Item 6A.
Additional Detail
BCWMC 7-18-13

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Memorandum

To: Bassett Creek Watershed Management Commission
From: Barr Engineering Company
Subject: Bassett Creek Watershed-Wide Water Quality (P8) Modeling Study
Date: June 5, 2013
Project: 23/27-0051.13

Summary

From 1993 through 2000, the Bassett Creek Watershed Management Commission (BCWMC) constructed water quality (P8) models to model total flow and phosphorus loadings to lakes and streams within the Bassett Creek watershed. This water quality modeling project was initiated in 2012 by the BCWMC to update the existing Bassett Creek P8 models to allow for their use in tracking the progress of the BCWMC and the MS4s towards Total Maximum Daily Load (TMDL) implementation for impaired water bodies, not only within BCWMC, but also downstream of Bassett Creek. When projects are proposed and/or completed, such as projects that come under Commission review and Commission CIP projects, the updated P8 model can also be used to estimate the loading reduction that will be achieved by the projects.

Eleven P8 models, distributed throughout the Bassett Creek watershed, were created from the updated modeling to simulate the quantity and quality of water discharged to Bassett Creek during stormwater runoff events. Approximately 600 ponds and wetlands were included in the P8 modeling, watershed-wide. The P8 modeling results were then compiled and compared to the available stormwater monitoring data from the Bassett Creek WOMP station during the water year monitoring periods between 2001 and 2011 to determine whether changes to the modeling were warranted for calibration.

This memorandum presents the results of the model calibration comparison, provides recommendations for future model use and refinements and describes the water quality modeling methodology.

Model Calibration

Updated P8 modeling was recently performed during completion of three Total Maximum Daily Load (TMDL) studies (Sweeney Lake, Wirth Lake, and Medicine Lake). The P8 parameters used for the TMDL modeling were generally used for this study because the P8 model calibration or optimization performed for each TMDL project was based on smaller-scale monitoring data. Barr also developed hourly precipitation and daily temperature files to represent the period 2000 through 2011 based upon measurements at the Watershed Outlet Monitoring Program (WOMP) station located on the Main Stem of Bassett Creek at Irving Avenue. The Irving Avenue WOMP station daily flow data and the Metropolitan Council's completed FLUX modeling were compiled to determine observed flow volumes and pollutant loadings for the 2001 through 2011 water years, based on the monitored monthly and annual estimates.

While the P8 modeling conducted for the Medicine Lake TMDL was based on monitoring of up to 11 sites in 2004 through 2007 and multiple sites in previous years, it was expected that assimilation of the flow and phosphorus loads in the lake (which cannot be accounted for in P8) could significantly affect the influence that the lake outflow would have on the observations in Bassett Creek at the Irving Avenue WOMP station. As a result, the approach for performing the P8 model calibration check for this study was based on a comparison of the modeling results to the difference in daily stormwater flow and cumulative phosphorus load between the WOMP station and the Medicine Lake outlet. The watershed area downstream of Medicine Lake and upstream of the WOMP station also represents the portion of the Bassett Creek watershed modeling that has undergone significant updates for this study and has not been included in previous attempts for model calibration. Flow data from the Medicine Lake outlet was synthesized from the available water surface elevation data (combination of BCWMC and DNR readings) and the headwater rating curve for the Medicine Lake dam (Barr Engineering Company, 1996). Since P8 was used to simulate stormwater runoff, the daily flow from the WOMP station and the Medicine Lake outlet was subject to a baseflow separation analysis with the Web-based Hydrograph Analysis Tool to differentiate the daily groundwater flow contributions from stormwater runoff in Bassett Creek. The results of the baseflow separation analysis showed that approximately 63% of the annual flow volume in Bassett Creek is derived from groundwater contributions, while the remaining volume is resulting from surface water or stormwater runoff.

Based on the long-term results, the difference in average daily stormwater flow between the WOMP station and the Medicine Lake outlet was 10 cfs from the P8 modeling and 8.5 cfs from the monitoring data, which is within 18%. Figure 1 shows the difference in the monthly cumulative phosphorus (TP) load between the WOMP station and the Medicine Lake outlet based on the P8 modeling and the Metropolitan Council's FLUX model estimates (from the non-zero, April through November loading data). Based on the long-term results, the difference in the monthly cumulative phosphorus load between the WOMP station and the Medicine Lake outlet was 35,184 lbs. from the P8 modeling and 36,700 lbs from the monitoring data, which is within 4%. The results show good overall agreement between the modeled and monitored stormwater runoff phosphorus loading throughout the 11-year period with slight underestimates of TP load in 2006 and 2007 and overestimated TP load in 2011.

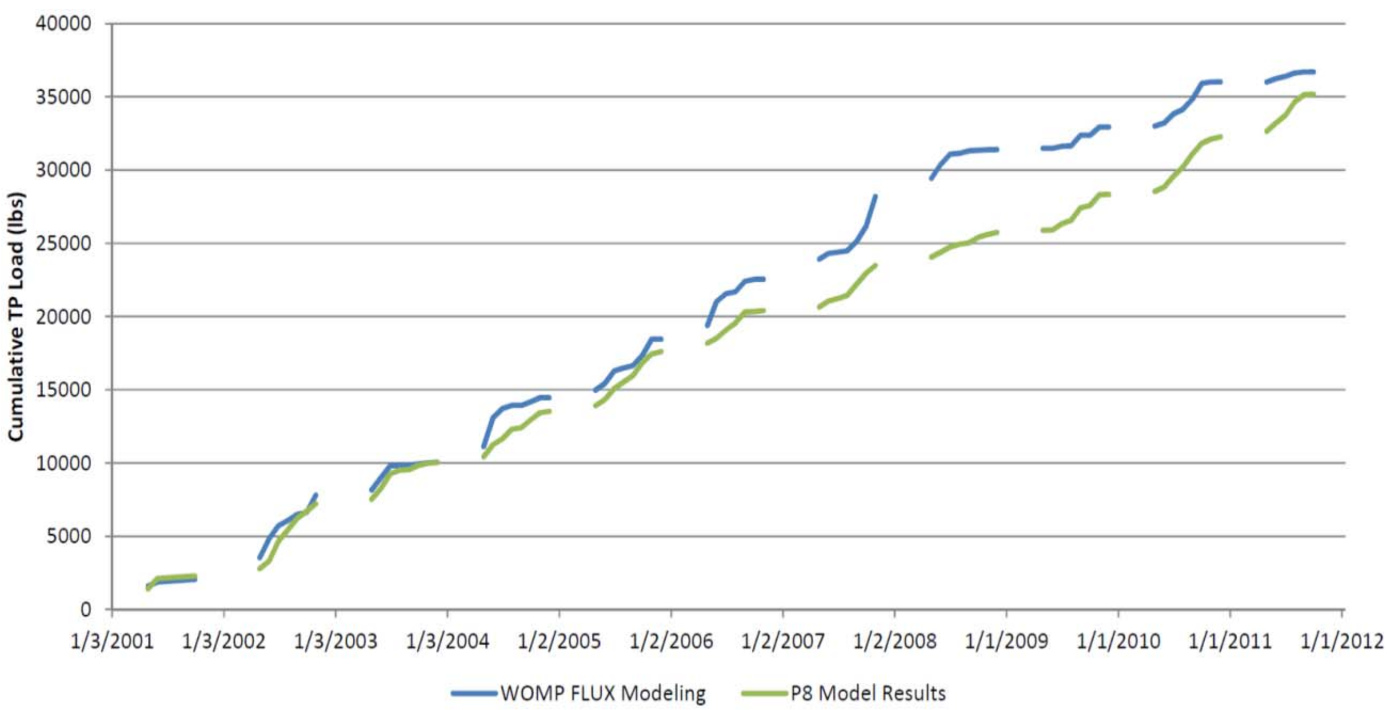

Figure 1 Simulated P8 Model and WOMP FLUX Model Cumulative Watershed TP Loadings

Recommendations for Future Use and Refinements

The updated P8 water quality modeling provides a key tool for the Commission to use in tracking the progress of the BCWMC and the MS4s towards TMDL implementation for impaired water bodies, not only within BCWMC, but also downstream of Bassett Creek. When projects are proposed and/or completed, the updated P8 model can be used to estimate the loading reduction that will be achieved by the projects. The updated P8 modeling can also be used to evaluate the effect of proposed projects, such as projects that come under Commission review and Commission CIP projects. The development of the model included all known water quality improvements devices and projects that were completed as of the summer of 2012.

It is expected that this modeling will be useful in the future development of the Bassett Creek Watershed Restoration and Protection (WRAP) study. As a result, it is recommended that these models be maintained by the Commission. If the member cities would like to update or change the model, the Commission should review and approve the changes. The updated model would then become the new Commission model. If this recommendation is followed, it is expected that the Commission will need to maintain different versions of the modeling. For example, implementation of proposed best management practices (BMPs) at a given location may require the modeling of multiple scenarios as the project(s) progress from diagnostic study to feasibility stage, and finally, an as-built stage. It is expected that the Commission will need to plan on periodic updates to the modeling to account for watershed, drainage and/or BMP changes associated with new development or redevelopment projects.

Two sources of potential revisions to the P8 modeling and associated inputs were identified during the preliminary review of the updated mapping circulated to the cities/MS4s in the watershed:

- A portion of the Crane Lake watershed was previously identified as landlocked as a result of the Medicine Lake TMDL modeling, but a recent project initiated by the City of Minnetonka included storm sewer and pond outlet construction for several ponds south of Crane Lake. As a result, the P8 modeling developed for this study should be updated to account for the watershed characteristics and pond outlet changes that now allow normal flow routing to Crane Lake.

- The subwatershed divide and flow direction data used in the model in the Hidden Lake area (southwest of Medicine Lake) conflicts with older DNR information. It is recommended that this area be evaluated in more detail in the future to address the questions about how MNDOT is managing stormwater runoff along Highway 55 and whether a culvert exists along the railroad tracks that would allow for inflow to Hidden Lake from the subwatershed immediately north of the lake.

The model input data for each of the watershed models are stored in a GIS database format that will be maintained for use on future Commission projects and for easy distribution to each of the member cities. This database will also be available to track compliance with TMDL wasteload allocations and TMDL implementation plans.

Modeling Methodology

The P8 (Program for Predicting Polluting Particle Passage through Pits, Puddles and Ponds) model predicts the generation and transport of stormwater runoff pollutants in urban watersheds. It is important to note that the strength of the P8 model is its use for relative comparisons as opposed to the use of the absolute pollutant loadings associated with each modeling scenario. In other words, P8 is a more powerful tool when the percentage change between a modeling run involving BMP implementation is compared to a baseline scenario that does not have BMPs.

From 1993 through 2000, the BCWMC constructed P8 models to estimate total flow and phosphorus loadings to lakes and streams within the Bassett Creek watershed. This water quality modeling project was initiated in 2012 to update the Bassett Creek P8 models. This resulted in eleven P8 models, distributed throughout the Bassett Creek watershed, that were created to simulate the quantity and quality of discharges to Bassett Creek receiving waters during stormwater runoff events.

Data used to construct the updated P8 models included watershed information (area, curve number, imperviousness, etc.) and device information (permanent pool area, permanent pool volume, flood pool area, and flood pool volume). Sources of information for updating the modeling included data collected from municipalities and other government agencies, information from previously constructed P8 models, field surveys, estimation from GIS, and calculations using XP-SWMM (i.e., outlet rating curve calculations).

The P8 modeling methods, including methods to compile information required for model construction, are detailed in the following subsections.

Watershed Divides

The P8 model requires watershed information for each device in the model. The first step in the process of compiling information to construct the updated P8 models was updating watershed divides throughout the Bassett Creek watershed. Data from the previous Bassett Creek P8 modeling project, together with data from government organizations, observation of aerial imagery, and LiDAR and storm sewer data were used in the process. The two primary pieces of information used to update the Bassett Creek watershed divides were LiDAR topographic and storm sewer data used within ESRI Geographic Information System (GIS) software.

LiDAR data are remotely sensed high-resolution elevation data collected by an airborne vehicle. LiDAR implements laser range finding, global position systems (GPS) and inertial measurement technologies to construct detailed elevations of the landscape (natural and constructed). The LiDAR data used to update watershed divides were collected at a resolution of 1 meter and includes reflective surface, last return, bare earth model, and intensity data in separate data files. The LiDAR data were obtained from the U.S Army Corps of Engineers in St. Paul, MN.

Municipalities and other governmental agencies with jurisdiction in the watershed were contacted with a request for storm sewer information. The following agencies provided updated data for the Bassett Creek 2012 P8 modeling project: Minnesota Pollution Contol Agency (MPCA), Hennepin County, Minnesota Department of Transportation (MNDOT), Minneapolis, Plymouth, St. Louis Park, Minnetonka, Golden Valley, New Hope, Crystal, and Robbinsdale. The City of Medicine Lake does not have records of storm sewer data and, hence, was unable to provide storm sewer data.

Information from governmental agencies, such as inverts, catch basin locations and lift station locations, were used in conjunction with the LiDAR data to delineate each watershed that drained to a common point. Previous Bassett Creek watersheds were used to begin this process and provide a check on the outcomes.

Determination of P8 Model Watershed Information

Watersheds are the source of flow and particles simulated by the P8 model. Watersheds are defined in P8 based upon factors controlling runoff and particle export (total area, impervious fraction, depression storage, SCS curve number for pervious areas, street-sweeping frequency). The model simulates runoff from pervious and impervious surfaces and particle buildup/washoff from impervious surfaces. Watershed runoff and percolation are routed to specified devices. The second step in the process of compiling information to construct the updated P8 models was determining total area, direct and indirect impervious fraction, SCS curve number for pervious areas, and depression storage for each Bassett Creek watershed.

GIS files were used to determine watershed information required for the updated P8 models. GIS files included:

1. Pond location data, obtained from previous projects, governmental organizations, and created from aerial imagery observation
2. Watershed data created from LiDAR and storm sewer data
3. Total imperviousness data obtained from the National Land Cover Database (NLCD) 2006 imperviousness data
4. Direct imperviousness data created only in residential areas by using LiDAR, where available, to determine building areas. In areas where LiDAR was not available, land cover data (NLCD, 2006) was used to determine average building cover per land cover type, based upon known areas with LiDAR. These averages were then applied to areas without LiDAR
5. SCS curve number data (pervious areas only) was determined based upon hydrologic soil groups.

Watershed information required for the P8 model is based upon upland areas, and hence, water bodies within watersheds are not included in the computation of watershed information. Ponds located within watersheds were removed prior to determining watershed area, SCS curve number, and direct and indirect imperviousness. Once a GIS layer of modified watersheds (i.e., watersheds without ponds) was created, the watershed area (in acres) was determined by calculating the geometry for each modified watershed in the attribute table. The GIS tool "Zonal statistics as table" was used to determine a mean average of total imperviousness, direct imperviousness, and SCS curve numbers within each modified watershed. Once these were calculated and combined, a table was created consisting of watershed name, area in acres, total imperviousness, direct imperviousness, and SCS curve number. Indirect imperviousness was then calculated by subtracting direct imperviousness from total imperviousness.

Determination of Device Information

In the P8 model, devices (i.e., ponds or other BMPs) collect, store, and/or treat pollutant particles discharged from watersheds. Device information required by the P8 model is based upon factors controlling hydraulic response and particle removal efficiency (i.e., elevation/area table and elevation/discharge tables for up to three outlets: 1= infiltration, 2 = normal outlet, 3 = overflow/spillway). Specific inputs vary with device types. Types of devices used in the Bassett Creek P8 models include:

- Detention Pond (Wet, Dry, Extended)
- General (User-Defined Elevation/Area/Outflow Table)
- Pipe/Manhole (Collector with One Outlet)

In the P8 model, routing from one device to another is accomplished by specifying downstream device numbers for each outlet. A downstream device number of 0 is used to route flow and loads out of the system (to receiving waters). The program keeps track of volume and mass fluxes into and out of each device, as well as changes in storage, with each time step. Program output formats (tables, graphs) summarize this information in various ways. The third step in the process of compiling information to construct the updated P8 models was determining permanent pool area and volume, flood pool area and volume, and outlet size for each device in the Bassett Creek watershed.

GIS files used to determine device information included (1) pond data from previous projects, governmental organizations, and created from aerial imagery observation and (2) outlet data acquired from various governmental agencies and site surveys. All devices that existed as of the summer of 2012 were considered in the development of the model.

Pond data from previous projects were compiled and then checked to determine whether changes had occurred. Current permanent pool area was measured to determine whether a change in pool size had occurred. When pool size had changed, or previous data could not be found, permanent pool data were determined using LiDAR data at the outlet elevation, if known. If no outlet elevation was known, the permanent pool area was determined by measuring the surface area of the current pool using aerial imagery and/or LiDAR data. If the pond was dry in the aerial imagery or no water surface was visible, LiDAR data was used to manually determine the maximum elevation of the pond before a spillover could occur. The area at this elevation within the basin was then measured to estimate permanent pool area.

Permanent pool volume data from previous studies were used whenever available. When previous data could not be found, the permanent pool volume was determined using a regression formula determined from known pool area and volume data from other ponds in the study. The regression formula estimated volume from a known surface area. If pond bathymetry was known or the pond was dry when LiDAR data was acquired (LiDAR does not penetrate water surfaces) a "pond volume calculator" tool created by Barr Engineering Company was used to determine pond areas and volumes using known outlet or flood elevations, which could be manually determined using LiDAR, if necessary.

Flood pool data from previous studies were used whenever available. When previous data could not be found, flood pool areas and volumes were determined using the "pond volume calculator" tool. Calculations were based upon outlet elevation data when available. When outlet elevation data were unavailable, LiDAR data were used to manually determine the lowest elevation at which the pool would spill over its banks and this elevation was used in the calculation.

Outlet data was determined from previous studies and outlet files provided by various governmental agencies. Where no data was available, site surveys were used to identify outlet sizes. If the outlet was an open channel or ditch with unknown width, this information was estimated by measurement from aerial imagery.

XP SWMM Rating Curves

The P8 model does not allow the user to enter a multiple outlet scenario for devices (i.e., ponds), but does allow the user to input a user defined rating curve. For general devices (i.e., ponds) in the Bassett Creek watershed with multiple outlet pipes, XP-SWMM software was used to calculate the rating curve.

XP-SWMM modeling parameters used to model watersheds whose devices had multiple outlets include area, curve number, imperviousness, inverts, and outlet pipe. To calculate rating curves for these watersheds, the watersheds were given constant inflows for varying outflow rates. Common constant inflows included one cubic feet per second (cfs), two cfs, five cfs, 10 cfs, 25 cfs, 50 cfs, 100 cfs, 250 cfs, and 500 cfs. The outflows from these watersheds, under constant inflow, were then used to construct a rating curve by comparing the depth of water in the device to the outflow.

P8 Model Parameter Selection

The P8 model version 3.4 was used to predict water, phosphorus, and suspended solids loads to Bassett Creek. The model performs continuous water-balance and mass-balance calculations on a user-defined system consisting of:

- Watersheds (nonpoint source areas)
- Devices (runoff storage/treatment areas)
- Particle Classes
- Water Quality Components

Simulations are driven by continuous hourly rainfall and daily air temperature. Proper development and calibration of the model also requires an accurate assessment of land use and impervious percentages, pond system morphology, flow routing, and water quality monitoring data. After supplying the required input data, the P8 model was used to estimate both the water and phosphorus loads generated from the entire Bassett Creek watershed.

When constructing the updated Bassett Creek P8 models, the standard default parameters were generally used for the models. Exceptions occurred for the following user-defined parameters:

Time Steps per Hour (Integer) selection was based upon the number of time steps required to prevent continuity errors greater than two percent. The default of 4 was used for seven of the eleven Bassett Creek watershed models. Four models required time steps ranging from 6 to 20 to prevent continuity errors greater than two percent. They include: Parkers East & Parkers model = 6 time steps per hour; Sweeney Twin model = 8 time steps per hour; Plymouth Creek model = 10 time steps per hour; and Midstream Downstream Wirth Grimes model = 20 time steps per hour.

Precipitation – Barr developed an hourly precipitation file to represent the period 2000 through 2011, based upon measurements at the WOMP station located on the Main Stem of Bassett Creek at Irving Avenue.

Temperature – Barr developed a daily temperature file to represent the period 2000 through 2011 based upon measurements at the WOMP station located on the Main Stem of Bassett Creek at Irving Avenue.

Watersheds – The watershed information specific to each model was summarized in an Excel spreadsheet and the watershed import function of the model was used to import the spreadsheet into each model.

Devices – The device information specific to each P8 model was summarized in an Excel spreadsheet. Visual Basic programming was then used to create a macro in the spreadsheet that summarized the device information in a format that could be inserted directly into the P8 model case file.

Particle Removal Scale Factor: The default of 1 was generally used. However, when past model calibration efforts indicated the need for a different value, past modeling values were used in the updated models unless a change in the pond warranted an updated value. For example, recent modeling of Plymouth Creek indicated a particle removal scale factor of 0.25 was needed for wetlands that the creek flows through to attain a match between observed and modeled values. Hence, values of 0.25 were used for these wetlands in the 2012 model. The recent construction of a pond in West Medicine Lake Park warranted an updated value in the 2012 model. Hence, the value of 0 used in the TMDL model was updated to 1 in the 2012 model.

Table 1 summarizes P8 parameters that differed from default values. Because P8 modeling was recently performed for completion of three TMDL studies (Sweeney Lake, Wirth Lake, and Medicine Lake), the P8 parameters for the TMDL models were generally used for the updated modeling of these watersheds. Table 1 shows the modeling parameters used for the TMDL models as well as the parameters used for all of the updated models developed for this study.

Changes to Address Known Data Gaps

The TMDL modeling developed for device BC107 (directly east of Medicine Lake) in the Medicine Lake Direct watershed did not reflect a high flow bypass for the device. As a result, the high flow bypass was incorporated into the updated modeling developed as a part of this study.

P8 Models

Eleven P8 models were created to model the entire Bassett Creek watershed (flow directions are shown in Figure 2):

- Main Stem Bassett Creek Upstream West
- Main Stem Bassett Creek Upstream East and Westwood Lake
- Main Stem Bassett Creek Midstream and Downstream and Wirth Lake, Grimes Pond, and North and South Rice Ponds
- Northwood Lake and Bassett Creek Park Pond (i.e., North Branch of Bassett Creek)
- Sweeney Lake and Twin Lake (i.e., Sweeney Branch of Bassett Creek)
- Plymouth Creek
- Parkers Lake and Parkers East
- Medicine Lake North
- Medicine Lake Northeast
- Medicine Lake Direct
- Medicine Lake South and Crane Lake

All subwatersheds and all known devices (i.e., stormwater treatment ponds and/or wetlands) were included in the models, except for Plymouth Creek. Because the P8 model has a limit of 75 devices and the Plymouth Creek watershed contained more than 75 devices, the model did not have capacity for all of

Table 1 2012 P8 Model Parameters and Comparison with Sweeney Lake, Wirth Lake, and Medicine Lake TMDL Model Parameters

Parameter	2012 Models, excluding Sweeney Lake, Wirth Lake, and Medicine Lake		Sweeney Lake TMDL Model		Sweeney Lake 2012 Model		Wirth Lake TMDL Model		Wirth Lake 2012 Model		Medicine Lake TMDL Models		Medicine Lake 2012 Models	
Time Steps per Hour	4		3		8		4		20		6		4 to 10[1]	
Minimum Inter-Event Time (hrs)	10		10		10		10		10		8		10	
Maximum Continuity Error %	2		3		2		2		2		2		2	
Rainfall Breakpoint (inches)	0.8		Not in Model		0.8		0.8		0.8		0.8		0.8	
Loops Thru Storm File	5		3		5		20		5		5		5	
Max Snowfall Temperature (deg-F)	32		32		32		32		32		32		32	
Snowmelt Temperature(deg-F	32		32		32		32		32		32[2]		32	
Snowmelt Coef (in/degF-Day)	0.06		0.06		0.06		0.06		0.06		0.03[3]		0.06	
Soil Freeze Temp (deg-F)	32		32		32		32		32		32[2]		21	
Snowmelt Abstraction Factor	1		1		1		1		1		1[4]		1	
Evapo-Trans. Calibration Factor	1		0.1		1		1		1		1		1	
CN Antecedent Moisture Condition	AMC-II	AMC-III	AMC-II	AMC-III	AMC-II	AMC-III	AMC-II	AMC-III	AMC-II	AMC-III	AMC-II	AMC-III	AMC-II	AMC-III
Growing Season	1.4	2.1	0.10	20	1.4	2.1	1.4	2.1	1.4	2.1	0.01[5]	100[7]	1.4	2.1
Non-Growing Season	0.5	1.1	0.50	1.1	0.5	1.1	0.5	1.1	0.5	1.1	0.01[6]	100[9]	0.5	1.1

Parameter	2012 Models, excluding Sweeney Lake, Wirth Lake, and Medicine Lake					Sweeney Lake (TMDL and 2012 Models)					Wirth Lake (TMDL and 2012 Models)					Medicine Lake (TMDL and 2012 Models)				
Unswept Depression Storage (inches)	0.03					0.03					0.02					0.03				
Unswept Imperv. Runoff Coefficient	0.94					0.94					1					0.94[7]				
Unswept Scale Factor for Particle Loads	1					1					1					1				
Particle Removal Scale Factor	1					1					1					1[8]				
Orifice Discharge Coefficient	0.6					0.6					0.6					0.6				
Weir Discharge Coefficient	3.3					3.3					No weir outlets					3.3				
Particle Class	P0%	P10%	P30%	P50%	P80%	P0%	P10%	P30%	P50%	P80%	P0%	P10%	P30%	P50%	P80%	P0%	P10%	P30%	P50%	P80%
Filtration Efficiency (%)	90	100	100	100	100	0	0	0	0	0	90	100	100	100	100	90	100	100	100	100
Settling Velocity (ft/hr)	0	0.03	0.3	1.5	15	0	0.075	0.075	3	20	0	0.03	0.3	1.5	15	0	0.03	0.3	1.5	15
Pervious Runoff Conc (ppm)	1	100	100	100	200	1	95	95	95	95	1	100	100	100	200	1	100	100	100	200
Pervious Conc Exponent	0	1	1	1	1	0	1.6	1.6	1.6	1.6	0	1	1	1	1	0	1	1	1	1
Accum. Rate (lbs-ac-day)	0	1.75	1.75	1.75	3.5	0	2	2	2	2	0	1.75	1.75	1.75	3.5	0	1.75	1.75	1.75	3.5
Washoff Coefficient	0	20	20	20	20	0	6	6	6	6	0	20	20	20	20	0	20	20	20	20
Washoff Exponent	0	2	2	2	2	0	3	3	3	3	0	2	2	2	2	0	2	2	2	2

Particle Composition (mg/kg)

2012 Models, excluding Sweeney Lake, Wirth Lake, and Medicine Lake

Component Name	TSS	TP	TKN	CU	PB	ZN	HC
P0%	0	99000	600000	13600	2000	640000	250000
P10%	1000000	3850	15000	340	180	1600	22500
P30%	1000000	3850	15000	340	180	1600	22500
P50%	1000000	3850	15000	340	180	1600	22500
P80%	1000000	0	0	340	180	0	22500

Sweeney Lake (TMDL and 2012 Models)

Component Name	TSS	TP	TKN	CU	PB	ZN	HC
P0%	0	99000	600000	13600	2000	640000	250000
P10%	1000000	3850	15000	340	180	1600	22500
P30%	1000000	3850	15000	340	180	1600	22500
P50%	1000000	3850	15000	340	180	1600	22500
P80%	1000000	0	0	0	180	0	22500

Wirth Lake (TMDL and 2012 Models)

Component Name	TSS	TP	TKN	CU	PB	ZN	HC
P0%	0	99000	600000	13600	2000	640000	250000
P10%	1000000	3850	15000	340	180	1600	22500
P30%	1000000	3850	15000	340	180	1600	22500
P50%	1000000	3850	15000	340	180	1600	22500
P80%	1000000	0	0	340	180	0	22500

Medicine Lake (TMDL and 2012 Models)

Component Name	TSS	TP	TKN	DisP[9]	CU	PB	ZN	HC
P0%	0	78000	600000	78000	13600	2000	640000	250000
P10%	1000000	5000	15000	0	340	180	1600	22500
P30%	1000000	5000	15000	0	340	180	1600	22500
P50%	1000000	5000	15000	0	340	180	1600	22500
P80%	1000000	0	0	0	340	180	0	22500

[1]Parkers & Parkers East = 6; Plymouth Creek = 10; All other Medicine Lake models = 4; [2]Plymouth Creek and Southwest Plymouth Creek TMDL models – Snowmelt and soil freeze temperatures = 34ºF; [3]Plymouth Creek and Southwest Plymouth Creek TMDL models – Snowmelt Coef = 0.01 in/degF-Day; [4] [2]Plymouth Creek and Southwest Plymouth Creek TMDL models – Snowmelt Abstraction Factor = 0.5; [52]Plymouth Creek and Southwest Plymouth Creek TMDL models – Growing Season AMC-II = 1.4 and AMC-III = 2.1; [62]Plymouth Creek and Southwest Plymouth Creek TMDL models – Non-Growing Season AMC-II = 0.5 and AMC-III = 1.1; [7]Plymouth Creek TMDL Model = 1; [8]Plymouth Creek TMDL and model – range of 0 to 4; Plymouth Creek 2012 model – range of 0.25 to 4; Ridgedale Creek TMDL and 2012 models – range of 0 to 0.5;

[9]DisP not in West Medicine Lake or City of Medicine Lake and Other Direct TMDL models.

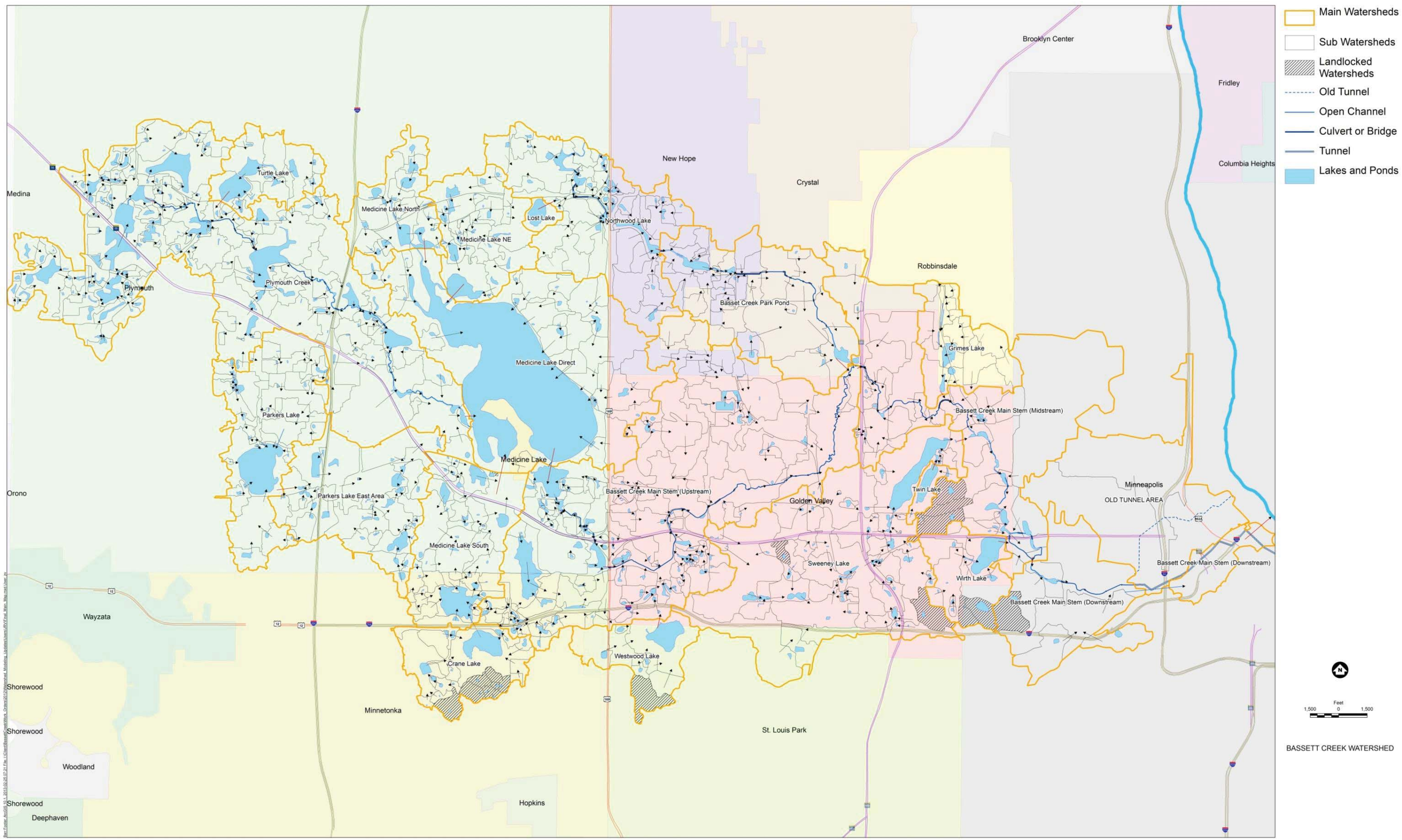

Figure 2 Bassett Creek Overall Watershed Map

the devices within the Plymouth Creek watershed. Hence, the Plymouth Creek model used in this project only contains the 75 devices deemed most important to the model. Devices located near Plymouth Creek were prioritized over devices located far from Plymouth Creek. Devices located in the downstream section of the creek were prioritized over devices located in the upstream section of the creek. Large devices were prioritized over small devices. It should be noted that all of the devices in the Plymouth Creek watershed were identified and the information assembled and, hence, is available for future use as it is expected that the next version of P8 will accommodate more treatment devices for each model.

Watershed Maps

Watershed maps were created to show the watershed and device network for each of the eleven Bassett Creek P8 models. Each map shows the major watershed and all subwatersheds, flow between subwatersheds, and devices that were in-place as of the summer of 2012 (i.e., shown on a table on each map). Each watershed map is provided as an attachment to this memorandum and the GIS data will be supplied with the final deliverables.

Outlet and Pond Surveys

The P8 model requires outlet information for each device. Although outlet information was available for most devices, field surveys were performed to gather outlet information for 49 devices that lacked outlet information. The field survey consisted of determining outlet type, measuring outlet diameter, and taking pictures of the outlet as well as each device (i.e., pond).

Bathymetric surveys were performed on ponds considered most important to the accuracy of the P8 models. The process for selecting ponds for the survey as well as the pond survey methods are discussed in the following paragraphs.

Ponds within the Bassett Creek watershed with higher phosphorus removal capacities are expected to exert a greater influence on P8 modeling results than ponds with lower phosphorus removal capacities. In addition, ponds with higher phosphorus removal rates may also have a high sediment accumulation rate which, in turn, would cause a more rapid permanent pool volume change than ponds with lower phosphorus removal rates. The eleven Bassett Creek P8 models were run and the modeling results compiled to identify ponds with higher phosphorus removal capacities. Thirty ponds were identified as significant ponds that exert a great influence on the Bassett Creek P8 modeling results. Table 2 shows the thirty ponds; these ponds were selected for a bathymetric survey.

Table 2 Bassett Creek Ponds Field Surveyed for Bathymetry

Watershed Name	Pond Name
Medicine Lake NE	BC81B
Medicine Lake North	BC29
Medicine Lake North	BC34
Medicine Lake South-Crane	BCBC77C
MidDownWirthGrimes	BC-11113-1
MidDownWirthGrimes	Basin K
Northwood-BassettCreekParkPond	BC-NB1-N
Northwood-BassettCreekParkPond	BC-NB1111-N
Parkers Lake-Parkers East	BCBC59
Parkers Lake-Parkers East	BCBC57
Parkers Lake-Parkers East	ML-PLY-BC44
Parkers Lake-Parkers East	PL-P7
Plymouth Creek	BC-P42
Plymouth Creek	ML-PLY-BC39-1
Plymouth Creek	ML-PLY-BC39F
Plymouth Creek	ML-PLY-BC27A-1
Plymouth Creek	BC18A1
Sweeney-Twin	DNR1A
Sweeney-Twin	Chicago Pond
Sweeney-Twin	Turners Pond
Sweeney-Twin	Spring
Upstream East-Westwood	BC-10-3
Upstream East-Westwood	Decola Pond F
Upstream East-Westwood	Decola Ponds B_C
Upstream East-Westwood	BC-HH1232-0A
Upstream East-Westwood	Boone Ave Pond
Upstream West	BC-HH12322-6
Upstream West	BC-HH12322-9
Upstream West	BC-HH123222-13
Upstream West	BC-HH12322-3A

The bathymetric field survey determined permanent pool storage volume capacities and gathered outlet structure data (size, type, and elevation). The survey of each pond began by determining whether the pond had an outlet. For each outlet, the type and size were recorded. The field elevation of the outlet was referenced to a benchmark and the elevation for each bench mark was determined at a later date.

If conditions were safe and the pond edge was accessible, the perimeter of each pond at its water edge was recorded using a Global Positioning System (GPS) data logger that tracked latitude and longitude.

The depth from the water surface to the pond bottom at various locations within each pond was physically measured and then added as a field note to a specific GPS location. Sediment type at each depth location was noted if a determination could be made. The overflow location and surface water elevation were referenced to a benchmark using an auto-level and survey rod. The embankment slopes were estimated and digital pictures were taken to provide visual images of the ponds and any points of interest (e.g., outlet).

After the field survey, all field elevations (outlet, water surface, and overflow location) were converted to NGVD 1929 datum. The field data were then processed to determine permanent pool area and volume as well as flood pool area and volume. The pond information from the field survey was then input to the updated Bassett Creek P8 models.