Comments from Nokomis CC Meeting
03212018

I initially became involved with flooding issues while attending the meetings here at Nokomis CC about the golf course. I've lived across the street from Hiawatha golf course for 20 years so I'm fairly familiar with the setting. I am also an environmental consultant for a Brownfields redevelopment company called Landmark Environmental. I look at near surface groundwater and soil for a living. The situation in the Hiawatha neighborhood is the same as the situation in Joan's neighborhood around Nokomis.

Since Gray's Bay dam was upgraded and replaced in 1986, the surface water elevation in Lake Hiawatha has risen approximately 1 to 3 feet (see Figure 7, Barr February Report). The high water table and the increased surface elevation of Lake Hiawatha has resulted in the unfavorable conditions at the course. This was documented by Gordy Eischens, of Soil Engineering and Testing, in a letter to the MPRB Superintendent David Fisher, dated August 14, in 1986, where he explained that the higher surface water elevation maintained in Lake Hiawatha has caused the constant high water table and deterioration of the golf course. So, the problems are not new They are the result of ever-increasing urbanization of the Watershed as the creek leaves Gray's Bay and flows through Minnetonka, Hopkins, St. Louis Park, Edina and southwest Minneapolis.

When the park board indicated that they were pumping a volume above their appropriations permit, my first question was, "is this volume significant"? 336M gallons sounds like a lot of water, but is it?

In 1993, MPRB installed an irrigation well at the course, which was screened in the Prairie du Chien aquifer from 215 to 260 feet below ground surface. The well was only used this well for irrigation intermittently. As part of course improvements in 2003, MPRB updated the DNR appropriations permit to pump water for irrigation from Pond E, which is located immediately west of Lake Hiawatha, and their 2003 permit was for 38.5M gallons.

In 2011, the City completed a sewer project which involved rerouting the existing stormwater system from the neighborhoods to the northwest of the course, up to approximately 38th Avenue and Chicago Avenue (Powderhorn neighborhood). These neighborhoods have historically had flooding problems during large storm events. Since 2011, stormwater from this neighborhood now flows into the northwest corner of the course, but enters the course at an elevation lower approximately 1 to 2 feet lower than the surface water elevation of Lake Hiawatha. So the water flows through a series of 5 ponds and eventually ends up in Pond E where it's pumped into Lake Hiawatha. I believe the annual stormwater volume flowing into this pond is about 50M – 65M gallons.

However, groundwater is only 1 to 3 feet below ground surface beneath most of the course, so as the storm water is pumped, groundwater flowing into the pond and is also pumped into Lake Hiawatha, and the annual volume is about 240M to 300M gallons –it's basically a mix of stormwater and near-surface groundwater. Of this volume, 140M gallons (58% of the total volume) is being recirculated. As water is discharged to Lake Hiawatha, the water is pulled back into the western shore of the lake and is re-pumped. For this reason, the February 2017 Barr report concluded in Section 10.4 that:

"….. the pumping of surface groundwater from the golf course to Lake Hiawatha was not impacting the deep groundwater aquifers in the region, but rather, just recirculating the surface groundwater inflows from the golf course ponds to Lake Hiawatha and back. Although energy intensive, the existing pumping is likely having minimal ecological impact".

The existing pumping wasn't intended to be a dewatering system to protect the homes or dewater the course. So the comparisons, or "choice" between pumping scenarios; either the current pumping from

Pond E or the proposed installation of a dewatering system in the northwest portion of the course, was manufactured by the Park Board.

So, if you step back and look at the pictures of the Minnehaha Creek Watershed District to see the boundaries, you realize it's huge. The boundaries extend way past Lake Minnetonka almost to Waconia, St. Bonnie and Maple Plain. If you look at the picture, you can see that the entire watershed bottlenecks at Lake Hiawatha, and the total volume of water pumped from Pond E doesn't really seem all that much.

Also, it's fairly obvious that the activities and decisions made upstream, directly affect the Hiawatha-Nokomis neighborhoods. As Barr Engineering pointed out in the first meeting, precipitation throughout the watershed no longer infiltrates into the ground. The western suburbs are no longer farm fields, the ground surface is now an impervious surface. Consequently, water now enters the watershed system as stormwater and the amount of water flowing down the creek has increase exponentially over the last 40 to 50 years.

As part of Barr's groundwater modeling effort, Section 10.3 of their Summary Report discusses various groundwater model parameters, and they state that:

> "The urban lakes of South Minneapolis, [however], are not natural lakes because their levels are managed by outlet structures and because they receive significant stormwater from storm sewers and/or direct runoff from urbanized, highly impervious watersheds."

It's important to understand that the watershed exists in a highly engineered system, and we can't expect to return the land to its natural state without consequences. Stormwater and groundwater problems require that responsible engineering controls are necessary.

In the February 2017 report conclusion, Barr states that the City, MPRB and MCWD are now all looking for flood mitigation opportunities. But the reality is, that the neighborhoods in this portion of Minneapolis were constructed on wetlands, and groundwater is only a few feet below ground surface. MPRB and the City are now looking at our neighborhood to help solve the upstream decisions with little regard for the existing hydrogeologic setting. It's now time that responsible engineering decisions and flood mitigation solutions are addressed along the entire watershed, not just in our neighborhood at the tail end of the watershed.

Besides the pumping issues, a few Park Board representatives have stated a few other odd reasons for closing the golf course (berm along the west side of Hiawatha may breach at any minute and result in a catastrophic flood, course is sinking, etc.), but I won't get into it. However, one of the main reasons why the Park Board and City want to construct a stormwater pond on the course is to provide water quality treatment, (mainly phosphorus loading) into Lake Hiawatha. And this issue relates exactly to the Nokomis area problems.

Phosphorus: Non-point source pollution

Besides the need to create storm water capacity, the City and Park Board want to construct that a large-scale water infiltration feature to remove about 40 lbs of phosphorus a year. Phosphorus reduction and water quality treatment have been the driving force behind the push to construct large-scale water infiltration features in our portion of the watershed.

Phosphorus is a non-point source of pollution. The source for the phosphorus is everywhere; its in the fertilizers we apply and the resulting runoff. The 2017 Minnehaha Watershed Management Plan lists the locations where water samples have been collected between Lake Minnetonka to the Mississippi. Section 2.3 of the MCWD Plan states that, "the primary nutrient cycling concern for Minnehaha Creek is that it conveys phosphorus load to Lake Hiawatha". There is very little difference in the total phosphorus concentrations with upstream and downstream samples near the golf course. All of this information is listed in the 2017 MCWD Plan.

- The 6 year Lake Hiawatha average of 70 ppb

- Although the total phosphorus concentrations in samples collected from various bays in Lake Minnetonka were found up to 114 ppb, the 15 year average concentration in Gray's Bay is 20 ppb. As you might expect, the total phosphorus concentrations in Minnehaha Creek increase as the water flows downstream. Samples collected from downstream locations indicate that:

    - Excelsior Blvd sample reported total phosphorus at 65 ppb
    - Xerxes Ave sample reported total phosphorus at 68 ppb.
    - Similar concentrations were reported in samples collected downstream from Lake Hiawatha at 28th Ave 71 ppb and Hiawatha Ave 75 ppb.

It's not just our upstream neighbors contributing to the phosphorus loading.

- The Powderhorn neighborhood has had a long history of elevated phosphorus as reflected in the historical water quality data collected at Powderhorn Lake. The average total phosphorus concentration measured in Powderhorn Lake between 2001 and 2015 is 114 ppb.

- The total phosphorus average concentration between 2001 and 2015 in Diamond Lake is 149 ppb, which is another example of an upstream source area.

So, my initial involvement was for the golf course, but then Joan Soholt contacted me and explained the various flood-related problems that her neighborhood has experienced over the last few years and we started to consider all of the changes over the last 10 to 15 years that could be considered to contribute to the high water table problems. As Joan indicated, MCWD and the City have basically said that "it's been wet everywhere, it's the increase in precipitation". There's no doubt this is a contributing factor; however, there has been a huge push over the last 10 – 15 years or so in our neighborhoods to construct large-scale water infiltration features, and we'd like clarification as to whether these are contributing to the flooding problems.

The first few projects involved the construction of wetlands along the south and west side of Nokomis in the early 2000s. The footprints of these features have grown considerably since construction. Over the last 5 to 10 years, the City of Richfield, MnDOT, City of Mpls and Metropolitan Airport Commission have constructed multiple stormwater infiltration features along both the north and south sides of Hwy 62, east of Portland Avenue all the way to 28th Ave. If you look at air photos between the early 2000s and 2016, you can really see the contrast in the size of the footprint of these features.

When we met with MCWD late last year, they indicated that "this portion of Mpls was constructed on a wetland" and that groundwater is shallow, so flooding should be expected because the water table is

high everywhere across the watershed right now. And that's true. However, homeowners in the neighborhood (some that have been there over 40 years) have never experience this sort of flooding. We understand that the area was once a wetland, but we feel that these features may be having a significant impact on the recent stormwater-groundwater problems in the area and I'm not sure that this portion of Minneapolis is the right setting for **multiple** large-scale water infiltration features.

The large volume of stormwater now flowing from the northwest portion of the airport into Nokomis (via Mother's and Taft Lakes) is just one example of the problems presented. I went on a tour of Bergan's SuperValue last week and Russell the manager took me on a tour of the settling that's occurred over the last 3 to 5 years. The mechanical room has sloughed 4 inches, pipes are strained. If you walk down Isle 7 (pop isle) you feel like you're walking downhill because of the foundation settling.

There have been two inter-governmental agency meetings with the Cities of Minneapolis and Richfield, MAC, DNR, MPCA, MnDOT, Hennepin County and MCWD to see who should take the lead on these problems. Each agency is trying to formulate a response to our concerns and we've met with a few of them. The agencies that we've met with over the last year all agree that there are limited groundwater, soil, and surface water data available that are specific to our neighborhoods and that there are significant data gaps.

The DNR has been very helpful, but they agree that their agency is best suited for groundwater issues. The MPCA and MCWD do surface water and storm water. There isn't an agency suited to address the big picture. We're hoping that USGS can offer some help in assessing the problems we now face and look at the problem with more of an "area-wide" perspective, and to better evaluate the relationship between surface water and groundwater in this portion of Minnehaha Watershed.

There are already significant flooding problems in the Lake Nokomis area. If you read the June 21, 2017 Barr Engineering *Water Management Alternatives* report, you can see that MPRB and the City want to create another large-scale water infiltration project on the golf course. The homeowners in the Hiawatha neighborhood are really worried. Flooding problems extend well beyond the golf course to the west toward Park Avenue and 35W. We've already witnessed the damage in Joan's neighborhood and now they're planning another large-scale water infiltration project.

Rather than make a decision about land use and then try to mitigate water issues, a detailed assessment of hydrogeologic setting is needed to fully understand all of the factors that'll influence flood potential prior to any decisions regarding the creation of another large-scale water infiltration project. To date, this assessment hasn't been completed. The DNR, MCWD and the City of Mpls are on board to further assess the situation, and the USGS is the one agency with the capacity to address these concerns. I hope that the newly elected Park Board realize that individual projects can't be completed in a vacuum. Future land use decisions should be based on science and a **comprehensive water management plan** needs to be developed.

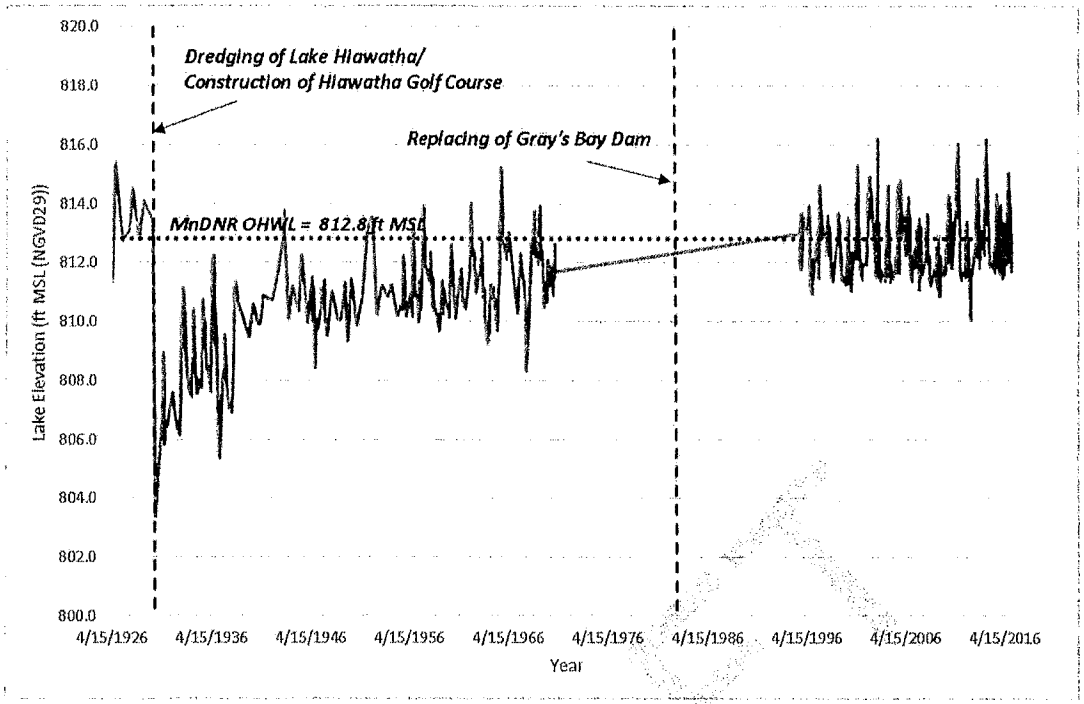

Figure 8 Lake Hiawatha Water Elevations

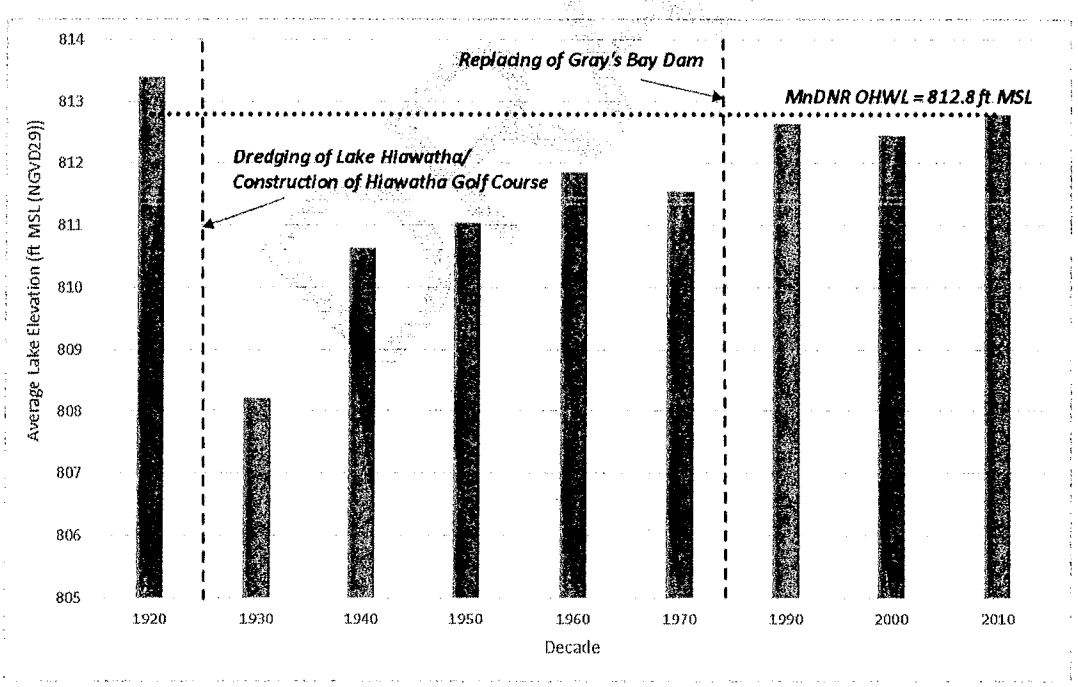

Figure 9 Lake Hiawatha Water Elevations By Decade

4501 17th Avenue South
Minneapolis, MN 55407
August 14, 1986

Mr. David Fisher
Superintendent of Parks
City of Minneapolis
310 4th Avenue South
Minneapolis, MN 55415

Dear Mr. Fisher:

SUBJ: Groundwater Problem - Hiawatha Golf Course

This letter concerns the constant high water table and deterioration of the Hiawatha Golf Course these past several years, especially this past year. The groundwater problems and the Dutch Elm Disease have rapidly taken its toll on this once beautiful golf course. One of the main reasons our family stayed in this area, rather than move to St. Paul in 1969, was the close proximity of our present house to the beautiful Hiawatha Golf Course.

The deterioration of most of the fairways, due to the constant high water table, has reached a permanently damaged state. To have playable fairways will likely require several years of remedial work. Regardless of the rainfall, the main problem is the level of the nearby Lake Hiawatha, in my opinion. The fairways cannot possibly dry to an elevation less than about 6" above the lake level. Raising the grade in many of the fairways would not solve the problem if the lake level is not controlled. The level of the lake must be lowered at least 6", preferably 1', by lowering the outlet structure at the East side of the lake.

Most of the time we and our friends are now golfing at Highland and Fort Snelling. It is ludicrous to pay $9.50 just to get wet feet and lose golf balls in the middle of the fairway aside from being turned off by the obvious deterioration of the golf course. Last year the pathway adjacent to the lake was upgraded. I assume this was done to maintain a stable pathway. If the upgrading was intended to control water problems in the adjacent fairways, the money and effort was a complete waste. There appears to be less maintenance and care given this course in recent years. Is it my imagination or are you in fact treating this golf course as an "inner city" or "hard core area" course that doesn't deserve the same care as a Columbia, Brookview, Gross or Meadowbrook? This may be a problem you inherited from your predecessor, who supposedly is responsible for the east outlet control structure.

I propose a twofold solution to the ever present ground water problems at Hiawatha Golf Course. Lower the water table about 1'. This will alleviate about 75% of the problem areas in the fairways. In the remaining problem areas, probably

the lowest areas elevation wise, the grade should be raised about 6-12": using the light, organic, surficial soils nearby. This can be accomplished by creating a few lateral hazards (ponds) and using the soils removed for filling the nearby low areas. This should be done with light equipment to minimize rutting and tearing up the fairways. The sod should be stripped, stored nearby, and reused. By doing half of a fairway section at a time the course could remain open with minimal interference.

In summary, something must be done to save this once beautiful golf course, and soon, to control remedial costs. I manage the Geotechnical Laboratory of Twin City Testing Corporation. Our company continually deals with soil and ground water problems. If you have any questions or comments, please call me at work at 641-9390; in the evenings at .

Sincerely,

Gordon R. Eischens

GRE/dls

cc: Mr. Jeff Spartz
Mr. Dick Yates

Minnesota Unique Well Number

482891

County Hennepin
Quad St Paul
Quad ID 103B

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date 07/08/1996
Update Date 12/30/2015
Received Date

Well Name	Township	Range	Dir	Section	Subsection
HIAWATHA	28	24	W	12	CDACCB

Elevation 817 ft. **Elev. Method** 7.5 minute topographic map (+/- 5 feet)

Address

Contact 250 4TH ST S MINNEAPOLIS MN 55415

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
FILL	0	3	BROWN	SOFT
PEAT	3	70	BLACK	SOFT
CLAY & GRAVEL	70	120	GRY/BLK	SOFT
GRAVEL	120	128	RED/BLK	SOFT
CLAY & GRAVEL	128	165	GRY/BLK	SOFT
SANDSTONE/SHALE	165	209	BRN/BLU	SOFT
SHAKOPEE	209	260	BRN/WHT	SOFT

Remarks

Well Depth 260 ft. **Depth Completed** 260 ft. **Date Well Completed** 06/01/1992

Drill Method Non-specified Rotary **Drill Fluid** Bentonite

Use irrigation **Status** Active

Well Hydrofractured? Yes ☐ No ☐ **From** **To**

Casing Type Single casing **Joint** Welded
Drive Shoe? Yes ☐ No ☒ **Above/Below** 3 ft.

Casing Diameter **Weight**
10 in. To 215 ft. 40.4 lbs./ft.

Open Hole From 215 ft. To 260 ft.

Screen? ☐ **Type** **Make**

Static Water Level
36 ft. land surface Measure 06/01/1991

Pumping Level (below land surface)
78.3 ft. 4 hrs. Pumping at 450 g.p.m.

Wellhead Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount	From	To
neat cement	10 Cubic yards	ft. 218	ft.

Nearest Known Source of Contamination
feet Direction Type
Well disinfected upon completion? ☒ Yes ☐ No

Pump ☒ Not Installed Date Installed
Manufacturer's name
Model Number HP Volt
Length of drop pipe ft Capacity g.p. Typ

Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

Variance
Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Miscellaneous
First Bedrock St.Peter Sandstone Aquifer Prairie Du Chien
Last Strat Prairie Du Chien Group Depth to Bedrock 165 ft
Located by Minnesota Geological Survey
Locate Method Digitization (Screen) - Map (1:24,000)
System UTM - NAD83, Zone 15, Meters X 481108 Y 4974285
Unique Number Verification Site Plan Input Date 11/21/2015

Angled Drill Hole

Well Contractor
Renner E.H. Well 71015 DAVIDSON, D.
Licensee Business Lic. or Reg. No. Name of Driller

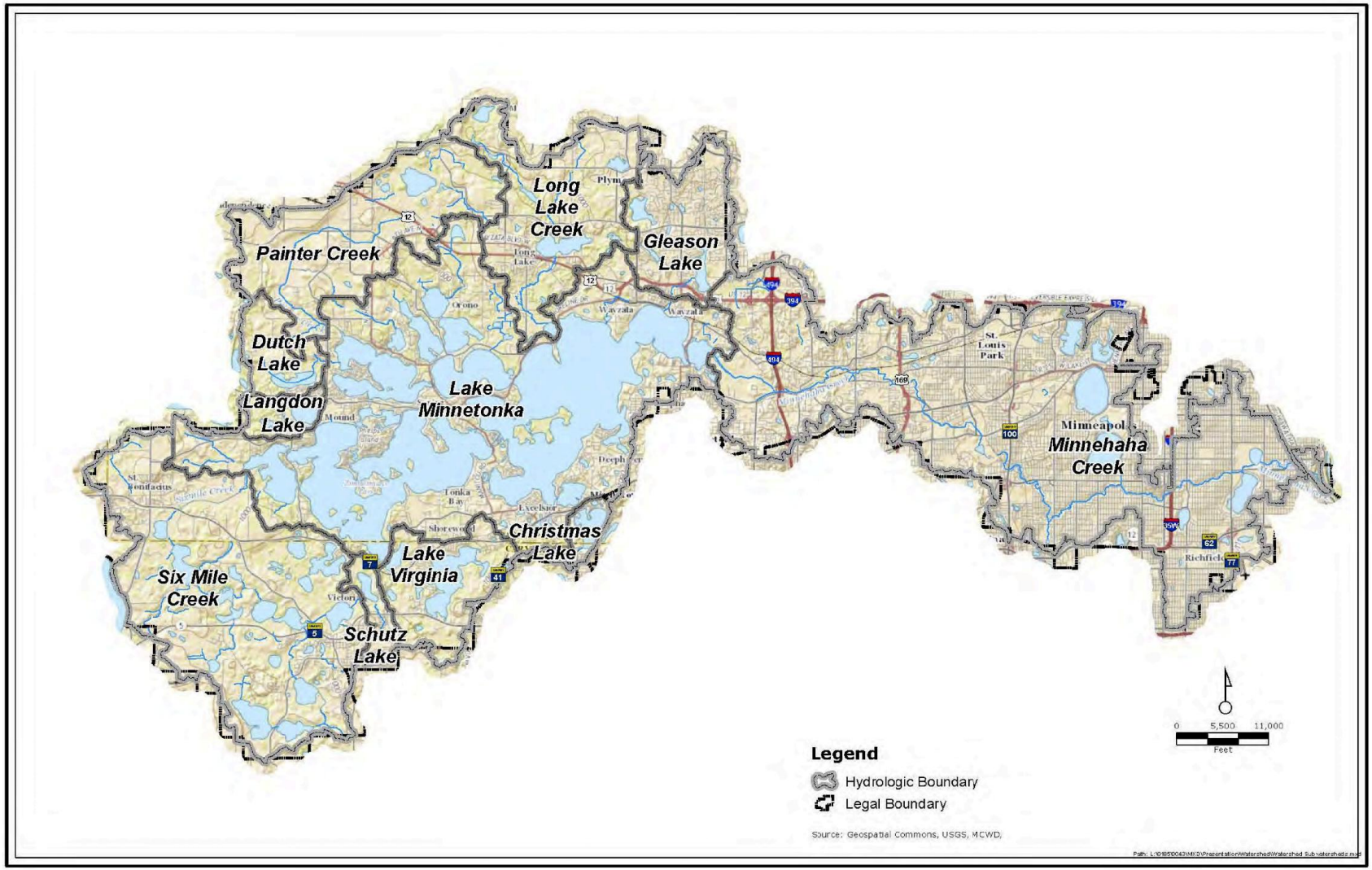

Figure 2. 4. Topography and subwatersheds within the Minnehaha Creek watershed.

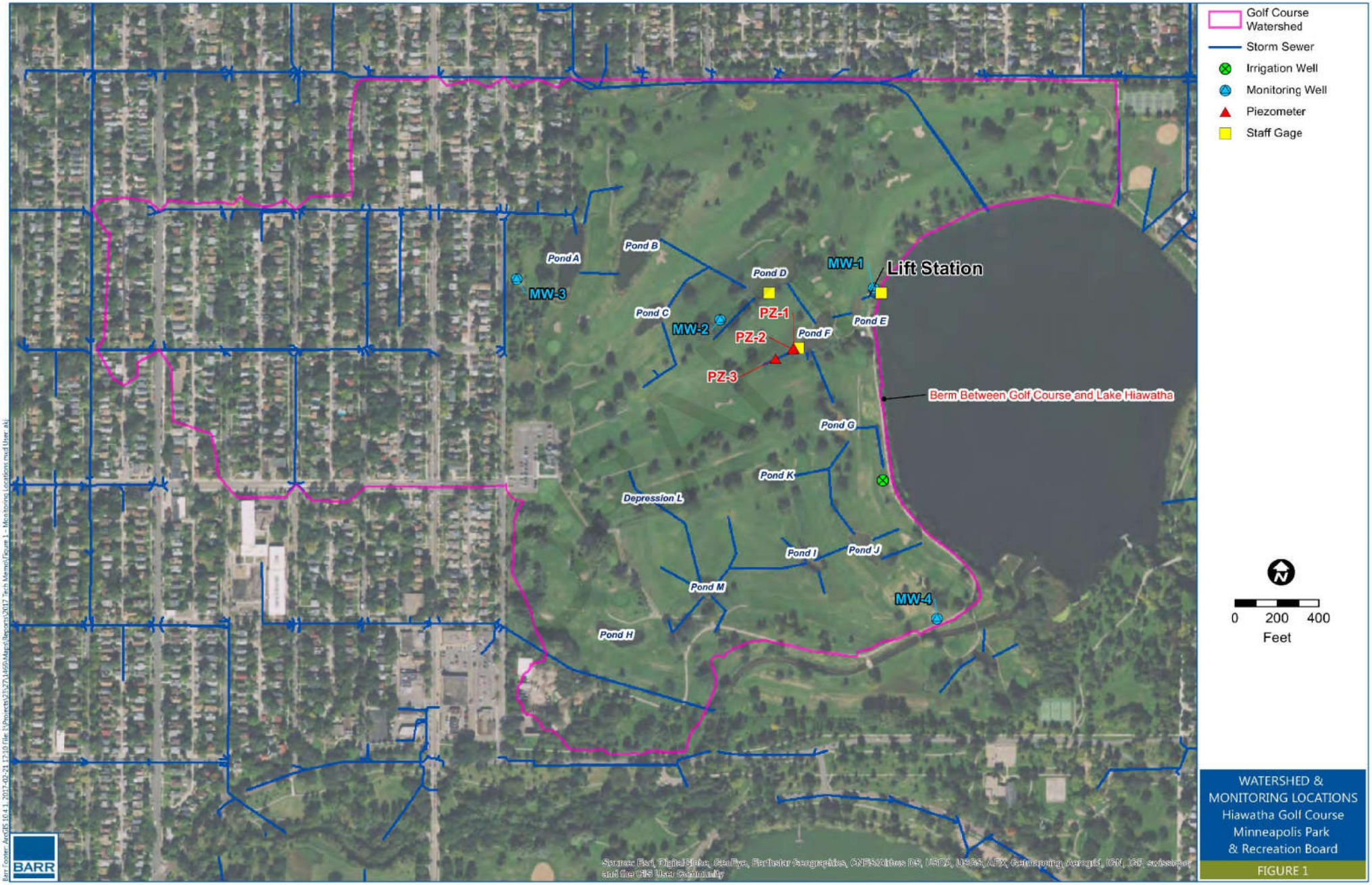
Golf Course Watershed
Storm Sewer
Irrigation Well
Monitoring Well
Piezometer
Staff Gage
Pond A
Pond B
Pond C
Pond D
Pond E
Pond F
Pond G
Pond H
Pond I
Pond J
Pond K
Pond M
Depression L
MW-1
MW-2
MW-3
MW-4
PZ-1
PZ-2
PZ-3
Lift Station
Berm Between Golf Course and Lake Hiawatha
0 200 400
Feet
WATERSHED & MONITORING LOCATIONS
Hiawatha Golf Course
Minneapolis Park & Recreation Board
FIGURE 1
BARR

Table 2. 37. Selected water quality goals and current conditions of lakes and bays in the Lake Minnetonka subwatershed.

Bay/Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend	2001-2015 Average			Years Monitored
				TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)	
Classen Lake	n/a	n/a	n/a	107	80	0.5	2009-2010
Forest Lake	40	n/a	No trend	63	49	0.9	1996-2015
French Marsh	n/a	n/a	n/a	48	11	0.9	2011-2012
Lake Galpin	60	60	n/a	n/a	n/a	1.4	2011
Hooper Lake	n/a	n/a	n/a	29	10	1.8	2010-2011
Lake Marion	n/a	*	n/a	14	3	3.6	2009-2012
Libbs Lake	60	30	n/a	22	5	1.5	2011-2012
Lake Louise	n/a	*	n/a	47	16	1.8	2006-2008
Peavey Pond	n/a	*	Deg SD, TP	89	20	1.9	1999-2015
Shavers Lake	60	*	n/a	42	8	1.2	2001-2015
Lake William	n/a	n/a	n/a	38	8	1.1	2009-2015
Lake Minnetonka Bays							
Black Lake	40	45	No trend	32	14	2.1	2006-2015
Browns	40	20	n/a	n/a	n/a	n/a	n/a
Carman	40	50	No trend	22	8	2.7	2004-2013
Carsons	40	50	Imp SD	22	4	3.5	2004-2015
Cooks	40	30	No trend	29	13	2.1	1997-2015
Crystal	40	25-30	Imp SD	26	10	2.6	1997-2015
Grays	40	20	Imp SD, TP	21	4	3.6	2004-2015
Halsted	40	50-60	No trend	104	62	0.9	1997-2015
Harrisons	40	50	No trend	58	48	0.9	2001-2013
Jennings	40	50-70	No trend	114	69	0.8	2005-2015
Lafayette	40	20	Imp SD, Chl-a	21	5.4	3.5	1997-2015
Lower Lake North	40	20	No trend	20	5	4	2005-2013
Lower Lake South	40	20	All Imp	19	5	3.7	1997-2015
Maxwell	40	40	No trend	32	14	1.9	1997-2015
North Arm	40	30	No trend	31	13	1.9	2001-2013
Phelps	40	20	n/a	24	7	3.3	2006-2013
Priests	40	30	Deg Chl-*a*	27	38	1.4	2006-2016
Robinsons	40	30	n/a	n/a	n/a	n/a	n/a
St. Albans	40	20	All Imp	20	4	4	1997-2015
St. Louis	40	50	n/a	n/a	n/a	n/a	n/a
Smithtown	40	n/a	No trend	22	8	2.5	2004-2013
Spring Park	40	20	Imp SD, TP	22	7	3.2	2006-2015
Stubbs	40	50-55	No trend	47	52	0.9	2006-2015
Wayzata	40	20	Imp SD	21	4	3.7	1997-2015
West Arm	40	50	No trend	72	54	1	1997-2015
West Upper	40	25	No trend	26	8.7	2.6	1997-2015

*10% reduction from existing, provided it is greater than 25 µg/L; will require baseline data

TP = Total phosphorus concentration, Chl-*a*= chlorophyll-*a*, SD= Secchi depth, Imp = improving, Deg = degrading.

Source: MCWD, MPCA, City of Minnetonka.

3.2.3 Nutrient Summary

Results from water quality samples collected in January 2016 were compared to the most recent 6-years (2010-2015) of water quality data for Lake Hiawatha as provided by the MPRB. It should be noted that water quality samples in 2010 to 2015 were taken mostly during summer months (July and August) and results will vary with time of year. Table 4 summarizes the nutrient comparisons.

Lake Hiawatha TMDL has a total annual phosphorus inflow of 6,463 pounds. The annual total phosphorus (TP) being pumped into Lake Hiawatha from Pond E is calculated at 165 pounds. This is based on pumping 263,000,000 MGY at a concentration of 0.076 mg/L.

Table 4 Lake Hiawatha and Hiawatha Golf Course Nutrient Summary

Water Quality Parameter	Pond E on 1/20/2016	Lake Hiawatha Average (6 Yr)	Lake Hiawatha on 1/20/2016
NOx (Nitrate and Nitrite as N, mg/L)	0.479	0.176	0.259
SRP (Soluble Reactive Phosphorus, mg/L)	0.004	0.018	0.005
TKN (Total Kjeldahl Nitrogen, mg/L)	2.18	0.985	0.991
TP (Total Phosphorus, mg/L)	0.076	0.07	0.028

3.3 Aquifer Testing

In order to inform the groundwater model calibration, data was needed to demonstrate how the groundwater system responds to a change in pumping conditions. Barr has conducted three "recovery tests" on the golf course ponds during which the pumps have been shut off and the water level recovery in the ponds and the monitoring wells has been monitored.

An additional aquifer test on the golf course's deep irrigation well was conducted in February 2016. The results from this test were used to evaluate the degree of connection between shallow and deep aquifers in order to assess whether shallow pumping at the golf course impacts deeper aquifers.

3.3.1 2014 Recovery Test

The 2014 recovery test began at 12:42 pm on December 8, 2014 when both pumps were turned on (one had been running prior to the test) in order to lower pond levels as much as possible. Pumping continued until the afternoon of December 9, when golf course staff reported that low water levels in the sump were causing the pumps to draw air. Both pumps were shut off at approximately 2:45 pm on December 9. Pond water levels were then allowed to recover in the absence of pumping for several days. By December 13 the staff gauges in Ponds D and F were completely submerged. One pump was activated at 11:45 am on December 13. Data collection ended with the removal of the transducers from the ponds on the afternoon of December 15, 2014. See Figure 6.

A small, unnamed channel (CGL04) that outlets the wetland on the southeast corner of Gleason Lake is also listed as impaired for chloride (Table 2.65).

Table 2. 65. Current conditions of streams in the Minnehaha Creek subwatershed.
See Figure 2.72 for monitoring locations.

Stream	Trend	2005-2015 Annual Average			
		TP (µg/L)	TN (mg/L)	TSS (mg/L)	Cl (mg/L)
Unnamed Gleason Channel (CGL04)	n/a	156	0.97	6	312
Gray's Bay Dam (CMH07)	n/a	20	0.66	2	47
I-494 (CMH01)*	Imp TP	38	0.64	3	62
W. 34th Street (CMH02)	Imp TP	52	0.80	7	76
Excelsior Blvd (CMH11)	Imp TP	65	0.85	12	79
Browndale Dam (CMH03)	Imp TSS, TP	62	0.87	5	80
W. 56th Street (CMH04)	n/a	59	0.78	7	79
Xerxes Avenue (CMH15)	Imp TSS, TP	68	0.80	9	85
21st Avenue (CMH24)	n/a	71	0.86	17	88
28th Avenue (CMH18)	n/a	71	0.93	6	90
Hiawatha Avenue (CMH06)	Imp TP	75	1.0	9	97

TP = total phosphorus, TN =total nitrogen, TSS = total suspended solids, Cl = chloride, Imp = Improving
*Station used to be named CMH19, but due to historic data findings, the station was renamed CMH01.
Source: MCWD.

Lake	State TP Standard (µg/L)	2007 Plan Goal TP (µg/L)	Trend	2001-2015 Summer Averages		
				TP (µg/L)	Chl-*a* (µg/L)	Secchi (m)
Brownie	60	35	n/a	44	12	1.3
Calhoun	40	25	No trend	17	4	3.7
Cedar	40	25	Deg SD	25	9	2.0
Diamond	n/a	90	n/a	149	46	0.5
Harriet	40	20	Deg TP	21	5	3.0
Hiawatha	50*	50	No trend	70	18	1.4
Isles	40	40	No trend	44	28	1.3
Nokomis	50*	50	Imp Chl-*a*, TP	52	22	1.2
Powderhorn	60	120	No trend	114	28	1.0
Twin	60	n/a	Imp TP	165	65	0.6

TP = Total phosphorus concentration, chl-*a*= chlorophyll-*a*, SD= Secchi depth, Imp = improving, Deg = degrading.
*Both Nokomis and Hiawatha were granted a site-specific standard by the MPCA due to unique conditions.
**

Source: MCWD, MPCA.

Streams:

Minnehaha Creek is the primary stream within the subwatershed. It is formed at the outlet of Grays Bay in Lake Minnetonka and flows 22 miles to the Mississippi River. Lake Hiawatha is in-line to the creek and heavily influenced by it. As an outlet for Lake Minnetonka and the upper watershed, Minnehaha Creek must discharge large volumes of water during spring snowmelt runoff, summer and fall. During a typical year, 4-6 inches of runoff from the 122 square-mile upper watershed are discharged to Minnehaha Creek. The typical average flow in the creek due to this runoff is 60 to 90 cfs.

An operating plan was established for Grays Bay dam headwaters control structure when it was put into service in 1980. The plan was intended to emulate the historical discharge hydrograph produced by previous controls and the natural outlet of Lake Minnetonka. In drier periods, Lake Minnetonka typically does not discharge water, and portions of the Creek may experience low or even no flow.

Total phosphorus concentrations on Minnehaha Creek are less than the state river eutrophication standards. The state river eutrophication standards also look at other indicators such as chlorophyll-a, diel oxygen flux, and biological oxygen demand, which have not been assessed on the Creek. The primary nutrient cycling concern for Minnehaha Creek is that it conveys phosphorus load to Lake Hiawatha.

Minnehaha Creek, however, is included in the State's Impaired Waters List due to excess chloride, fecal coliform concentrations and low dissolved oxygen as well as impaired fish and macroinvertebrate communities. Table 2.65 shows the average concentrations in Minnehaha Creek to be well below the 30 mg/L state standard for this ecoregion. Maintaining sufficient DO is necessary to support aquatic life. The DO state standard requires the stream to never fall below 5 mg/L DO. Monitoring data show that Minnehaha Creek upstream of the Browndale Dam can fall below this standard in summer, but the reaches below the dam have not been observed to do so. The upstream reaches are influenced by through-flow and riparian wetlands, which may increase sediment oxygen demand.

Minnehaha Creek was studied in-depth in 2003 and 2012 as part of the District's *Minnehaha Creek Stream Assessment*, which included a physical inventory, erosion survey, and a fluvial geomorphic assessment to determine channel stability. For more information regarding these parameters, please refer to the *Minnehaha Creek Stream Assessments*. For more information regarding water quality in the subwatershed, please refer to the District's Water Quality (Hydrodata) Reports.