot) concrete block wall is used to tie in the bottom edge of the mat. A concrete block wall installed without cellular web matting and backfilled would be approximately three feet high.

The recommended solution, the concrete block wall, is slightly less costly than the cellular web mat. The incremental cost of going from a one foot concrete block wall to three foot wall is more than offset by the cost of the web matting.

Area E

While not as erosion prone as the other sites, this area is still lacking adequate erosion protection. Therefore, it would be beneficial to provide additional protection. Average slopes in this area are approximately 2:1. Installing cellular web mats or taking vegetation management actions to enhance the ground cover were considered.

The recommended solution, vegetation management is less costly and disruptive than the alternate solution of installing the web matting.

Atwater Park Erosion Control Alternatives Cost Estimates

Materials, labor, and planting costs for each of the erosion control alternative were estimated. Design costs were not included.

Table A-2
Atwater Park Erosion Control Cost Estimates

Area	Recommended Solution	Cost Estimate	Alternate Solution	Cost Estimate
Area A	concrete block wall	$4,500	N/A	N/A
Area B	cellular web mat	$9,200	concrete block wall	$14,600
Area C	drain tile extension	$1,800	timber terraces	$4,000
Area D	concrete block wall	$6,300	cellular web mat	$6,400
Area E	vegetation management	$4,000	cellular web mat	$20,000
Total		$25,800		

EDGEWOOD DEVELOPMENT CONSTRUCTION SITE EROSION CONTROL

The Edgewood Development site is the block of land bounded by Edgewood, Prospect, and Maryland Avenues, and Stratford Court. The Village of Shorewood has purchased this land with the intent of constructing residential housing. The site plan has not been determined and construction sequence and timing is not currently known.

Construction site erosion can be a major short term source of sediment in nonpoint source pollution. Due to the lack of undeveloped land in Shorewood, this has not been a major concern. However, the Edgewood site is one of the few parcels of land in Shorewood with new construction planned and, it is important that construction site erosion from this site be minimized.

The Village currently has a construction site erosion control ordinance (Article 3 of Ordinance 1697) which is based upon Wisconsin's model construction site erosion control ordinance. This ordinance applies to redevelopment as well as to new development. If implemented correctly, this ordinance can significantly minimize the amount of construction site sediment coming off of a site. The ordinance requires and erosion control plan in order to receive an erosion control permit.

The erosion control plan is to include a map of erosion control best management practices (BMPs) as required by the ordinance. During the construction period, the site is to be inspected at least once a week and after every rainfall of 0.5 inches or greater. Inspectors are to make requests for needed repairs or to request BMPs as outlined in the erosion control plan. If these requests are not complied with, the Village may post a stop work order or issue a notice of violation. Having the ordinance on the books is by no means a guarantee that it will be complied with. Specific BMPs are described in the "Wisconsin Construction Site Best Management Practice Handbook" (WDNR Publication WR-222 93 REV.). BMPs applicable to this site include:

- tracking pads at site entrances/exits to collect soil from vehicle tires,
- seeding/mulching of disturbed ground which will be exposed for greater than 7 days,
- storm drain inlet protection with filter insert baskets,
- silt fence along down slope edges of graded areas before runoff reaches a street or drainage way,
- clean off-site sediment daily.

EDGEWOOD DEVELOPMENT STORMWATER MANAGEMENT

Alternatives for stormwater management on the site after any potential development were also considered. The costs for these practices, described below, can be borne by the developer.

Direct Rooftop and Parking Lot Runoff onto Pervious Areas. Rather than directly connecting roof drains and parking lot inlets to the combined sewer system, direct the runoff onto grassed areas. This would allow water to infiltrate in the soil or be filtered by the vegetation, improving water quality and reducing runoff volume. Other studies have shown that directing rooftop/parking lot runoff onto pervious areas reduces pollutant loading by approximately 15 percent. Typically, this is unfeasible in currently developed areas of the Village because most yards pitch towards the street and water flowing over the yards could end up icing over the sidewalks in the winter. However, this may be feasible at the Edgewood site if the lot is designed so that overland flow from the landscaped areas does not flow over the sidewalks. Field inlets could be placed to intercept overland flow from grassed areas.

Grass Swale Drainage. The site could be graded so that runoff drains to a grass drainage swale in the center of the block. The grass swale could then drain into a field drain and then into the combined sewer. The grass swale could filter and infiltrate stormwater and slow down peak flows. SLAMM analysis indicates a 42 percent reduction in sediment loading by switching from curb and gutter drainage to grass swale drainage. The site has a number of trees which the development will try to avoid removing. The resulting green space may provide room for the grass swale, which would be configured to blend in with the natural topography of the site.

Parking Lot Bioswales. Runoff from the parking lots could drain to bioswales which are swales with a series of check dams planted with wetland vegetation. Bioswales both enhance infiltration and filter runoff. Water that is not infiltrated flows into a raised overflow into the combined sewer system. A properly designed bioswale can reduce sediment loading from the parking lot by greater than 50 percent. Approximately two feet of length is required from each parking stall for the bioswale.

EDGEWOOD DEVELOPMENT RECOMMENDATIONS

It is recommended that the Village erosion control ordinance be adhered to and enforced during any potential construction. Recommended stormwater practices for the site after construction include directing rooftop and parking lot runoff onto pervious areas, constructing parking lot bioswales, and constructing an interior lot grass drainage swale. The costs for these practices can be born by the developer.

APPENDIX B

REPLACEMENT AND STORAGE ALTERNATIVES

TABLE B-1
REPLACEMENT ALTERNATIVE
10-YEAR RECURRANCE INTERVAL STORM
SHOREWOOD, WISCONSIN

Pipe Id.	Link No.	Length (Ft.)	Size (In.)	Cost ($)
1130-1140	4	229	30	$22,674.00
1140-1200	5	114	30	$11,800.00
1200-1300	6	153	36	$27,237.00
1300-1310	7	199	42	$47,445.00
1310-1400	8	80	42	$10,448.00
1400-1410	9	80	42	$9,945.00
1410-1420	10	35	42	$4,230.00
1420-1430	11	370	42	$40,745.00
2100-2110	12	174	21	$8,343.00
2110-2220	13	58	36	$10,908.00
2200-2220	14	174	30	$14,740.00
2220-2300	15	130	36	$19,093.00
2300-2310	16	35	36	$4,765.00
3400-3410	31	315	30	$39,023.00
3410-3415	32	295	36	$62,605.00
3415-3500	33	51	30	$13,551.00
3610-3620	39	320	30	$33,338.00
3620-3630	40	102	30	$12,933.00
3630-3650	41	106	30	$33,477.00
3500-3510	46	245	54	$89,942.00
3510-3650	47	282	54	$117,074.00
3650-3710	48	627	54	$291,861.00

TABLE B-1 CONTINUED

Pipe Id.	Link No.	Length (Ft.)	Size (In.)	Cost ($)
3260-3300	53	329	30	$33,272.00
3300-3350	54	271	30	$31,011.00
3050-3060	56	300	30	$31,795.00
3060-3100	57	122	30	$12,997.00
3100-3110	58	275	36	$32,835.00
3110-3120	59	40	36	$4,886.00
3120-3160	60	35	36	$3,383.00
3160-3170	61	332	42	$43,938.00
3170-3180	62	385	42	$53,004.00
3180-3190	63	25	42	$3,614.00
3190-3200	64	23	42	$3,349.00
4100-4200	70	323	21	$18,892.00
4200-4300	71	97	30	$9,285.00
4300-4400	72	218	30	$22,104.00
4400-4500	73	133	30	$16,997.00
5000-5010	75	198	24	$16,764.00
5010-5020	76	280	24	$20,753.00

	$1,285,056.00
Manholes and Appurtenances	$128,506.00
Contingency	$321,264.00
Total	$1,734,826.00

TABLE B-2
STORAGE ALTERNATIVE
10-YEAR RECURRANCE INTERVAL STORM
SHOREWOOD, WISCONSIN

Pipe Id.	Length (Ft.)	Volume (cuft)	Box culvert (Ft x Ft)	Cost ($)
1000	178	12,866	12 x 6	$140,118.00
2100	221	15,985	12 x 6	$176,635.00
2200	75	7,253	12 x 8	$64,658.00
3450	287	17,283	12 x 5	$210,002.00
3400	103	9,996	12 x 8	$91,524.00
3600	123	8,919	12 x 6	$98,455.00
3250	87	6,314	12 x 6	$68,183.00
3050	138	10,016	12 x 6	$110,917.00
4000	101	6,114	12 x 5	$73,924.00
5000	256	12,347	12 x 4	$172,234.00
Total		107,093		$1,206,651.00
			Manholes and Appurtenances	$120,655.00
			Contingency	$301,663.00
			Total	$1,628,979.00

SUB-BASIN LAND USE AREAS

TABLE C-1
SUB-BASIN LAND USE AREAS
VILLAGE OF SHOREWOOD

Basin i.d.	HDRDC (acres)	MDRDC (acres)	MFRDC (acres)	STRDC (acres)	INSDC (acres)	LINDC (acres)	OPN (acres)	PRK (acres)	Total (acres)
1100	9		0.8		6				15.8
1200	12.1		0.8	0.5					13.4
1300	0.9		3.7	0.8				1	6.4
1390			0.4					2.9	3.3
1400	2.3							1.7	4
2100	1			8.9					9.9
2200	3.7			3.1	10.2				17
2300			1.8	4.2	2	1.8		0.4	10.2
2400			0.3		4.9			0.8	6
3050	10.2			2.8					13
3100	13.8			0.2					14
3150	7.5			0.4					7.9
3200	7.9		0.1	0.5					8.5
3250	0.1	6.2	4.3					0.6	11.2
3300	1	5.3	3.8					0.7	10.8
3350	10.2		3.2		0.5			1.1	15
3400	12.6	2.7							15.3
3450	9.4	9.8		0.9					20.1
3500	7.6	16.2							23.8
3550	3.6	7.8							11.4
3600	9.8			0.8	4.2				14.8
3650	11.8				3.9				15.7
3700	3.4	15.8							19.2
3750	12.9			0.8					13.7
3800	7.2			1.3	4.2				12.7
3850	7.6	0.2							7.8
3900	18.7								18.7
4100	1.1	4.9							6
4200	6.4		6.1					0.5	13
5000			14.2						14.2
6000	1.8			0.1		5.2			7.1
7000			1.3		2.6	2.3	4.9	76	87.1
8000		0.3							0.3
									467.3
TOTALS	**193.6**	**69.2**	**40.8**	**25.3**	**38.5**	**9.3**	**4.9**	**85.7**	**467.3**