Water Quality Trading Plan

Springfield Clean Water LLC

This document outlines Springfield Clean Water LLC's plan to implement Water Quality Trading to maintain compliance with its Wisconsin Pollution Discharge Elimination System Permit WI - 0065889

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Water Quality Trading Plan

Springfield Clean Water LLC

1 Executive Summary

This Water Quality Trading Plan summarizes Springfield Clean Water LLC's (SCW) plan to use Wisconsin Department of Natural Resources (WDNR) water quality trading program, Wis. State. 283.84, to comply with its total phosphorus Water Quality Based Effluent Limits (WQBEL's) in its Wisconsin Pollution Discharge Elimination System (WPDES) permit WI-0065889 for Outfall #001. Springfield Clean Water has been partnering with GL Dairy Biogas LLC, Blue Star Dairy, Ziegler Diary, Hensen Dairy, and Dane County on Dane County's second community manure digester located just outside of Middleton Wisconsin. Project partners intend to implement additional technology at the facility to concentrate nutrients and produce clean water to be discharged to nearby surface water. Springfield Clean Water has submitted its application material to obtain a new WPDES permit for discharge of treated wastewater. To ensure compliance with this new permit's total phosphorus (TP) and total suspended solids (TSS) discharge limits; SCW will work with Dane County who will, in turn, assist landowners on implementing grassed waterways on concentrated flow areas located on agricultural fields upstream and within the same subwatershed as Outfall #001. Dane County has quantified the current phosphorus and soil losses from three identified concentrated flow areas as well as the reduction in phosphorus and soil losses once these areas have been stabilized with grassed waterways. Using a trade ratio of 1.5:1 and a Credit Threshold of 57% for TP and 61% for TSS Dane County calculated the TP and TSS *Interim* water quality trading credits (Table 1). Springfield Clean Water will use these credits to demonstrate compliance with its TP and TSS limit in its new WPDES permit (WI-0065889).

Table 1. Interim and long-term total phosphorus and total suspended solids trading credits.

	Total Phosphorus (TP) (Pounds per Year)	Total Suspended Solids (TSS) (Pounds per Year)
Interim Credits (available first 5 years)	99	145,733
Long-term Credits (available after first 5 years)	To be determined	To be determined

2 PROJECT HISTORY AND BACKGROUND

2.1 HISTORY OF PROJECT SITE

The Yahara River Watershed is located within the larger Rock River Watershed and has an approved Total Maximum Daily Load (TMDL) with nonpoint sources of TP and TSS being the primary source of pollution. Dane County secured funding for the construction of two Community Manure Digesters to help address the nonpoint TP sources within the Yahara. GL Dairy Biogas LLC was awarded funding for construction of the second Community Manure Digester in 2013. The intent of this project is to provide a manure treatment facility in which participating agricultural livestock producers can take their manure for processing to remove up to 60% of phosphorus prior to land applying the manure to meet growing crop nutrient needs. Per agreements between Dane County and GL Dairy Biogas LLC, and with the intent in making improvements to the second digester based on lessons learned from the first one, a secondary treatment system that would allow for improved management of the remaining manure nutrients is planned to be implemented at this location.

2.2 PURPOSE OF WATER QUALITY TRADING PLAN

The purpose of this Water Quality Trading Plan is to demonstrate how SCW will utilize water quality trading to comply with the TP and TSS limits on Outfall #001 of WPDES permit WI-0065889. Three grassed waterways will be utilized to stabilize nonpoint source erosion from concentrated flow areas upstream and within the same HUC-12 subwatershed as Outfall #001. The phosphorus and soil reductions and corresponding credits generated from stabilizing these concentrated flow areas will be used by SCW. Construction of these grassed waterways is scheduled for the Fall of 2016 and Spring 2017.

2.3 TOTAL PHOSPHORUS AND TOTAL SUSPENDED SOLIDS PERMIT REQUIREMENTS FOR OUTFALL #001

Springfield Clean Water LLC is the operating company that is seeking the WPDES permit WI-0065889 for Outfall#001 in order to discharge clean water to Pheasant Branch Creek. Clean water will be generated as a result of operating a Nutrient Concentration System (NCS) that will be located at the current GL Dairy Biogas LLC digester site in Middleton, Wisconsin. Historically manure that has been sent to this facility has undergone mechanical separation processes in which phosphorus rich fiber has been removed from the liquid manure to be exported out of the watershed. However, these separation processes result in no net decreases in the volume of material needing to be land applied. The purpose of the NCS is to further concentrate the remaining nutrients into a form that can be more strategically managed to meet growing crop needs while also returning clean water back to the watershed. This will, in turn, help reduce the risk of phosphorus runoff from reaching nearby surface water.

The NCS will discharge between 10 and 22 pounds of TP per year and 200 to 430 pounds of TSS per year through Outfall #001. This is based on Outfall #001 discharging between 32,600 to 70,000 gallons per day with a TP concentration in Outfall #001 of 0.10 mg/L and TSS concentration of 2.0 mg/l. These effluent concentrations in TP and TSS will be achieved through the use of ultrafiltration and reverse osmosis membranes. If ultrafiltration and reverse osmosis cannot achieve the TP and TSS permit requirements, as well as the credits available through associated trade agreements, then flow through Outfall #001 will be bypassed. The bypass will result in all NCS processed material being directed to the storage lagoon to be handled according to the land spreading conditions set forth in WPDES permit WI-0065099.

3 Project and Credit Locations

3.1 Project Location

Outfall #001 is located at approximately: latitude 43.124433, longitude -89.541219 in HUC12 watershed #070900020603 also known as the Pheasant Branch subwatershed (Attachment A). Pheasant Branch is part of the larger Yahara River Watershed which drains to the Rock River. Pheasant Branch is located in the eastern part of the Rock River TMDL and is also listed as a 303d impaired water body for TP, TSS, and chloride.

3.2 Practice/Credit Locations

Springfield Clean Water will work with Dane County Land and Water Resources Department in assisting landowners with implementing conservation practices to generate TP and TSS credits on fields located within Pheasant Branch Creek and upstream of Outfall #001. Attachment A shows the general location of where the conservation practices generating total phosphorus credits will be implemented along with their proximity to Outfall #001. These fields are located roughly 2.5 to 3.7 miles upstream and within the same HUC12 watershed as Outfall #001.

4 Existing Land Uses

The predominant land use within the watershed above Outfall #001 is agriculture accounting for 83% (2,575 acres) of the total area. This is based on the 2010 Capital Area Regional Planning Commission land use inventory. Dane County has indicated that they have worked with the majority if not all the landowners on developing conservation plans as well as nutrient management plans for agricultural lands located above Outfall #001. The fields in which the grassed waterways will be constructed on are included within each current operators nutrient management plan.

5 DANE COUNTY BROKERING ROLES AND RESPONSIBILITIES

Dane County will serve as a broker in providing SCW with total phosphorus trading credits for compliance with WPDES permit WI-0065889. Dane County's role as a broker will consist of two primary components.

1. Providing technical and financial assistance to landowners who are implementing grassed waterways in areas where gullies currently exist to ensure that all technical standards are being met.
2. Providing services to SCW in verifying practice installation, calculating associated total phosphors trading credits to be used by SCW for compliance with WPDES permit WI-0065889, and continued monitoring to ensure all practices are being maintained.

5.1 TECHNICAL AND FINANCIAL ASSISTANCE TO LANDOWNERS

Dane County will develop agreements with the landowners who will be implementing the grassed waterways that will generate TP and TSS trading credits similar to that provided in (Attachment B). County staff will ensure that each waterway is designed, constructed, and maintained according to the USDA - Natural Resources Conservation Service (NRCS) Technical Standard Code 412. All associated financial assistance will be overseen by county staff. Records certifying the design and as built construction of the waterways will also be maintained by Dane County.

5.2 SERVICES TO SPRINGFIELD CLEAN WATER

Dane County and SCW are developing an agreement pursuant to 283.84(1)(c) Wisconsin state statute for brokering services related to practice installation, TP and TSS trading credit generation, and continued monitoring (Attachment C). The agreement is anticipated to be finalized no later than August 31, 2017. The agreement identifies;

- SCW as the credit user and Dane County as the credit generator
- The pollutant being traded as TP and TSS
- A TP Credit of 99 pounds and TSS Credit of 145,733 pounds will be available to be used by SCW
    - These credits will be available upon written notice by Dane County that the grassed waterways have been installed along with the corresponding TP and TSS Credits available for each practice.
- The anticipated date upon which the credits will be generated. Dane County will provide SCW with written notice once the practices have been implemented. These credits will remain available to SCW for the design life expectancy of the practice (10 years for grassed waterways) as identified in the operation and maintenance plan for the practice or upon written notification that the practice is no longer functioning.

- Verification of practice installation and certification of practice maintenance will be conducted by Dane County on an annual basis. Inspections will include the following information:
    - Date of Inspection,
    - Statement of finding indicating that the waterways are functioning and being, maintained according to the operation and maintenance plan,
    - Any deficient items identified in the operation and maintenance plan if applicable,
    - Remedies as to how, who, and in what timeframe corrections will be made for identified deficient items,
- Liability conditions of the trade agreement
- Termination conditions of the trade agreement
- The duration of the agreement

6 Stabilization of Concentrated Flow Areas Using Grassed Waterways

6.1 Description and Practice Standard

Dane County will be assisting landowners with the installation of grassed waterways according to USDA - NRCS Technical Standard Code 412 (Attachment D). Dane County will be responsible for the design and oversee the construction of each of the three waterways. Once construction is complete Dane County will verify all constructed waterways meet standards and specifications (Attachment E). Individual landowners will be responsible for the continued operation and maintenance of the grassed waterways (Attachment F).

6.1.1 Establishment Plan

Dane County has been engaged with each of the landowners that will be installing the grassed waterways to establish approximate timelines and design criteria. Individual designs were developed for each waterway with the following components included in each design.

a) General site location map identifying where the waterway is to be constructed,
b) Estimated quantities of various practice components including seeding, mulching, and erosions control matting (if required),
c) A waterway profile design and/or cross section design depicting all necessary construction details including reach location, channel slopes, bottom widths, depths, side slopes, and lengths. All construction details are calculated using methodologies outlined in Chapter 2 of NRCS's Engineering Field Handbook,
d) Seeding establishment plan containing the recommended seed types and amounts as well as appropriate seeding dates,
e) An Operation and Maintenance Plan,
f) Estimated costs based on Dane County's average costs.

All establishment plans are approved by Dane County staff having the proper engineering job approval class for each waterway. This engineering approval is overseen by both the WI-Department of Agriculture Trade and Consumer Protection as well as the WI-NRCS.

6.1.2 Operation and Maintenance Plan

The operation and maintenance plan in Attachment F outlines the requirements on how the grassed waterways will be maintained. This plan will be customized to the site conditions for each waterway. The timeframe for implementing the plan, as well as the design lifespan of the waterways, is 10 years. Some of the requirements included in the plan are; when mowing's of the waterways can occur, conditions for ensuring vegetative cover, and restrictions on use as an access road.

7 Quantifying Phosphorus and Total Suspended Solids Reductions

The quantification of phosphorus and total suspended solids from the installation of grassed waterways will be calculated by Dane County. The County will use field measurements and the NRCS Gully Erosion Calculator to determine the amount of soil being lost (Appendix G). This soil loss will then be multiplied by the Initial Surface Total Phosphorus value using the equation from SNAP Plus (Appendix H) to determine phosphorus reductions. Total suspended solids reductions will be equal to the soil loss calculated using the NRCS Gully Erosion Calculator. Below are the calculations:

SOIL LOSS FROM GULLY = A x [(B + C) / 2] x D x E ÷ 2000 (pounds/ton) ÷ F

A = Channel Depth (feet)

B = Top Channel Width (feet)

C = Bottom Channel Width (feet)

D = Channel Length (feet)

E = Soil Weight (pounds/feet^3)

F = Formation Time (years).

INITIAL SURFACE TOTAL PHOSPHORUS = [13 + (2.7 x F) + (0.03 x G)]^2 x 0.002 (lbs/ton).

G = organic matter % from soil test

H = soil test P (ppm)

PHOSHORUS REDUCTION = I x J

I = Soils Loss From Gully (tons/year)

J = Initial Surface Total Phosphorus (pounds/ton of soil)

Each of the gully's that will be treated with implementation of a grassed waterway was inventoried by Dane County staff. Values for the above variables and corresponding results are provided in Table 2. All totaled 148.8 pounds of phosphorus and 218,600 pounds of total suspended solids will be reduced once the grassed waterways are installed.

Table 2. Gully erosion values for variables needed to calculate phosphorus reductions through implementation of grassed waterways.

Gully#	A	B	C	D	E	F	Total Suspended Solids Reduction (pounds)	G	H	I	J	Phosphorus Reduction (pounds)
#1	0.5	2	0	200	95	0.25	38,000	3.4	44	19.0	1.1	20.9
#2	0.5	2	0	1500	95	0.5	142,600	3.8	129	71.3	1.5	107.0
#4	1	2	0	400	95	1	38,000	3.2	65	19.0	1.1	20.9
Total							218,600					148.8

8 Trade Ratio Calculations

8.1 Calculation Factors

8.1.1 Delivery Factor (DF)

The concentrated flow areas that will be treated as a result of installing grassed waterways are located within the same HUC12, Pheasant Branch, as Outfall #001. Therefore, a delivery factor of 0 will be used in establishing the trade ratio.

8.1.2 Downstream Factor (DSF)

All of the grassed waterways will be installed upstream of Outfall #001 and as such a downstream factor of 0 will be used in establishing the trade ratio.

8.1.3 Equivalency Factor (EF)

As stated in the Guidance for Implementing Water Quality Trading in WPDES Permits (section 2.11.3) provided by WDNR an equivalency factor of 0 will be used since the pollutants being traded under this plan are total phosphorus and total suspended solids.

8.1.4 Uncertainty Factor (UF)

All concentrated flow areas that will be treated with grassed waterways are located on fields that are included within a 590 Nutrient Management Plan. Using Table 4 from the Guidance for Implementing Water Quality Trading in WPDES Permits an uncertainty factor of 1.5 will be used.

8.1.5 Habitat Adjustment (HA)

No habitat adjustment will be used in establishing the trade ratio.

8.2 Calculations

Trade Ratio Calculation= (DF + DSF + EF + UF – HA):1

Trade Ratio = (0 + 0 + 0 + 1.5 – 0):1 = **1.5:1**

Dane County will use a trade ratio of **1.5:1** in calculating TP and TSS credits as a result of installing grassed waterways.

9 Credit Generation

Multiplying the phosphorus and total suspended solids by the trade ratio results in the generation of TP and TSS credits to use in demonstrating compliance with WPDES Permit WI-0065889. A total of 148.8 pounds of phosphorus and 218,600 pounds of soil will be reduced through implementation of three grassed waterways. Using a trade ratio of 1.5:1 as calculated above a total of **99 pounds per year of TP and 145,733 pounds per year of TSS** is available to be used as a credit.

Credit Generation = H ÷ K

H = Phosphorus Reduction (pounds/year)

K = Trade Ratio

Total Phosphorus (TP) Credits generated = 99 pounds/year

Total Suspended Solids (TSS) Credits generated = 145,733 pounds/year

10 Pollutant Reduction Credit Threshold

10.1 Credit Threshold Criteria

Since Outfall #001 will discharge into Pheasant Branch Creek which is located within the Rock River TMDL a Credit Threshold will need to be applied. A Credit Threshold as described in *WDNR Guidance for Implementing Water Quality Trading in WPDES Permits* as the pollutant loading from a point source or nonpoint source, below which reductions are made to generate credits.

10.2 Rock River TMDL Load Reductions/Credit Thresholds

Based on the approved Rock River TMDL Percent Reduction Tables (Appendix I) the Load Reduction and subsequent Credit Threshold for TP and TSS are 57% and 61% respectively.

11 INTERIM AND LONG-TERM CREDITS

11.1 INTERIM CREDITS

Interim TP and TSS credits will be available for the first permit term (5 years) of WPDES permit WI-0065889. Credit thresholds will not be applied to the interim credits.

Interim TP Credits Available = 99 pounds per year

Interim TSS Credits Available = 145,733 pounds per year

11.2 LONG-TERM CREDITS

Long-term credits for both TP and TSS are being evaluated. These long-term credits will be in place prior to issuance of the second permit term of WPDES permit WI-0065889.

12 TIMELINE

12.1 NUTRIENT CONCENTRATION SYSTEM CONSTRUCTION TIMELINE

Construction of the NCS is scheduled for the fall of 2017. Agreements between all parties involved in the project are being finalized for approval. Upon approval construction of both the NCS equipment and facilities that will house the NCS will commence. Construction and installation is anticipated to take approximately six months. Startup and commissioning of the equipment will occur shortly thereafter with anticipated discharge through Outfall #001 of WPDES permit WI-0065889 to commence on Feb 1, 2018. If the grassed waterways are not installed and generating credits prior to the discharge through Outfall #001 the clean water from the NCS will be diverted from Outfall #001 to the storage lagoon for land application according to WPDES permit WI-0065099.

12.2 PRACTICE AND CREDIT GENERATION TIMELINE

All three grassed waterways are currently under contract to be constructed in either the Fall of 2016 or Spring of 2017. Dane County staff are working with the landowners and their contractors to ensure they are constructed according to standards and specifications. Specific dates of installation are dependent upon contractor availability, crop harvest, and weather.

13 INSPECTIONS AND REPORTING

13.1 PRACTICE REGISTRATION

Once the waterways have been installed Dane County will certify that the practices have been completed and will notify SCW in writing that the waterways were installed according to standards and specifications. Springfield Clean Water will then file a completed Registration Form 3400-207 (Attachment J) for Water Quality Trading Management Practice Registration with the WDNR.

13.2 Certification

Certification that the waterways are being maintained and functioning properly will be conducted by Dane County on an annual basis. A letter from Dane County to SCW will be sent prior to and included in Springfield Clean Water's Annual Trading Reporting certifying compliance.

13.3 Inspections/Verification

Dane County will inspect and verify on an annual basis that the waterways generating Phosphorus Credits as part of this water quality trading plan are functioning and being maintained according to the operation and maintenance plan. Inspection reports will be included in the Annual Certification Letter sent to SCW. Inspection reports will include:

- Date of Inspection,
- Statement of finding indicating that the waterways are functioning and being, maintained according to the operation and maintenance plan,
- Any deficient items identified in the operation and maintenance plan if applicable,
- Remedies as to how, who, and in what timeframe corrections will be made for identified deficient items,

13.4 Annual Trading Report

Springfield Clean Water will report to WDNR by January 31 of each year the following:

- The number of total phosphorus reduction credits (pounds/year) used for the previous year to demonstrate compliance
- Inspection reports and certification letters for the grassed waterway management practices that generated the total phosphorus credits used to demonstrate compliance
- Identification of noncompliance or failure to implement any terms or conditions of WPDES permit WI-0065889 with respect to water quality trading that have not been reported in discharge reports.

13.5 Notification of practice failure

Springfield Clean Water will notify WDNR by phone within 24 hours after becoming aware that total phosphorus credits used or intended to be used for compliance with permit WI-0065889 are not being implemented or generated as a set forth in this Water Quality Trading Plan.

14 COMPLIANCE WITH WATER QUALITY TRADING CHECKLIST

This Water Quality Trading Plan complies with the Water Quality Trading Checklist identified in Table 8 on page 37 of the WDNR Guidance for Implementing Water Quality Trading in WPDES Permits. This plan complies with the requirements for Credit Source (item c) in Table 8. Credit Source includes sources where "Credits are obtained from either the Wisconsin DNR or a local governmental unit acting as a broker." Dane County will be serving as a broker in assisting with implementing grassed waterways on fields which are currently not covered under SCW's WPDES permit.

Below is a table identifying the required elements for this Water Quality Trading Plan. Corresponding page numbers are also provided in Table 3.

Table 3. Water Quality Trading Checklist.

WDNR Content of Water Quality Trading Plan (Table 8 item (c) of WDNR Water Quality Trading Guidance.	Page Number
Permittee's/credit user's WPDES permit number	1
Permittee's/credit user's contact information	10
Pollutant(s) for which credits will be generated	2
Amount of credits available from each location/management practice/local government unit when acting as a broker	8
Certification that the content of the trading application is accurate and correct	10
Signature and date of signature of permittee's/credit user's authorized representative	10
Verification either by certification or submittal that a trade agreement has been completed	4 (Attachment C)
Identification of the local governmental unit when acting as a broker	3
Signature and date of signature of an authorized representative for the local governmental unit when acting as a broker	(Attachment C)

15 Certification of Water Quality Trading Plan

The undersigned hereby certifies that this Water Quality Trading Plan is to the best of his/her knowledge accurate and correct.

SPRINGFIELD CLEAN WATER LLC

BY: ______________________________________

Name: Daniel Nemke

Title: CTO

Company: Dynamic Holding, Inc.

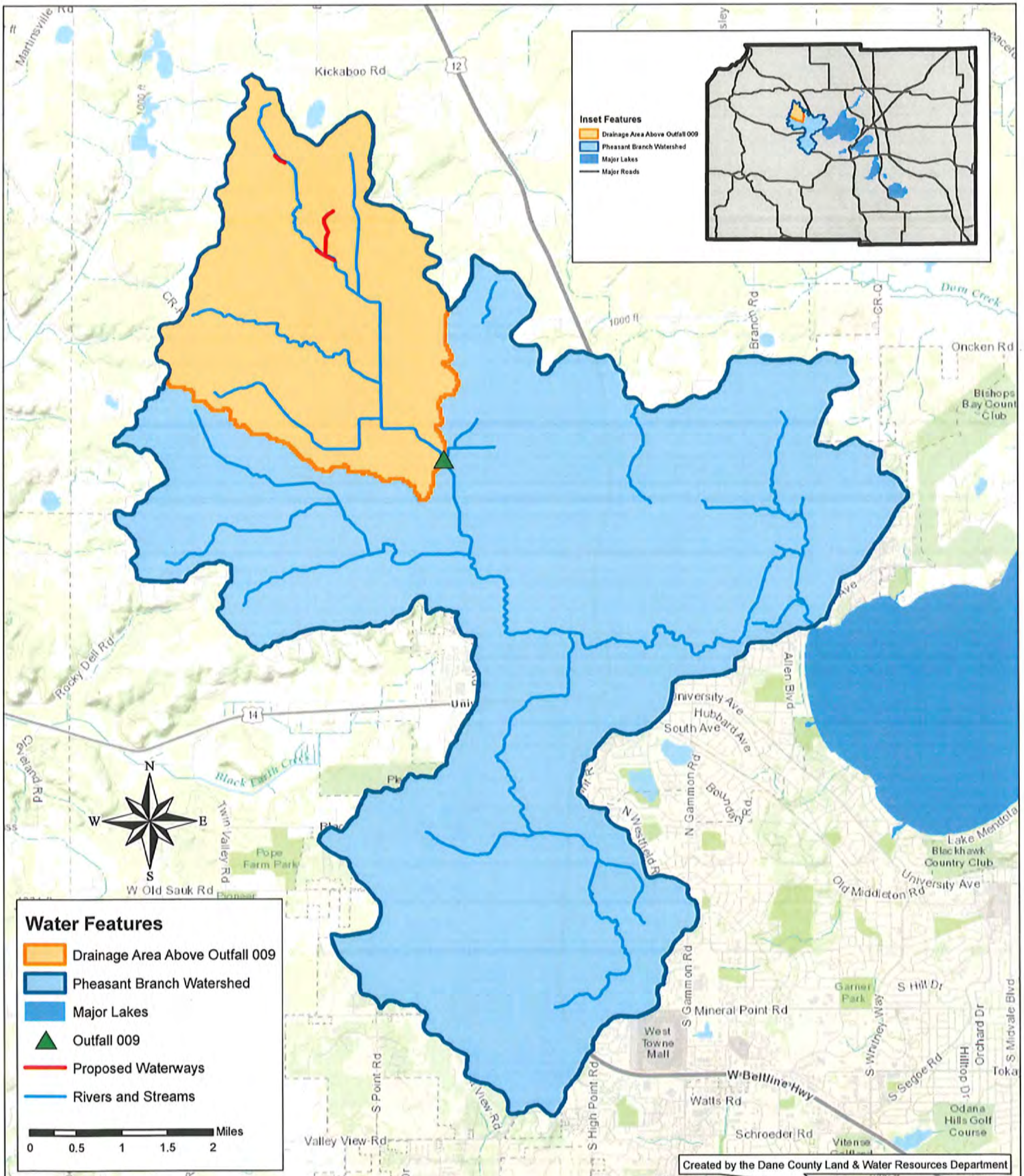
Address: 737 W. Glen Oaks Lane, Mequon, WI 53092

Phone Number: 262-422-1899

Attachment A

Map of Project Location

Generating Phosphorus Trading Credits



Attachment B

Example Dane County Cost-Share Agreement

COST-SHARE AGREEMENT NO.

DANE COUNTY
COST-SHARE AGREEMENT

This contract is made and entered into, *pursuant to §92.10 of the Wisconsin Statutes,* by and between Dane County Land Conservation Committee, and landowners_________________________________ and or grant recipient (s)_________________________________.

This agreement is complete and valid as of the date signed by the county representative.

In consideration of the terms and conditions herein, the parties agree to this agreement as set forth in the following Sections 1, 2, and 3, and any addenda that are annexed and made a part hereof.

Return to: Dane County Land & Water Resources
5201 Fen Oak Drive, Room 208
Madison, WI 53718

PIN#

______________________________ ________
LANDOWNER/ REPRESENTATIVE **DATE**

PRINT OR TYPE NAME: ______________________________

State of Wisconsin)
) ss.
________County)

This instrument was acknowledged before me on ______________
(date)

by ______________________________
(name of landowner or representative)

as ______________________________
(representative's position or type of authority)

for ______________________________.
(name of entity on behalf of whom instrument was executed)

______________________ ______________________
SIGNATURE PRINT NAME
Notary Public, State of Wisconsin
My commission expires ______________ (is permanent).

______________________________ ________
LANDOWNER/SPOUSE/REPRESENTATIVE **DATE**

PRINT OR TYPE NAME: ______________________________

State of Wisconsin)
) ss.
________County)

This instrument was acknowledged before me on ______________
(date)

by ______________________________
(name of landowner or representative)

as ______________________________
(representative's position or type of authority)

for ______________________________.
(name of entity on behalf of whom instrument was executed

______________________ ______________________
SIGNATURE PRINT NAME
Notary Public, State of Wisconsin
My commission expires ______________ (is permanent).

______________________________ ________
SIGNATURE OF COUNTY REPRESENTATIVE **DATE**

PRINT OR TYPE NAME: ______________________________

State of Wisconsin)
) ss.
____Dane_County)

This instrument was acknowledged before me on ______________, 20__ by ______________________

as ______________________of ______________________________.

______________________________ ______________________________
SIGNATURE PRINT NAME
Notary Public, State of Wisconsin
My commission expires ________________ (is permanent)

Personal information you provide may be used for purposes other than that for which it was originally collected (Privacy Law sec. 19.62-19.80, Wis. Stats.).

COST SHARE AGREEMENT NO.

SECTION 1A. COUNTY INFORMATION	PAGE 2 of 5
NAME OF COUNTY AGENCY Dane County Land & Water Resources	TELEPHONE NUMBER 608-224-3730
ADDRESS 5201 Fen Oak Drive , Rm 208	CITY, STATE, ZIP CODE Madison, WI 53718
NAME OF AUTHORIZED REPRESENTATIVE Kevin Connors, Director	

SECTION 1B. LANDOWNER INFORMATION	
TOTAL COST-SHARE AMOUNT (from page 3)	
NAME OF LANDOWNER (Individual, Corporation, Trust, Estate, Partnership) NOTE: SPOUSE MUST BE INCLUDED	
ADDRESS	
CITY, STATE, ZIP CODE	TELEPHONE NUMBER
LEGAL DESCRIPTION OF SUBJECT PROPERTY (COMPLETE BELOW OR ATTACH AS EXHIBIT B) Example: NW ¼ of the NW ¼ of Section 12, T. 14 N., R 6 E. (Aerial photo without description is not sufficient)	
NAME OF GRANT RECIPIENT, if different than above. NOTE: SPOUSE MUST BE INCLUDED	
ADDRESS	
CITY, STATE, ZIP CODE & PHONE NUMBER	

INSTALLATION PERIOD
Each practice must be installed by November 30st in the year of the cost-share agreement unless the project is extended by the Land Conservation Committee. Extension must to approved by December 31st in the year of the cost-share agreement

Appeal Rights

The landowner or grant recipient may appeal to the county, in writing, any decision of the county land conservation department regarding this grant. The county corporation counsel will determine if the grantee is eligible for a hearing under Chapter 68, Wis. Stats Sections 14.26 and 14.71.

Landowner Initials	Date	Spouse Initials	Date	Grant Recipient Initials	Date	Spouse Initials	Date	County Reps. Initials	Date

COST-SHARE AGREEMENT NO.

ADDENDA MAY BE ATTACHED TO THIS DOCUMENT TO RECORD SPECIAL CONDITION

A. The landowner/grant recipient (hereinafter referred to as "Landowner" agrees:

1. To install and maintain cost-shared practice(s) listed in Section 3, consistent with the plans and specifications referenced in Section 3, during periods identified in Section 3 and in the Notice of Continuing Compliance Requirements referenced in A.7, below..
2. To make all payments for which the Landowner is obligated under this agreement, as specified in Section 3. Recording of this agreement is required, if the cost-share amount exceeds $25,000.00,including the legal description of subject property with the deed to subject property, Said deed will be removed at the end of the 10 year period. The 10 year period starts from the date of installation.
3. To provide the county with evidence of payment, as applicable, for services, supplies, and practices performed or installed pursuant to this contract. Proof of payment may be in the form of a statement or invoice, or receipts or cancelled checks with the related vendor contract. For services provided by the landowner, the landowner shall submit a detailed invoice or cost-estimate for those services
4. To operate and maintain each cost-shared practice for the time period specified in the "Notice of Continuing Compliance Requirements" referenced in A.7(below), following the certification of installation or replace it with an equally effective practice. To refrain, during the maintenance period, from actions that may reduce a practice's effectiveness, or may result in water quality problems. Where appropriate, the Landowner agrees to follow an operation and maintenance plan for 10 years from the date of installation. All nutrient management plans must comply with s. ATCP 50.04(3), Wis. Admin. Code.
5. To repay cost-share funds immediately, upon demand by the county, if the Landowner fails to operate and maintain the cost-shared practice according to the contract. Repayment of grant funds shall not be required if a practice(s) is rendered ineffective during the required maintenance period due to circumstances beyond the control of the Landowner.
6. To comply with (i) the performance standards, prohibitions, conservation practices and technical standards under s. 281.16, Stats., (ii) plans approved under ss. 92.14, 92.15 (1985 Stats.), 92.10 and 281.65, Stats., and Chapter 14, Subchapter 1 of the Dane County Ordinances and (iii) the practices necessary to meet the requirements of this agreement, and to continue such compliance after the term of this agreement, without further cost-sharing, if the landowner has received cost-sharing for compliance at least equal to the cost-sharing required under s. ATCP 50.08, Wis. Admin. Code. There is no requirement for continuing compliance without cost-sharing for land that is taken out of production.
7. To acknowledge receipt, where applicable, of a notice provided by the county explaining continuing compliance requirements arising out of the installation of specific cost-shared practices. (Initial here________,___________.
8. Prior to the sale or lease, in whole or in part, of the property described in Section I.B. above, The Landowner shall notify, in writing, the buyer/lessor of the continuing legal obligations set forth in this agreement. This agreement shall be binding on all subsequent owners and lessors as well as their heirs, executors, administrators, successors, trustees, assigns and all users of the land for the period set forth in this agreement.
9. Landowner shall not discriminate against contractors or vendors because of age, race, ethnicity, religion, color, gender, disability, marital status, sexual orientation, national origin, cultural differences, ancestry, physical appearance, arrest or conviction record, military participation or political beliefs.

B. The county agency agrees:

1. To provide technical assistance for the design, construction, and installation of cost-shared practice(s) according to applicable standards in ch. ATCP 50, Wis. Admin. Code. Dane County Land Conservation Committee shall approve or deny all cost share agreements prior to the design, construction, and installation of the cost-shared practice(s).The county agrees to provide written notice, when applicable, to inform each landowner of the full ramifications of a cost-share contract, including future compliance obligations.
2. To use the most cost-effective methods to address the water quality concerns of this project, and apply cost containment procedures, consistent with ch. ATCP 50, Wis. Admin. Code, when estimating and paying for cost-shared practice(s).
3. To provide cost-share funds to the landowner, in the amounts specified in Section 3 and any amendments, upon proof that (i) the landowner has made all payments for which the landowner is responsible under the agreement, (ii) the practice(s) are designed and installed according to standards in ch. ATCP 50, Wis. Admin. Code and this agreement, including compliance with applicable construction site erosion control standards, and (iii) nutrient management plans comply with s. ATCP 50.04(3) Wis. Admin. Code. The county may make payments to third parties as provided in s. ATCP 50.40(13), Wis. Admin. Code.
4. To collect and retain all agreement-related documents regarding operation and maintenance, proof of certification of design and installation, change orders, receipts and payments, and other referenced materials for a minimum of three years after making the last cost-share payment to the landowner, or for the duration of the maintenance period of this contract, whichever is longer. Records may be retained longer to demonstrate that a

COST SHARE AGREEMENT NO.

landowner meets the cost-sharing exemption under s. ATCP 50.08(5), Wis. Admin Code. Payment records from the landowner and county must provide proof of payment in full for all cost-shared practices installed.

SECTION 2 Continued

C. **General conditions of the agreement.**

1. This agreement is void if, prior to installation, the county determines that due to a material change in circumstances the proposed practices will not provide cost-effective water quality benefits.
2. If a significant archeological or historical site is found, to cease construction immediately and relocate, redesign or delete a cost-shared practice, as needed, to prevent damage to the archeological or historical site.
3. Any amendment increasing cost-share dollars in excess of $500.00 to this contract shall be in writing, signed by both parties.
4. Dane County reserves the right to stop work or withhold cost-share grant funds if Landowner has breached this agreement.
5. Dane County has the right to enforce the terms of this agreement and prevent or remedy violations through appropriate legal proceedings. . If County determines that a violation of the terms of this agreement has occurred or is threatened, County may initiate judicial action after Landowner has been given written notice of the violation or threatened violation, and at least thirty (30) days to correct the violation. This 30-day prior notice period does not apply if the County determines that immediate intervention is necessary in order to prevent or mitigate imminent harm to the waters of Dane County or the state.
6. Landowner releases Dane County from any claims of damage which may arise as a result of implementing the cost-share plan contained herein.
7. Landowner agrees that the obligations of the Land Conservation Committee and the County under this agreement are limited by and contingent upon budget appropriations from State and Federal legislative branches and from the County Board and that if, the appropriations that fund the program under which this agreement is made are repealed or reduced by action of the County Board, the Land Conservation Committee and the County's obligation to fund the practices described in this agreement will be suspended.

Landowner Initials	Date	Spouse Initials	Date	Grant Recipient Initials	Date	Spouse Initials	Date	County Reps. Initials	Date

COST SHARE AGREEMENT NO.

SECTION 3. PRACTICES, COST, COST-SHARE AMOUNTS, AND INSTALLATION SCHEDULE

The parties agree to the practices, specifications, eligible costs, cost-share amounts, and installation schedule set forth below. The plans and specifications for installation of the following practices were developed for the subject property of landowner(s):

Name of Person Preparing	Representing: (COUNTY OR PRIVATE ENGINEERING FIRM) DANE COUNTY LAND & WATER RESOURCES	USE OF THE 3 BOXES BELOW IS OPTIONAL REPRESENTING: / DATE OF APPROVAL: AMOUNT OF COST-SHARE CONTRACT APPROVED:

*	Cost-Shared Item Description And Installation Schedule	Quantity and Units	Unit Cost or Flat Rate	Estimated Total Cost $	ESTIMATED COST-SHARE AMOUNTS			
					County WINs	Landowner	Other LRWM	Total
			$	$	$	$	$	$
			$	$	$	$	$	$
			$	$	$	$	$	$
				$	$	$	$	$
				$	$	$	$	$
				$	$	$	$	$
				$	$	$	$	$
			TOTALS	$	$	$	$	$

ENTER COST-SHARE TOTAL AMOUNT ON PAGE 2

Landowner Initials	Date	Spouse Initials	Date	Grant Recipient Initials?	Date	Spouse Initials?	Date	County Reps. Initials	Date

Attachment C

Dane County Service Agreement with Springfield Clean Water LLC

WATER QUALITY BROKERING AGREEMENT

This Water Quality Brokering Agreement ("Agreement") is entered into between the County of Dane, Wisconsin, a Wisconsin quasi-municipal corporation ("County') and Springfield Clean Water, LLC, a Wisconsin limited liability corporation ("SCW").

WHEREAS, County and SCW wish to cooperate in the development and operation of a nutrient concentration system in the Town of Springfield, Dane County, Wisconsin.

WHEREAS, SCW is applying for a Wisconsin Pollution Discharge Elimination System ("WPDES") permit for the discharge of wastewater from the nutrient concentration system to the North Fork of Pheasant Branch Creek ("HUC12 #070900020603").

WHEREAS, SCW is seeking authorization as part of the WPDES permit to discharge total phosphorus and total suspended solids above levels otherwise authorized in the permit by entering into the Agreement with County as authorized by Wis. Stat. § 283.84(1)(c).

WHEREAS, County is willing to serve as a broker, credit generator, and has in place conservation practices that reduce total phosphorus and total suspended solids pollution in the North Fork of Pheasant Branch Creek Basin.

WHEREAS, SCW is contributing to County's phosphorus reduction practices by participating in a demonstration project utilizing a shared manure digester and processing facility along with a nutrient concentration system that removes phosphorus from manure while discharging clean water to Pheasant Branch Creek. The goals of the demonstration project are to provide an agriculturally viable and sustainable alternative to managing manure while maintaining economic feasibility and protecting water quality. All of the partners are providing financial, technical, and operational support to ensure these goals are met.

NOW THEREFORE, the Parties, for the mutual consideration contained herein, agree as follows:

1. TERM. The term of this Agreement shall be for ten (10) years from the date on which this Agreement is executed by both parties. The parties shall have the option to renew for one (1) five (5) year period.

2. RESPONSIBILITIES OF SCW. SCW shall pay annually to County the sum of $1.00 during the term of this Agreement and continue to participate in the demonstration project to reduce phosphorus discharge into the Pheasant Branch Creek.

3. COUNTY TOTAL PHOSPHORUS AND TOTAL SUSPENDED SOLIDS REDUCTION PRACTICES

The County agrees to provide planning, technical, and cost share program services to landowners in the basin who are implementing total phosphorus and total suspended solids reducing practices and ensures that all practices are designed and implemented to meet technical standards. Services provided include:

a. Planning Services
    i. Working with landowners to establish objectives that reduce phosphorus.
    ii. Identifying and evaluating alternative conservation practices and/or engineered solutions that could result in total phosphorus and total suspended solids reductions as determined through one-on-one conversations and farm walk-overs with landowners, producers, renters and consultants.
    iii. Analyzing available information to establish current baseline conditions including estimated total phosphorus and total suspended solid losses.
    iv. Formulating options for installing conservation practices and/or structural practices to address total phosphorus and total suspended solids and evaluate the effectiveness of these options with landowners.
    v. Consulting with landowners to make conservation practice implementation plans that can reduce total phosphorus and total suspended solids and address other resource concerns as appropriate.
    vi. Assisting landowners with developing timelines to implement conservation practices.
    vii. Developing cost estimates for planned and designed practices where the County is providing the technical services.

b. Technical Services
    i. Conducting survey and design work for conservation practices.
    ii. Reviewing third party construction plans when the County is not the primary technical service provider.
    iii. Conducting construction oversight of practice installation.
    iv. Verifying and documenting that conservation practices are installed in accordance with the design and applicable technical standards.

c. Cost Share Program Services
    i. Discussing with landowners available cost share options.

ii. Developing and reviewing cost share agreements with landowners for approved conservation practices and funding sources.
iii. Processing reimbursement payments in accordance with cost share agreements and contracts.

4. COUNTY REPORTING OF WATER POLLUTION CREDITS

a. Written Notice of Credit Generation to SCW as to the total phosphorus credits that can be used by SCW as a result of conservation practice implementation.
    i. It is estimated that 99 pounds in total phosphorus credits and 145,733 pounds of total suspended solids will be available to SCW.
    ii. All practices needed to generate the total phosphorus and total suspended solids credits are anticipated to be installed and functioning by the November 1st, 2017.
    iii. Total phosphorus and total suspended solids reductions are calculated using models and or calculations readily used by the County.
    iv. Total phosphorus and total suspended solids reductions are multiplied by the trade ratio provided by SCW to the County to determine the total phosphorus credits available to SCW.
b. Annual inspections and certification that installed practices are functioning and generating reported total phosphorus and total suspended solids credits.
c. Information that will be included in the written Notice of Credit Generation and Annual Reporting are:
    i. Date of Credit Generation/Inspection
    ii. Statement of finding indicating that the practices are functioning and being maintained according to the operation and maintenance plan,
    iii. Any deficient items identified in the operation and maintenance plan if applicable,
    iv. Remedies as to how, who, and in what timeframe corrections will be made for identified deficient items,
    v. Amount of total phosphorus and total suspended solids credits available to SCW,
    vi. Duration of the availability of the total phosphorus and total suspended solids credits based on the design life expectance and maintenance of the practices implemented.

5. TERMINATION. Either party may terminate this Agreement upon 30 days notice.

6. LIABILITY. Each party shall be responsible for the consequences of its own acts, errors, or omissions and those of its employees, boards, commissions, agencies, officers, and representatives and shall be responsible for any losses, claims, and liabilities which are attributable to such acts, errors, or omissions including providing its own defense. In situations of joint liability, each party shall be responsible for the consequences of its own acts, errors, or omissions and those of its employees, agents, boards, commissions, agencies, officers and representatives. It is not the intent of the parties to impose liability beyond that imposed by state statutes.

7. MISCELLANEOUS

A. Controlling Law and Venue. It is expressly understood and agreed to by the Parties hereto that in the event of any disagreement or controversy between the Parties, Wisconsin law shall be controlling. Venue for any legal proceedings shall be in the Dane County Circuit Court.

B. Assignment. Except as permitted or provided for herein, neither Party shall assign this Agreement without prior written consent of the other Party hereto, provided that Owner may assign its interest in this Agreement to a subsidiary or affiliate or in connection with an asset or stock sale or merger, consolidation, or transfer of assets.

C. Limitation of Agreement. This Agreement is intended to be an agreement solely between the Parties hereto and for their benefit only. No part of this Agreement shall be construed to add to, supplement, amend, abridge or repeal existing duties, rights, benefits or privileges of any third party or parties, including but not limited to employees of either of the parties.

D. Entire Agreement. The entire agreement of the Parties is contained herein and this Agreement supersedes any and all oral agreements and negotiations between the parties relating to the subject matter hereof. The Parties expressly agree that this Agreement shall not be amended in any fashion except in writing, executed by both Parties, provided to the extent any exhibit is not available on the Effective Date, the Parties agree to attach missing exhibits to this Agreement as those exhibits become available.

E. Survival. All provisions of Sections VIII and IX shall survive the expiration, surrender or termination of this Agreement to the extent allowed under law.

F. Counterparts. The Parties may evidence their agreement to the foregoing upon one or several counterparts of this instrument, which together shall constitute a single instrument.

IN WITNESS WHEREOF, the Parties have executed this Water Quality Brokering Agreement.

SPRINGFIELD CLEAN WATER, LLC

__________________________________ Date: 8-17-2017

DANE COUNTY

__________________________________ Date:____________________

County Executive

Attachment D

Grassed Waterway Technical Standard Code 412

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

GRASSED WATERWAY

CODE 412
(FT.)

DEFINITION

A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet.

PURPOSE

- To convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding.
- To prevent gully formation.
- To protect/improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applied in areas where added water conveyance capacity and vegetative protection are needed to prevent erosion and improve runoff water quality resulting from concentrated surface flow.

CRITERIA

General Criteria Applicable To All Purposes

Plan, design, and construct grassed waterways to comply with all federal, state, tribal, and local laws and regulations.

Drainage areas must be treated to minimize sediment deposition to the grassed waterway.

Capacity. Design the waterway to convey the peak runoff expected from the 10-year frequency, 24-hour duration storm. Waterways which are components of waste management systems shall have a minimum capacity to convey the peak runoff from the 25-year frequency, 24 hour storm. Increase capacity as needed to account for potential volume of sediment expected to accumulate in the waterway between planned maintenance activities. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. Ensure that the design capacity, at a minimum, will remove the water before crops are damaged.

Peak discharge for all storms will be determined by the method outlined in NRCS National Engineering Handbook (NEH), Part 650 - Engineering Field Handbook (EFH), Chapter 2; or Technical Release 55 (TR-55).

The vegetative retardance used shall consider the types of grasses to be seeded and the type of management anticipated. The retardance used shall be in accordance with the EFH, Chapter 7, Table 7-4.

Capacity of waterways shall be based on vegetative retardance A, B, or C.

Stability. Determine the minimum depth and width requirements for stability of the grassed waterway using the procedures in EFH, Chapter 7, Grassed Waterways; the Agricultural Research Service (ARS), Agriculture Handbook 667, Stability Design of Grass-Lined Open Channels, or the Handbook of Channel Design for Soil and Water Conservation (SCS-TP-61).

Ensure that the vegetation species selected are suited to the current site conditions and intended uses. Select species that have the capacity to achieve adequate density, height, and vigor within an appropriate time frame to stabilize the waterway.

Stability of waterways shall be based on vegetative retardance C, D, or E.

Stability of waterways shall convey the peak discharge expected from the design storm without exceeding the allowable effective stress or permissible velocity.

Design velocities shall not exceed the values shown in Table 1.

Evaluate the potential effect of waterways with velocities exceeding the critical velocity (super critical).

Table 1

Waterway Slope Range (%)	Permissible Velocity[1]	
	Erosion Resistant Soils[2] (ft./sec.)	Easily Eroded Soils[3] (ft./sec.)
0-5	7	5
5.1-10	6	4
Over	5	3

[1]Use velocities exceeding 5 ft./sec only where good cover and proper maintenance can be obtained.
[2]Cohesive (clayey) fine-grain soils and coarse-grain soils with cohesive fines with a plasticity index of 10 to 40 (CL, CH, SC, and GC).
[3]Soils that do not meet the requirements for erosion-resistant soils.

Alignments. Except for short transition sections, flow in the range of 0.7 to 1.3 of the critical slope must be avoided unless the waterway is straight.

Velocities exceeding the critical velocity shall be restricted to straight reaches.

Use transition sections of at least 50 feet long to change channel dimensions.

Width. Keep the bottom width trapezoidal waterways less than 100 feet unless multiple, or divided waterway, or other means are provided to control meandering of low flows.

Side slopes. Keep the side slopes flatter than a ratio of two horizontal to one vertical (2:1). Reduce the side slopes as needed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting equipment so that damage to the waterway is minimized.

Depth. The capacity of the waterway must be large enough so that the water surface of the waterway is below the water surface of the tributary channel, terrace, or diversion that flows into the waterway at design flow.

The minimum designed depth of the waterway shall be 0.6 feet.

Provide 0.5 foot freeboard above the designed depth when flow must be contained to prevent damage. Provide freeboard above the designed depth when the vegetation has the maximum expected retardance.

Drainage. When needed to establish or maintain vegetation on sites having prolonged flows, high water tables, or seepage problems, use Wisconsin NRCS Conservation Practice Standards (WI NRCS CPS), Subsurface Drain (606), Underground Outlet (620), or other suitable measures in waterway designs.

Where drainage practices are not practicable or sufficient to solve these seepage problems, use WI NRCS CPS, Lined Waterway or Outlet (468) in place of WI NRCS CPS, Grassed Waterway (412).

All grassed waterways shall have stable inlet areas. The area downstream of bridges, culverts, or other structures shall be stabilized with durable lining materials if vegetation cannot be established.

Outlets. Provide a stable outlet with adequate capacity. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip or other suitable outlet.

Grassed waterways that serve as terrace outlets shall be established with adequate vegetation prior to the terrace construction.

Crossings. Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation. Crossings shall be in accordance with the criteria contained in WI NRCS CPS, Stream Crossing (578), Access Road (560), or Trail and Walkways (575).

Vegetative Establishment. Establish vegetation as soon as possible using the criteria listed under "Establishment of Vegetation" in WI NRCS CPS, Critical Area Planting (342).

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock or straw or hay bale dikes, fabric or rock checks, filter fences, or runoff diversion to protect the vegetation until it is established. Planting of a close growing crop, e.g., small grains or millet, on the contributing watershed prior to construction of the grassed waterway can also significantly reduce the flow through the waterway during establishment.

CONSIDERATIONS

Where environmentally-sensitive areas need to be protected from dissolved contaminants, pathogens, or sediment in runoff, consider establishment of an increased width of vegetation on the waterway above the flow area. Increasing the width of the waterway above the flow area will increase filtering of sediment and pathogens as well as increase infiltration of runoff and increase nutrient removal. Where sediment control is the primary concern, consider using vegetation in the waterway which can withstand partial burial and adding sediment control measures above the waterway such as residue management. Consider increasing the channel depth and/ or designing areas of increased width or decreased slope to trap and store sediment to reduce the amount of sediment that leaves a field. Be sure to provide for regular cleaning out of the waterway when trapping sediment in this manner.

Tillage and crop planting often takes place parallel to the waterway, resulting in preferential flow – and resulting erosion – along the edges of the waterway. Consider installation of measures that ensure that runoff from adjacent areas will enter the waterway. Measures such as directing spoil placement or small swales can direct this preferential flow into the grassed waterway.

Avoid areas where unsuitable plant growth limiting subsoil and/or substratum material such as salts, acidity, root restrictions, etc. may be exposed during implementation of the practice. Where areas cannot be avoided, seek recommendations from a soil scientist for improving the condition or, if not feasible consider over-cutting the waterway and add topsoil over the cut area to facilitate vegetative establishment.

Avoid or protect, if possible, important wildlife habitat, such as woody cover or wetlands when determining the location of the grassed waterway.

If trees and shrubs are incorporated, they should be retained or planted in the periphery of grassed waterways so they do not interfere with hydraulic functions. Medium or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat.

Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands. When possible, select plant species that can serve multiple purposes, such as benefiting wildlife, while still meeting the basic criteria needed for providing a stable conveyance for runoff.

Water-tolerant vegetation may be an alternative to subsurface drains or stone center waterways on some wet sites.

Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Wildlife habitat benefits can be provided by adding width of appropriate vegetation to the sides of the waterway. Care should be taken to avoid creating small isolated planting zones that could become population sinks where wildlife attracted to an area experience reproductive loss due to predation.

Consider including diverse legumes, forbs, and flowering plants such as milkweeds that provide pollen and nectar for native bees and other pollinators. In dry regions, these sites may be able to support flowering forbs with higher water requirements and thus provide bloom later in the summer

The construction of a grassed waterway can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

Consider using energy dissipating features when velocities exceeding the critical velocity are abruptly reduced to a subcritical velocity.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for grassed waterways that describe the requirements for applying the practice according to this standard. This should include:

- A plan view of the layout of the grassed waterway.
- Typical cross sections of the grassed waterway(s).
- Profile(s) of the grassed waterway(s).
- Disposal requirements for excess soil material.
- Site specific construction specifications that describe in writing the installation of the grassed waterway. Include specification for control of concentrated flow during construction and vegetative establishment.
- Vegetative establishment requirements.

OPERATION AND MAINTENANCE

Provide an operation and maintenance plan to review with the landowner. Include the following items and others as appropriate in the plan:

- Establish a maintenance program to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.
- Protect the waterway from concentrated flow by using diversion of runoff or mechanical means of stabilization such as silt fences, mulching, hay bale barriers and etc. to stabilize grade during vegetation establishment.
- Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods. Permit grazing in the waterway only when a controlled grazing system is being implemented.
- Inspect grassed waterways regularly, especially following heavy rains. Fill, compact, and reseed damaged areas immediately. Remove sediment deposits to maintain capacity of grassed waterway.
- Avoid use of herbicides that would be harmful to the vegetation or pollinating insects in and adjacent to the waterway area.
- Avoid using waterways as turn-rows during tillage and cultivation operations.
- Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition. Mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.
- Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the waterway.
- Control noxious weeds.
- Do not use waterways as a field road. Avoid crossing with heavy equipment when wet.
- Lift tillage equipment off the waterway when crossing and turn off chemical application equipment.

REFERENCES

USDA, ARS. (1987). Stability design of grass-lined open channels. Washington, D.C.: U.S. Dept. of Agriculture, Agricultural Research Service.

USDA, NRCS (2007). National Engineering Handbook, Part 650, Engineering Field Handbook, Chap. 7, Grassed waterways.

Stillwater Outdoor Hydraulic Laboratory (1954). Handbook of Channel Design for Soil and Water Conservation SCS-TP-61 (Revised. ed.). Washington: United States Department of Agriculture, Soil and Conservation Service.

Attachment E

Grassed Waterway Construction Quality Assurance Plan

Construction Quality Assurance Plan
Grassed Waterways

Must be adopted to the Landowner's construction site.

LANDOWNER: ______________________________ ENGINEERING JOB CLASS ______

LOCATION OF PRACTICE OR PLAN ID: ______________________________

INSPECTOR: ______________________ APPROVER: ______________________

Initial and date items as completed. Date all additional documentation and keep in construction file.

PRE-CONSTRUCTION

_____ Verify that the landowner or contractor notified all utilities prior to construction. Document DIGGERS HOTLINE Ticket Number ________________.

_____ Obtain copies of PERMITS, or documentation that they aren't needed.

_____ Inspect EROSION CONTROL PRACTICES (silt fence, etc.) if they are called for in the plan. Document proper installation with photographs and job diary notations.

MATERIALS

_____ EROSION CONTROL blanket material. Obtain a tag from the material, an invoice or product brochure from the supplier.

_____ FERTILIZER. Place tag in construction documentation file. Document quantity. Verify meets drawing WI-710 requirements. 150 lbs. of 20-10-10 per acre required.

_____ LIME. Document quantity. 2 tons of 80 – 85 lime required.

_____ SEED. Document species, quantities of pure live seed, and date seeded. Verify that it meets requirements of WI-710 drawing. Place seed tag in construction documentation file.

_____ MULCH. Document type used and quantity.

CONSTRUCTION

_____ SITE PREPARATION Record in job diary when striping and topsoil stockpiling is done.

_____ LAY OUT the alignment of the waterways prior to excavation. Mark cuts on stakes if the contractor requests the information. Place grade stakes every 100' along alignment.

_____ SURVEY profile of drainage tile. Redline on as-built drawings.

_____ INSPECT subgrade prior to topsoil placement. Survey cross sections and profile. Verify depth meets drawing requirements. If different from design, re-design must be approved by someone with design job approval authority or contractor must correct to meet the plans. Red-line on as-built drawings.

FINAL INSPECTION

______ Obtain final PROFILE AND CROSS-SECTIONS of completed waterway(s). Minimum is one cross-section per design reach of waterway. Verify correct:

- □ Bottom Width – Planned bottom width is ______
- □ Depth – Planned depth is______.
- □ Channel Grade – Planned channel grade is ___________
- □ Side Slopes – Planned side slope is __________ :
- □ Final Length of waterway(s). Record the information in engineering field notes.

______ Verify a stable, adequate OUTLET. Document with a notation in the job diary. Take photograph.

______ Verify that all disturbed areas not to be cropped are FERTILIZED, LIMED, SEEDED AND MULCHED. Note and record the date of seeding, note whether germination has occurred, note orientation of seed rows (should be perpendicular to waterway channel). Document how seed was applied. Document how mulch was stabilized.

______ Observe the INSTALLATION OF THE EROSION CONTROL blanket material; verify that installation follows the construction specification, record observations in engineering field notes.

______ Document installed quantities (payment units) of the practices. Note: Financial assistance programs may have payment units different than the e-FOTG conservation practice standards reporting units.

Document all of the above with photographs, data in engineering field book and job diary.

I have reviewed this plan and understand my responsibilities in the quality assurance needed for my project.

Landowner's Signature: __________________________________ Date: ________________________

Attachment F

Grassed Waterway Operation and Maintenance Plan

Operation and Maintenance Plan
Grassed Waterway

Must be adopted to the landowner's site

Cooperator: ______________________ Date: ______________________

By: ______________________ Title: ______________________

Project Location: ____

I agree to the following for the next _____ years.

1. Installed berms will not be removed without prior approval from NRCS. When grass is well established, contact NRCS for berm removal approval.
2. During the first year of the seeding establishment growing season, waterway vegetation must be clipped by August 1 to allow seeded grasses to compete with weed species.
3. Vegetation height should be maintained between __________ inches and __________ inches.
4. Channel bottom will not be used as a field access road. Lift tillage equipment when crossing waterways.
5. Graze only when the ground is firm. Waterway will be fenced if necessary to avoid excessive grazing.
6. Chemicals which kill grass will not be sprayed onto or allowed to drain into the waterway. This includes runoff from barnyards, feeding areas, etc.
7. Waterway side slopes are not to be tilled.
8. After vegetation has been established one or more years, delay mowing until after August 1 to allow nesting birds to complete nesting. Haying when conditions are dry enough is allowed.
9. A maintenance program shall be established to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.
10. Inspect grassed waterways regularly, especially following heavy rains. Damaged areas will be filled, compacted, and seeded immediately. Remove sediment deposits to maintain capacity of grassed waterway.
11. Landowners should be advised to avoid areas where forbs have been established when applying herbicides. Avoid using waterways as turn-rows during tillage and cultivation operations. Prescribed burning and mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.
12. Additional Recommendations:

Cooperator's signature: ______________________ Date: __________

I have discussed the maintenance guidelines with the above cooperator.

Conservationist's signature: ______________________ Date: __________

Attachment G

NRCS Gully Erosion Calculator Example

NRCS Classic Gully Erosion Estimator

Farmer / Cooperator Name: ______ Evaluated By: ______

Tract Number: ______ Evaluation Date: ______

Field Number	Gully	Total Active Gully Length (Feet) *	Gully Average Top Width (Feet)	Gully Average Bottom Width (Feet)	Gully Average Depth (Feet)	Estimated Total Volume (FT^3) Eroded	Gully Formation: Estimated Number of Years	Soil Texture	Approximate Pounds of Soil per FT^3	Estimated Total Gully Soil Loss (Tons)	Estimated Gully Soil Loss Per Year (Tons/yr)
	1										
	2										
	3										
				Total Estimated Annual Gully Soil Loss (Tons/yr):							

Field Number	Gully	Total Active Gully Length (Feet) *	Gully Average Top Width (Feet)	Gully Average Bottom Width (Feet)	Gully Average Depth (Feet)	Estimated Total Volume (FT^3) Eroded	Gully Formation: Estimated Number of Years	Soil Texture	Approximate Pounds of Soil per FT^3	Estimated Total Gully Soil Loss (Tons)	Estimated Gully Soil Loss Per Year (Tons/yr)
	1										
	2										
	3										
				Total Estimated Annual Gully Soil Loss (Tons/yr):							

Field Number	Gully	Total Active Gully Length (Feet) *	Gully Average Top Width (Feet)	Gully Average Bottom Width (Feet)	Gully Average Depth (Feet)	Estimated Total Volume (FT^3) Eroded	Gully Formation: Estimated Number of Years	Soil Texture	Approximate Pounds of Soil per FT^3	Estimated Total Gully Soil Loss (Tons)	Estimated Gully Soil Loss Per Year (Tons/yr)
	1										
	2										
	3										
				Total Estimated Annual Gully Soil Loss (Tons/yr):							

Total Estimated Annual Gully Soil Loss (Tons/yr): ______

* Only measure the active gully erosion areas. Areas which have become stabilized are no longer a major resource concern.

Classic Gully Erosion Calculation Formula:

$$\frac{\text{Gully Length} \times (\text{Average Width} \times \text{Average Depth}) \times \text{Soil Weight (lbs/ft3)}}{2000} \; / \; \text{Formation Years} = \text{Estimated Soil Loss Per Year (Tons/yr)}$$

Attachment H

SNAP Plus Initial Surface Total Phosphorus Calculation

CURRENT CALCULATIONS IN THE WISCONSIN P INDEX

November 18, 2010[1]

Laura Ward Good, John Panuska, and Peter Vadas

The intent of this document is to inform Wisconsin Phosphorus Index (WPI) users about the equations and assumptions for the current WPI that is part of the Snap-Plus nutrient management planning software package, Version 1.132. The WPI provides a relative indicator of the potential for runoff P from a given field to contaminate surface water. It is calculated as an estimate of average annual runoff P delivery from a field to the nearest surface water in pounds per acre per year. The crop year is defined as the day after fall harvest of one crop to the completion of the next fall's harvest, roughly from November 1 to October 30. In order for the WPI to be calculated "seamlessly" during the Snap-Plus nutrient management planning process, it must use the types of data that can be maintained in Snap-Plus databases or obtained and entered by the user. The goal throughout WPI development has been to create the best scientifically based indexing model possible with information inputs that are easily accessible to farmers and agricultural consultants. For the most part, it uses data already required for nutrient management planning and conservation planning. The units for many of the WPI factors described in this document are ones commonly used in Wisconsin for planning fertilizer and manure applications (e.g. lb per acre), rather than standard international units.

Wisconsin's PI is currently limited to estimating surface runoff P transport and does not consider delivery through subsurface flow or tile drainage. Although a great deal of recent Wisconsin research has gone into the refinement of the WPI, some components do not yet have an extensive research base. Where we know accuracy is limited by a lack of research or by the imprecision of information available for the model, we try to err on the side of over-estimating rather than under-estimating P delivery.

The only adjustments to this version compared to previous versions are in the equations for dissolved P losses from soil and from manure applications. These changes are noted in the text and are expected to result in insignificant changes in the WPI values under most Wisconsin cropping situations. The adjustments were made to improve the WPI fit for runoff dissolved P loads from a dataset of 86 field years of runoff monitoring on sites throughout Wisconsin. This monitoring is described in Stuntebeck et al. 2008, Bonilla et al. 2006, Jokela and Casler 2010.

The Principal Equation and Its Components

Total Risk Index for Phosphorus (PI, lb per acre per year) = [Particulate P losses from the edge of the field (PP, lb per acre per year) + Dissolved P losses from the edge of the field, lb per acre per year (SP)] x Total P Delivery Ratio (TPDR)

<u>Equation components</u>:

Particulate P from the edge of the field = annual P losses in eroded sediment .... See page 2
Soluble P from the edge of the field = annual dissolved P losses in runoff ....See page 4
Total P delivery ratio = proportion of total edge-of-field P losses delivered to surface water ....See page 15

Additional information used for more than one component:

Adjusting reported plow layer soil test P values to represent surface soil test P.......See page 17

The Particulate Phosphorus Component

Sediment-bound P losses in pounds per acre per year are calculated by estimating the mass of three size-classes of eroded particles with the NRCS soil loss estimation software, RUSLE2, which is imbedded within the WPI in the Snap-Plus software. The mass of each class is multiplied by a P concentration, and the resulting calculated P masses are summed.

Particulate P = [(Clay x Clay P) + (Silt x Silt P) + (Large Particles x Large Particle P)] x correction factor for units

The correction factor to convert the units to pounds per acre per year is 0.002.

Calculating Annual Sediment Mass by Particle Size

The unit area mass of eroded particles is calculated with RUSLE2 (USDA-Agricultural Research Service, 2006). RUSLE2 routes particles with five diameters: clay (0.0020 mm), silt (0.010 mm), small aggregates (0.03 - 0.1 mm), sand (0.20 mm), and large aggregates (0.3 - 1 mm). The diameters of the small and large aggregates increase with increasing soil clay content.

Factor	Source or equation
Clay *(tons acre^{-1} yr^{-1})*	Mass per area for clay from RUSLE2
Silt *(tons acre^{-1} yr^{-1})*	Mass per area for silt from RUSLE2
Large particles *(tons acre^{-1} yr^{-1})*	Mass per area for (sand + small aggregates + large aggregates) from RUSLE2

Calculating Sediment P Concentration by Particle Size

Each of these particle sizes is assigned a P concentration based on the enrichment of that particle size compared to surface soil total P. These P enrichment ratios (PER) are based on measurements of runoff sediment P by particle size class and bulk soil total P for Plano silt loam soil at the Arlington Agricultural Research Station (Panuska and Karthikeyan 2010, Panuska 2006). Research on silt loam soils at the UW-Platteville Pioneer Farm has confirmed these enrichment ratios for similar soils. Note that the PER for clay may be an underestimate for fields with little erosion. In the WI runoff studies noted on page 1, P enrichment of sediment was observed to be greater than 3 times soil total P in cases where total sediment yields were very low (less than 0.2 T a^{-1} yr^{-1}) and thus likely to be dominated by very fine particles. The underestimation of ER at low erosion rates has little impact on total calculated particulate P losses, however, because of the low sediment mass loss.

Factor	Source or equation
Clay P *(mg P kg^{-1}) P concentration in the clay fractions of sediment*	**Surface soil total P** x 3
Silt P *(mg P kg^{-1}) P concentration in the silt fractions of sediment*	**Surface soil total P** x 1
Combined Large Particle P *(mg P kg^{-1}) P concentration in sand, small and large aggregate fractions of sediment*	**Surface soil total P** x 0.7

The one exception to the use of the above method for calculating P enrichment of runoff sediments for the WPI in Snap-Plus is on fields in strip crops. Currently we are unable to retrieve the correct sediment delivery values by particle size from RUSLE2 for fields in contour strips. If strip crops are selected, then the total RUSLE2 sediment delivery mass is used with an enrichment ratio of 1.

The initial surface soil total P is calculated using routine soil test P and organic matter (OM %). This relationship was identified for mineral (OM % < 10) soils collected throughout WI using a dataset of 189 plow layer samples ($R^2 = 0.83$) and for organic soils using a dataset of 19 plow layer samples with OM % ranging from 11% to 57% ($R^2 = 0.63$) (unpublished data). The estimated surface soil total P is then further adjusted for manure and fertilizer P added during the crop year.

Factor	Source or equation
Initial Surface Total P *(mg kg^{-1})* *This is the initial (beginning of the crop year) surface soil total P concentration before new additions of manure or fertilizer.*	If routine soil OM is less than 10%: **In. Surface TP** = (13+ (2.7 x OM %) + (0.03 x **In. Surface Bray P1***))^2 If routine soil OM is greater than 10%: **In. Surface TP** = 631 + (16 OM %) + (6.6 x **In. Surface Bray P1***) * Before being entered into the equation, the soil test P value is adjusted for stratification (See page 17)
Total P Added to Surface *(lb elemental P acre^{-1})* *This is the sum of all of the manure and fertilizer P applied to the surface in the crop year*	**TP Added to Surf.** = P broadcast (lb/acre) + (P incorp.(lb/acre) x 0.4) The 0.4 factor represents the proportion of manure left on the surface following incorporation by tillage. Research by Wolkowski (2003) on incorporation of solid dairy manure with bedding at four locations in Wisconsin shows that this proportion varies by type of tillage and by manure application rate. The 0.4 value was within the range for residue left on the surface found in that research and also within the range of values used for P fraction left on the surface in the Minnesota P Index (Moncrief et al, 2006). This probably overestimates P on the surface following incorporation by moldboard plow and underestimates that following disking or cultivation. Injected manure or subsurface P applications are not included in this calculation.
Surface soil total P *This is the total P concentration in surface soil adjusted for the total P added (mg kg^{-1}).*	**Surface soil total P** = **In. Surface TP** + (**TP Added to Surface** * 8) Note: This equation uses the assumption that 1 lb P is equivalent to 0.5 mg kg^{-1} in a 6-inch plow layer and further assumes that, on average for the crop year, the total P applied with the manure is completely mixed with the surface 1 cm of soil.

The Soluble Phosphorus Component

Surface runoff dissolved P losses in pounds per acre per year are calculated by adding the annual dissolved P in runoff from the soil and from manure or fertilizer applied to the soil surface.

Soluble Phosphorus = Soil Runoff dissolved P + Direct dissolved P losses from manure or fertilizer applied to the surface

Runoff dissolved P from the soil in pounds per acre per year is estimated

Soil Runoff dissolved P (lb per acre per year) = [(Winter runoff x Frozen soil period dissolved P concentration) + (Non-frozen soil period runoff x Non-frozen soil runoff dissolved P concentration)] x Correction factor for units

The **Correction factor** to convert the units to lb per acre per year is 0.2265.

Calculating Runoff Volumes

Both frozen and non-frozen soil runoff are important contributors of P to surface water in Wisconsin. For non-frozen soil runoff, we have adapted the NRCS standard runoff curve number (CN) method to estimate annual volumes. In contrast, we were unable to find a suitable standard method that could be adapted for estimating runoff volumes from frozen soil. Therefore we used long-term stream flow records to obtain an empirical estimate of runoff from agricultural land during the period when the soil is frozen or thawing as described below.

Calculating Frozen and Thawing Soil (Winter) Runoff Volumes

Winter runoff = Base winter runoff x Fall Soil Conditions Factor

For WPI runoff volume calculations, the period of time when the soil surface is likely to be frozen or snow covered is designated November 15 to April 1 for southern and central Wisconsin and November 15 to April 15 for northern Wisconsin. Average frozen-soil period runoff was determined through an analysis of long-term (10-year) USGS daily stream flow gage records for 17 small (avg. 92 mi^2), primarily agricultural, watersheds throughout Wisconsin. A base flow separation program (Arnold et al., 1995) was run for each site to estimate the volume of stream flow attributable to overland flow. We found that the average runoff across all watersheds during the frozen/snow-covered period was 1 inch, while the average total annual runoff (frozen + non-frozen soil period) was 3 inches. There was, however, a wide range (0.3 to 2.4 in) in the average winter runoff volumes. Examination of the geographic distribution of these 10-year average winter runoff volumes for individual watersheds suggested that variations in soil/landscape and regional precipitation contributed to the variation in runoff volume. In the absence of detailed information on the soils, landscape, and climate in these watersheds during the 10-year monitoring period, it is not possible to precisely define these relationships. We chose the Wisconsin soil groups used for nutrient application guidelines as categories for assigning base winter runoff volumes to soil series. A group name is assigned to each soil series mapped in Wisconsin in UW-Extension publication A2809 (Laboski et al, 2006). The base winter runoff volumes shown below represent the mean value for all of the watersheds within a soil group region. Average winter runoff volumes for watersheds with predominately A or mixed A and B soils ranged from 0.7 in to 1.2 in (n = 7); those dominated by soil group C ranged from 1.2 in to 1.3 in (n = 2); and group D watersheds were 0.5 in to 2.4 in (n = 7). The one watershed examined that was dominated by group E (sandy) soils had a comparatively low average winter runoff volume of 0.3 in.

The fall soil condition factors are adapted from the Soil Fall Conditions Factors in the Minnesota P Index (Moncrief et al, 2006) with modifications based on an analysis of the volume of water that can potentially be stored in tillage induced soil surface depressions during the winter with various tillage systems and slopes using a formula developed by Molling et al. (2005). Please note that, although we have a good basis for assessing the *relative* effects of management, particularly surface roughness, on runoff for the fall soil condition factor, the base winter runoff values represent the runoff from aggregate land uses in the gauged watersheds. It is therefore not possible to determine a set of "average" land management conditions that each of the runoff volumes represents. In assigning the fall soil condition factors, we made an initial assumption that fields with smooth surfaces (alfalfa and no-till) have two times the annual base runoff.

Factors	Source or equation
Base winter runoff (in) – *Long-term average runoff volumes for agricultural watersheds by Wisconsin soil group*	"Base" winter runoff is assigned by Wisconsin soil group as follows:
Fall soil condition factors	(see table below)

"Base" winter runoff is assigned by Wisconsin soil group as follows:

Soil Group	Base winter runoff (in)
A and B (Southern medium and fine-texture soils)	0.9
C (Red medium and fine-textured soils)	1.3
D (Northern and central medium and fine-textured soils)	1.1
E (Sands and loamy sands) and O (mucks and peats)	0.3

Fall soil condition factors

Snap-Plus/RUSLE2 tillage	**contour**	**slope**	**Factor for adjusting winter runoff volume**
Fall chisel plow (with or without spring disking)	no		1.2
	yes	<2	0.2
	yes	2 - 6	0.4
	yes	≥6	0.8
Fall moldboard plow	no		0.6
	yes	<6	0.1
	yes	≥6	0.4
No-till, strip-till, all spring tillages and all managements with an over-wintering small grain or cover crop	no		2
	yes		1.5
All established alfalfa and all other over-wintering crops with tillages labeled "none" in Snap-Plus			2

Calculating Frost-Free-Period Runoff Volumes

We calculate average annual rainfall runoff volumes using an adaptation of the standard NRCS runoff curve number method for calculating the total annual runoff as the sum of the runoff from a series of individual storms, an approach recommended by Dr. Ken Potter (UW-Madison Engineering Department). Frost-free period 24-hour rainfall volume histograms were created from 20-year daily precipitation records for nine sites in Wisconsin (see Appendix). The rainfall data used for analysis was provided by the Wisconsin State Climatology Office, Madison, Wisconsin, http://www.aos.wisc.edu/~sco/ . For histogram development, the frost-free (non-winter) period was assumed to be April 1 through Nov. 30 in southern and central Wisconsin and April 15 through Nov. 30 in northern Wisconsin. Runoff volume calculations use the histogram for the closest of the nine weather stations assigned by county (see Appendix).

The runoff volume calculations use field-specific frost-free period runoff curve numbers (CN) generated by RUSLE2. We use RUSLE2 CN because they are field-specific and are more sensitive to differences in soil type, residue, and tillage than are CN found in published planning tables.

Factors	Source or equation
Non-winter runoff volume (in)	A. Select the appropriate rainfall volume histogram for the county using the county link and rainfall runoff histogram tables (see Appendix) B. The appropriate annual field rainfall runoff curve number for the frost-free period is obtained from RUSLE2 (RUSLE2 parameter WI_SNAP_PTR:WI_SNAP_FROST_FREE_YEARLY_CN) and is used to calculate runoff for a storm with P at mid-point of each rainfall range in the histogram according to the following formula: P= accumulated precipitation, calculate for midpoint of each rainfall range Q= accumulated runoff volume $S = (1000/CN) - 10$ Calculate for midpoint Ps where P>0.2S $Q = (P-0.2S)^2/(P+0.8S)$ C. The resulting runoff volume for each mid-range storm is multiplied by the number of storms per year in that range. D. The results of step C are summed to arrive at inches of rainfall runoff for an average year.

Calculating Runoff Dissolved P Concentrations

Runoff dissolved P concentrations are controlled by the surface soil P concentration (as indicated by routine soil test P) unless manure or fertilizer is applied to the soil surface (Andraski and Bundy, 2003; Andraski et al., 2003). To identify the relationship between soil test P and water-soluble P in soils, we sampled 106 sites representing the predominant agricultural soils throughout Wisconsin. Sites were chosen to include a range of soil test P (Bray P1) values for each soil type. The relationship between soil test P and water-extractable P (WEP) in solution (dissolved reactive P in a 1 soil:20 water, 1 hour extraction) appeared to best be described by splitting the sites into two populations. To characterize the populations, we again used the soil groups defined in Laboski, et al. (2006). The relationship for the A, B, and C groups (Southern and red-colored medium and fine textured soils) was strong (WEP in solution = 0.012 x Bray P, $r^2 = 0.79$). For the D and E groups, (Northern medium and fine textured soils and sandy coarse-textured soils) the relationship was not as strong and the slope was approximately half (WEP in solution = 0.0065, $r^2 = 0.47$). When examined alone, the D group of soils had the weakest relationship between soil test P and WEP ($r^2 = 0.45$) with some samples that appeared to overlap with the A, B, and C group. This indicates that soil group alone is not adequate for defining the soluble P characteristics of group D soils, but we have found no better method yet.

In addition to soil test P concentration, many other factors are know to influence the dissolved P concentrations in water interacting with soil, including the soil:water ratio, temperature, and time of interaction. Dissolved P (DP) as measured in rainfall runoff from a given plot or field tends to vary somewhat from storm-to-storm. For the purpose of the WPI, we were looking for an indicator of the average DP concentration in runoff water over the course of a year. Remarkably, the relationship between soil test P and runoff DP concentrations in 43 small natural runoff plots (B group soils) in corn monitored in Wisconsin was very similar to the relationship described above for soil test P and WEP in 1 soil: 20 water extraction solutions (DP =0.011 Bray P, $r^2 = 0.73$). In previous versions of the WPI, runoff DP concentrations for A, B and C group soils were estimated using the runoff regression equation from these natural runoff small plot experiments and an equation having half of that slope was used for the D and E soil groups. These factors have been changed due to the results of in-field monitoring described below.

In the Wisconsin field runoff dataset used for P Index validation, there were 25 site years on fields with no manure or surface P fertilizer applications during that year. The relationship between estimated surface soil test P (see p. 17) and annual flow volume weighted dissolved reactive P for these sites was roughly half of that observed in the small plot runoff experiments (DP = 0.006 Adjusted Surface Bray P1, $r^2 = 0.40$). For this reason, the factor for relating surface soil test P to runoff DP concentrations for Soil groups A, B, and C has been reduced to 0.006. Unfortunately, there were no D or E soils in the field runoff dataset without P applications. The only representatives of the D soil group in the dataset were fields at Marshfield, which received incorporated manure in the fall. During events that were prior to manure application or several months after manure application, the relationship between soil test P and dissolved P was quite low compared to the prior value of 0.0055; this factor has been adjusted to 0.002 as that gave the best model fit for these sites. This is also consistent with the factor used for all soils in Vadas et al. 2009 and Vadas et al. 2005b.

In the absence of fall or winter manure applications, the in-field monitoring data in Wisconsin did not show consistently significant differences in runoff dissolved P concentrations between the frozen and non-frozen soil periods. However, fall manure applications that increased soil surface P concentrations prior to freezing do appear to have resulted in increases in snowmelt dissolved P concentrations. Consequently, the WPI frozen soil period runoff dissolved P concentration is calculated using a surface soil test P value that is adjusted to account for P in fall manure or fertilizer applications. The non-winter rainfall runoff dissolved P is estimated using soil surface P adjusted for all crop-year manure and fertilizer applications. The process for adjusting soil test P to account for manure and fertilizer applications is explained on page 17. Dissolved P losses that come directly from manure or fertilizer on the soil surface are accounted for in the acute losses calculations described in the next section.

Factors	Source or equation
Winter Runoff Dissolved P (mg P L^{-1} runoff)	Soil group — Equation A, B, C, O — *Runoff D P = 0.006 x* **Surface Bray P1 adjusted for fall-applied P** * D, E — *Runoff D P = 0.002 x* **Surface Bray P1 adjusted for fall-applied P** * * Adjusted for all fall manure and fertilizer applications (see p.17)
Non-winter runoff dissolved P concentration (mg P L^{-1} runoff))	Soil Group — Equation A, B, C, O — *Runoff D P = 0.006 x* **Adjusted surface Bray P1** * D, E — *Runoff D P = 0.002 x* **Adjusted surface Bray P1** * * Adjusted for all crop year manure and fertilizer applications (see p.17)

Calculating Dissolved P in Direct Runoff from Surface-Applied Manure or Fertilizer

$$DP_{manure} = \Sigma_{manure\ apps}\ \text{Season 1 } DP_{manure} + \text{Season 2 } DP_{manure} + \text{Season 3 } DP_{manure}$$

$$\text{Season } n\ DP_{manure} = \text{Soluble P from surface-applied manure}_{season\ n} \times \text{Runoff to precipitation ratio}_{season\ n} \times \text{Phosphorus Distribution Factor}_{season\ n}$$

$$\text{Phosphorus Distribution Factor}_{season\ n} = (\text{Runoff to precipitation ratio}_{season\ n})^{0.225}$$

When manure or P-containing fertilizers are present on the soil surface during a runoff event, release of soluble P from the manure or fertilizers usually results in elevated runoff dissolved P concentrations. The WPI estimates the dissolved P from unincorporated manure and fertilizer applications using simplified forms of formulas developed to estimate the release of dissolved P from unincorporated manures and fertilizers in daily time-step runoff models (Vadas et al, 2009, Vadas et al 2007, Vadas et al 2008). These formulas take into account the field and weather conditions that determine the likelihood that there will be runoff following the application. This version of the WPI has been revised to allow for continued release of water soluble P from manure remaining at the soil surface during the second and third season after application. This change was made to obtain a better fit with the observed Wisconsin field runoff database and is consistent with the model developed by Vadas et al (2009).

- In the first season following application, all of the manure water-soluble P on the soil surface is considered to be available to runoff or leaching. Water-soluble P is defined here as P that can be extracted with a 1 hour shaking in deionized water with a 1:250 extraction ratio (Vadas et al., 2007). All of this water-soluble P at the surface is assumed to be dissolved by precipitation over the course of the season of application. In the second season following application, 20% of the manure total P remaining on the soil surface is expected to become water soluble. Finally, in the third season following application, 5% of the total P remaining on the soil surface is expected to become water soluble.

- The seasonal runoff to precipitation ratio defines the proportion of the precipitation coming into contact with the surface-applied P that runs off instead of infiltrating into the soil during each season following manure application.
- The third term, the Phosphorus Distribution Factor, is calculated as (Runoff to precipitation ratio)$^{0.225}$ and was developed by Vadas et al. (2005a, 2007) to distribute dissolved P that leaches out of manure between infiltration and runoff. During a storm, a longer time to between the start of rain and the start of runoff means more rain has a chance to interact with manure and infiltrate manure P into the soil before runoff begins. Because dissolved P concentrations released from manure during a rain event are greatest at the beginning of the event and decrease with time, this means a longer time to runoff should result in lower dissolved P concentrations in runoff. The distribution factor accounts for this process. These calculations assume that dissolved P concentrations across a season are distributed similarly to those within a single storm. A Phosphorus Distribution Factor is calculated for the season during manure application and for the two following seasons using the Runoff to precipitation ratios for those seasons.

The results of the nearly 600 simulated rainfall runoff trials conducted by Dr. Larry Bundy's research group (*http://www.soils.wisc.edu/extension/nonpoint/SimulatedMethods2007.pdf*) indicate that manure solids as well as dissolved constituents can be present in runoff following unincorporated manure applications. WPI calculations do not account for direct transport of manure particulates in runoff. The increase in soil surface total P following manure application and the consequent increase in calculated eroded sediment P concentration described on page 3 is intended to account for manure particulate P losses.

$$\mathbf{DP_{fertilizer} = \Sigma_{fertilizer\ apps}\ Soluble\ P\ in\ surface\text{-}applied\ fertilizer \times Runoff\ to\ precipitation\ ratio_{season\ 1} \times 0.034\ exp\ [(3.4)\ (Runoff\ to\ precipitation\ ratio_{season\ 1})]}$$

All the P in fertilizer is assumed to be soluble. The seasonal runoff to precipitation ratio used here is the same as that for DP_{manure} calculations. The third term is analogous to the Phosphorus Distribution Factor for manure and is empirically derived (Vadas et al., 2008).

Calculating Surface Water-Soluble P Following Manure or Fertilizer Application

$$\mathbf{Soluble\ P\ in\ surface\text{-}applied\ manure_{season\ 1} = Total\ P\ in\ applied\ manure \times Water\text{-}solubility\ factor \times Fraction\ of\ application\ on\ surface}$$

$$\mathbf{Soluble\ P\ in\ surface\text{-}applied\ manure_{season\ 2} = (Total\ P\ in\ applied\ manure - Soluble\ P\ in\ surface\text{-}applied\ manure_{season\ 1}) \times Incorporation\ factor_{season\ 2} \times 0.2}$$

$$\mathbf{Soluble\ P\ in\ surface\text{-}applied\ manure_{season\ 3} = (Total\ P\ in\ applied\ manure - Soluble\ P\ in\ surface\text{-}applied\ manure_{season\ 1} - Soluble\ P\ in\ surface\ applied\ manure_{season\ 2}) \times Incorporation\ factor_{season\ 3} \times 0.05}$$

Total P and Soluble P in applied manure in these calculations are in lb acre^{-1}.

<table>
<tr><th>Factors</th><th>Source or equation</th></tr>
<tr><td>Water solubility factor
Proportion of manure total P that will be released into solution in a 1 hour 1:250 manure: water extraction</td><td>
<table>
<tr><th>Snap-Plus manure types</th><th>Water-solubility factor</th></tr>
<tr><td>Solid, semi-solid and grazing manures</td><td></td></tr>
<tr><td>Beef</td><td>0.4[a,b]</td></tr>
<tr><td>Chicken</td><td>0.25[a,b]</td></tr>
<tr><td>Dairy</td><td>0.4[a,b]</td></tr>
<tr><td>Duck</td><td>0.4[c]</td></tr>
<tr><td>Horse</td><td>0.2[c]</td></tr>
<tr><td>Sheep</td><td>0.2[c]</td></tr>
<tr><td>Swine</td><td>0.55[d]</td></tr>
<tr><td>Turkey</td><td>0.5[a]</td></tr>
<tr><td>Liquid manures</td><td></td></tr>
<tr><td>Beef</td><td>0.4[a,b]</td></tr>
<tr><td>Dairy</td><td>0.4[a,b]</td></tr>
<tr><td>Poultry</td><td>0.5[c]</td></tr>
<tr><td>Swine</td><td>0.5[e]</td></tr>
<tr><td>Veal calf</td><td>0.4[a,b]</td></tr>
</table>
Sources:
[a.] Studnicka, 2005.
[b] Good, 2002.
[c] No data. Used information from similar species and/or handling situations. For sheep and horse solid manure, low estimate is based on an assumption of high bedding rates, partial composting.
[d.] Weinhold and Miller, 2004.
[e.] Baxter et al, 2003.
</td></tr>
<tr><td>Incorporation factor$_{season\ 2}$</td><td>If there is any primary or secondary tillage during the second season following a manure application, this factor is 0.4 (see incorporation explanation for Total P added to surface on p. 3). With no tillage, it is 1.</td></tr>
<tr><td>Incorporation factor$_{season\ 3}$</td><td>If there is any primary or secondary tillage during the third season following a manure application, this factor is 0.4 (see incorporation explanation for Total P added to surface on p. 3). With no tillage, it is 1.</td></tr>
</table>

Fraction of application on surface *Proportion of manure or fertilizer particulates on the soil surface*	**Fractions left on surface by manure type and Snap-Plus application method** **Liquid manures (application units gallons per acre)** The equation for the fraction of liquid manure left on the surface is empirically derived from the data published by Vadas (2006) to account for a decreasing fraction of total P leaching into the soil with increasing application rate. *Unincorporated:* Fraction left on surface is 0.0041 x (liquid application rate in lb/acre)$^{0.4127}$ *Incorporated:* Fraction left on surface is 0.4 x 0.0041 x (liquid application rate in lb/acre)$^{0.4127}$ **Solid and semi solid manures (application units are tons/acre)** Not Incorporated /Grazing — 1 Incorporated — 0.4 **Dry fertilizer** Unincorporated — 1 Incorporated — 0.4 Subsurface — 0 **Liquid fertilizer** Unincorporated — 0 Incorporated — 0 Subsurface — 0

- The Water-solubility factor represents the proportion of amendment total P that will dissolve in water. There can be a wide range in the total P and water-soluble P in manures from a single animal species (Studnicka, 2005; Good, 2002). In view of this variability and to avoid extreme under-estimations, the water-solubility factors were set within the range of values measured in Wisconsin, but above the mean. Literature values were used for manure types without Wisconsin datasets. As none of the manure water-soluble P determinations used to set the water-solubility factor were actually conducted with a 1:250 manure:water extraction ratio, the factors were adjusted to represent probable 1:250 extractable P (Vadas et al. 2005a, Vadas and Kleinman 2006). Again, all of the P in fertilizer is assumed to be completely soluble. We are unaware of any slowly soluble P fertilizers in common use in Wisconsin.
- The Fraction of application on surface factor uses the same proportion of the application remaining on the surface as was used for calculating soil P increases following manure application (page 3). It also accounts for some manure particulate infiltration into the soil at application time and at the initiation of rainfall for manures applied as liquids. In soil column experiments, Vadas (2006) found about 20% of manure slurry solids infiltrated within 96 hour following application. Liquid fertilizers are assumed to infiltrate completely when applied to the surface.

Calculating Non-Winter Runoff to Precipitation Ratios

For calculating seasonal runoff volumes for fall, spring or summer manure applications, we use the same modification of the standard NRCS runoff CN method that was used for calculating non-winter runoff volumes (page 6). The seasonal rainfall histograms were constructed from 20 years of 24-hour rainfall data for the same nine sites and are also included in the Appendix. Rainfall data were again provided by the Wisconsin State Climatology Office, Madison, Wisconsin, http://www.aos.wisc.edu/~sco/ .

The CN used in the calculations is the RUSLE2-generated daily CN for the day following the manure application. In Snap-Plus, a season of application is chosen for each planned manure application. For Snap-Plus RUSLE2 soil loss calculations, fall manure applications are assumed to occur on November 1. In the cases when there are tillage or planting operations after September 1 and prior to November 1, the manure is assumed to be applied immediately before the first of these operations in the RUSLE2 calculations. Winter manure applications are assumed to be on January 15; spring applications are on April 25 or immediately prior to any April tillage or planting, and summer applications are on July 21. Depending on manure dry matter content, whether or not the manure is incorporated, and the type of tillage used, manure applications can decrease RUSLE2 CNs, indicating that it will take a larger storm to cause runoff following the application than prior to it.

Factors	Source or equation
Seasonal run-off to precipi-tation ratio	**Runoff (in)** for season of manure application/**Rainfall for season of manure application (in)**
Runoff (in) for season of manure application	A. Select the appropriate seasonal rainfall volume histogram for the county using the county link and the season of application. (See Appendix). B. Obtain the appropriate daily rainfall runoff curve number for the day of the manure application "SEG_SIM_DAY_CN" from RUSLE2 Use it to calculate runoff for a storm with P at mid-point of each rainfall range in the histogram according to the following formula: P= accumulated precipitation, calculate for midpoint of each rainfall range Q= accumulated runoff volume $S = (1000/CN) - 10$ Calculate for midpoint Ps where $P>0.2S$ $Q = (P-0.2S)^2/(P+0.8S)$ C. The resulting runoff volume for each mid-point storm is multiplied by the number of storms per season in that range. D. The results of step C are summed to arrive at average inches of rainfall runoff for that season.

Factors	Source or equation
Rainfall for season of manure application (in)	**Average precipitation by season for selected rainfall stations in Wisconsin.**

	Fall[a]	Winter[b]	Spring[c]	Summer[d]
Blair	6.0	6.3	10.0	12.9
Burlington	6.7	7.8	8.6	10.0
Chilton	6.2	6.6	7.8	10.1
Crivitz	6.9	6.5	7.1	9.8
Hancock	6.0	6.2	9.3	12.6
Madison	5.9	7.2	9.3	12.6
Richland Center	6.3	6.6	10.3	14.6
Spooner	6.8	6.9	6.8	12.3
Willow	6.6	6.9	6.3	11.4

[a]Fall: September 15 to November 30, average for 20-years from 4/1/1988 to 3/31/2008.
[b]Winter: November 15 to April 1 or April 15 frost-in period used for agricultural watershed average frost-in runoff volume determination (10-year average from 1992-2002). Note that the fall periods have overlap with the frost-in period. As the purpose of this factor is to account for the risk of runoff during the time of manure application, a wide time-frame was used to include storms over the range of times when manure would be applied if the ground was not frozen.
[c]Spring: April 1 to June 14 for all sites except Spooner and Willow, for which it is April 15 to June 14, average for 20-years from 4/1/1988 to 3/31/2008.
[d]Summer: June 15 to September 14, average for 20-years from 4/1/1988 to 3/31/2008.

Counties represented by each site:
Blair -Buffalo, Chippewa, Clark, Dunn, Eau Claire, Jackson, LaCrosse, Monroe, Pepin, Pierce, St.Croix, Trempealeau
Burlington - Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, Waukesha
Chilton - Brown, Calumet, Door, Fond du Lac, Kewaunee, Manitowoc, Outagamie, Sheboygan, Winnebago
Crivitz - Florence, Forest, Marinette Oconto
Hancock: Adams, Green Lake, Juneau, Marathon, Marquette, Menominee, Portage, Shawano, Waupaca, Waushara, Wood
Madison - Columbia, Dane, Dodge, Green, Jefferson, Rock
Richland Center - Crawford, Grant, Iowa, Lafayette, Richland, Sauk, Vernon
Spooner - Barron, Bayfield, Burnett, Douglas, Polk, Rusk, Sawyer, Washburn
Willow -Ashland, Iron, Langlade, Lincoln, Oneida, Price, Taylor, Vilas

Calculating the Runoff to Rainfall Ratio for the Frozen Ground Acute Loss Index

We use the same dissolved P loss equation for manure on frozen as for non-frozen soil, and soluble P in surface-applied manures is calculated the same regardless of season of application. Phosphorus fertilizer applications to frozen soils are not allowed under Wisconsin Nutrient Management Standard 590. The difference between frozen and non-frozen soil manure dissolved P loss calculations is in the source of the runoff factor and that all winter-applied manures are assumed to have a Fraction left on surface value of 1.

Factors	Source or equation
Winter runoff (in)	This is the same Winter runoff volume as we are using for the Soluble P Index (see page 4)
Winter precipitation (in)	Select these values from the table showing "Average precipitation by season for selected rainfall stations in Wisconsin" on page 13.

On the Snap-Plus cropping screen for each field where the Annual Total PI components are displayed (under "details"), the Acute loss (frozen) PI is in a separate row below the Soluble PI. The Soluble P I displayed there includes all Soluble PI components except for the Frozen Ground Acute Loss Index, so if you add those two together, you will get the complete Soluble P Index. One reason for the separate display is to make it apparent when there are high losses due to winter applications. In many typical Wisconsin fall and spring manure application scenarios, calculated runoff-to-rainfall ratios are low due to low RUSLE2 daily runoff CN following the manure application. Consequently, calculated direct manure dissolved P losses from non-frozen soil usually contribute only a small fraction of the total annual P loss risk. In contrast to fall and spring applications, manure on frozen soil often contributes a significant proportion of the total annual P loss risk. Another reason that the Frozen Ground Acute Loss PI is shown separately is that the Wisconsin NR 243 rules governing manure applications for animal feeding operations require the use of this value for planning in specific winter-spreading situations.

Total P Delivery Ratio

In the WPI, phosphorus delivery is estimated to the edge of the field as particulate or dissolved P and then these losses are multiplied by the appropriate total P delivery factor for the length and slope of the flow path from the field to a perennial stream or lake. The table of total P delivery factors used in the WPI is shown below. The slope classes are designed to match with soil mapping unit names, so the predominate slope between the field and the stream can easily be picked off a soil map. As you can see, the categories for distance to stream are very broad and therefore also easily estimated from a soil map. The slope and length of the flow path from the field to the nearest surface water is the only "extra" information the P Index uses in Snap-Plus beyond what is required for regular nutrient management planning and conservation planning.

Pull-down menu options for Snap-Plus

Dominant slope	Distance from stream	TP delivery factor
0-2%	0- 300 ft	1
	300 -1,000 ft.	0.95
	1,001-5,000 ft	0.87
	5,001 -10, 000 ft	0.72
	10,001 - 20,000 ft.	0.55
	> 20,000 ft.	0.45
2-6%	0- 300 ft	1
	300 -1,000 ft.	0.96
	1,001-5,000 ft	0.91
	5,001-10, 000 ft	0.79
	10,001 - 20,000 ft.	0.65
	> 20,000 ft.	0.56
6-12%	0- 300 ft	1
	300 -1,000 ft.	0.98
	1,001-5,000 ft	0.92
	5,001-10, 000 ft	0.81
	10,001 - 20,000 ft.	0.69
	> 20,000 ft.	0.61
> 12%	0- 300 ft	1
	300 -1,000 ft.	0.98
	1,001-5,000 ft	0.93
	5,001-10, 000 ft	0.83
	10,001 - 20,000 ft.	0.71
	> 20,000 ft.	0.64

This table is based on modeling work conducted using APEX (ARS Temple, TX) and P8 (W.W. Walker). The delivery modeling assumed a drainage system comprised of a field drained via a trapezoidal grassed waterway to a receiving stream. The channel transport routines within P8 and APEX were used to evaluate the potential of fine (< 50 μm) particles to settle during transport. Various channel slope and length conditions were evaluated using continuous daily simulation. Model output was then fit using regression analysis to develop a set of equations for use in the WPI. A 20-year modeling time period was used to better account for temporal variability. The edge-of-field particle size and P distribution by particle size used in the modeling analysis were those monitored for corn productions systems in Dane County (Panuska 2006).

The total P delivery ratio does not distinguish between the forms of P delivered. It is applied equally to the dissolved and particulate P transported from the field. Note that on the Snap-Plus cropping screen where details are provided about the WPI components, each of the component indices has already been adjusted independently using the total P delivery ratio.

Adjusting reported plow layer soil test P levels to represent surface soil test P over consecutive crop years

Wisconsin's Nutrient Management Standard 590 requires routine plow layer soil testing every four years for every field under nutrient management planning. The WPI calculations adjust these plow layer soil test P values to better represent surface soil test P values during the crop year by accounting for P stratification in the plow layer and for the effects of that year's P fertilizer and manure amendments. At the end of a crop year, the original plow layer soil test P is readjusted using the assumption that the effects of any P amendments and crop P removal will be distributed evenly throughout the plow layer by that time. This new plow layer Bray P1 value is then passed on to the next year. The adjusted values continue to be passed from crop year to crop year until the field is resampled and new soil test results are entered. The factors used for this adjustment are described below.

Step 1. Accounting for soil P stratification

This step adjusts the plow layer soil test P value to account for the likelihood of greater P concentrations at the soil surface than in the rest of the plow layer. The soil test P value is multiplied by a factor based on soil group as defined in Laboski et al. (2006) and on tillage to arrive at the "initial surface Bray P1".

Initial surface Bray P1 = *Initial plow layer Bray P (ppm) x Stratification Factor*

Subsoil Fertility Group	Stratification Factor	
A, B, C, D	Stratification factor depends on tillage:	
	Fall moldboard plow	0.9
	Fall chisel plow	1.2
	Spring tillage (moldboard, chisel, disk, field cultivate)	1.3
	No-till or zone-till	1.4
	Continuous no-till or zone-till (at least 4 prior years)	1.6
	Pasture	1.4
	Established legume or grass hay	1.4
	Anything else	1.3
E	Any tillage	1.1
O	Any tillage	1

The stratification factors for row crops for the A, B, C, and D soil groups represent the mean values for the ratio of Bray P1 in the surface one inch of soil to that in the 6-inch plow layer found by sampling 80 fields in the spring of 2008. All fields had been in corn in 2007. Unlike a previous study, this sampling project did not find a significant difference in stratification between soil group C soils and the other groups with medium to fine-textured soils (http://www.soils.wisc.edu/extension/onfarmdemo/). The stratification factors for grass hay and pasture came from another 2008 sampling project conducted by Nick Schneider of 150 fields in grazed pasture or grasses in Winnebago County. The stratification factors for established alfalfa and for the E soil group (sands and loamy sands) are the means found in a 2002-2003 sampling study for soils from throughout Wisconsin (unpublished data).

Step 2. Accounting for new additions of P to the soil to adjust soil test P

Surface total P additions are calculated using the assumption that 100% of unincorporated applications and 40% of incorporated applications remain on the surface (page 3). These calculations use the soil P buffer capacities, or the pounds of P_2O_5 equivalents required to increase plow layer (6 in or 15 cm) soil test P by 1 ppm, listed in Table 7.3 of Laboski et al. (2006). For A, B,C, D, and O soil groups, the plow layer P buffer capacity is18 lb P_2O_5 equivalent (7.9 lb P) per acre, and for group E (sandy) soils, it is 12 lb P_2O_5 equivalent (5.3 lb P per acre). This surface soil test P adjustment assumes that all of the surface-applied P is mixed with soil to a depth of just 0.8 in (2 cm), rather than the whole plow layer, for the duration of the crop year of application. With these assumptions, a 1 ppm increase in Bray P at the surface for A, B. C, D, and O soil groups will require 1.1 lb P per acre and for E soil groups will require 0.7 lb P per acre applied to the surface.

Fall adjusted surface Bray P and **Crop year adjusted surface Bray P**

Fall adjusted and Crop year adjusted surface Bray P use the same equation but account for P additions during different time periods. The fall adjusted surface Bray P is used in calculating the winter runoff dissolved P concentration and the "Total P added to the surface" includes only fall applications. In contrast, the crop year adjusted surface Bray P is used in calculating the frost-free period runoff dissolved P and "Total P added to the surface" includes all P applied throughout the crop year.

All soils except sands (E soil group):

Adjusted surface Bray P 1 (ppm) = Initial Surface Bray P (ppm) + (Total P added to the surface in lb acre^{-1} / 1.1)

E soil group:

Adjusted surface Bray P 1 (ppm) = Initial Surface Bray P (ppm) + (Total P added to the surface in lb acre^{-1} /0.7)

You may note that the 2 cm depth of mixing here is greater than the 1 cm assumed when calculating changes in surface soil total P. This is because the loss of soluble P released directly from manure dry matter left on the surface during the season of application is accounted for by a separate set of component equations within the Soluble P Index, while there is as of yet no mechanism within the Particulate P Index for accounting for direct loss of eroded manure particles in addition to sediment. In addition, some of the particulate components of manure are expected to infiltrate less rapidly than the soluble manure P.

Step 3. Accounting for the effects of plow layer P inputs and crop removal at the end of the cropping season

At the end of the cropping season, before being passed along to the next crop year in the program, the plow layer soil test P is adjusted for inputs and crop removal, again using the soil group P buffer capacity. Calculation of P removal by crops is based on UW-Extension soil fertility guidelines (Laboski et al., 2006).

Step 2 assumed that P applied with surface applications of manure or fertilizer remained in the surface 2 cm during the crop year. Analysis of the soil testing project data discussed in Step 1 above suggested that surface-applied P is distributed throughout the plow layer over the course of the crop year, even in no-till systems, to achieve a soil surface P to plow-layer P stratification ratio that is soil-dependent rather than tillage- or P-amendment-dependent. Thus this procedure assumes that all of the current crop year's P inputs and removals were evenly distributed throughout the plow layer.

<u>All soils except E soil group (sands):</u>

Adjusted end of crop year plow layer Bray P (ppm) = Initial plow layer Bray P (ppm) + (Total P added in manures and fertilizer by all methods in lb $acre^{-1}/7.9$) + (Total P removed in crops in lb $acre^{-1}/7.9$)

<u>E soil group (sands):</u>

All soils except sands (E soil group):

Adjusted end of crop year plow layer Bray P (ppm) = Initial plow layer Bray P (ppm) + (Total P added in manures and fertilizer by all methods in lb $acre^{-1}/5.3$) + (Total P removed in crops in lb $acre^{-1}/5.3$)

This end-of-crop-year plow layer P value will be multiplied by the stratification factor (step 1) for the beginning of the next year's adjustment calculations.

[1] This document altered from original version to correct typographical errors on p. 9 in the "Fraction of application left on surface" equations. In the original version, the liquid manure application rate used on the equations was previously given as gallons/acre and has been corrected to lb/acre.

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Attachment I

Rock River TMDL Required Percent Reductions from Annual Baseline Load

Appendix H. Required Percent Reduction of TP from Annual Baseline Load
Note: Baseline load is defined in Section 4.2. Average percent load reduction is the average of the monthly average percent load reductions.

***Note that the non-permitted urban percentage of baseline load is not a percent reduction. This column is shown to facilitate division of nonpoint source load between agricultural and non-permitted urban sources. See Section 6.3 for specific allocation approach.**

Reach	Waterbody Name	Waterbody Extents	Required Average Percent Reduction of TP from Baseline Load			Non-Permitted Urban Percentage of Baseline Load*
			Nonpoint Source	MS4	WWTF	
1	West Branch Rock River	South Branch Rock River to Mile 39	23%	-	-	2%
2	South Branch Rock River	Mile 3 to 20	29%	29%	19%	6%
3	South Branch Rock River	Mile 1 to 3	67%	82%	92%	19%
4	West Branch Rock River/Horicon Marsh	Mile 0 to South Branch Rock River	38%	-	7%	6%
5	Wayne Creek	Mile 4.1 to 4.8	47%	-	-	0%
6	Wayne Creek	Kohlsville River to Mile 4.1	32%	-	-	0%
7	Kohlsville River	Mile 0 to 9	32%	-	-	0%
8	Limestone Creek	Mile 0 to 1	24%	-	-	0%
9	East Branch Rock River	Kohlsville River to Limestone Creek	30%	-	1%	0%
10	East Branch Rock River	Kummel Creek to Kohlsville River	27%	-	-	5%
11	Kummel Creek	Mile 14 to 18	19%	-	-	0%
12	Kummel Creek	Mile 0 to 14	29%	-	10%	3%
13	East Branch Rock River	Mile 11 to Kummel Creek	37%	-	15%	3%
14	East Branch Rock River	Gill Creek to Mile 11	56%	-	78%	13%
15	Gill Creek	Mile 0 to 6	40%	-	-	0%
16	Irish Creek	Mile 0 to 3	39%	-	-	0%
17	East Branch Rock River	Mile 0 to Irish Creek	45%	-	48%	1%
18	Rock River	Mile 296 to 305	62%	-	77%	46%
19	Dead Creek	Mile 0 to 3	41%	-	60%	6%
20	Rock River	Mile 270 to 293	27%	14%	0%	1%
21	Rock River	Oconomowoc River to Mile 270	27%	10%	0%	3%
22	Flynn Creek	Mile 0 to 6	30%	-	-	0%
23	Oconomowoc River	Mason Creek to Flynn Creek	29%	12%	-	2%
24	Mason Creek	Mile 0 to 5.2	39%	11%	-	0%
25	Oconomowoc River	Battle Creek to Mason Creek	52%	64%	77%	33%
26	Battle Creek	Mile 2.1 to 4.6	32%	35%	-	13%
27	Oconomowoc River	Rock River to Battle Creek	10%	0%	-	9%
28	Rock River	Mile 249 to Oconomowoc River	15%	1%	-	6%
29	Rock River	Johnson Creek to Mile 249	36%	51%	64%	2%
30	Johnson Creek	Mile 0 to 17.5	24%	0%	-	1%
31	Rock River	Crawfish River to Johnson Creek	47%	-	72%	41%
32	Alto Creek	Mile 0 to 6.15	27%	-	-	0%
33	Mill Creek, Beaver Dam Lake	Beaver Dam to Fox Lake	34%	29%	22%	11%
34	Beaver Dam River	Calamus Creek to Mile 30	37%	81%	92%	0%
35	Calamus Creek	Mile 0 to 17	18%	-	-	0%
36	Beaver Dam River	Mile 14 to Calamus Creek	23%	-	-	0%
37	Park Creek	Mile 0 to 3	39%	66%	-	0%
38	Schultz Creek	Mile 0 to 5	30%	-	-	0%
39	Shaw Brook	Beaver Dam River to Schultz Creek	27%	0%	-	0%
40	Beaver Dam River	Casper Creek to Mile 14	28%	-	0%	7%
41	Casper Creek	Mile 0 to 2	27%	-	-	0%
42	Beaver Dam River	Lau Creek to Casper Creek	22%	-	-	0%

Reach	Waterbody Name	Waterbody Extents	Required Average Percent Reduction of TP from Baseline Load			Non-Permitted Urban Percentage of Baseline Load*
			Nonpoint Source	MS4	WWTF	
43	Lau Creek	Mile 0 to 6	24%	-	-	0%
44	Beaver Dam River	Mile 0 to Lau Creek	22%	-	-	0%
45	Maunesha River	Mile 13.21 to 31.8	35%	13%	-	1%
46	Maunesha River	Mile 5.5 to 13.2	37%	-	33%	2%
47	Maunesha River	Stony Brook to Mile 13.2	41%	-	73%	0%
48	Stony Brook	Mile 0 to 15	28%	-	-	0%
49	Maunesha River	Mile 0 to Stony Brook	29%	-	-	0%
50	Mud Creek	Mile 0 to 10	24%	-	-	0%
51	Crawfish River	Maunesha River to Mud Creek	30%	14%	0%	2%
52	Crawfish River	Beaver Dam River to Maunesha Creek	-	-	-	0%
53	Crawfish River	Rock River to Beaver Dam River	18%	-	0%	9%
54	Rock River	Bark River to Crawfish River	36%	61%	77%	0%
55	Bark River	Mile 35 to 41	54%	68%	79%	14%
56	Bark River	Scuppernong River to Mile 35	33%	19%	6%	2%
57	Spring Creek	Mile 0 to 5	49%	-	88%	9%
58	Steel Brook	Mile 3 to 4	26%	-	-	0%
59	Steel Brook, Scuppernong River, Bark River	Rock River to Steel Brook, Spring Creek	41%	54%	67%	4%
60	Rock River	Mile 213 to Bark River	23%	29%	29%	0%
61	Rock River	Mile 201 to 207	8%	6%	5%	17%
62	Pheasant Branch Creek	Mile 1 to 9	57%	70%	-	5%
63	Spring (Dorn) Creek	Mile 1 to 6	36%	14%	-	0%
64	Yahara River, Lake Mendota, Lake Monona	Nine Springs Creek to Spring (Dorn) Creek, Pheasant Branch Creek	41%	47%	29%	7%
65	Nine Springs Creek	Mile 0 to 6	43%	49%	35%	53%
66	Yahara River, Lake Waubesa, Lake Kegonsa	Mile 16 to Nine Springs Creek, Lake Waubesa	39%	37%	-	3%
67	Yahara River	Mile 16 to 22	5%	0%	-	6%
68	Yahara River	Mile 7 to 16	36%	52%	65%	0%
69	Yahara River	Mile 0 to 7	45%	72%	86%	3%
70	Rock River	Mile 193 to 201	29%	1%	-	0%
71	Rock River	Blackhawk Creek to Mile 193	33%	29%	-	9%
72	Blackhawk Creek	Mile 2 to 4	32%	0%	-	0%
73	Blackhawk Creek	Rock River to Mile 2	43%	51%	-	7%
74	Rock River	Mile 183 to Blackhawk Creek	21%	17%	-	18%
75	Markham Creek	Mile 0 to 5	34%	15%	-	0%
76	Rock River	Bass Creek to Mile 183	49%	75%	88%	18%
77	Stevens Creek	Mile 0 to 8	40%	-	-	0%
78	Bass Creek	Rock River to Stevens Creek	33%	4%	0%	1%
79	Rock River	Mile 171 to Bass Creek	40%	54%	70%	4%
80	Turtle Creek	Mile 24 to 32	49%	-	75%	19%
81	Turtle Creek	Rock River to Mile 24	34%	20%	1%	4%
82	Fox Lake		40%	-	-	12%
83	Lake Koshkonong		37%	37%	30%	4%
	Lake Sinnissippi		-	-	-	0%

Appendix I. Required Percent Reduction of TSS from Annual Baseline Load
Note: Baseline load is defined in Section 4.2. Average percent load reduction is the average of the monthly average percent load reductions.

***Note that the non-permitted urban percentage of baseline load is not a percent reduction. This column is shown to facilitate division of nonpoint source load between agricultural and non-permitted urban sources. See Section 6.3 for specific allocation approach.**

Reach	Waterbody Name	Waterbody Extents	Required Average Annual Percent Reduction of TSS from Baseline Load			Non-Permitted Urban Percentage of Baseline Load*
			Nonpoint Source	MS4	WWTF	
1	West Branch Rock River	South Branch Rock River to Mile 39	18%	-	-	2%
2	South Branch Rock River	Mile 3 to 20	20%	1%	0%	5%
3	South Branch Rock River	Mile 1 to 3	20%	26%	23%	58%
4	West Branch Rock River/Horicon Marsh	Mile 0 to South Branch Rock River	16%	-	11%	12%
5	Wayne Creek	Mile 4.1 to 4.8	52%	-	-	0%
6	Wayne Creek	Kohlsville River to Mile 4.1	36%	-	-	0%
7	Kohlsville River	Mile 0 to 9	36%	-	-	0%
8	Limestone Creek	Mile 0 to 1	24%	-	-	0%
9	East Branch Rock River	Kohlsville River to Limestone Creek	20%	-	-	0%
10	East Branch Rock River	Kummel Creek to Kohlsville River	24%	-	-	3%
11	Kummel Creek	Mile 14 to 18	19%	-	-	0%
12	Kummel Creek	Mile 0 to 14	19%	-	0%	2%
13	East Branch Rock River	Mile 11 to Kummel Creek	29%	-	1%	2%
14	East Branch Rock River	Gill Creek to Mile 11	33%	-	15%	9%
15	Gill Creek	Mile 0 to 6	38%	-	-	0%
16	Irish Creek	Mile 0 to 3	37%	-	-	0%
17	East Branch Rock River	Mile 0 to Irish Creek	40%	-	13%	0%
18	Rock River	Mile 296 to 305	24%	-	11%	64%
19	Dead Creek	Mile 0 to 3	14%	-	1%	9%
20	Rock River	Mile 270 to 293	23%	0%	0%	1%
21	Rock River	Oconomowoc River to Mile 270	19%	0%	0%	3%
22	Flynn Creek	Mile 0 to 6	36%	-	-	0%
23	Oconomowoc River	Mason Creek to Flynn Creek	33%	11%	-	1%
24	Mason Creek	Mile 0 to 5.2	43%	12%	-	0%
25	Oconomowoc River	Battle Creek to Mason Creek	29%	32%	17%	26%
26	Battle Creek	Mile 2.1 to 4.6	26%	29%	-	9%
27	Oconomowoc River	Rock River to Battle Creek	2%	0%	-	21%
28	Rock River	Mile 249 to Oconomowoc River	16%	0%	-	4%
29	Rock River	Johnson Creek to Mile 249	24%	7%	0%	1%
30	Johnson Creek	Mile 0 to 17.5	23%	0%	-	0%
31	Rock River	Crawfish River to Johnson Creek	13%	-	2%	36%
32	Alto Creek	Mile 0 to 6.15	23%	-	-	0%
33	Mill Creek, Beaver Dam Lake	Beaver Dam to Fox Lake	20%	9%	1%	12%
34	Beaver Dam River	Calamus Creek to Mile 30	22%	31%	33%	0%
35	Calamus Creek	Mile 0 to 17	14%	-	-	0%
36	Beaver Dam River	Mile 14 to Calamus Creek	20%	-	-	0%
37	Park Creek	Mile 0 to 3	35%	54%	-	0%
38	Schultz Creek	Mile 0 to 5	29%	-	-	0%
39	Shaw Brook	Beaver Dam River to Schultz Creek	26%	0%	-	0%
40	Beaver Dam River	Casper Creek to Mile 14	19%	-	3%	7%
41	Casper Creek	Mile 0 to 2	27%	-	-	0%
42	Beaver Dam River	Lau Creek to Casper Creek	13%	-	-	0%

Reach	Waterbody Name	Waterbody Extents	Required Average Annual Percent Reduction of TSS from Baseline Load			Non-Permitted Urban Percentage of Baseline Load*
			Nonpoint Source	MS4	WWTF	
43	Lau Creek	Mile 0 to 6	30%	-	-	0%
44	Beaver Dam River	Mile 0 to Lau Creek	13%	-	-	0%
45	Maunesha River	Mile 13.21 to 31.8	35%	8%	-	1%
46	Maunesha River	Mile 5.5 to 13.2	30%	-	4%	1%
47	Maunesha River	Stony Brook to Mile 13.2	26%	-	4%	0%
48	Stony Brook	Mile 0 to 15	27%	-	-	0%
49	Maunesha River	Mile 0 to Stony Brook	28%	-	-	0%
50	Mud Creek	Mile 0 to 10	23%	-	-	0%
51	Crawfish River	Maunesha River to Mud Creek	23%	0%	1%	2%
52	Crawfish River	Beaver Dam River to Maunesha Creek	-	-	-	0%
53	Crawfish River	Rock River to Beaver Dam River	8%	-	0%	8%
54	Rock River	Bark River to Crawfish River	24%	6%	0%	0%
55	Bark River	Mile 35 to 41	39%	43%	28%	11%
56	Bark River	Scuppernong River to Mile 35	24%	0%	5%	1%
57	Spring Creek	Mile 0 to 5	34%	-	11%	5%
58	Steel Brook	Mile 3 to 4	34%	-	-	0%
59	Steel Brook, Scuppernong River, Bark River	Rock River to Steel Brook, Spring Creek	31%	15%	1%	3%
60	Rock River	Mile 213 to Bark River	7%	1%	0%	0%
61	Rock River	Mile 201 to 207	5%	2%	0%	16%
62	Pheasant Branch Creek	Mile 1 to 9	61%	70%	-	3%
63	Spring (Dorn) Creek	Mile 1 to 6	34%	11%	-	0%
64	Yahara River, Lake Mendota, Lake Monona	Nine Springs Creek to Spring (Dorn) Creek, Pheasant Branch Creek	49%	55%	42%	4%
65	Nine Springs Creek	Mile 0 to 6	41%	46%	35%	46%
66	Yahara River, Lake Waubesa, Lake Kegonsa	Mile 16 to Nine Springs Creek, Lake Waubesa	41%	37%	-	2%
67	Yahara River	Mile 16 to 22	7%	0%	-	4%
68	Yahara River	Mile 7 to 16	33%	18%	0%	0%
69	Yahara River	Mile 0 to 7	28%	21%	9%	2%
70	Rock River	Mile 193 to 201	30%	1%	-	0%
71	Rock River	Blackhawk Creek to Mile 193	37%	31%	-	4%
72	Blackhawk Creek	Mile 2 to 4	31%	0%	-	0%
73	Blackhawk Creek	Rock River to Mile 2	41%	49%	-	5%
74	Rock River	Mile 183 to Blackhawk Creek	23%	20%	7%	8%
75	Markham Creek	Mile 0 to 5	38%	19%	-	0%
76	Rock River	Bass Creek to Mile 183	23%	29%	26%	8%
77	Stevens Creek	Mile 0 to 8	42%	-	-	0%
78	Bass Creek	Rock River to Stevens Creek	29%	0%	3%	1%
79	Rock River	Mile 171 to Bass Creek	39%	37%	34%	1%
80	Turtle Creek	Mile 24 to 32	25%	-	1%	15%
81	Turtle Creek	Rock River to Mile 24	33%	7%	2%	3%
82	Fox Lake		34%	-	-	12%
83	Lake Koshkonong		35%	25%	5%	2%
	Lake Sinnissippi		-	-	-	0%

Attachment J

Water Quality Trading Management Practice Registration (Form 3400-207)

State of Wisconsin
Department of Natural Resources
101 South Webster Street
Madison WI 53707-7921
dnr.wi.gov

Water Quality Trading Management Practice Registration

Form 3400-207 (R 1/14)

Notice: Pursuant to s. 283.84, Wis. Stats., this form must be completed by any WPDES permittee that is using water quality trading as a method of complying with a permit limitation. Failure to complete this form would not result in penalties. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Open Records Law (ss. 19.31 - 19.39, Wis. Stats.).

Applicant Information

Permittee Name	Permit Number	Facility Site Number
Springfield Clean Water LLC	WI-0065889-01-0	

Facility Address	City	State	ZIP Code
7167 Schneider Rd	Middleton	WI	53562

Project Contact Name (if applicable)	Address	City	State	ZIP Code
Daniel Nemke	737 W. Glen Oaks Ln.	Mequon	WI	53092

Project Name
Springfield Clean Water NCS Project

Broker/Exchange Information (if applicable)

Was a broker/exchange be used to facilitate trade?
◉ Yes
◯ No

Broker/Exchange Organization Name	Contact Name	
Dane County	Kyle Minks	
Address	**Phone Number**	**Email**
5201 Fen Oak Drive, Room 208	(608) 224-3675	minks.kyle@countyofdane.com

Trade Registration Information (Use a separate form for each trade agreement)

Type	Trade Agreement Number	Practices Used to Generate Credits	Anticipated Load Reduction	Trade Ratio	Method of Quantification
◯ Urban NPS ◉ Agricultural NPS ◯ Other	LWRM#6(2016)	Grassed Waterways	TP = 148.8 TSS = 218,600	1.5:1	NRCS Gully Erosion Calculator

County	Closest Receiving Water Name	Land Parcel ID(s)	Parameter(s) being traded
Dane	Pheasant Branch Creek	080821390003	TP and TSS

The preparer certifies all of the following:

- I have completed this document to the best of my knowledge and have not excluded pertinent information.
- I certify that the information in this document is true to the best of my knowledge.

Signature of Preparer	Date Signed
David Nemke	8/17/17

Authorized Representative Signature

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision. Based on my inquiry of those persons directly responsible for gathering and entering the information, the information is, to the best of my knowledge and belief, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature of Authorized Representative	Date Signed
David Nemke	8/17/17

Leave Blank – For Department Use Only

Date Received		Trade Docket Number
Entered in Tracking System ☐ Yes	Date Entered	Name of Department Reviewer