SUMMARY NOTES OF THE FEBRUARY 6, 2013, MEETING OF THE ROOT RIVER WATERSHED RESTORATION PLAN ADVISORY GROUP

INTRODUCTION

The February 6, 2013, meeting of the Root River Watershed Restoration Plan Advisory Group was convened at the Racine County Ives Grove Office Complex at 9:10 a.m. The meeting was called to order by Susan Greenfield, Executive Director of the Root-Pike Watershed Initiative Network (Root-Pike WIN). Attendance was taken by circulating a sign-in sheet.

In attendance at the meeting were the following individuals:

Advisory Group Members	
Susan Greenfield, Co-Chair	Executive Director, Root-Pike Watershed Initiative Network
Jeff Martinka, Co-Chair	Executive Director, Southeastern Wisconsin Watersheds Trust, Inc. (Sweet Water)
Michael G. Hahn, Secretary	Chief Environmental Engineer, Southeastern Wisconsin Regional Planning Commission
Joseph E. Boxhorn	Senior Planner, Southeastern Wisconsin Regional Planning Commission
Roger Chernik	Board of Directors President, River Bend Nature Center
Alan V. Jasperson	Secretary-Treasurer, Racine County Board of Drainage Commissioners
Michael Luba	Basin Supervisor, Wisconsin Department of Natural Resources
Christopher Magruder	Community Environmental Liaison, Milwaukee Metropolitan Sewerage District
Monte G. Osterman	Supervisor, Racine County Board of Supervisors
Brian Russart	Natural Areas Coordinator, Milwaukee County Parks/ University of Wisconsin-Extension
Chad Sampson	County Conservationist, Racine County
Melissa H. Warner	Commissioner, Village of Caledonia Storm Water Utility District
Sarah Wright	Research Assistant II, City of Racine Health Department
Andrew D. Yencha	Natural Resources Educator, University of Wisconsin-Extension
Guests	
Robert Smage	Root-Pike Watershed Initiative Network

Ms. Greenfield welcomed the attendees to the meeting and thanked them for their participation. She noted that the draft chapters to be reviewed were sent to the Group by electronic mail.

REVIEW OF SUMMARY NOTES FROM NOVEMBER 7, 2012, MEETING OF THE ROOT RIVER WATERSHED RESTORATION PLAN ADVISORY GROUP

At Ms. Greenfield's request Mr. Hahn addressed the summary notes from the November 7, 2012, meeting of the Advisory Group. He said that he would not do a detailed review, but that he would highlight a few topics in the summary notes, and would respond to any questions or comments from the Group.

Mr. Hahn drew the Group's attention to the Secretary's Note on page 2 of the summary notes. He stated that this note was a response to Mr. Sampson's comments regarding saturated riparian buffer projects. He said that Exhibit A in the summary notes contains a brochure regarding this practice that was developed by the Iowa State University. He added that the diagrams in the brochure illustrate how this technique works.

Mr. Sampson stated that he approached two farmers in Racine County about conducting a pilot project to examine the effectiveness of this best management practice (BMP). He explained that this project would involve comparing this method to standard drain tiles. He noted that the farmers he contacted were reluctant to participate. He added that he is still interested in conducting a pilot project and will contact other farmers. He commented that installation of this practice does not appear to be that expensive. Mr. Magruder said that this practice would likely address nutrients in dissolved form. He added that it would probably be workable if the diversion box can be readily operated.

Mr. Osterman asked where the brochure on the practice originated. Mr. Sampson replied that the brochure was developed in Iowa. He added that the Natural Resources Conservation Service (NRCS) is not currently looking at including saturated riparian buffer projects in funding packages, such as the Environmental Quality Incentives Program **(**EQIP**)**. Mr. Yencha commented that the University of Wisconsin is conducting research on this sort of practice in relation to the hypoxia in the Gulf of Mexico.

Mr. Osterman asked whether there are local conditions that would impact upon the effectiveness of this practice. Mr. Sampson replied that he would need to have the practice installed at a few sites and examine the results in order to answer that question.

Ms. Greenfield asked whether a project calling for installation of this practice would be too small to be funded by the Fund for Lake Michigan. Mr. Sampson replied that he thought it would not be too small, but he would like to gauge interest among farmers first. Ms. Greenfield noted that funding may be available through Root-Pike WIN’s and Sweet Water’s small grant programs. She asked whether farmers could be compensated for participation. Mr. Sampson replied that it might be possible to compensate them or provide cost sharing, depending on the program under which this would be funded.

Mr. Jasperson asked whether there are data on nutrient levels in water conveyed in drainage tiles. Mr. Boxhorn replied that his understanding is that Discovery Farms has been conducting research on this topic; however, the last time he checked the results had not been published. Mr. Yencha added that Discovery Farms has also conducted a study on the effects of earthworm channels on conveying nutrients from fertilizers to drainage tiles.

Mr. Hahn commented that the important aspect of the saturated buffer practice is that plants in the buffer would take up the nutrients. He added that the width of the buffer may be a key factor in how well this practice works.

Mr. Russart noted that there has also been some research done on discharging water from drainage tiles into wood chips and corn cobs, with anaerobic bacteria in these media taking up the nutrients.

Mr. Hahn stated the Commission staff will examine the available research on these topics.

> [Secretary’s Note: A copy of a presentation given by Eric Cooley, Research Coordinator at the University of Wisconsin Discovery Farms on nutrients in drain tiles and notes taken at this presentation by SEWRPC staff are attached as Exhibit A. A copy of a fact sheet developed by Iowa State University on the use of woodchip bioreactors for treatment of nitrate in agricultural drainage is attached as Exhibit B. It should be noted that on page 4 of Exhibit B it is stated that “[woodchip bioreactors … may not be effective for other pollutants such as phosphorus, pesticides, herbicides, and pathogens. However, the potential of bioreactors to remove some of these pollutants is an area of ongoing research.”]

Mr. Hahn asked whether there were questions or comments on the summary notes. Ms. Warner commented that the last paragraph on page 3 that continues into page 4 is unclear as to what is to be emulated. She suggested clarifying this.

[Secretary's Note: The first six sentences in the last paragraph on page 3 that continues into page 4 should read:

"Mr. Owens stated that Figure IV-6C shows riparian buffer areas on tributaries to the Root River. He noted that the 2010 color digital orthophotographs indicate the presence of more grassed waterways than are shown on the 2005 orthophotographs. He added that this is a positive trend. Mr. Sampson indicated that many farmers have observed the agricultural practices that others have implemented and want to emulate them. Mr. C. Magruder noted that in 2005 many farmers plowed right up to the waterway. Mr. Sampson added that his office has assisted in installing buffers and grassed waterways along streams."]

Mr. Hahn drew the Group's attention to the first Secretary's Note on page 4 of the summary notes. He asked Mr. Sampson whether he had provided the information on projects that was requested. Mr. Sampson replied that he had provided shape files for the last three or four years for the entire County to Aaron Owens of the SEWRPC staff. Ms. Greenfield noted that these projects are also mapped on the Root River inventory that is included on Root-Pike WIN's website.

Mr. Hahn then noted that, with regard to the first Secretary's Note on page 9 of the summary notes, the SEWRPC staff had met with Sara Strassman from American Rivers. He indicated that relevant Horlick dam information will be shared between the SEWRPC staff and American Rivers. He noted that American Rivers could assist with obtaining the necessary funding if removal of the dam is pursued.

Ms. Greenfield said that the River Alliance of Wisconsin submitted a proposal to the Fund for Lake Michigan for a buffer demonstration project on Hoods Creek, but that proposal was not funded.

Mr. Sampson stated that his office is conducting an inventory and analysis of conservation practices in the Hoods Creek subwatershed of the Root River watershed. He noted that this study is funded by a grant from the River Network. He indicated that a five-to-six page report should be completed in April 2013. He stated that the study examines a number of features of the landscape including soil types, slopes, existing riparian buffers, and floodplains. He added that the analysis will identify which fields need additional conservation practices and which practices are needed. He indicated that he will provide a copy of the report to the SEWRPC staff.

No other questions or comments were offered on the summary notes, and they were approved by consensus of the Advisory Group.

REVIEW OF PARTIAL PRELIMINARY DRAFT CHAPTER IV, "CHARACTERIZATION OF THE WATERSHED," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 316 (CAPR NO. 316), "*A RESTORATION PLAN FOR THE ROOT RIVER WATERSHED*"

At Ms. Greenfield's request, Mr. Boxhorn began the review of the third partial preliminary draft of Chapter IV, "Characterization of the Watershed." He indicated the that draft distributed for this meeting includes all portions of the chapter that have been developed up to this date, including material that was reviewed at the September 5, 2012 and November 7, 2015 Advisory Group meetings. He noted that the new material to be reviewed at this meeting is highlighted in the text.

Mr. Boxhorn drew the Group's attention to the highlighted material on page 10 of draft Chapter IV. He stated that the highlighted text summarized what is shown on Map IV-14, which had been previously presented to the Group.

Mr. Boxhorn reviewed the "Nutrients" subsection on pages 44 and 45and the "Phosphorus" subsection on pages 45 through 47.

Mr. Osterman asked what the typical sources of phosphorus are to surface waters. Mr. Boxhorn replied that this varies by location.

Ms. Warner asked how much of the phosphorus entering surface waters originates as detergents. Mr. Boxhorn replied that this is difficult to track. He explained that, with the exception of orthophosphate, the sampling does not look at the chemical form the phosphorus is in. He added that what sampling for phosphorus usually looks at is whether the phosphorus is in dissolved or particulate form and or tied up in sediment and plants. He noted that because of this it is generally not possible to tell what the source or phosphorus is from the water chemistry data.

Mr. Magruder commented that because of the ban on phosphorus in detergents, the Milwaukee Metropolitan Sewerage District (MMSD) expected to see a decrease in the phosphorus concentration in the influent to the South Shore wastewater treatment plant. He added that this expected decrease has not occurred, noting that the concentration of phosphorus in the influent is generally the same as it was before the ban. Mr. Yencha asked whether Green Bay or Madison have detected decreases in the concentration of phosphorus in the influent to their wastewater treatment plants. Mr. Magruder replied that he would check with these wastewater utilities. Ms. Greenfield suggested that there may be a time lag between the ban and a response in the influent concentrations. Mr. Magruder noted that it has been over one year since the ban went into effect and no change has been detected in influent concentrations.

Mr. Boxhorn noted that no standard line is shown for portions of the graphs of total phosphorus concentration for the East and West Branches of the Root River Canal in Figure IV-29 because these portions are classified as limited aquatic life waters. He added that limited aquatic life waters are specifically excluded from coverage under the State’s phosphorus criterion.

In reference to the high concentrations of total phosphorus shown in Figure IV-29 for the East Branch of the Root River Canal, Ms. Greenfield asked whether a sample could be collected upstream from the Fonk’s wastewater treatment plant to assess the relative contributions of agricultural land and the wastewater treatment plant to the phosphorus concentrations in this stream. Ms. Wright responded that she could collect a sample upstream from the wastewater treatment plant on the next sampling date.

Mr. Boxhorn reviewed the “Nitrogen” subsection on pages 47 through 49. Mr. Yencha asked why the proportion of organic nitrogen is decreasing from upstream to downstream. Mr. Boxhorn responded that the concentration of organic nitrogen is increasing from upstream to downstream, but the proportion of total nitrogen that is represented by organic nitrogen is decreasing from upstream to downstream. He explained that this is because the rate of increase in the concentration of nitrate plus nitrite from upstream to downstream is much greater than the increase in organic nitrogen.

Mr. Osterman asked whether there will be specific recommendations regarding the types of plants to plant in buffers to better remove nitrogen. Mr. Boxhorn replied that this could be done. He also noted that soil testing before applying fertilizers could address this issue.

Mr. Martinka suggested tying phosphorus and nitrogen into their sources.

[Secretary’s Note: The following sentences were added to the end of the second full paragraph on page 45:

“In areas where water utilities add phosphates to municipal water for corrosion control, discharges by industrial facilities that use municipal water as noncontact cooling water may contribute phosphorus to receiving waterbodies. In rural settings, phosphorus from agricultural fertilizers or animal manure may be contributed through discharges from drain tiles or direct runoff into waterbodies. Phosphorus may also be contributed by poorly maintained or failing onsite wastewater treatment systems."

The following paragraph was added after the fourth full paragraph on page 47:

"Nitrogen compounds can be contributed to waterbodies from a variety of point and nonpoint sources. In urban settings, nitrogen compounds from lawn fertilizers and other sources may be discharged through storm sewer systems and direct runoff into streams. Cross-connections between sanitary and storm sewer systems, illicit connections to storm sewer systems, and decaying sanitary and storm sewer infrastructure may contribute sanitary wastewater to waterbodies through discharges from storm sewer systems. In rural settings, nitrogen compounds from chemical fertilizers and animal manure may be contributed through discharges from drain tiles or direct runoff into waterbodies. Nitrogen compounds may also be contributed by poorly maintained or failing onsite wastewater treatment systems."]

Mr. Magruder asked whether there were benchmarks for nitrogen that could be used to compare to the existing concentrations. Mr. Boxhorn replied that while the State currently has no water quality criteria for total nitrogen, the studies by the U.S. Geological Survey (USGS) that were conducted as part of developing the State's phosphorus rule also developed reference concentrations for nitrogen. He added that these reference concentrations could be added to the graphs.

[Secretary's Note: A reference value line was added to Figure IV-31 at 0.4 mg/l. The revised figure is attached herein as Exhibit C. The following paragraph was added after the first partial paragraph on page 48:

"With the exception of toxicity criteria for ammonia, the State of Wisconsin has not promulgated water quality criteria for nitrogen compounds. Figure IV-31 shows that the concentration of total nitrogen in most samples collected from the mainstem of the Root River was greater than a reference concentration calculated by USGS the for wadeable streams in soils with high clay content.[81] It is important to recognize that this reference value is not a water quality criterion. Instead, it represents a potential level of water quality that could be achieved in the absence of human activity.

[81]*Dale M. Robertson, David J. Graczyk, Paul J. Garrison, Lizhu Wang, Gina LaLiberte, and Roger Bannerman,* Nutrient Concentrations and Their Relations to Biotic Integrity of Wadeable Streams in Wisconsin, *U.S. Geological Survey Professional Paper No. 1772, 2006.*

Subsequent footnotes were renumbered accordingly."]

Mr. Boxhorn reviewed the "Suspended Materials" subsection on pages 49 through 52. Ms. Wright asked how much seasonal fluctuation occurs in concentrations of chlorophyll-*a* in the River. Mr. Boxhorn replied that chlorophyll-*a* concentrations are generally low in the winter and increase in spring. He added that he has not done a specific seasonal analysis of this. He noted that phytoplankton samples would be helpful for interpreting this; however, he is unaware of the existence of any phytoplankton sampling having been conducted in the Root River watershed.

Mr. Boxhorn reviewed the "Synthesis" section on pages 52 through 54. He stated that the water quality inventory shows that many of the conclusions of the regional water quality management plan update for the greater Milwaukee watersheds (RWQMPU) still apply to the streams of the Root River watershed. He added that these include the conclusions that dissolved oxygen concentrations are chronically low in upstream portions of the mainstem of the River and concentrations of total phosphorus and fecal indicator bacteria are high in all the streams of the watershed. He noted that the inventory has also found some things that were not revealed in by the RWQMPU. He stated that these include the presence of areas that experience supersaturation of dissolved oxygen. He explained that this suggests that those sites are experiencing wide swings in dissolved oxygen concentration over the course of the day, and that continuous monitoring at three sites by the USGS shows that this is occurring. He said that he would present these data at the next meeting.

Mr. Boxhorn stated that the water quality inventory also revealed the presence of water quality "hot spots." He noted that Figure IV-37 shows the presence of one such location on the mainstem of the Root River. He indicated that the data suggest that sanitary wastewater may be causing this. He noted that it is coming in either along the mainstem of the River between W. Cleveland Avenue and the intersection of W. National Avenue and W. Oklahoma Avenue or through Hale Creek. Mr. Magruder stated MMSD will do additional monitoring in this area this coming summer. He suggested making similar plots of chloride concentrations.

[Secretary's Note: Because an increase in chloride concentrations at the sampling station at the intersection of W. National Avenue and W. Oklahoma Avenue relative to the upstream and downstream stations is readily apparent in Figure IV-23, a graph of chloride was not added to Figure IV-37. The fifth sentence of the third full paragraph on page 53 was revised to read (text in bold is included here, and in similar subsequent Secretary's Notes, to indicated language change or added onto the text. Text will not be bold in the report):

"In addition, median concentrations of organic nitrogen, total phosphorus, **and chloride** were higher at this station than at adjacent stations, and the median value of pH was lower at this station than at adjacent stations **(see Figures IV-20, IV-23, and IV-28)**."]

Mr. Boxhorn noted that the there is an error in the identification of this hot spot in the text. In the last sentence of the last full paragraph on page 53, W. Cold Spring Road should be W. Cleveland Avenue.

[Secretary's Note: The last sentence of the last full paragraph on page 53 was revised to read (text in bold is included here to indicated language change or added onto the text. Text will not be bold in the report):

"The source is likely to be discharging either into the mainstem of the Root River between the intersection of W. National Avenue and W. Oklahoma Avenue and W. **Cleveland Avenue** or into Hale Creek, which flows into the Root River between these two locations."]

Mr. Boxhorn stated that Figure IV-38 shows the presence of another water quality hotspot about 100 meters upstream from Memorial Drive in the City of Racine. He added that he was uncertain what was causing the high turbidity at this site. Mr. Russart suggested that this could be a result of carp feeding on aquatic plants.

[Secretary's Note: The following sentence was added to the end of the first full paragraph on page 54:

"This may be the result of carp feeding on aquatic plants at or upstream of this site."]

Mr. Boxhorn reviewed the "Water Quality in Lakes and Ponds" subsection on pages 54 through 57. He noted that Quarry Lake is the only lake or pond for which data on fecal indicator bacteria are available. Mr. Osterman stated that a Friends of Quarry Lake group has recently formed. He noted that there has been little use of Quarry Lake recently because of problems with green water. Mr. Boxhorn suggested monitoring the lake for blue-green algae.

Mr. Osterman asked whether it can be concluded that the geese that are present are not creating a bacteria problem at Quarry Lake. Mr. Boxhorn replied that the data do not indicate the presence of a bacteria problem at the Lake. Mr. Smage noted that the geese tend to be more prevalent at this lake during winter open water periods. He noted that sampling is not conducted at the Lake during these periods. Mr. Boxhorn suggested that monitoring secchi depth, chlorophyll-*a*, phosphorus, temperature profiles, and other chemicals would be useful regarding concerns about green water. He explained that a green color could be caused by blue-green algae or by other algae. He noted that blue-green algae could be a concern because some strains produce toxins that can cause dermatitis and other problems. Following additional discussion of conditions in Quarry Lake, Mr. Magruder suggested dye testing of restroom toilets in the park.

Mr. Magruder suggested adding delimiters to Figures IV-45 and IV-46 to show where the Wisconsin Trophic State Index indicates oligotrophic, mesotrophic, and eutrophic conditions.

[Secretary's Note: Figures IV-45 and IV-46 were revised to show where the Wisconsin Trophic State Index indicates oligotrophic, mesotrophic, and eutrophic conditions. Copies of the revised figures are attached herein as Exhibit D.]

Mr. Boxhorn reviewed the "Achievement of Water Use Objectives" subsection on pages 57 through 60. He indicated that during the period 2005 through mid-2012, the recommended water use objectives were only being partially achieved in much of the watershed.

In reference to Map IV-22, Mr. Jasperson asked where the Wisconsin Department of Natural Resources (WDNR) obtains the data for listing decisions for the 303(d) impaired waters list. Mr. Boxhorn responded that the WDNR uses the same data sources and data sets as were used for the water quality inventory in Chapter IV.

Mr. Yencha asked why Hoods Creek and the East Branch of the Root River Canal are not on the 303(d) impaired water list. Mr. Boxhorn explained that for the purposes of this list, impairment is defined as not meeting the water quality criteria that support the stream's designated use. He noted that Hoods Creek is classified as a limited forage fish water. He added that the upper section of the East Branch of the Root River Canal is classified as a limited aquatic life water, while the lower section of this stream is classified as a limited forage fish water. He indicated that these objectives have different expectations for water quality than full fish and aquatic life waters.

[Secretary's Note: It should also be noted that prior to this planning effort, relatively few data were available for evaluating water quality conditions in these two streams.]

Ms. Greenfield asked whether water use objectives can be changed. There was considerable discussion on this point. The conclusion was that changing water use objectives for particular waterbodies would require changes and revisions in the *Wisconsin Administrative Code.*

Ms. Wright noted that there has been discussion regarding abandoning the Town of Yorkville Sewer Utility District's wastewater treatment plant. She asked whether the water use objective for Hoods Creek would be changed if this happened. Mr. Hahn replied that historically water use objectives have not been changed in such cases. Mr. Luba noted that this plant will be faced with more stringent effluent limitations under its upcoming discharge permit.

Mr. Yencha noted the low flow conditions in the upper sections of the Root River. He asked whether there is a connection between historical alterations of the flow regime and low dissolved oxygen concentrations in these sections. Mr. Boxhorn replied that to some extent, this is beyond what can be determined from the available flow data. He noted that the USGS currently has gauges in only four locations in the watershed: W. Grange Avenue, W. Ryan Road, and STH 38 on the mainstem of the Root River and 6 Mile Road on the Root River Canal. He stated that conditions in the upper part of the watershed are not favorable for groundwater recharge.

Mr. Hahn noted that several sections of Chapter IV listed in the draft have yet to be completed. He stated that these will be presented at future meetings of the Group.

REVIEW OF PARTIAL PRELIMINARY DRAFT CHAPTER V, "DEVELOPMENT OF TARGETS AND ALTERNATIVE MEASURES," OF SEWRPC COMMUNITY ASSISTANCE PLANNING REPORT NO. 316 (CAPR NO. 316), "*A RESTORATION PLAN FOR THE ROOT RIVER WATERSHED*"

At Ms. Greenfield's request, Mr. Boxhorn began the review of the preliminary draft of Chapter V, "Development of Targets and Alternative Measures." Mr. Boxhorn distributed updated copies of Tables V-1 and V-2 to the Group. He explained that the adjusted urban pollutant load reductions became available after the draft chapter was sent to the Group. He added that the relevant numbers from the tables were substituted for the blanks in the text describing the tables.

> [Secretary's Note: The revised Tables V-1 and V-2 are attached as Exhibit E. These tables replace the ones in the preliminary draft Chapter. The third sentence of the last full paragraph on page 5 was revised to read:
>
> "Of this reduction, 5,200 pounds would come from urban nonpoint sources, with **2,268** pounds of this reduction being attributable to implementation of NR 151 and **2,932** pounds of this reduction being attributable to implementation of other measures."
>
> The third sentence of the first paragraph on page 6 was revised to read:
>
> "Of this reduction, 2,257,370 pounds would come from urban nonpoint sources, with **1,388,338** pounds of this reduction being attributable to implementation of NR 151 and **869,032** pounds of this reduction being attributable to implementation of other measures."]

Mr. Hahn noted that the pollutant reductions listed in Tables V-1 and V-2 would result in the degree of compliance with water quality criteria that was envisioned under the recommended plan in the RWQMPU and not full compliance with these criteria. He stated that these constituted good targets for the five-year plan implementation time frame of the watershed restoration plan.

In reference to Tables V-1 and V-2, Mr. Hahn explained that the rural NR 151-related pollutant load reductions assume a reasonable degree of implementation of NR 151, not the amount of cost-share funding that would be necessary for full implementation.

Mr. Boxhorn noted that Table V-4 is mistakenly labeled as Table IV-4.

> [Secretary's Note: The label for Table V-4 was corrected.]

Mr. Osterman asked whether the revised Tables V-1 and V-2 could be sent to the Group. Mr. Boxhorn replied that they could.

> [Secretary's Note: Copies of Tables V-1 and V-2 were sent to Mr. Osterman by electronic mail. As noted above, they are also attached herein as Exhibit E.]

Mr. Martinka asked for additional explanation on Table V-3, including what is indicated by the first line. Mr. Boxhorn and Mr. Hahn explained that the table shows the improvements in water quality that could be expected if the load reductions indicated in Tables V-1 and V-2 were achieved. They continued that there would be relatively small increases in the level of compliance with the planning standard recommended in the RWQMPU. They added that at the same time, there would be larger reductions in mean and median concentrations of total phosphorus.

[Secretary's Note: Subsequent to the February 6, 2013, meeting of the Advisory Group, the SEWRPC staff revised Table V-3. A column was added to the table showing levels of compliance with the State's water quality criterion for total phosphorus in the Root River watershed under recommended plan conditions in the year 2020, as estimated by a water quality simulation model. It is important to note that the assumptions of the model used to compute these estimates were slightly different from the assumptions of the model used in the RWQMPU. A major difference is that the meteorological records from the weather station at General Mitchell International Airport were used to develop these estimates over the entire Root River watershed. The model for the RWQMPU utilized meteorological records from four weather stations, each for a different portion of the watershed. The revised table is attached as Exhibit F.]

Mr. Yencha noted that 2011 Wisconsin Act 32 included an anti-backsliding provision, in which municipal separate storm sewer systems which had achieved TSS reductions in excess of the required 20 percent are required to maintain the practices which achieved the reductions. He asked how this is reflected in the urban nonpoint source load reductions in Table V-1. Mr. Boxhorn answered that, for communities that have achieved TSS reductions in excess of 20 percent, the increment over 20 percent is included in the "Other Reductions" column.

DATE AND TIME OF NEXT MEETING

Mr. Chernik announced that there will be pancake breakfasts at River Bend Nature Center on March 3, 2013, March 10, 2013, and March 17, 2013 from 9:00 a.m. to noon as fund raisers for the Nature Center.

Ms. Greenfield noted that the next meeting would be the Stakeholder Group meeting on February 27, 2013, from 10:00 a.m. to noon at a location that is to be determined. Mr. Sampson noted that the May 1, 2013, Advisory Group meeting will not be held in Ives Grove because the hearing room will not be available. Ms. Greenfield stated that this meeting may be held at the Milwaukee County Sport Complex in the City of Franklin.

ADJOURNMENT

There being no further business, the meeting was adjourned by unanimous consent at 12:04 p.m.

MATERIAL ADDED TO CHAPTER IV CHAPTER IV, "CHARACTERIZATION OF THE WATERSHED," OF SEWRPC CAPR NO. 316 BY SEWRPC STAFF FOLLOWING THE FEBRUARY 6, 2013 MEETING OF THE ADVISORY GROUP

Subsequent to the February 6, 2013, meeting of the Advisory Group, the SEWRPC staff added figures, tables, and discussion of several continuously-recorded dissolved oxygen data records from the upper sections of the mainstem of the Root River to the dissolved oxygen subsection of Chapter IV. These data were collected and provided by the U.S. Geological Survey. The material that was added to the chapter is attached as Exhibit G.

ROOT RIVER WRP SUMMARY NOTES 02/06/2013 MTG (00209752).DOC
300-1104
MGH/JEB/pk
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Exhibit A

MEMORANDUM

TO: Files

FROM: Joseph E. Boxhorn

DATE: February 12, 2013

SUBJECT: **NOTES ON ERIC COOLEY'S APRIL 30, 2012 PRESENTATION, "NUTRIENTS DISCHARGING FROM TILE DRAINS IN EASTERN WISCONSIN"**

This memorandum contains notes taken on presentation given by Eric Cooley, Research Coordinator from the University of Wisconsin-Discovery Farms, at the Eighth Annual Clean Rivers, Clean Lakes Conference on April 30, 2012. This presentation was entitled, "Nutrients Discharging from Drain Tiles in Eastern Wisconsin." It presented findings from a study monitoring nutrients in drainage tiles at three farms in Kewaunee, Manitowoc, and Waukesha Counties during the period 2004-2011. The notes taken highlight some of the data and findings presented by Mr. Cooley during this presentation.

It should be noted that this memorandum is a transcription of the notes that I took at the presentation. I have not added any interpretations or corrections to them.

1. The research found that during snowmelt conditions, infiltration into tiles occurs even when the ground is frozen. Flow begins in tiles days before surface water flow begins (see slide 7). Mr. Cooley noted that about 50 percent of tiles have flow about 365 days a year.

2. Very rapid flow occurs in tiles in response to precipitation. Surface water flow starts when the tiles are flowing at capacity (see slide 9).

3. Flow in tiles represents 65 percent to 75 percent of the precipitation leaving the landscape as surface water (see slide 10).

4. Where tiles blow out, most of the sediment comes in through tile. Where tile is intact, about 75 percent of sediment comes out in surface runoff.

5. Total phosphorus loading follows the pattern in point 4. Where tiles are intact, about 15 percent to 34 percent of total phosphorus moves through tile. On the farm with tile blow outs, 65 percent of phosphorus moved through the tile (see slide 11).

6. Nitrogen mostly flows through tile. Between 78 percent and 87 percent of nitrogen loss was through tiles (see slide 12).

7. No-till systems are stratified with respect to phosphorus. They rarely runoff, but when they do the runoff carries a lot of phosphorus. No till and grazing systems have high losses as dissolved phosphorus. He suggested that this is phosphorus that has not incorporated into the soil (see slides 13 and 14).

8. Much organic nitrogen is lost in surface runoff. If cows are present, surface runoff also has high ammonium. Tiles tend to have a lot of nitrate losses (see slide 14).

9. Macropores get nutrients down to tile quickly. There is less filtering (see slide 15).

10. Factors that influence manure contamination in tile include (see slide 17):

- Consistency of manure: there is low risk if the manure is greater than 5 percent solids,
- Application rate,
- Tillage/manure incorporation
- Soil moisture/tiles flowing
- Frozen soils

* * *

#209873 - NOTES ON NUTRIENTS DISCHARGING IN TILE DRAINS TALK
300-1104
JEB

Nutrients Discharging from Tile Drains in Eastern Wisconsin

Eric Cooley
Research Coordinator
UW Discovery Farms

What Are Discovery Farms?

The Discovery Farms Program will develop on-farm and related research to determine the economic and environmental effects of Best Management Practices on a diverse group of Wisconsin farms;

University of Wisconsin–Extension
DISCOVERY FARMS
University of Wisconsin–Madison

USGS
science for a changing world

Discovery Farms Tile Research

A - Kewaunee County

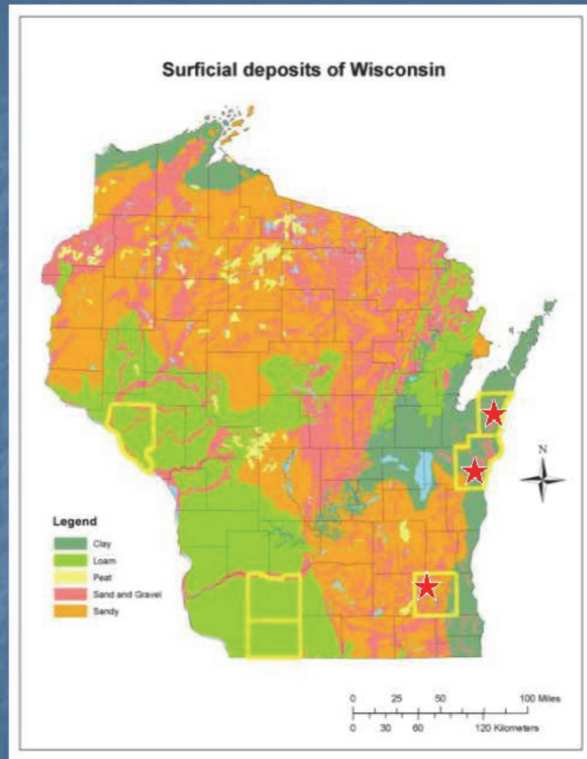
- Two tile line sites (2004 – 2009)

B - Manitowoc County

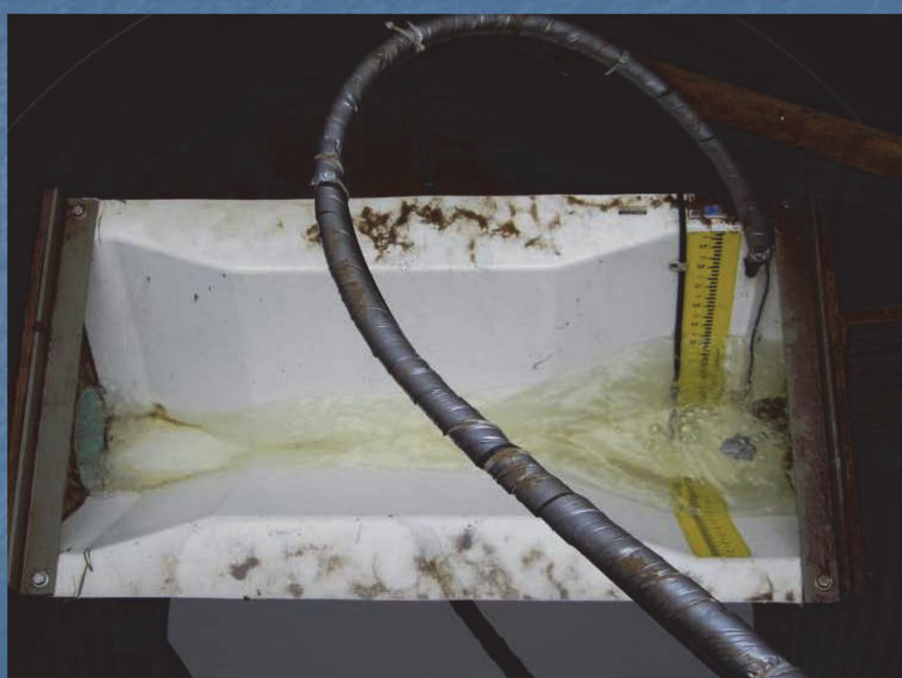
- Two tile line sites (2004 – 2007, 2007 – 2011)

C - Waukesha County

- Two tile line sites (2004 – 2009)



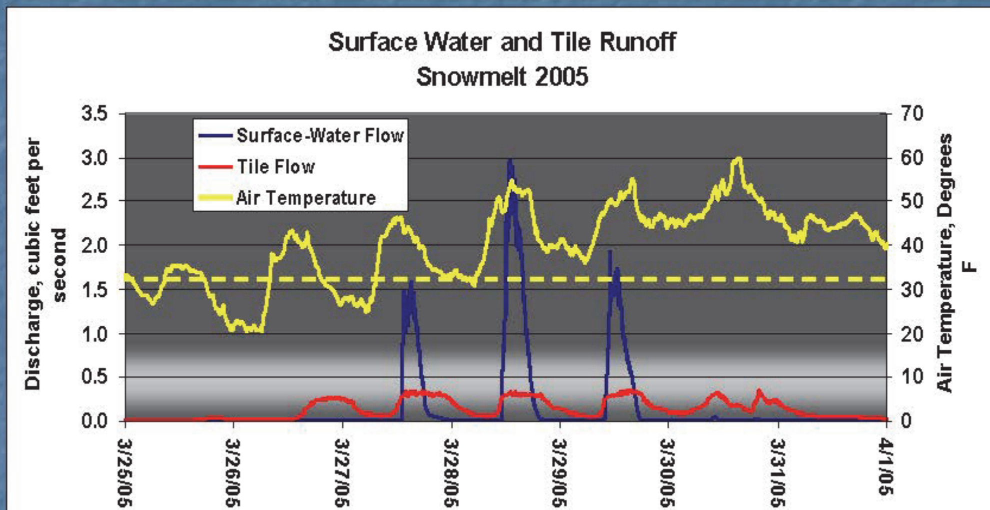
Tile line water monitoring



Tile line water monitoring

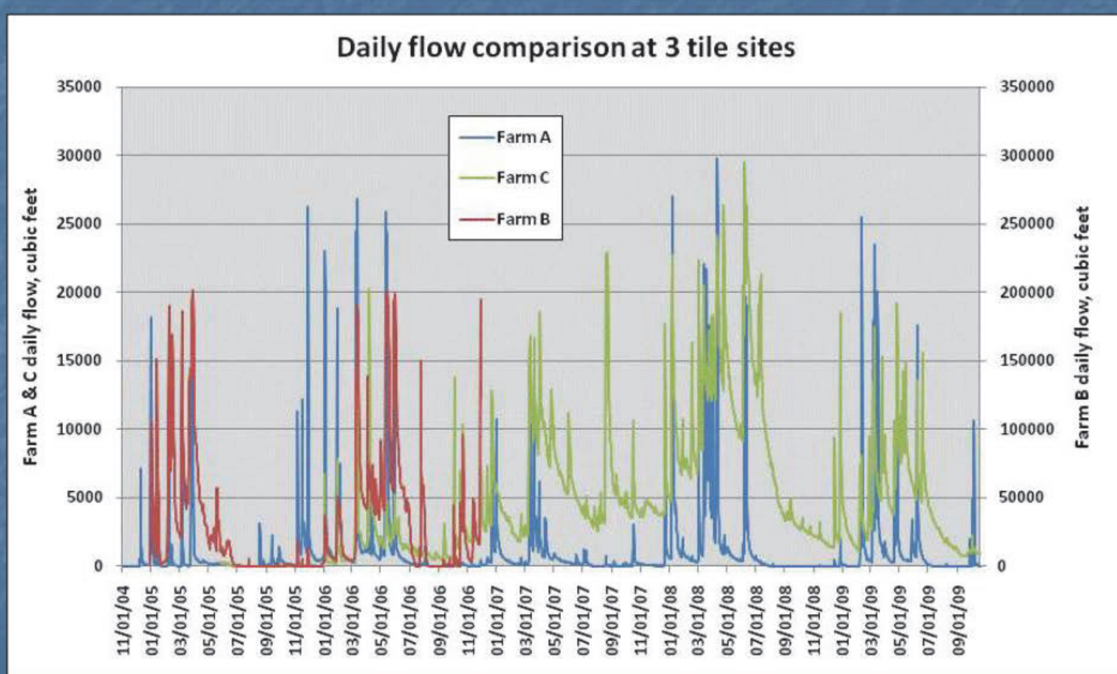
Tile monitoring equipment

Surface and Tile Runoff Under Snowmelt Conditions

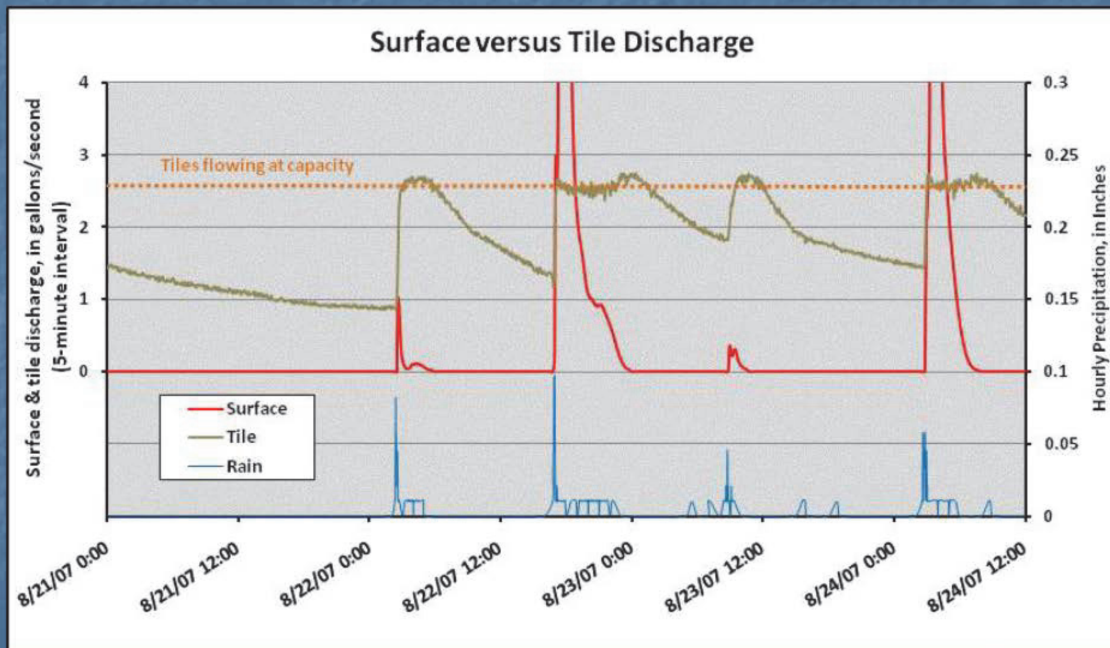


- Tile flow began before surface flow
- Relative volumes of water flowing in surface and tile were similar for this snowmelt period

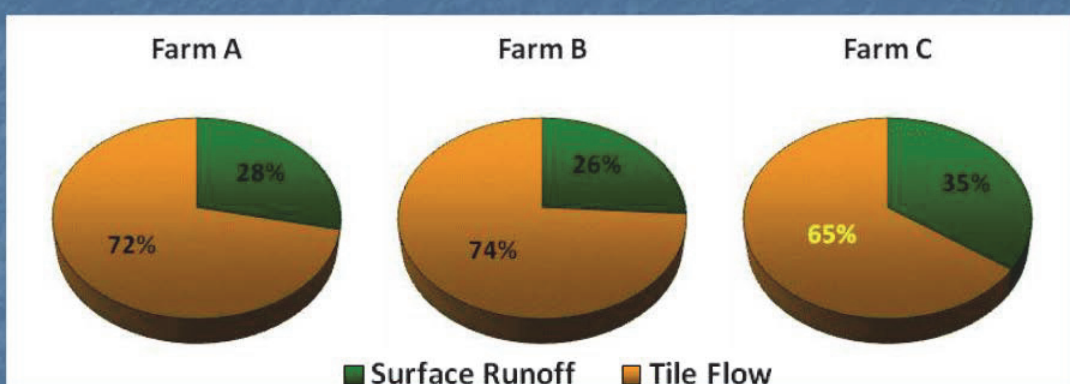
Tile flow periods



Efficiency of tile water removal

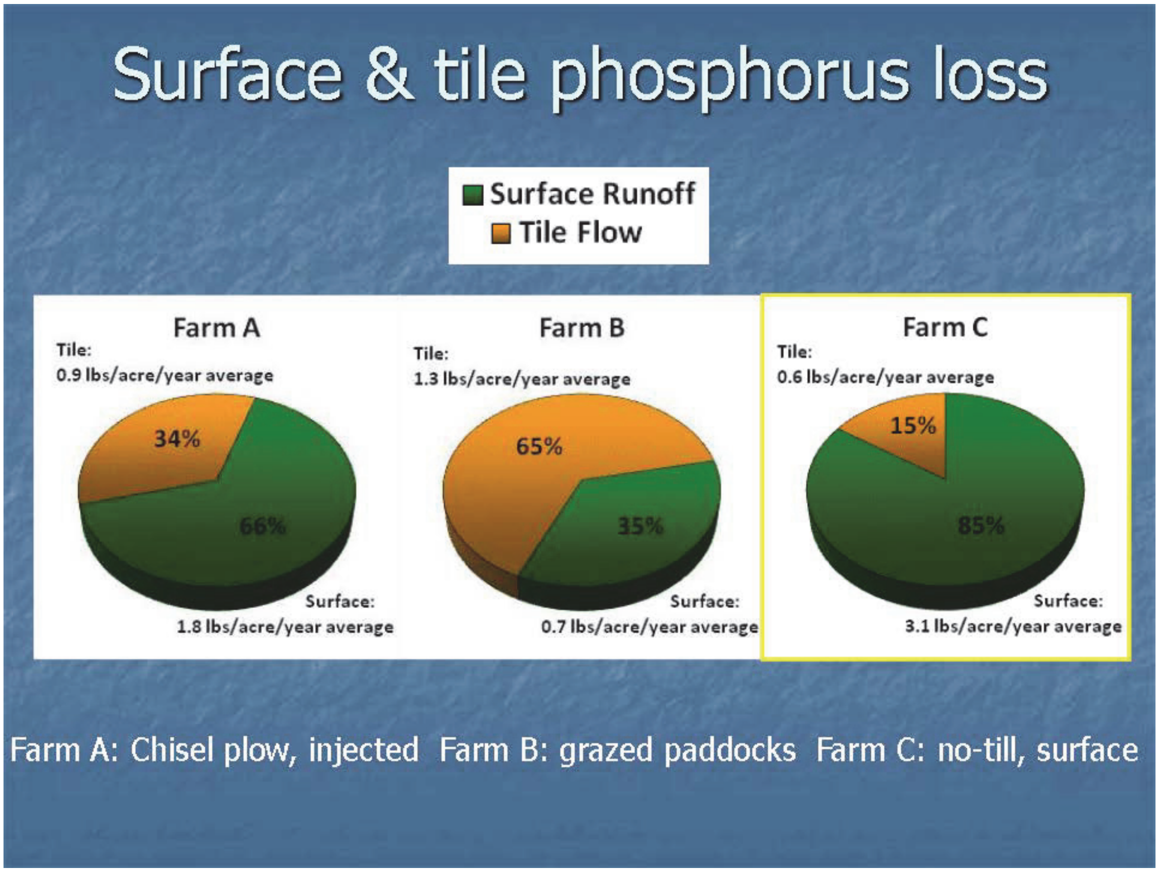


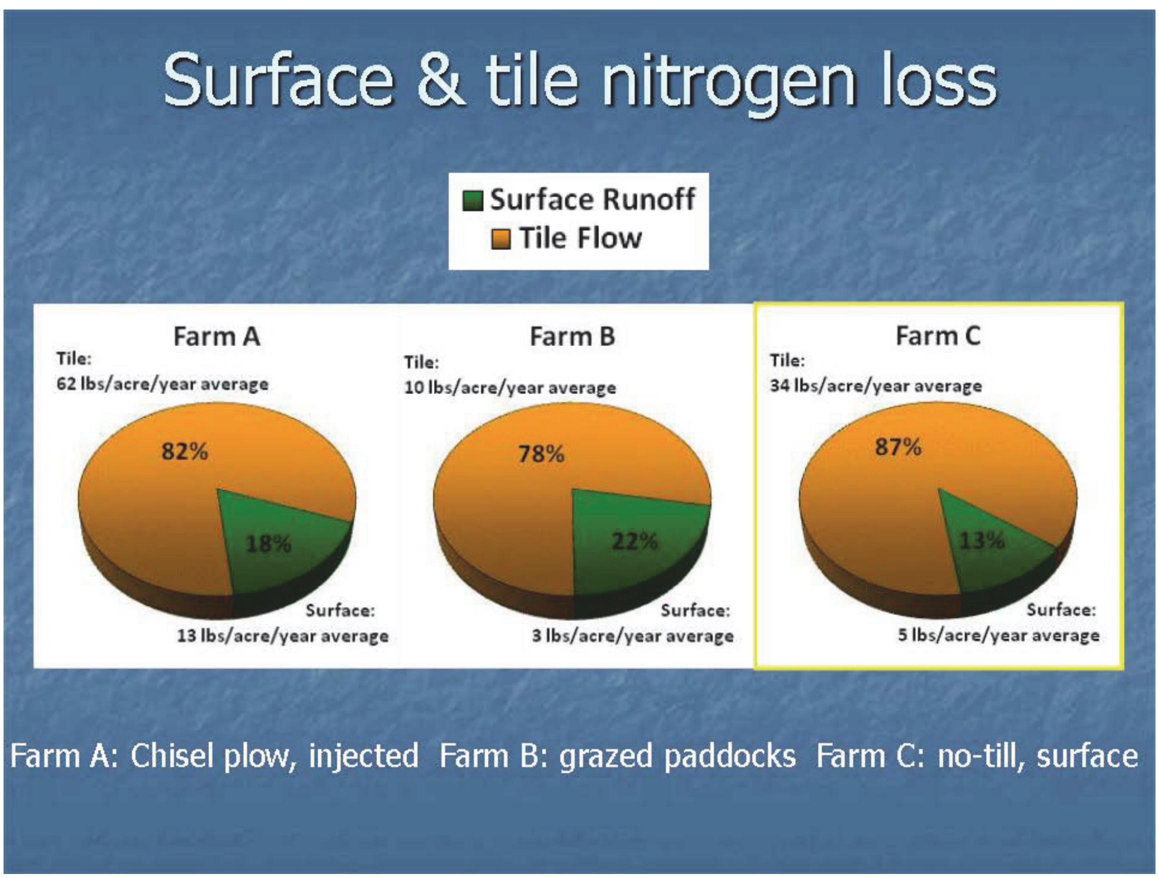
Water Budget



Percentage of total precipitation leaving the landscape as surface water

	Farm A	Farm B	Farm C
Surface runoff	10%	6%	9%
Tile flow	24%	16%	16%


Surface & tile phosphorus loss
Surface Runoff
Tile Flow
Farm A
Tile:
0.9 lbs/acre/year average
34%
66%
Surface:
1.8 lbs/acre/year average
Farm B
Tile:
1.3 lbs/acre/year average
65%
35%
Surface:
0.7 lbs/acre/year average
Farm C
Tile:
0.6 lbs/acre/year average
15%
85%
Surface:
3.1 lbs/acre/year average
Farm A: Chisel plow, injected Farm B: grazed paddocks Farm C: no-till, surface


Surface & tile nitrogen loss
Surface Runoff
Tile Flow
Farm A
Tile:
62 lbs/acre/year average
82%
18%
Surface:
13 lbs/acre/year average
Farm B
Tile:
10 lbs/acre/year average
78%
22%
Surface:
3 lbs/acre/year average
Farm C
Tile:
34 lbs/acre/year average
87%
13%
Surface:
5 lbs/acre/year average
Farm A: Chisel plow, injected Farm B: grazed paddocks Farm C: no-till, surface

Surface & tile loss timing

Total Phosphorus

	Surface		Tile	
	Frozen	Non-frozen	Frozen	Non-frozen
Farm A	37%	63%	52%	48%
Farm B	36%	64%	41%	59%
Farm C	21%	79%	33%	67%

Farm A: Chisel plow, injected Farm B: no-till, surface Farm C: grazed paddocks

Total Nitrogen

	Surface		Tile	
	Frozen	Non-frozen	Frozen	Non-frozen
Farm A	57%	43%	52%	48%
Farm B	42%	58%	46%	54%
Farm C	16%	84%	24%	76%

Nutrient loss timing and speciation

Phosphorus Speciation

	Surface		Tile	
	Particulate	Dissolved	Particulate	Dissolved
Farm A	73%	27%	46%	54%
Farm B	13%	87%	54%	46%
Farm C	18%	82%	23%	77%

Farm A: Chisel plow, injected Farm B: no-till, surface Farm C: grazed paddocks

Nitrogen Speciation

	Surface			Tile		
	Nitrate	Ammonium	Organic	Nitrate	Ammonium	Organic
Farm A	45%	18%	37%	93%	2%	5%
Farm B	20%	38%	41%	50%	18%	32%
Farm C	22%	17%	61%	94%	1%	5%

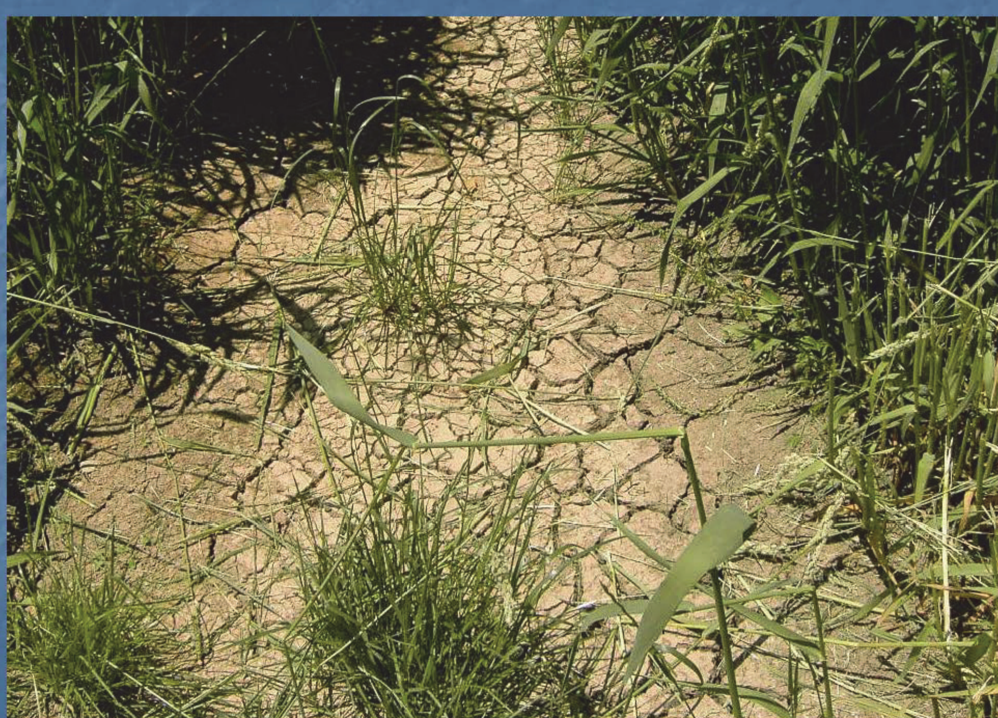
Environmental Risks of Tiles
- Macropores -

Preferential flow

- Earthworm burrows
- Root channels
- Shrinkage cracks
- Structural porosity

Credit: John Panuska

Soil drying and crack formation



Factors Influencing Manure Contamination of Tile Lines

- Consistency of manure:
  - 0-2% solids: high risk
  - 2-5% solids: moderate risk
  - > 5% solids: low risk
- Application rate
- Tillage / manure incorporation
- Soil moisture content / tiles flowing
- Frozen soils

Take home points

✓ Tile drains can flow up to 365 days a year, even during frozen ground conditions

✓ Tile drainage can deliver the majority of water and total nitrogen leaving agricultural fields and can also deliver significant phosphorus

✓ Good manure and fertilizer management is critical to reduce the loss of nutrients in tile drained landscapes

Updated website!

www.uwdiscoveryfarms.org

Exhibit B

Woodchip Bioreactors for Nitrate in Agricultural Drainage

Introduction

Subsurface agricultural drainage can allow large gains in agricultural productivity in the midwestern United States. There is, however, concern about pollutants moving through these systems. One specific water quality concern is nitrate, a form of nitrogen that moves readily through the soil and often can be present in high amounts in clear drainage waters. The water quality of our local streams, rivers, and lakes can be negatively impacted by nitrate in tile drainage. Moreover, because many streams and rivers in this region lead to the Mississippi River, nitrate in midwestern agricultural drainage also contributes to the hypoxic zone (or Dead Zone) in the Gulf of Mexico. Fortunately, there are a number of practices that can reduce the amount of nitrate in drainage water. Woodchip bioreactors are a new option to reduce the amount of nitrate in drainage before it gets to local surface waters. This factsheet describes key questions relevant to this innovative approach to water quality.

Figure 1. Subsurface tile drain outlet (courtesy of the Leopold Center for Sustainable Agriculture, Jerry DeWitt)

Woodchip Bioreactor Basics

How do bioreactors work?

A woodchip bioreactor is made by routing drainage water through a buried trench filled with woodchips. Woodchip bioreactors also are known as denitrification bioreactors, a name that is slightly more descriptive of the actual process occurring inside the bioreactor. Denitrification is the conversion of nitrate (NO_3^-) to nitrogen gas (dinitrogen, N_2) that is carried out by bacteria living in soils all over the world and also in the bioreactor. These good bacteria, called denitrifiers, use the carbon in the woodchips as their food and use the nitrate as part of their respiration process. Because these bacteria also can breathe oxygen, providing anaerobic conditions through more constantly flowing tile water helps ensure that the bacteria utilize the nitrate.

Figure 2. Woodchips commonly used in woodchip bioreactors

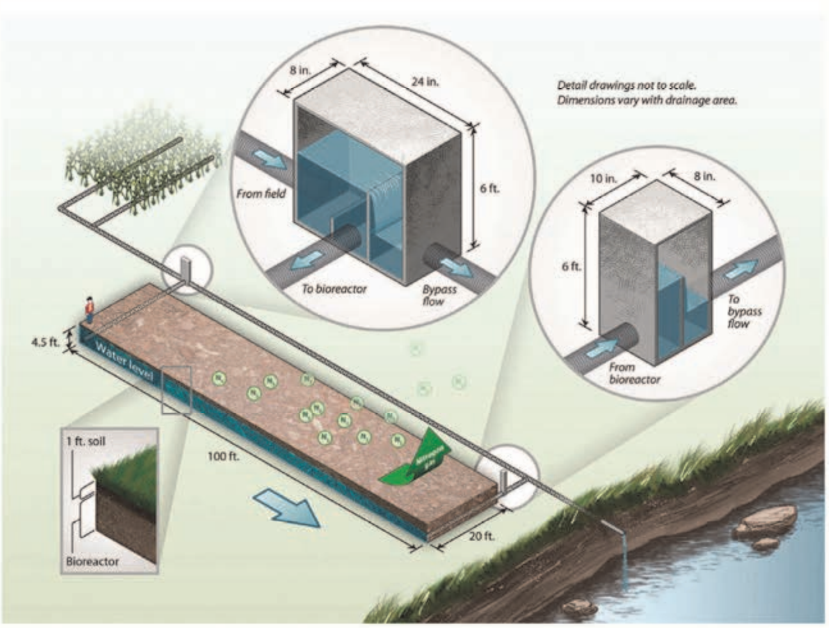


Figure 3: Descriptive illustration of a woodchip bioreactor (image by John Petersen, www.petersenart.com)

PMR 1008 October 2011

Figure 4. Excavation for a bioreactor installation (courtesy of the Iowa Soybean Association Environmental Programs and Services)

Figure 5. Filling an excavation with woodchips for a bioreactor installation (courtesy of the Iowa Soybean Association Environmental Programs and Services)

Providing these denitrifiers an ample supply of carbon to eat and giving them anaerobic conditions in the bioreactor offers them a perfect environment to remove nitrate from drainage.

Two control structures are important parts of the bioreactor design, and each structure plays a different role. The inflow control structure is responsible for routing water into the bioreactor and for allowing excessive water to by-pass the bioreactor at high flow events. The outflow control structure helps to retain water in the bioreactor so the water remains in the bioreactor long enough for the bacteria to have time to remove nitrate from the water before it leaves. These structures allow gates or stop logs to be lowered into place to increase the amount of water routed into the reactor (inflow structure) or increase the retention time of the water in the bioreactor (outflow structure). Likewise, these gates also can be removed to decrease the amount of water treated and decrease the retention time.

How big are woodchip bioreactors?

Most installations in Iowa to date have been approximately 100 to 120 feet long and 10 to 25 feet wide. Typically, no land is taken out of production for a bioreactor. Because bioreactors tend to have an orientation that is long and narrow, they fit well in edge-of-field buffer strips and grassed areas.

Does the type of woodchip matter? Can I use materials other than chips?

Not all woodchips are created equal. To allow the good, denitrifying bacteria time to remove the nitrate from the water, bioreactors are designed based on a specific flow rate of water that the woodchips allow (that is, hydraulic conductivity of the woodchips). Using chips that have many fine materials, shredded materials, dirt, and gravel can change this allowable rate of water flow, meaning the bioreactor may not work as intended. Currently chips used in bioreactor research have had the majority of the chips falling within the ¼-inch to 1-inch size range. Chips made from treated or preserved wood are not recommended because this limits the bacteria's ability to use the carbon in the wood. Also, including green material such as leaves or conifer needles is not recommended due to their relatively high nitrogen content and their potential to quickly be degraded. A number of other carbon source materials such as corn cobs, corn stalks, wheat straw, cardboard, and newspaper have been investigated, but research has recommended woody material because it provides a sustainable carbon source that lasts longer.

What is the life of a bioreactor?

Research has estimated bioreactor lifespans of 15 to 20 years, after which the woodchips would be replaced if treatment was to be continued. Because it is a new practice, no bioreactors have been in the ground long enough to have direct evidence of longevity. The oldest working denitrification system that treats septic wastewater was 15 years old in 2010.

How many acres of drainage can I treat?

Most current bioreactor designs have been successful at reducing the amount of nitrate in drainage from 30 to 80 acres. Some larger designs have been installed and are being watched closely for performance.

Installation/Operation

Are certain areas better than others for woodchip bioreactors?

Bioreactors are specifically designed to treat subsurface drainage water that contains high amounts of nitrogen as nitrate and that has relatively little sediment. These systems are not intended to treat runoff or water collected along terraces, and they work best in drainage systems that have few surface intakes. Many bioreactors in Iowa have been targeted for watersheds identified as having high nitrate in surface waters and having a large percentage of land drained. Though some bioreactors are lined, they may not be as effective in sandy areas because the drainage water being treated may leak into the surrounding soil and escape treatment. Also, considerations should be made for possible contaminants like the initial flushing of organics at each bioreactor regardless of location.

How do I manage the bioreactor? How much management is required?

It is estimated that at minimum, twice per year the outlet control structure needs to have gates either raised or lowered. In the spring and early summer, when drainage water is typically flowing faster and in greater quantities, more gates should be lowered into the outflow structure to retain water for a longer time in the bioreactor. Later when drainage flow rates decrease, typically mid-July, these gates in the outflow structure should be removed so water can flow unimpeded through the bioreactor. The gates should be reinserted in late fall prior to spring drainage events or in anticipation of the possibility of late fall drainage. Management at each location will be site-specific and can vary from year to year. Ideally, periodic samples would be taken at the site to confirm bioreactor performance and help guide management decisions.

Figure 6. Covering the woodchips with a geo-textile fabric before laying the soil cover at a bioreactor installation (courtesy of the Iowa Soybean Association Environmental Programs and Services)

Will my tile back up because of my bioreactor?

The slope of the site will have the biggest impact on whether this is a significant issue. A small amount of backup will occur, especially at flatter sites due to the way the inflow control structure diverts water into the bioreactor. This has not been a significant issue at the installations in Iowa thus far. Landowners will get a feel for the number of gates or stop logs that can be comfortably lowered into the inflow control structure, and if they feel that the site is not draining properly, these gates can be removed.

Figure 7. Woodchip bioreactor after installation; circular sumps and PVC wells used for research monitoring (Northeast Iowa Research and Demonstration Farm)

Will this work on an existing drainage system?

They are easy to install on existing systems, but the tile depth, diameter, and slope as well as tile connectivity need to be known. It also is helpful to have a good estimate of the drainage area for the system. All the bioreactors in Iowa to date have been installed on existing drainage systems.

Is there a yield or soil impact, and will a bioreactor work with other conservation practices?

Because this is an edge-of-field practice, in-field yields will not be affected. Likewise, bioreactors will have no impact on soil quality. Other practices such as cover crops and adding perennials to a crop rotation can improve water quality while also maintaining or enhancing soil quality. One of the biggest benefits of bioreactors being on the edge of the field is that they are minimally impacted by what is done in the field. This means that other conservation practices such as no-till, cover crops, and improved nutrient management can be done in the field, and the bioreactor will continue to treat the remaining nitrate that is lost in drainage.

Water Quality

How much nitrate will a woodchip bioreactor remove? How big an impact will I have?

A bioreactor's annual nitrate load reduction can range from about 10 percent to greater than 90 percent depending on the bioreactor, the drainage system, and the weather patterns for a given year. Based on research from Iowa, Illinois, and Minnesota, most bioreactors show performance of about 15 to 60 percent nitrate load removed per year. It may be best to target fields or watersheds that have higher nitrate loads in order to have the biggest impact.

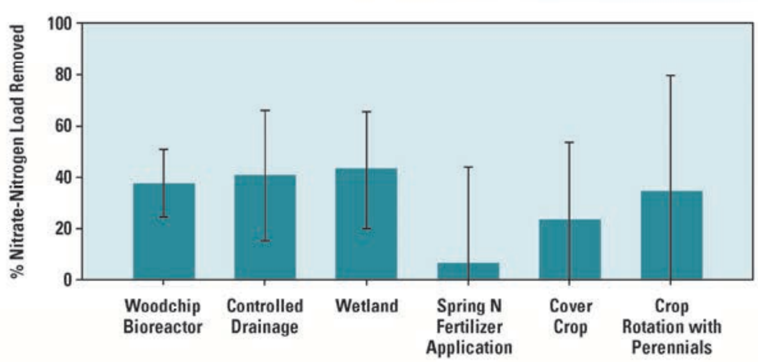


Figure 8. Comparison of nitrate removal from bioreactors and other practices; bar shows the average removal with the whisker showing plus and minus one standard deviation (adapted from data from the authors)

Authors

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Expert Reviewed

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...and justice for all

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Cathann A. Kress, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.

How do bioreactors compare to wetlands and other nitrate reduction strategies?

Bioreactors and wetlands often are compared because both technologies provide edge-of-field or off-site treatment. In terms of percent reduction of nitrate loads, wetlands have been shown to have nitrate removal of 40 to 70 percent. Bioreactors have far smaller surface footprints than wetlands, but also receive drainage from far smaller areas; bioreactors will treat drainage from a field-sized area while wetlands will receive drainage from several thousand acres. Also, wetlands can be effective for other water pollutants such as sediment and can have many additional benefits for wildlife habitat and flood regulation.

A number of other practices in addition to bioreactors and wetlands can help reduce nitrate export in drainage water. Several of these other options include improved nutrient management, cover crops, crop rotations that include perennials, and controlled drainage. In systems that are not tile-drained, nitrate could be moving to the stream via shallow groundwater flow. In those cases, buffers or prairie strips can help reduce nitrate export to the stream. The acceptability of any water quality practice will vary by individual producer and individual farm, and it is likely that a variety of practices applied across the landscape will be necessary to meet overall water quality goals.

Will the bioreactor remove other chemicals?

Woodchip bioreactors are specifically designed to reduce the amount of nitrate in drainage, and may not be effective for other pollutants such as phosphorus, pesticides, herbicides, and pathogens. However, the potential of bioreactors to remove some of these pollutants is an area of ongoing research.

Are there negative side effects?

One of the first things a bioreactor owner may notice after installation is that the outflow water is tea-colored. This is because these first waters contain some of the most readily dissolvable organic material that will wash out in the initial weeks. This has been noted at nearly every site and could be minimized by holding back some drainage water in the field with the inflow control structure, and then allowing this accumulated water to flush through the bioreactor as quickly as possible. Another possible side effect is the export of methyl mercury. If the water stays in the bioreactor too long, all the nitrate will be removed through denitrification and other processes may begin. One of these processes involves the transformation of sulfate, which is naturally present in drainage water, to hydrogen sulfide gas. The bacteria that perform this process also are involved in transforming mercury in the water or the chips to a toxic form called methyl mercury. This concern can be minimized be managing the bioreactor closely during low flow periods and monitoring for a rotten egg smell (hydrogen sulfide); if this smell is detected, the outflow control structure should be lowered to allow water to move unimpeded through the bioreactor. The last concern may be the production of nitrous oxide, a greenhouse gas, which is a natural by-product of this denitrification process. Research suggests that nitrous oxide emissions from bioreactors are a very small percentage of the nitrate entering the systems. Though it is thought these concerns may be minimized through good design and management, research still is ongoing.

How much do they cost? Who will help pay?

Most bioreactor installations in Iowa have been in the range of $7,000 to $10,000 in order to treat drainage from about 30 acres to over 100 acres. In Iowa, the Environmental Quality Incentive Program (EQIP) allows cost sharing for about half the installation cost of this water quality practice. In 2011, the EQIP practice code 747 for denitrifying bioreactors specified $3,999.50 as a one-time installation payment. Also, location within a watershed that has an organized watershed group may help increase a landowner's chances of finding other funding.

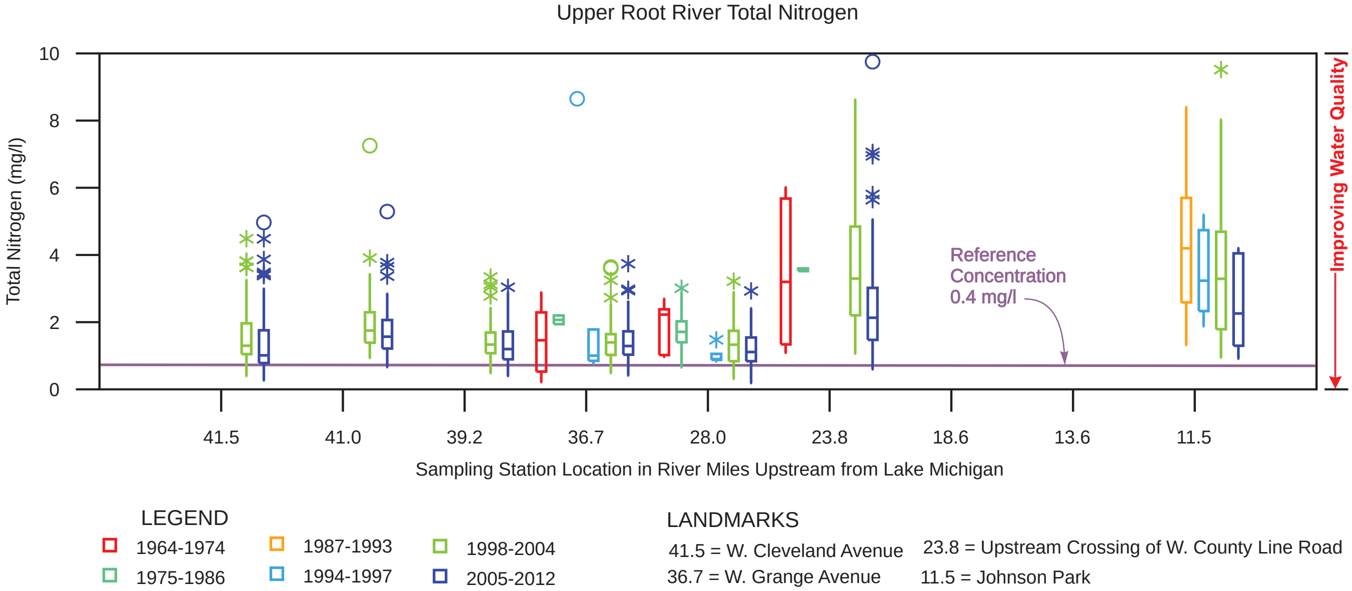
Where can I get more information?

Contact Laura Christianson (laurac@iastate.edu) or Matt Helmers (mhelmers@iastate.edu) Agricultural and Biosystems Engineering, Iowa State University, Ames, Iowa.

Exhibit C

Figure IV-31

TOTAL NITROGEN CONCENTRATIONS AT SITES ALONG THE MAINSTEM OF THE ROOT RIVER: 1964-2012



NOTES: See Figure IV-7 for description of symbols.

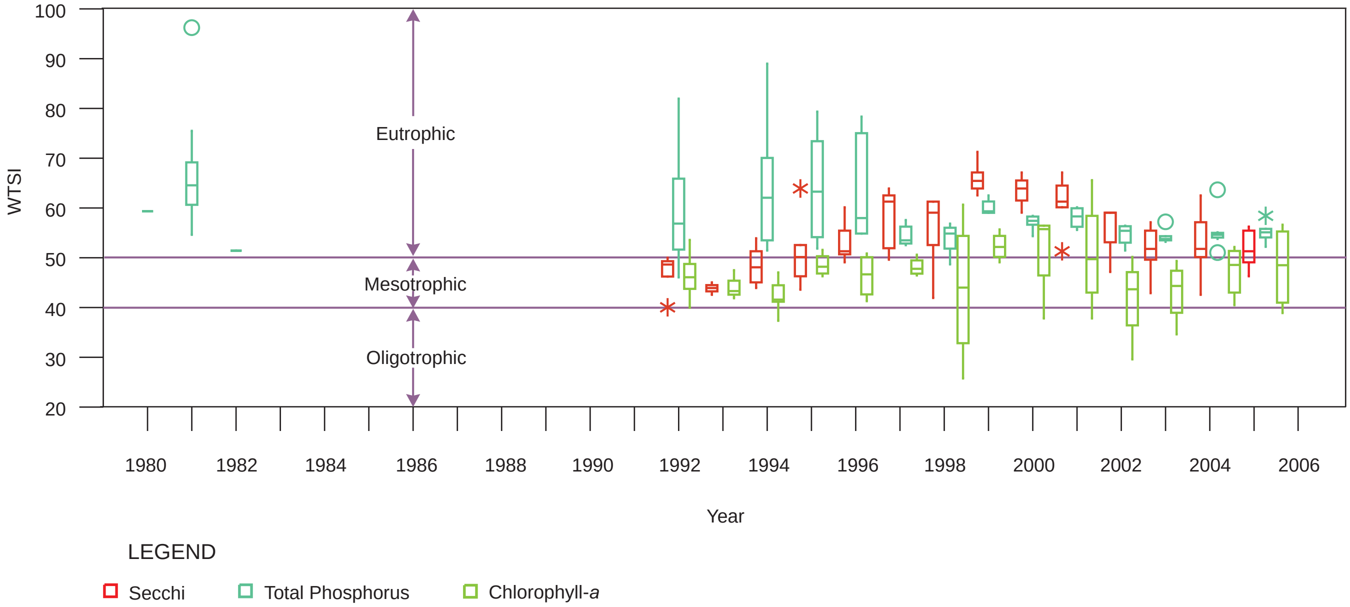
See Table IV-10 for location of sample sites.

Source: U.S. Geological Survey, Wisconsin Department of Natural Resources, Milwaukee Metropolitan Sewerage District, and SEWRPC.

Exhibit D

Figure IV-45

WISCONSIN TROPHIC STATE INDEX VALUES FOR SCOUT LAKE: 1980-2005

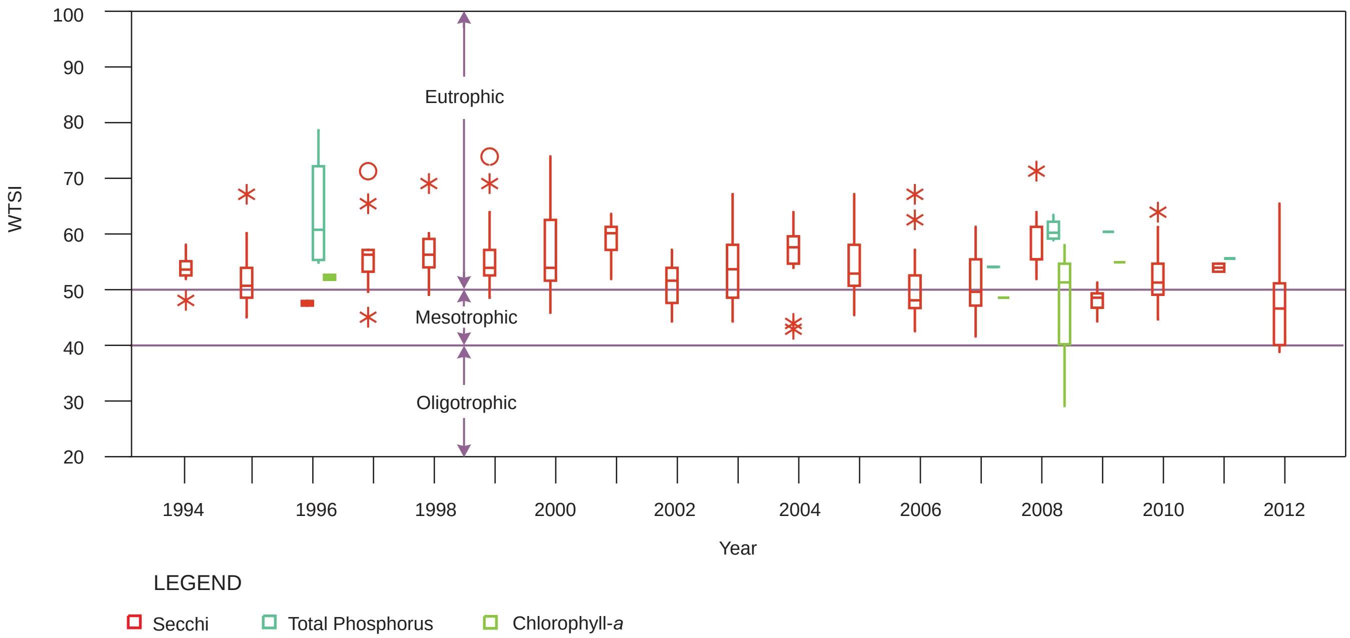


NOTE: See Figure IV-7 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Figure IV-46

WISCONSIN TROPHIC STATE INDEX VALUES FOR UPPER KELLY LAKE: 1994-2012



NOTE: See Figure IV-7 for description of symbols.

Source: Wisconsin Department of Natural Resources and SEWRPC.

Exhibit E

Table V-1

ANNUAL REDUCTIONS IN NONPOINT SOURCE LOADS OF TOTAL PHOSPHORUS REQUIRED BY THE RWQMPU ADJUSTED FOR CHANGES IN NR 151

		Annual Reduction in Loads of Total Phosphorus (pounds)						
		Urban Sources			Rural			
Subwatershed	Assessment Areas	NR 151-Related	Other Reductions	Subtotal	NR 151-Related	Other Reductions	Subtotal	Total
Upper Root River	Upper Root River, Upper Root River Headwaters	820	920	1,740	50	0	50	1,790
Whitnall Park Creek	Whitnall Park Creek	430	430	860	270	50	320	1,180
Middle Root River	Middle Root River-Dale Creek, Middle Root River-Legend Creek, Middle Root River-Ryan Creek	175	285	460	610	640	1,250	1,710
East Branch Root River	East Branch Root River	125	155	280	130	0	130	410
West Branch Root River Canal	Upper West Branch Root River Canal, Lower West Branch Root River Canal	0	80	80	1,950	2,990	4,940	5,020
East Branch Root River Canal	East Branch Root River Canal	0	20	20	870	1,300	2,170	2,190
Root River Canal	Root River Canal	6	4	10	460	860	1,320	1,330
Lower Root River	Lower Root River-Caledonia, Lower Root River Johnson Park, Lower Root River-Racine	689	991	1,680	2,910	1,830	4,740	6,420
Hoods Creek	Hoods Creek	23	47	70	1,190	510	1,700	1,770
	Total	2,268	2,932	5,200	8,440	8,180	16,620	21,820

Source: SEWRPC.

Table V-2

ANNUAL REDUCTIONS IN NONPOINT SOURCE LOADS OF TOTAL SUSPENDED SOLIDS REQUIRED BY THE RWQMPU ADJUSTED FOR CHANGES IN NR 151

		Annual Reduction in Loads of Total Suspended Solids (pounds)						
		Urban Sources			Rural			
Subwatershed	Assessment Areas	NR 151-Related	Other Reductions	Subtotal	NR 151-Related	Other Reductions	Subtotal	Total
Upper Root River	Upper Root River, Upper Root River Headwaters	327,575	291,275	618,850	10,910	0	10,910	629,760
Whitnall Park Creek	Whitnall Park Creek	200,063	130,537	330,600	569,940	0	569,940	900,540
Middle Root River	Middle Root River-Dale Creek, Middle Root River-Legend Creek, Middle Root River-Ryan Creek	177,182	76,388	253,570	3,218,650	437,680	3,656,330	3,909,900
East Branch Root River	East Branch Root River	77,118	45,852	122,970	225,190	0	225,190	348,160
West Branch Root River Canal	Upper West Branch Root River Canal, Lower West Branch Root River Canal	31,744	21,296	53,040	3,644,870	5,799,000	9,443,780	9,496,820
East Branch Root River Canal	East Branch Root River Canal	0	0	0	1,613,540	2,421,010	4,034,550	4,034,550
Root River Canal	Root River Canal	4,561	3,699	8,260	996,270	1,620,240	2,616,510	2,624,770
Lower Root River	Lower Root River-Caledonia, Lower Root River Johnson Park, Lower Root River-Racine	460,790	268,290	729,080	6,254,040	2,510,630	8,764,670	9,493,750
Hoods Creek	Hoods Creek	109,305	31,695	141,000	2,428,470	902,540	3,331,010	3,472,010
	Total	1,388,338	869,032	2,257,370	18,961,880	13,691,100	32,652,890	34,910,260

Source: SEWRPC.

Exhibit F

Table V-3

MODELED TOTAL PHOSPHORUS SUMMARY STATISTICS FROM THE RWQMPU FOR THE ROOT RIVER WATERSHED

Assessment Point	Assessment Area	Mean Concentration (mg/l)		Median Concentration (mg/l)		Percent Compliance with Recommended Phosphorus Planning Standard (0.1 mg/l)		Percent Compliance with State Total Phosphorus Criterion (0.075 mg/l)[a]
		Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Existing (2000)	Recommended Plan (2020)	Recommended Plan (2020)
RT-2: Root River	Upper Root River-Headwaters	0.079	0.067	0.025	0.020	82	84	81
RT-4: Root River	Upper Root River	0.080	0.068	0.022	0.019	78	80	76
RT-7: Whitnall Park Creek Downstream of Tess Corners Creek	Whitnall Park Creek	0.078	0.066	0.023	0.020	78	80	76
RT-8: Middle Root River	Middle Root River-Dale Creek	0.092	0.080	0.061	0.056	73	76	69
RT-9: East Branch Root River	East Branch Root River	0.072	0.063	0.029	0.024	82	83	79
RT-10: Root River upstream of Ryan Creek	Middle Root River-Legend Creek	0.087	0.075	0.057	0.051	73	77	69
RT-11: West Branch Root River Canal	Upper West Branch Root River Canal	0.266	0.231	0.179	0.147	32	41	29
RT-13: West Branch Root River Canal	Lower West Branch Root River Canal	0.164	0.143	0.076	0.067	63	67	59
RT-15: East Branch Root River Canal	East Branch Root River Canal	0.143	0.131	0.065	0.063	72	73	64
RT-16: Root River Canal	Root River Canal	0.129	0.114	0.069	0.063	71	74	64
RT-17:Root River at Upstream Crossing of Milwaukee-Racine County Line	Middle Root River-Ryan Creek	0.104	0.091	0.071	0.065	71	74	65
RT-18: Root River Upstream of Hoods Creek	Lower Root River-Caledonia	0.102	0.089	0.068	0.064	73	76	67
RT-20: Hoods Creek	Hoods Creek	0.381	0.345	0.131	0.113	43	49	32
RT-21: Root River at City of Racine	Lower Root River-Johnson Park	0.109	0.094	0.075	0.070	67	71	56
RT-22: Mouth of Root River at Lake Michigan	Lower Root River-Racine	0.115	0.099	0.079	0.073	65	70	53

NOTE: Locations of assessment points are shown on Map IV-1 in Chapter IV.

[a]*The assumptions of the model used to compute these estimates were slightly different from the assumptions of the model used in the RWQMPU. A major difference is that the meteorological records from the weather station a General Mitchell International Airport were used to develop these estimates over the entire Root River watershed. The model for the RWQMPU utilized meteorological records from four weather stations, each for a different portion of the watershed.*

Source: Tetra Tech, Inc., and SEWRPC.

Exhibit G

[This text should be inserted after the paragraph on page 38 of Chapter IV]

Supersaturation of dissolved oxygen can indicate that a site is experiencing wide swings in dissolved oxygen over the course of the day. Data from in situ continuously recording dissolved oxygen data loggers show that concentration swings of this type occur during the growing season (May through September) in upper sections of the mainstem of the Root River. Figures IV-17A and IV-17B show continuous records of dissolved oxygen concentration collected at three sampling stations in the upper reaches of the River during 2010 and 2011, respectively. The figures show dissolved oxygen data that were collected at 15-minute intervals during the months of May through September. They also show continuously collected stream discharge at the USGS discharge gauge at W. Grange Avenue (RM 36.7), which is located downstream from the sites where the continuous dissolved oxygen data were collected.

Figure IV-17A shows that large oscillations in dissolved oxygen concentration over the course of the day occurred at the stations at W. Beloit Road (RM 39.8) and W. Layton Avenue (RM 38.6) stations during late May 2010 and at the W. Beloit Road (RM 39.8) station during early July and from mid-August into early September of the same year. During the period from mid-August into early September, the range in dissolved oxygen concentration over the day at the W. Beloit Road station increased from 2.6 mg/l on August 9 to 7.0 mg/l on August 10. The daily range continued to increase through mid-August, peaking at a maximum of 10.2 mg/l on August 20. While the daily range decreased after this date, it remained greater than 7.0 mg/l into early September.

Figure IV-17B shows that these large oscillations in dissolved oxygen concentration over the course of the day were more common during 2011 than they were during 2010. Periods of these oscillations occurred at the stations at W. Beloit Road (RM 39.8) and W. Layton Avenue (RM 38.6) stations during early May and mid-May and at the station at W. Beloit Road (RM 39.8) during early June, early and mid-July, and early and mid-August. Exceptionally broad fluctuations occurred at station at W. Beloit Road (RM 39.8) during early and mid-July. The range in dissolved oxygen concentration over the day at this site increased from 5.2 mg/l on July 1 to 11.4 mg/l on July 5. The daily range continued to increase over the following days, peaking at a maximum of 16.7 mg/l on July 9. By July 11 it decreased to 4.3 mg/l. The range in dissolved oxygen concentration over the day at this site increased again, reaching 9.1 mg/l on July 13 and peaking at 15.9 mg/l on July 17. Following this maximum, the daily range in dissolved oxygen concentration decreased, reaching 2.3 mg/l on July 22.

Table IV-12A shows mean dissolved oxygen concentrations, mean daily ranges in dissolved oxygen concentrations, and maximum daily ranges in dissolved oxygen concentrations from the growing seasons of 2010 and 2011 from the three stations with continuous data records. At all three stations, mean daily ranges and maximum daily ranges in dissolved oxygen concentration were higher in 2011 than in 2010.

As previously stated, Figures IV-17A and IV-17B also show continuously collected stream discharge at the USGS discharge gauge at W. Grange Avenue (RM 36.7). This gauge is located downstream from the sites where the continuous dissolved oxygen data were collected. The magnitude of the daily ranges in dissolved oxygen concentrations at the three upstream stations do not appear to be related to the amount of discharge at the W. Grange Avenue (RM 36.7) gauge; however, the figures show that large spikes in discharge were often accompanied by increases in the concentration of dissolved oxygen at the three upstream stations. While this was especially the case at the station at S. Seymour Place (extended) (RM 41.4), it also occurred at the stations at W. Beloit Road (RM 39.8) and W. Layton Avenue (RM 38.6).

Table IV-12A

MEAN CONCENTRATIONS, MEAN DAILY RANGES, AND MAXIMUM DAILY RANGES OF CONTINUOUSLY RECORDED DISSOLVED OXYGEN CONCENTRATIONS FROM THREE SAMPLING STATIONS ALONG THE ROOT RIVER: 2010 AND 2011[a]

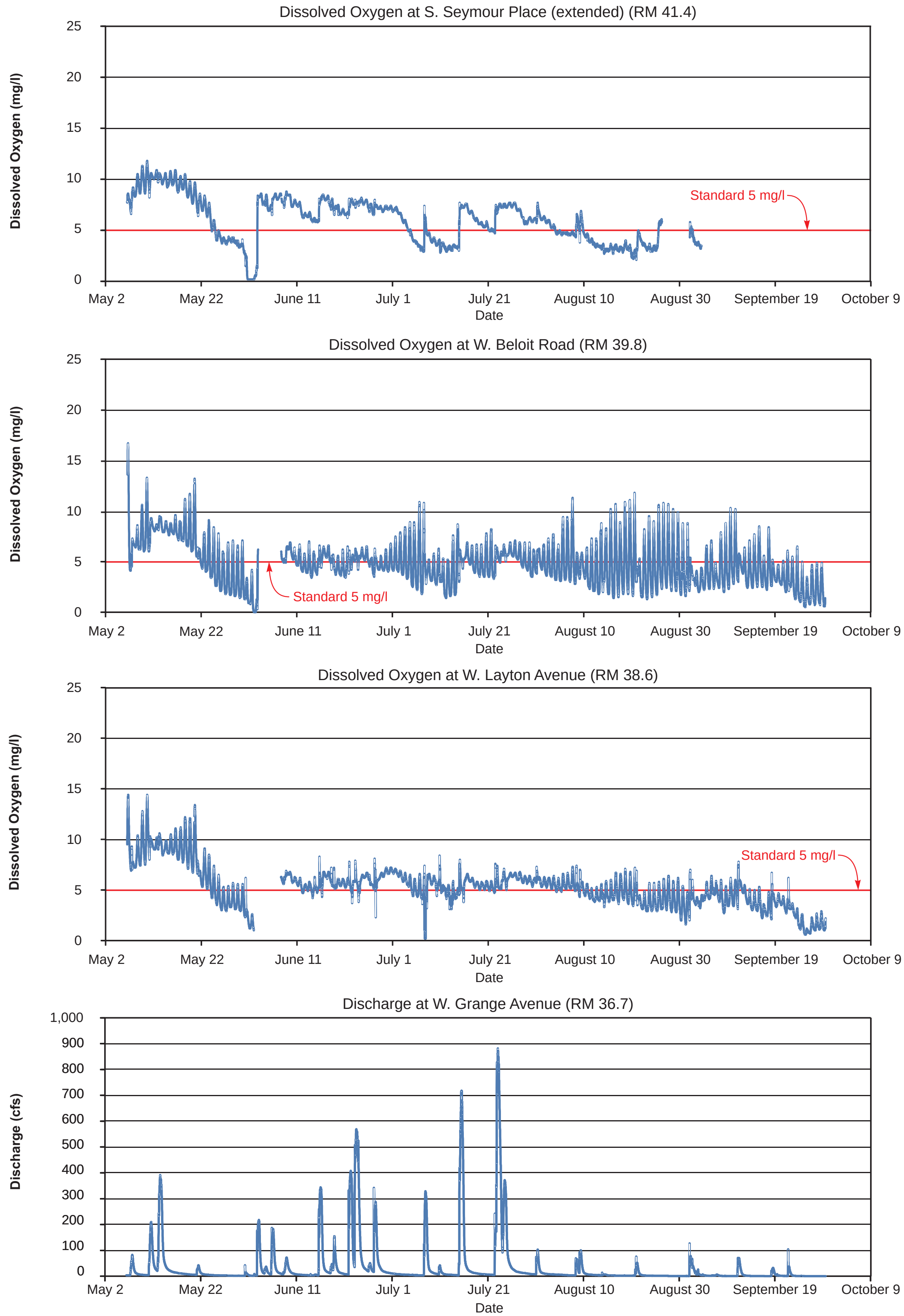
Station	2010				2011			
	Days of Record	Mean Concentration (mg/l)	Mean Daily Range (mg/l)	Maximum Daily Range (mg/l)	Days of Record	Mean Concentration (mg/l)	Mean Daily Range (mg/l)	Maximum Daily Range (mg/l)
S. Seymour Place	112	6.02	1.22	8.20	72	6.10	2.56	6.50
W. Beloit Road	140	4.91	4.23	10.20	153	4.85	5.42	16.70
W. Layton Avenue	139	5.34	2.25	7.20	153	4.59	3.46	15.80

[a] *For the May through September growing season.*

Source: U.S. Geological Survey and SEWRPC.

Figure IV-17A

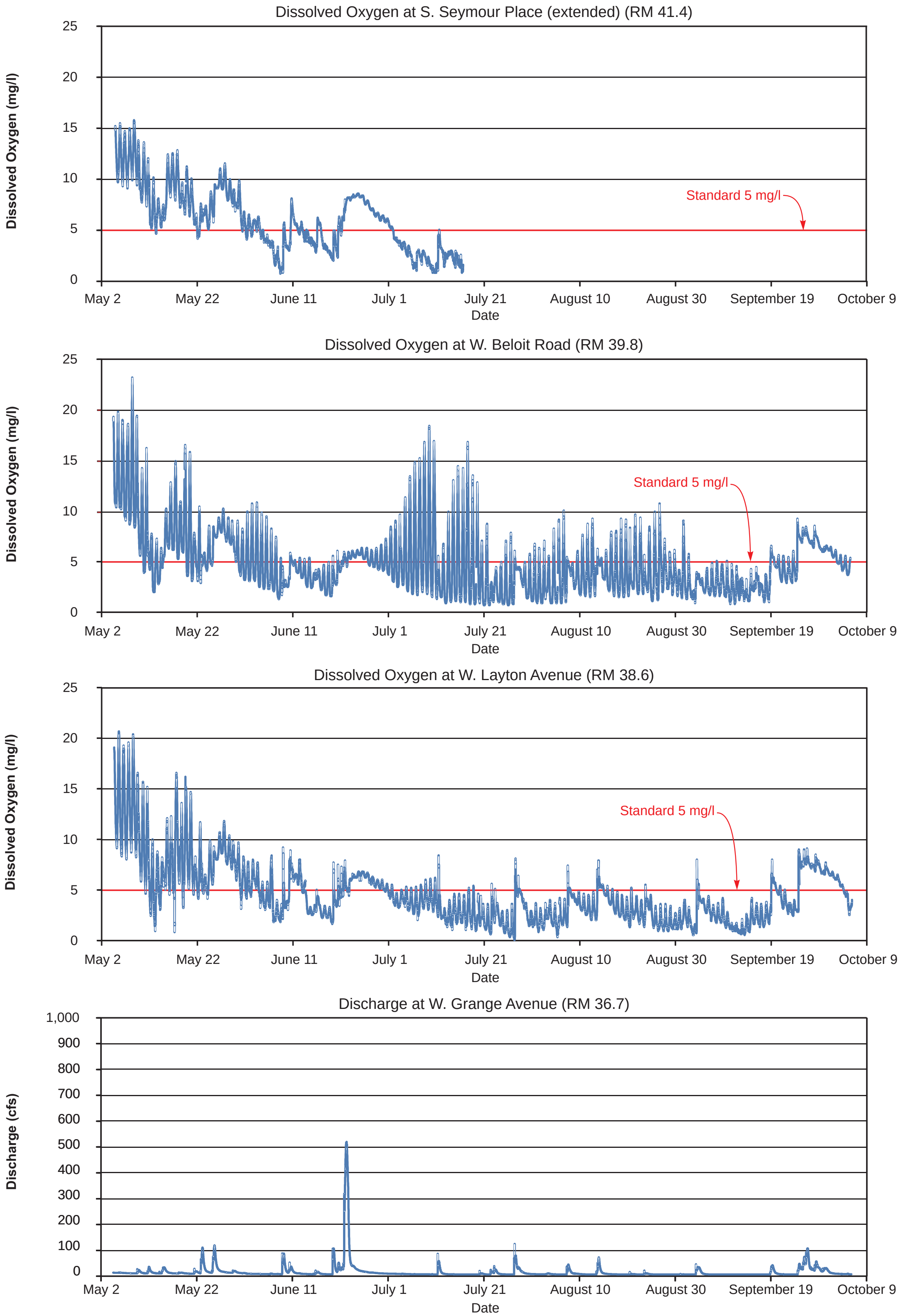
CONTINUOUSLY MONITORED DISSOLVED OXYGEN CONCENTRATIONS AT THREE LOCATIONS ALONG THE MAINSTEM OF THE ROOT RIVER: 2010



Source: U.S. Geological Survey and SEWRPC.

Figure IV-17B

CONTINUOUSLY MONITORED DISSOLVED OXYGEN CONCENTRATIONS AT THREE LOCATIONS ALONG THE MAINSTEM OF THE ROOT RIVER: 2011



Source: U.S. Geological Survey and SEWRPC.