Appendix D
Water Quality Program

(Appendix D is divided into 4 parts)

Part 1

2012 VBWD Water Quality Data Collection Program

(Narration, Tables D-1 through D-6, Figure D-1 [Avg. water clarity depths], and Figures D-2 and D-3 [Biotic Index Values])

2012 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 2012, the VBWD did not recruit any CLMP volunteers.

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 2012, the VBWD recruited volunteers to collect the water quality samples for this monitoring program at the following ten basins: Lakes Jane, Olson, DeMontreville, Elmo, Sunnybrook, and

Edith; Long and Cloverdale Lakes; and Klawitter and Rest Area Ponds. Ramsey County Public Works continued to monitor the water quality of Silver Lake in a manner equivalent to the CAMP in 2012. The VBWD hired the Washington Conservation District to collect water quality samples in a manner equivalent to CAMP from ten basins, including Lake Edith; Bay, Downs, Echo, Eagle Point, Goose (North and South), Horseshoe, Kramer, McDonald, and Sunfish Lakes. These samples were generally collected once in April, once in May, five times in June through September, and once in October.

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 2012, 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. No intensive water quality monitoring was done in 2012.

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. Starting in 2010, the VBWD scaled back its habitat monitoring efforts and only conducted macrophyte

surveys. In 2012, macrophyte data were collected in fifteen basins and figures summarizing the data are included in this appendix. 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, see Table D-1). 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 25^{th} 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.

Table D-1

WATER QUALITY RANKINGS AND WATER QUALITY GUIDELINES FOR VBWD WATER BODIES
Valley Branch Watershed District

VBWD Water Quality Ranking	MPCA Swimmable-Use Classification & MPCA Swimmable Use Support Definition	Guidelines Guidelines (Water quality conditions adopted as VBWD "Action Levels" that, when violated, trigger management actions.)
Excellent (A) These water bodies have the highest/best water quality and are usually the most popular water bodies with the public. These water bodies fully support all water-based recreational activities including direct-contact activities, such as swimming, scuba diving and snorkeling.	***Full-Support*** Few algal blooms and adequately high transparency exists throughout summer to support swimming.	Water bodies that do not meet the following water quality guidelines may not support all water-based recreational activities: Minimum summer Secchi disc depth of at least 1.1 meters (3.5 feet)[1]. Summer average Secchi disc depth of at least 1.2 meters (3.9 feet). Summer average total phosphorus concentrations less than 40 µg/L. Summer average chlorophyll-a concentrations less than 15 µg/L. Carlson TSI index (Secchi disc based) no greater than 57. Of equal importance are guidelines related to aesthetic enjoyment and wildlife habitat to maintain/improve desired use of these water bodies.
Good (B) These water bodies have poorer water quality than A water bodies, but are still popular with the public and some people might swim in them.	***Partial-Support (impaired)*** Algal blooms and low transparency may limit swimming for a significant portion of the summer.	Water bodies that do not meet the following water quality guidelines may not support all non-direct-contact recreational activities: Summer average Secchi disc depth of at least 1.1 meters (3.5 feet), but less than 1.2 meters (3.9 feet). Summer average total phosphorus concentrations less than 45 µg/L, but more than 40 µg/L. Summer average chlorophyll-a concentrations less than 18 µg/L, but more than 15 µg/L. Carlson TSI index (Secchi disc based) should be no greater than 59. Of equal importance are guidelines related to aesthetic enjoyment and wildlife habitat to maintain/improve desired use of these water bodies.
Fair (C) These water bodies are not viewed as swimmable because of lower water quality. Water bodies in this classification generally support fishing (in lakes capable of supporting a fishery), and provide opportunities for aesthetic viewing, and observing wildlife.	***Non-Support (impaired)*** Severe and frequent algal blooms and low transparency will limit swimming for most of the summer.	Water bodies that do not meet the following water quality guidelines may not support fishing and may be subject to winterkill: Summer average Secchi disc depth greater than 0.7 meters (2.3 feet), but less than 1.1 meters (3.5 feet)[2]. Summer average total phosphorus concentration greater than 45 µg/L, but less than 112 µg/L[2]. Summer average chlorophyll-a concentration greater than 18 µg/L, but less than 62 µg/L[2]. Carlson TSI index (Secchi disc based) less than or equal to 65[3]. Of equal importance are guidelines related to aesthetic enjoyment and wildlife habitat to maintain/improve desired use of these water bodies.
Poor (D) These water bodies may be suitable for aesthetic viewing activities, observing wildlife, and other appropriate public uses. These water bodies are generally too shallow to support fishing activities.	***Non-Support*** Severe and frequent algal blooms and low transparency will limit swimming for most of the summer.	Of primary importance are guidelines related to aesthetic enjoyment and wildlife habitat to maintain/improve desired use of these water bodies.

[1] Minnesota Lake Water Quality Assessment Report, MPCA 1988, page 72, "no swimming" 50th percentile.
[2] Minimum Secchi disc depth and maximum total phosphorus & chlorophyll-a concentrations computed using Carlson TSI Index of 65 and Minnesota Lake Water Quality Assessment Report, MPCA 1988, equations on page 15 for TP>17 and equation on page 6.
[3] Upper range of Carlson TSI index (65) based on a Class 43 Lake in Table 3 of the DNR's Division of Fish and Wildlife Document 417: An Ecological Classification of Minnesota Lakes with Associated Fish Communities, August 1992.

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-2 (Table 4.2-6 from the VBWD Plan) from the Plan summarizes the recommended actions.

Table D-2

(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.

2011 Basin Water Quality Results & 2012 Basin Monitoring Program

Barr Engineering Company added the 2012 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-3 summarizes this information. Figure D-1 shows the 2012 summer-average Secchi disc transparency depths for all of the basins monitored in 2012. Charts of historic water quality data for each water body monitored in 2012 are included at the end of this appendix.

Only one water body had 2012 summer-average Secchi disc transparency depths poorer than its respective action trigger: Silver Lake. Silver Lake also had two individual Secchi disc transparency depths less than the summer minimum trigger of 1.2 meters (3.9 feet). Silver Lake was the only lake that had a statistically significant degrading trend in water quality.

TABLE D-3
WATER QUALITY ACTION TRIGGERS AND WATER QUALITY TRENDS SUMMARY

Water Body (Water Quality Ranking)	Action Triggers and Secchi Disc Transparency Depths (meters)						2012 Water Quality Trend? (95% Confidence)
	Based on Summer Average			Based on Two Minimum Individual Readings			
	Summer Average Trigger	2012 Summer Average Secchi Disc Transparency Depth	2012 Summer Average Better than Summer Average Trigger?	Summer Minimum Trigger for A Ranked Water Bodies	2012 Summer Minima	2012 Minima Better than Minimum Trigger?	
Acorn Lake (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Bay Lake (D)	N/A	0.32	N/A	N/A	N/A	NA	None (but degrading trend at 80% confidence)
Beutel Pond (assume D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Capaul's Pond - East (D)	N/A	Not Sampled	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)	2.70	2.73	Yes	1.2	2.4 & 2.6	Yes	None
Lake DeMontreville (A)	2.48	2.93	Yes	1.2	1.5 & 1.9	Yes	None
Downs Lake (D)	N/A	0.38	N/A	N/A	N/A	NA	**
Eagle Point Lake (D)	N/A	0.65	N/A	N/A	N/A	NA	None
Echo Lake (D)	N/A	1.68	N/A	N/A	N/A	NA	**
Lake Edith (A)	1.81	2.28	Yes	1.2	1.4 & 2.0	Yes	None
Lake Elmo (A)	3.60	3.60	Yes	1.2	4.0 & 5.0	Yes	None
Fahlstrom Pond - East (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Fahlstrom Pond - West (D)	N/A	Not Sampled	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)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Goose Lake - North (D)	N/A	0.38	N/A	N/A	N/A	NA	**
Goose Lake - South (D)	N/A	0.30	N/A	N/A	N/A	NA	**
Horseshoe Lake (C)	1.09	1.71	Yes	N/A	N/A	NA	None (but improving trend at 80% confidence)
Lake Jane (A)	4.18	5.33^	Yes	1.2	5.0 & 5.0	Yes	**
Klawitter Pond (D)	N/A	0.81	N/A	N/A	N/A	NA	None
Kramer Pond (D)	N/A	0.15	N/A	N/A	N/A	NA	**
Lake Olson (A)	2.56	2.69	Yes	1.2	1.2 & 1.9	Half	None
Legion Pond (C)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Long Lake (C)	2.16	3.10	Yes	N/A	N/A	NA	None (but improving trend at 80% confidence)
McDonald Lake (C)	1.38	1.68	Yes	N/A	N/A	NA	None
Mergens Pond (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Rest Area Pond (D)	N/A	0.61	N/A	N/A	N/A	NA	None
Rose Lake - North (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Rose Lake - South (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
Silver Lake (A)	1.30	1.06	No	1.2	0.4 & 0.5	No	Yes (degrading trend at 99% confidence)
Sunfish Lake (C)	0.57	1.22	Yes	N/A	N/A	NA	None
Sunnybrook Lake (A)	2.31	2.82	Yes	1.2	2.7 & 2.7	Yes	None (but improving trend at 90% confidence)
Weber Pond (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**
West Lakeland Storage Site - North (D)	N/A	Not Sampled	N/A	N/A	N/A	NA	**

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

5.33^ – Based on 3 measurements collected in Lake Jane in June 2012. No measurements were collected after June 18.

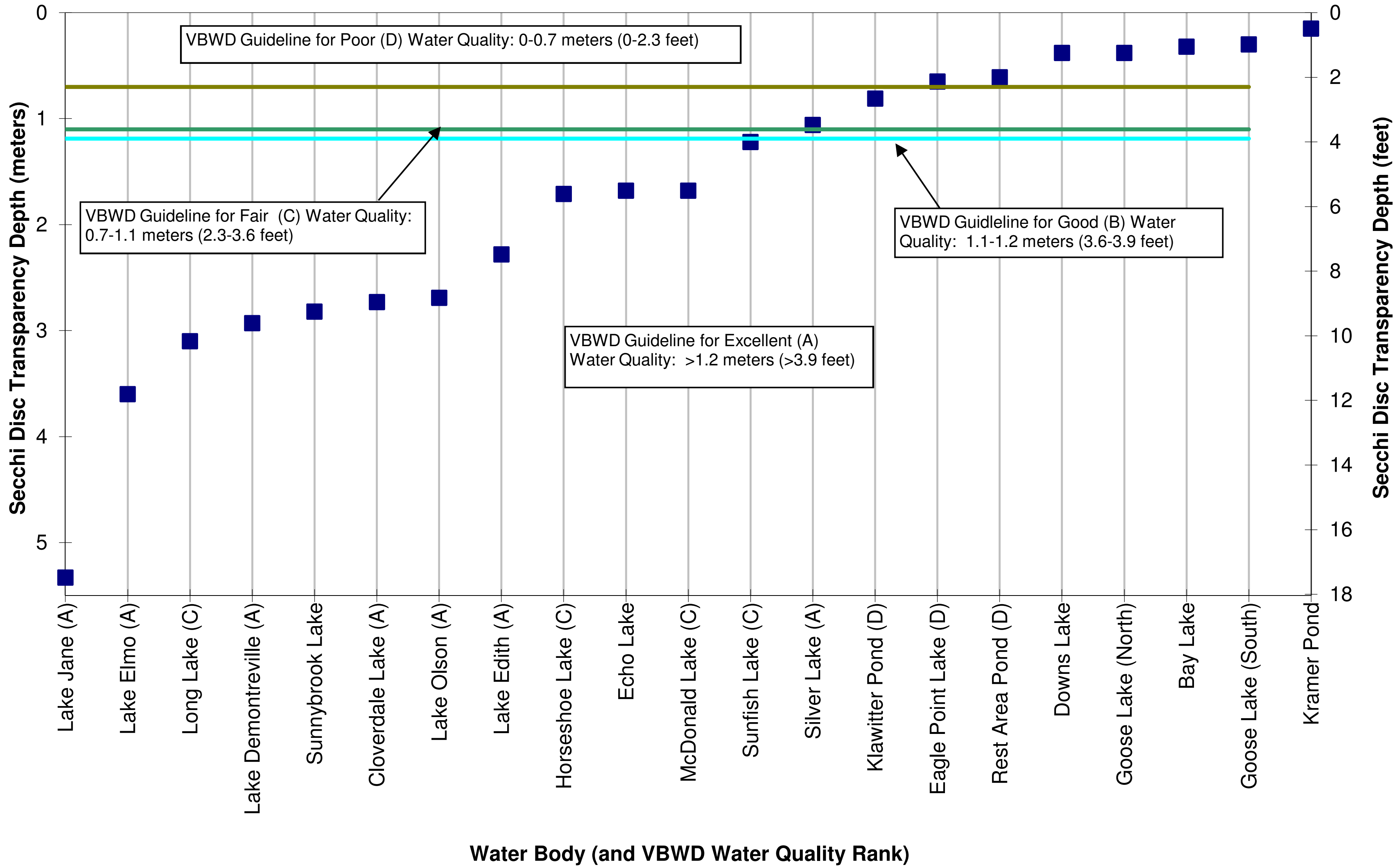
N/A – Action triggers do not apply to "D" water quality rankings (summer average Secchi disc readings) or to "B", "C", or "D" water quality rankings (minimum Secchi disc readings)

[green box] – 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

2012 SUMMER AVERAGE WATER CLARITY DEPTHS OF MAJOR WATER BODIES
VALLEY BRANCH WATERSHED DISTRICT



The following paragraphs discuss the noteworthy 2012 water quality monitoring results and 2013 monitoring plans. Table D-4 shows the Managers' 2013 monitoring plan, based on 2012 results and the annual monitoring plan framework contained in the VBWD Plan.

Lakes Failing VBWD Action Triggers
Silver Lake

Silver Lake's 2012 summer-average Secchi disc transparency of 1.06 meters (3.48 feet) is the poorest summer-average since 1977. The historic water quality data show a rapid decrease in water quality beginning in 2007. The degrading water quality conditions observed during the recent 6-year period of 2007-2012 are most likely due to the whole-lake aquatic plant treatment applied to the lake.

The VBWD summer-average Secchi disc action trigger for Silver Lake was 1.30 meters (4.27 feet) for 2012, while the calculated summer-average was only 1.06 meters (3.48 feet). In addition, the VBWD set a goal for Silver Lake of having at least a 1.2 meter (3.9 foot) minimum summer Secchi disc transparency depth, but the two worst readings of the season were only 0.40 meters (1.3 feet) and 0.49 meters (1.6 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 2012 summer-average total phosphorus concentration for Silver Lake was 131 μg/L, which is poorer than the VBWD goal of 40 μg/L and the poorest observed summer-average since 1976. This value is worse than the MPCA total phosphorus criterion for shallow lakes, which is 60 μg/L or less. The total phosphorus concentration was 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* above 20 μg/L or Secchi disc depth less than 3.2 feet in addition to total phosphorus levels above 60 μg/L). In 2012, 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

Table D-4
2013 WATER QUALITY MONITORING PROGRAM
Valley Branch Watershed District

Water Body	2013 Sampling	Water Quality Sampler	Macrophytes Monitoring Sampler & Schedule	Phytoplanton & Zooplankton Sampler & Schedule	Water Levels Reader
Acorn Lake	SL^, Q^			None	
Bay Lake	SD^^	WCD-B		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: June	None	Gage for Dr. Bjork
Lake DeMontreville	ML, PI	Steve Iverson	Qualified contractor: June	None	(Chuck uses Lake Olson gage)
Downs Lake	SD^^	WCD-B		None	Gage for Chuck Taylor
Eagle Point Lake	SL, PI	WCD-B	Qualified contractor: June	None	Chuck Taylor (no gage)
Echo Lake	SD^	WCD-B		None	WCD
Lake Edith	**Edith**[2], PI	Joe Reithmeyer and WCD-B	Qualified contractor: June	None	WCD
Lake Elmo	ML, PI	Jeff Berg & Wendy Griffin	Qualified contractor: June	None	Gage for Chuck Taylor
Fahlstrom Pond - East	SD^			None	
Fahlstrom Pond - West	SD^			None	
Friedrich's Pond	SD^			None	
Goetschel Pond	SL^, Q		Barr: June	None	
Goose Lake - North	SD^^	WCD-B		None	
Goose Lake - South	SD^^	WCD-B		None	
Horseshoe Lake	SD^^, PI	WCD-B	Qualified contractor: June	None	Gage for Chuck Taylor
Lake Jane	ML, PI	Anne McGee	Qualified contractor: June	None	Gage for Chuck Taylor
Klawitter Pond	SD^^	Bonnie Juran		None	Gage for Bonnie Juran
Kramer Pond	SD^^	WCD-B		None	
Legion Pond	SL^, Q		Barr: June	None	
Long Lake	SL, PI	Bill Feely	Qualified contractor: June	None	Gage for Bill Feely & Chuck Taylor
McDonald Lake	SL, PI	WCD-B	Qualified contractor: June	None	Gage for WCD
Mergens Pond	SD^			None	
Lake Olson	ML, PI	Bob Meier	Qualified contractor: June	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, PI	WCD-B	Qualified contractor: June	None	Gage for Chuck Taylor
Sunnybrook Lake	SL, Q	Gary and Phyllis Holborn	Barr: June	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, Eagle Point Lake, Lake Demontreville, Lake Olson, Lake Jane, and Lake Elmo; DNR for Silver Lake, if feasible)

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 of field parameter data each event. Depth profile date includes 1-meter interval temperature and dissolved oxygen data with a field probe.

VBWD. Based on the 2007-2012 monitoring results for Silver Lake, the lake's water quality is not improving or being protected. We recommend that the Managers take the following actions at Silver Lake in 2012:

- 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.
- Continue to encourage the DNR to conduct point-intercept aquatic plant surveys of the lake.
- Continue to request that Ramsey County Public Works collect water quality, phytoplankton, zooplankton, and water level data.
- First complete the Watershed Restoration and Protection Project (WRPP) that includes Silver Lake (see discussion later in this document) and then work with the Cities of North St. Paul and Maplewood and the SLIA to implement stormwater runoff treatment practices to improve water quality.

Other Noteworthy Results and Recommendations
Lake Edith
Based on past monitoring results, the Managers took additional water quality management actions in 2011 and 2012 at Lake Edith. Lake Edith had summer-average Secchi disc transparencies better than the action triggers in 2012, and the summer-average Secchi disc transparency was considerably better in 2011 and 2012 than in 2009 and 2010. The summer-average Secchi disc transparency in 2012 was 2.28 meters (7.5 feet), compared to 1.53 meters (5.0 feet) in 2010. Recall that the 2010 summer-average Secchi disc transparency in Lake Edith was the worst recorded since 1979, and was part of a declining trend in summer-average Secchi disc transparency for the period of 2002–2010. Note that the 2002 summer-average Secchi disc transparency was the best on record.

The trend in declining summer-average Secchi disc transparency from 2002-2010 had triggered additional action from the VBWD Managers in 2011 and 2012. In addition to water quality measurements collected at the lake surface, water samples were collected at various depths in Lake Edith and analyzed for phosphorus. Results demonstrated higher concentrations of phosphorus in the deeper waters of Lake Edith, indicating release of phosphorus from the lake sediment (i.e., internal loading of phosphorus). The degree to which internal loading of phosphorus from the sediment affects the water quality at the surface of the lake is dependent on a number of factors, including climate. Spring and summer temperatures, and the degree to which wind forces mixing of the lake, can have a large effect on how internal loading of phosphorus will affect the water quality at the surface of the lake.

Lake Edith is one of the lakes that will be studied as part of the Watershed Restoration and Protection Project (WRPP) study. The WRPP study is discussed later in this report. Because Lake Edith will be studied in more detail through the WRPP, Barr does not recommend any additional water quality monitoring for Lake Edith in 2013 above the standard monthly survey level monitoring of Secchi disc transparency, total phosphorus, and chlorophyll *a*, with the exception of measurements of field parameters (e.g., temperature and oxygen) at 1-meter depth intervals.

Long Lake

In 2006, Long Lake's summer-average Secchi disc transparency depth of 1.41 meters (4.63 feet) failed to be better than the VBWD-set action trigger of 1.50 meters (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 is not eventually 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, which resulted in a shorter period of summer thermal stratification, less hypolimnetic oxygen depletion, and reduced late-summer internal phosphorus loading to the lake. The 2009 summer-average Secchi disc transparency was 5.3 meters (17.4 feet), nearly double the summer-averages of 2007 and 2008, and the highest on record. Summer averages of total phosphorus and chlorophyll *a* concentrations were the lowest on record for Long Lake in 2009. Phosphorus and chlorophyll *a* concentrations increased some in 2010 (summer-average Secchi disc transparency of 4.69 meters (15.4 feet)), but were still the second best on record behind 2009.

The 2012 summer-average Secchi disc transparency for Long Lake was 3.1 meters (10.2 feet), which is similar to the 2011 summer average, as well as the pre-alum treatment summer averages of 2007 and 2008. The 2012 summer-average Secchi disc transparency is markedly better than the summer averages during the period of 1997–2006. The 2012 summer-average total phosphorus concentration was 15 µg/L, which is better than the 2011 summer average of 23 µg/L and similar to the 2009 and 2010 summer averages of 11 and 16 µg/L. Factors that may have contributed to the poorer summer-average Secchi disc transparency in 2011 and 2012 as compared to 2009–2010 include: (1) more spring and summer runoff in 2011 and 2012 than in previous years, and (2) a whole-lake herbicide treatment in 2011 to reduce the growth of Eurasian watermilfoil, an invasive aquatic plant. Prior to the herbicide treatment, Eurasian watermilfoil grew at nuisance levels in Long Lake. The summer averages for Secchi disc transparency, total phosphorus, and chlorophyll *a* have been better than the VBWD's guidelines for "Excellent" water quality for the last 6 years (2007-2012).

Lake Elmo

In 2011, Lake Elmo's summer-average total phosphorus concentration was 40.5 µg/L, which is significantly worse than previous years' summer averages. Additionally, the 2011 summer average was slightly worse than the VBWD's guideline for "Excellent" water quality, which is 40 µg/L total phosphorus. The poorer summer average of 2011 is primarily due to a single sample collected on July 18, 2011. The total phosphorus concentration on July 18 was 122 µg/L. If this data point were removed, the 2011 summer-average total phosphorus concentration would be 24.2 µg/L. The high concentration of total phosphorus measured on July 18, 2011, may be a result of the heavy precipitation that occurred on July 16, 2011. High flows from Eagle Point Lake, which has high phosphorus concentrations, discharged directly into Lake Elmo after the storm. The water would have been warmer than the colder deep water of Lake Elmo and would have traveled across the surface of the lake where the samples are collected. It is also possible the data point is erroneous.

In 2012, Lake Elmo's summer-average total phosphorus concentration was 20.0 µg/L, less than half the summer-average of 2011 and well below the VBWD's guideline for "Excellent" of 40 µg/L total phosphorus. Barr does not recommend any changes to the routine monitoring plan for Lake Elmo.

Lake Jane

In 2012, the CAMP (the Metropolitan Council's Citizen-Assisted Monitoring Program) volunteer only collected samples at Lake Jane in the months of April, May, and June. Too few measurements were collected during the summer-averaging period to determine summer-average values for 2012. Recall that in 2011, the summer-average Secchi disc transparency of 3.8 meters (12.5 feet) was less than the summer-average trigger of 4.2 meters (13.6 feet) for Lake Jane. Overall, the water quality of Lake Jane remains excellent; only Lake Elmo and Lake Olson had better 2011 summer averages of Secchi disc transparency. The period of 2004-2008 consistently saw some of the highest (best) summer-average Secchi disc transparencies on record for Lake Jane. Barr does not recommend any additional water quality monitoring for Lake Jane in 2013 above the standard monthly survey level monitoring of Secchi disc transparency, total phosphorus, and chlorophyll *a*.

Watershed Restoration and Protection Project (WRPP) Study

The VBWD has partnered with the Minnesota Pollution Control Agency (MPCA) to perform a Watershed Restoration and Protection Project (WRPP) study for a portion of VBWD. The WRPP study will be conducted by Barr Engineering and will study the following lakes: Sunfish Lake (impaired because of excessive nutrients), Eagle Point Lake (impaired because of excessive nutrients), Silver Lake, Horseshoe Lake, and Lake Edith. The lakes selected for the WRPP are either included on the MPCA 303(d) impaired waters list or have shown degrading water quality over the most recent years of monitoring. The objectives of the WRPP include providing knowledge of the following for the study lakes:

- The extent and statistical significance of degraded water quality conditions.
- The trophic status of each lake and how its water quality compares to "minimally impacted" background or reference conditions.
- The climatic conditions for the current, representative water-quality-monitoring periods compared to the entire period of record.
- The effects of stormwater inputs to the basins under dry, normal, and wet seasons.
- How the pollutant loadings (or concentrations/readings) and potential pollutant sources within each subwatershed compare.
- What phosphorus load reductions and future efforts will be needed—and the relative priority of each action—to maintain or improve water quality.

Kelle's Coulee, which is impaired for bacteria (*E. coli*), will also be studied through the WRPP. Work performed as part of the VBWD WRPP will identify sources of the *E. coli* and develop a plan to address the high levels found in Kelle's Coulee.

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

2012 Stream Water Quality Monitoring Results
The 2012 stream water quality program consisted of quality, quantity, and invertebrate monitoring on Valley Creek and water quality monitoring on Kelle's Coulee (also known as Kelle's Creek). The Managers also conducted flow monitoring at the outlet of Rest Area Pond.

Valley Creek WOMP Station
In 2012, 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 2012 annual report, which will be available from the VBWD.

Valley Creek Stations Upstream of WOMP Station
In 2012, 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 reports will be available from the VBWD when they are complete.

Kelle's Coulee and Rest Area Pond Outlet Monitoring
In 2012, the VBWD continued to monitor Kelle's Coulee and outflows from Rest Area Pond, with some funding provided through a grant from the St. Croix River Association. Preliminary results are summarized in Table D-5.

Table D-5
Kelle's Creek and I-94 Rest Area Pond (RAP) 2011 and 2012 Loads and Flow-weighted Mean (FWM) Concentrations

Site	Year	Parameter	Start date of flow data	End date of flow data	Volume (cf)	Annual Load (kg)	FWM conc (mg/L)
Kelle's Creek[1]	2011	TP	1-Jan-11	31-Dec-11	13,395,916	63.9	0.174
Kelle's Creek[2]	2012	TP	1-Jan-12	31-Dec-12	9,985,556	47.8	0.257
I94 RAP[3]	2011	TP	1-Jan-11	31-Dec-11	15,500,000	49.0	0.110
I94 RAP	2012	TP	No Flow in 2012	No Flow in 2012	0	0	-

[1]Load value is the sum of 2 separate modeling efforts. MCES staff calculated the load for the monitored period (4/19/11 - 10/30/11) only. Barr staff calculated load for the unmonitored period by using estimated flow data. Flow estimates were based on data from the nearby station on South Branch Valley Cr. Both MCES and Barr staff calculated the loads manually using a spreadsheet model.

[2]Load value was calculated by Barr staff manually using a spreadsheet model. Flows for the unmonitored period were estimated based on data from the nearby station on South Branch Valley Cr.

[3]Load value was calculated by MCES staff using the Flux32 program. Flows for the unmonitored period were assumed to be 0.

Valley Creek Invertebrate Sampling

Sampling by VBWD

The invertebrate program is discussed in the following paragraphs. Invertebrate samples were collected by the VBWD from two locations (Stations B and C) on Valley Creek in 2012. 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 2012 are included in Table D-6. The pollution-sensitive organisms again dominated the benthic invertebrates found at Station B. The largest number of the specimens captured at Station B was scuds and caddisflies. The largest number of specimens captured at Station C was mayflies and scuds. 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-2 and D-3 within this appendix. Based on the HBI, the 2012 water quality for Valley Creek at both stations was "Very Good." These ratings are generally consistent with the ratings of previous years.

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 2012 as in previous years. The samples are identified by the students, and verified by their teacher and staff of the Washington Conservation District. The 2012 data will likely be reported to the VBWD Managers in the spring of 2013.

Table D-6

Valley Branch Creek
Aquatic Macroinvertebrates: October 2, 2012

Identifications by Dean C. Hansen
(Numbers refer to larvae except where noted)

Taxa	Station B (No. Specimens)	Station C (No. Specimens)
PHYLUM ARTHROPODA		
CLASS INSECTA		
Coleoptera (beetles)		
Curculionidae ,undetermined adult	0	0
Dryopidae	0	0
Helicus, adult	0	0
Dytiscidae		
Coptotomus, adult	0	0
Laccodytes, adult	0	0
Liodissus, adult	0	0
Elmidae		
Stenelmis (adult)	0	0
Optioservus, larvae	112	12
Optioservus, adult	16	4
Gyrinnidae		
Gyrinus, adult	0	0
Haliplidae		
Peltodytes, adults	0	0
Haliplus	0	32
Hydrophilidae		
Anacaena, adults	0	0
Tropisternus, adult	1	0
Undetermined (adult)	0	0
Staphylinidae, adult	0	0
Diptera (true flies)		
Athericidae		
Chironomidae		
Diamesa, (larvae)	0	0
Unidentified Chironomidae (larvae)	136	192
Unidentified Chironomidae (pupae)	0	0
Culicidae		
Anopheles	0	0
Orthocladinae		
Corynoncura, larvae	0	0
Unidentified pupae	0	0
Prodiamesa	0	0
Dixidae: Dixa	8	0
Empididae	0	0

Table D-6 (cont.)

Valley Branch Creek
Aquatic Macroinvertebrates: October 2, 2012

Taxa	Station B (No. Specimens)	Station C (No. Specimens)
Empididae pupae	0	0
Psychodidae	0	0
Simuliidae (undetermined pupa)		
Simulium vittatum (larvae)	0	0
Simulium tuberosum	0	0
Simulium venustum	0	0
Simulium sp.	160	560
Simulium sp. (undertemined pupa)	0	32
Syrphidae	0	0
Eristalis		
Tabanidae, Chrysops	0	0
Tipulidae (undetermined)	8	4
Tipula	19	36
Antocha	0	0
Microspectra	0	0
Unidentified Higher Diptera larva	0	0
Unidetified Higher Diptera pupa	16	0
Ephemeroptera (mayflies)		
Baetidae		
Baetis flavistriga	0	160
Baetis brunneicolor	64	3536
Baetis sp	0	0
Baetis tricaudatus.	24	512
Undetermined Baetidae	40	112
Ephemerellidae		
Ephemerella	0	0
Heptageniidae		
Heptagenia	0	0
Stenacron	0	0
Stenonema fuscum	0	0
Unidentified Heptageniidae	0	0
Caenidae		
Caenis	0	0
Hemiptera (true bugs)		
Gerridae		
Aquarius, larvae	0	0
Gerris, adult	0	0
Macroveliidae		
Macrovelia	0	0
Nepidae		
Ranatra, adult	0	0
Belostomatidae		

Table D-6 (cont.)

Valley Branch Creek
Aquatic Macroinvertebrates: October 2, 2012

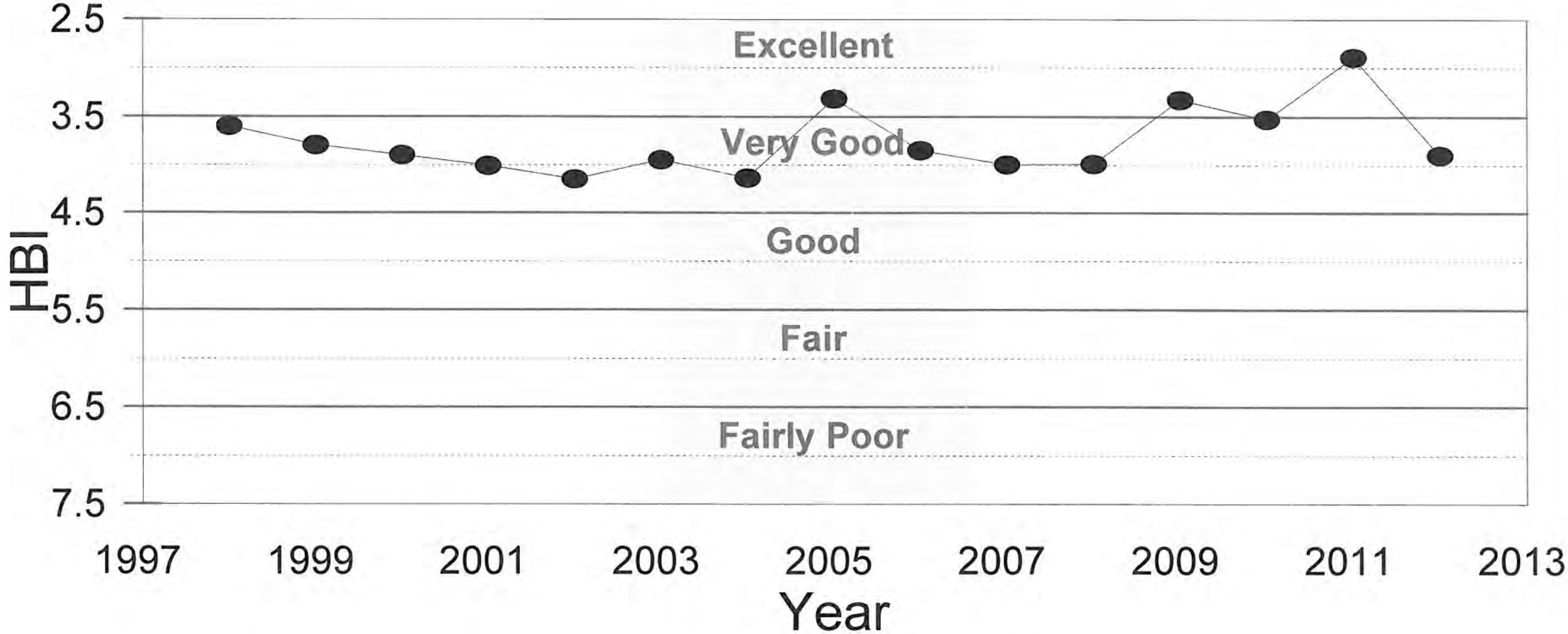
Taxa	Station B (No. Specimens)	Station C (No. Specimens)
Belostoma, adults	2	0
Corixidae		
Sigara	0	0
Megaloptera		
Sialidae		
Sialis	0	0
Odonata (dragonflies and damselflies)		
Coenagrionidae	0	0
Aeshnidae	0	0
Anax spp.	0	0
Aeshna spp.	1	0
Calopterygidae		
Calopteryx or *Hetaerina*	0	0
Boyeria	0	0
Plecoptera	0	0
Taeniopteryx	0	0
Trichoptera (caddisflies)		
Brachycentridae		
Brachycentrus spp.	0	0
Brachycentrus occidentalis	536	0
Goeridae		
Goera (?) (pupa)	4	0
Glossosomatidae		
Glossosoma (larvae)	56	0
Glossosoma (pupa)	0	0
Hydroptilidae		
Hydroptila		32
Undetermined pupae	0	144
Hydropsychidae		
Cheumatopsyche	56	16
Hydropsyche betteni	8	0
Hydropsyche slossonae	40	0
Hydropsyche alhydra	56	0
Hydropsyche undetermined, need slide preparation to I.D.	32	0
Hydropsyche morosa group	0	0
Hydropsyche sparna	0	0
Hydropsyche undetermined, too small	0	0
Lepidostomatidae		
Lepidostoma	16	0
Limnephilidae (undetermined)	0	0
Limnephilus	16	0
Hesperophylax	76	0
Limnephilidae pupae	0	0

Table D-6 (cont.)

Valley Branch Creek
Aquatic Macroinvertebrates: October 2, 2012

Taxa	Station B (No. Specimens)	Station C (No. Specimens)
Philopotamidae		
Chimara	0	0
Phrygeniidae		
Phryganea	0	4
Ptilostomis	0	0
Psychomyiidae		
Lype	0	0
Undetermined Trichoptera pupae	0	0
CLASS CRUSTACEA		
Amphipoda (scuds)		
Gammaridae		
Gammarus	6112	1552
Talitridae		
Hyalella azteca	0	0
Isopoda		
Undetermined terrestrial isopod	0	0
Ascellus	12	16
CLASS DIPLOPODA		
Milliped (undetermined)	1	0
CLASS ARACHNIDA		
Spiders	0	0
Acarina (mites)		
Piona	0	0
Hygrobatidae, megapus	0	0
Phylum Annelida		
Large earthworm	0	0
Hirudinea (leeches)	0	0
Helobdella stagnalis	0	0
Oligochaeta (aquatic earthworms)		
Undetermined Oligochaeta	0	0
Phylum Mollusca		
Gastropoda (snails)		
Lybinaeidae	0	0
Physa	384	16
Undertermined slug	0	0
Pelecypoda		
Sphaeriidae (fingernail clams)	0	0
Pisidium	16	0
Phylum Turbellaria (flatworms)		
“Dugesia” type	0	400
Total Specimens	**8028**	**7372**

Biotic Index Values 1998-2012
Station B, Valley Branch Creek

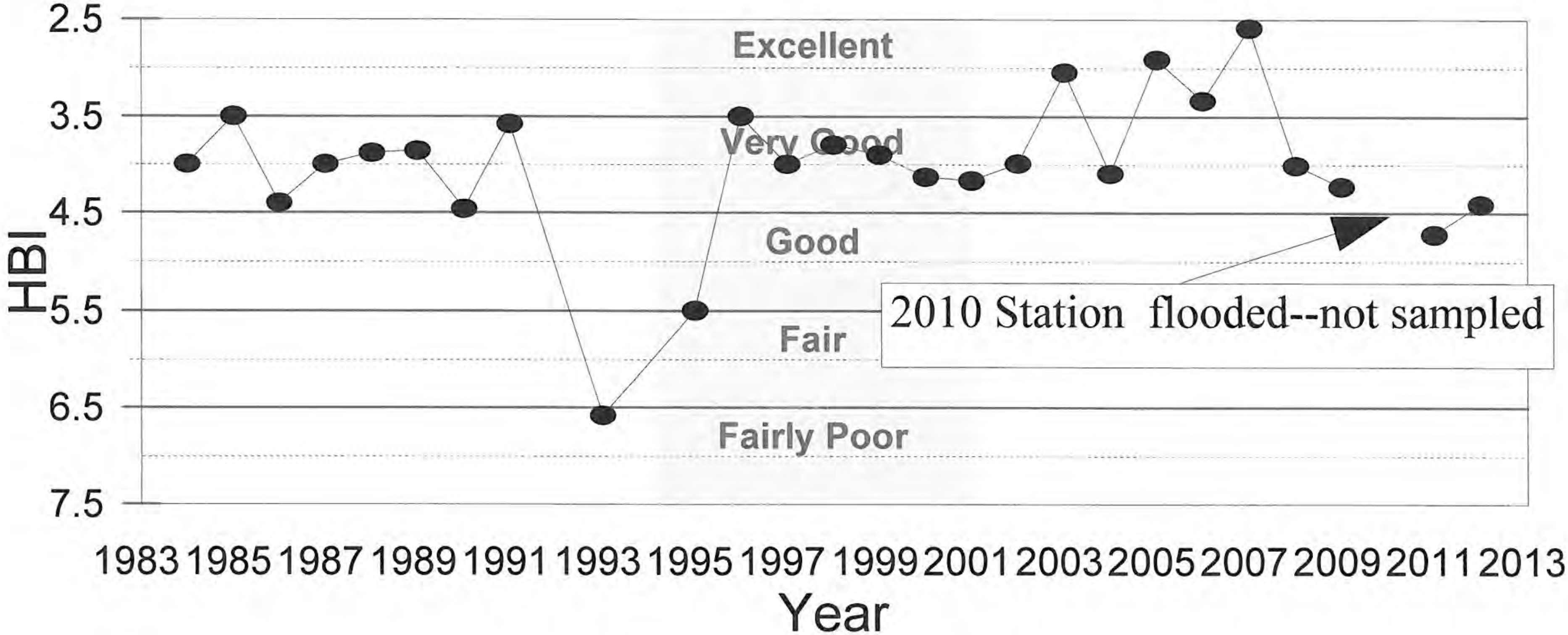


Hilsenhoff Biotic Index (HBI) is a measure of organic pollution and dissolved oxygen availability in streams based on indicator species of benthic invertebrates.
A higher HBI indicates a greater tolerance to low dissolved oxygen and, thus, lower water quality.

Figure D-2

H:\DJM\VBWD\VBWD Invertebrates\2012 Invertebtrates\2012 HBI_graphs.wb2

Biotic Index Values 1984-2012
Station C, Valley Branch Creek



Hilsenhoff Biotic Index (HBI) is a measure of organic pollution and dissolved oxygen availability in streams based on indicator species of benthic invertebrates.
A higher HBI indicates a greater tolerance to low dissolved oxygen and, thus, lower water quality.
Station C flooded during 2010 monitoring event: not sampled

Figure D-3

H:\DJM\VBWD\VBWD Invertebrates\2012 Invertebtrates\2012 HBI_graphs.wb2