



1414 West Hamilton Avenue  
PO Box 8  
Eau Claire, WI 54702-0008

December 17, 2021

*VIA Electronic Mail*

Ms. Cheryl Laatsch  
WI Dept. of Natural Resources  
N7725 Hwy 28  
Horicon, WI 53032

Mr. Darin G. Simpkins  
U.S. Fish & Wildlife Service  
Green Bay Field Office  
2661 Scott Tower Drive  
New Franken, Wisconsin, 54229

**Subject: 2021 Water Quality Monitoring Report  
Big Falls (P-2390-01), Thornapple (P-2475) & Turtle-Flambeau (P-2390-02)**

Dear Ms. Laatsch and Mr. Simpkins:

Enclosed is the 2021 Water Quality Sampling Report for Big Falls and Thornapple flowages. The samples were taken in May, July and August from the deepest point of each reservoir immediately upstream of the boat restraining barrier. The report includes the results for the past five years of monitoring.

Annual water quality monitoring for the Turtle Flambeau Flowage is conducted by the Citizens Lake Monitoring Program and the results are published on the WDNR's website. The link is: <https://dnr.wi.gov/lakes/clmn/Stations.aspx?location=26>. Should citizen monitoring be discontinued in the future, NSPW will provide replacement services as stipulated in the 2008 Water Quality Certification for Big Falls Hydro.

Should you have any questions regarding this report, you may contact me at (715) 737-1353 or [matthew.j.miller@xcelenergy.com](mailto:matthew.j.miller@xcelenergy.com). **Please provide any comments you may have by January 20, 2022.**

Sincerely,

Matthew J. Miller  
Hydro License Compliance Consultant

Enclosure

c: General Project Files

**2021 Water Quality Monitoring Report for Big Falls Flowage  
(P-2390-01) and Thornapple Flowage (P-2475)**

Northern States Power Company – WI  
An Xcel Energy Company

December 2021

## **APPENDIX A**

### **2021 Water Quality Lab Analysis For Big Falls and Thornapple Flowages**



Minneapolis Testing Laboratory  
1518 Chestnut Ave N  
Minneapolis, MN 55043  
Certification # MN-027-053-197  
WI-999071150  
Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/06/2021 09:29

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Big Falls Flowage Surface		MGE0003-01	Water	04/28/2021 11:07	05/03/2021 6:30
Big Falls Flowage Bottom		MGE0003-02	Water	04/28/2021 11:13	05/03/2021 6:30



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 Certification # MN-027-053-197  
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 Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/06/2021 09:29

**Big Falls Flowage Surface**  
**MGE0003-01 (Water) - Chain of Custody Number: 249477**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					

**Wet Chemistry**

<b>Phosphate, Total as P</b>	0.0260	0.00200	0.00667	mg/L		1	BGE0014	5/3/21 10:38	5/4/21 13:24	EPA 365.1	HRD
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Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/06/2021 09:29

**Big Falls Flowage Bottom**

**MGE0003-02 (Water) - Chain of Custody Number: 249477**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0270	0.00200	0.00667	mg/L		1	BGE0014	5/3/21 10:38	5/4/21 13:25	EPA 365.1	HRD

**Wet Chemistry**

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	05/06/2021 09:29

### Wet Chemistry - Quality Control

Analyte	Result	LOD	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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#### Batch BGE0014 - Wet Prep

<b>Blank (BGE0014-BLK1)</b>					Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	<0.00200	0.00200	0.0066666	mg/L							
<b>LCS (BGE0014-BS1)</b>					Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.54000	0.00200	0.0066666	mg/L	0.49700		109	90-110			
<b>Duplicate (BGE0014-DUP1)</b>					Source: MGD0172-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.092000	0.00200	0.0066666	mg/L		0.092000			0.00	20	
<b>Duplicate (BGE0014-DUP2)</b>					Source: MGD0198-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.076000	0.00200	0.0066666	mg/L		0.076000			0.00	20	
<b>Matrix Spike (BGE0014-MS1)</b>					Source: MGD0172-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.63600	0.00200	0.0066666	mg/L	0.49700	0.092000	109	90-110			
<b>Matrix Spike (BGE0014-MS2)</b>					Source: MGD0198-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.60800	0.00200	0.0066666	mg/L	0.49700	0.076000	107	90-110			
<b>Matrix Spike Dup (BGE0014-MSD1)</b>					Source: MGD0172-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.63900	0.00200	0.0066666	mg/L	0.49700	0.092000	110	90-110	0.471	20	
<b>Matrix Spike Dup (BGE0014-MSD2)</b>					Source: MGD0198-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.62500	0.00200	0.0066666	mg/L	0.49700	0.076000	110	90-110	2.76	20	



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1518 Chestnut Ave N  
Minneapolis, MN 55043  
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Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/06/2021 09:31

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Thornapple Flowage Surface		MGE0004-01	Water	04/28/2021 13:00	05/03/2021 6:30
Thornapple Flowage Bottom		MGE0004-02	Water	04/28/2021 13:08	05/03/2021 6:30





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Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/06/2021 09:31

**Thornapple Flowage Surface**  
**MGE0004-01 (Water) - Chain of Custody Number: 249477**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0310	0.00200	0.00667	mg/L		1	BGE0014	5/3/21 10:38	5/4/21 13:26	EPA 365.1	HRD

**Wet Chemistry**



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Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/06/2021 09:31

**Thornapple Flowage Bottom**  
**MGE0004-02 (Water) - Chain of Custody Number: 249477**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0330	0.00200	0.00667	mg/L		1	BGE0014	5/3/21 10:38	5/4/21 13:27	EPA 365.1	HRD

**Wet Chemistry**

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	05/06/2021 09:31

### Wet Chemistry - Quality Control

Analyte	Result	LOD	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
<b>Batch BGE0014 - Wet Prep</b>											
<b>Blank (BGE0014-BLK1)</b>					Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	<0.00200	0.00200	0.0066666	mg/L							
<b>LCS (BGE0014-BS1)</b>					Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.54000	0.00200	0.0066666	mg/L	0.49700		109	90-110			
<b>Duplicate (BGE0014-DUP1)</b>					Source: MGD0172-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.092000	0.00200	0.0066666	mg/L		0.092000			0.00	20	
<b>Duplicate (BGE0014-DUP2)</b>					Source: MGD0198-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.076000	0.00200	0.0066666	mg/L		0.076000			0.00	20	
<b>Matrix Spike (BGE0014-MS1)</b>					Source: MGD0172-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.63600	0.00200	0.0066666	mg/L	0.49700	0.092000	109	90-110			
<b>Matrix Spike (BGE0014-MS2)</b>					Source: MGD0198-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.60800	0.00200	0.0066666	mg/L	0.49700	0.076000	107	90-110			
<b>Matrix Spike Dup (BGE0014-MSD1)</b>					Source: MGD0172-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.63900	0.00200	0.0066666	mg/L	0.49700	0.092000	110	90-110	0.471	20	
<b>Matrix Spike Dup (BGE0014-MSD2)</b>					Source: MGD0198-03 Prepared: 05/03/2021 Analyzed: 05/04/2021						
Phosphate, Total as P	0.62500	0.00200	0.0066666	mg/L	0.49700	0.076000	110	90-110	2.76	20	

NORTHERN LAKE SERVICE, INC.  
 Analytical Laboratory and Environmental Services  
 400 North Lake Avenue - Crandon, WI 54520  
 Ph: (715)-478-2777 Fax: (715)-478-3060

# ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460  
 WDATCP Laboratory Certification No. 105-330  
 EPA Laboratory ID No. WI00034

Printed: 05/17/21 Page 1 of 1

Client: Xcel Energy  
 Attn: Matt Miller (reports)  
 1414 W. Hamilton Ave  
 P.O. Box 8  
 Eau Claire, WI 54702

NLS Project: 365297  
 NLS Customer: 96708  
 Phone: 715 737 1353

Project: Big Falls - Thornapple

**Big Falls Flowage NLS ID: 1251512**

COC: 247750:1 Matrix: SW  
 Collected: 04/28/21 11:07 Received: 04/30/21

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					05/14/21	10200-H	721026460
Lab filtration for Chlorophyll	yes					05/02/21	NA	721026460

**Thornapple Floeage NLS ID: 1251513**

COC: 247750:2 Matrix: SW  
 Collected: 04/28/21 13:00 Received: 04/30/21

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					05/14/21	10200-H	721026460
Lab filtration for Chlorophyll	yes					05/02/21	NA	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(\*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution and/or solids content.

ND = Not Detected (< LOD)    LOD = Limit of Detection    LOQ = Limit of Quantitation    NA = Not Applicable  
 DWB = Dry Weight Basis    %DWB = (mg/kg DWB) / 10000    1000 ug/L = 1 mg/L  
 MCL = Maximum Contaminant Levels for Drinking Water Samples.    Shaded results indicate >MCL.

Reviewed by:



Authorized by:  
 R. T. Krueger  
 President

Northern Lake Service, Inc.  
Chlorophyll Results

Customer: Xcel Energy

Project: 365297

Big Falls - Thornapple

<u>Sample</u>	<u>Description</u>	<u>CC a</u>	<u>Pheo a</u>	<u>TC a</u>	<u>TC b</u>	<u>TC c</u>
1251512	Big Falls Flowage	0.77	0.69	1.2	0.5	0.6
1251513	Thornapple Floeage	0.65	0.89	1.2	0.057	0.28

CC a = Corrected Chlorophyll a

Pheo a = Pheophytin a

TC a = Trichromatic Chlorophyll a

TC b = Trichromatic Chlorophyll b

TC c = Trichromatic Chlorophyll c

Units = ug/L for Water, ug/cm<sup>2</sup> for periphyton samplers

\*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.



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Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/09/2021 06:34

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Big Falls Flowage Surface		MGG0212-01	Water	07/21/2021 9:26	07/23/2021 11:06
Big Falls Flowage Bottom		MGG0212-02	Water	07/21/2021 9:35	07/23/2021 11:06



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Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/09/2021 06:34

**Big Falls Flowage Surface**  
**MGG0212-01 (Water) - Chain of Custody Number: 249476**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	0.0330	0.00200	0.00667	mg/L		1	BGH0018	8/2/21 12:38	8/3/21 10:56	EPA 365.1	HRD

**Wet Chemistry**



Minneapolis Testing Laboratory  
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Minneapolis, MN 55043  
Certification # MN-027-053-197  
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Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/09/2021 06:34

**Big Falls Flowage Bottom**

**MGG0212-02 (Water) - Chain of Custody Number: 249476**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	<b>0.0320</b>	0.00200	0.00667	mg/L		1	BGH0018	8/2/21 12:38	8/3/21 10:57	EPA 365.1	HRD



Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	08/09/2021 06:34

### Wet Chemistry - Quality Control

Analyte	Result	LOD	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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#### Batch BGH0018 - Wet Prep

<b>Blank (BGH0018-BLK1)</b>					Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	<0.00200	0.00200	0.0066666	mg/L							
<b>LCS (BGH0018-BS1)</b>					Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.52300	0.00200	0.0066666	mg/L	0.49700		105	90-110			
<b>Duplicate (BGH0018-DUP1)</b>					Source: MGG0229-03 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.20800	0.00200	0.0066666	mg/L		0.20900			0.480	20	
<b>Duplicate (BGH0018-DUP2)</b>					Source: MGG0229-04 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.035000	0.00200	0.0066666	mg/L		0.035000			0.00	20	
<b>Matrix Spike (BGH0018-MS1)</b>					Source: MGG0229-03 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.72000	0.00200	0.0066666	mg/L	0.49700	0.20900	103	90-110			
<b>Matrix Spike (BGH0018-MS2)</b>					Source: MGG0229-04 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.55400	0.00200	0.0066666	mg/L	0.49700	0.035000	104	90-110			
<b>Matrix Spike Dup (BGH0018-MSD1)</b>					Source: MGG0229-03 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.73200	0.00200	0.0066666	mg/L	0.49700	0.20900	105	90-110	1.65	20	
<b>Matrix Spike Dup (BGH0018-MSD2)</b>					Source: MGG0229-04 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.55500	0.00200	0.0066666	mg/L	0.49700	0.035000	105	90-110	0.180	20	



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Certification # MN-027-053-197  
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Christine Keefe, Manager (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	08/09/2021 06:36

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Thornapple Flowage Surface		MGG0211-01	Water	07/21/2021 11:17	07/23/2021 11:06
Thornapple Flowage Bottom		MGG0211-02	Water	07/21/2021 11:23	07/23/2021 11:06



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Certification # MN-027-053-197  
WI-999071150  
Christine Keefe, Manager (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	Reported:
W 5506 Dam Road		08/09/2021 06:36
Glen Flora WI, 54563	Project Manager: Matt J Miller	

**Thornapple Flowage Surface**  
**MGG0211-01 (Water) - Chain of Custody Number: 249476**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	<b>0.0260</b>	0.00200	0.00667	mg/L		1	BGH0018	8/2/21 12:38	8/3/21 10:52	EPA 365.1	HRD



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 Minneapolis, MN 55043  
 Certification # MN-027-053-197  
 WI-999071150  
 Christine Keefe, Manager (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	08/09/2021 06:36

**Thornapple Flowage Bottom**  
**MGG0211-02 (Water) - Chain of Custody Number: 249476**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0260	0.00200	0.00667	mg/L		1	BGH0018	8/2/21 12:38	8/3/21 10:55	EPA 365.1	HRD

**Wet Chemistry**

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	08/09/2021 06:36

### Wet Chemistry - Quality Control

Analyte	Result	LOD	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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#### Batch BGH0018 - Wet Prep

<b>Blank (BGH0018-BLK1)</b>					Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	<0.00200	0.00200	0.0066666	mg/L							
<b>LCS (BGH0018-BS1)</b>					Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.52300	0.00200	0.0066666	mg/L	0.49700		105	90-110			
<b>Duplicate (BGH0018-DUP1)</b>					Source: MGG0229-03 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.20800	0.00200	0.0066666	mg/L		0.20900			0.480	20	
<b>Duplicate (BGH0018-DUP2)</b>					Source: MGG0229-04 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.035000	0.00200	0.0066666	mg/L		0.035000			0.00	20	
<b>Matrix Spike (BGH0018-MS1)</b>					Source: MGG0229-03 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.72000	0.00200	0.0066666	mg/L	0.49700	0.20900	103	90-110			
<b>Matrix Spike (BGH0018-MS2)</b>					Source: MGG0229-04 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.55400	0.00200	0.0066666	mg/L	0.49700	0.035000	104	90-110			
<b>Matrix Spike Dup (BGH0018-MSD1)</b>					Source: MGG0229-03 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.73200	0.00200	0.0066666	mg/L	0.49700	0.20900	105	90-110	1.65	20	
<b>Matrix Spike Dup (BGH0018-MSD2)</b>					Source: MGG0229-04 Prepared: 08/02/2021 Analyzed: 08/03/2021						
Phosphate, Total as P	0.55500	0.00200	0.0066666	mg/L	0.49700	0.035000	105	90-110	0.180	20	

NORTHERN LAKE SERVICE, INC.  
 Analytical Laboratory and Environmental Services  
 400 North Lake Avenue - Crandon, WI 54520  
 Ph: (715)-478-2777 Fax: (715)-478-3060

# ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460  
 WDATCP Laboratory Certification No. 105-330  
 EPA Laboratory ID No. WI00034

Printed: 08/02/21 Page 1 of 1

Client: Xcel Energy  
 Attn: Matt Miller (reports)  
 1414 W. Hamilton Ave  
 P.O. Box 8  
 Eau Claire, WI 54702

NLS Project: 369965  
 NLS Customer: 96708  
 Phone: 715 737 1353

Project: Big Falls-Thornapple

**Big Falls Flowage NLS ID: 1267096**

COC: 256395:1 Matrix: SW  
 Collected: 07/21/21 09:26 Received: 07/23/21

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					07/30/21	10200-H	721026460
Lab filtration for Chlorophyll	yes					07/27/21	NA	721026460

**Thornapple Flowage NLS ID: 1267097**

COC: 256395:2 Matrix: SW  
 Collected: 07/21/21 11:17 Received: 07/23/21

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					07/30/21	10200-H	721026460
Lab filtration for Chlorophyll	yes					07/27/21	NA	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(\*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution and/or solids content.

ND = Not Detected (< LOD)    LOD = Limit of Detection    LOQ = Limit of Quantitation    NA = Not Applicable  
 DWB = Dry Weight Basis    %DWB = (mg/kg DWB) / 10000    1000 ug/L = 1 mg/L  
 MCL = Maximum Contaminant Levels for Drinking Water Samples.    Shaded results indicate >MCL.

Reviewed by:



Authorized by:  
 R. T. Krueger  
 President

Northern Lake Service, Inc.  
Chlorophyll Results

Customer: Xcel Energy

Project: 369965

Big Falls-Thornapple

<u>Sample</u>	<u>Description</u>	<u>CC a</u>	<u>Pheo a</u>	<u>TC a</u>	<u>TC b</u>	<u>TC c</u>
1267096	Big Falls Flowage	4.7	2.6	6.5	0.0*	0.45
1267097	Thornapple Flowage	1.9	0.77	2.5	0.0052	0.13

CC a = Corrected Chlorophyll a

Pheo a = Pheophytin a

TC a = Trichromatic Chlorophyll a

TC b = Trichromatic Chlorophyll b

TC c = Trichromatic Chlorophyll c

Units = ug/L for Water, ug/cm<sup>2</sup> for periphyton samplers

\*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.



Minneapolis Testing Laboratory  
1518 Chestnut Ave N  
Minneapolis, MN 55043  
Certification # MN-027-053-197  
WI-999071150  
Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/22/2021 10:02

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Big Falls Flowage Surface		MGH0257-01	Water	08/26/2021 9:07	08/30/2021 6:15
Big Falls Flowage Bottom		MGH0257-02	Water	08/26/2021 9:17	08/30/2021 6:15





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Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/22/2021 10:02

**Big Falls Flowage Surface**  
**MGH0257-01 (Water) - Chain of Custody Number: 275727**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0330	0.00200	0.00667	mg/L		1	BGI0090	9/21/21 9:00	9/21/21 15:54	EPA 365.1	HRD



Minneapolis Testing Laboratory  
 1518 Chestnut Ave N  
 Minneapolis, MN 55043  
 Certification # MN-027-053-197  
 WI-999071150  
 Christine Keefe, Manager (612) 630-4506

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/22/2021 10:02

**Big Falls Flowage Bottom**  
**MGH0257-02 (Water) - Chain of Custody Number: 275727**

Analyte	Result	LOD	LOQ	Units	Analyte		Batch	Prepared	Analyzed	Method	Analyst
					Qualifier	Dilution					
<b>Phosphate, Total as P</b>	0.0400	0.00200	0.00667	mg/L		1	BGI0090	9/21/21 9:00	9/21/21 15:57	EPA 365.1	HRD

**Wet Chemistry**

Big Falls Hydro	Project Name/Location: Phosphorus	
1400 Western Ave		Reported:
Eau Claire WI, 54701	Project Manager: Matt J Miller	09/22/2021 10:02

### Wet Chemistry - Quality Control

Analyte	Result	LOD	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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#### Batch BGI0090 - Wet Prep

<b>Blank (BGI0090-BLK1)</b>					Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	<0.00200	0.00200	0.0066666	mg/L							
<b>LCS (BGI0090-BS1)</b>					Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.49900	0.00200	0.0066666	mg/L	0.49700		100	90-110			
<b>Duplicate (BGI0090-DUP1)</b>					Source: MGI0074-03 Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.17300	0.00200	0.0066666	mg/L		0.17000			1.75	20	
<b>Duplicate (BGI0090-DUP2)</b>					Source: MGI0074-04 Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.032000	0.00200	0.0066666	mg/L		0.031000			3.17	20	
<b>Matrix Spike (BGI0090-MS1)</b>					Source: MGI0074-03 Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.66900	0.00200	0.0066666	mg/L	0.49700	0.17000	100	90-110			
<b>Matrix Spike (BGI0090-MS2)</b>					Source: MGI0074-04 Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.53900	0.00200	0.0066666	mg/L	0.49700	0.031000	102	90-110			
<b>Matrix Spike Dup (BGI0090-MSD1)</b>					Source: MGI0074-03 Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.67600	0.00200	0.0066666	mg/L	0.49700	0.17000	102	90-110	1.04	20	
<b>Matrix Spike Dup (BGI0090-MSD2)</b>					Source: MGI0074-04 Prepared & Analyzed: 09/21/2021						
Phosphate, Total as P	0.53800	0.00200	0.0066666	mg/L	0.49700	0.031000	102	90-110	0.186	20	



Minneapolis Testing Laboratory  
1518 Chestnut Ave N  
Minneapolis, MN 55043  
Certification # MN-027-053-197  
WI-999071150  
Christine Keefe, Manager (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/22/2021 10:09

### ANALYTICAL REPORT FOR SAMPLES

Sample ID	Sample Qualifier	Laboratory ID	Matrix	Sampled	Received
Thornapple Flowage Surface		MGH0258-01	Water	08/26/2021 11:05	08/30/2021 6:15
Thornapple Flowage Bottom		MGH0258-02	Water	08/26/2021 11:10	08/30/2021 6:15



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Certification # MN-027-053-197  
WI-999071150  
Christine Keefe, Manager (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/22/2021 10:09

**Thornapple Flowage Surface**  
**MGH0258-01 (Water) - Chain of Custody Number: 275727**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0320	0.00200	0.00667	mg/L		1	BGI0090	9/21/21 9:00	9/21/21 15:58	EPA 365.1	HRD



Minneapolis Testing Laboratory  
 1518 Chestnut Ave N  
 Minneapolis, MN 55043  
 Certification # MN-027-053-197  
 WI-999071150  
 Christine Keefe, Manager (612) 630-4506

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/22/2021 10:09

**Thornapple Flowage Bottom**  
**MGH0258-02 (Water) - Chain of Custody Number: 275727**

Analyte	Result	LOD	LOQ	Units	Analyte Qualifier	Dilution	Batch	Prepared	Analyzed	Method	Analyst
<b>Phosphate, Total as P</b>	0.0330	0.00200	0.00667	mg/L		1	BGI0090	9/21/21 9:00	9/21/21 15:59	EPA 365.1	HRD

**Wet Chemistry**

Thornapple Hydro	Project Name/Location: Phosphorus	
W 5506 Dam Road		Reported:
Glen Flora WI, 54563	Project Manager: Matt J Miller	09/22/2021 10:09

### Wet Chemistry - Quality Control

Analyte	Result	LOD	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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#### Batch BGI0090 - Wet Prep

##### Blank (BGI0090-BLK1)

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	<0.00200	0.00200	0.00666666	mg/L							
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##### LCS (BGI0090-BS1)

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.49900	0.00200	0.00666666	mg/L	0.49700		100	90-110			
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##### Duplicate (BGI0090-DUP1)

Source: MGI0074-03

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.17300	0.00200	0.00666666	mg/L		0.17000			1.75	20	
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##### Duplicate (BGI0090-DUP2)

Source: MGI0074-04

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.032000	0.00200	0.00666666	mg/L		0.031000			3.17	20	
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##### Matrix Spike (BGI0090-MS1)

Source: MGI0074-03

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.66900	0.00200	0.00666666	mg/L	0.49700	0.17000	100	90-110			
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##### Matrix Spike (BGI0090-MS2)

Source: MGI0074-04

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.53900	0.00200	0.00666666	mg/L	0.49700	0.031000	102	90-110			
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##### Matrix Spike Dup (BGI0090-MSD1)

Source: MGI0074-03

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.67600	0.00200	0.00666666	mg/L	0.49700	0.17000	102	90-110	1.04	20	
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##### Matrix Spike Dup (BGI0090-MSD2)

Source: MGI0074-04

Prepared & Analyzed: 09/21/2021

Phosphate, Total as P	0.53800	0.00200	0.00666666	mg/L	0.49700	0.031000	102	90-110	0.186	20	
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NORTHERN LAKE SERVICE, INC.  
 Analytical Laboratory and Environmental Services  
 400 North Lake Avenue - Crandon, WI 54520  
 Ph: (715)-478-2777 Fax: (715)-478-3060

# ANALYTICAL REPORT

WDNR Laboratory ID No. 721026460  
 WDATCP Laboratory Certification No. 105-330  
 EPA Laboratory ID No. WI00034

Printed: 09/07/21 Page 1 of 1

Client: Xcel Energy  
 Attn: Matt Miller (reports)  
 1414 W. Hamilton Ave.  
 PO Box 8  
 Eau Claire, WI 54702

NLS Project: 372133  
 NLS Customer: 96708  
 Phone: 715 737 1353

Project: Big Falls- Thornapple

**Big Falls Flowage NLS ID: 1274204**

COC: 257314:1 Matrix: SW

Collected: 08/26/21 09:07 Received: 08/30/21

Notes: Noncompliance: Sample received beyond EPA holding time for Chlorophyll A. Noncompliance: Sample received at 22.6 degrees C, which is above WDNR protocol of 6 degrees C.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					09/02/21	10200-H	721026460
Lab filtration for Chlorophyll	yes					08/31/21	NA	721026460

**Thornapple Flowage NLS ID: 1274205**

COC: 257314:2 Matrix: SW

Collected: 08/26/21 11:05 Received: 08/30/21

Notes: Noncompliance: Sample received beyond EPA holding time for Chlorophyll A. Noncompliance: Sample received at 22.6 degrees C, which is above WDNR protocol of 6 degrees C.

Parameter	Result	Units	Dilution	LOD	LOQ	Analyzed	Method	Lab
Chlorophyll, all species	See Attached					09/02/21	10200-H	721026460
Lab filtration for Chlorophyll	yes					08/31/21	NA	721026460

Values in brackets represent results greater than or equal to the LOD but less than the LOQ and are within a region of "Less-Certain Quantitation". Results greater than or equal to the LOQ are considered to be in the region of "Certain Quantitation". LOD and/or LOQ tagged with an asterisk(\*) are considered Reporting Limits. All LOD/LOQs adjusted to reflect dilution and/or solids content.

ND = Not Detected (< LOD)    LOD = Limit of Detection    LOQ = Limit of Quantitation    NA = Not Applicable  
 DWB = Dry Weight Basis    %DWB = (mg/kg DWB) / 10000    1000 ug/L = 1 mg/L  
 MCL = Maximum Contaminant Levels for Drinking Water Samples.    Shaded results indicate >MCL.

Reviewed by:



Authorized by:  
 R. T. Krueger  
 President



Northern Lake Service, Inc.  
Chlorophyll Results

Customer: Xcel Energy

Project: 372133

Big Falls- Thornapple

<u>Sample</u>	<u>Description</u>	<u>CC a</u>	<u>Pheo a</u>	<u>TC a</u>	<u>TC b</u>	<u>TC c</u>
1274204	Big Falls Flowage	7.1	3.3	9.4	0.0*	0.54
1274205	Thornapple Flowage	0.88	1.3	1.7	0.18	0.32

CC a = Corrected Chlorophyll a

Pheo a = Pheophytin a

TC a = Trichromatic Chlorophyll a

TC b = Trichromatic Chlorophyll b

TC c = Trichromatic Chlorophyll c

Units = ug/L for Water, ug/cm<sup>2</sup> for periphyton samplers

\*: The complex calculations used to differentiate the various chlorophyll species magnify error at low concentrations and sometimes produce negative values, which are reported as 0.0 on this report.

## **APPENDIX B**

**Summary Of Total Phosphorous And Chlorophyll A  
Data For Big Falls And Thornapple Flowages  
2017 - 2021**

## Summary of Water Quality Data for Big Falls and Thornapple Flowages (2017-2021)

Date	<u>Big Falls Flowage</u>			<u>Thornapple Flowage</u>		
	Surface	Surface	Bottom	Surface	Surface	Bottom
	Total Phosphorus (mg/L P)	Chlorophyll-A (CCa) (ug/L)	Total Phosphorus (mg/L P)	Total Phosphorus (mg/L P)	Chlorophyll-A (CCa) (ug/L)	Total Phosphorus (mg/L P)
4/24/2017	0.020	3.60	0.030	0.020	2.50	0.030
7/24/2017	0.030	1.60	0.050	0.030	1.30	0.040
8/29/2017	0.020	3.10	0.060	0.030	1.10	0.030
5/8/2018	0.030	7.80	0.030	0.020	2.50	0.020
7/24/2018	0.040	7.80	0.040	0.040	13.00	0.040
8/29/2018	0.040	8.10	0.040	0.030	0.90	0.030
5/7/2019	0.030	2.10	0.020	0.020	2.90	0.030
7/23/2019	0.050	n/a*	0.060	0.040	n/a*	0.050
8/27/2019	0.030	2.30	0.040	0.040	1.70	0.040
April**	n/a	n/a	n/a	n/a	n/a	n/a
July**	n/a	n/a	n/a	n/a	n/a	n/a
8/18/2020	0.040	2.80	0.050	0.040	0.40	0.040
<b>4/28/2021</b>	<b>0.026</b>	<b>0.77</b>	<b>0.027</b>	<b>0.031</b>	<b>0.65</b>	<b>0.033</b>
<b>7/21/2021</b>	<b>0.033</b>	<b>4.70</b>	<b>0.032</b>	<b>0.026</b>	<b>1.90</b>	<b>0.026</b>
<b>8/26/2021***</b>	<b>0.033</b>	<b>7.10</b>	<b>0.040</b>	<b>0.032</b>	<b>0.88</b>	<b>0.033</b>
Average (Ice-out sample)	0.027	3.57	0.027	0.023	2.14	0.028
Average (July sample)	0.038	4.700	0.046	0.034	5.400	0.039
Average (August sample)	0.033	4.680	0.046	0.034	0.996	0.035

\* Lab lost samples during analysis - see analytical report

\*\* Sampling suspended due to COVID-19 restrictions

\*\*\* Chlorophylla-A Samples received out of temperature range (overnight mail delivery failed)

## **APPENDIX C**

**Summary Of Dissolved Oxygen and Temperature  
Data for Big Falls Flowage and Thornapple Flowage  
2017-2021**

**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2017.**

Date: 4/24/2017  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample (ft): 34  
 Weather Conditions: Overcast, south wind @ 15  
 Temperature (F): 55

Date: 7/24/2017  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: Partly cloudy, light winds  
 Temperature (F): 62

Date: 8/29/2017  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample: 34  
 Weather Conditions: Overcast, calm winds  
 Temperature (F): 58

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	11.6	11.09	Surface	24.5	6.27	Surface	18.7	8.25
2	11.4	11.06	2	24.1	6.23	2	18.7	8.23
4	11.3	11.05	4	24.1	6.23	4	18.5	8.20
6	11.3	11.02	6	24.1	6.25	6	18.5	8.18
8	11.3	11.00	8	24.1	6.26	8	18.4	8.17
10	11.3	10.98	10	24.0	6.26	10	18.4	8.13
12	11.3	10.98	12	24.0	6.26	12	18.4	8.09
14	11.2	10.97	14	24.0	6.25	14	18.4	8.08
16	11.2	10.96	16	24.0	6.24	16	18.4	8.08
18	11.2	10.95	18	23.9	6.25	18	18.4	8.07
20	11.2	10.95	20	23.9	6.27	20	18.4	8.07
22	11.2	10.94	22	23.8	6.26	22	18.4	8.07
24	11.2	10.94	24	23.7	6.28	24	18.4	8.05
26	11.2	10.93	26	23.7	6.28	26	18.4	8.04
28	11.1	10.92	28	23.7	6.25	28	18.3	8.01
30	11.1	10.90	30	23.7	6.27	30	18.3	8.01
32	11.1	10.89	32	23.7	6.25	32	18.3	8.01
34	11.1	10.87	34	23.7	6.22	34	18.2	7.84
36	Bottom	Bottom	36	23.7	6.13	36	Bottom	Bottom
			38	Bottom	Bottom			

**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2018.**

Date: 5/8/2018  
 Secchi Disk (ft.): 4.5  
 Depth of Bottom Sample (ft): 34  
 Weather Conditions: overcast, calm wind  
 Temperature (F): 73

Date: 7/24/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: mostly sunny, winds NW @ 5-10  
 Temperature (F): 72

Date: 8/29/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: partly sunny, winds N @ 5-10  
 Temperature (F): 59

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	17.6	9.88	Surface	24.0	8.35	Surface	21.6	7.33
2	16.6	10.00	2	23.7	8.34	2	21.6	7.31
4	16.6	9.97	4	23.4	8.22	4	21.6	7.30
6	16.4	9.96	6	23.3	8.20	6	21.6	7.29
8	16.2	9.92	8	23.3	8.16	8	21.6	7.27
10	16.2	9.92	10	23.3	8.15	10	21.5	7.23
12	16.2	9.92	12	23.3	8.14	12	21.5	7.24
14	16.2	9.92	14	23.1	7.95	14	21.4	7.27
16	16.2	9.91	16	23.0	7.94	16	21.4	7.28
18	16.2	9.91	18	23.0	7.90	18	21.4	7.26
20	16.2	9.90	20	23.0	7.77	20	21.4	7.22
22	16.2	9.90	22	22.7	7.74	22	21.4	7.22
24	16.2	9.89	24	22.5	7.60	24	21.4	7.23
26	16.2	9.91	26	22.5	7.57	26	21.4	7.23
28	16.2	9.90	28	22.4	7.51	28	21.4	7.24
30	16.2	9.90	30	22.3	7.47	30	21.4	7.21
32	16.2	9.89	32	22.2	7.29	32	21.4	7.15
34	16.1	9.91	34	22.2	7.24	34	21.4	6.92
36	Bottom	Bottom	36	22.2	7.18	36	21.3	6.7
			38	Bottom	Bottom		Bottom	Bottom

**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2019.**

Date: 5/7/2019

Secchi Disk (ft.): 5.5

Depth of Bottom Sample (ft): 36

Weather Conditions: mostly sunny, wind NW @ 5 mph

Temperature (F): 47

Date: 7/23/2019

Secchi Disk (ft.): 4.5

Depth of Bottom Sample (ft): 34

Weather Conditions: mostly sunny, wind NW @ 5 mph

Temperature (F): 73

Date: 8/27/2019

Secchi Disk (ft.): 5.0

Depth of Bottom Sample (ft): 30

Weather Conditions: partly sunny, winds SW @ 5-10

Temperature (F): 60

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	12.3	10.65
2	12.2	10.64
4	12.1	10.66
6	11.9	10.63
8	11.8	10.62
10	11.8	10.61
12	11.8	10.60
14	11.7	10.59
16	11.4	10.60
18	11.4	10.59
20	11.4	10.59
22	11.4	10.58
24	11.4	10.58
26	11.4	10.57
28	11.4	10.57
30	11.4	10.57
32	11.4	10.56
34	11.3	10.56
36	11.3	10.54
38	Bottom	Bottom

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	23.4	7.77
2	23.3	7.65
4	23.1	7.58
6	23.0	7.64
8	23.0	7.68
10	23.0	7.68
12	23.0	7.68
14	23.0	7.68
16	23.0	7.67
18	23.0	7.67
20	23.0	7.67
22	23.0	7.66
24	23.0	7.57
26	23.0	7.55
28	23.0	7.52
30	23.0	7.50
32	22.9	7.44
34	22.9	7.44
36	Bottom	Bottom

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	19.8	8.06
2	19.8	8.08
4	19.8	8.06
6	19.8	8.04
8	19.8	8.05
10	19.8	8.05
12	19.8	8.04
14	19.8	8.04
16	19.8	8.05
18	19.8	8.03
20	19.8	8.04
22	19.8	8.03
24	19.8	8.03
26	19.8	8.01
28	19.8	7.99
30	19.7	7.88
32	Bottom	Bottom

**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2020.**

Date: April  
No Sampling due to Covid-19 Restrictions

July  
No Sampling due to Covid-19 Restrictions

Date: August  
No Sampling due to faulty DO/temp. meter



**Dissolved Oxygen and Temperature Profiles for the Big Falls Flowage in 2021.**

Date: 4/28/2021  
 Secchi Disk (ft.): 4.5  
 Depth of Bottom Sample (ft): 38  
 Weather Conditions: partly sunny, wind NE 5-10  
 Temperature (F): 46

Date: 7/21/2021  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 38  
 Weather Conditions: cloudy, SE wind 5-10  
 Temperature (F): 64

Date: 8/26/2021  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 36  
 Weather Conditions: mostly sunny  
 Temperature (F): 65

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	8.1	11.47	Surface	25.0	7.43	Surface	24.1	7.99
2	7.9	11.50	2	25.1	7.40	2	24.1	8.09
4	7.9	11.47	4	25.1	7.35	4	24.1	8.15
6	7.8	11.45	6	25.0	7.18	6	24.1	8.16
8	7.9	11.43	8	25.0	7.09	8	24.1	8.17
10	7.9	11.40	10	24.9	7.05	10	24.1	8.17
12	7.8	11.36	12	24.9	7.01	12	23.8	7.65
14	7.8	11.36	14	24.8	6.94	14	23.6	7.52
16	7.8	11.35	16	24.8	6.89	16	23.4	7.34
18	7.8	11.35	18	24.8	6.85	18	23.3	7.26
20	7.8	11.36	20	24.7	6.82	20	23.2	7.22
22	7.8	11.35	22	24.7	6.80	22	23.2	7.11
24	7.8	11.35	24	24.7	6.77	24	23.1	7.00
26	7.9	11.35	26	24.5	6.60	26	23.1	6.84
28	7.9	11.36	28	24.5	6.50	28	23.1	6.82
30	7.9	11.34	30	24.5	6.48	30	23.1	6.78
32	7.9	11.33	32	24.5	6.50	32	23.0	6.72
34	7.9	11.33	34	24.5	6.47	34	23.0	6.64
36	7.8	11.32	36	24.5	6.46	36	23.0	6.6
38	Bottom	Bottom	38	24.5	6.42	38	Bottom	Bottom
			40	Bottom	Bottom			

**Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2017.**

Date: 4/24/2017  
 Secchi Disk (ft.): 4.0  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: overcast, windy  
 Temperature (F): 60

Date: 7/24/2017  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: mostly sunny, light winds  
 Temperature (F): 72

Date: 8/29/2017  
 Secchi Disk (ft.): 6.0  
 Depth of Bottom Sample (ft): 18  
 Weather Conditions: cloudy, light winds  
 Temperature (F): 62

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	10.1	11.15	Surface	24.5	6.82	Surface	21.6	7.59
2.0	10.1	11.05	2.0	23.4	6.84	2.0	21.3	7.47
4.0	10.1	10.95	4.0	23.1	6.83	4.0	21.2	7.42
6.0	10.0	10.97	6.0	23.0	6.80	6.0	21.1	7.39
8.0	10.0	10.94	8.0	22.9	6.79	8.0	21.1	7.35
10.0	10.0	10.97	10.0	22.9	6.79	10.0	21.0	7.33
12.0	10.0	10.95	12.0	22.9	6.77	12.0	21.0	7.30
14.0	10.0	10.90	14.0	22.9	6.76	14.0	21.0	7.24
16.0	10.0	10.95	16.0	22.9	6.73	16.0	21.0	7.23
18.0	10.0	10.90	18.0	22.9	6.72	18.0	20.9	7.21
20.0	10.0	10.9	20.0	22.9	6.69	20.0	Bottom	Bottom
22.0	Bottom	Bottom	22.0	Bottom	Bottom			

**Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2018.**

Date: 5/8/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: cloudy, south wind @ 5-10  
 Temperature (F): 73

Date: 7/24/2018  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 18  
 Weather Conditions: mostly sunny, wind NW @ 5-10  
 Temperature (F):

Date: 8/29/2018  
 Secchi Disk (ft.): 5.5  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: partly cloudy, light winds  
 Temperature (F):

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	12.5	11.55	Surface	26.2	7.90	Surface	21.5	6.20
2.0	12.1	11.62	2.0	25.7	7.67	2.0	21.5	6.18
4.0	12.0	11.61	4.0	25.6	7.48	4.0	21.4	6.17
6.0	12.0	11.59	6.0	25.4	7.26	6.0	21.4	6.16
8.0	11.9	11.58	8.0	25.3	7.14	8.0	21.4	6.17
10.0	11.8	11.59	10.0	25.3	7.19	10.0	21.4	6.16
12.0	11.7	11.58	12.0	25.3	7.16	12.0	21.4	6.14
14.0	11.7	11.56	14.0	25.3	7.16	14.0	21.4	6.15
16.0	11.7	11.55	16.0	25.0	7.16	16.0	21.4	6.14
18.0	11.7	11.53	18.0	23.8	6.78	18.0	21.4	6.13
20.0	11.6	11.5	20.0	Bottom	Bottom	20.0	21.4	6.1
22.0	Bottom	Bottom				22.0	Bottom	Bottom

**Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2019.**

Date: 5/7/2019  
 Secchi Disk (ft.): 6  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: sunny, winds N @ 5 mph  
 Temperature (F): 56

Date: 7/23/2019  
 Secchi Disk (ft.): 6  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: mostly sunny, NW wind @ 5 mph  
 Temperature (F): 74

Date: 8/27/2019  
 Secchi Disk (ft.): 5.0  
 Depth of Bottom Sample (ft): 18  
 Weather Conditions: partly sunny, SW wind at 15 mph  
 Temperature (F):

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	9.4	12.23	Surface	25.3	6.45	Surface	20.8	7.33
2.0	9.3	12.28	2.0	24.6	6.36	2.0	20.8	7.30
4.0	9.2	12.26	4.0	24.3	6.25	4.0	20.8	7.29
6.0	9.2	12.25	6.0	24.2	6.21	6.0	20.7	7.26
8.0	9.2	12.23	8.0	24.2	6.20	8.0	20.7	7.25
10.0	9.2	12.22	10.0	24.2	6.20	10.0	20.7	7.24
12.0	9.2	12.23	12.0	24.2	6.19	12.0	20.7	7.28
14.0	9.2	12.22	14.0	24.2	6.18	14.0	20.7	7.31
16.0	9.1	12.21	16.0	24.2	6.18	16.0	20.6	7.26
18.0	9.1	12.20	18.0	24.2	6.16	18.0	20.6	7.21
20.0	9.1	12.1	20.0	24.2	6.10	20.0	Bottom	Bottom
22.0	Bottom	Bottom	22.0	Bottom	Bottom			

**Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2020.**

Date: **April**  
 No Sampling due to Covid-19 Restrictions

Date: **July**  
 No Sampling due to Covid-19 Restrictions

Date: **August**  
 No Sampling due to faulty DO/temp. meter

**Dissolved Oxygen and Temperature Profiles for the Thornapple Flowage in 2021.**

Date: 4/28/2021  
 Secchi Disk (ft.): 5  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: partly sunny, NE wind 5-10  
 Temperature (F): 56

Date: 7/21/2021  
 Secchi Disk (ft.): 6  
 Depth of Bottom Sample (ft): 20  
 Weather Conditions: mostly cloudy, light winds  
 Temperature (F): 64

Date: 8/26/2021  
 Secchi Disk (ft.): 6.0  
 Depth of Bottom Sample (ft): 18  
 Weather Conditions: hazy sunshine, light winds  
 Temperature (F): 71

Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)	Depth (ft.)	Temperature (celsius)	Dissolved Oxygen (mg/l)
Surface	9.2	10.64	Surface	23.8	6.36	Surface	23.4	6.92
2.0	9.0	10.68	2.0	23.8	6.20	2.0	23.2	6.91
4.0	9.0	10.62	4.0	23.8	6.10	4.0	23.1	6.86
6.0	8.9	10.68	6.0	23.8	6.04	6.0	23.1	6.83
8.0	8.9	10.68	8.0	23.8	6.01	8.0	23.1	6.76
10.0	8.9	10.67	10.0	23.7	6.00	10.0	23.0	6.60

## **APPENDIX D**

### **Agency Correspondence**