

Section 8

Storm Water Management Options

8.1 Introduction

Development of an effective and efficient Storm Water Management Master Plan for the City of New Berlin requires consideration of practices related to flood control and water quality protection which mitigate the storm water drainage problem areas and improve the water quality. General storm water management alternative approaches include:

- Structural and non-structural measures
- Multi-purpose regional and site specific strategies
- Opportunities to integrate features that provide both water quantity and water quality benefits

The storm water management approaches utilize storm water management measures which may include:

Wet detention basins/ponds - designed to reduce peak runoff flows and provide sedimentation. Wet ponds have a permanent pool, usually with a minimum depth of three to five feet, and an outlet structure. The permanent pool prevents re-suspension of accumulated sediments and provides conditions that enhance biochemical degradation and removal of pollutants. When properly designed, constructed, and maintained, wet detention ponds can retain a large portion of the in flowing pollutants. Wet ponds can be designed to provide either onsite detention or regional detention. Regional detention facilities provide benefits for large areas, thereby reducing the need for numerous onsite controls. A typical wet detention pond/basin is shown on Figure 8-1.

Dry detention basins - designed primarily for flood control. Dry basins impound water only during and immediately after runoff-producing storm events. Because the basins are designed to drain completely following storms, only minor sedimentation occurs, providing minimal water quality benefit. A typical dry detention basin is shown on Figure 8-2.

Extended detention basins - detain a portion of the storm water runoff for up to 24 hours or more after a storm by limiting the capacity of the outlet structure, thereby reducing peak runoff flows. Extended detention allows sedimentation to occur. The basins generally do not have a permanent pool and can be dry between storm events.

Infiltration systems - reduce storm water runoff volumes and rates and provide pollutant load reductions by allowing storm water to infiltrate into the soil. Some pollutants are removed from the percolating water by adhering to soil particles. Microorganisms that are naturally present in the soil biochemically break down and

remove some of the attached pollutants, and also feed on some of the dissolved pollutants. Types of infiltration systems include seepage pits and beds, trenches, porous pavement, and channels and vegetated swales with permeable beds. Pretreatment systems, such as grit chambers or detention ponds, are often used to prevent clogging of the infiltration bed. In some locations, the use of infiltration systems may require the installation of monitoring wells to ensure that contamination of groundwater does not occur.

Filtration systems - provide pollutant load reductions by filtering storm water runoff through media, typically sand or peat. The filter systems typically include a sedimentation area to retain the largest particles and a filter chamber that filters and removes soluble constituents. Filtration systems are typically constructed underground which minimizes land use requirements.

Grassed swales - reduce storm water runoff volume by allowing infiltration into the soil, and reduce storm water pollutant loads by filtering through vegetation. Vegetation traps sediments and utilizes nutrients, while microorganisms in the soil biochemically remove dissolved pollutants. The sediments trapped by vegetation are not as easily re-suspended during subsequent storm water runoff events as sediments accumulated in storm sewers, which are readily flushed out during later storms.

Constructed or retrofit wetlands - stabilize storm water runoff and flood flows and remove sediment and nutrients from surface water runoff. The wetland configuration slows runoff volume and provides storage opportunity. The wetland vegetation traps sediment and utilizes nutrients to reduce pollutant loadings.

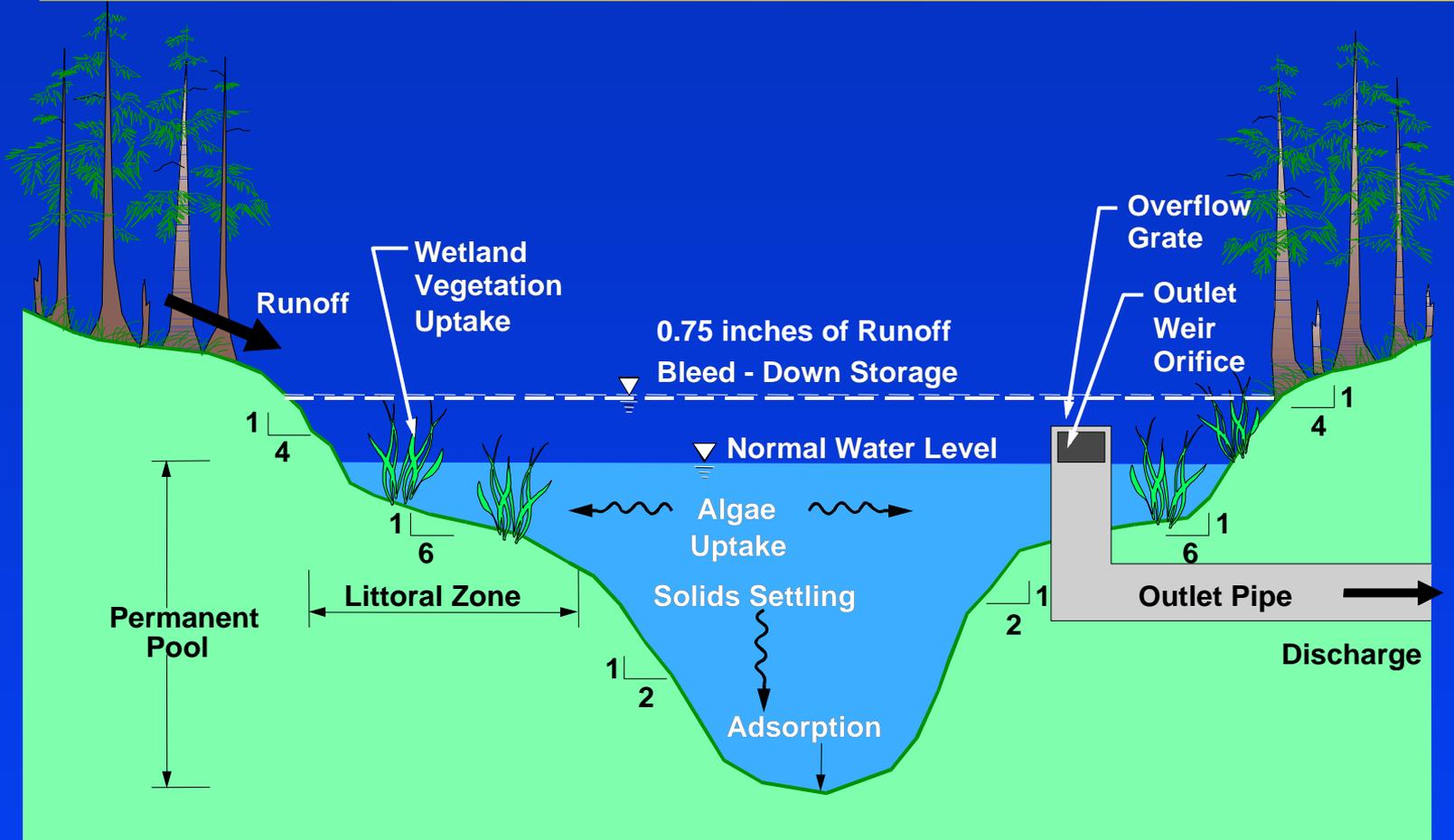
Engineered storm water drainage facilities - efficiently and effectively convey storm water runoff to receiving waters. Engineered facilities include storm sewers, culverts, constructed channels, catch basins, and manholes. Where flooding or drainage problems occur, these facilities can sometimes be upgraded to provide additional capacity to resolve the problems.

Streambank erosion controls - prevent channel degradation, reduce sediment transport and deposition, maintain channel capacity, and enhance water quality. Both structural (i.e., riprap) and vegetative controls may be used. Vegetative bank stabilization measures can enhance aquatic habitats and provide a natural appearance to the channel.

Buffer easements - vegetated zones adjacent to waterways or other environmentally sensitive features that serve to filter out pollutants in overland flow. The easements can also help stabilize streambanks, provide wildlife habitat, and offer stream shading.

Best Management Practices (BMPs) or source controls - include good housekeeping practices, preventive maintenance measure, spill prevention and response procedures, sediment and erosion controls.

Typical Wet Detention Pond



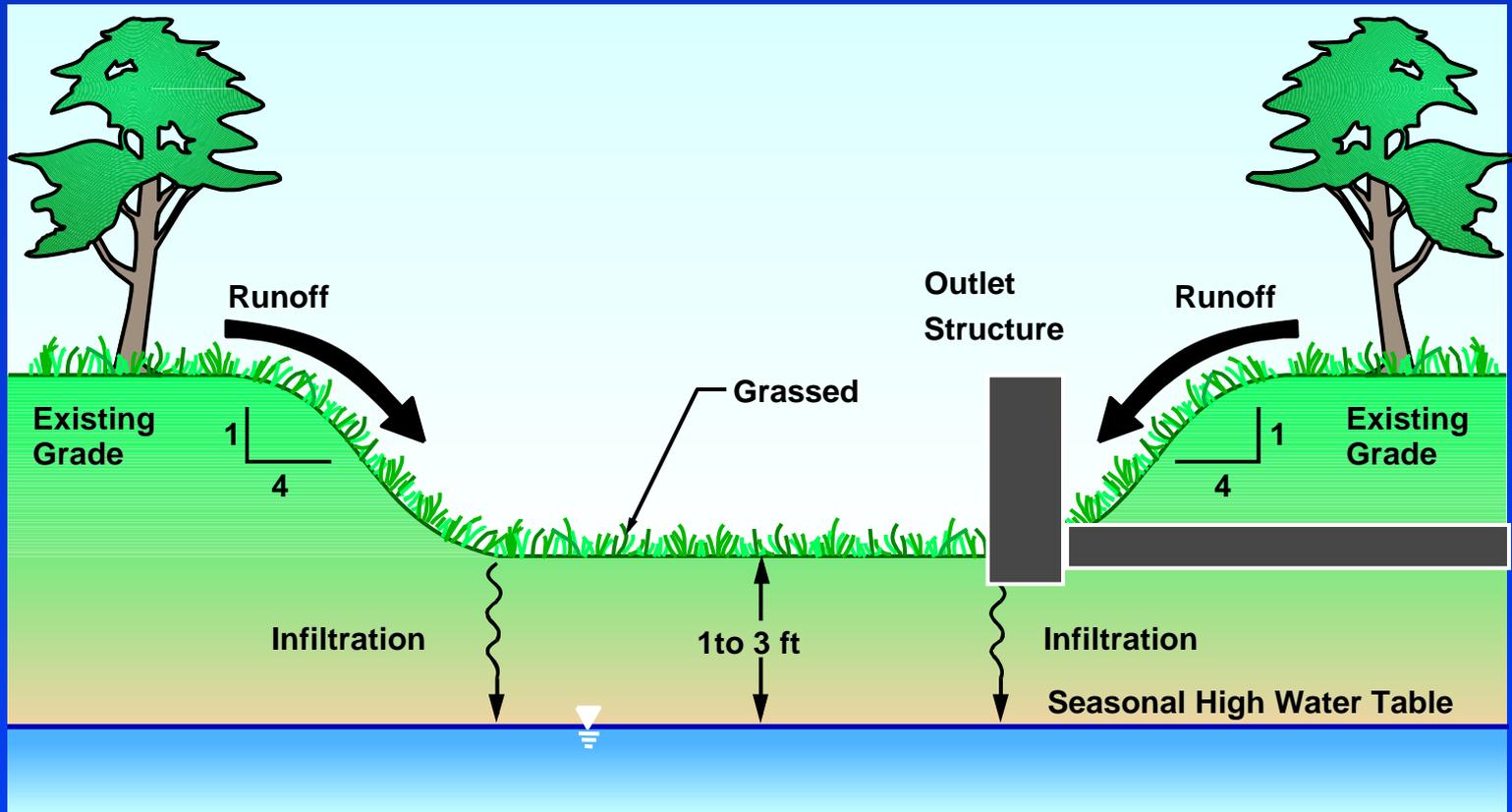
Notes:

1. Runoff is directed to the pond and detained for flood control and treatment by algae and vegetative uptake, solids settling, and adsorption.
2. The first 0.75 inches of runoff is typically detained above a permanent pool (with no more than half discharged in the first 24 hours) for water quality treatment.

Figure 8-1



Typical Dry Detention Basin



Notes:

1. Runoff is directed to the pond and detained for 6 to 24 hours before discharge to downstream.
2. The first 0.5 to 1.0 inches of runoff is typically detained for treatment and attenuation.
3. Infiltration and evapotranspiration provide for recovery of storage (6 to 24 hours for treatment volume).
4. Sideslopes should be no steeper than 4 horizontal to 1 vertical.

Figure 8-2



Inlet filters - typically consist of a frame with a screen filter or other filtration or absorbent media placed into a storm sewer inlet or catch basin. Storm water draining to the inlet passes through the filter, which traps sediment, floatable substances, and other pollutants, such as metals, associated with sediments.

Pavement cleaning - with mechanical or vacuum sweepers, removes sediments and associated pollutants from streets and parking lots. The effectiveness of sweeping can be improved by sweeping more frequently or by using improved sweeping techniques or equipment.

Catch basin cleaning - is an effective measure to remove accumulated deposits from catch basins and manholes. Frequent cleaning of the catch basins facilitates the trapping of additional sediments and prevents the scouring and re-suspension of accumulated sediments during subsequent storm events.

Public information and education programs - can increase the public's knowledge and understanding of storm water management, change people's attitudes and actions, and generate support for the implementation of the plan. Examples of public education programs include informational materials, posters, public announcements, press releases, presentations, workshops, video presentations on cable television, direct mailings, and personal contacts.

Water quality monitoring - may include the sampling and analysis of storm water or receiving waters, dry weather testing for non-storm water discharges, bottom sediment testing, biological assessments, and inspection of potential pollution sources and management measures. These monitoring programs may be designed to clarify existing water quality conditions, identify newly developing problems, monitor the implementation of the plan, and evaluate the effectiveness of the controls.

Urban land development guidelines - assist municipalities, residents, and developers in minimizing the adverse environmental impacts of urban development, while providing for safe and efficient urban services. These guidelines help prevent the creation of new storm water problems or the exacerbation of existing storm water problems. These guidelines may include:

- Establishing site grading requirements and zoning restrictions
- Requiring buffer zones or green spaces along streams
- Building setbacks distances from streams
- Defining allowable peak rates and volumes of discharge
- Protecting wetlands and other sensitive areas
- Providing water quality improvement

- Implement operations and maintenance activities

8.2 Storm Water Drainage and Flood Control Options

Options related to storm water drainage and flood control are typically either detention/storage measures or hydraulic system improvement measures. Detention/storage measures include wet and dry detention ponds and extended detention basins where storm water runoff is collected and detained in a storage area and released slowly during and after the storm event. Detention/storage measures reduce peak runoff flows which reduce the required capacity of the downstream hydraulic system. Hydraulic system improvements focus on system modifications to improve conveyance capacity such as channel widening, channel clearing and culvert improvements.

An effective storm water management plan requires the selection of the most appropriate option to address each identified drainage or flooding problem. Storm water problem areas were identified based on field investigation, review of citizen complaint records, and computer modeling. This study focuses on storm water problem areas within the primary storm water management system. Basement back up due to overloading of the sanitary sewer, and localized flooding, sideyard or backyard flooding in areas not part of the primary drainage system, are not evaluated as part of this plan and are not considered in the major flooding areas identified.

8.2.1 Storm Water Drainage and Flooding Option Criteria

Design criteria for storm water flood control solutions are established based on the storm water management goals and objectives identified in Section 2 of this report. These criteria include:

- New facilities will provide protection against structure flooding and road overtopping in the 100-year recurrence interval storm event.
- Channels, bridges and culverts in the major storm system should be designed to accommodate runoff from the 100-year recurrence interval storm event.
- Storm sewers and roadside ditches in the minor storm system should be designed to accommodate runoff from a 10-year recurrence interval storm event.
- Emergency spillways for detention basins should be established to safely convey flow during a 100-year recurrence interval storm event.

8.2.2 Storm Water Flooding Options

Eight primary system storm water flooding problem areas were identified in Section 7 based on:

- Review of citizen complaint records: citizen complaint logs from the March and August 1998 storm event, as well as other storms, were reviewed and mapped

- Potential for damage: flooding areas which threaten homes or other structures
- History of the severity of the flooding problem: based on the knowledge of the City of New Berlin Staff

The flooding areas and storm water management options considered for each primary storm water flooding area are summarized in Table 8-1 and are discussed in the following paragraphs.

Problem UNDERWOOD1: Underwood Creek at Meadow Lane

Description: Along Meadow Lane between 128th and 124th Street, the South Branch of Underwood Creek is enclosed in a rectangular storm sewer that is 9 feet wide by 4 feet high initially, and ultimately is 14 feet wide at 124th Street. There are numerous reports of house, yard and street flooding associated with this enclosed channel. The causes of these problems include the following:

- < Analysis of the culvert entrance using the computer model indicates the storm sewer is undersized for the 100-year storm flow. This deficiency results in overtopping of the storm sewer entrance and backwater upstream toward Elm Grove Road.
- < Citizens have reported that debris accumulates at the storm sewer entrance during major storm events. Debris can further reduce the culvert entrance capacity and worsen the backwater and overflow problem.
- < The outlet of the storm sewer in Greenfield Golf Course is restricted by growth of trees and shrubs in the channel overbanks and accumulated sediment.
- < Reported yard and street flooding between 124th and 128th Streets is due to restricted surface inlet capacity and lack of a sufficient positive drainage path toward and across 124th Street. This problem is made worse by poor channel maintenance and the presence of fences, sheds, and other obstructions in the channel upstream of the inlet.
- < There is no well defined flow path over 124th Street to carry excess flows when the storm sewer is full.

Options: Assuming that buyouts and floodproofing are not acceptable in this area, there are two basic options to solve this flooding problem: reduce the flow of the storm sewer entrance with upstream detention storage or increase the conveyance capacity of the box. Storage will be considered in conjunction with problem UNDERWOOD2a. Like all storage retrofits, it is an extremely expensive solution but would provide significant, reliable flood relief. The capacity shortfall could be addressed partly by improving the entrance to the storm sewer on the

Table 8-1: Summary of Flooding Problem Options

Problem Number	Problem Description	Alternative Solution	Level of Protection			Estimated Construction Cost
			100 Year	25 Year	10 Year	
UNDERWOOD 1	Along Meadow Lane between 128th and 124th St., the South Branch of Underwood Creek is enclosed in a storm sewer. Overflow of box culvert entrance at 124th St. and Meadow Lane floods basements and backyards. There are numerous reports of house, yard, and street flooding associated with this enclosed channel.	A. Reduce flow with upstream detention storage/increase conveyance capacity of entrance. Upstream storage provided by UNDERWOOD 2a solution.	X			\$50,000 - \$100,000*
		B. Construct added storm sewer capacity.	X			Not Calculated**
UNDERWOOD 2a	Overbank flooding of yards and homes along the South Branch of Underwood Creek beginning about 500 feet upstream of Arcadian Drive. Flooding southwest of the intersection of Elm Grove and Meadow Lane.	A. Floodplain Lowering between Sunny Slope Road and Arcadian Drive.	X			\$1,480,000
		B. Storage Facility north of Greenfield Avenue in the City of Brookfield. (significant land acquisition cost may be required)	X			\$790,000
UNDERWOOD 2b	Yard, street, and basement flooding in the Gatewood Park neighborhood.	A. Additional 60-inch storm sewer to serve Gatewood Park.		X		\$400,000
ROOT 1	One residence experiences flooding along Park Ave near Elm Grove Rd. Yard flooding and erosion in backyards on north side of Park Ave.	A. Installation of new culvert at Graham St. and channel expansion between Graham St. and Elm Grove Rd.		X		\$101,000
ROOT 2	15 Homes are within the floodplain in the area bounded by Cleveland Ave., National Ave., 24th St., and 132nd St. Road flooding on Lagoon Rd. north of Cleveland Ave. Washout of private bridge at 128th St. and Cleveland Ave.	A. Online detention storage at four locations and floodplain lowering.	X			\$2,500,000
		B. Buyout 15 residences within floodplain.	X			\$2,940,000
ROOT 3	House flooding upstream of Grange Ave. near Francis Ave.	A. Replace culverts at St. Mary's Dr. and lower floodplain south of Grange Ave.	X			\$350,000
ROOT 4	Yard flooding and erosion near Honey Lane and Elm Grove Road. Flooding of 1 residence and several yards east of the intersection at Elm Grove and Honey Lane.	A. Re-grade roadside ditches and railroad ditches.			X	\$30,000
DEER 1	6 residences experience structural flooding along 168th Street in the Buena Park neighborhood south of Greenfield Ave. The flooding is caused by inadequate drainage. Sump pumps discharge to the drainage ditch and lawn clippings and yard waste contribute to culvert blockage.	A. Construct new storm sewer/pump station	X			Not Calculated**
		B. Reconstruct ditches with some segments of storm sewer from Fullerton to Roosevelt. Redirect sump pumps to discharge to lawns. Maintain clean culverts and ditches			X	\$180,000
		C. Floodplain storage / pump station in Buena Park	X			Not Calculated**

Notes: * requires implementation of UNDERWOOD 2 solution.

** Options containing multi-million dollar solutions were not calculated.

Cost estimates do not include environmental impacts (i.e. contaminated soil), legal, financing, or land acquisition costs.

north side of Meadow Lane near 128th Street. Proposed improvements would include a sloped trash rack that is less susceptible to debris clogging. Also, a program of improved maintenance would be beneficial. Initially the interior of the storm sewer should be inspected to determine the extent of accumulated sediment within the storm sewer and immediately downstream in West Allis. Then the cost of restoring the full capacity of the storm sewer could be determined. The entrance improvements and removal of obstructions would cost \$50,000 to \$100,000 depending on the amount of debris that has made its way deep into the storm sewer. There would be additional operation and maintenance costs to clean the entrance after storms. It would also be possible to construct additional storm sewer capacity. However, this would be very expensive and difficult to permit because it would increase flows downstream.

Problem UNDERWOOD2a: Underwood Creek near Elm Grove Road

Description: This problem involves overbank flooding of yards and homes along a reach of the South Branch of Underwood Creek beginning about 500 feet upstream of Arcadian Drive. The primary cause of the problem is that the properties are in or very close to the 100-year floodplain in this area. Limited capacity of the Arcadian Drive and Elm Grove Road culverts also contributes to this problem.

Options: The available options to solve this problem include upstream storage, conveyance improvements, or floodproofing. Conveyance improvements in this area will increase the flow downstream at this location. Increased flows would likely increase the flooding potential in the area of Meadow Lane and 128th Street.

Two storage solutions were investigated. The first involves channel widening and floodplain lowering between Sunny Slope Road and 300 feet upstream of Arcadian Drive. This “in-channel” storage solution would provide approximately 50 acre feet of storage and would lower water levels by approximately 1.5 feet at Elm Grove Road. The estimated cost of constructing this channel storage is \$1,480,000.

A more effective storage approach would be to construct an offline storage basin to control flows. The only available location where there is existing open land to construct a basin is north of Greenfield Avenue in the City of Brookfield. A basin covering approximately 5 acres could be constructed to hold 30 acre-feet of storage. When completed, this basin would reduce flows in the South Branch of Underwood Creek by approximately 100 cubic feet per second (cfs). This reduction would solve the flooding problems at Elm Grove Road and Meadow Lane and could be used to address drainage problems in the Gatewood

Park neighborhood. The basin would cost approximately \$650,000 to build plus the cost of acquiring the site which is estimated at \$600,000 for the purpose of comparison in this plan. In addition, \$140,000 in storm sewer improvements would be needed to divert flows into the basin.

Problem UNDERWOOD2b: Gatewood Park

Description: There are problems with yard, street, and basement flooding in this neighborhood located southwest of the intersection of Greenfield and Sunny Slope Roads. The neighborhood is drained by roadside ditches that flow north to a main drainage way along Greenfield Road. The problems are caused by a combination of factors. The neighborhood area is quite flat. Thus, there is widespread flooding when the ditches overflow. The lack of topographical relief also reduces the capacity of the ditches. However, roadside ditches are minor storm water drainage system components and the problem in Gatewood Park is an inadequate primary system. The system outlet at Sunny Slope Road is inadequate and there is insufficient capacity in the conveyance system to provide for runoff from Highland Cemetery west of the area.

Options: There are limited options available to solve the problems in Gatewood Park. There are no storage site available and the alternative to storage is a high capacity storm sewer system. Retrofitting the area with storm sewers would cost \$1.0 to \$2.0 million depending on whether a partial of full system is constructed. The level of service could be improved by increasing the capacity for conveying flow across Sunny Slope Road. The current outlet is a 60-inch storm sewer which serves Gatewood Park, Greenfield Avenue, and a 128-acre area north of Greenfield Avenue in Brookfield. This storm sewer provides approximately 80 cfs capacity while the 100-year flow from Gatewood Park and Greenfield Avenue is 196 cfs and the flow from Brookfield is 101 cfs. An additional 60-inch outlet and storm sewer serving Gatewood Park would cost about \$400,000 to construct. This project would increase flows in the South Branch of Underwood Creek downstream of Sunny Slope Road. Therefore, it should be constructed in conjunction with one of the storage projects recommended for problem UNDERWOOD2a or appropriate easements should be obtained to compensated for the downstream flow increases.

Problem area ROOT1: 130th Block of Park Avenue

Description: One residence experiences flooding along Park Avenue due to inadequately sized downstream culvert at Graham Street. Also, inadequate drainage ditch capacity exists between Elm Grove Road and Honey Lane south to the golf course.

Options: The capacity of the Graham Street culvert will be increased by installing 36 inch culvert to eliminate backwater effects. To mitigate potential increases in flow, 2,000 feet of channel between Graham Street and Elm Grove Road will be expanded. The expansion of the channel provides 5.4 acre-feet of storage to offset the increased flow at Graham Street. The estimated cost of this option is \$101,000.

Problem ROOT2: 132nd Street to Lagoon Road along Cleveland Avenue

Description: Approximately 15 homes are within the floodplain in the area bounded by Cleveland Avenue, National Avenue, 124th Street, and 132nd Street. The inlet and outlet configuration of the culverts are not parallel to the stream at the eastern Lagoon Road culverts and Cleveland Avenue. Road flooding occurs on Lagoon Road north of Cleveland Avenue. A Private bridge at 128th Street and Cleveland Avenue has been washed out.

Options: The first option is construction of online detention storage at four locations. The first will be in a low-lying area at the southwest corner of Cleveland Avenue and 131st Street extended. The other locations are the southeast corner of 128th Street and Cleveland Avenue, south of National Avenue approximately at 130th Street extended, and floodplain lowering along a 100-foot buffer on the east side of the stream southwest of 124th Street and Cleveland Avenue. These sites provide a total of 20 acre feet of storage. The estimated cost of the proposed storage facilities is \$2,500,000.

A second option requires the buyout of the fifteen residences in the floodplain between Lagoon Road and 130th Street along Cleveland Avenue. The estimated cost of these buyouts is \$2,940,000.

Problem ROOT3: LaSalle Drive and Grange Avenue

Description: A structure located adjacent to a tributary of the Upper Root River near Grange Avenue experiences flooding. The problem is caused by inadequate culvert capacity downstream at St. Mary's Drive.

Options: The twin 3-foot by 11-foot concrete box culverts at St. Mary's Drive are more than half filled with accumulated sediment. The resulting reduced capacity is the cause of this problem. Removing the sediment is a short term solution. However, the problem would likely recur due to the geometry of the existing culverts. These culverts are too wide for the channel in which they are located. Thus, sediment tends to accumulate in the under-used part of the overall width. The permanent solution will be to replace these culverts with taller,

narrower pipes and raise the road to accommodate them. The culverts need to be equivalent to three 60-inch diameter culverts. The estimated construction cost of the culverts is \$120,000. This construction cost does not include road improvements necessary to accommodate the culverts. To mitigate potential flow increases caused by the added conveyance capacity, the floodplain will be lowered south of Grange Avenue extending south to near Upper Kelly Lake. The total estimated cost for this option is \$350,000.

Problem ROOT4: Honey Lane

Description: Yard flooding and erosion are experienced by several residences along a tributary to the Upper Root River and also drainage problems along the railroad tracks north of Honey Lane near Elm Grove Road. The problem is caused by inadequate culverts and channel capacity.

Options: Currently, patches of low-lying areas along the tracks accumulate water resulting in the flooding of yards of neighboring properties. The ditches along the southern boundaries of the Union Pacific Railroad require spot re-grading from Woodshire Drive to 124th Street. Ditch re-grading is also proposed north from Ferguson Road and along the west side of Old Oak Lane to the south side of Park Avenue extending to Sunny Slope Road. Additional re-grading should extend north of Old Oak Lane to the north side of Honey Lane and then to Sunny Slope Road. The total length of ditch regrading is 3,000 feet. The estimated cost of this option is \$30,000.

Problem DEER1: Buena Park

Description: Six residences experience structural flooding along 168th Street in the Buena Park Neighborhood south of Greenfield Avenue. Several additional residences experience yard and basement flooding. The problem stems from backup from inadequate culverts, ditch capacity, and lot grading. The general area slope is very flat. In addition, most homes have sump pump discharge into the ditch. Lawn clippings and yard waste contribute to culvert blockage.

Options: The Buena Park neighborhood originally developed with insufficient lot grading to accommodate an open channel ditch conveyance system. Many homes have low water entry elevations at or below the top of the roadside ditch. The ditch slope is very flat and cannot be increased. When ditch capacity is met, the runoff potentially floods the homes. Raising homes one to two feet is not a practical solution. Floodproofing homes is also difficult to implement or fund.

The storm water discharge location for the neighborhood is into the floodplain of Deer Creek at Buena Park. Rainfall events greater than minor storms can be restricted from release into the park and create a backwater effect upstream. Increasing culvert capacity is not a remedial solution in a backwater effected area. Installing a new storm sewer system with associated pump station is not cost effective with pump station. Construction of large floodplain detention in Buena Park is also not cost effective.

The most practical solution is to maximize the existing system. Reconstruction of the ditches, including some storm sewer sections, from Fullerton to Roosevelt will help to discharge the water in the drainage ditch. Additionally, all sump pumps should be discharged to the lawn. Home owners should create as much positive drainage away from the house as possible. Ditches should be clear of yard waste and debris. Crushed driveway culverts should be replaced. Buyout of homes in the Deer Creek floodplain may be considered in the future.

8.2.3 Culvert Capacity Improvements

Analysis of the primary and secondary culverts indicates that 32 primary system culverts and 83 secondary culverts have deficient capacity.

Culverts identified as deficient in the primary and secondary storm water management systems are listed in Table 7-2 and 7-3, respectively. Some of the culvert deficiencies would be resolved through implementation of the recommended storm water improvements.

8.2.4 Drainage Ditch Improvements

Thirty-two drainage ditch problem areas were identified in Section 7 and listed on Table 7-5. The improvements require maintenance operations for restabilization, clearing of sediment, or collection of debris. Future problems will be identified and resolved through the implementation of the operations and maintenance program.

8.2.5 Further Study of Minor System Problems

Thirteen minor system problems were identified in Section 7. It may not be cost effective to solve minor system problems based on the current level of damages. However, further study of specific areas may be warranted based on staff recommendations at a later date (such as the Parkwood Lane storm sewer capacity).

8.3 Storm Water Quality Options

Options related to water quality improvement generally consist of treatment measures or source control measures. Treatment control measures are designed to treat storm water runoff prior to discharge to a receiving stream. Non-structural

measures generally involve a change in procedure and are designed to reduce the amount of pollutants in the storm water runoff from an area.

8.3.1 Source Control Options for Storm Water Quality Improvement

Source controls considered effective for specific areas in New Berlin are presented on Table 8-2. Options recommended for consideration in the final recommended plan are described below:

Industrial Best Management Practices

Subchapter 2 of the Wisconsin Administrative Code NR216 regulates industrial storm water dischargers. Industries which are regulated by NR216 are required to identify sources of potential storm water pollution at their facilities and implement best management practices to reduce or eliminate pollutants from the identified sources. The permit issued to industries generally requires the facility to implement the following general types of best management practices:

- Good housekeeping: practices intended to maintain areas in a clean and orderly manner
- Preventive maintenance: practice to maintain equipment and systems
- Spill prevention and response: practices which reduce the potential for a spill to occur and minimize the effect of a spill
- Sediment and erosion control - practice to reduce sedimentation and erosion

Pollutant reductions from the implementation of the industrial storm water regulations are estimated to range from 15 to 20 percent. Individual industries are responsible for the costs related to industrial storm water permit compliance.

Based on the industrial analysis specific best management practices are recommended for various industry groups. The suggested industrial best management practices recommended for specific industrial groups are presented in Appendix F.

Pavement sweeping

New Berlin currently sweeps all of the streets on an annual basis. The effectiveness of a sweeping program pollutant reduction is directly related to the frequency of sweeping between storm events. The frequency of early spring street sweeping is critical because studies have indicated that pollutant

Table 8-2: Comparison of Source Control Alternatives

Alternative	Pollutant Removal Effectiveness				Cost		Comments	Recommended for Further Consideration
	Winter Loading	Sediment	Nutrients	Metals	Capital	Maintenance		
Industrial Best Management Practices	o	o	-	o	o	o	Required for most industries for compliance with NR216	Yes
Pavement Sweeping	+	o	-	+	o	o	Frequency and timing determine effectiveness. Effectiveness is reduced on roadways without curbing.	Yes
Snow/Ice Management	+	o	o	o	o	-	Snow storage locations and deicing techniques	Yes
Landscaping Practices	-	o	+	+	+	+	Fertilizer and pesticide management	Yes
Catch Basin Cleaning	o	o	o	o	+	+	Frequency and timing determine effectiveness	Yes
Erosion Control Ordinance	-	+	-	-	o	o	New Berlin has an erosion control ordinance - increase enforcement	Yes
Storm Water Management Ordinance	o	+	o	o	-	-	Draft ordinance includes provisions for water quality improvements for developing lands.	Yes
Public Education and Information	o	o	o	o	+	o	Can use existing materials developed by WDNR and the UW-Extension Will help in reduction from residential areas	Yes
Agricultural Practices	o	+	+	-	+	o	Includes vegetated Filter strips and barnyard runoff controls	Yes

Notes: + indicates HIGH Pollutant Removal Effectiveness/ LOW Cost
o indicates MODERATE Pollutant Removal Effectiveness/MODERATE Cost
- indicates LOW Pollutant Removal Effectiveness/ HIGH Cost

loadings from spring snowmelt can account for one- to two-thirds of the annual pollutant loadings from urban areas. Pavement sweeping options incorporate:

- #Curbed highways and arterials
- #Rural cross section roadways (no curbs)
- #Commercial/Industrial parking lots

A comparison of the effectiveness and cost of street sweeping schedules is presented in Table 8-3. The effectiveness of street sweeping on non-curbed streets will be reduced.

Table 8-3: Comparison of Street Sweeping Schedules

Frequency of Sweeping	Estimated Pollutant Reduction (%)
Monthly	10 %
Seasonal (weekly - April & May, bi-weekly - June through September; monthly October, November & March)	25 %
Bi-Weekly	30%

Catch basin cleaning

Catch basins are designed to collect and temporarily store sediment and debris. Regular cleaning, to remove the collected materials, improves the pollutant removal effectiveness of the catch basins. New Berlin has catch basins within areas of the storm sewer system. Storm sewered areas are limited within the city.

A catch basin cleaning schedule of twice per year, once in spring and fall of each year was evaluated. The estimated pollutant reduction for semi-annual catch basin cleaning is 17 percent for sediment and 25 percent for metals. Alternatively catch basins could be inspected quarterly and cleaned when about 40 percent full.

Installation of catch basins in developing areas or areas undergoing redevelopment will improve water quality from the drainage area and should be considered. Existing catch basins should be replaced/retrofitted as needed and during construction activities.

Landscape Practices

Park and institutional land uses contribute about 19 percent of the study area total phosphorous loading. The major source of the phosphorous is landscaping

practices. Landscaping practices which will reduce the pollutant loading in this area include:

- converting high maintenance lawn areas into low impact areas planted with ground cover, trees, shrubs, or perennials;
- test soils and adjust fertilizer applications accordingly;
- only water landscaped areas in early morning hours;
- increase average turf height to three inches to improve turf health and reduce weed growth; and
- consideration of low toxicity weed control.

Implementation of these landscaping practices may result in approximately a 10 percent reduction in phosphorous loadings.

Snow and Ice Management

Parking lots and roadways are plowed to remove snow fall as needed during the winter months.

In order to provide a reduction in pollutant loadings from the snow melt, a vegetated filter area should be provided between snow storage areas and receiving streams or storm sewer inlets. Additional snow and ice management practices include:

- tailoring the application rate of de-icers to the use of the area;
- training handlers of road salt to improve the efficiency of deicer application and reduce losses;
- equip trucks with ground-speed sensors;
- promptly clean-up spills after loading operations;
- monitor the deicer market for the development of new products and price reduction of existing products; and
- sweeping accumulated salt and grit from paved areas as soon as practical after the surface clears of snow and ice.

Implementation of snow and ice management practices can result in pollutant reductions up to 15 percent of the total annual loading.

Erosion Control Ordinance

The City of New Berlin currently has an erosion control ordinance which provides adequate authority to control sediment from land disturbing activities. In order to

improve compliance with the ordinance a vigorous site inspection program should be implemented by the City. The inspections should be conducted by qualified staff to check for proper implementation of erosion control measures during construction. Inspections should be conducted during or after storm events to observe the effectiveness of the measures implemented. Post construction inspections should also be conducted to check for signs of site erosion, as well as to evaluate the downstream impacts of the project.

Storm Water Management Ordinance

The City of New Berlin draft storm water ordinance which includes provisions for implementation of storm water quality improvements for developing land. New Berlin should adopt and enforce this ordinance to meet the water quality goals described in Section 3 of this Plan.

Agricultural Practices

Agricultural Best Management Practices including conservation tillage, streambank erosion control, vegetated drainage ways, and barnyard runoff controls should be encouraged in all agricultural areas of New Berlin. Additionally, a shoreland management ordinance which requires maintenance of buffer strips along all perennial and intermittent streams within the City of New Berlin should be established. The pollutant removal effectiveness of buffer strips ranges from 40 to 70 percent. The ordinance should require that the agricultural buffer strips be maintained even if the land is otherwise developed. A model draft ordinance from Ozaukee County Land Conservation Department is in Appendix G.

Public Information and Education

A public education and information program established to target the general public, city staff, and industries will assist New Berlin in its efforts to implement a storm water management program. An information and education program will increase the public's knowledge and understanding of storm water management, change people's attitudes and actions, and generate support for the implementation of this plan. An education program for the general public should include:

- storm water management goals,
- lawn care and landscaping,
- pet waste handling, and
- other best management practices.

An education and training program for City staff could be developed. Highway maintenance crews, Park and Recreation employees, and construction inspection personnel would all receive training and education about erosion, plant life, soil,

and storm water. An industrial education program should focus on compliance with the NR216 industrial storm water regulations and improved selection and implementation of best management practices. A public education program may include informational materials, posters, public announcements and press releases, presentations, workshops, video presentations on cable television, direct mailings, and personal contacts. Information for education programs is available from the University of Wisconsin Extension office, Waukesha County Land Conservation Department, and New Berlin School District. The New Berlin School District is currently helping administer a \$16,000 matching grant from the Wisconsin Environmental Education Board to educate the public. Additional storm water-related curriculum could be developed. Waukesha County Land Conservation Department also has relevant publications and there is public education and equipment available (with training) for water testing at no cost through Retzer Nature Center.

8.3.2 Treatment Options for Water Quality Improvement

Storm water treatment options considered for New Berlin are compared in Table 8-4. Treatment options recommended for consideration in the final recommended plan are described below.

Wet detention basin/pond

Water quality detention ponds include a forebay and adequate sizing to provide the required conditions for pollutant reduction. Pollutant removal effectiveness by wet detention ponds is estimated to be 90 percent for sediment, 50 percent for phosphorous, and 70 percent for lead. One location where a wet detention basin may be practical is summarized in Table 8-5. The water quality detention basin will reduce pollutants from the drainage area incorporating about 840 acres and will reduce the overall pollutant loading from the City of New Berlin.

Table 8-4: Comparison of Stormwater Treatment Alternatives

Alternative	Pollutant Removal Effectiveness				Cost		Comments	Recommended for Further Consideration
	Winter Loading	Sediment	Nutrients	Metals	Capital	Maintenance		
Wet Detention Pond	o	+	+	+	-	o	Can be combined with flood control alternatives	Yes
Extended Detention Basin	o	+	+	+	-	o	Can be combined with flood control alternatives	Yes
Constructed/ Retrofit Wetlands	-	o	+	o	-	o	Utilize prior converted wetland areas, may be an effective way to create additional habitat and remove pollutants from stormwater, can have flood control benefits	Yes
Standard Catch Basins	o	o	-	o	o	o	Potential for redeveloping areas, replace existing basins as needed	Yes
In-Line Treatment Systems	o	+	o	+	-	o	Vortechinics™, Stormceptor™ , Other	Yes
Inlet Filters	o	o	-	o	o	-	Limited flows can be treated, requires routine maintenance, may be effective for industrial yards or parking lots	Yes
Filter Systems	+	+	o	+	-	o	Limited flows can be treated, may be effective for industrial yards or parking lot areas	Yes
Infiltration Systems	o	+	+	+	-	o	Requires sandy soils, potential groundwater contamination	Yes
Porous Pavement	o	o	-	o	-	o	Practical for very small areas only Winter maintenance activities may damage pavement, potential use in parking areas not used during winter months	No
Streambank Stabilization	-	+	-	-	o	o	Vegetative protection, rip rap, channel clearing and cleaning, deposit removal	Yes
Grassed Swales	o	+	+	+	-	+	Maintain existing swales	Yes

Notes: + indicates HIGH Pollutant Removal Effectiveness/ LOW Cost,
o indicates MODERATE Pollutant Removal Effectiveness/MODERATE Cost
- indicates LOW Pollutant Removal Effectiveness/ HIGH Cost

Table 8-5: Summary of Water Quality Detention Pond Options

Area/ detention pond/basin designation	Location	Existing Annual Pollutant Loadings from Drainage Area (Percent of Total Loading)	Reduction in Total Study Area Pollutant Load
Basin 2E071 <i>(basin recommended by others as part of the Lake Management Plan for Upper and Lower Kelly Lakes)</i>	West of Upper Kelly Lake	Sediment - 102 tons (2%) Phosphorous - 337 lbs. (3%) Lead - 250 lbs. (4%)	Sediment - 2% Phosphorous - 1.5% Lead - 3%

Typical maintenance for a wet detention basin includes routine mowing, debris and litter removal, and erosion control inspection. Non-routine maintenance includes sediment removal and structural repairs.

Constructed/Retrofit Wetlands

The wetland inventory described in Section 4 of this report identified numerous wetland areas throughout the New Berlin area. Wetlands classified as prior-converted have a very high potential for restoration of wetland features which could result in valuable water quality and flow improvements. Restoration of prior converted wetlands is often very simple. Wetland storm water management areas are identified in Table 8-6.

Table 8-6: Summary of Retrofit Wetland Options

Wetland Designation/ Location	Wetland Area Available (acres)	Wetland Volume Required for Retrofit (acre-ft)	Targeted Drainage Area (acres)	Existing Annual Pollutant Loading from Targeted Drainage Area	Pollutant Removal in Total Annual Load
33-1 / Basin 46060 North of Interstate Highway 43, west of Calhoun	25.4	2.5	64 acres of highway land use	Sediment - 31 tons (0.6%) Phosphorous - 139 lbs. (1%) Lead - 353 lbs. (6 %)	Sediment - 28 tons (0.5%) Phosphorous- 95 lbs. (0.7%) Lead - 265 lbs. (4%)
27-3 / Basin 4C020 North of Interstate Highway 43, west of Moorland Rd.	11.6	0.5	12.5 acres of highway land use	Sediment - 18 tons (0.3%) Phosphorous - 84 lbs. (0.6%) Lead - 212 lbs. (3%)	Sediment - 17 tons (0.3%) Phosphorous- 58 lbs.(2%) Lead - 159 lbs. (2.5%)
26-1 / Basin 4C030 South of Interstate Highway 43, east of Moorland Rd.	12.2	2	57 acres of highway land use	Sediment- 36 tons (0.7%) Phosphorous - 162 lbs. (1%) Lead - 409 lbs. (6 %)	Sediment - 33 tons (0.6%) Phosphorous- 114 (0.9%) Lead - 307 lbs.(4.8%)
14-2 / Basin 3A060 South of National Ave., east of Moorland Rd.	52.9	1	21 acres of commercial land use	Sediment -12 tons (0.2%) Phosphorous -24 lbs. (0.1%) Lead - 60 lbs. (0.9%)	Sediment- 11 tons (0.2%) Phosphorous- 17 lbs (0.1%) Lead - 45 lbs. (0.7 %)
34-2 / Basin 5A020 North of College Ave., west of Sunny Slope Rd., & east of Small Rd.	30.4	11	312 acres of agricultural and residential land use	Sediment- 47 tons (0.8%) Phosphorous -171 lbs. (1%) Lead - 34 lbs. (0.5 %)	Sediment- 42 tons (0.8%) Phosphorous-120 lbs (0.9%) Lead - 26 lbs. (0.4%)

Prior converted wetland areas should be evaluated for flood control and water quality improvement as new development is considered. The prior converted wetland areas which may be effective for storm water management are discussed in Section 4. The pollutant removal effectiveness for wetland management practices ranges from 80 to 99 percent of sediment loadings, from 50 to 99 percent of phosphorous loadings, and from 60 to 95 percent of lead loadings.

Standard Catch Basins

Standard catch basins collect sediment and pollutants in a sump prior to discharge of the storm water runoff to the storm sewer. Pollutants collected in the catch basins must be cleaned out to prevent flows from washing collected pollutants into the storm sewer. Catch basins are currently located in storm sewered areas.

In order to continue the current level of pollutant reduction existing catch basins should be replaced, as necessary, with new catch basins rather than direct storm sewer inlets. Additionally, standard catch basins should be provided where new development plans include an urban type cross section with storm sewer. Additional catch basin installation will improve water quality from the drainage area. The estimated pollutant reduction per catch basin is 20 percent of the sediment loading from the drainage area.

In-Line Treatment System

An in-line treatment type system such as Vortechs™, StormFilter™, or Stormceptor™ will treat storm water entering the basin and discharge the water to the existing storm sewer system. The in-line systems are underground chambers where storm water collects and is treated. Typical maintenance includes regular clean-out of the collected sediment with vacuum trucks. Construction and maintenance costs vary depending on the size of the system. Possible locations for an in-line collection system include the industrial park. However, based on the drainage numerous systems would be required to effectively reduce the pollutants discharging from this area. Therefore, the in-line drainage system is not recommended for consideration at this time. However, an in-line treatment system should be considered in areas of future development.

The pollutant removal effectiveness of the in-line treatment systems ranges from 70 to 90 percent of sediment, and 40 to 50 percent of the phosphorous load. The pollutant removal rate will vary with the type and sizing of system selected for installation. Estimated costs vary with the size of the unit, generally ranging from, \$45,000 to \$80,000 per unit.

Vegetated Drainage Ditches

Vegetated drainage swales are located throughout the City of New Berlin. The drainage ditches reduce storm water velocity and provide opportunity for pollutants to filter through vegetation. The regular maintenance program for the

drainage ditches, described in Section 9.6, will provide continued effectiveness for the removal of pollutants from drainage areas.

8.3.3 Discussion of Storm Water Quality Options

The above sections describe options which will assist New Berlin in improvement of water quality. The water quality objective, as identified in Section 3 of this report, is to provide water quality suitable to support the designated potential recreational and biological uses of the streams within New Berlin.

The water quality option effectiveness and cost are summarized in Table 8-7.

The options recommended for incorporation into the storm water management plan for the City of New Berlin are presented in Section 9.

8.4 Streambank Stabilization Options

Streambank stabilization measures include vegetative protection, rip rap protection, channel clearing and cleaning, and deposit removal. The streambank inventory identified about 13.6 miles of streambank which were classified as fair or poor. Of these reaches, 13.6 miles were identified for stabilization measures. The streambank reaches and actions needed are described in Table 8-8.

The options recommended for incorporation into the storm water management plan for the City of New Berlin are presented in Section 9.

8.5 Regional Storage Options

Regional detention options mitigate the cumulative impacts of the existing and future development in an area. Regional detention is often proposed because it can be more effective at controlling flood peaks than construction of individual storage ponds at numerous sites. Regional detention facilities may also be more cost-effective than individual basins due to the economy of scale associated with building one large pond and an associated inlet and outlet structures.

Regional detention has impediments to implementation that do not exist with detention at individual sites. Common problems associated with implementation of regional detention include:

Acquisition of a feasible site - There are many constraints on the site selected for regional detention: it must be located along the stream in the developing watershed, it should be downstream of the majority of the development and it must be large enough to satisfy the storage requirement.

Development of the site - The site topography must support detention pond operation by having sufficient channel frontage for a gravity inlet and outlet. The site must be reasonably low and flat so that excavation cost is not excessive. Workable sites

Table 8-7: Summary of Recommended Water Quality Control Options

Area of Concern	Option	Option Effectiveness (<i>pollutant reduction within Drainage Area</i>)	Estimated Pollutant Reduction (<i>% reduction in total Annual study area load</i>)			Estimated Capitol Costs*	Estimated Operation and Maintenance Costs per year
			Sediment (tons)	Phosphorous (lbs.)	Lead (lbs.)		
Entire Study Area	Public Information & Education Program	variable	--	--	--	variable	variable
Entire Study Area	Urban Planning and zoning in accordance with the City of New Berlin Zoning Map (change from existing to future land use)	variable	135 (12%)	750 (6%)	-2140 (-34%)	no cost anticipated for city	no cost anticipated for city
Entire Study Area	Adopt and Enforce the Draft Storm Water Management Ordinance	40 - 80%	480 (9%)	640 (5%)	890 (14%)	Costs incurred by developers	Costs incurred by developers
Industrial Best Management Practices	Industrial best management practices as required by Wisconsin Administrative Code NR216 and implementation of suggested industry specific practices	20%	35 (0.6%)	20 (0.2%)	200 (3%)	Costs incurred by industry	Costs incurred by industry
Roadways	Arterials and Industrial Park Roadways (approx 100 miles): Seasonal sweeping (weekly in April & May, bi-weekly from June through August, monthly from September thru November)	15%	30 (0.6%)	55 (0.45%)	170 (3%)	---	\$125,000
Winter pollutant loadings from paved areas	Ice management practices including improved salt distribution methods and training of salt truck drivers	14% in pavement loadings	variable	variable	variable	minimal	minimal
Catch Basin Cleaning and/or Retrofit	Catch basin cleaning twice per year and/or installation of catch basins in development or redevelopment areas	17 - 25%	0.04 tons/acre drained	--	0.05 lbs./acre drained	\$5,000 / new catch basin installed	\$70/catch basin /year for cleaning
Institutional and Park lawn /High Maintenance Turf Areas	Landscaping practices including increased turf height, reduced weed control, replacement of turf with low maintenance ground cover or perennials, reduced fertilizer application.	10%	20 (0.4%)	250 (2%)	10 (2%)	minimal	minimal
Snow Storage Areas	Locate snow storage areas in a well vegetated area at least 200 feet from a drainage way of storm sewer inlet	up to 15% of street loadings	variable	variable	variable	minimal	minimal

Table 8-7: Summary of Recommended Water Quality Control Options

Area of Concern	Option	Option Effectiveness (<i>pollutant reduction within Drainage Area</i>)	Estimated Pollutant Reduction (<i>% reduction in total Annual study area load</i>)			Estimated Capitol Costs*	Estimated Operation and Maintenance Costs per year
			Sediment (tons)	Phosphorous (lbs.)	Lead (lbs.)		
New Construction Areas / Redevelopment Areas	Increase inspections for construction sites for compliance with the ordinance, provide erosion control techniques training for inspectors.	Variable	variable	variable	variable	minimal	minimal
Extractive Land Use Areas	Implement suggest best management practices	15%	170 (3%)	10 (0.1%)	1 (<0.1%)	cost incurred by industry	cost incurred by industry
Agricultural Land Use Areas	Encourage use of Agricultural best management practices such as conservation tillage and barnyard controls	5%	80 (1.5%)	310 (2%)	--	cost incurred by farmers	cost incurred by farmers
	Implement shoreland management ordinance	40 - 70%	280 (5%)	610 (5%)	5 (0.1%)		
Highway Land Use Areas	Retrofit three prior converted wetlands into storm water treatment wetlands for highway runoff. Locations are: north of I-43, west of Calhoun; north of I-43 west of Moorland ; and south of I-43 east of Moorland	70 - 90%	85 (2%)	385 (3%)	970 (15%)	\$75,000	to be determined
Basin 2E071 Kelly Lake	Construct water quality detention basin west of Kelly Lake	50 - 90%	85 (2%)	190 (1.5%)	15 (3%)	to be determined	to be determined
Basin 5A020	Retrofit one prior converted wetland into a storm water treatment wetland for agricultural and residential land use area south of National Ave., east of Moorland Rd.	70 - 90%	47 (0.8%)	170 (1%)	30 (0.5%)	\$165,000	to be determined
Basin 3A060	Retrofit one prior converted wetland into a storm water treatment wetland for commercial land use area north of College Ave., east of Small Rd.	70 - 90%	12 (0.2%)	20 (0.1%)	60 (0.9%)	\$15,000	to be determined

* These costs are for planning purposes only and do not include land acquisition, construction site erosion control, unknown environmental constraints, legal fees, or utility relocation costs which may be associated with the plan.

Table 8-8: Recommended Actions for Stream Reaches with the Most Significant Streambank Stability Concerns

Subwatershed and Stream Reach Designation	Reach Length (miles)	Location	Overall Stream Rating	Streambank Stability Concern	Recommended Actions
Upper Root River - A Designation	0.1	Tributary to Root River from point 0.2 mile east of New Berlin Hills Golf Course property line northeast 0.1 mile	Poor	Poor landform slope cutting; fair mass wasting, debris jam potential, and vegetative bank protection	Protect , vegetate, and stabilize banks, remove potential jam materials
Upper Root River - C Designation	0.1	Tributary to Root River from pond north 0.1 mile to point extending south of Dakota St. and east of 134th St.	Poor	Poor landform slope and vegetative bank protection; fair mass wasting, debris jam potential, obstructions, cutting, and deposition	Protect , vegetate, and stabilize banks, remove potential jam materials, clean out sedimentation.
Upper Root River-A Designation	0.1	Tributary to Root River from point 0.1 mile west of New Berlin Hills Golf Course property line east to New Berlin Hills Golf Course property line	Fair	Fair landform slope, debris jam potential, vegetative bank protection, obstructions, cutting, and deposition	Protect , vegetate, and stabilize banks, remove potential jam materials and flow obstructions, clean out sedimentation.
Tess Corners Creek - A Designation	0.1	Tributary to Root River from College Ave. north 0.1 mile	Fair	Poor debris jam potential, vegetative bank protection, and obstructions; fair cutting	Remove potential jam materials and flow obstructions, vegetate or protect banks, repair cut areas.
Upper Root River - B Designation	0.1	Tributary to Root River from point 0.4 mile east of Sunny Slope Rd. southeast 0.1 mile	Fair	Poor landform slope; fair cutting and deposition	Repair cut areas, protect banks.
Upper Root River - A Designation	0.1	Tributary to Root River from point 0.3 mile east of New Berlin Hills Golf Course property line north 0.1 mile	Fair	Poor landform slope; fair mass wasting, debris jam potential, and vegetative bank protection	Stabilize slopes, remove potential jam materials, vegetate or protect banks.
Poplar Creek	0.8	From Cleveland Ave. south to corner of Calhoun Rd. and Victor Rd.	Fair	Poor obstructions; poor/fair debris jam potential and vegetative bank protection; fair channel capacity, cutting, and deposition	Remove flow obstructions and potential jam materials, vegetate and protect banks, repair cut areas.
Upper Root River - A Designation	0.1	Tributary to Root River from point 0.1 mile east of New Berlin Hills Golf Course property line east 0.1 mile	Fair	Poor mass wasting; fair landform slope and debris jam potential	Stabilize slopes, remove potential jam materials.
Tess Corners Creek - A Designation	0.1	Tributary to Root River between Grange Ave. and College Ave.	Fair	Fair vegetative bank protection, cutting, and deposition	Vegetate and protect banks, repair cut areas.

Table 8-8: Recommended Actions for Stream Reaches with the Most Significant Streambank Stability Concerns

Subwatershed and Stream Reach Designation	Reach Length (miles)	Location	Overall Stream Rating	Streambank Stability Concern	Recommended Actions
Calhoun Creek - B Designation	0.2	Tributary to Calhoun Creek from point 0.2 mile south of Beloit Rd. southwest 0.2 mile to pond in Calhoun Park	Fair	Fair debris jam potential, obstructions, cutting, and deposition	Remove potential jam materials and flow obstructions, repair cut areas.
Underwood Creek - A Designation	1.0	Tributary to Underwood Creek from corner of Meadow Ln. and Sunny Slope Rd. east to storm sewer under Meadow Ln.	Fair	Poor/fair cutting; fair landform slope, debris jam potential, vegetative bank protection, and deposition	Repair cut areas, protect banks.
Upper Root River - D Designation	0.1	Tributary to Root River from point extending southwest of Manitoba Ave. north 0.1 mile	Fair	Fair landform slope, mass wasting, vegetative bank protection, and cutting	Stabilize upper slopes, vegetate and repair banks, repair cut areas.
Upper Root River - G Designation	0.1	Tributary to Root River from point extending northeast of White Ct. southeast 0.1 mile to corner of Howard Ave. and 128th St.	Fair	Fair debris jam potential, vegetative bank protection, and cutting	Remove potential jam materials, vegetate and protect banks, repair cut areas.
Upper Root River - C Designation	0.2	Tributary to Root River from point extending south of Dakota St. and east of 134th St. northeast to 133rd St.	Fair	Poor vegetative bank protection; poor/fair landform slope and cutting; fair mass wasting	Vegetate and protect banks, repair cut areas, stabilize upper slopes.
Poplar Creek - F Designation	0.6	Tributary to Poplar Creek from Cleveland Ave. northwest to junction with Poplar Creek	Fair	Poor/fair debris jam potential; fair landform slope, vegetative bank protection, obstructions, and cutting	Remove potential jam materials and flow obstructions, vegetate and protect banks, repair cut areas.
Deer Creek	0.2	From point south of 162nd St. east 0.6 mile to point between Glendale Dr. and Cleveland Ave.	Fair	Fair landform slope, mass wasting, cutting, and deposition	Stabilize upper slopes, repair cut areas.
URR-A Designation	0.3	Tributary to Root River from point 0.2 mile west of 124th St. in New Berlin Hills Golf Course east 0.3 mile	Fair	Fair landform slope, debris jam potential, obstructions, and deposition	Remove potential jam material and flow obstructions.

Table 8-8: Recommended Actions for Stream Reaches with the Most Significant Streambank Stability Concerns

Subwatershed and Stream Reach Designation	Reach Length (miles)	Location	Overall Stream Rating	Streambank Stability Concern	Recommended Actions
Deer Creek Designation	0.1	From Cleveland Ave. south 0.1 mile	Fair	Poor landform slope; fair debris jam potential and obstructions	Remove potential jam materials and flow obstructions.
URR-A Designation	0.2	Tributary to Root River from Meadowlark Dr. east to point 0.1 mile west of New Berlin Hills Golf Course	Fair	Fair debris jam potential, vegetative bank protection, cutting, and deposition	Remove potential jam materials, vegetate and protect banks, repair cut areas.
URR-D Designation	0.5	Tributary to Root River from point extending west of Ohio Dr. east to Highpointe Dr.	Fair	Fair obstructions, cutting, and deposition	Remove flow obstructions, repair cut areas.
Poplar Creek Designation	1.3	From junction with tributary UF-E southeast 1.3 miles	Fair	Fair debris jam potential, vegetative bank protection, cutting, and deposition	Remove potential jam materials, vegetate and protect banks, repair cut areas.
CC-B Designation	0.5	Tributary to Calhoun Creek from I-43 south to Westridge Dr.	Fair	Fair debris jam potential and vegetative bank protection	Remove potential jam materials, vegetate and protect banks.
Deer Creek Designation	0.6	From National Ave. northwest 0.6 mile	Fair	Poor obstructions; fair landform slope, debris jam potential, cutting, and deposition	Remove flow obstructions and potential jam materials, repair cut areas.
Deer Creek Designation	0.2	From junction with tributary DC-C north 0.2 mile	Fair	Poor obstructions; fair landform slope and cutting	Remove flow obstructions, repair cut areas.
CC-B Designation	0.7	Tributary to Calhoun Creek from I-43 northwest 0.7 mile	Fair	Fair debris jam potential, vegetative bank protection, obstructions, and deposition	Remove potential jam materials and flow obstructions, vegetate and protect banks.

Table 8-8: Recommended Actions for Stream Reaches with the Most Significant Streambank Stability Concerns

Subwatershed and Stream Reach Designation	Reach Length (miles)	Location	Overall Stream Rating	Streambank Stability Concern	Recommended Actions
CC-C Designation	0.3	Tributary to Calhoun Creek from I-43 north to point extending east of Dale Dr.	Fair	Fair landform slope and debris jam potential	Remove potential jam materials.
UF-A Designation	1.4	Tributary to Poplar Creek from Cleveland Ave. north 1.4 miles	Fair	Poor vegetative bank protection; fair landform slope, debris jam potential, obstructions, cutting, and deposition	Vegetate and protect bank, remove potential jam materials and flow obstructions, repair cut areas.
Poplar Creek Designation	0.1	From Calhoun Rd. west 0.1 mile	Fair	Fair landform slope and cutting	Repair cut areas.
CC-B Designation	0.1	Tributary to Calhoun Creek from Beloit Rd. northeast 0.1 mile	Fair	Fair debris jam potential and vegetative bank protection	Remove potential jam materials, vegetate and protect banks.
CC-H Designation	0.4	Tributary to Calhoun Creek from Linnie Lac southwest 0.4 mile to point extending north of College Ave.	Fair	Fair vegetative bank protection and obstructions	Vegetate and protect banks, remove flow obstructions.
URR-B Designation	0.3	Tributary to Root River from point extending north of Tammy Ln. east 0.3 mile to point 0.1 mile east of Sunny Slope Rd.	Fair	Fair vegetative bank protection and deposition	Vegetate and protect banks.
Poplar Creek Designation	0.7	From junction with tributary UF-L northeast 0.7 mile	Fair	Poor debris jam potential; fair obstructions and cutting	Remove potential jam materials and flow obstructions, repair cut areas.
URR-D Designation	0.1	Tributary to Root River from beginning near Long Acre Dr. east 0.1 mile	Fair	Fair deposition	

Table 8-8: Recommended Actions for Stream Reaches with the Most Significant Streambank Stability Concerns

Subwatershed and Stream Reach Designation	Reach Length (miles)	Location	Overall Stream Rating	Streambank Stability Concern	Recommended Actions
URR-E Designation	0.2	Tributary to Root River from 132nd St. east 0.2 mile	Fair	Fair landform slope, vegetative bank protection, and cutting	Vegetate and protect banks, repair cut areas.
CC-A Designation	1.0	Tributary to Calhoun Creek from junction with CC-B and CC-C north 1.0 mile	Fair	Fair landform slope, debris jam potential, and vegetative bank protection	Remove potential jam materials, vegetate and protect banks.
CC-C Designation	0.2	Tributary to Calhoun Creek from Bener Rd. southwest 0.2 mile	Fair	Fair landorm slope	
CC-G Designation	0.1	Tributary to Calhoun Creek from junction with CC-H northwest to I-43	Fair	Fair vegetative bank protection	Vegetate and protect banks.
UF-F Designation	0.2	Tributary to Poplar Creek from Willow Rd. northwest to New Berlin West High School	Fair	Fair debris jam potential and vegetative bank protection	Remove potential jam materials, vegetate and protect banks.
UF-H Designation	0.2	Tributary to Poplar Creek from junction with UF-L east 0.2 mile	Fair	Fair vegetative bank protection	Vegetate and protect banks.
URR-F Designation	0.2	Tributary to Root River from Cleveland Rd. north 0.2 mile to beginning of concrete lining on northern wall of creek	Fair	Fair vegetative bank protection	Vegetate and protect banks.
URR-F Designation	0.1	Tributary to Root River from Cleveland Rd. southwest to 128th St.	Fair	Fair vegetative bank protection	Vegetate and protect banks.

Table 8-8: Recommended Actions for Stream Reaches with the Most Significant Streambank Stability Concerns

Subwatershed and Stream Reach Designation	Reach Length (miles)	Location	Overall Stream Rating	Streambank Stability Concern	Recommended Actions
Deer Creek Designation	0.1	From point 0.1 mile north of Glendale Rd. north 0.1 mile	Fair	Fair landform slope, cutting, and deposition	Repair cut areas.
URR-D Designation	0.1	Tributary to Root River from point extending between National Ave. and Cleveland Ave. north 0.1 mile to point extending west of Montana Ave.	Fair	Fair landform slope, vegetative bank protection, obstructions, and cutting	Vegetate and protect banks, remove flow obstructions, repair cut areas.

14.2

usually contain wetlands and floodplains; thus, there will be regulatory requirements and constraints.

Facility construction - Usually, the facility will be constructed using funds collected from developers. However, it will be necessary for the City to acquire the site and begin initial construction using general funds. Also, it will be necessary to oversize upstream conveyance facilities to assure that flows from new developments can reach the regional storage facility.

Design criteria for regional storage areas are established based on the storm water management goals and objectives identified in Section 2 of this report. The regional detention ponds are designed to restrict the 100-year 24-hour peak discharge to the 100-year pre-development flow rate. Sufficient storage capacity will be provided to contain flow in excess of the pre-development 10-year flow.

Four sites located in the Poplar Creek and Tess Corners Creek subwatersheds were evaluated as potential regional detention facility locations. Site RD-1 is located in the Tess Corners Creek subwatershed and sites RD-2, RD-3 and RD-4 are located in the Poplar Creek subwatershed. These detention sites would help prevent future flooding problems due to development and may mitigate flooding problems that already exist.

- Site RD-1 is located just north of College Avenue on the northeast side of Tess Corners Creek. This site will hold 240 acre-feet of water which will reduce the existing landuse 100-year peak flow by 100 cfs and reduce the future conditions peak flow by as much as 300 cfs. The detention facility would have a design depth of about 7 feet and cover an area of 38 to 40 acres.
- Site RD-2 is located just east of Calhoun Road, on the east side of Poplar Creek and south of Coffee Road. This site would be designed to hold 51 acre-feet of water which will reduce the future conditions 100-year peak flow by as much as 80 cfs. The detention facility would have a design depth of about 4.4 feet and cover an area of 20 acres.
- Site RD-3 is located on the west side of Poplar Creek, just south of Coffee Road. This site would be designed to hold 200 acre-feet of water which will reduce the future conditions 100-year peak flow by as much as 260 cfs. The detention facility would have a design depth of about 7.7 feet and cover an area of 45 acres.
- Site RD-4 is located on the east side of Calhoun Road, just north of Coffee Road. This site would be designed to hold 236 acre-feet of water which will reduce the future conditions 100-year peak flow by as much as 240 cfs. The detention facility would have a design depth of about 5.9 feet and cover an area of 67 acres.

The conceptual design of each detention facility is based on the following:

<Each detention site will be filled and drained by gravity to reduce operation and maintenance costs.

<The inlet will be controlled by a broad crested weir and the outlet will be controlled by an appropriately sized reinforced concrete pipe.

<The sides of the storage sites will have a maximum 3:1 (horizontal:vertical) slope and could utilize terracing to provide areas for trees and shrubs.

<When dry, the sites may be used for parks, athletic fields or other recreational purposes.

<A portion of the bottom area could be excavated to include a small, permanent pond to enhance the aesthetics and increase recreational options.

Additional specific information concerning each site, including conceptual design data, is presented in Tables 8-9 and 8-10. The reduction in flow after implementation of the regional detention sites is presented in Table 8-11.

Table 8-9: Regional Storage Site Drainage Area Characteristics

Site Identification	Site Location	Drainage Area (acres)	Percent Impervious (%)	
			Existing Land Use	Future Land Use
RD-1	Northeast side of Tess Corners Creek, north of College Avenue	1570	8	23
RD-2	East of Calhoun Road, south of Coffee Road	260	6	13
RD-3	West side of Poplar Creek, south of Coffee Road	2152.1	7.6	12.5
RD-4	East of Calhoun Road, north of Coffee Road	372.9	21	35

Table 8-10: Regional Storage Site Conceptual Design Parameters

Site ID	Surface Area of Site (acres)	Max. Depth (feet)	Volume (acre-feet)	Invert Elevation (feet)		Inflow Weir Crest (feet)	Outlet Diameter (inches)	Maximum Outflow (cfs)	Cost
				Inlet	Outlet				
RD-1	38	7	260	NA	820	NA	2@24	70	\$2,651,000
RD-2	20	4.4	51	NA	867.5	NA	18	11.4	\$1,712,130
RD-3	45	7.7	200	867	863	30	6	1	\$8,430,030
RD-4	67	5.93	236	861.5	859	60	18	15	\$41,810

Table 8-11a: Reduction in Flow Resulting from Regional Detention

Location		24-hour Storm Peak Flow (cfs)				100-year Peak Storm Flow for Future Land Use with Regional Detention (cfs)		
		Present		Future				
Node	Street Name	10-year	100-year	10-year	100-year	RD-2	RD-3	RD-4
PA23632	D/S Coffee Road	149	416	173	443	401	197	447
PA21034	U/S Calhoun Road	241	486	282	503	480	429	417
P03490	D/S Arcadian Lane	335	855	436	935	932	928	891

Table 8-11b: Reduction in Stage Resulting from Regional Detention

Location		24-hour Storm Peak Stage (feet)				100-year Peak Storm Stage for Future Land Use with Regional Detention (feet)		
		Present		Future				
Node	Street Name	10-year	100-year	10-year	100-year	RD-2	RD-3	RD-4
PA23632	D/S Coffee Road	865.61	867.03	865.77	867.22	866.98	865.98	867.22
PA21034	U/S Calhoun Road	861.24	864.1	861.79	864.33	864.02	863.52	863.3
P03490	D/S Arcadian Lane	828.22	829.08	828.44	829.18	829.18	829.18	829.13

Additional regional detention sites were recommended in the *Stormwater Management Plan for the Deer Creek Watershed* prepared by Bonestroo Rosene Anderlik & Associated in 1993 and in the *Westridge Stormwater Management Plan* prepared by Ruckert/Mielke in 1995. The sites recommended in these plans were not re-evaluated or analyzed as part of the preparation of this plan. Information related to the sites recommended is presented in Section 9.