



Public Facilities Needs Assessment
For Implementation of a Stormwater Management
Plan for the Urbanizing Watershed of the
Upper Badger Mill Creek Watershed

Stormwater Background

The **hydrology*** of the Upper Badger Mill Creek (UBMC) watershed as it exists today is somewhat unique. Specifically, the watershed is made up of two (2) primary tributaries or branches. One branch is largely urbanized. It accounts for about 60% of the area in the watershed and has a very short **time of concentration**. The other branch is primarily rural and has a significantly longer **time of concentration**. These circumstances lead to a **hydrograph** with two **peak flows**. The first **peak** is from the highly urbanized branch of the watershed, the second lower **peak** is from the rural section. As this rural portion of this watershed develops, however, it is probable that without careful stormwater management planning the **time of concentration** will decrease and the two peaks in the hydrograph will merge into one.

A reduction in the **time of concentration** is a typical result of development. As grass and cropland are replaced with rooftops and pavement the amount of time it takes for water to get from the top of the watershed (top of the hill) to the discharge point (bottom of the hill) is reduced. At the same time as this reduction in the **time of concentration**, the volume of runoff increases significantly as **impervious surfaces** replace cropland and grassland. Without a stormwater management plan in the rural branch of the UBMC watershed the two (2) peaks would merge and, at a minimum, be added together to produce a significantly higher peak flow.

The peak flow from the developed branch is 1000 cubic feet per second (CFS) and the peak from the undeveloped branch is 500 CFS (before development). In the *current* situation, the total peak as measured at the City of Madison corporate limits (downstream of where these two (2) branches join) would be 1000 CFS because the second peak of 500 CFS would come several hours *after* the initial peak of 1000 CFS from the developed branch (refer to **Figure 1** on Page 4).

Next consider the case *after* development with little stormwater planning. First, the **time of concentration** for the newly-developed branch would tend to match that of the existing developed branch. Therefore, the peak flow of both branches occurs at the same time, effectively *adding* the peaks together for a new and higher peak flow. Additionally, a reasonable estimation for the anticipated peak flows from the proposed type of development will be twice or three times that of the peak flows from the undeveloped area (currently 500 CFS). Assuming a 100% increase in peak flow from the newly developed branch, the peak flow from this branch will be 1000 CFS. Since this new peak flow will be higher and will tend to occur at the same time as the peak flow from the prior-developed branch, the new downstream peak is 1000 CFS + 1000 CFS, or 2000 CFS. This represents a 100% increase over the conditions that exist currently.

* See "Definitions" on Page 4

The Upper Badger Mill Creek Stormwater Management Plan was developed to avoid the type of situation described above. Implementation of the plan as proposed will keep the peak discharge seen by the downstream properties at the same level as it currently is.

The existing peak flow will be maintained through a series of **retention basins** and **detention basins**. These basins do not, however, address the concerns of increasing volumes of water due to increasing **impervious areas**. Controlling the volumes of water can only be accomplished with best management practices that enhance infiltration, which will soon be required by NR-151. As all development in this watershed will likely take place after implementation of NR-151, the effects of all development complying with that regulation was analyzed. The effects of NR-151 were found to have a minimal effect at the level of the 100-year design storm.

Definitions

Detention Basin: A basin that collects stormwater runoff, temporarily detaining it, and slowly discharging it to a conveyance structure at a controlled rate.

Flow Rate: Volume of water passing a point per unit of time

Hydrograph: Plot of runoff rate versus time

Hydrology: The field of science dealing with rainfall-runoff relationships

Impervious Surface: Constructed surfaces such as roads, sidewalks, rooftops, and parking lots that prevent stormwater from infiltrating on site

Peak: Maximum flow rate of runoff from a given event (shown as “bumps” on hydrograph)

Retention Basin: A basin capable of retaining a permanent supply of water while collecting stormwater runoff

Time of Concentration: Defined by the USDA-NRCS as the time required for surface runoff water to travel from the watershed’s most remote point to the point-of-interest (i.e., outlet)



Figure 1 Hydrographs of Upper Badger Mill Creek Watershed under existing conditions and unmanaged and managed future conditions. (*Earth Tech, Inc, 2002*)

Introduction

The City of Madison has prepared this public facilities needs assessment for stormwater management practices required to control the quantity and quality of water in the upper Badger Mill Creek watershed.

The 6,790-acre Upper Badger Mill Creek Watershed is located on the southwest side of the City of Madison and portions of the Towns of Middleton and Verona and the Cities of Fitchburg and Verona. The area continues to experience rapid development, necessitating stormwater management planning. Currently, 60% of the area is developed. The City of Madison, the largest municipality in the watershed, recognizes that unmanaged stormwater runoff from development will negatively impact the water resources in the watershed and in downstream areas by increasing runoff volumes and peak flows while decreasing runoff quality. The City contracted with Earth Tech, Inc. in July 1998 to develop a stormwater management plan for this watershed. That report was completed in February 2001.

The watershed is comprised of four major drainage basins that are in varying degrees of development. The westernmost basin is predominantly rural, though light-, medium-, and high-density residential development is planned. A stormwater management strategy for the upper Badger Mill Creek watershed is maintaining the current hydrograph from the west branch. Any increase in flow or decrease in the time to peak would significantly increase the peak flow at the watershed's outlet near Nesbitt Road and US Highway 18/151.¹

The primary goal of the Upper Badger Mill Creek Watershed Stormwater Management Plan is to maintain or reduce existing peak flows at the discharge point, of the Upper Badger Mill Creek, from the corporate limits of the City of Madison. This goal was chosen to limit impacts to downstream riparian owners and municipalities during flood events. A secondary goal of the plan is to limit peak flows, in the upper watershed, to the capacity of existing drainage facilities within the City of Madison. The existing 100-year peak discharge (as estimated in early 2000), at the discharge point from the City of Madison, is estimated at 1,495 cubic feet per second (CFS). With full development of the watershed upstream of the discharge point, and with the management plan proposed in place, the future 100-year peak discharge is estimated to be approximately 1485 CFS.

The City of Madison must also comply with the stormwater management requirements of the Dane County Regional Planning Commission and the Wisconsin Department of Natural Resources. One function of a stormwater management plan is to avoid the negative

¹ From a report by Earth Tech, Inc. *Upper Badger Mill Creek (Southwest Madison) Stormwater Management Analysis*. February, 2001.

consequences of an increase in stormwater runoff associated with the increasing imperviousness of an urbanizing landscape. In regions outside of the Central Urban Service Area (CUSA), such as the Upper Badger Mill Creek Watershed, stormwater management plans need to be prepared before the CUSA boundary can be approved for amendment, which would allow for further development.

To control the excess runoff associated with development, the City of Madison proposes to design and construct “regional” improvements including three retention ponds, three new roadway culvert crossings, and three segments of greenways. Developers will be required to construct “local” improvements consisting of detention basins, wet ponds, and greenways with their developments in the watershed, in compliance with County and City stormwater management ordinances. However, developers will benefit overall from this plan since it reduces the uncertainty associated with meeting the regional stormwater goals. Designing stormwater plans and waiting for their approval costs them time and money.

In order to finance the watershed management plan, the City, pursuant to Wis. Stats. § 66.0617(2), has passed an Impact Fee Ordinance (Chapter 20 of Madison Code of Ordinances) that can require fees to be paid by developers to compensate for the capital costs necessary to accommodate land development. In the upper Badger Mill Creek watershed, these costs would be associated with the installation of regional retention basins, greenways, and roadway culvert crossings, including costs for surveying, design, and inspection.

Location Description of Impact Fee District

Any and all parcels (platted and/or metes and bounds), or portions thereof, that reside within, or is altered to discharge within the Upper Badger Mill Creek Watershed. These lands are located within the City of Madison , Town of Middleton, and Town of Verona as follows:

Parts of Section 25; Southwest ¼ Section 26; Southeast ¼ Section 26; Southwest ¼ Section 27; Southeast ¼ Section 27; Northeast ¼ Section 33; Southeast ¼ Section 33; Sections 34 and 35; Northeast ¼ Section 36; and Southwest ¼ Section 36, all within Town 7 North, Range 8 East, located in the Town of Middleton and the City of Madison.

Parts of Sections 2 and 3; Northeast ¼ Section 4; Southwest ¼ Section 4; and Southeast ¼ Section 4, all within Town 6 North, Range 8 East, located in the Town of Verona and the City of Madison.

Impact Fee

To calculate the impact fees associated with the stormwater management project, the City of Madison first estimated the total cost to complete the project to be \$4,079,780 (2003 dollars). This estimate was divided by the area of parcels within the watershed. The

prorated cost for developed parcels will be assumed by the City Stormwater Utility. Refer to the attached tables (Exhibit A) for a detailed cost analysis for each segment of the project. The Stormwater Utility's total portion will be \$2,442,681. The impact fee will cover the remainder of the cost, \$1,637,100, or \$2239 per net developable acre. The net developable area is the area of parcels of land, exclusive of street rights of ways and drainage areas. The rate will be the same for all land uses and zoning districts.

Adjustments to Impact Fee

The impact fee shall be adjusted annually for inflation, based on the Construction Cost Index as published in the *Engineering News Record*. The base month/year for calculating such adjustment shall be the month/year of final Common Council adoption of this Impact Fee Ordinance.

Existing public facilities

Currently there are 16 detention basins serving the entire upper Badger Mill Creek watershed. Most have been constructed since 1982, when the City first enacted a stormwater management ordinance. The new facilities will be concentrated in the western portion of the watershed where most future development will happen. Without these additional stormwater management practices, the existing basins would not be able to withstand the increased peak flows that would occur with new development. For a more detailed description of existing conditions, refer to the report put out by Earth Tech, Inc. titled "Upper Badger Mill Creek...Stormwater Management Analysis" on file at City of Madison Engineering. The attached map (Exhibit B) shows the locations of existing detention basins in the watershed.

New public facilities required for land development

The new detention basins will be the primary tool for controlling the quantity of stormwater runoff. They will have engineered outlet structures and properly proportioned storage areas to prevent exceeding capacities downstream up to and including the 100-year storm event. The majority of the basins will be planned and constructed by private development.

The City of Madison has already constructed the Badger Mill Regional Basin near Nesbitt Road and Hwy 18/151 that controls watershed-wide stormwater flow. Three more City-designed basins are planned.

- The existing Muirfield Detention Pond, located just upstream of CTH PD, will be retrofitted to improve its detention characteristics to better manage flow for a developed area.
- The Confluence Detention Pond, is downstream from Raymond Road and upstream from CTH PD. Its purpose is flow management for the major drainageway in the western part of the watershed.

- The proposed Marty Farm Detention Pond, located near Marty Road between Midtown Road and Raymond Road. It will help to manage the high peaks from an existing developed area upstream.

The City of Madison is also planning to construct three greenway segments within the area. The primary function of a greenway is to convey all storm events safely and effectively. Greenways are important features of the landscape as they provide an open space aesthetic for humans, protect the remaining natural resources in an urbanized area, and preserve connectivity between other, larger open spaces. There will be a greenway running from Raymond Road to CTH M, and another from CTH M to Midtown Road. The third greenway will stretch from Marty Pond to Elver Park. Greenways are generally 100 feet wide, with a minimum width of 75 feet.

As part of the greenway construction, three new roadway culvert crossings will be constructed and designed for at least a 25-year storm event. These include two locations at Raymond Road and one at County Highway M.

The estimated costs associated with designing and constructing the remaining basins, three greenways, and three new culverts is included in Exhibit A. The locations of the projects are shown on the attached map, Exhibit B.

Effect of impact fees on housing costs

Impact fees were estimated to be **\$2239 per net acre** in accordance with Exhibit A. The effect on housing costs was also calculated, based on minimum and average housing densities for a variety of residential zones, including the two examples that follow. The minimum lot size for R-1, single-family residence district, low-density housing is 8000 square feet whereas the average lot size is 0.25 acre (10,890 square feet). The additional cost incurred by the impact fees would be approximately \$411.20 and \$559.75, respectively. In R-4, general residence district, medium-density housing, the minimum lot size per unit is 2,000 square feet, adding about \$102.80/ unit to the cost of housing.

**COST ESTIMATES FOR NEW PUBLIC FACILITIES REQUIRED FOR
DEVELOPMENT IN THE UPPER BADGER MILL CREEK WATERSHED
(IN 2003 DOLLARS)**

MUIRFIELD POND				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Outlet Structure	1	Each	\$10,000.00	\$10,000.00
Excavation Cut/ Fill	35,000	Cu Yd	\$3.50	\$122,500.00
Erosion Matting	2,100	Sq Yd	\$2.50	\$5,250.00
Permanent Seeding	9,200	Sq Yd	\$1.25	\$11,500.00
Temporary Seeding	2,100	Sq Yd	\$1.00	\$2,100.00
Land Acquisition (Dedication)				\$0.00
			SUBTOTAL	\$151,350.00
			ENGINEERING	\$12,108.00
			TOTAL	\$163,458.00

CONFLUENCE POND				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Outlet Structure	1	Each	\$15,000.00	\$15,000.00
Box Culverts	510	Linear Ft	\$300.00	\$153,000.00
Excavation Cut/ Fill	395,851	Cu Yd	\$3.50	\$1,385,478.50
Erosion Matting	25,000	Sq Yd	\$2.50	\$62,500.00
Permanent Seeding	87,370	Sq Yd	\$1.25	\$109,212.50
Temporary Seeding	34,610	Sq Yd	\$1.00	\$34,610.00
			SUBTOTAL	\$1,759,801.00
			ENGINEERING	\$110,249.14
			TOTAL	\$1,870,050.14

MARTY ROAD POND AT RAYMOND ROAD				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Outlet Structure	1	Each	\$15,000.00	\$15,000.00
Box Culverts	120	Linear Ft	\$300.00	\$36,000.00
Excavation Cut/ Fill	160,000	Cu Yd	\$3.50	\$560,000.00
Erosion Matting	2,500	Sq Yd	\$2.50	\$6,250.00
Permanent Seeding	8,000	Sq Yd	\$1.25	\$10,000.00
Temporary Seeding	2,500	Sq Yd	\$1.00	\$2,500.00
Land Acquisition	16	Acre	\$40,000.00	\$640,000.00
			SUBTOTAL	\$1,269,750.00
			ENGINEERING	\$101,580.00
			TOTAL	\$1,371,330.00

GREENWAY (RAYMOND ROAD TO CTH M)				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Excavation Cut	29,000	Cu Yd	\$3.50	\$101,500.00
Erosion Matting	7,800	Sq Yd	\$2.50	\$19,500.00
Permanent Seeding	19,977	Sq Yd	\$1.25	\$24,971.25
Temporary Seeding	7,800	Sq Yd	\$1.00	\$7,800.00
Land Acquisition (By Dedication)				\$0.00
			SUBTOTAL	\$153,771.25
			ENGINEERING	\$12,301.70
			TOTAL	\$166,072.95

GREENWAY (CTH M TO MIDTOWN ROAD)				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Excavation Cut	12,037	Cu Yd	\$3.50	\$42,129.50
Erosion Matting	8,088	Sq Yd	\$2.50	\$20,220.00
Permanent Seeding	6,356	Sq Yd	\$1.25	\$7,945.00
Temporary Seeding	8,088	Sq Yd	\$1.00	\$8,088.00
Land Acquisition (By Dedication)				\$0.00
			SUBTOTAL	\$78,382.50
			ENGINEERING	\$6,270.60
			TOTAL	\$84,653.10

GREENWAY (MARTY POND TO ELVER PARK)				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Excavation Cut	10,000	Cu Yd	\$3.50	\$35,000.00
Erosion Matting	3,400	Sq Yd	\$2.50	\$8,500.00
Permanent Seeding	8,820	Sq Yd	\$1.25	\$11,025.00
Temporary Seeding	3,400	Sq Yd	\$1.00	\$3,400.00
Land Acquisition (By Dedication)				\$0.00
			SUBTOTAL	\$57,925.00
			ENGINEERING	\$4,634.00
			TOTAL	\$62,559.00

NEW CULVERT AT RAYMOND ROAD WEST				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Traffic Control	1	Each	\$5,000.00	\$5,000.00
Box Culvert	125	Sq Yd	\$300.00	\$37,500.00
Trench Patch Type 3	40	Sq Yd	\$100.00	\$4,000.00
Select Backfill	60	Sq Yd	\$50.00	\$3,000.00
Box Culvert Apron Ends	2	Each	\$10,000.00	\$20,000.00
			SUBTOTAL	\$69,500.00
			ENGINEERING	\$5,560.00
			TOTAL	\$75,060.00

NEW CULVERT AT CTH M				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Traffic Control	1	Each	\$10,000.00	\$10,000.00
Box Culvert	200	Sq Yd	\$400.00	\$80,000.00
Trench Patch Type 3	100	Sq Yd	\$100.00	\$10,000.00
Select Backfill	125	Sq Yd	\$75.00	\$9,375.00
Box Culvert Apron Ends	2	Each	\$10,000.00	\$20,000.00
			SUBTOTAL	\$129,375.00
			ENGINEERING	\$8,750.00
			TOTAL	\$138,125.00

NEW CULVERT AT RAYMOND ROAD EAST				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Traffic Control	1	Each	\$5,000.00	\$5,000.00
Box Culvert	120	Sq Yd	\$300.00	\$36,000.00
Trench Patch Type 3	60	Sq Yd	\$100.00	\$6,000.00
Select Backfill	80	Sq Yd	\$50.00	\$4,000.00
Box Culvert Apron Ends	2	Each	\$10,000.00	\$20,000.00
			SUBTOTAL	\$71,000.00
			ENGINEERING	\$5,680.00
			TOTAL	\$76,680.00

ENGINEERING AND SURVEYING				
BID ITEM	QUANTITY	UNIT	UNIT COST	COSTS
Mayo Corporation Surveying	1	LS	\$15,525.00	\$15,525.00
Earth Tech – Upper Badger Mill Creek Study	1	LS	\$50,950.00	\$50,950.00
			SUBTOTAL	\$66,475.00
			ENGINEERING	\$5,318.00
			TOTAL	\$71,793.00

TOTAL COST \$4,079,781.19

2003 dollars