Appendix D
Water Quality Program

2010 VBWD Water Quality Data Collection Program

Introduction
The lakes, streams, and wetlands in the VBWD are valuable community resources that:

- Provide wildlife habitat
- Provide recreational opportunity
- Provide fishery resources
- Provide aesthetic enjoyment
- Enhance property values
- Serve as sources for groundwater recharge and nutrient removal.

Urbanization can result in the addition of increased loads of pollutants to the lakes, ponds, wetlands, and streams within the VBWD. The Board of Managers is concerned about the water resources within the VBWD and tries to protect them from degradation through careful management practices. The VBWD collects water quality samples from its lakes, ponds, wetlands, and streams to assess current conditions and changes or trends in the water quality or habitat over time, thereby determining the effect of changing land use patterns in the watershed and the effectiveness of the VBWD's efforts to preserve/improve water quality.

Basin Monitoring Program
The type of monitoring conducted for a water body varies according to the classification the VBWD has assigned to it. Following is a description of the VBWD's basin monitoring programs.

Secchi Disc Only/CLMP Water Quality Monitoring
This monitoring program involves measuring Secchi disc transparencies from spring to fall, typically through participation in the Minnesota Pollution Control Agency's (MPCA's) Citizen Lake Monitoring Program (CLMP). The CLMP provides low-cost Secchi discs to participants for measuring water clarity on an approximate weekly basis. In 2009, the VBWD did not recruit any CLMP volunteers. In 2010, Paul Anderson continued to monitor the Silver Lake Secchi disc transparency depths for the MPCA through CLMP.

Survey Level/CAMP Water Quality Monitoring
This monitoring program is equivalent to the Metropolitan Council's Citizen Assisted Monitoring Program (CAMP). The CAMP uses volunteers to measure surface water temperature and transparency (Secchi disc readings), and to collect surface water samples on a biweekly basis from mid-April to mid-October (approximately 14 sampling events). The water samples are analyzed for total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a. In 2010, the VBWD recruited

volunteers to collect the water quality samples for this monitoring program at the following 14 basins: Lakes Jane, Olson, DeMontreville, Elmo, Eagle Point, Sunnybrook, Cloverdale, Echo, and Downs Lakes; and Klawitter and Rest Area Ponds. Due to low water levels, the volunteer was unable to sample Eagle Point Lake. Ramsey County Public Works continued to monitor the water quality of Silver Lake in a manner equivalent to the CAMP in 2010. The VBWD hired the Washington Conservation District to collect water quality samples in a manner equivalent to CAMP from 20 basins, including Acorn Lake, Weber Pond, east Capaul's Pond, west Capaul's Pond, Buetel Pond, Horseshoe Lake, Upper West Lakeland Storage Site, east Fahlstrom Pond, west Fahlstrom Pond, Clear Lake, Bay Lake, Goetschel Pond, Friedrich's Pond, Legion Pond, north Goose Lake, south Goose Lake, Mergens Pond, north Rose Lake, south Rose Lake, and Kramer Pond. These samples were generally collected once in April, once in May, five times in June through September, and once in October. However, several basins completely dried up in 2010 so only a few samples were collected.

Supplemental Water Quality Monitoring

This monitoring program is supplemental to the Survey Level/CAMP Water Quality Monitoring Program, and involves collecting supplemental (additional) samples and data approximately six times between mid-April to mid-October (typically once in April, June, July, and September and twice in August). In addition to the sample collection and analysis performed as part of the Survey Level/CAMP Water Quality Monitoring Program, the supplemental monitoring involves analyzing total phosphorus concentrations at depths throughout the water column, analyzing surface water samples for ortho-phosphorus and total nitrogen, and collecting dissolved oxygen, specific conductance, turbidity, and pH data. This type of monitoring is needed to assess problems (e.g., degrading water quality trends) and is also appropriate for regular monitoring of regionally important water bodies, such as the High Priority water bodies. This sampling and laboratory work is performed by a contractor for the VBWD. In 2010, no Supplemental Water Quality Monitoring was conducted.

Intensive Water Quality Monitoring

This monitoring program involves more sample collection dates and analyzing parameters at depth in addition to total phosphorus. This program is more intensive than the Supplemental Water Quality Monitoring program. If triggered or implemented, this program will be developed for a specific water body to answer specific questions, calibrate water quality models, etc., usually as part of a diagnostic-feasibility study. Intensive water quality monitoring was done by Barr Engineering Company for the VBWD at Long, Edith, and Sunfish Lakes in 2010.

Habitat Monitoring

This program monitors habitat conditions, using indicators such as the existence and

extent of an upland buffer zone surrounding the water body, erosion and sedimentation in the water body and along its shoreline, the presence and number of non-native exotic species in or near the water, vegetative diversity, ecological quality, and wildlife habitat. The Habitat Monitoring Program involves collecting data in the summer (late June/mid-July is ideal). The monitoring is completed by a wetland scientist or a team of water resource professionals. In 2010, the VBWD scaled back its habitat monitoring efforts and only conducted macrophyte surveys. Macrophyte data were collected in eight basins. Macrophyte (rooted aquatic plant) surveys were performed to identify the current conditions of plant growth throughout the lakes. Macrophytes are primary producers in the aquatic food chain, converting the basic chemical nutrients in the water and soil into plant matter, which becomes food for all other aquatic life.

Basin Water Quality Action Triggers

The VBWD set water quality "action triggers" in its 2005-2015 Watershed Management Plan (Plan) for water bodies with water quality rankings of A, B, or C (better than poor). These action triggers were designed to assist in determining appropriate water quality management actions. After each year of sampling, the VBWD re-evaluates the action triggers, re-analyzes trends for each water body, and makes appropriate changes. Action triggers were (and will be) set as follows:

- For water bodies with at least five years of data and unchanging water quality (no statistically significant improving or degrading trend), the 25th and 75th percentiles of summer-average Secchi disc transparency data from the last five to ten sampling years were calculated to obtain the interquartile range. The action trigger was set at the 25th percentile (i.e., some type of water quality management action must be taken if the summer-average transparency is less than the 25th percentile value).

- For water bodies with at least five years of data and changing water quality (statistically significant improving or degrading trend), the 25th and 75th percentiles of *individual* summer Secchi disc transparency data from the last five sampling years were calculated to obtain the interquartile range. The action trigger was set at the 25th percentile.

- For water bodies with insufficient (or no) water quality data, the VBWD will need to collect more data before setting lake-specific action triggers. In the meantime, the following action triggers apply:

    - *Water Bodies with "A" and "B" Water Quality*: the action trigger was set at an summer-average Secchi disc reading of 1.3 meters (4.3 feet),

- *Water Bodies with "C" Water Quality*: the action trigger was set at a summer-average Secchi disc reading of 0.7 meters (2.3 feet).

- For all "A" water bodies, the following action trigger also applies: if more than two individual Secchi disc readings (in a sampling season) are less than 1.2 meters (3.9 feet), water quality management action is required.

Each year the VBWD analyzes the collected water quality data and compares it to the action trigger. If the lake water quality data (Secchi disc transparency) is worse than the action trigger, or there is a degrading trend in water quality, some type of water quality management action will need to be taken. Table D-3 (following: Table 4.2-6 from the VBWD Plan) from the Plan summarizes the recommended actions.

Table D-3

(Table 4.2-6 from the VBWD Plan)

RECOMMENDED WATER QUALITY MANAGEMENT ACTIONS FOR HIGH AND MEDIUM PRIORITY WATER BODIES[1]
Valley Branch Watershed District

Comparison of Most Recent Summer Average Secchi Disc Transparency to Action Trigger[2]	95% Confidence Water Quality Trend	Type(s) of Management Action Needed		
		Watershed Management	Water Quality Monitoring	Runoff Monitoring or Equivalent
Better Than Trigger Value	No Trend Analysis Available, No Trend or Improving Trend	No Action	Continue existing water quality monitoring program	None
	Degrading Trend	No Action	Perform Supplemental monitoring next year	Watershed land use review[3]
At or Worse Than Trigger Value	No Trend Analysis Available, No Trend or Improving Trend	No Action	Perform Supplemental monitoring next year	None
	Degrading Trend	Comprehensive lake/ watershed diagnostic-feasibility study	Intensive monitoring (as part of diagnostic-feasibility study)	Detailed runoff water quality monitoring, if needed, as part of diagnostic-feasibility study

1. For Low Priority lakes, the VBWD Managers will review data and implement appropriate actions, on a case by case basis.
2. For lakes with an "A" water quality ranking that fail to meet the VBWD's minimum summer Secchi disc depth goal of at least 3.5 feet (1.1 meters), the VBWD Managers will review data and implement appropriate actions, on a case by case basis.
3. Watershed land use review: Review changes in watershed land use since last trend analysis and review weather/climate conditions.

2010 Basin Water Quality Results & Anticipated 2011 Basin Monitoring Program

Barr Engineering Company added the 2010 water quality monitoring data to the VBWD water quality database and compared the data to VBWD's water quality action triggers. Barr also updated the VBWD water quality action triggers and evaluated the data for statistically-significant water quality trends. Table D-4 summarizes this information. Figure D-1 shows the 2010 summer-average Secchi disc transparency depths for all of the basins monitored in 2010. Charts of historic water quality data for each water body

TABLE D-4
WATER QUALITY ACTION TRIGGERS AND WATER QUALITY TRENDS SUMMARY

Water Body (Water Quality Ranking)	Action Triggers and Secchi Disc Transparency Depths (meters)						2010 Water Quality Trend? (95% Confidence)
	Based on Summer Average			Based on Two Minimum Individual Readings			
	Summer Average Trigger	2010 Summer Average Secchi Disc Transparency Depth	2010 Summer Average Better than Summer Average Trigger?	Summer Minimum Trigger for A Ranked Water Bodies	2010 Summer Minima	2010 Minima Better than Minimum Trigger?	
Acorn Lake (D)	N/A	0.84	N/A	N/A	N/A	NA	**
Bay Lake (D)	N/A	0.46	N/A	N/A	N/A	NA	None
Beutel Pond (assume D)	N/A	0.91	N/A	N/A	N/A	NA	**
Capaul's Pond - East (D)	N/A	0.46	N/A	N/A	N/A	NA	**
Capaul's Pond - West (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Clear Lake - North (assume D)	N/A	Not Sampled	N/A	N/A	N/A	N/A	**
Clear Lake – South (assume D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Cloverdale Lake (A)	2.20	2.60	Yes	1.2	2.6 & 2.6	Yes	None
Lake DeMontreville (A)	2.39	2.40	Yes	1.2	1.2 & 1.2	Yes	None
Downs Lake (D)	N/A	0.30	N/A	N/A	N/A	NA	None
Eagle Point Lake (D)	N/A	Not Sampled	N/A	N/A	N/A	Na	**
Echo Lake (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Lake Edith (A)	**1.68**	**1.53**	**No**	**1.2**	**1.0 & 1.3**	**Half**	**Yes** (**degrading** trend at 99% confidence)
Lake Elmo (A)	3.51	4.18	Yes	1.2	3.3 & 3.7	Yes	None (but improving trend at 80% confidence)
Fahlstrom Pond - East (D)	N/A	0.35	N/A	N/A	N/A	NA	**
Fahlstrom Pond - West (D)	N/A	0.65	N/A	N/A	N/A	NA	**
Friedrich's Pond (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Goetschel Pond (C)	1.43	1.18	No	N/A	N/A	NA	**Yes** (**degrading** trend at 95% confidence)
Goose Lake - North (D)	N/A	0.15	N/A	N/A	N/A	NA	**
Goose Lake - South (D)	N/A	0.17	N/A	N/A	N/A	NA	**
Horseshoe Lake (C)	0.99	0.99	Yes	N/A	N/A	NA	None
Lake Jane (A)	4.17	4.18	Yes	1.2	3.2 & 3.4	Yes	None
Klawitter Pond (D)	N/A	0.38	N/A	N/A	N/A	NA	None
Kramer Pond (D)	N/A	0.42	N/A	N/A	N/A	NA	**
Lake Olson (A)	2.56	2.10	No	1.2	1.1 & 1.2	Half	None
Legion Pond (C)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Long Lake (C)	1.46	4.70	Yes	N/A	N/A	NA	Yes (improving trend at 95% confidence)
McDonald Lake (C)	1.40	Not Sampled	N/A	N/A	N/A	NA	**
Mergens Pond (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Rest Area Pond (D)	N/A	0.63	N/A	N/A	N/A	NA	**
Rose Lake - North (D)	N/A	0.27	N/A	N/A	N/A	NA	**
Rose Lake - South (D)	N/A	0.30	N/A	N/A	N/A	NA	**
Silver Lake (A)	**0.76**	**1.28**	**Yes**	**1.2**	**0.5 & 0.7**	**No**	**Yes** (**degrading** trend at 99% confidence)
Sunfish Lake (C)	0.56	0.60	Yes	N/A	N/A	NA	None
Sunnybrook Lake (A)	2.31	2.44	Yes	1.2	1.8 & 2.2	Yes	None
Weber Pond (D)	N/A	1.26	N/A	N/A	N/A	NA	**
West Lakeland Storage Site - North (D)	N/A	0.69	N/A	N/A	N/A	NA	**

** – Insufficient data available to compute trend in water quality.

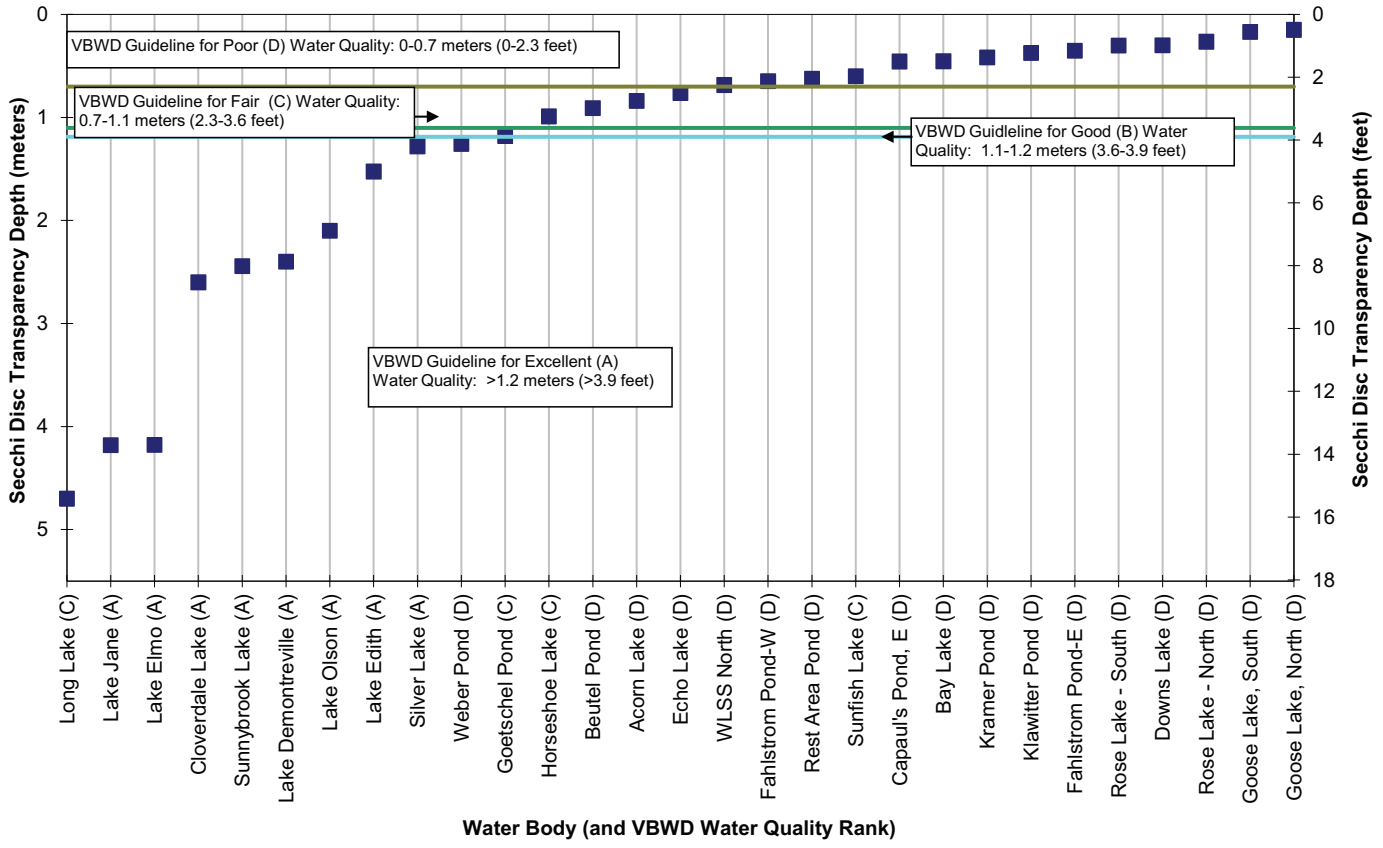
N/A – Action triggers do not apply to "D" water quality rankings (summer average Secchi disc readings) or to "B", "C", or "D" water quality rankings (minimum Secchi disc readings)

– Lakes failing one or more action triggers

Note: Barton Pit is not included in this table since it does not normally hold water.

FIGURE D-1

2010 SUMMER AVERAGE WATER CLARITY DEPTHS OF MAJOR WATER BODIES
VALLEY BRANCH WATERSHED DISTRICT



H:\2010 Results\2010ResultsMemorandum_Figure D-1 2010 Summer Avg Wtr Clar.xls

monitored in 2010 are included at the end of this appendix.

Three water bodies had 2010 summer-average Secchi disc transparency depths less than their respective action triggers: Lake Edith, Lake Olson, and Goetschel Pond. Silver Lake also had two individual Secchi disc transparency depths less than the summer minimum trigger of 3.9 feet (1.2 meters). Two lakes, Lake Edith and Silver Lake, have statistically significant degrading trends in water quality.

The following paragraphs discuss the noteworthy 2010 water quality monitoring results and 2011 monitoring plans. Table D-5 shows the Managers' 2011 monitoring plan, based on 2010 results and the annual monitoring plan framework contained in the VBWD Plan.

Lakes Failing VBWD Action Triggers

Silver Lake

Silver Lake's 2010 summer-average Secchi disc transparency of 4.2 feet (1.28 meters) is slightly better than the 2009 summer-average, which was the worst observed summer-average Secchi disc transparency since 1977. The historic water quality data show a rapid decrease in water quality beginning in 2007. The poorer water quality conditions observed in 2007, 2008, 2009, and 2010 are most likely due to the whole-lake aquatic plant treatment applied to the lake. As previously stated in the memoranda to the Managers regarding the 2007 and 2008 Silver Lake water quality results, the relationship between total phosphorus and phytoplankton (as chlorophyll *a*) levels in Silver Lake may have been fundamentally changed. Meaning, there were much higher levels of phytoplankton in the lake in 2007 and 2008 even though total phosphorus concentrations were only somewhat higher. Because of the loss of shading that the macrophytes once provided in Silver Lake, it may be expected that even if total phosphorus levels in Silver Lake are similar to past levels, phytoplankton levels will be higher.

The VBWD summer-average Secchi disc action trigger for Silver Lake was 2.5 feet (0.76 meters) for 2010, while the calculated summer-average was 4.2 feet (1.28 meters). In addition, the VBWD set a goal for Silver Lake of having at least a 3.9 foot (1.2 meter) minimum summer Secchi disc transparency depth, but the two worst readings of the season were only 1.6 and 2.3 feet. A statistical analysis of the Silver Lake Secchi disc transparency depths for the last 10 years indicates that there is a statistically significant degrading trend to a 99% confidence level.

In addition to poorer Secchi disc transparency, the 2010 summer-average total

Table D-5
2011 WATER QUALITY MONITORING PROGRAM
Valley Branch Watershed District

Water Body	2011 Sampling	Water Quality Sampler	Macrophytes Monitoring Sampler & Schedule	Phytoplanton & Zooplankton Sampler & Schedule	Water Levels Reader
Acorn Lake	SL^, Q		Barr: Early June & Mid-August	None	
Bay Lake	SD^			None	
Beutel Pond	SD^			None	
Capaul's Pond - East	SL^, Q^			None	
Capaul's Pond - West	SL^, Q^			None	
Clear Lake	SD^			None	
Cloverdale Lake	SL, Q	Dr. Bjork	Barr: Early June & Mid-August	None	Gage for Dr. Bjork
Lake DeMontreville	ML, Q	Bob Meier and WCD-B	Barr: Early June & Mid-August	None	(Chuck uses Lake Olson gage)
Downs Lake	SD^^	Slys		None	Gage for Chuck Taylor
Eagle Point Lake	SL, Q	WCD-B	Barr: Early June & Mid-August	None	Chuck Taylor (no gage)
Echo Lake	SD^			None	WCD
Lake Edith	**Edith**[2], Q	Joe Reithmeyer and WCD-B	Barr: Early June & Mid-August	None	WCD
Lake Elmo	ML, Q	Jeff Berg & Wendy Griffin	Barr: Early June & Mid-August	None	Gage for Chuck Taylor 2nd Gage for NE Landowners
Fahlstrom Pond - East	SD^			None	
Fahlstrom Pond - West	SD^			None	
Friedrich's Pond	SD^			None	
Goetschel Pond	SL^, Q^			None	
Goose Lake - North	SD^			None	
Goose Lake - South	SD^			None	
Horseshoe Lake	SD^^	WCD-B		None	Gage for Chuck Taylor
Lake Jane	ML, Q	Chuck Taylor	Barr: Early June & Mid-August	None	Gage for Chuck Taylor
Klawitter Pond	SD^^	Bonnie Juran		None	Gage for Bonnie Juran
Kramer Pond	SD^			None	
Legion Pond	SL^, Q^			None	
Long Lake	SL, PI	Bill Feely and WCD-B	Qualified contractor: Mid-August	None	Gage for Bill Feely & Chuck Taylor
McDonald Lake	SL, Q	WCD-B	Barr: Early June & Mid-August	None	Gage for WCD
Mergens Pond	SD^			None	
Lake Olson	ML, Q	Bob Meier and WCD-B	Barr: Early June & Mid-August	None	Gage for Chuck Taylor
Rest Area Pond	SD^^	MnDOT		None	Gage resurveyed for MnDOT
Rose Lake - North	SD^			None	
Rose Lake - South	SD^			None	
Silver Lake	**Silver**[1], PI	Ramsey County Public Works	Done by others through the DNR	Ramsey County Public Works	Ramsey County
Sunfish Lake	SL, Q	WCD-B	Barr: Early June & mid-August	WCD*	Gage for Chuck Taylor
Sunnybrook Lake	SL, Q	Arnie Johnson	Barr: Early June & mid-August	None	
Weber Pond	SD^			None	
West Lakeland Storage Site - central	SD^			None	Gage for Chuck Taylor
West Lakeland Storage Site - north	SD^			None	

SL = Survey Level (equal to CAMP) = WCD LWQB1 (WCD-B)

SL^ = Survey Level suggested in 2005 Watershed Management Plan, but not currently suggested because of budget

SD^ = Secchi Disc Transparency (equal to CLMP) suggested in 2005 Watershed Management Plan, but no currently suggested because of budget

SD^^ = Secchi Disc Transparency suggested in 2005 Watershed Management Plan, but SL proposed because of long-term volunteers or lack of data

ML = Survey Level plus Supplemental (SL plus analyzing total phosphorus concentrations at depths throughout the water column, analyzing surface water samples for orthophosphorus and total nitrogen, and collecting dissolved oxygen, specific conductance, turbidity, and pH data) . If budget doesn't allow, SL only.

Q = Qualitative Aquatic Plant Survey (Barr)

Q^ = Qualitative Aquatic Plant Survey suggested in 2005 Watershed Management Plan, but not currently suggested because of budget

PI = Point Intercept Aquatic Plant Survey (qualified subcontractor for Long Lake; DNR for Silver Lake, if feasible)

* = Phytoplankton and phytotoxin sampling to be conducted first week of August and first week of September. Primary sample collected from deepest area of Sunfish Lake. Second sample collected from near shore area. Phytoplankton samples to be analyzed by Barr. Phytotoxin samples to be sent to laboratory for analyses of two phytotoxins.

Silver[1] = Monthly (Apr-Sept) phosphorus and field probe profile in deep area of lake: total phosphorus, total dissolved phosphorus, and soluble reactive phosphorus profile top to bottom; field probe profiles of temperature, dissolved oxygen, chlorophyll and conductivity top to bottom. Monthly (Apr-Sept) surface samples of total phosphorus, total dissolved phosphorus, soluble reactive phosphorus, and chlorophyll *a* in shallow area of lake.

Edith[2] = Survey Level water quality monitoring at lake surface equal to CAMP, plus collection of depth profile data each event. Depth profile date includes total phosphorus and dissolved phosphorus samples at four additional depths and 1-meter interval temperature and dissolved oxygen data with a field probe.

phosphorus concentration for Silver Lake was 97 µg/L, which is poorer than the VBWD goal, and the highest observed summer-average since 1984. This value is above the MPCA total phosphorus criterion for shallow lakes, which is 60 µg/L or less. This total phosphorus concentrations is no longer below (better than) the level that would cause it to be included on the MPCA's list of Impaired Waters (ref. Sec. 303(d) of the Clean Water Act, PL 92-500). According to MPCA guidance on impaired water determination, total phosphorus is the primary determinant upon which listing is based; however, chlorophyll *a* or Secchi disc depth are also used to determine listing (chlorophyll *a* must be above 20 µg/L or Secchi disc depth must be below 3.2 feet in addition to total phosphorus levels above 60 µg/L). In 2010, Silver Lake's summer-average chlorophyll *a* was also above (worse than) the impaired water listing criterion. The summer-average Secchi disc transparency was greater (better) than the impaired water listing criterion.

One of the VBWD Managers' missions is to manage and protect water resources by *improving and protecting the quality of water for all water bodies within the VBWD.* Based on the 2007, 2008, 2009, and 2010 monitoring results for Silver Lake, the lake's water quality is not improving or being protected. The Managers plan to take the following actions at Silver Lake in 2011:

- The Managers will continue to discourage the Minnesota Department of Natural Resources (DNR) from allowing the Silver Lake Improvement Association (SLIA) to conduct lake-wide aquatic plant management treatments that adversely affect lake water quality conditions.
- The Managers will continue to encourage the DNR to conduct point intercept aquatic plant surveys of the lake.
- The Managers will continue to request that Ramsey County Public Works collect water quality, phytoplankton, zooplankton, and water level data.
- The Managers will work with the Cities of North St. Paul and Maplewood and the SLIA to implement stormwater runoff treatment practices, in an effort to improve water clarity.

Lake Edith

Lake Edith is 77 acres in size, with a maximum depth of 43 feet. The lake remains strongly stratified during the summer, and the hypolimnion becomes anoxic.

The VBWD summer-average Secchi disc action trigger for Lake Edith was 5.5 feet (1.68 meters) in 2010, while the calculated average was 5.0 feet (1.53 meters).

However, Lake Edith met the VBWD goal of having at least a 3.9-foot minimum summer-average Secchi disc transparency depth.

Analysis of water quality data collected for Lake Edith over the past nine years (2002-2010) indicates that summer-average water transparencies—as measured by the limits of Secchi disc visibility—have declined significantly, from about 2.9 meters to 1.5 meters. While this decline in transparency is statistically significant (at the 95% confidence level), conditions remain indicative of *Excellent* water quality, and within the range of values previously observed. Reasons for the decreasing transparency trend are not evident in the data record, which is somewhat irregular in scope, year-to-year (i.e., varying numbers of monitoring sites and parameters analyzed).

A somewhat similar trend toward poorer water quality is evident in recent (2006-2010) Lake Edith summer-average chlorophyll *a* concentration values. This apparent trend does not test significant at the 95% confidence level, however. Total phosphorus concentration data for the same period are even more highly variable with no apparent trend over recent years.

It is unclear why summer-average transparencies have declined significantly over the past ten-years, without corresponding significant changes in total phosphorus and chlorophyll *a* concentrations being observed. The fact that carp are reported to be in the lake suggests that non-algal turbidity (i.e., resuspended sediment) from their feeding activities could be contributing to decreased transparencies, but the Minnesota Department of Natural Resources has little data on Lake Edith carp population dynamics to confirm or refute this possibility.

In addition, Lake Edith appears to be meromictic (its lower and upper waters seldom mix). Because of this, it is possible that episodic mixing of the lake waters above a strong thermocline (a distinct layer in the lake in which temperature changes more rapidly with depth than it does in the layers above or below) could be entraining seston (i.e., dead algal cells, largely) into the lake's upper layer. The presence of a mid-water column maximum in chlorophyll *a* concentrations on most 2010 sampling dates, especially in the early-summer, reinforces this possibility. This mixing, if it occurs, would tend to increase surface water turbidity, and thereby decrease water transparency, without significantly adding to chlorophyll *a* and total phosphorus concentrations. However, the widely spaced (i.e., every 3-weeks) lake water quality data collected along depth profiles do not evidence any mixing, and site-specific wind

speed/duration data are not available to infer this possibility. A weather station installed at the lake to obtain site-specific data would be necessary to make sense of future in-lake data (using a sophisticated modeling tool like DYRESM) in order to determine the cause(s) of the observed decreasing transparency trend. (Data from the nearby Belwin Conservancy weather station probably wouldn't help because its location is unlike the sheltered lake site.)

For lakes that have water quality worse than the action trigger and have a trend of degrading water quality, Table 4.2-6 of the VBWD Plan recommends a comprehensive study and intensive monitoring of the watershed and the lake be conducted. Because the apparent trend in Lake Edith water transparencies may be caused by a variety of environmental factors, most of which would be quite time-consuming and expensive to assess, the Managers plan to continue monitoring conditions at a relatively basic level instead to determine if the trend is maintained or not. Should the trend toward poorer water quality continue, and should conditions transition into a lower quality level (e.g., move from *Excellent* to *Good*, or worse), then more detailed monitoring as part of a future, comprehensive diagnostic study may be warranted. For 2011, Lake Edith will be monitored at a scope comparable to that followed in the Metropolitan Council's Citizen Assisted monitoring Program (CAMP). The VBWD will hire Washington Conservation District (WCD) to supplement CAMP-level monitoring with collection of other data (e.g., water temperature, plus dissolved oxygen and total phosphorus concentrations) along a one-meter depth interval profile at the center (deep) hole of the lake. The VBWD will also hire the WCD to record lake water levels.

<u>Goetschel Pond</u>

The 2010 summer-average Secchi disc transparency of 3.9 feet (1.18 meters) for Goetschel Pond was less than the summer average trigger of 4.7 feet (1.43 meters). VBWD considers Goestschel Pond a wetland; therefore, no additional monitoring above normal monthly water quality monitoring is planned in 2011.

<u>Lake Olson</u>

Lake Olson had an average summer-average Secchi disc transparency of 6.9 feet (2.10 meters), worse than the summer average trigger of 8.4 feet (2.56 meters). The lowest Secchi disc transparency reading of the season was 3.6 feet (1.1 meters), while the second lowest was equal to the summer minimum trigger of 3.9 feet (1.2 meters). Lake Olson is connected to Lake DeMontreville by a small channel, and there are some similarities between which years have better or worse water quality parameters. No additional monitoring is planned in 2011

beyond normal monthly monitoring of Secchi disc transparency and collection of surface samples for phosphorus and chlorophyll *a* for Lake Olson.

Other Noteworthy Results and Recommendations

Based on past monitoring results, the Managers took additional water quality management actions in 2008, 2009, and/or 2010 at Long Lake and Sunfish Lake. Results of these additional water quality management actions are discussed in the following paragraphs.

Long Lake

In 2006, Long Lake's summer-average Secchi disc transparency depth (4.63 feet) failed to be better than the VBWD-set action trigger (4.92 feet). In accordance with Table 4.2-6 of the Plan, the VBWD collected supplemental water quality data from Long Lake in 2007. The Managers also ordered a detailed study of the lake to determine if it is feasible to improve the lake's water quality so that it will not eventually be listed as nutrient-impaired by the Minnesota Pollution Control Agency. In 2008 and 2009, the Managers implemented a water quality improvement project. The project consisted of:

- Application of aluminum sulfate (alum) to the lake in October 2008
- Application of a second dose of alum to the lake in October 2009

The 2008, 2009, and 2010 Long Lake water quality monitoring results indicate much improved water quality, including lower concentrations of total phosphorus and chlorophyll *a*, and higher Secchi disc transparencies compared to previous years. The 2008 improved water quality was likely due to late ice-out that year, which resulted in a shorter period of summer thermal stratification, less hypolimnetic oxygen depletion, and reduced late-summer internal phosphorus loading to the lake. Nearby Lake DeMontreville also experienced improved water quality in 2008 for the same reasons. The 2009 water quality results for Long Lake demonstrate the effects of the Fall 2008 alum treatment. The 2009 summer-average Secchi disc transparency was (5.3 meters), nearly double the summer-averages of 2007 and 2008, and the highest on record. Summer averages of total phosphorus and chlorophyll *a* concentrations in 2009 were the lowest on record for Long Lake. Phosphorus and chlorophyll *a* concentrations rebounded some in 2010, but the summer-averages were still the second best on record behind 2009.

As expected, the improved average summer lake water clarity created

more habitat for aquatic plants in the lake. Low water levels in recent years also allowed plants to grow in more areas of the lake. The Friends of Long Lake Association is very concerned that Eurasian watermilfoil and curlyleaf pondweed have overtaken the native plants in the lake and these invasive plants are negatively affecting the lake.

The Managers plan to conduct the following monitoring activities at Long Lake in 2011:

- Normal monthly monitoring of Secchi disc transparency and collection of surface samples for phosphorus and chlorophyll *a* for Long Lake
- The Managers will have an August point-intercept aquatic plant survey conducted to determine the extent to which aquatic plants have been able to colonize additional areas of the lake. All sampling and data analysis will be conducted according to the methodologies described in the DNR protocol for aquatic vegetation surveys. The survey would incorporate assessments at roughly 150 GPS points, with documentation of the following at each sample point:
    - Water depth
    - Plant species retrieved (using the rake method)
    - Plant growth density

<u>Sunfish Lake</u>

In 2006, Sunfish Lake's summer-average Secchi disc transparency depth was 1.44 feet, which was worse than the VBWD-set action trigger of 2.3 feet. Therefore, in accordance with Table 4.2-6 of the Plan, the VBWD collected supplemental water quality data from Sunfish Lake in 2007. The Managers also ordered a detailed study of the lake to determine if it was feasible to improve the lake's water quality so that it will not eventually be listed as nutrient-impaired by the Minnesota Pollution Control Agency. In 2008, the Managers implemented the following plan to improve Sunfish Lake's water quality:

- Applying alum to the lake in October/November of 2008 at a low dosage to improve water quality, but not dramatically enough to the point where macrophytes colonize the entire lake bed due to high water clarity;
- If needed, apply additional alum within five years to maintain water quality

Alum was applied in the fall of 2008 at a relatively low dosage, in accordance with the Managers' plan. The 2009 and 2010 Sunfish Lake water quality monitoring results do not show improved water quality over year 2008. Summer-average Secchi disc transparency for 2010 was 2.0 feet (0.60 meters), still less than the MPCA shallow lake water quality standard of 3.3 feet. The Managers had originally planned to perform an additional alum treatment in fall 2010, and additional water quality data and sediment data were collected to assist with planning of the alum treatment. However, water levels in Sunfish Lake continue to be below normal, and the area of the lake is well below normal. Due to low water levels, as well as difficulty gaining access to the lake for equipment and materials, the alum treatment did not occur in 2010. The Managers plan to have WCD continue monitoring Sunfish Lake in 2011. Conducting additional alum treatments on Sunfish Lake remains an option, but currently there are no plans to conduct an alum treatment in 2011 due to the low water levels in Sunfish Lake.

Stream Water Quality Monitoring Program

Stream monitoring can be broken down into three categories:

1) Physical condition of the stream (including such factors as riffles, pools, bottom material, bank stability, bank vegetation)

2) Quality and quantity of the water supply (including water chemistry parameters such as pH, temperature, dissolved oxygen, fecal coliform bacteria, etc. and the fluctuation of water levels and flow rates)

3) Diversity of aquatic insects and other stream inhabitants

2010 Stream Water Quality Monitoring Results

The 2010 stream water quality program consisted of quality, quantity, invertebrate, and fish monitoring on Valley Creek.

WOMP Station

In 2010, the VBWD continued to participate in the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP) by collecting discrete and continuous quality and quantity data from the Main Stem of Valley Creek, just upstream of the Putnam Boulevard bridge. The Metropolitan Council will report the water quality data in a yet to be published 2010 annual report, which will be available from the VBWD.

Stations Upstream of WOMP Station
In 2010, the VBWD continued to collect discrete and continuous quality and quantity data from one station on the South Fork of Valley Creek and one station on the North Fork of Valley Creek. The VBWD contracts with the St. Croix Watershed Research Station to collect these data and the data at the WOMP station. The St. Croix Watershed Research Station's *Valley Creek Data Report July 2009 – June 2010* will be available from the VBWD when it is complete.

Invertebrate Sampling
Sampling by VBWD
An invertebrate sample was collected by the VBWD from one location (Stations B) on Valley Creek in 2010. Typically, a sample is also collected at a second location (Station C), but this location was flooded due to backwater of the St. Croix River in the fall of 2010 when the samples are collected.

The invertebrate program is discussed in the following paragraphs. Sample location stations are:

- *Station B*: Located on the South Fork of Valley (Branch) Creek, 800 feet upstream of the Main Stem, near Stagecoach Trail.

- *Station C*: Located on the Main Stem of Valley (Branch) Creek, immediately downstream of CSAH 18 (old Highway 95).

While water samples provide an assessment of stream water quality at the time of sample collection, benthic invertebrates provide a long-term assessment of water quality. They live on the bottom and in the vegetation of a stream as long as water quality conditions permit. As attached organisms, benthic aquatic invertebrates are exposed to all the temporal variations in stream quality and "integrate" the quality of passing water. Each type of benthic invertebrate has a different tolerance for pollution; studying the numbers and types of benthic invertebrates can indicate pollution in a stream. When sufficient pollutants enter the stream to prevent their survival, they are eliminated. Monitoring the presence or absence of biological indicator organisms provides indirect evidence of the effects of transitory changes in stream water quality related to stormwater runoff.

Methods
Samples were collected from a riffle location with a D-frame aquatic net. The substrate was disturbed with the sampler's feet, allowing dislodged invertebrate to drift into the net downstream. Samplers also passed the D-frame net through debris and vegetation near the banks. Rocks were examined, too. All the invertebrate samples were preserved in 80 percent alcohol and later identified. The samples collected by Barr Engineering Company were identified by Dr.

Dean Hansen of the University of Minnesota.

Results

Once individual invertebrates were identified, the Hilsenhoff's Biotic Index (HBI, Hilsenhoff, W.L. 1987. An Improved Biotic Index of Organic Stream Pollution. The Great Lakes Entomologist, 20(1): 31--39) was used to further analyze the data. The index uses invertebrate data to rank a stream according to its water quality. Water quality categories include excellent, very good, good, fair, poor, and very poor. Other indicators of stream water quality include numbers of families and the dominant family percentage.

Invertebrate data for 2010 are included in Table D-6. The pollution-sensitive organisms again dominated the benthic invertebrates found at Station B. A large number of the specimens captured at both sites were mayflies, scuds, and caddisflies. These organisms have a relatively low HBI, indicating higher water quality. The pollution-sensitive organisms at both stations exist in similar percentages and make up a diverse biotic community, which is also an indicator of high water quality.

The Hilsenhoff Biotic Index (HBI) for Station B and for Station C is presented for the period of record in Figures D-1 and D-2 within this appendix. Based on the HBI, the 2010 water quality for Valley Creek at Station B was "Very Good." The Station B rating is consistent with previous sampling years.

The HBI rating for Valley Creek has been Very Good or Excellent during the entire period of record, except for 1993 and 1995, when fair water quality indices were calculated. Sampling staff observed that the stream substrate had changed from sandy/rocky to sediment during 1993. Therefore, it appears that conveyance of sediment to Valley Creek caused the significant change noted by the biotic index assessment of the stream. During the 2008 and 2009 sample collections at Station C, the sampling staff member observed sediment, likely caused a slower water velocity due to a silt fence installed for a bridge replacement project directly upstream of Station C.

Sampling by Stillwater Area High School Students

Through VBWD funding, students from the Stillwater Area High School collected stream macroinvertebrate and physical habitat data from Valley Creek in 2010 as in previous years. The samples are identified by the students, and verified by their teacher and staff of the Washington Conservation District. The 2010 data will likely be reported to the VBWD Managers in the spring of 2011.