RIVER FALLS MUNICIPAL UTILITIES
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VIA E-FILING January 29, 2021

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Docket Room
Washington, D.C. 20426-001

RE: River Falls Hydroelectric Project, FERC Project No. 10489
Updated Study Report

Dear Secretary Bose:

In accordance with 18 CFR § 5.15(f), the Licensee for the River Falls Hydroelectric Project, City of River Falls Municipal Utilities (RFMU or Licensee), files with the Federal Energy Regulatory Commission (FERC or Commission) the Updated Study Report (USR) for the River Falls Hydroelectric Project (Project) (FERC P-10489). This USR is being submitted in accordance with the FERC's Integrated Licensing Process (ILP) regulations and describes the Licensee's overall progress in implementing the Commission-approved study plan. This USR also provides an explanation of variances, if any, from the study plan and schedule approved by the FERC in their July 11, 2019 Study Plan Determination (SPD). The USR includes the results of the Decommissioning Plan and studies conducted during 2020, as follows:

- Hydrologic and Hydraulic Evaluation
- Water Quality Report
- Lake George Shoreline Habitat Assessment
- Mussel Survey
- Aquatic Invasive Species Survey
- Riverine Habitat Evaluation Below Powell Falls
- Recreation Use Assessment
- Archaeological Resources Survey
- Sediment Study
- Decommissioning Plan

In accordance with 18 CFR § 5.15(c), within 15 days following the filing of the USR, the Licensee must hold a meeting with participants and Commission staff to discuss study results. The Licensee will conduct the USR Meeting virtually on Tuesday, February 9, 2021 from 9 a.m. to 4 p.m. All interested agencies, Tribes, and stakeholders are invited to attend. The purpose of the USR Meeting is to provide an opportunity to review the contents of the USR and to discuss

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the study results and proposals, if any, to modify the study plan in light of the progress of the study plan and data collected.

If there are any questions or comments regarding the USR, please contact Kevin Westhuis at (715) 426-3442, or by email at kwesthuis@rfcity.org.

Sincerely,

Kevin Westhuis
Utility Director
City of River Falls Municipal Utilities
222 Lewis Street
River Falls, WI 54022

Attachment: Updated Study Report for the River Falls Hydroelectric Project (P-10489)

cc: Interested Parties Mailing List
Lesley Brotkowski, TRC

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UPDATED STUDY REPORT

RIVER FALLS HYDROELECTRIC PROJECT
FERC NO. 10489

SUBMITTED BY:

CITY OF RIVER FALLS MUNICIPAL UTILITIES
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PREPARED BY:

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JANUARY 2021

CITY OF RIVER FALLS MUNICIPAL UTILITIES

RIVER FALLS HYDROELECTRIC PROJECT

FERC NO. 10489

UPDATED STUDY REPORT

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LIST OF ACRONYMS

APE	Area of Potential Effects
Commission	Federal Energy Regulatory Commission
DLA	Draft License Application
DO	Dissolved oxygen
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
ILP	Integrated Licensing Process
ISR	Initial Study Report
kW	kilowatts
Licensee	River Falls Municipal Utilities
MSL	Mean sea level
NOI	Notice of Intent
PAD	Pre-Application Document
PAS	Planning Assistance to States
Project	River Falls Hydroelectric Project (FERC No. 10489)
PSP	Proposed Study Plan
RFMU	River Falls Municipal Utilities
RSP	Revised Study Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SDR	Supporting Design Report
SHPO	State Historic Preservation Office
SPD	Study Plan Determination
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USR	Updated Study Report
Wisconsin DNR	Wisconsin Department of Natural Resources

1.0 OVERVIEW

The City of River Falls Municipal Utilities (Licensee or RFMU) is the Licensee of the River Falls Hydroelectric Project (FERC No. 10489) (Project). The Project is licensed by the Federal Energy Regulatory Commission (FERC or Commission) as a two-development project. The two developments include the Junction Falls Development and the Powell Falls Development.

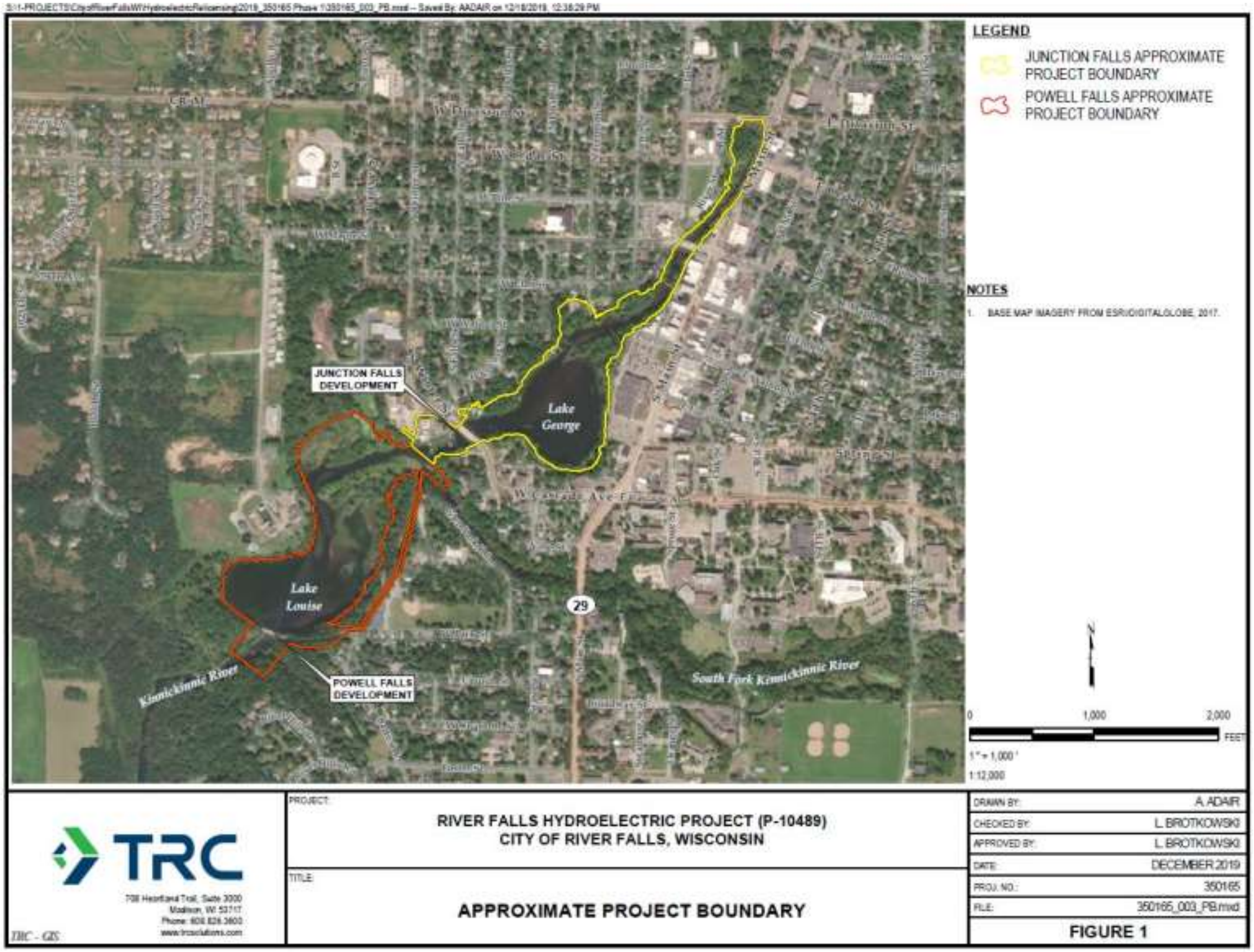
The FERC license expires on August 31, 2023. The Licensee declared its intent to apply for relicense of the Junction Falls Development and proposed the decommissioning of the Powell Falls Development with dam removal. The Licensee proposes to submit a decommissioning plan with the Final License Application in August 2021. The Licensee is using the FERC's Integrated Licensing Process (ILP) as established in regulations issued by FERC July 23, 2003 (Final Rule, Order No. 2002) and found at Title 18 CFR, Part 5. The Licensee filed a Pre-Application Document (PAD) and Notice of Intent (NOI) for the Project on August 30, 2018. FERC prepared and filed Scoping Document 1 (SD1) on October 25, 2018 and held two agency and public scoping meetings, one on November 15, 2018 and one on November 16, 2018. A visit to the Project was held on November 15, 2018. The FERC issued Scoping Document 2 (SD2) on February 7, 2019 and on February 11, 2019, the Licensee filed its Proposed Study Plan (PSP). The Licensee held a study plan meeting on March 13, 2019 and the Licensee filed its Revised Study Plan (RSP) on June 11, 2019. On July 10, 2019, the FERC issued a Revised Process Plan and Schedule for the River Falls Hydroelectric Project. On July 11, 2019 the FERC issued its Study Plan Determination (SPD). On January 30, 2020 the Licensee submitted the Initial Study Report (ISR). The Initial Study Report Meeting was held on February 13, 2020. Comments on the ISR and meeting summary were filed by Commission staff on March 27, 2020. RFMU submitted a Response to Stakeholder Comments on Initial Study Report on April 30, 2020 and FERC issued a Determination on Request for Study Modifications for the River Falls Hydroelectric Project on May 26, 2020.

The Licensee has conducted all required studies in accordance with 18 CFR § 5.15(c) and has prepared this Updated Study Report (USR). This USR describes the Licensee's overall progress with implementing study plans, schedules, data collection for second year study efforts including an explanation of variances from approved study plan.

1.1 Project Location and Area

The Project is located along the Kinnickinnic River in the City of River Falls, in Pierce County, Wisconsin (Figure 1). The approximate Project Boundary is divided into two portions, the Junction Falls Approximate Project Boundary and the Powell Falls Approximate Project Boundary. This distinction was made due to the proposed action for the Project (the Junction Falls Development is proposed to be relicensed and the Powell Falls Development is proposed to be decommissioned and dam removed). Upstream from the confluence with the St. Croix River, the Powell Falls dam is located at approximately river mile 9.9 of the Kinnickinnic River and the Junction Falls dam is located at approximately river mile 10.4. There are no federal or tribal lands within the Project Boundary.

Figure 1: Approximate FERC Project Boundary



1.2 Project Description

The Junction Falls Development consists of: (1) a 140-foot-long, 32-foot-high concrete dam; (2) an impoundment with a surface area of 15.5 acres; (3) a 200-foot-long, 6-foot-diameter penstock; (4) a powerhouse containing one generating unit rated at 250 kilowatts (kW); (5) a 50-foot-long transmission line; and (6) appurtenant facilities. The impoundment of the Junction Falls development, also known as Lake George, has a surface area of approximately 15.5 acres at the normal pool elevation of 865.3 feet mean sea level (MSL). The Junction Falls Development has one generating unit with an installed capacity of 250 kW.

The Powell Falls Development consists of: (1) a 110-foot-long, 16.5-foot-high concrete dam; (2) an impoundment with a surface area of 15.4 acres; (3) a powerhouse containing one generating unit rated at 125 kW; (4) a 2,500-foot-long transmission line; and (5) appurtenant facilities. The Powell Falls impoundment, also known as Lake Louise, has a surface area of 15.4 acres at the normal pool elevation of 821.8 feet MSL. The Powell Falls Development has one generating unit with an installed capacity of 125 kW.

Both developments are operated in a run-of-river mode.

1.3 Description of Process and Schedule of Study Conduct, Reporting, and Study Plan Modification

According to the revised process plan and schedule approved by FERC in a letter dated July 10, 2019, the Licensee is required to file its USR by January 30, 2021. Within 15 days of filing the report, the Licensee must conduct a USR meeting with the resource agencies, interested parties, and Commission staff and discuss 2020 study results and modifications to the study plan (18 CFR §5.15(c)(2)). The Licensee has scheduled the USR meeting for **Tuesday, February 9, 2021 from 9 a.m. to 4 p.m.** Due to continued precautions during the COVID 19 pandemic, this meeting will be held virtually. The Licensee must file a summary of the USR meeting by March 1, 2021 as outlined in the Revised Process Plan and Schedule issued by FERC on July 10, 2019, after which participants may file, by March 31, 2021, any disagreement concerning the USR meeting summary. Recommendations for modified or new studies must be accompanied by justification in accordance with FERC's regulations (18 CFR §5.15(c)(4)). The Licensee subsequently has 30 days to file any responses to comments and FERC will resolve any disagreements and/or modifications to the study plan within another 30 days.

As described in 18 CFR §5.15(d), any request to modify a study or request new studies must demonstrate that the approved study was not conducted as described in the approved study plan, was conducted under anomalous environmental conditions, or that environmental conditions have changed in a material way since the study plan's approval. As described in 18 CFR §5.15(e), any proposal for new information gathering or studies must accompanied by a showing of good cause why the proposal should be approved and must include, as appropriate to the facts of the case, a statement explaining: (1) Any material changes in the law or regulations applicable to the information request; (2) Why the goals and objectives of any approved study could not be met with the approved study methodology; (3) Why the request was not made earlier; (4) Significant changes in the project proposal or that significant new information material to the study objectives has become available; and (5) Why the new study request satisfies the study criteria in 18 CFR § 5.9(b).

1.4 Study Plan Implementation

The status of each of the studies approved in FERC's SPD is provided in Table 1. The Hydrologic and Hydraulic Evaluation was not specifically required by FERC in the SPD; however, the Licensee has chosen to conduct this study as the Licensee feels it will add pertinent information. The Licensee has conducted 11 studies at the time of this USR. Any schedule variances from the FERC-approved study plan are described in Section 2.0, by study.

Table 1: List of Relicensing Studies and Status

Study	Status
Hydrologic and Hydraulic Evaluation	Evaluation was conducted in 2020 and the report is provided in Appendix A.
Water Quality Study	The Interim report on the 2019 monitoring season is provided in Appendix A of the ISR. The updated study report on 2019 and 2020 monitoring seasons is provided in Appendix B.
Lake George Shoreline Habitat Assessment	Assessment was conducted in 2020 and the report is provided in Appendix C.
Mussel Survey	Mussel Survey was conducted in 2020 and the report is provided in Appendix D, filed under separate cover as a Privileged document.[1]
Aquatic Invasive Species Survey	Aquatic Invasive Species Survey was conducted in 2020 and the report is provided in Appendix E.
Wetland, Riparian, and Terrestrial Resources Survey	The Wetland, Riparian, and Terrestrial Resources Survey was conducted in 2019 and the report is provided in Appendix B of the ISR.
Riverine Habitat Evaluation below Powell Falls	The Riverine Habitat Evaluation was conducted in 2020 and the report is provided in Appendix F.
Recreation Facility Inventory and Recreation Use Assessment	Recreation Facility Inventory was conducted in 2019 and the report is provided in Appendix C of the ISR. Recreation Use Assessment was conducted in 2020 and the report is provided in Appendix G.

[1] Due to the confidential nature of the results, the details of the Mussel Survey are not provided in the public filing and the report is being filed as privileged.

Study	Status
Cultural Resources Study	The first phase of this study, Project Area of Potential Effects (APE) consultation, was conducted and is described in the ISR in Section 2.9. The record of Project APE consultation is provided in Appendix D of the ISR. The Architectural Resources Survey, was conducted in 2019 and the report is provided in Appendix E of the ISR. The Archaeology Resources Survey was conducted in 2020 and the report is provided in Appendix H.
Sediment Study	Sediment Study was conducted in 2020 and report is provided as Appendix I
Powell Falls Decommissioning Plan	The draft Powell Falls Decommissioning Plan was provided in Appendix F of the ISR. The revised Powell Falls Decommissioning and Dam Removal Study is provided as Appendix J.

The Licensee received 2020 study assistance from the U.S. Army Corps of Engineers' (USACE) Planning Assistance to States (PAS) Program. The USACE PAS Program is a program to assist states, eligible Native American Indian tribes, local governments or other non-federal entities in the preparation of comprehensive plans for the development, utilization, and conservation of water and related land resources.[2]

1.5 Variances from the FERC-approved Study Plan and any Proposed Modifications

Variances from the FERC-approved study plan are discussed individually, for each study, in Section 2 of this USR. At this time, the Licensee has not identified the need for any additional studies so no additional studies are proposed by the Licensee.

1.6 Updated Study Report Meeting

The Licensee has scheduled the USR Meeting for **February 9, 2021 from 9 a.m. to 4 p.m.** via Virtual Microsoft Teams Meeting. The meeting summary will be filed by the Licensee in accordance with the FERC Revised Process Plan and Schedule by March 1, 2021.

1.7 Studies Conducted

All studies were completed in 2020, as required by FERC in their SPD. The final study reports are provided in this USR.

[2] Additional information on the PAS Program may be found on the USACE website: https://www.nao.usace.army.mil/Business-With-Us/Flood-Plain-Management/PAS/

1.8 Draft License Application

In accordance with 18 CFR §5.16(c) and 18 CFR §5.18, the Licensee is electing to file a Draft License Application (DLA) in lieu of the Preliminary Licensing Proposal (PLP) with the Commission and distribute the DLA to the relicensing stakeholders on or before April 3, 2021.

2.0 UPDATED STUDY REPORTS

Provided below is an overview of each study and any variances from the FERC-approved study plan and schedule.

2.1 Hydrologic and Hydraulic Evaluation

The Hydrologic and Hydraulic Evaluation was not required by FERC in the SPD; however, the Licensee has chosen to conduct this study as will add pertinent information for compliance with the local floodplain ordinances are met as participants in the National Flood Insurance Program.

The Licensee had proposed in the RSP to conduct this study in 2019. In consultation with the USACE regarding the PAS program, it was determined that the USACE had staff that specialize in Hydrologic and Hydraulic Evaluations. This study was delayed until 2020 to take advantage of USACE staff expertise by completing this evaluation under the PAS Program. The Hydrologic and Hydraulic Evaluation was completed in 2020 and the report is provided as Appendix A.

2.2 Water Quality Study

Water quality data collection was initiated in 2019, beginning in mid-July and ending in mid-September. The interim report describing the 2019 monitoring season is provided in the ISR as Appendix A. In response to Wisconsin DNR comments on the ISR, the Licensee agreed to modify the water quality monitoring protocols by adding one transect of dissolved oxygen (DO) and water temperature profiles across Lake George and to measure DO downstream with a handheld monitor if levels were observed to drop below 6 mg/L. In 2020, water quality monitors were deployed from May 15 to September 30, except for an interval in early July after a large flood event destroyed or displaced all of the monitoring instrumentation. The second season of monitoring was completed in 2020 and the report is provided in Appendix B.

Data gaps occurred due to the public tampering with the instrumentation at some locations both in 2019 and 2020 and the June 28 – 29, 2020 flood event. Due to the flood, no continuous data are available between June 19 (the date of the last download visit) and July 17, 2020 when instruments were being replaced.

2.3 Lake George Shoreline Habitat Assessment

The Lake George Habitat Assessment was conducted in July 2020 and the assessment is provided as Appendix C. There are no variances to the study plan described in the Licensee's RSP and approved by FERC in the SPD.

2.4 Mussel Survey

FERC required a mussel study in the SPD, stating that the survey should be conducted after consultation with the U.S. Fish and Wildlife Service (USFWS) and Wisconsin DNR on the locations and methodology to implement the mussel survey. The SPD stated the results of the mussel survey, including documentation of consultation with the agencies, should be included in the ISR. Due to the timing of the issuance of the SPD in the middle of the field season, the Licensee was not able to coordinate study implementation for 2019. This study was scheduled for 2020 after consultation with the agencies regarding study methodology and locations. The survey was conducted in July and August 2020. The report is marked as confidential and therefore is being filed under separate cover as a Privileged document as Appendix D.

2.5 Aquatic Invasive Species Survey

The Aquatic Invasive Species Survey was conducted in July 2020 and the report is provided in Appendix E. There are no variances to the study plan described in the Licensee's RSP and approved by FERC in the SPD.

2.6 Wetland, Riparian, and Terrestrial Resources Survey

The Wetland, Riparian, and Terrestrial Resources Survey was conducted in September 2019 and the report is provided as Appendix B in the ISR. An updated report was included with the ISR Meeting Summary as Appendix B, filed with FERC on February 28, 2020. The updated report included revised Figures 2 and 3 to provide clarification on vegetation cover types and invasive botanical species.

2.7 Riverine Habitat Evaluation Below Powell Falls

The schedule for the Riverine Habitat Evaluation Below Powell Falls varied from the study plan approved by FERC with modifications as described in the Licensee's RSP and FERC's SPD. In the study plan, it was stated that the desktop evaluation and field work will be performed in 2019. The Riverine Habitat Evaluation below Powell Falls Desktop Evaluation Summary was conducted in 2019 and provided in Appendix B of the February 28, 2020 ISR Meeting Summary. Field work, however, was delayed. The field work associated with this study was scheduled for October 2019, when it was confirmed by field staff that water levels were too high to safely and accurately conduct this study. The field staff demobilized and monitored water levels, but high water levels persisted, followed by cold temperatures, which continued to render 2019 field conditions unsafe. The Licensee proposed that the Riverine Habitat Evaluation below Powell Falls be conducted in

2020 under normal flow conditions. The Riverine Habitat Evaluation was conducted in 2020 and the report is provided in Appendix F. No other modifications to the study plan occurred.

2.8 Recreation Facility Inventory and Recreation Use Assessment

The Recreation Facility Inventory was conducted in September 2019 and the report is provided in Appendix C of the ISR. The Recreation Use Assessment was conducted in 2020 and the report is provided in Appendix G. This study included schedule and methodology variances from the RSP. The Recreation Use Assessment was scheduled to begin Memorial Day weekend in 2020 but was delayed until June 27, 2020 due to delays caused by the COVID-19 pandemic and the State of Wisconsin Department of Health Services Emergency Order #28, Stay at Home Order. One survey day was added in September to maintain a total of 15 survey days. The RSP defined spot counts as short duration counts to be used as a snapshot of recreation use at each survey location. The Recreation Use Assessment defined spot counts as a tally of observed recreation use within three survey areas, with two one-hour counts occurring at each area. The RSP called for survey dates to be randomly selected; however, actual survey dates were grouped and scheduled ahead of time to accommodate the surveyors travel schedule from out of state.

2.9 Cultural Resources Study

As described in the study plan approved by FERC with modifications as described in the Licensee's RSP and FERC's SPD, the first objective of the Cultural Resources Study was to determine the Project APE in consultation with the State Historic Preservation Office (SHPO) and interested Tribes. On October 2, 2019, the Licensee sent a letter to the SHPO and Tribes requesting review and comment on the proposed Project APE. The SHPO replied in a letter dated October 10, 2019 stating that they concur with the proposed Project APE. No other responses were received. The Project APE consultation record is provided in Appendix D of the ISR.

The second phase of this study, the Architectural Resources Survey, was completed in 2019. The field work associated with the Architectural Resources Survey was conducted during November 2019. The Architectural Resources Survey Report is provided as Appendix E of the ISR.

The Archaeology Resources Survey was originally scheduled to occur in 2019. In consultation with the USACE regarding the PAS program, it was determined that this survey could be conducted under the PAS Program. The Archaeology Resources Survey was conducted in July 2020 and the report is provided in Appendix H. No other modifications to the study plan occurred.

2.10 Sediment Study

FERC required a sediment study in the Determination on Request for Study Modifications. The study was conducted in 2020 and the results are provided in Appendix I. Part 1 of this report, "Kinnickinnic River Sediment Analysis for Proposed Powell Falls Dam Removal" addresses

Objective 1 of the FERC study request. Part 2 of this report, the "Powell Falls Dam Removal Sediment Study Ecological Risk Assessment" addresses Objective 2 of the FERC study request.

2.11 Powell Falls Decommissioning Plan

The draft Powell Falls Decommissioning Plan was provided in Appendix F of the ISR. The Powell Falls Decommissioning Plan was revised to incorporate comments and questions on the draft included in the ISR and presented at the ISR meeting by FERC and stakeholders. The revised Powell Falls Decommissioning Plan is provided in Appendix J.

A large flood in 2020 damaged the existing Powell Falls dam and Lake Louise was drawn down in October 2020 for a dam safety inspection. On December 22, 2020, RFMU filed the Post-Flood Dam Safety Inspection and Repair Options Letter for Powell Falls with FERC. The report outlined five action options following the dam safety inspection. These options were presented at a Joint Workshop with the Common Council and Utility Advisory Board on January 19, 2021. Following this discussion, RFMU plans to pursue decommissioning and removal of the Powell Falls Development from the FERC license. RFMU plans to submit an amendment application to FERC to decommission the Powell Falls Development, which will include maintaining the drawn down condition of Lake Louise, a physical disconnection from the utility grid (pulling breakers, locking out equipment controls), and improving flow management by removing the turbine and improving sluice gate operation, but otherwise leaving the facilities in place. RFMU will pursue dam removal under state jurisdiction after the amendment application to decommission and remove the Powell Falls Development from the FERC license is approved by the Commission.

Due to the circumstances described above (flood, associated damage to the dam, and decision to decommission and remove the Powell Falls Development from the FERC license and remove the dam through the state process), the revised Powell Falls Decommissioning Plan does include variances from the study plan described in the Licensee's RSP and approved by FERC in the SPD. The study methodology in the RSP includes the generation of a supporting design report (SDR), as described in section 4.41(g)(3) of the Commission's regulations, to be included with the Decommissioning Plan. As the dam will not be removed through the FERC process, a SDR has not been prepared. The dam removal is expected to be regulated and reviewed by the Wisconsin DNR Dam Safety Program dam safety engineers. During the transition period from FERC dam safety jurisdiction to Wisconsin DNR dam safety jurisdiction, the Licensee proposes to 1) keep the impoundment drawn down, 2) pull the turbine to increase flow capacity, 3) sandbag the right abutment to reduce the risk of continued bedrock erosion, 4) clean the trashrack to improve flow capacity, and 5) repairing the gate and operator to allow dam operations to minimize the rate of drawdown (lake "bounce") after flood events.

The RSP approved by FERC in the SPD also included the development of a sediment management plan. The draft Powell Falls Decommissioning Plan outlined sediment management for a future drawdown of Lake Louise, but this step was taken earlier than expected in order to conduct a dam safety evaluation. The Licensee will continue to manage sediment by minimizing impoundment water elevation "bounce," adaptively working with the Wisconsin DNR dam safety engineers on options to manage sediment releases that occur prior to dam removal, remove tailrace sediment, and seed the dewatered lakebed.

The Decommissioning Plan will be used as a study on decommissioning and dam removal options, which outlines overall removal goals, considers lessons learned at other nearby dam removals, and describes risks associated with dam removal so that regulatory agencies and stakeholders understand the potential impacts of the project. The Decommissioning Plan as drafted will not be submitted to FERC for approval of dam removal activities, as RFMU plans to purse dam removal through the Wisconsin DNR.

Appendix A – Hydrologic and Hydraulic Evaluation

Kinnickinnic River, Wisconsin

Hydraulic and Hydrologic Analysis

River Falls Hydroelectric Project

Planning Assistance to States (PAS)

January 2021

US Army Corps of Engineers®

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Date	Version	Principal Author	Reviewer	Review Type/Comments
8/15/2020	1	Pat Dowd, EIT, USACE MVP	Garrett Blomstrand, PE, USACE MVP Charles Boyd, PE, USACE MVP	Draft Report for DQC Comments
10/9/2020	2	Pat Dowd, EIT, USACE MVP	Garret Blomstrand, PE, USACE MPV Charles Boyd, PE, USACE MVP	Draft Report incorporating DQC Comments
11/30/2020	3	Pat Dowd, EIT, USACE MVP Grant Halvorson, EIT, USACE MVP	Garret Blomstrand, PE, USACE MPV Charles Boyd, PE, USACE MVP	Draft Report Incorporating DQC Back-Check Comments and Climate Assessment
12/17/2020	4	Pat Dowd, EIT, USACE MVP Grant Halvorson, EIT, USACE MVP	Garret Blomstrand, PE, USACE MPV Charles Boyd, PE, USACE MVP	Draft Report Incorporating Additional DQC Back-Check Comments and Climate Assessment
12/22/2020	5	Pat Dowd, EIT, USACE MVP Grant Halvorson, EIT, USACE MVP	Lesley Brotkowski, TRC Environmental Ellen Faulkner, PE, Ayres Associates Kevin Westhuis, City of River Falls Municipal Utilities	Draft Report for Review by Local Sponsor
01/14/2021	6	Pat Dowd, EIT, USACE MVP		Final Report

DQC – District Quality Control (U.S. Army Corps of Engineers)
EIT – Engineer In Training
MVP – St. Paul District (U.S. Army Corps of Engineers)
PE – (Registered) Professional Engineer
USACE – U.S. Army Corps of Engineers

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1 Purpose and Scope of Work

1.1 Background

The City of River Falls Municipal Utilities (RFMU) currently owns and operates two hydroelectric dams along the Kinnickinnic River in River Falls, WI. Known as Junction Falls and Powell Falls, these hydroelectric dams are licensed by the Federal Energy Regulatory Commission (FERC) under the River Falls Hydroelectric Project (License No. 10489). RFMU is currently going through the relicensing process with FERC, as this license expires on August 31, 2023, (Reference 1). Both Junction Falls and Powell Falls are included in the National Inventory of Dams (NID) under NID IDs WI00021 and WI00079, respectively, (Reference 2).

When declaring their Notice of Intent to relicense the River Falls Hydroelectric Project, RFMU proposed only relicensing Junction Falls, while decommissioning Powell Falls and removing the dam, (Reference 1). Declaring the Notice of Intent began the relicensing process, which resulted in the development and filing of a Proposed Study Plan, which responded to additional information requests, proposed certain studies, and provided a rationale for why RFMU did not propose certain studies requested by stakeholders. Following a stakeholder comment period, RFMU submitted a Revised Study Plan (RSP). (Much greater detail on the development of the RSP is available in the document itself, (Reference 2)).

Section 6 of the RSP outlines the individual studies proposed by RFMU to analyze the potential effects of the continued operation of Junction Falls dam and the proposed decommissioning and removal of Powell Falls dam. Section 6.1 specifically describes the proposed Hydrologic and Hydraulic Analyses, with the objective of developing an analytical tool and hydrologic inputs that can be used to predict streamflow characteristics under the proposed project conditions. The goal for this study is that it will better inform stakeholders interested in balancing floodplain risk management with the beneficial use of the Kinnickinnic's riparian resources. The study will also help River Falls in meeting Wisconsin's floodplain management regulations, as they require floodplain zoning to be consistent with the existing hydraulic geometry in an area. Dams, for example, are a significant feature in a river's hydraulic geometry that affect how water flows through its channel; removing one would change the river's geometry, and potentially alter how water moves through the system. Additionally, as a participant in the National Flood Insurance Program, the City will eventually need to provide technical analysis supporting a Letter of Map Revision (LOMR) when Powell Falls dam is removed, (Reference 1).

1.2 Previous Studies

The Federal Emergency Management Agency's (FEMA) Flood Insurance Study (FIS) for Pierce County, WI, (where River Falls is located), outlines the results of hydrologic and hydraulic analyses conducted in 2002 to support floodplain zoning in the City of River Falls. The FIS, published in 2011, lists flow rates associated with the 10%, 1%, and 0.2% annual exceedance probability (AEP) floods, and presents water surface elevation profiles associated with each of those flood events for the reach of the Kinnickinnic River that flows through River Falls. At the time that the RSP was developed, the location of the Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) model, (used to support the hydrologic analysis for the FIS), was unknown.

The RSP, (Reference 2), made a point to mention that the hydrologic and hydraulic models used in FEMA's FIS for River Falls would not include current estimates of rainfall frequency, the river geometry associated with the dam removal, or comparisons to known peak streamflows at the downstream U.S. Geological Survey (USGS) gage on the Kinnickinnic River near River Falls, WI, (USGSG gage 05342000). The gage along the Kinnickinnic currently has 24 years of data, with a systematic period of record that includes October 1916 to September 1921 and July 2002 to present, (Reference 5).

The engineering consulting firm Short, Elliot, and Hendrickson (SEH) conducted a hydraulic analysis of the Kinnickinnic River with hypothetical, post-removal conditions in conjunction with the dam removal feasibility studies. When conducting the analysis, however, SEH assumed that both Powell Falls dam and Junction Falls dam would be removed; this is reflected in their Hydrologic Engineering Center – River Analysis System (HEC-RAS) model and their technical memo on the study, (Reference 6). SEH also included updated precipitation frequency values using the National Oceanic and Atmospheric Administration's (NOAA) *Atlas 14*, (Reference 7), and updated channel geometry near both dams, informed by sediment studies conducted by another engineering consulting firm, Inter-Fluve, in 2016, (Reference 8). In their study, however, SEH opted to use flood frequency flows outlined in FEMA's FIS for Pierce County. This was primarily due to a lack of an adequate hydrologic model at the time.

1.3 Hydrologic Analysis Scope of Work

The hydrologic analysis proposed within the Revised Study Plan (RSP), (Reference 2), focuses on developing an updated flood frequency analysis for the Kinnickinnic River through the use of a variety of methods. These methods include:

- Applying the methods outlined within the USGS's *Guidelines for Determining Flood Flow Frequency – Bulletin 17C*, (Reference 9), to develop a flood frequency curve for the USGS on the Kinnickinnic River, 05342000, located 4.8 miles downstream from Powell Falls dam, (Reference 5).
- Retrieving, (if possible), the HEC-HMS model used for FEMA's FIS for the Kinnickinnic River, (Reference 4). The HEC-HMS model would then be used in conjunction with the 24-hour, 1% AEP precipitation depth specified in the National Oceanic and Atmospheric Administration's (NOAA) *Atlas 14* and using the MSE-3 distribution, (Reference 7).
- Applying the 2019 USGS flood frequency regression equations for WI, (Reference 10).

1.4 Hydraulic Analysis Scope of Work

The hydraulic analysis proposed within the RSP, (Reference 2), focuses on reviewing and refining the HEC-RAS model developed by SEH in their 2017 study, (Reference 6). To approximate the water surface profiles for the channel and overbank areas following the hypothetical removal of Junction Falls and Powell Falls dams, the model incorporates the refusal area identified by Inter-Fluve in their 2016 sediment assessment, (Reference 7). The RSP outlined how the HEC-RAS model would need to be updated and reviewed, including:

- Adding Junction Falls dam back into the model. (SEH's study assumed that both dams were removed).
- Reviewing the model's input geometry data and site conditions to determine whether a topographic survey of the channel and bedrock near Powell Falls, prior to dam removal, will support significant model improvements.
- If judged to be beneficial during the step above, conducting a topographic and bathymetric survey on the downstream side of Powell Falls dam and incorporating the survey geometry into the HEC-RAS model.

Once complete, the HEC-RAS model will be used to calculate water surface elevations, velocities, depths, and wetted top widths for several flow conditions, including: a typical summer low flow, and the 50%, 10%, and 1% AEP floods. The information generated by this model will be utilized in submittals related to floodplain zoning and the National Flood Insurance Program (NFIP). The submittal of this information will be deferred until the decommissioning process is underway though, which is expected to occur in 2025 or 2026.

During initial coordination on this project between the Project Management and Hydraulic & Hydrologic Engineering Branches of the U.S. Army Corps of Engineers' (USACE) St. Paul District, it was determined that current funding levels would not allow for topographic and bathymetric surveying of the downstream side of Powell Falls dam. Due to this, this task was not conducted as part of this study, but may be recommend as part of a future analysis.

1.5 Climate Change Assessment

Although not included in the scope of work outlined in the RSP, (Reference 2), USACE guidance requires qualitative climate change assessments to be included with every hydrologic analysis that supports planning and engineering decisions that have an extended decision time frame. Due to this, the USACE has included a climate assessment with this analysis, Appendix 1.

2 Watershed Information

2.1 General Information

The Kinnickinnic River (Kinni) watershed is located in west central Wisconsin, approximately 30 miles east from the center of the Minneapolis-St. Paul metro area. The watershed drains 172 square miles across Pierce and St. Croix Counties, and encompasses the entirety of the USGS's Hydrologic Unit Code (HUC)-10 watershed 0703000511, (Reference 11). The watershed is dominated by agriculture (57%), grassland (22%), and forest (17%), with approximately 2% of the watershed consisting of wetlands and lakes, (Reference 12). The Kinni begins its journey as the culmination of flows from several intermittent, spring-fed streams, approximately 16 miles northeast of River Falls, WI. The Kinni then flows 26 miles southwest, through the center of River Falls, discharging as the last major tributary to the St. Croix River at Kinnickinnic State Park, approximately halfway between Prescott, WI and Hudson, WI. The average slope of the Kinni is approximately 10 feet/mile with middle portions of the river being flatter. Elevations in the watershed vary from 1,205 feet NAVD 88, in the upper portions of the watershed, to 680 feet NAVD 88 at its confluence with the St. Croix. The Kinni is classified as a Class I trout stream and is very popular for fishing and kayaking. Plate 1 shows the location of the Kinnickinnic River.

2.2 Geodesy used in Study

The North American Vertical Datum (NAVD) 88 was used as the vertical datum throughout the study. The North American Datum (NAD) 83 was used throughout the study as the horizontal datum, with the Central Zone of Wisconsin's State Plane Coordinate (SPC) system 83 used as the projection for mapping and calculating areas.

2.3 Geomorphological Setting

The Kinni is located in a unique geomorphological setting for Wisconsin, containing the only true prairie potholes in the state, (Reference 12). The Environmental Protection Agency's Level IV Ecoregions map of the United States highlights the watershed's distinctiveness, showing it as falling entirely within the small and only portion of Wisconsin that is defined as ecoregion 47g, the Prairie Pothole Region, or the Lower St. Croix and Vermillion Valleys of the Western Corn Belt Plains, (Reference 13). This ecoregion is characterized by,

> "Smooth to undulating topography, productive prairie soils, and loess- and till-capped dolomite bedrock. The potential natural vegetation is predominantly tall grass prairie with a gradual transition eastward to more mixed hardwoods, distinguishing 47g from the greater concentration of mixed hardwoods of both 51a to the north and 51b to the east, and the mixed prairie and oak savanna of 52b to the south," (Reference and 14).

The geology of the Kinnickinnic River basin consists of loess and glacial till deposited as moraines during the Quaternary Period. The soil overlies Ordovician bedrock, with the depth to bedrock ranging from 0 to 50 feet. The glacial till consists of unstratified clay, silt, sand, gravel, and boulders. The uppermost bedrock units include Galena Dolomite, Decorah Shale, and Platteville Limestone ranging from 0 to 115 feet thick. Below these units lies St. Peter Sandstone, ranging in thickness from 0 to 200 feet, (Reference 15).

2.4 Climatological Setting

Most of the Kinnickinnic River basin is located within the warm summer, humid continental Köppen climate type, characterized by warm summers with ample rainfall, and cold to frigid winters with moderate snowfall, (Reference 16). Average monthly temperatures in River Falls, WI vary from a minimum of 13.3 degrees Fahrenheit (°F) in January to a maximum of 70.3 °F in July. Average monthly precipitation ranges from a minimum of 0.7 inches in January to a maximum of 4.75 inches in August, (Reference 17). Figure 2-1 below shows a climatograph depicting typical monthly temperatures and average cumulative precipitation depths for River Falls. Precipitation that falls during the months of November through March is typically snow. However, snow has the potential to begin accumulating as early as October and fall as late as April. The closest snow recording station to River Falls is located in Baldwin, WI, (USC00470486), where average annual snowfall is 44.8 inches, (Reference 18).

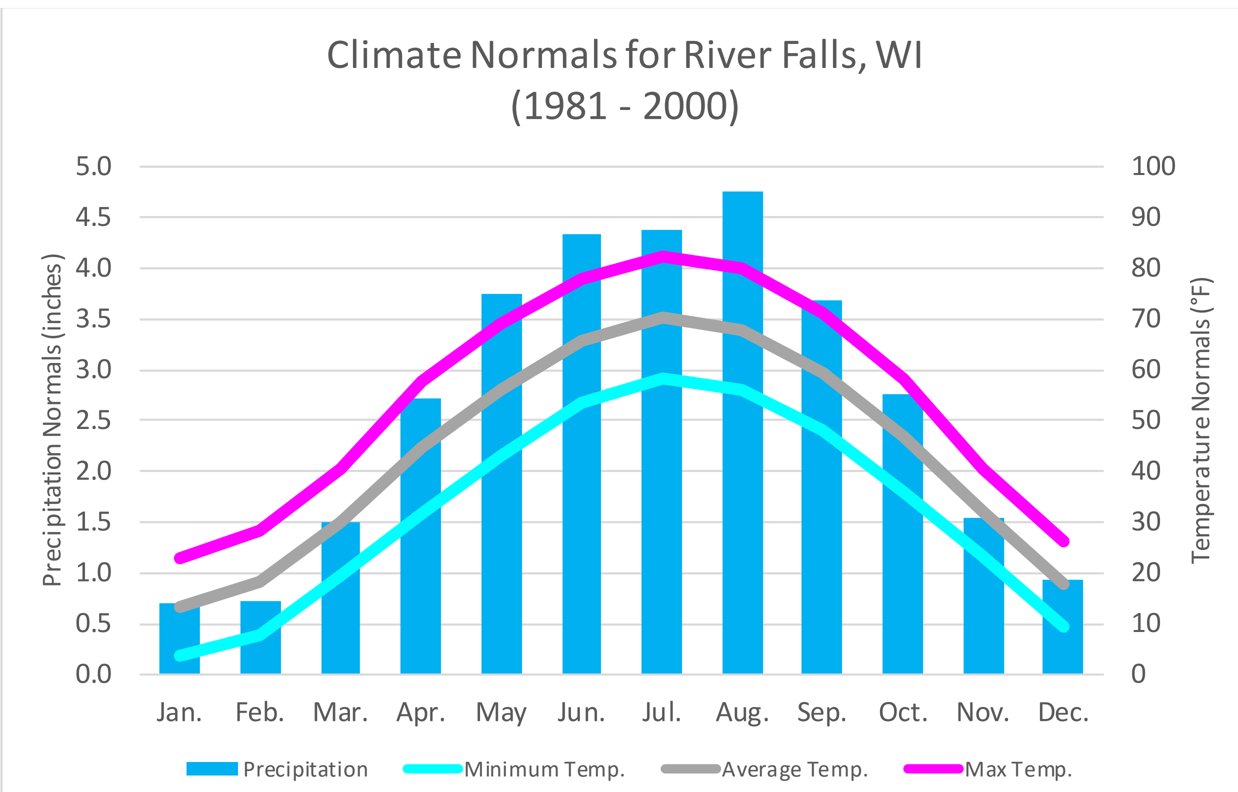


Figure 2-1. Climate Normals for River Falls, WI, (Reference 17)

NOAA's *Atlas 14* provides precipitation depth-duration-frequency curves for the entire United States. Figure 2-2 depicts the depth-duration-frequency curves for River Falls for the full ranges of storm durations, precipitation depths, and corresponding annual percent chance exceedance probabilities included in *Atlas 14*. Table 2-1 summarizes the estimated precipitation depths associated with the 24-hour storm and several annual percent chance exceedance probabilities.

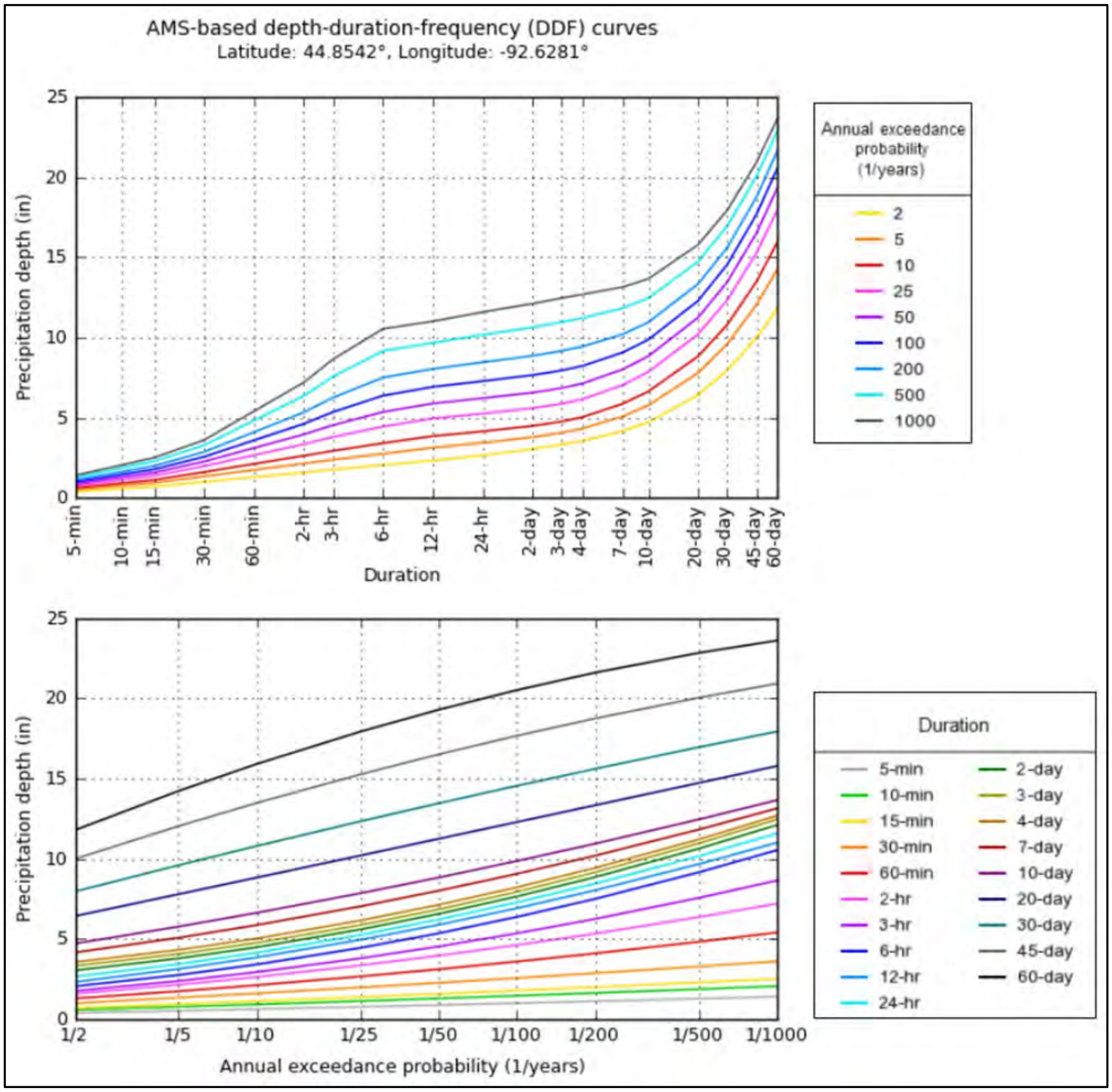


Figure 2-2. Annual Maximum Series-Based Depth-Duration-Frequency Curves for River Falls, WI, (Reference 7)

Table 2-1. Precipitation Depth Estimates for a 24-Hour Storm Duration for Varying Annual Percent Chance Exceedance Probabilities, (in inches), with 90% Confidence Intervals, (Reference 7).

Duration	Annual Percent Chance Exceedance Probability					
	50%	10%	2%	1%	0.5%	0.2%
24-hr	2.65 (2.20-3.23)	4.15 (3.41-5.07)	6.22 (4.86-8.01)	7.28 (5.48-9.52)	8.46 (6.09-11.3)	10.2 (7.02-13.8)

2.5 Flooding

Upon examining the annual maximum series of peak flows recorded by the USGS gage on the Kinnickinnic River, (05342000), it is apparent that there are at least two types of meteorological events that can result in flooding; intense rainfall brought by thunderstorms during the summer months and the rapid melting of snow during the spring. It is likely that rain on snow during the spring is another flood inducing event, but it is difficult to discern this from the streamgage record alone. Table 2-2 displays the annual peak streamflows recorded at the USGS's gage on the Kinni. Note that the annual maximum from 2020 was provided only as provisional data, subject to revision, at the time of this study; it is considered important to include in this study, however, as it would represent the largest flood ever recorded by this stream gage, and occurred after 6 inches of rain fell during a summer thunderstorm, (Reference 19).

The floods of 1894, 1934, and 1965 predate the installation of the USGS gage on the Kinnickinnic River, but are the most significant floods noted in the historical record. The flood of 1894 followed 8.0 inches of rainfall over 24 hours in mid-May. Thought to be the greatest flood ever recorded in the watershed, the 1894 flood washed out the Maple Street bridge, as well as the Prairie Mill dam and the Junction Falls dam, (Reference 20). Two floods occurred in 1934; the first in April when a rapid rise in temperature accompanied by 3.0 inches of rain quickly melted snow, and the second in September when 4.0 inches of rain fell in River Falls, with considerably more rain further up the watershed. 7.37 inches of rain fell in River Falls on June 1, 1965, with even more precipitation falling further up the watershed, (Reference 21).

Flow estimates for the three historical floods were made in a 1976 report by Roger Swanson, PhD, then an Associate Professor of Plant & Earth Science at the University of Wisconsin – River Falls, (Reference 21). Professor Swanson did this by calculating a flow-frequency curve for the County Road MM Bridge (Powell Avenue), and then equating the flood stages observed at that location to estimated discharges using that curve. In that report, he states that the 1934 and 1965 events were approximately 2% and 1% AEP events, and that the 1894 event "must have had a recurrence interval in excess of 200 years," or had an AEP <0.5%, (Reference 21). As the 1976 report includes an estimate for the 0.2% event, it's assumed that flow for the 1894 event was above his estimate for the 0.5% event and below that of the 0.2% event.

The University Archives and Area Research Center at the University of Wisconsin – River Falls has additional information on these floods, including photographs. As the methods used for estimating the stage of these historical floods in the 1976 study are somewhat ambiguous, it may be possible to determine better estimates for the discharges associated with these floods by examining the photos and personal accounts available through the archives, and then correlating those to a hydraulic model. Conducting this thorough of an analysis of historical flooding of the Kinnickinnic River was outside the scope of this study, however. Figure 2-3 and

Figure 2-4 show photos taken of the 1894 and 1934 floods, respectively, that were available on the website for the University Archives and Area Research Center, (Reference 22).

Table 2-2. Annual Peak Streamflow Measurements for Every Water Year on Record for the USGS's Gage on the Kinnickinnic River, (05342000), (Reference 5)

Water Year	Date	Gage Height (feet)	Streamflow (cfs)
1917	Mar. 27, 1917	5.67	1,970
1918	Jun. 05, 1918	6.60	3,080
1919	Mar. 12, 1919	7.00	3,560
1920	Mar. 15, 1920	7.98	4,760
1921	Jun. 14, 1921	5.35	410
2002	Aug. 21, 2002	12.53	774
2003	Jun. 25, 2003	15.05	2,130
2004	Mar. 02, 2004	11.31	516
2005	Mar. 06, 2005	12.84	1,120
2006	Mar. 30, 2006	12.06	842
2007	Mar. 13, 2007	15.21	2,490
2008	Mar. 14, 2008	10.92	360
2009	Aug. 08, 2009	13.69	1,560
2010	Aug. 11, 2010	17.98	4,340
2011	Jun. 22, 2011	12.56	997
2012	Jun. 20, 2012	12.23	718
2013	Jun. 26, 2013	13.37	1,380
2014	Jun. 01, 2014	15.68	2,180
2015	Jul. 06, 2015	17.84	3,100
2016	Jul. 05, 2016	12.69	909
2017	May 29, 2017	13.32	1,230
2018	Aug. 24, 2018	12.24	745
2019	Apr. 17, 2019	18.02	3,160
2020	Jun. 29, 2020	21.00	6,300

Table 2-3. Historical Flood Estimates for the Kinnickinnic River at River Falls, WI, (Reference 21)

Flood	1976 AEP Estimates (%)	Discharge Estimate at County Road MM (cfs)
May 15, 1894	<0.5	8,900 – 9,900
April 5, 1934	1	8,600
June 1, 1965	2	7,200

Figure 2-3. Photograph of the Former Site of the Maple Street Bridge during the 1894 Flood, (Reference 22)

Figure 2-4. Photograph of an Unknown Location in Downtown River Falls during the 1934 Flood, (Reference 22)

3 Climate Change Analysis

3.1 Background

An underlying assumption in conducting a hydrologic analysis is that climatic conditions have remained stable within the watershed being analyzed for the duration of the period or record. Due to the existence of climate change, this assumption may or may not be true, and it is USACE policy to verify it by conducting a climate assessment. If the assumption of stationary hydrologic conditions is found to be false, then the hydrologic analysis is adjusted accordingly.

Two documents outline the USACE's current procedures for conducting a climate assessment: these include the USACE's Engineering and Construction Bulletin (ECB) 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects*, (Reference 23), and the USACE's Engineering Technical Letter (ETL) 1100-2-3, *Guidance for Detection of Nonstationarities in Annual Maximum Discharges,* (Reference 24). In accordance with these two documents, the USACE conducted a qualitative climate assessment of hydrologic conditions for the Kinnickinnic River watershed in conjunction with the main River Falls Hydroelectric study. The full climate assessment is included with this document as Appendix 1, with key points summarized in Section 3.2.

3.2 Summary

An extensive review of climate change literature demonstrates consensus among the scientific community that average temperatures have increased in the region encompassing the Kinnickinnic River watershed and that heavy precipitation events have become increasingly frequent and intense. These trends are projected to continue into the future. This same literature review, however, showed a lack of consensus on if and how peak streamflows have changed over the same period, and how they may change in the future.

A first order statistical analysis of observed annual peak streamflow records at two USGS gages in the vicinity of the Kinnickinnic River watershed found no statistically significant trends or nonstationarities. A third site analyzed exhibited evidence of nonstationarity, but the cause of what is driving the shifts in statistical properties there is unclear. Additionally, an analysis of projected, peak streamflows within the St. Croix River watershed did not show a statistically significant trend through the end of the 21st century. A screening level vulnerability assessment carried out for the St. Croix River watershed did not indicate that the area is particularly vulnerable to the impacts of climate change in terms of high flow conditions.

Taking the entirety of the climate assessment into account, the hydrologic analysis for this study was not altered. Although temperature and precipitation have changed over time, the remaining statistics describing hydrologic conditions within the region, particularly peak streamflow, either appear stable or there is a lack of consensus on if they have changed.

4 Hydrologic Analysis

4.1 Basin Delineation

The HEC-RAS model created by SEH for their 2017 study includes three cross-sections for steady-state flow inputs, (Reference 6). To aid in updating the discharge estimates for these three locations, the HEC-RAS model was georeferenced using version 2.3 of Esri's ArcGIS Pro software, (Reference 23), the Kinnickinnic Rivers centerline shapefile available through the USGS's National Hydrography Dataset, (Reference 26), and the "World Imagery" basemap available in ArcGIS Pro. Once the steady-state flow input locations were determined, the following datasets and tools were used to determine the drainage areas and longest flow-paths for each of the three flow input locations, as well as the USGS gage on the Kinnickinnic River:

- The Kinnickinnic River watershed boundary, (Reference 11)
- The Kinnickinnic River's HUC-12 subwatershed boundaries, available in the USGS's National Watershed Boundary Dataset, (Reference 11)
- The "USA Topo Maps" basemap (available in ArcGIS Pro)
- The USGS's 1 arc-second digital elevation model, (Reference 27), in conjunction with ArcGIS Pro's Watershed Tool and Spatial Analyst+ Toolbox, (Reference 28)
- The Kinnickinnic River's stream centerline, available in the USGS's National Hydrography Dataset, (Reference 26)

Plate 1 is a map depicting the Kinnickinnic River, its watershed boundary, the three steady-state flow input locations, the location of the USGS gage on the Kinnickinnic River, the locations of Powell Falls and Junction Falls, and the outlines of the four watersheds determined through the process described in the previous paragraph. It should be noted that utilizing the USGS's StreamStats tool for this process was attempted, (Reference 29), but the results did not agree well with known watershed information. For example, the USGS states that the Kinnickinnic River gage has a drainage area of 165 square miles, (Reference 5). However, the StreamStats tool determined a drainage area of 148 square miles, approximately a 10% difference. Table 4-1 shows the drainage areas and main channel slopes determined through ArcGIS Pro for the HEC-RAS model's three flow input locations and the USGS gage on the Kinnickinnic River.

Table 4-1. Watershed Characteristics Associated with the HEC-RAS Model's Flow Input Locations and the USGS Gage on the Kinni

Location	HEC-RAS Model Cross-Section	Drainage Area, A (square miles)	Main Channel Slope (feet/mile)
Upstream of State Route 35	RS-71222	102.9	7.020
Upstream Junction Falls Dam	RS-66059	112.8	6.898
Upstream of Powell Falls Dam	RS-53219	134.8	6.814
USGS Gage 05342000	N/A	162.5	9.896

4.2 Soil and Land Use Characteristics

Average saturated hydraulic conductivity (K_{sat}) is often used as a proxy for how quickly precipitation can infiltrate the soil in a watershed. Soils with higher infiltration rates typically produce less direct runoff than soils with lower infiltration rates do. K_{sat} values were determined for each of the drainage areas, (defined in Section 4.1 of this report), using the Natural Resource Conservation Service's (NRCS) Soil Survey Geographic Database (SSURGO), available through the U.S. Department of Agriculture's (USDA) Web Soil Survey tool, (Reference 30). After importing shapefiles for each of the subbasins into the Web Soil Survey tool to define the "Area(s) of Interest", the following parameters were chosen to extract K_{sat}:

- Aggregation Method = Weighted Average
- Tie Break Rule = Fastest
- Layer Option = Surface Layer

Once the Web Soil Survey tool is run it creates a report that defines every type of soil found within the defined "Area of Interest", the number of acres defined as each soil type, and the K_{sat} values associated with each soil type. Using the generated reports, an area-weighted average K_{sat} value was determined for each subbasin.

Table 4-2. Area-Weighted Average Saturated Hydraulic Conductivity Values for Each Subbasin

Location	HEC-RAS Model Cross-Section	Average Saturated Hydraulic Conductivity, Ksat (micrometers/second)
Upstream of State Route 35	RS-71222	15.06
Upstream Junction Falls Dam	RS-66059	14.87
Upstream of Powell Falls Dam	RS-53219	15.97
USGS Gage 05342000	N/A	16.34

It should be noted that attempts were made to utilize the USGS's StreamStats tool in determining K_{sat} values for each subbasin, (Reference 29). However, the values it output were on magnitude of 113 micrometers per second, approximately 8 times the K_{sat} values estimated using the USDA's Web Soil Survey tool, (Reference 30). Additionally, the values estimated using the Web Soil Survey tool correlate well to maps of K_{sat}, including Plate 2 and Figure 2-1, respectively, of the 2003 and 2017 versions of the USGS's *Flood Frequency Characteristics of Wisconsin Streams* report, (References 10 and 31). After considering the other information on K_{sat} available for the watershed, the StreamStats tool was judged to be inaccurate for the Kinnickinnic River basin.

The percentage of a watershed that can be defined as "forest" was found to be an important parameter/predictor for estimating flood discharges in the region that the Kinnickinnic River watershed is located in the USGS's 2017 paper titled *Flood Frequency Characteristics of Wisconsin Streams*, (Reference 10). Land cover data for the entirety of the United States is available through the Multi-Resolution Land Characteristics Consortium's (MRLC) National Land Cover Database (NLCD) up to 2016 (at the time of this study), (Reference 32). Areas defined as "forest" within the NLCD are classified as follows:

- **41, Deciduous Forest:** areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
- **42, Evergreen Forest**: areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
- **43, Mixed Forest:** areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

To determine the percentage of each subbasin classified as forest, NLCD data was imported into ArcGIS Pro version 2.3. Areas classified as forest that fell within each subbasin were summed, and then divided by the total area of each subbasin. Table 4-3 displays the percentage of each subbasin determined to be forest through this process.

Table 4-3. Percent Area of Each Subbasin that is Classified as Forest in the NLCD, (Reference 32)

Location	HEC-RAS Model Cross-Section	Forest Land Use, F (%)
Upstream of State Route 35	RS-71222	12
Upstream Junction Falls Dam	RS-66059	12
Upstream of Powell Falls Dam	RS-53219	15
USGS Gage 05342000	N/A	17

It's important to note, if this study is conducted again in the future, that as land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization increases the amount of impervious areas, causing runoff to be up to two to six times that of what would have occurred on natural terrain, (Reference 33). As the population of River Falls likely continues to grow, having more than doubled since 1970, it's possible that an increase in impervious areas in the Kinnickinnic River basin will follow and contribute to increased runoff, (Reference 34).

4.3 USGS Regression Equations for Wisconsin

The USGS completed a study in 2017, (updated in 2020), relating watershed characteristics to flood frequency discharges for 360 gaged Wisconsin streams. A statistical analysis of these 360 gaged sites was used to develop regional regression equations that can be used for estimating flood discharges at ungaged sites for annual exceedance probabilities (AEP) ranging from the 50% AEP event to the 0.2% AEP event. AEP is defined as the chance that a certain streamflow condition will be met or exceeded in any year. For example, there may be a 1 in 100 chance (1% AEP) that a streamflow of 15,000 cubic feet per second (cfs, ft^3/s) will occur during any year in a particular stream, (Reference 33). Data at these gaged locations was collected through water year 2010. Stations with a minimum of 10 years of record were used in the statistical regression analysis of rural streams, (Reference 10).

The 2017 USGS study separated stream gages in Wisconsin into eight areas of similar physiographic characteristics and developed a unique set of regression equations for each area. The Kinnickinnic River watershed falls within Area 5 in the analysis, which primarily encompasses the Driftless Area. Table 4-5 shows a summary of the basin characteristics used to define the regression equations for Area 5, along with the range of applicable values that can be used for other ungaged sites.

Regression equations relating basin characteristics to flood frequency were developed using multiple linear regression analysis. The principal method of regression analysis used to develop the 2017 regression equations was the generalized least squares (GLS) technique, (Reference 39). Significant regression characteristics included in the adopted equations are drainage area (A, square miles, mi^2), saturated hydraulic conductivity (K_{sat}, micrometers per second, µm/s), and forest cover (F, percent). A summary of the regression equations for the region encompassing the Kinnickinnic River watershed, (Area 5), is shown in Table 4-4.

The standard error of prediction of the 2017 regression equations for the 1% event varied between 56 percent and 70 percent for Wisconsin streams, (Reference 10). This standard error value is quite high and illustrates the large amount of uncertainty which arises from using regression equations to develop estimates for flood frequency analysis.

Regression equations are useful tools for estimating frequency curves at sites without observed data. However, this technique has limitations; the regression equations presented in this section of the report should only be applied to rural sites which are not affected by regulation from hydraulic structures. The regression characteristics are only valid within the area or region they were developed. Flood estimates can be made using basin characteristics outside the range of values shown in Table 4-5 from which the equations were derived, but it is not possible to estimate the error associated with those results using the methods presented in the regression study.

Table 4-4. 2017 USGS Regression Equations for the State of Wisconsin, Area 5, (Reference 10)

Best-fit equation						SEP, in percent
Area 5, 26 streamflow-gaging stations						
Q_{50p}	=	183	$A^{0.701}$	$K_{sat}^{-0.540}$	$F^{-0.422}$	47.5
Q_{20p}	=	521	$A^{0.707}$	$K_{sat}^{-0.701}$	$F^{-0.403}$	45.4
Q_{10p}	=	951	$A^{0.709}$	$K_{sat}^{-0.796}$	$F^{-0.383}$	45.1
Q_{4p}	=	1,870	$A^{0.709}$	$K_{sat}^{-0.906}$	$F^{-0.358}$	46.0
Q_{2p}	=	2,950	$A^{0.710}$	$K_{sat}^{-0.982}$	$F^{-0.340}$	47.7
Q_{1p}	=	4,530	$A^{0.709}$	$K_{sat}^{-1.05}$	$F^{-0.316}$	48.5
$Q_{0.5p}$	=	6,750	$A^{0.709}$	$K_{sat}^{-1.12}$	$F^{-0.302}$	50.1
$Q_{0.2p}$	=	11,100	$A^{0.708}$	$K_{sat}^{-1.21}$	$F^{-0.277}$	51.1

SEP, standard error of prediction; Q_{xp}, discharge for x-percent annual exceedance probability flood; A, drainage area, in square miles; K_{sat}, saturated hydraulic conductivity, in micrometers per second; F, land use classified as forest, (percent + 0.01)/100)

Table 4-5. The Typical Range of Basin Characteristics Used in Developing the 2017 USGS Regression Equations for the State of Wisconsin, Area 5, (Reference 10)

Basin characteristic	Minimum	Average	Maximum
Area 5, 26 streamflow-gaging stations			
Drainage area, mi^2	0.27	264	2,082
Saturated hydraulic conductivity, µm/s	6.63	22.9	63.4
Land use, forest, percent	13.0	39.3	67.9

Table 4-6 summarizes the estimated discharges for the 50%, 10%, and 1% AEP events, determined using the 2017 USGS regression equations, and associated with the three HEC-RAS model steady-state flow input locations and the USGS gage on the Kinnickinnic River. It's interesting to note how the estimated discharge stays the same from cross-section RS-66059 downstream to RS-53219, and even drops slightly for the 1% AEP event. This is likely not reflective of reality, considering that the south branch of the Kinnickinnic River enters the main branch between these two cross-sections and consists of a primarily urban watershed. Cross-section RS-53219 also has a drainage area that's approximately 22 square miles larger than that of cross-section RS-66059's. This is an example of the significant uncertainty associated with the regression equations, and may also reflect the unique geomorphological environment that the Kinnickinnic River watershed is located in, described in Section 2.3. The results of the analysis that utilized the USGS regression equations would likely not be suitable as direct inputs into the HEC-RAS model, but may help inform the expected magnitudes of discharges associated with the AEP floods of interest at these locations.

Table 4-6. Discharge Estimates Associated with the 50%, 10%, and 1% AEP Events Determined Using the 2017 USGS Regression Equations for the State of Wisconsin, Area 5

HEC-RAS Model Cross-Section/Location	50% AEP Discharge (cfs)	10% AEP Discharge (cfs)	1% AEP Discharge (cfs)
RS-71222	2,700	6,600	13,800
RS-66059	2,800	7,000	14,600
RS-53219	2,800	7,000	14,500
USGS Gage 05342000	3,000	7,500	15,600

4.4 Drainage Area Transfer Method

General relations methodology (GRM), also known as the drainage area transfer method, can be applied to estimate flow at a location on a river by relating flow at a gaged location to the ratio of the drainage areas at both sites, raised to an exponent. The GRM is given by Equation 1 below.

Equation 1. General Relations Method Equation, (Reference 35)

$$\left(\frac{DA_1}{DA_2}\right)^n = \frac{Q_1}{Q_2}$$

Where: DA_1 = ungaged site

DA_2 = gaged site

Q_1 = flow at ungaged site for a given exceedance probability

Q_2 = flow at gaged site for the same exceedance probability

n = regional exponent

The drainage area transfer exponent, n, was determined from statistical regression analysis of 184 stream gages in the State of Wisconsin which had a minimum of 10 recorded annual peak flood events. The state of Wisconsin was divided into five areas based on similar physical basin characteristics to develop a transfer coefficient for each area. The Kinnickinnic River basin is in an area where the regional n value was determined to be 0.68, (Reference 35). This n value was used throughout the Bulletin 17C analysis, described in Section 4.5, to transfer frequency curves from one location in the watershed to another.

4.5 Bulletin 17C Analysis for the USGS Gage on the Kinnickinnic River

Through a process called flood frequency analysis, statistical techniques can be used to estimate the probability that a given streamflow or rainfall event will occur. Methods for estimating annual exceedance probabilities are outlined in *Bulletin 17C* and are used to estimate discharge frequencies for the Kinnickinnic River in this analysis, (Reference 9).

The USGS gage on the Kinnickinnic River near River Falls, WI, (USGS gage 05342000), is located on the right bank of the Kinnickinnic River, approximately 325 feet upstream from County Trunk Highway F, 1.9 miles upstream from the river's mouth, and 4.8 miles downstream from Powell Falls dam. The drainage area at the Kinnickinnic River gage is 162.5 square miles. The available systematic observed record, (also discussed in Section 2.5), at the gage extends from October 1916 to September 1921 and from July 2002 to present. At the time of this hydrologic analysis, the most recently published annual peak flow was the 2019 value, for a total of 23 systemic peak flow values, (not including 2020) (Reference 5).

In addition to the systematic records of annual peak flow, the discharge estimates for the floods of 1894, 1934, and 1965, (described in Section 2.5), are included as historical records, as well as the peak flow record for the 2020 event (that was only available as provisional data at the time of the writing of this report). The drainage area transfer method, (described in Section 4.4), was applied to estimate the discharges that would have occurred at the Kinnickinnic River gage during these floods had the gage been active during these events. As County Road MM (Powell Avenue) is located approximately 1 mile downstream from cross-section RS-66059 within the HEC-RAS model, (Reference 6), and approximately 1 mile upstream of the entrance of the south branch of the Kinnickinnic River, it's assumed that the drainage area contributing to the historical floods is approximately the same as that for cross-section RS-66059.

Table 4-7. Estimated Historical Flood Discharges at the USGS Gage on the Kinnickinnic River

Location	Drainage Area (square miles)	1894 Flood Discharge (cfs)	1934 Flood Discharge (cfs)	1965 Flood Discharge (cfs)
RS-66059	112.8	8,900 - 9,900	8,600	7,200
USGS Gage 05342000	162.5	11,400 - 12,700	11,000	9,200

It should be noted that, due to the relatively short systematic record, a record extension was attempted for the USGS gage on the Kinnickinnic River using the methods described in Appendix 8 of *Bulletin 17C*, (Reference 9). In order to extend the record of a streamgage, another near-by streamgage in a hydrologically similar watershed must have an overlapping record of at least 10 years. Annual peak flows recorded at each gage during the same water year must also show a high degree of correlation with one-another. After fitting an exponential trend line to the dataset plotted in log-log space, the correlation between peak annual flows at the two gages must have a correlation coefficient, R value, of at least 0.8.

After combing through dozens of nearby gages for unregulated streams in the surrounding area, only 13 had a long enough overlapping record with the Kinnickinnic gage that also had records predating its installation. Unfortunately, out of all of the streamgages for which this process was attempted, none showed a sufficient enough of a correlation in annual peak flows to the gage on the Kinni – this was even true for the USGS gage on the south branch of the Kinnickinnic River in River Falls (USGS gage 05341900), which showed the highest correlation. This is likely reflective of the unique geomorphological environment that the Kinnickinnic River finds itself in, described in Section 2.3. Additionally, as one of the primary flood mechanisms in the Kinnickinnic River is severe thunderstorms, it becomes increasingly unlikely that a separate storm of a similar severity would impact another watershed in the same water year as the storm frequency decreases.

Table 4-8. Streamgages with a Sufficient Overlapping Systematic Record that were Examined for Use in a Record Extension

USGS Gage	Correlation Coefficient (R Value) with USGS Gage 053242000, Kinnickinnic River near River Falls, WI
Kinnickinnic River Tributary at River Falls, WI, USGS Gage 05341900	0.73
Apple River near Somerset, WI, USGS Gage 05341500	0.01
Buffalo River near Mondovi, MN, USGS Gage 05371920	0.69
Cannon River at Welch, MN, USGS Gage 05355200	0.08
Hay River at Wheeler, WI, USGS Gage 05368000	0.64
Kettle River below Sandstone, MN, USGS Gage 05336700	0.34
Lightning Creek at Almena, WI, USGS Gage 05367700	0.00
Snake River near Pine City, MN, USGS Gage 05338500	0.37
Spring Creek near Durand, WI, USGS Gage 05370900	0.21
St. Croix River at St. Croix Falls, WI, USGS Gage 05340500	0.25
Straight River near Faribault, MN, USGS Gage 05353800	0.08
Vermillion River near Empire, MN, USGS Gage 05345000	0.21
Zumbro River at Zumbro Falls, MN, USGS Gage 05374000	0.09

To apply the *Bulletin 17C* methods for estimating a flow-frequency curve for the Kinnickinnic River gage, a Bulletin 17 analysis was conducted using version 2.2 of the Hydrologic Engineering Center – Statistical Software Package (HEC-SSP), (Reference 42). Low and high perception thresholds were set to values of 11,400 cfs and infinity, respectively, for the periods of 1854 to 1893, 1895 to 1916, and 1922 to 1933. The discharge of 11,400 cfs for these periods is equal to the lower discharge estimate for the 1894 flood. The Prairie Mill dam, the first dam on the Kinni constructed in 1854, was one of several dams that washed out during the 1894 event, (Reference 21). Based on the historical record, it's assumed that any flood would have been recorded had it been equal to or greater in magnitude to the 1894 flood during these periods. Similarly, low and high perception thresholds were set to 11,000 cfs and infinity, respectively, for the period from 1935 to 1964 following the 1934 event, and to 9,200 and infinity, respectively, for the period from 1966 to 2001 following the 1965 event. Table 4-9 summarizes the perception thresholds used in the flood frequency analysis, as they appear in HEC-SSP.

Table 4-9. Perception Thresholds Used in the Flood Frequency Analysis

Perception Thresholds				
Start Year	End Year	Low Threshold	High Threshold	Comments
1854	2020	0.0	inf	Total Record
1854	1893	11400.0	inf	Historical Period
1895	1916	11400.0	inf	Historical Period
1922	1933	11400.0	inf	Discontinued Record
1935	1964	11000.0	inf	Historical Period
1966	2001	9200.0	inf	Historical Period

The Expected Moments Algorithm was used to estimate the statistical parameters and fit a Log Pearson Type III distribution to the available systematic streamflow data, as well as the discharge estimates gleaned from the historical record. Hirsh-Stedinger plotting positions were used to plot the observed events. A Median plotting position would have been used to plot low outliers, if any were detected. A weighted skew value was calculated, and adopted, using results from the 2017 USGS report on *Flood Frequency Characteristics of Wisconsin Streams*, (Reference 39). The weighted/adopted skew value of -0.159 was calculated by weighting the regional skew value of -0.23 with an MSE of 0.309, estimated in that report, and a calculated station skew of 0.018. Table 4-10 summarizes the flood frequency curve, and associated statistics, that was calculated through this process. Figure 4-1 shows the estimated flood frequency curve and the systematic and historical peak flow events included in the analysis.

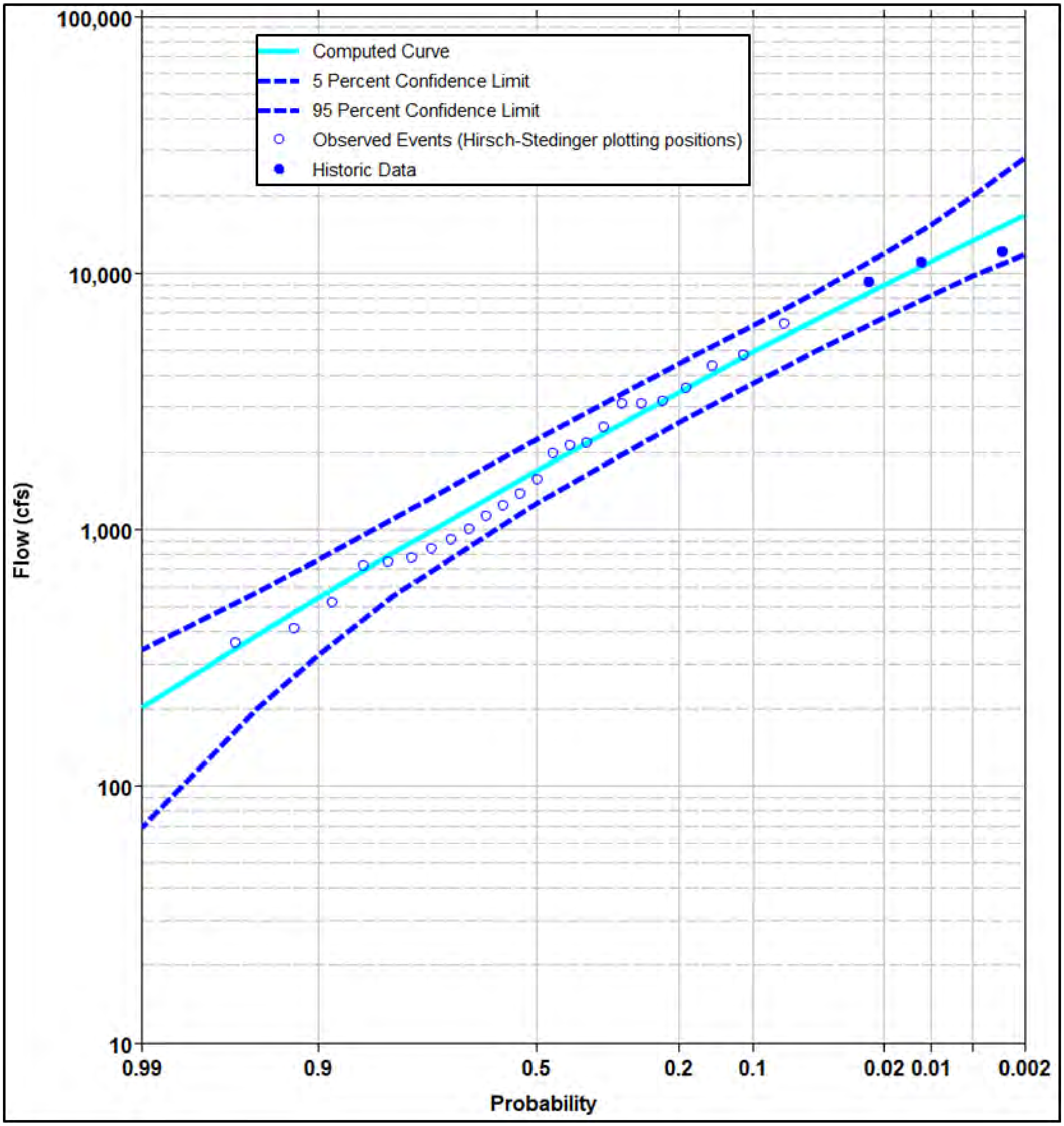


Figure 4-1. Flood Frequency Curve for the USGS Gage on the Kinnickinnic River (05342000), Calculated Using Bulletin 17C Methods

In practice, a minimum of 30 years of flood data is used for developing a flow-frequency curve. *Bulletin 17C* officially states that 10 years of information is the absolute minimum for frequency analysis and still may not produce an appropriate estimate of events like the 1% AEP event. Although the period of record for the Kinnickinnic River is less than 30 years, it should be considered appropriate for this analysis for a few reasons:

- The analysis includes three historical floods, one dating back to 1894, with knowledge of the river dating back to 1854, providing a historical context for flood magnitude estimations
- The 2020 event was relatively large, on the order of a 5% AEP event, and is included in the analysis
- 24 years of record is greater than the minimum recommended in *Bulletin 17C*

Table 4-10. Flood Frequency Curve for the USGS Gage on the Kinnickinnic River (05342000), Calculated Using Bulletin 17C Methods

Exceedance Probability	Peak Discharge Estimate (cfs)	90% Confidence Limits (cfs)	
		5%	95%
0.002 (0.2%)	16,690	28,060	11,740
0.005 (0.5%)	13,350	20,000	9,690
0.01 (1%)	11,070	15,390	8,170
0.02 (2%)	9,000	11,820	6,710
0.05 (5%)	6,550	8,320	4,950
0.1 (10%)	4,910	6,250	3,740
0.2 (20%)	3,440	4,450	2,620
0.5 (50%)	1,700	2,240	1,260
Statistics			
Mean	3.219	Systematic Record	24 Years
Standard Deviation	0.374	Historical Period	167 (1854-2020)
Station Skew	-0.061	Systematic Years in Record	1917-1921, 2002-2020
Regional Skew	-0.23	Missing Flows	140 Years
Regional Skew MSE	0.309	Low Outlier Test	Multiple Grubbs-Beck
Weighted Skew (Adopted)	-0.159	Number of Low Outliers	0

4.6 Adopted Flow-Frequency Curve

Discharges for the three steady-state flow input locations were estimated using the flood frequency curve calculated for the Kinnickinnic River gage and the GRM methodology described in Section 4.4. Note that *Bulletin 17C* states that the results from a flood frequency analysis examining annual peak flows are most applicable to the upper end of the flood frequency curve, including and above the 10% AEP event, (Reference 9). The flow-frequency curves and discharge estimates for the three steady-state flow input locations are compared against those generated for the Kinnickinnic River gage in Table 4-11 and Figure 4-2. The flow-frequency curves for the three flow input locations are also displayed in Figure 4-3 through Figure 4-5 and summarized in Table 4-12 through Table 4-14, along with their associated 90% confidence intervals.

The 90% confidence interval for the unaged frequency curves was estimated using the order statistics approach within HEC-SSP's General Frequency Analysis tool, (Reference 36). To compute the confidence limits, 12 years of record were used to define the equivalent record length required for the order statistics approach, along with the flow-frequency curves for each of the three steady-state flow input locations (summarized above). The value of 12 years was chosen in accordance with Engineering Manual (EM) 1110-2-1619, (Reference 37). According to EM 1110-2-1619, in the situation that a flow-frequency curve was estimated from an analytical distribution for a long-period gage in the same watershed, as is the case here, 50% to 90% of the systematic record length for that gage should be used. As the systematic record length of the USGS's gage on the Kinnickinnic River is 24 years, to be conservative, an equivalent record length equal to 50% of the length of the systematic record, 12 years, was chosen for this analysis.

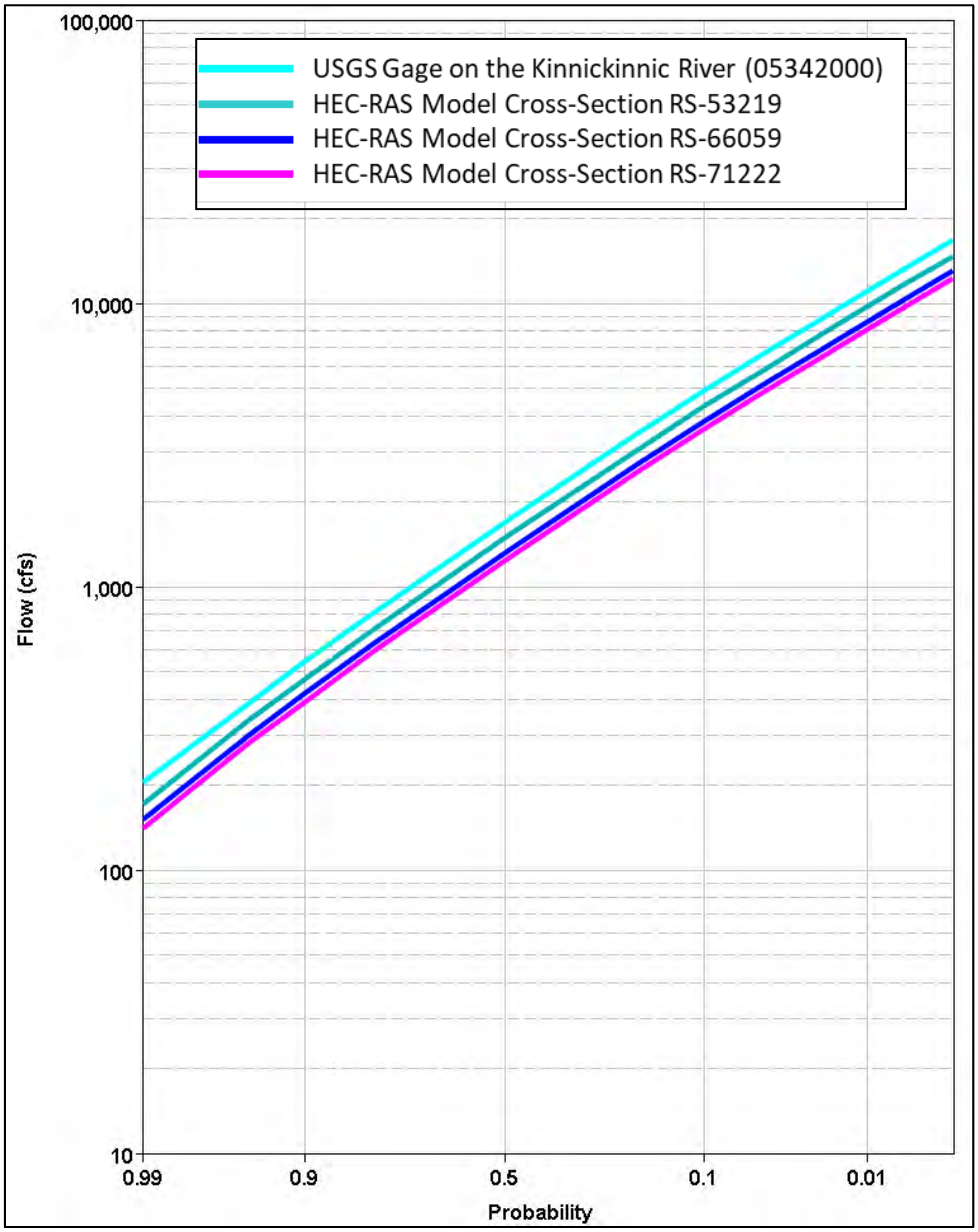


Figure 4-2. Graphical Comparison of Calculated Flow-Frequency Curves for Points of Interest to this Project

Table 4-11. Comparison of Discharge Estimates for the Points of Interest to this Project

	Discharge Estimates (cfs)			
Exceedance Probability	**Cross-Section RS-71222**	**Cross-Section RS-66059**	**Cross-Section RS-53219**	**USGS Gage 05342000**
0.002 (0.2%)	12,200	13,000	14,600	16,690
0.01 (1%)	8,110	8,630	9,740	11,070
0.02 (2%)	6,590	7,020	7,920	9,000
0.1 (10%)	3,590	3,830	4,320	4,910

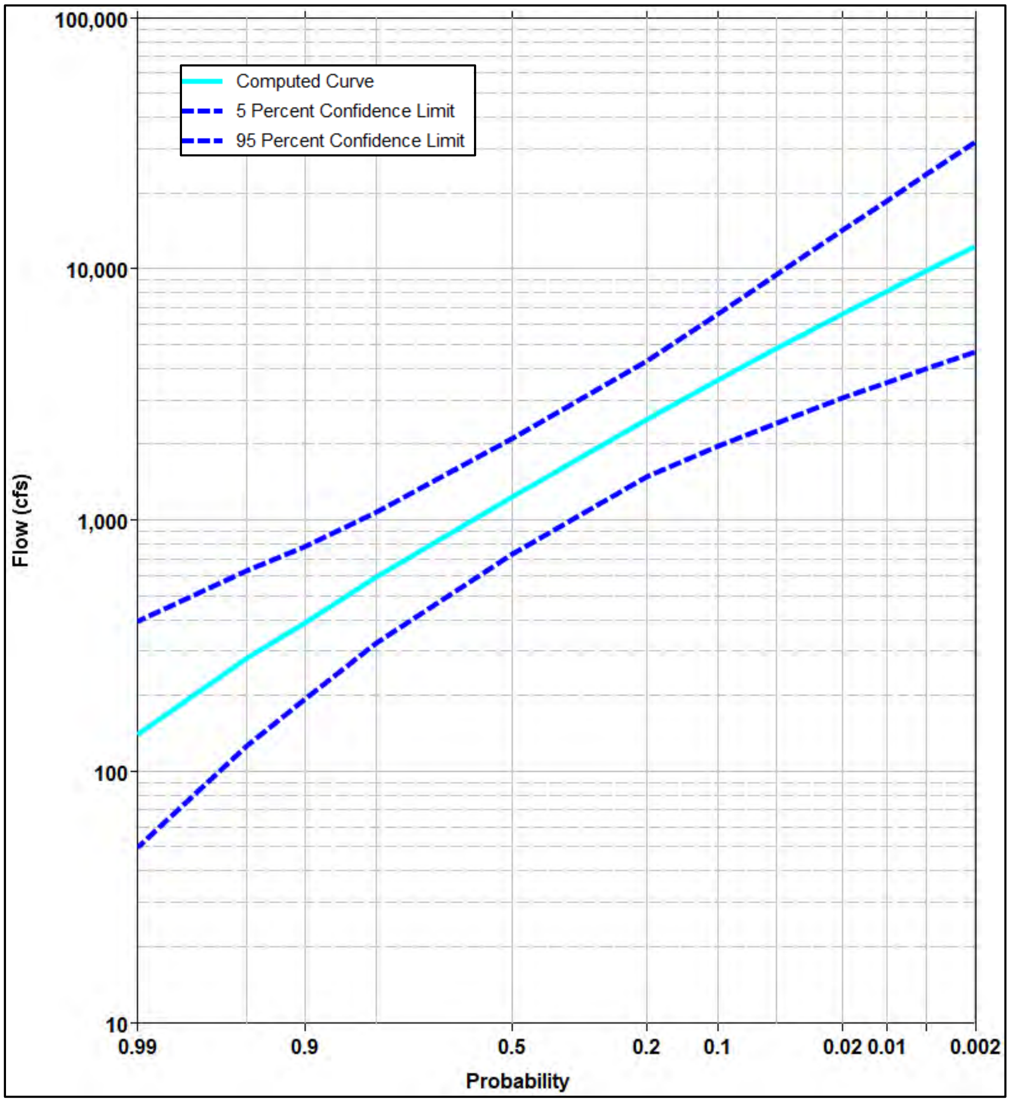


Figure 4-3. Flow-Frequency Curve Calculated for Cross-Section RS-71222

Table 4-12. Discharge Estimates for the HEC-RAS Model Steady-State Flow Input Location at Cross-Section RS-71222 (Upstream of State Route 35)

Exceedance Probability	Peak Discharge Estimate (cfs)	90% Confidence Interval (cfs)	
		5%	95%
0.002 (0.2%)	12,200	31,900	4,660
0.005 (0.5%)	9,780	23,800	4,000
0.01 (1%)	8,110	18,600	3,520
0.02 (2%)	6,590	14,200	3,040
0.05 (5%)	4,800	9,480	2,420
0.1 (10%)	3,590	6,580	1,950
0.2 (20%)	2,520	4,280	1,480
0.5 (50%)	1,240	2,100	730

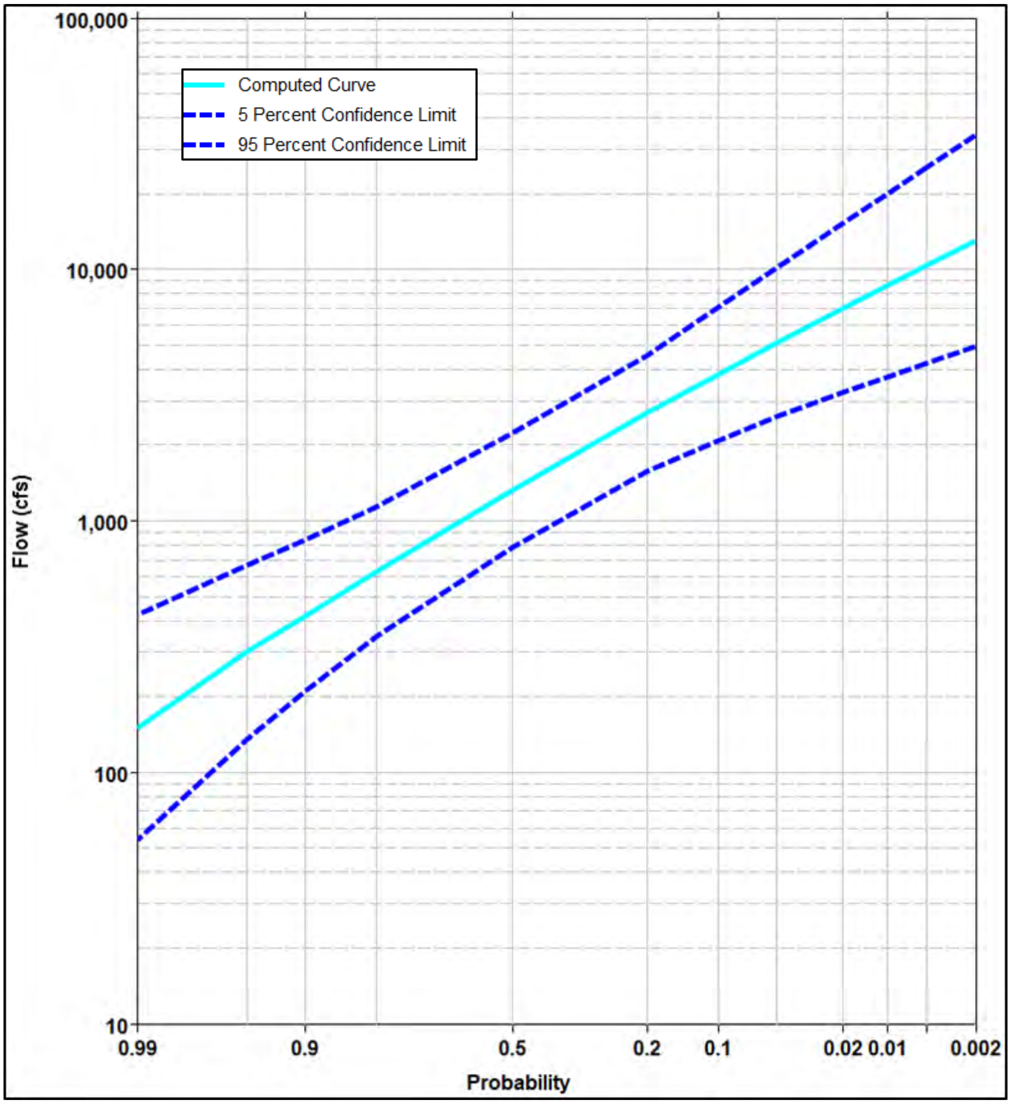


Figure 4-4. Flow-Frequency Curve Calculated for Cross-Section RS-66059

Table 4-13. Discharge Estimates for the HEC-RAS Model Steady-State Flow Input Location at Cross-Section RS-66059 (Upstream of Junction Falls)

Exceedance Probability	Peak Discharge Estimate (cfs)	90% Confidence Interval (cfs)	
		5%	95%
0.002 (0.2%)	13,000	34,100	4,950
0.005 (0.5%)	10,400	25,400	4,250
0.01 (1%)	8,630	19,800	3,740
0.02 (2%)	7,020	15,200	3,240
0.05 (5%)	5,110	10,100	2,580
0.1 (10%)	3,830	7,030	2,080
0.2 (20%)	2,680	4,550	1,570
0.5 (50%)	1,320	2,230	770

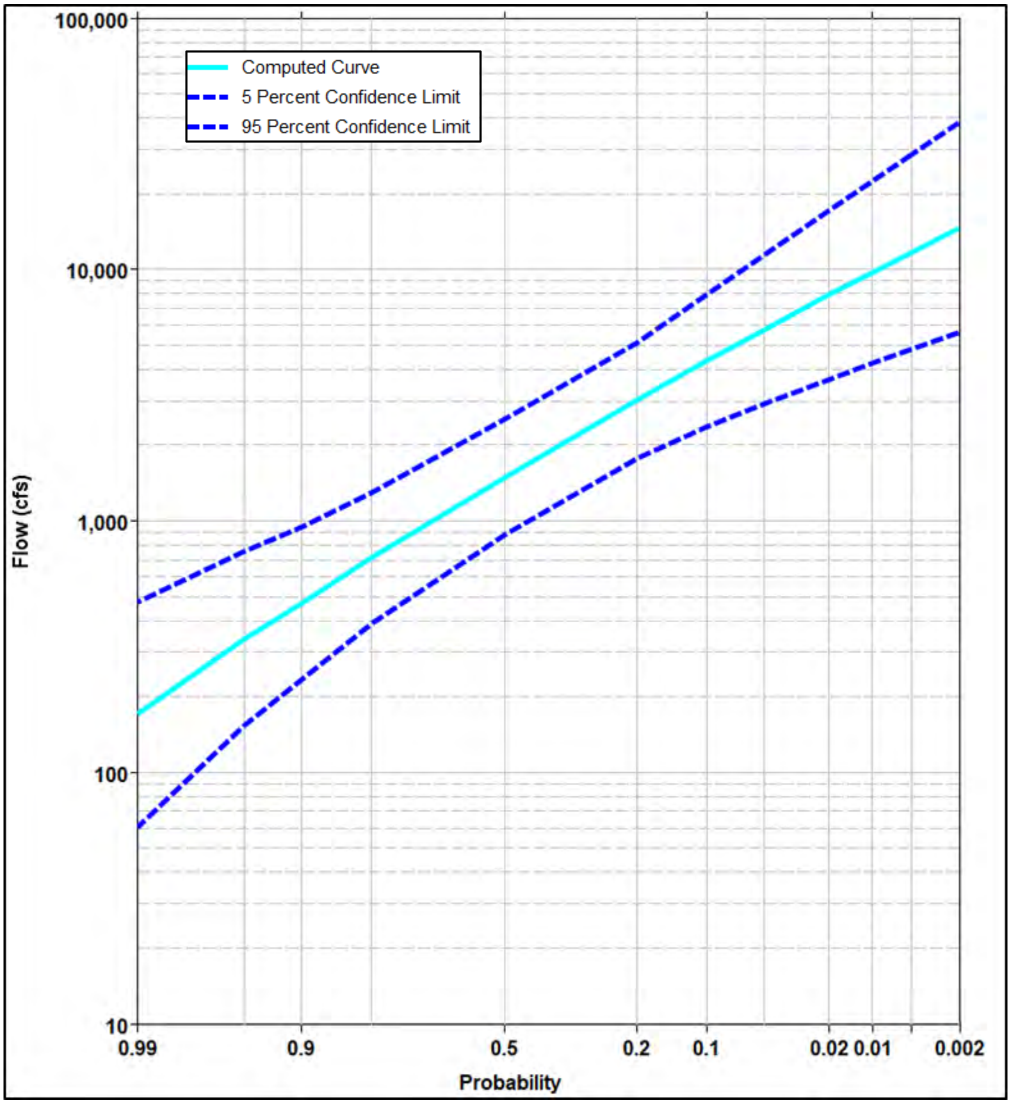


Figure 4-5. Flow-Frequency Curve Calculated for Cross-Section RS-53219

Table 4-14. Discharge Estimates for the HEC-RAS Model Steady-State Flow Input Location at Cross-Section RS-53219 (Upstream of Powell Falls)

Exceedance Probability	Peak Discharge Estimate (cfs)	90% Confidence Interval (cfs)	
		5%	95%
0.002 (0.2%)	14,600	38,200	5,570
0.005 (0.5%)	11,700	28,500	4,790
0.01 (1%)	9,740	22,400	4,220
0.02 (2%)	7,920	17,100	3,650
0.05 (5%)	5,760	11,380	2,910
0.1 (10%)	4,320	7,920	2,350
0.2 (20%)	3,020	5,130	1,770
0.5 (50%)	1,490	2,520	870

4.7 Updated HEC-HMS Analysis

After an extensive search for the original HEC-HMS model, (that was used to calculate the flood discharges for the 2011 FIS), (Reference 39), including reaching out to FEMA, the Wisconsin Department of Natural Resources, and SEH, the study team has come to the conclusion that this model is either lost or no longer exists. According to unit hydrograph theory, (Reference 37), it may be possible to create updated discharge estimates for the three steady-state flow input locations in the HEC-RAS model using the discharge estimates available in the FIS report, (Reference 4), and updated precipitation values available in *Atlas 14*, (Reference 7). However, with the limited knowledge on loss rates that would be expected across the Kinnickinnic River's watershed during a large rainstorm event, and the consideration of past experience with hydrologic modeling that has shown loss rates are the most sensitive parameter in runoff modeling, it is impossible to conduct this analysis with a high degree of confidence. This may be a possibility in future studies though where a review of loss rates and, potentially, the creation of a new HEC-HMS are included in the scope of work and budget.

4.8 Comparison to Past Hydrologic Studies

These discharge estimates compare reasonably well to those used as steady-state flow inputs in the HEC-RAS model created by SEH, (Reference 6), and in the 2011 FIS study, (Reference 4). Table 4-15 displays the discharges estimated in the 2011 FIS study. One notable difference between the two flow-frequency estimates is the greater increase in relative discharge between the RS-66059 and RS-53219 cross-sections in the FIS study discharges and the discharges displayed in Table 4-14 and Table 4-15. The south branch of the Kinnickinnic River enters the main branch of the Kinnickinnic between these two locations. One explanation for the higher discharge estimates included in the FIS study may be that this river is relatively more developed than the rest of the basin, meaning there is more impermeable land cover, and likely relatively greater runoff as a proportion of drainage area. This is difficult to discern without the hydrologic model used for the FIS study. Taking into consideration only the difference in drainage areas between the RS-66059 and RS-53219 watersheds of 17%, the discharges estimated in this study seem to align more with the discharges that may be expected. Thus, the updated discharges, calculated through the Bulletin 17C analysis conducted as part of this study, are adopted for use in the HEC-RAS model.

Table 4-16 compares the flow estimates for the location of cross-section RS-66059 from the 1976 hydrologic study, (Reference 21), the 2011 FIS study, and this study. It's notable how similar the discharge estimates are for this cross-section location in the 2011 FIS study and this study, especially considering the different methods used for estimating flood discharges in both studies. While this study estimated discharges using methods described in *Bulletin 17C*, (Reference 9), for estimating flood flow-frequency curves, the 2011 FIS study utilized a hydrologic (HEC-HMS) model. It is also notable that discharge estimates in the 1976 study for this location differ from those made in this study and the 2011 FIS study by approximately 25% for the 10% and 0.2% AEP frequency events. All studies though have approximately the same discharge estimates at the 1% and 2% AEP events.

This differences in flow estimates between the studies may be indicative of greater variability in the magnitude of flood inducing events under current climatic conditions, (thunderstorms, for example), and hydrologic conditions that have remained relatively constant in time throughout the watershed, (land use, for example). More likely, this is model driven though, as both the 1976 and 2011 studies used the same precipitation inputs, and the 2011 study uses a more sophisticated hydrologic model. Moreover, the conclusion of the nonstationarity analysis of peak streamflow in the region, in particular, that the streamflow regime has remained stationary in time, provides evidence that this shift is likely not due to changing hydrologic conditions. (The nonstationarity analysis is summarized in Section 3.2 and described in detail in Appendix 1). It's encouraging that this study found similar results to the 2011 study, especially considering different methods were used, and this provides greater confidence in the results of the *Bulletin 17C* analysis.

Table 4-15. Discharge Estimates Included in the 2011 FIS Study, (Reference 4)

Exceedance Probability (%)	Discharge at Cross-Section RS-71222 (Upstream of State Route 35) (cfs)	Discharge at Cross-Section RS-66059 (Upstream of Junction Falls) (cfs)	Discharge at Cross-Section RS-53219 (Upstream of Powell Falls) (cfs)
0.2	11,900	13,000	16,900
1	8,000	8,700	12,800
2	6,450	7,050	11,000
10	3,050	3,350	6,800

Table 4-16. Comparison of Discharge Estimates for Cross-Section RS-66059 between the Various Studies Conducted on the Kinnickinnic River Watershed

	Discharge Estimates for Cross-Section RS-66059 (Upstream of Junction Falls) (cfs)		
Exceedance Probability (%)	1976 Study (Reference 21)	2011 FIS Study (Reference 4)	This Study
0.2	9,900	13,000	13,000
1	8,600	8,700	8,630
2	7,200	7,050	7,020
10	4,200	3,350	3,830

5 Hydraulic Analysis

5.1 HEC-RAS Model Updates

As part of their 2017 *Kinni Corridor* study, SEH created an HEC-RAS model for use in modeling flood flows through the reach of the Kinnickinnic River that passes through River Falls, (Reference 6). The HEC-RAS model was adopted from the 2011 FIS, (Reference 4). SEH updated the model's terrain data and added stream cross-sections from downstream of Powell Falls dam to just upstream of Lake George. These updates were based on the sediment survey conducted by Inter-Fluve as part of their 2016 study, (Reference 8), LiDAR data, and as-built drawings of the dams, (Reference 6).

The HEC-RAS model updates based on sediment surveys were made to reflect the likely scenario that all of the sediment that has built up behind the dams since their construction would be removed through dredging and/or natural erosion, exposing the original channel bed, in the event both dams were removed. These bathymetric updates were made for both the "Proposed Conditions" geometry, representing the river channel as it would appear with both dams removed, and the "Existing Conditions" geometry, representing the channel as it exists now. It should be noted though that the bathymetry of the HEC-RAS model was only updated for cross-sections where the sediment survey was conducted, and the remainder of the channel's bathymetry is modeled as it was in the original FIS model. For additional information on the updates SEH made to the HEC-RAS model, please see their 2017 report, (Reference 6). The HEC-RAS model itself extends 3.9 river miles along the Kinnickinnic, from approximately 1 mile upstream of the Highway 35/65 bridge to just downstream of Powell Falls.

SEH assumed that both Junction Falls and Powell Falls dams would be removed when creating their model. Due to this, SEH's model includes one simulation with the Kinnickinnic's existing geometry, and one that shows both dams removed. However, the City of River Falls only plans to remove Powell Falls dam in the near future. As discussed in Section 1.4, Junction Falls dam was added back to the model geometry created under the assumption that both dams were removed. Additionally, cross-section RS-56095 through RS-53580, all immediately upstream of Junction Falls, were made consistent with the geometry of the existing conditions scenario, to reflect the sediment that has built up behind Junction Falls, which would remain in place with the dam. Figure 5-1 and Figure 5-2 show the parameters used for the "Inline Structure" added back into the HEC-RAS model to represent Junction Falls dam.

Junction Falls dam acts as a run-of-river dam, in that it does not regulate flows in excess of the powerhouse capacity at the dam site. Because of this, the dam is modeled as a weir. As the maximum controlled flow capacity of the facility is 960 cfs when the water level is at the dam's crest, (Reference 39), this is considered reasonable for modeling flood flows. Flows at the 10% AEP event magnitude are over 4 times this flow rate, and it's expected that flood flows would quickly eliminate any storage capacity in the lake upstream of Junction Falls, as the maximum available storage of the lake is 39 acre-ft under current conditions, (Reference 39). A flood scenario would cause uncontrolled flows to spill over the dam's crest; this, in conjunction with the maximum flow capacity going through the controlled outlets would mimic unregulated conditions upstream and downstream from the dam. As the controlled outlet is not included in the HEC-RAS model, flows over the Junction Falls crest are overestimated. However, as flows over the dam would also likely enter a supercritical flow state, and the model is not configured to calculate this condition, flows at the dam should not be considered fully representative of real conditions. Updating the HEC-RAS model to include the controlled outlet and to be able to calculate supercritical flow conditions was outside the scope of this study. Updating both in future studies would lead to model improvements. The controlled outlet becomes more influential the more common an event is, (the higher its frequency), as its discharge decreases.

Discharge estimates summarized in Table 4-12 were used as flow inputs for the three steady-state flow change locations included in the HEC-RAS model. Five scenarios were modeled, including the 0.2%, 1%, 2%, 10%, 50% AEP floods, as well as a summer low-flow/baseflow condition. A baseflow discharge value of 100 cfs was chosen for the model, as SEH did in their 2017 study, (Reference 6).

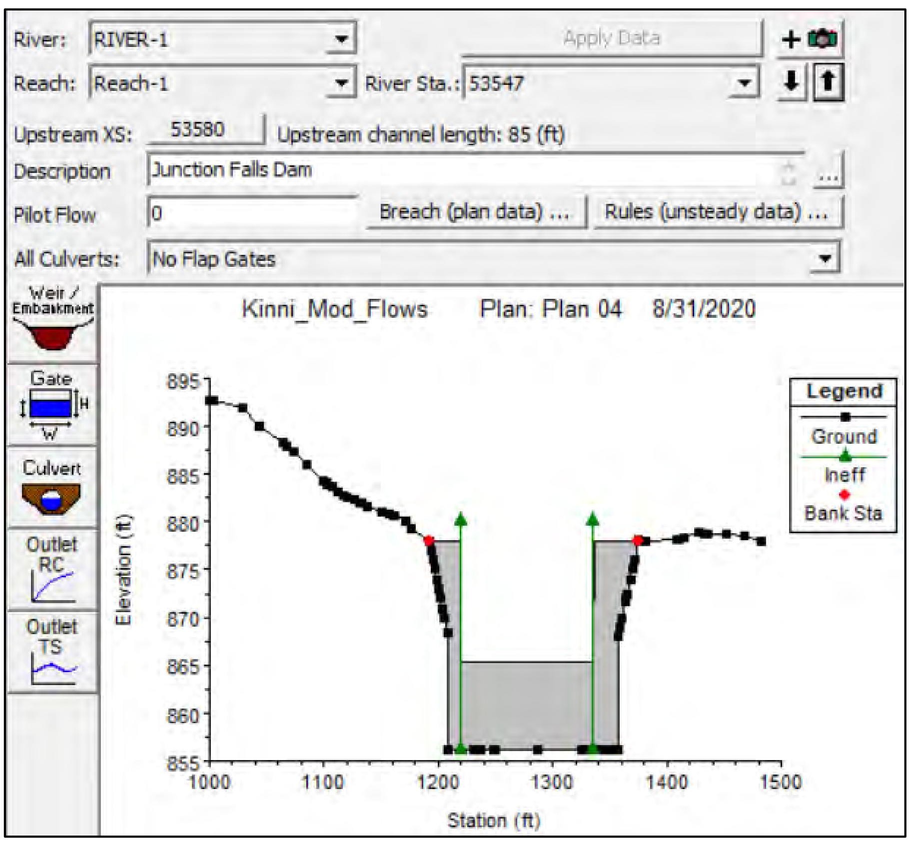


Figure 5-1. Inline Structure Parameters Used to Represent Junction Falls, as it Appears in the HEC-RAS Model

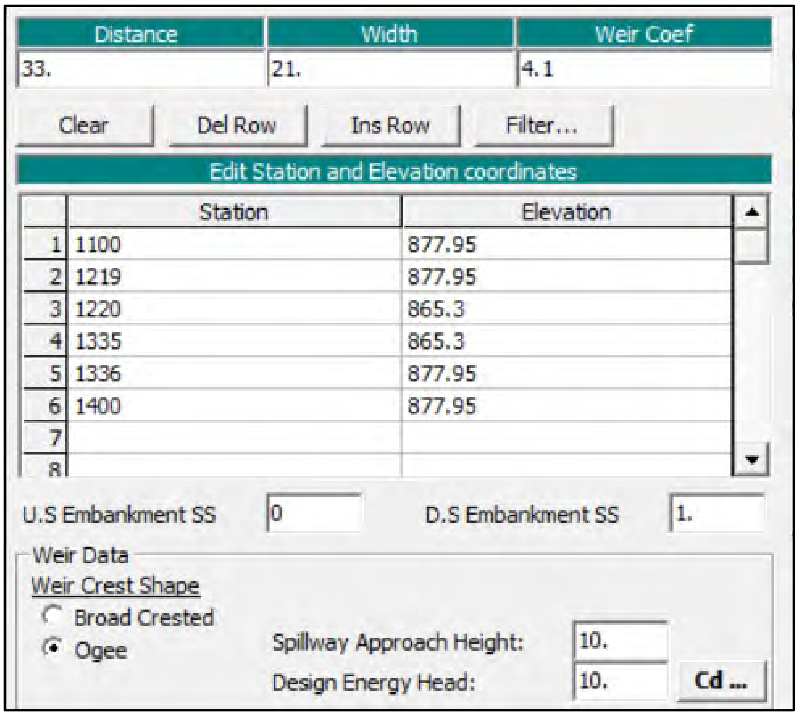


Figure 5-2. Weir Parameters Used to Model Flow Over Junction Falls Dam

5.2 Results of the HEC-RAS Simulations

Results from the HEC-RAS simulations are summarized below. Table 5-1 and Table 5-2 display the average cross-sectional flow velocities modeled for multiple scenarios for the channel geometries with and without Powell Falls dam, respectively, for several cross-sections. These cross-sections correspond to those in the cross-sectional velocities table included in SEH's 2017 report, (Reference 6). Of note, the cross-sections upstream of Junction Falls dam, (located at cross-section 53547), are the same for both geometries, which would be expected. In general, channel velocities increase as the flowrate increases, which would also be expected in a well-defined channel like the Kinnickinnic River.

Figure 5-3 and Figure 5-4 are inundation maps of the area surrounding Lake George and Lake Louise, (the impoundments formed by Junction Falls dam and Powell Falls dam). The map compares modeled flood conditions for the 1% AEP event under the scenarios with and without Powell Falls dam. The map in Figure 5-4 also shows the area that is included in FEMA's National Flood Hazard Layer, (Reference 40); this area corresponds to the inundated area along the Kinnickinnic River in FEMA's 2011 FIS, (Reference 4). Note that information on the channel geometry for the South Branch of the Kinnickinnic River, (the stream that enters the Kinni from the southeast, below Junction Falls dam), was not available for this analysis. Because of this, the inundated area along the South Branch of the Kinnickinnic River is drawn as it is in FEMA's National Flood Hazard Layer. As the inundated area above Lake Louise does not differ significantly between the scenarios with and without Powell Falls dam, and the discharge estimates in this study are similar to those in FEMA's FIS, this is likely a reasonable assumption. However, updated modeling of this reach in future flood studies would be recommended.

Figure 5-5 and Figure 5-6 show the flow profiles of the 1% AEP event and baseflow conditions modeled in both scenarios, (with and without Powell Falls dam). Of note, the Main Street bridge appears to be overtopped and pressure flow conditions occur under the Highway 35/65 bridge during the 1% AEP event and less frequent floods. Additionally, both flood profiles are exactly the same above Junction Falls dam, which would be expected.

When examining the HEC-RAS results for this study, it is important to note that a few reaches would likely enter a supercritical flow regime, particularly at locations downstream of Lake George and below a few of the bridges. This can be seen when examining individual flow profiles where the critical depth is equal to the water surface elevation. The model is only configured to calculate water surface profiles under a subcritical flow regime. In this scenario, when the model is attempting to calculate a subcritical flow profile that is truly supercritical, the program will default to the critical depth, (Reference 41). This means that the elevations of the water surface profiles are overestimated for these cross-sections, and that the flow velocities are underestimated. Using an unsteady flow input for this model would remedy this and would be more appropriate than the current steady-state model. Unfortunately, reconfiguring the model in this way was outside the scope of this project, but would offer a significant opportunity for improvement.

Table 5-1. Average Cross-Sectional Velocity, (feet per second), Corresponding to Flood Events with Both Dams in Place

Exceedance Probability (%)	HEC-RAS Model Cross-Section/River Station								
	51060	52038	53219	53389	53495	53978	54260	54912	55167
0.2	7.10	4.33	7.82	25.21	23.26	7.54	6.07	5.64	6.38
1	5.38	3.67	6.26	21.89	20.00	5.81	5.03	4.94	5.29
2	4.71	3.43	5.62	20.48	18.61	5.10	4.57	4.63	4.75
10	3.14	2.82	4.04	16.53	14.84	3.42	3.39	3.86	3.40
Base Flow	0.13	0.32	0.37	8.65	7.03	0.16	0.27	0.48	0.25

Table 5-2. Average Cross-Sectional Velocity, (feet per second), Corresponding to Flood Events with Powell Falls Dam Removed

Exceedance Probability (%)	HEC-RAS Model Cross-Section/River Station								
	51060	52038	53219	53389	53495	53978	54260	54912	55167
0.2	12.93	11.89	14.31	26.33	23.63	7.54	6.07	5.64	6.38
1	13.30	11.99	12.46	23.10	20.37	5.81	5.03	4.94	5.29
2	13.48	11.27	11.69	21.59	18.85	5.10	4.57	4.63	4.75
10	11.27	9.41	9.73	17.51	15.07	3.42	3.39	3.86	3.40
Base Flow	3.34	3.21	3.80	7.42	7.09	0.16	0.27	0.48	0.25

Figure 5-3. Flood Inundation Map for the 1% AEP Event

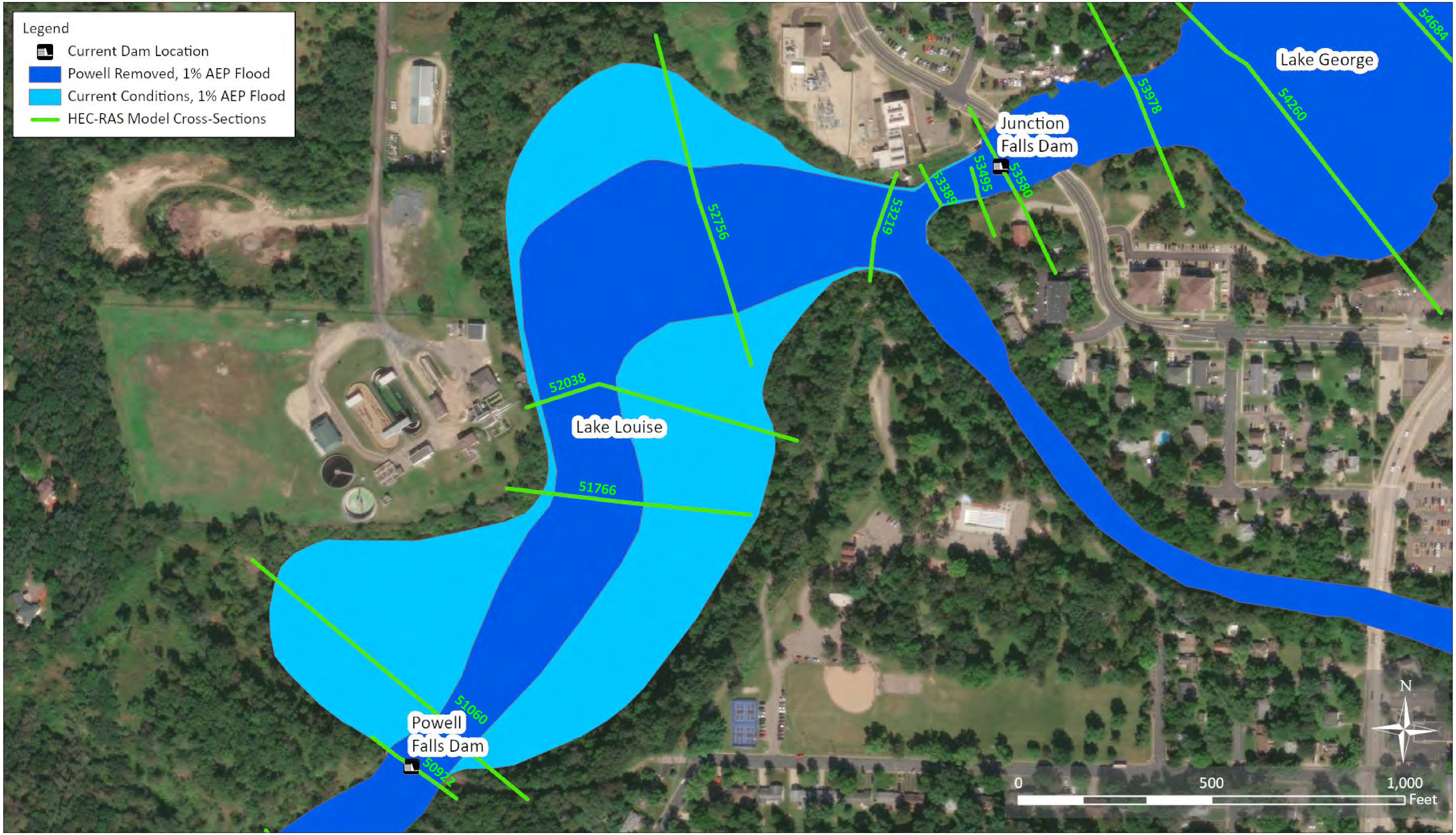


Figure 5-4. Flood Inundation Map for the 1% AEP Event with Superimposed FEMA Layers

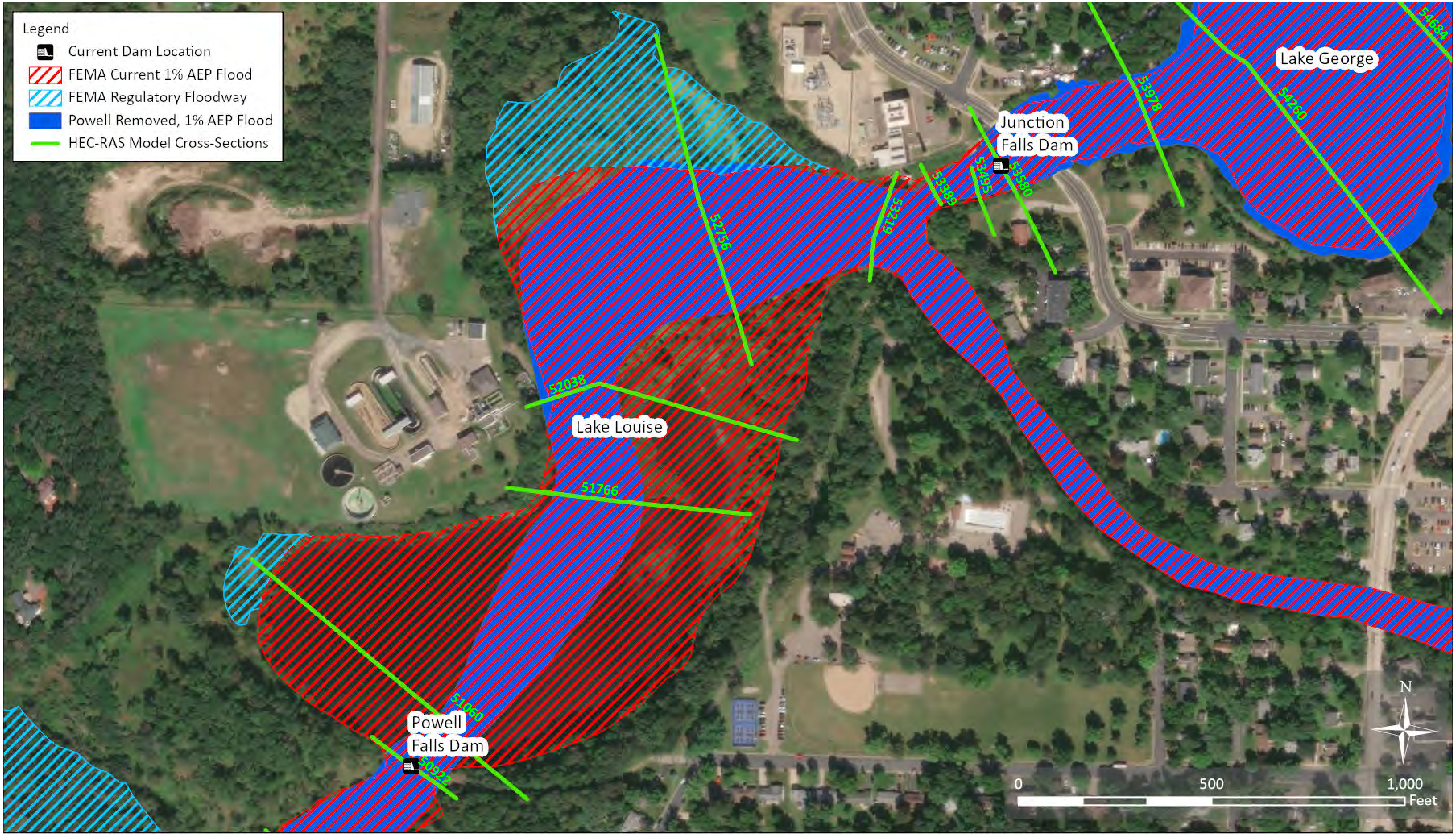


Figure 5-5. 1% AEP Event and Baseflow Profiles under Current Channel Conditions with Both Dams in Place

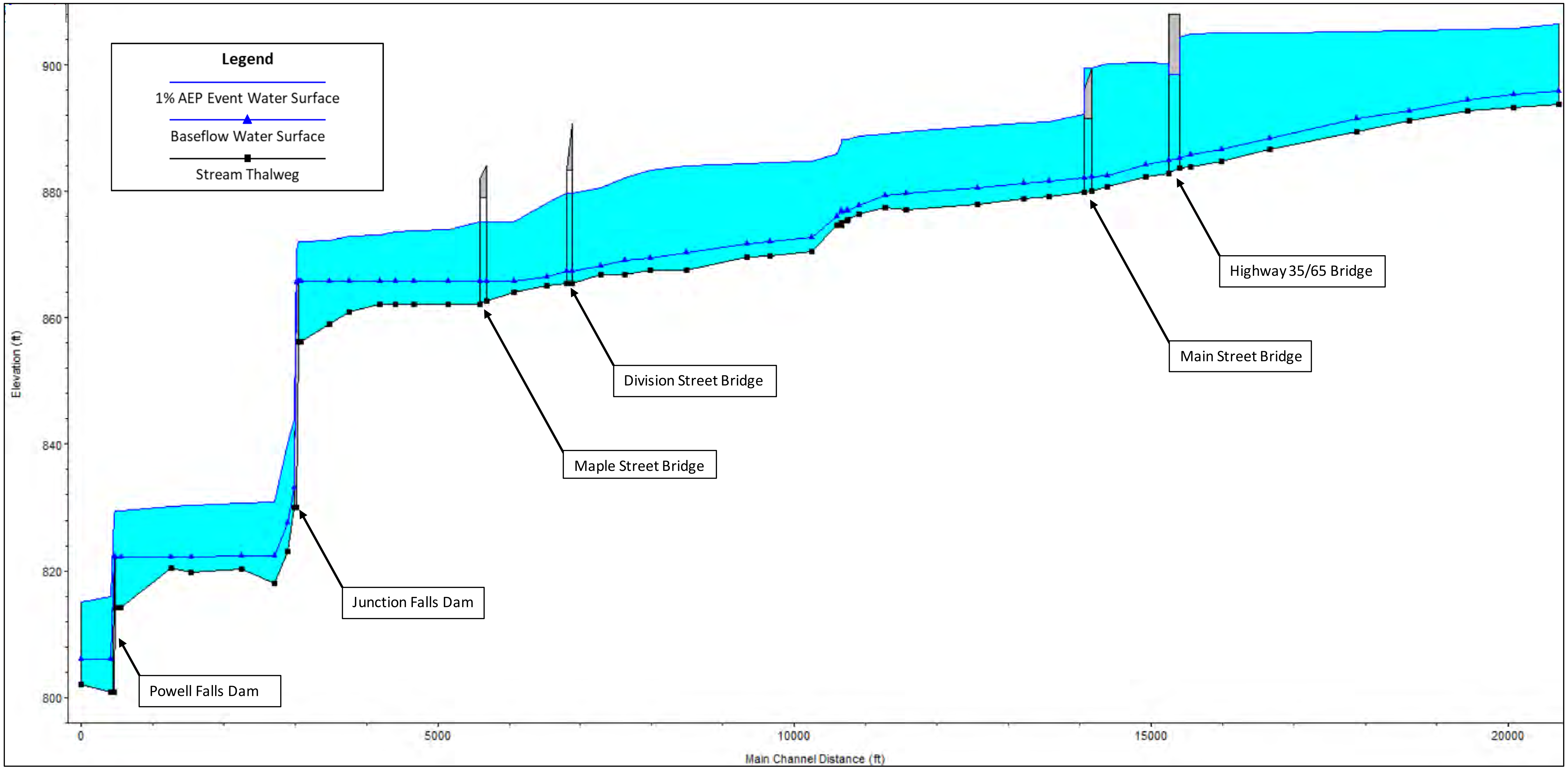
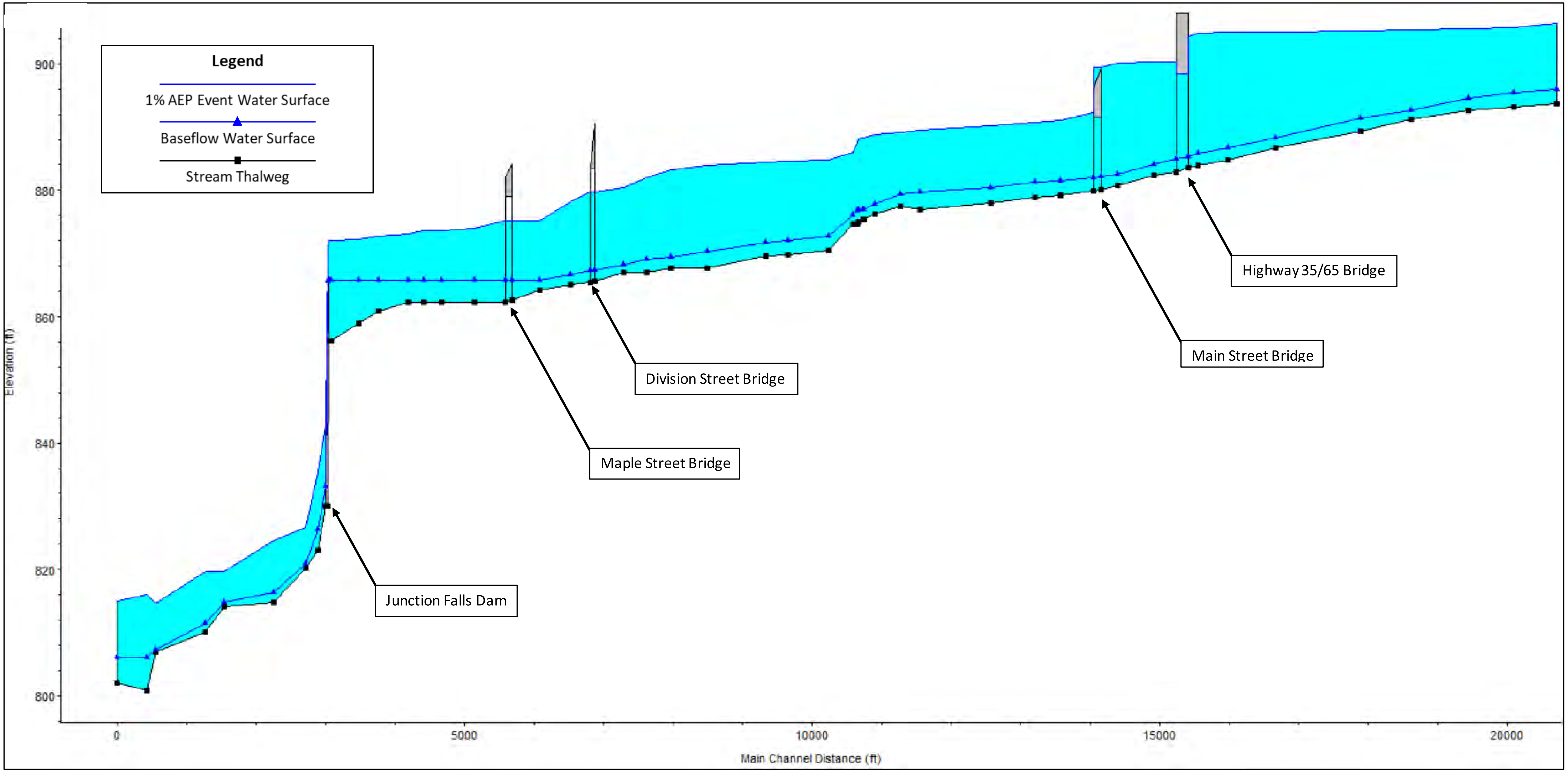


Figure 5-6. 1% AEP Event and Baseflow Profiles under Proposed Channel Conditions with Powell Falls Dam Removed



5.3 Opportunities for HEC-RAS Model Improvements

Updating the HEC-RAS model's terrain/geometry data was outside the scope of work for this study. However, there are several improvements that would be worthwhile for future studies to consider undertaking, as they offer the opportunity to improve the model's accuracy.

A few of the cross-sections upstream of the dams should be replaced, or expanded, so that they capture the full extent of flood inundation. Figure 5-7 below, for example, shows a cross-section where the water surface profile of the 1% AEP flood is higher than the elevation of the outermost station. This eliminates possible area within the stream cross-section for water to be conveyed, likely increasing the water surface elevation at these locations, as well as cross-sections upstream from them. In addition to raising the water surface profile, the full horizontal extent of flooding is not fully represented at these locations. This is a greater issue for modeling the 0.2% AEP flood, as this occurs at even more cross-sections.

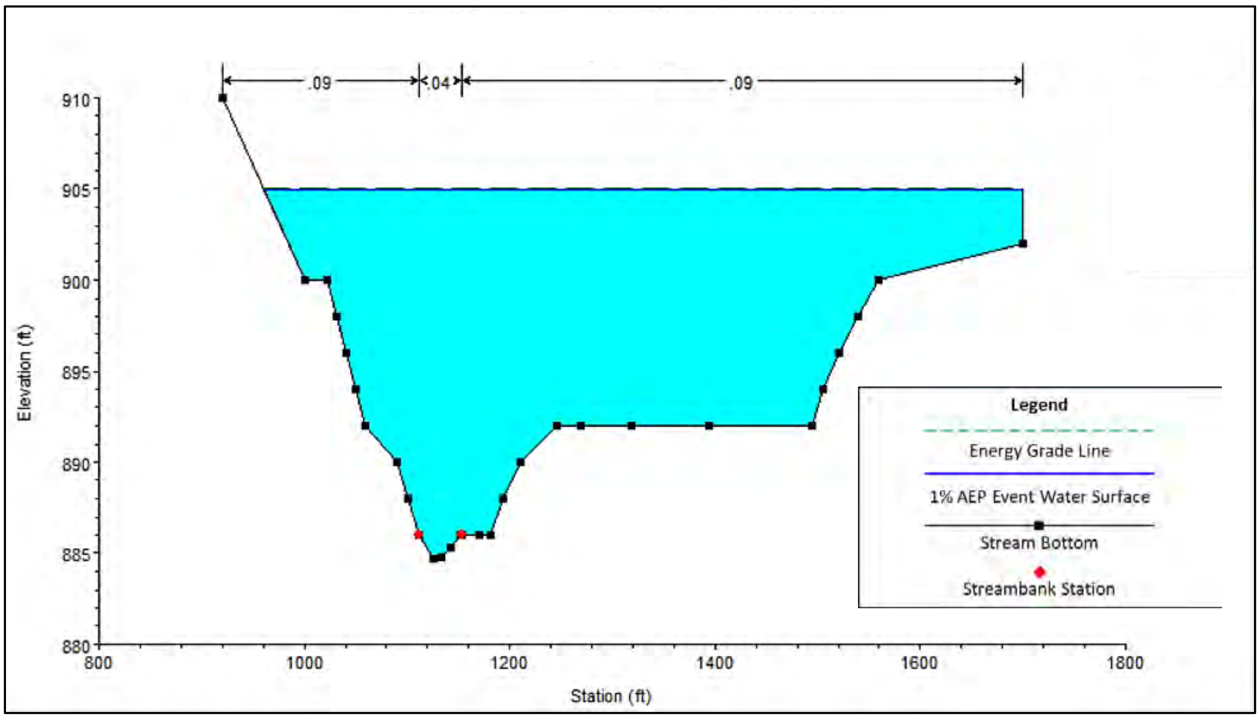


Figure 5-7. Example of a Cross-Section where the Water Surface Elevation is above the Elevation of the Outer Most Station

It would be worthwhile to resample the Kinnickinnic River's bathymetry beyond the locations examined by Inter-Fluve in their 2016 analysis to cover the full extent of the river included in the model. Much of the bathymetric data presumably dates back to at least 1995, when the hydraulic model for the current FIS was developed, (Reference 3). Since then, the river has experienced numerous significant flood events, including four that were considered major flood stage. Floods are a significant geomorphological force that can reshape all rivers over time.

Additionally, there is still considerable uncertainty in what the channel immediately upstream of Powell Falls dam will look like following the dam's removal. This uncertainty was highlighted during an October 2020 drawdown of Lake Louise; during this drawdown, the channel that formed in the sediment did not align well with what was estimated by Inter-Fluve following their sediment survey and analysis. This suggests that the refusal surface identified by Inter-Fluve may not be the ultimate, post-removal channel. However, it is possible that significantly more sediment would have needed to have eroded for the original, pre-dam channel to be revealed. This aspect is highlighted by the waterfall, (Powell Falls), not being visible during the drawdown. As the USACE was not present for the drawdown, and no formal documentation on these observations was available at the time of the writing of this report, it is impossible to comment on the accuracy of Inter-Fluve's estimated channel. Through conversation with engineers who are familiar with the project though, there is consensus that a more thorough sediment survey and fluvial geomorphological analysis of this river reach would be necessary prior to submitting a formal floodplain to FEMA, if one was desired prior to dam removal. However, as the removal of Powell Falls dam does not require a determination of the expected stream profile, beyond the generalized one through Lake Louise that this analysis utilized, such an investigation would be premature. The most accurate hydraulic analysis would occur either in conjunction with or after the final stream restoration design is determined.

Beyond updating the channel's bathymetry, updating the overbank data using LiDAR data would provide significant model improvements. The cross-section shown in Figure 5-7, for example, suggests that the overbank area is completely flat for over 2,000 feet; this level of detail is typical of FEMA FIS models of the era when this one was developed. Updating the overbank data using higher resolution data available now would better capture secondary channels, embankments, etc., and would produce a more accurate model. SEH updated this overbank data to a limited extent as part of their 2017 Kinni Corridor study, (Reference 6). It is recommended that the model be updated in this way over its full extent.

An additional recommendation would be to georeference the hydraulic model, or, rather, put it in the context of its geographical location. The current HEC-RAS model depicts the river as a straight channel, not capturing its many bends and meanders throughout this reach. The current model will likely produce a reasonable water surface profile, but it is more difficult to place accurate banks and ineffective flow areas. Georeferencing the model would also allow for the easier implementation of all the other geometry upgrades discussed previously.

Finally, as discussed in Section 5.2, the model should be updated to run as an unsteady flow model. Reconfiguring the model in this way would allow for a more accurate calculation of water surface profiles and flow velocities in reaches where flows enter a supercritical flow regime. This would reduce the current limitations of the model and the applicability of its results. Additional cross-sections in reaches that transition from subcritical to supercritical flow regimes and vice versa, particularly downstream of Junction Falls, would also improve the model's accuracy and resolution.

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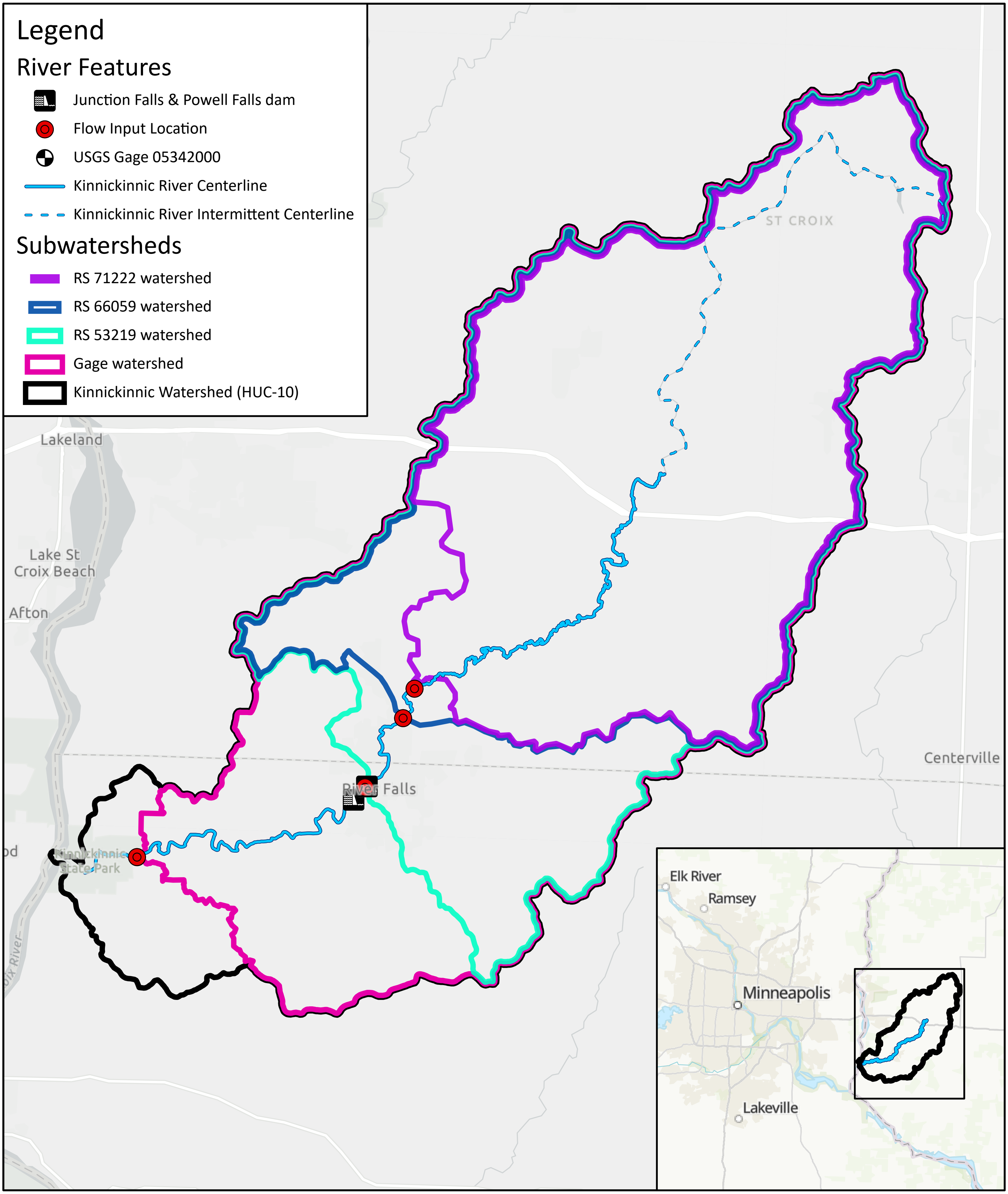

St. Paul District GIS CENTER

US Army Corps of Engineers®

Kinnickinnic River Watershed Overview

Base Image:

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Appendix 1: Climate Change Analysis

Kinnickinnic River, Wisconsin

Hydraulic and Hydrologic Analysis

River Falls Hydroelectric Project

Planning Assistance to States (PAS)

January 2021

US Army Corps of Engineers®

Prepared by:
U.S. Army Corps of Engineers
St. Paul District
180 Fifth Street East, Suite 700
St. Paul, Minnesota 55101-1678

Date	Version	Principal Author	Reviewer	Review Type/Comments
11/16/2020	1	Grant Halvorson, EIT, USACE MVP	Garrett Blomstrand, PE, USACE MVP	Draft Report for DQC Comments
11/23/2020	2	Grant Halvorson, EIT, USACE MVP	Garrett Blomstrand, PE, USACE MVP	Draft Report Incorporating DQC Comments
12/3/2020	3	Grant Halvorson, EIT, USACE MVP	Chris Frans, PhD, PE, USACE NWS	Draft Report for ATR
12/22/2020	5	Grant Halvorson, EIT, USACE MVP	Lesley Brotkowski, TRC Environmental Ellen Faulkner, PE, Ayres Kevin Westhuis, City of River Falls Municipal Utilities	Draft Report Incorporating ATR Comments for Review by Local Sponsor
01/12/2021	6	Grant Halvorson, EIT, USACE MVP		Final Report

ATR – Agency Technical Review
DQC – District Quality Control (U.S. Army Corps of Engineers)
EIT – Engineer In Training
MVP – St. Paul District (U.S. Army Corps of Engineers)
NWS – Seattle District (U.S. Army Corps of Engineers)
PE – (Registered) Professional Engineer
PhD – Doctor of Philosophy
USACE – U.S. Army Corps of Engineers

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1 Background

Recent scientific evidence shows that, in some places and for some impacts relevant to USACE operations, climate change is shifting the climatological baseline about which that natural climate variability occurs and may be changing the range of that variability as well. This is relevant to the USACE because the assumptions of stationary climatic baselines and fixed range of natural variability, as captured in the historic hydrologic record, may no longer be appropriate for long-term projections of flood risk. Current USACE policy is to interpret and use climate change information for hydrologic analysis through a qualitative assessment of potential climate change threats and impacts relevant to the USACE project for which the hydrologic analysis is being performed. Qualitative analyses required include consideration of both past (observed) changes, as well as potential future (projected) changes to relevant hydrologic inputs. Climate change impacts on the hydrology of the Kinnickinnic River around River Falls, WI are evaluated in accordance with USACE Engineering and Construction Bulletin (ECB) 2018-14, (Reference 1), *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs and Projects*, and USACE Engineering Technical Letter (ETL) 1100-2-3 *Guidance for Detection of Nonstationarities in Annual Maximum Discharges,* (Reference 2).

The Kinnickinnic River is a tributary to the St. Croix River (HUC0703) in western Wisconsin (see Figure 1-1). According to the Wisconsin DNR, the Kinnickinnic River originates from a series of springs in central St. Croix County and flows through the City of River Falls into Pierce County and eventually enters the St. Croix River south of the City of Hudson in Kinnickinnic State Park. The Kinnickinnic River reaches its confluence with the St. Croix just upstream of where the St. Croix combines with the Mississippi River, between St. Paul, MN and Red Wing, MN. The Kinnickinnic River is 22 miles long and captures 174 square miles of drainage area. The proposed project consists of removing Powell Dam. Powell Dam is a hydropower dam on the Kinnickinnic River and it currently impounds Lake Louise. Removal of the hydropower dam is not anticipated to have a detrimental hydrologic impact on the study area in any way. Removing the structure will return the river to a more natural state and will result in a reduction in localized flood risk.

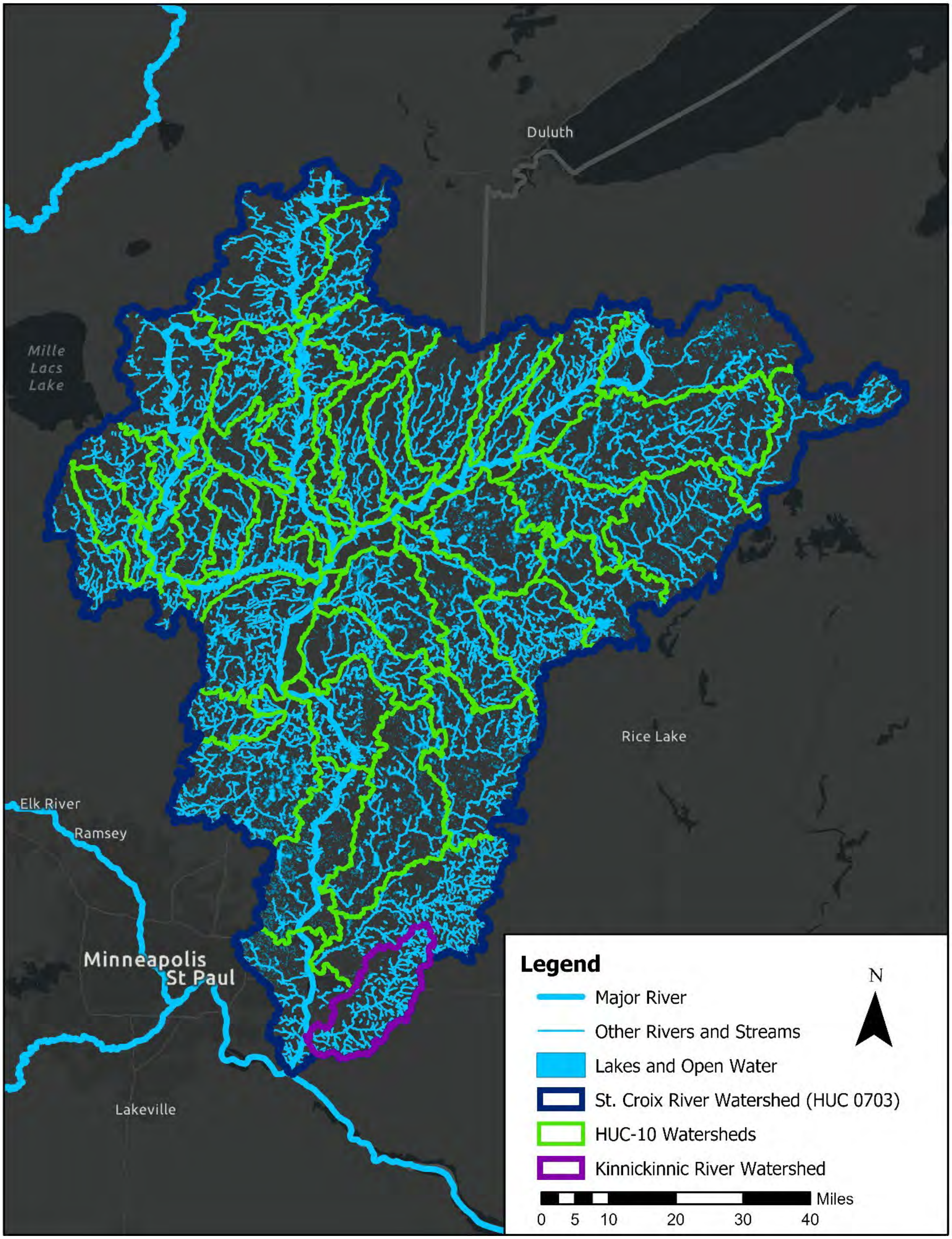


Figure 1-1. Map of the St. Croix River Watershed (HUC 0703) with the Kinnickinnic River Highlighted

2 Literature Review

The literature review summarizes peer reviewed science regarding both natural and human driven climate trends in the region which encompasses the Kinnickinnic River. The Kinnickinnic River watershed falls within the Water Resources Region 07 (HUC 07): Upper Mississippi River. The Upper Mississippi River HUC 07 encompasses the drainage of the Mississippi River basin above the confluence with the Ohio River, excluding the Missouri River Basin. The Upper Mississippi River basin includes parts of Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, South Dakota, and Wisconsin. The reviewed sources identify observed changes and assess projected future changes in hydro-climatic variables. The literature review does not attempt to identify the causes of climate change, (e.g. natural or anthropogenic sources).

2.1 Temperature

According to the 4th National Climate Assessment, (Reference 3), temperatures have been rising in the Midwest over the last century and projections show the average temperature throughout the region increasing between 5.6°F and 9.5°F by 2100.

2.1.1 Observed Temperature Trends

Regional Observed Temperature Trends – A literature synthesis carried out by USACE in 2015, (Reference 5), reported statistically significant warming in the Upper Mississippi Region's observed seasonal temperatures for winter, spring, and summer. The fall season saw a slight decrease in temperature over several studies, but this change was not statistically significant.

Local Observed Temperature Trends – The U.S National Oceanographic and Atmospheric Administration (NOAA) State Climate Summary for Wisconsin, (Reference 4), has observed a temperature increase of about 2 degrees Fahrenheit for the state since 1900. According to Wisconsin Initiative on Climate Change Impacts, (Reference 6), all nine subregions in Wisconsin saw statistically significant increases in daily average temperature for each season. This increase was the most prominent in the winter season and largely reflects an increase in the daily minimum temperatures. Daily maximum temperatures have experienced statistically significant increases as well, but to a lesser degree than the daily minimum temperatures, (Reference 6).

2.1.2 Projected Temperature Trends

Regional Projected Temperature Trends – According to the 2015 USACE literature synthesis, there is consensus amongst temperature projections in the Upper Mississippi Region that significant warming will occur, (Reference 5). The 4th National Climate Assessment considers the Midwest to be particularly susceptible to warming due to its relatively high latitude and lack of nearby oceans. The high emission scenario (RCP 8.5) projects temperatures in the Midwest to increase roughly 9 degrees Fahrenheit by late-century, (Reference 3).

Local Projected Temperature Trends – Relative to the period 1981-2010, Wisconsin's temperatures around 2050 are projected to increase by about 5 degrees Fahrenheit, (Reference 6). This warming is expected to affect all seasons to a similar extent (within several degrees) for both the average daily minimum and daily maximum temperatures. This rise in temperature is expected to deplete soil moisture and cause an earlier snowmelt, (Reference 4).

2.2 Precipitation

Within the Upper Mississippi Region, there is evidence that climate change is impacting precipitation. Throughout the United States, trends in precipitation vary by region, but observations and projections in the Midwest show a notable increase, (Reference 5).

2.2.1 Observed Precipitation Trends

Regional Observed Precipitation Trends – The USACE Literature Synthesis, (Reference 5), reported that statistically significant precipitation increases have been observed in the Upper Mississippi Region. This increase is evident for both total annual precipitation and for the frequency and magnitude of precipitation events. The 4th National Climate Assessment, (Reference 3), agrees with both trends for the Midwest.

Local Observed Precipitation Trends – Wisconsin Climate Trends and Projects, (Reference 6), offers an assessment of historic trends in climate for nine regions within the state of Wisconsin. From 1950 to 2018, a statistically significant increase of about 20% has been observed in the annual precipitation in the region which contains the Kinnickinnic River watershed. A similar increase has been observed on a seasonal basis, (fall, winter, spring, and summer), but is only statistically significant for the winter. NOAA, (Reference 4), has found similar trends in precipitation, noting an influx of unusually wet years in recent history as well as an increase in annual snowfall totals. Additionally, the occurrence of extreme rain events has been increasing in frequency since 1990.

2.2.2 Projected Precipitation Trends

Regional Projected Precipitation Trends – For the Upper Mississippi Region, a reasonable consensus supports a projected increase in annual precipitation totals and extreme precipitation intensity and frequency, (Reference 5). The 4th National Climate Assessment, (Reference 3), supports this finding, citing a projected increase in springtime precipitation by 20 to 40%. The intensity and frequency of extreme precipitation events are projected to continue to increase with temperature as well.

Local Projected Precipitation Trends – NOAA, (Reference 4), projects an increase in annual precipitation throughout all of Wisconsin of at least 15% by the middle of the 21st century, relative to the late 20th century averages. The most likely increases will occur in the winter and spring. Despite the increase in winter precipitation and the observed increases in annual snowfall totals, Wisconsin's average annual snowfall is projected to decline due to warmer temperatures. Extreme precipitation is projected to continue to increase in the state. Over a similar period, Wisconsin Climate Trends and Projects, (Reference 6), suggests a more conservative annual precipitation increase that is closer to 5%, based on a moderate assumption of greenhouse gas emissions (the RCP 4.5 scenario). The projections also show a large increase in the frequency of extreme precipitation events by as much as two times.

2.3 Hydrology & Streamflow

2.3.1 Observed Hydrologic Trends

The 4th National Climate Assessment reports that a statistically significant increase in annual maximum streamflow has been observed in the Upper Mississippi River valley, (Reference 3). According to the 2015 USACE Literature Synthesis, the Upper Mississippi Region, HUC02 watershed has observed a general increase in river flow, as well, (Reference 5). Increases in annual peak flows have resulted in increases in the risk and severity of floods. What is driving this increase in streamflow peaks has been assessed throughout the region. Although it has been found that changes in land use and agricultural practices may have some influence on streamflow trends, this trend has been attributed mostly to the increase in observed precipitation throughout the Midwest, (Reference 3).

2.3.2 Projected Hydrologic Trends

Generally, projected increases in extreme precipitation are expected to result in an increase in the frequency and intensity of floods, (Reference 4). Increases in temperature may offset future flood magnitudes as a result of increased evapotranspiration and changes in snowmelt timing and volume. This contributes to the high degree of uncertainty in projecting future hydrologic trends, as noted by the USACE Literature Synthesis, (Reference 5). Not only do the reports cited by the 2015 USACE Synthesis lack consensus, but the different models within the same reports sometimes showed opposite results. Although lacking a strong consensus, studies generally supported the idea of regional flows increasing in the winter and spring and decreasing in the summer, (Reference 5).

2.4 Literature Review Summary

The consensus from the literature review indicates that increases in temperature, precipitation, and streamflow have been observed within the Upper Mississippi River Region. Some consensus shows that extreme storms have increased in frequency in the region. Projections have a strong consensus that air temperature will increase significantly over the next century. Both precipitation and the frequency of large storms are projected to increase; however, some portions of the region will experience decreases in precipitation. There is little consensus on projected streamflow amounts, as increases in precipitation could be offset by increased evapotranspiration rates and changes in snowmelt timing. These observed and projected trends are summarized in Figure 2-1, which includes an indication of the level of consensus within the 2015 USACE synthesis peer reviewed literature, (Reference 5).

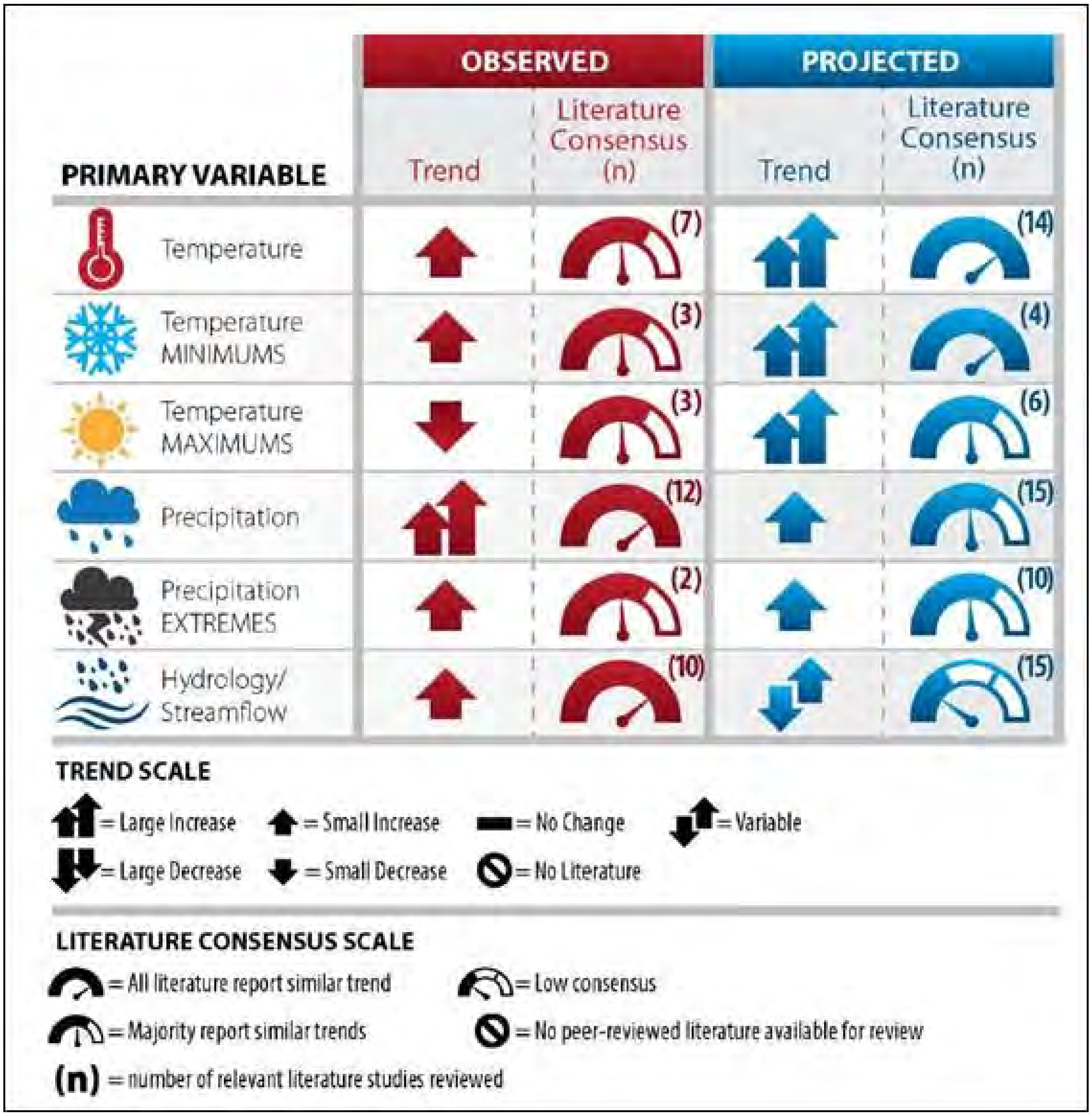


Figure 2-1. Summary Matrix of Observed and Projected Climate Trends and Literature Consensus for the Upper Mississippi Region 07, (Reference 5)

3 First Order Statistical Analysis

ECB 2018-14, (Reference 1), requires a first order statistical analysis of hydrometeorological variables relevant to the study objective. For this assessment peak streamflow will be analyzed. The removal of the River Falls Hydropower structure will result in a reach of river that is no longer inundated due to the upstream impacts of the dam, reducing flood risk within this reach of the river. (See Section 5 of the Main Report for details). Because this dam is operated as run-of-the-river and does not impact peak flows, its removal will not increase the flood risk downstream. Removing the hydropower dam is not expected to negatively impact the hydrology of the study area in an operationally significant way. Thus, the potential negative effects of climate change on the study area in terms of the USACE Flood Risk Reduction business line are not anticipated to be compounded by the proposed hydropower dam removal. To provide for a study area specific assessment of how climate change is impacting streamflow in the study area, annual peak flows are analyzed.

3.1 Streamflow Gage Sites – Background Information

There are two dams on the Kinnickinnic River that support hydropower operation: Junction Falls dam/Lake George and the dam being assessed as part of this study: Powell Falls dam/Lake Louise. Neither dam is thought to impact high flows. The Powell Falls dam is scheduled for removal in 2026, part of a FERC relicensing and decommissioning plan for the City's hydroelectric operations. The second dam, Junction Falls, is scheduled for removal between 2035 and 2040. Neither dam impacts peak streamflows.

The historic annual peak streamflows on the Kinnickinnic River, as recorded by USGS gage 05324200, were considered for this assessment. However, USGS gage 05324200 has less than 30 years of continuous data. A minimum of 30 years of record is required for first order statistical analysis, (including trend analysis and nonstationarity detection). As further described in Section 4.5 of the Main Report, nearby gages were analyzed to evaluate hydrologic similarity to the drainage area captured by USGS gage 05324200. The three gages with the best correlation to USGS gage 05342000 were chosen for analysis: Kinnickinnic River Tributary at River Falls, WI (USGS gage 05341900); the Buffalo River near Mondovi, WI (USGS gage 05371920); and the Hay River at Wheeler, WI (USGS gage 05368000).

The gaged Kinnikinnic River Tributary is upstream of USGS gage 05342000. The USGS does not flag the annual instantaneous peak streamflow record collected at USGS gage 05342000 as being significantly impacted by regulation. Consequently, it can be assumed that peak flows measured along the Kinnickinnic River Tributary are not impacted by regulation. Despite there being several small, earthen structures located throughout the Hay River and Buffalo River watersheds, there are no significant sources of regulation on these two rivers that would impact the high flow regimes. The location of these gages, relative to the Kinnickinnic Watershed and USGS gage 05324200 are illustrated in Figure 3-1 and analyzed in Section 3.2. The period of record associated with each gage, drainage area captured by each gage site and pertinent information from the USGS related to regulation, data quality etc. is included in Table 3-1.

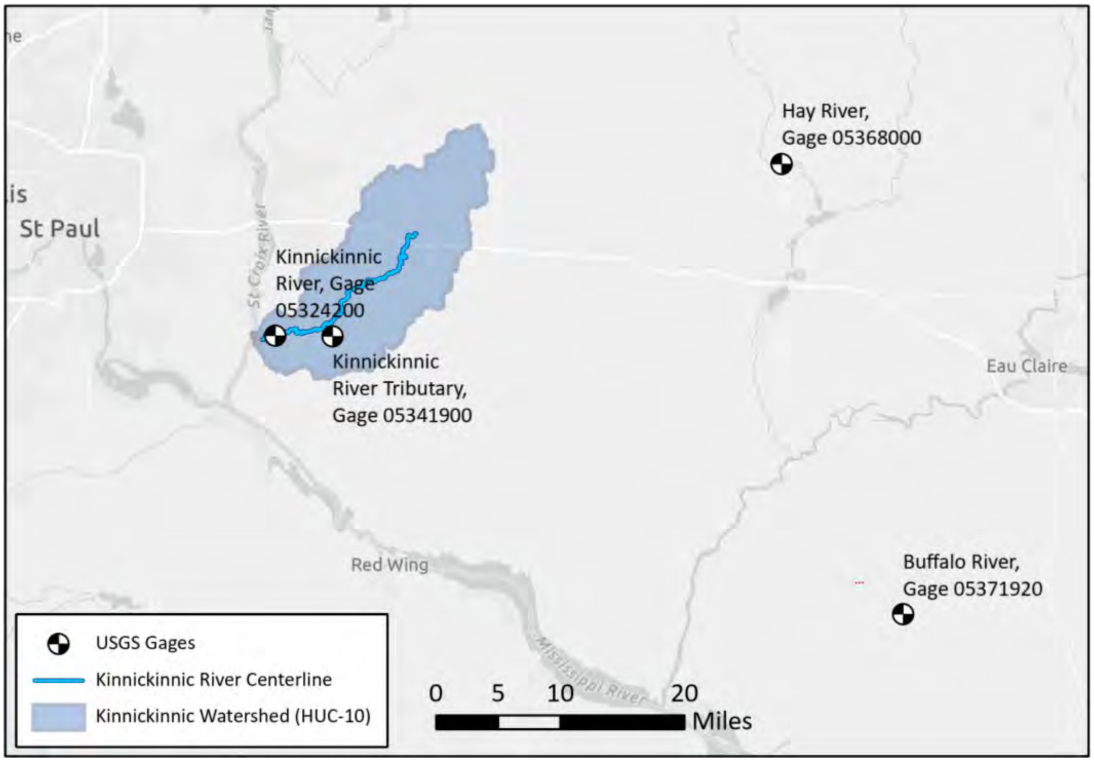


Figure 3-1. Locations of USGS Gages Considered in the Climate Assessment

Table 3-1. Information about USGS Gages Considered in the Climate Assessment

USGS Gage ID	Location	Period of Record	Drainage Area (sq. mi.)	Pertinent Information
05342000	Kinnickinnic River near River Falls, WI	1917 - 1921, 2002 - Present	165	Gage moved 325 feet upstream in 2012; 4.8 mi Downstream of Lake Louise Dam, Peak flows unimpacted by Regulation
05341920	Kinnickinnic River Tributary (Rocky Branch) at River Falls, WI	1959 - Present	10.4	Peak flows unimpacted by Regulation, Gage replaced in 1999
05371920	Buffalo River near Mondovi, WI	1974 - Present	279	On Hwy 88 bridge, 4.0 mi south of Mondovi, no regulation known to significantly impact peak flows
05368000	Hay River at Wheeler, WI	1950 - Present	418	2.4 mi Downstream of South Fork Hay River, no regulation known to significantly impact peak flows

3.2 Assessment of Trends & Nonstationarities in Observed Data

The USACE Nonstationarity Detection (NSD) Tool, (Reference 8), was applied to the full period of record to determine whether annual instantaneous peak flows recorded by the three analyzed gages are representative of stationary hydroclimatic conditions. The stationarity of the flow record at the gages was assessed by applying twelve statistical tests to the observed, annual maximum instantaneous peak flow record. These tests identify changes in the statistical properties of the dataset, including the mean, standard deviation, and overall distribution. The data was also evaluated for monotonic trends using the Mann-Kendall Test and the Spearman Rank Order Test. For gages not included within the NSD Tool, the USACE Time Series Toolbox was used to apply the same statistical tests.

The criteria of consensus, robustness, and magnitude were used to assess the relative strength of a nonstationarity. The level of consensus refers to different statistical tests targeted at detecting the same type of nonstationarity (mean, variance/standard deviation, distribution), in the flow data series, indicating a changepoint. A second criterion for adopting nonstationarities is robustness. Robustness is achieved when tests targeting changes in two or more different statistical properties, (mean, variance/standard deviation, and overall distribution), indicate a statistically significant nonstationarity. Another criterion for detection of nonstationarities is change in magnitude. To be considered strong a nonstationarity, there must be a significant change in the magnitude of the mean or standard deviation/variance.

Neither the Hay River nor Buffalo River gages showed any strong nonstationarities in the observed time series data. The Nonstationarity Detection Tool was used to analyze the annual instantaneous peak streamflow record collected by the Hay River gage at Wheeler, WI for the period or record of 1950-2019. On the Hay River, three nonstationarities were detected in the record in 1985, 1990, and 2007 by a single test each. Because there is no consensus between results, the evidence of nonstationarity is not considered strong enough to warrant further consideration. As can be seen from Figure 3-2, simple linear regression analysis applied within Microsoft Excel indicates that there is evidence of a decreasing trend (p-value = 0.03 < 0.05). Additionally, the more robust Mann-Kendall and Spearman Rank Order monotonic trend analysis tests applied within the Nonstationarity Detection tool indicate no statistically significant trends at a 0.05 significance level (p-values of 0.14 for both) within the annual peak streamflow record for the Hay River.

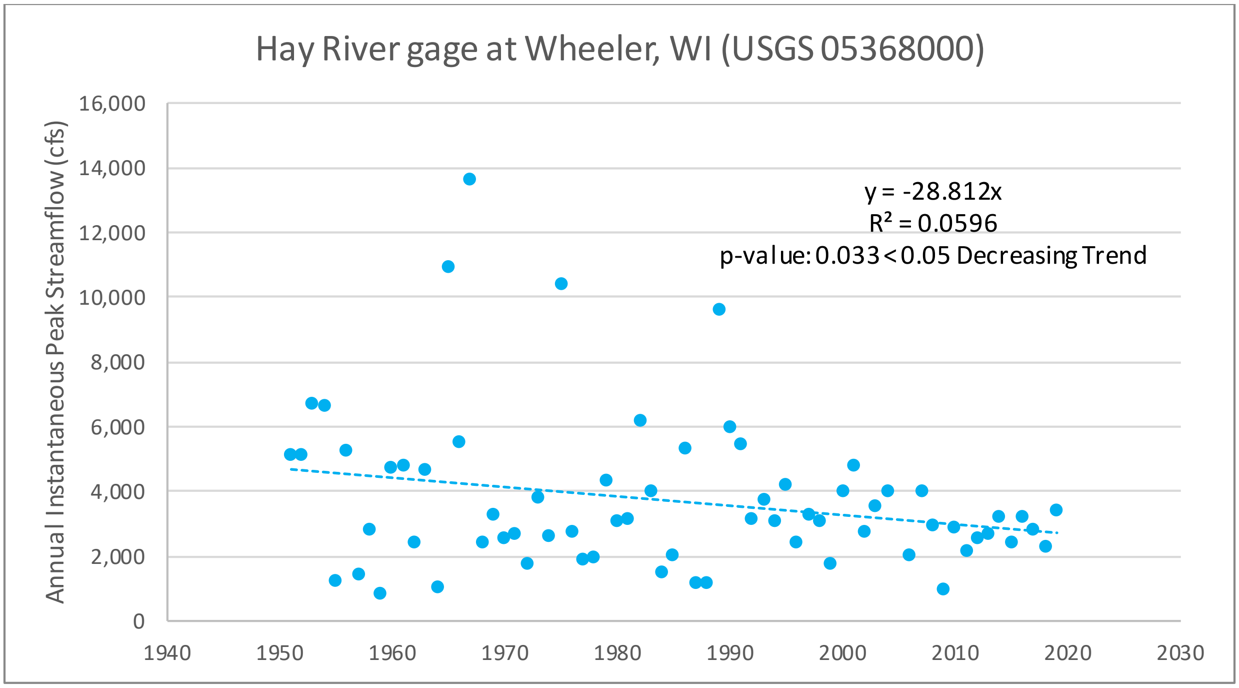


Figure 3-2. Observed Peaks & Linear Regression Analysis Hay River (1950-2019)

The Time Series Toolbox (TST) was used to analyze the annual instantaneous peak streamflow record collected between 1974 and 2017, (42 years), by the Buffalo River gage near Mondovi, MN. Data is missing in 1981, 1988 and 2014. The TST and the NSD tool are configured to analyze continuous datasets. When datasets are missing data, it has the potential to undermine results. However, one to three years of missing data is not likely to produce misleading output, particularly when they aren't consecutive years. On the Buffalo River, no nonstationarities were detected in the record. Additionally, TST output identified no statistically significant monotonic trends, (t-test, Mann-Kendall, Spearman Rank-Order at a 0.05 significance level), in the annual peak streamflow record for the Buffalo River. Annual peak flow data plotted in Microsoft Excel is displayed in Figure 3-3.

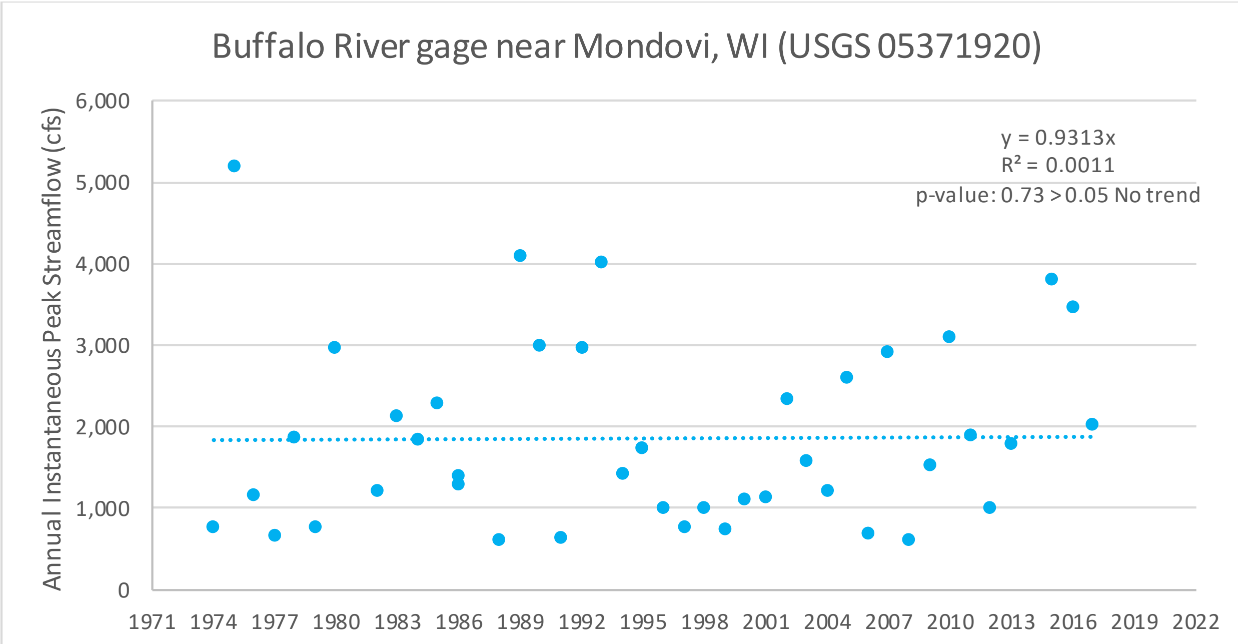
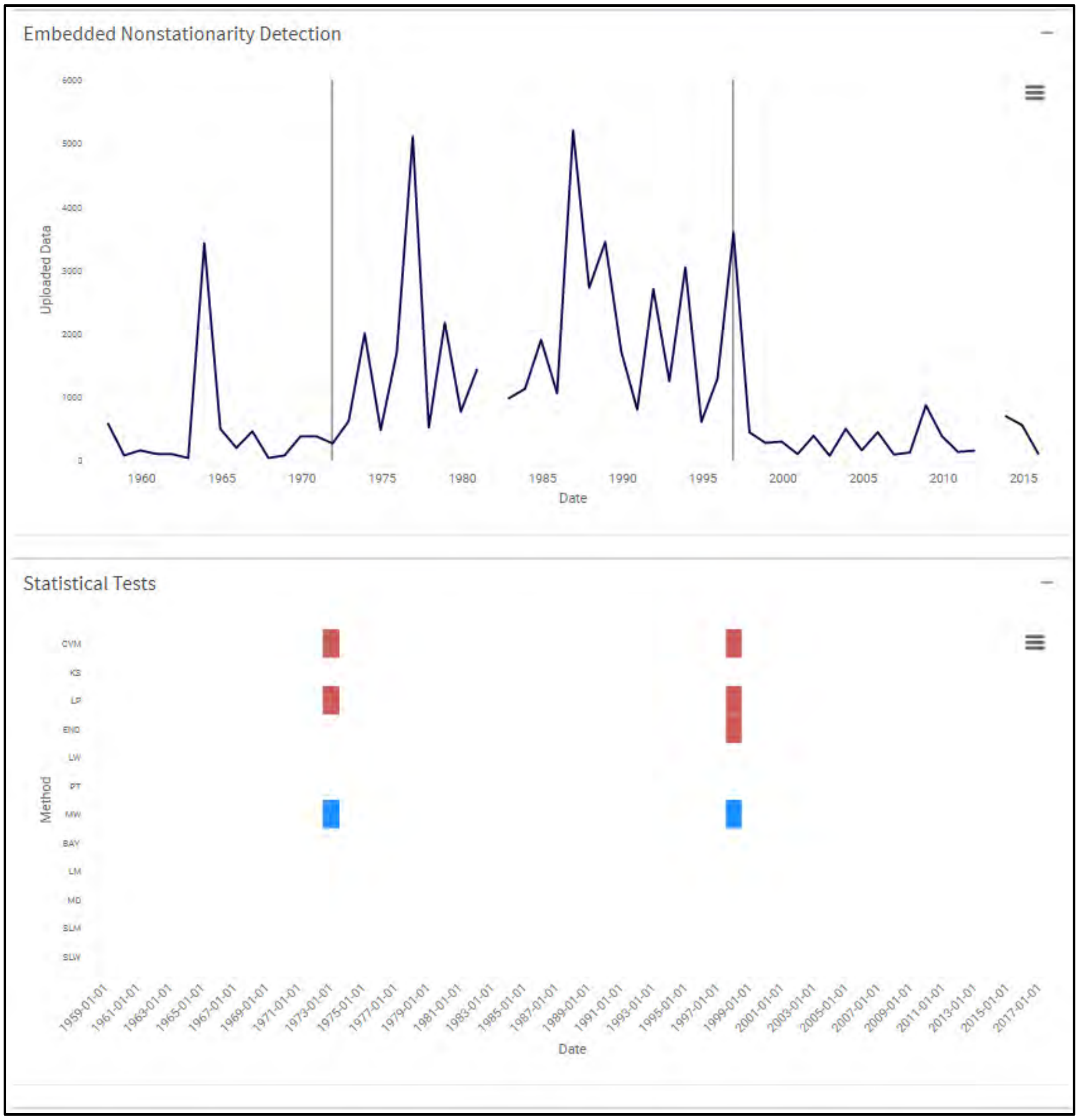


Figure 3-3. Observed Peaks & Linear Regression Analysis Buffalo River (1974-2017)

The Time Series Toolbox was used to analyze peak streamflows on the Kinnickinnic River Tributary between 1959 and 2019. The nonstationarity detection results for Kinnickinnic River Tributary gage, (USGS gage 05341900), showed two, strong nonstationarities, which are shown in Figure 3-4. A strong, nonstationarity was identified circa water year 1973 and 1998. The Cramer-Von-Mises (CVM) test, LePage test (LP), and Mann Whitney (MW) test all detect abrupt nonstationarities within a five-year span that encompasses 1973 and 1998. The 1973 and 1998 nonstationarities are considered strong because they demonstrate a degree of consensus, robustness, and a significant shift in the magnitude of the dataset's statistical properties. The criteria of consensus are fulfilled because multiple tests targeted at detecting shifts in the distribution of the dataset, (i.e. CVM and LP), indicate nonstationarities. The detected nonstationarities are considered robust because tests targeted at detecting abrupt shifts in multiple statistical properties, overall distribution and mean, indicate that 1973 and 1998 are nonstationarities. Additionally, the results presented by the Time Series Toolbox indicate a significant shift in both the magnitude of the mean and standard deviation. The standard deviation was assessed through the Coefficient of Variance (CoV). The Time Series Toolbox found the following results for each of the individually assessed data subsets: 1959-1973 (mean = 453 cfs; CoV = 0.67); 1974-1998 (mean = 1926 cfs; CoV = 0.38); and 1999-2017 (mean = 324 cfs; CoV = 0.4). Within the period of record analyzed (1959-2019) and the subsets of data prior to and after the detected, strong nonstationarities, no statistically significant trends were detected, (t-test, Mann-Kendall, Spearman Rank-Order at a 0.05 significance level). A simple linear regression analysis carried out in Microsoft Excel also did not find a significant trend at a 0.05 significance level, see Figure 3-5.



Type: Mean Distribution Variance Smooth

Figure 3-4. Time Series Plot (y-axis is annual peak flow, in cfs) and Nonstationarity Detection Results, (see Table 3-2), of the Annual Peak Streamflow for the Kinnickinnic River Tributary (USGS Gage 05341900)

Table 3-2. Abbreviations of Statistical Test Methods.

Abbreviation	Statistical Method	Abbreviation	Statistical Method
CVM	Cramer-von-Mises	BAY	Bayesian
KS	Kolmogorov-Smirnov	LM	Lombard Mood
LP	LePage	MD	Mood
END	Energy Divisive	SLM	Smooth Lombard Mood
LW	Lombard Wilcoxon	SLW	Smooth Lombard Wilcoxon
PT	Pettitt	MW	Mann-Whitney

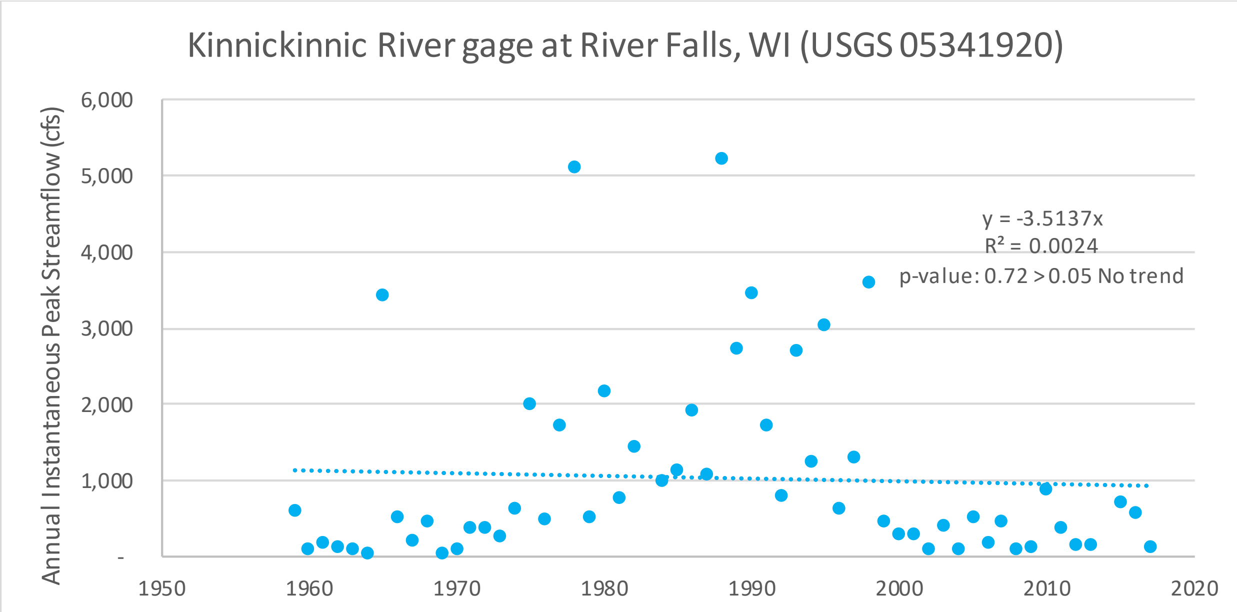


Figure 3-5. Linear Trend Analysis Annual Peak Streamflow for USGS Gage 05341900

It was discovered that the heavy rains in 1998 washed away the staff gage on the Kinnickinnic River. This coincides with the second nonstationarity. A new crest gage was installed the following year. It is unclear what is driving the nonstationarity detected in 1973 and whether nonstationarity detected in 1998 is caused by the change in monitoring equipment. Generally, the installation of a new gage should not result in such an abrupt shift in the range of streamflow peaks observed. Further investigation would be required to definitively attribute the detected nonstationarities to a specific driver.

3.3 Projected Hydrologic Trends

The USACE Climate Hydrology Assessment Tool, (CHAT; Reference 9), was used to investigate potential future changes to annual maximum monthly flows. CHAT works by combining the results of 93 different unregulated hydrologic model simulations for the St. Croix HUC-04 (HUC 0703) between 2000 and 2099. The hydrologic model simulations are forced with meteorological data derived from General Circulation Model (GCM) simulations that represent multiple future emissions scenarios, referred to as Representative Concentration Pathways (RCPs). The meteorological projections (temperature and precipitation) from the GCMs are spatially downscaled using the bias corrected spatially downscaled (BCSD) statistical method and then inputted in the Variable Infiltration Capacity (VIC) precipitation-runoff model. The VIC model is a macro-scale model representative of unregulated basin conditions and is used to generate a streamflow response.

As expected for this type of qualitative analysis, there is a considerable, but consistent spread in the projected annual maximum monthly flows, as shown in Figure 3-6. This spread is indicative of the uncertainty associated with climate changed hydrology and range in natural variability. Uncertainty in projected, climate changed hydrology is generated as a result of each component of the modeling chain. For instance, assumptions related to selected RCPs, downscaling techniques, and hydrologic modeling each insert their associated uncertainties into the projected, climate changed hydrology. The CHAT tool fits a linear trend line to the mean projected annual maximum monthly streamflow data for the period from 2000-2099 computed for the HUC 0703 watershed, as shown in Figure 3-7. The mean projected annual maximum monthly streamflow increases slightly over time, but this increase is not statistically significant, (p-value 0.585 < 0.05).

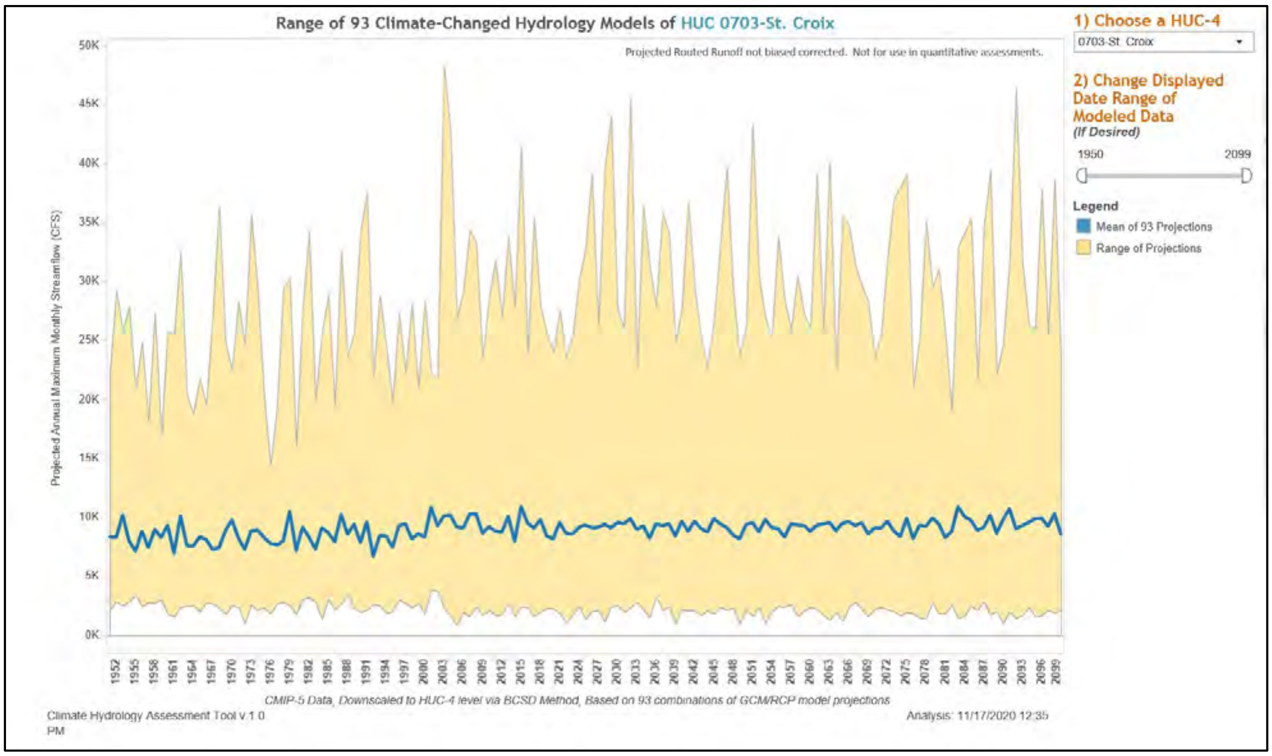


Figure 3-6. Range of 93 Climate-Changed Hydrology Model Runs for HUC 0703.

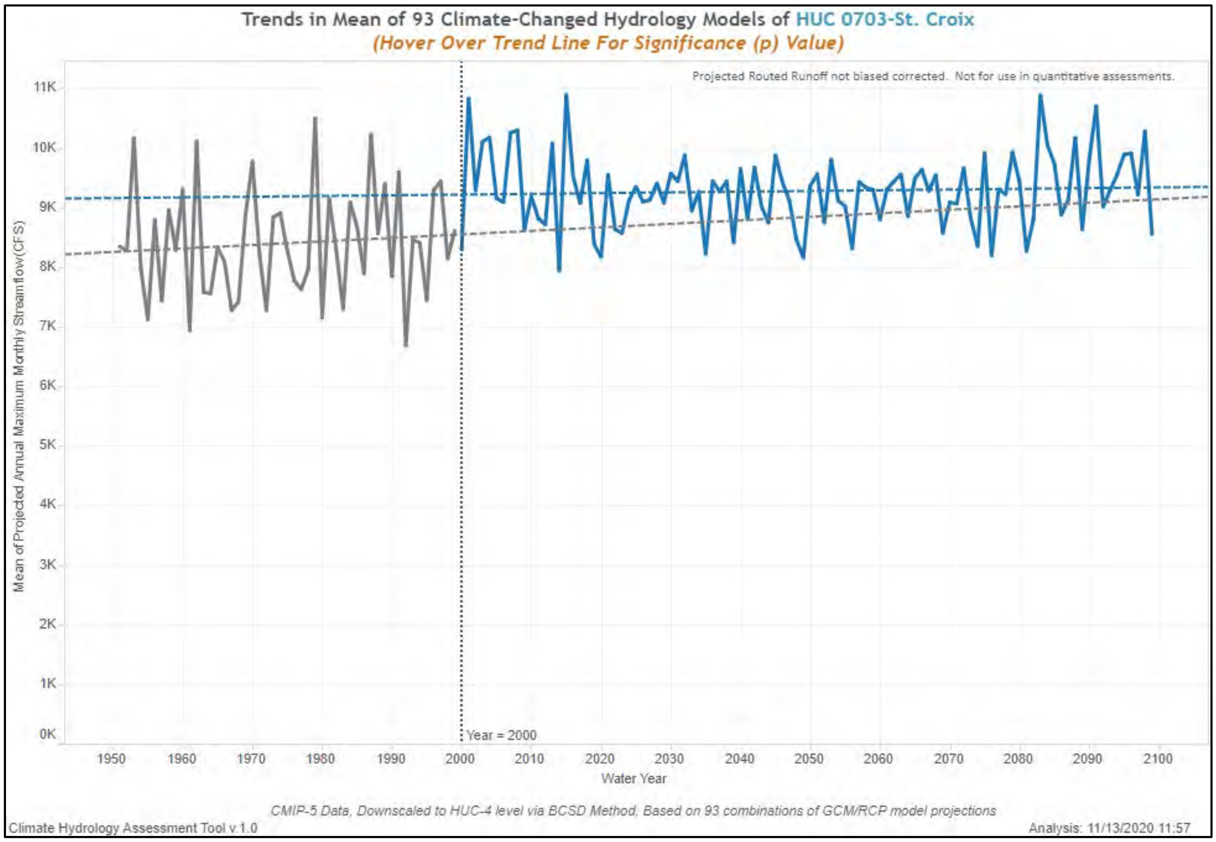


Figure 3-7. Trends in Means of 93 Climate-Changed Hydrology Model Runs for HUC 0703

4 Vulnerability Assessment

The USACE Watershed Climate Vulnerability Assessment (VA) Tool, (Reference 10), facilitates a screening level, comparative assessment of the vulnerability of a given HUC-04 watershed to the impacts of climate change relative to all other HUC-04 watersheds within the continental United States (CONUS). The HUC-04 watershed used in the Vulnerability Assessment analysis is the HUC 0703 St. Croix subbasin, which contains the Kinnickinnic River watershed. The tool is used to assess the relative vulnerability of a specific USACE business line, such as Flood Risk Reduction, to projected climate change impacts. Assessments using this tool identify and characterize specific climate threats and sensitivities or vulnerabilities, at least in a relative sense, across regions and business lines.

The Watershed Vulnerability tool uses the Weighted Order Weighted Average (WOWA) method to compute a composite index, (i.e. vulnerability score or WOWA score), of how vulnerable a given HUC-04 watershed is to climate change specific to a given business line. The HUC-04 watersheds with the top 20% of WOWA scores across CONUS are flagged as vulnerable. The vulnerability assessment analysis for this study was performed using the National Standard Settings. The USACE Climate Vulnerability Assessment Tool makes an assessment for two 30-year epochs centered at 2050 and 2085 to evaluate future risk due to climate change. These two epochs are selected to be consistent with many other national and international analyses related to climate. The Vulnerability tool assesses climate change vulnerability for a given business line using climate changed hydrology based on a combination of projected climate outputs from GCMs and RCPs of greenhouse gas emissions resulting in 93 traces per HUC-04 watershed per epoch. The top 50% of the traces by flow magnitude is called the “wet” subset of traces and the bottom 50% of traces is called the “dry” subset of traces. Meteorological data projected by the GCMs is translated into runoff using the Variable Infiltration Capacity (VIC) macro-scale hydrologic model. This model represents unregulated basin conditions. Presenting results based on two epochs and two subsets of GCM model outputs reveals some of the uncertainty of potential future conditions.

The Flood Risk Reduction business line is used to carry out the vulnerability assessment. Removing the structure will result in a reduction in flood risk. The primary purpose of this hydrologic and hydraulic study is to generate information which will be utilized in a submittal related to floodplain zoning; therefore, the USACE flood risk reduction business line is the most appropriate to evaluate vulnerability of this watershed to climate change. While recreation opportunities and ecosystem habitats are expected to increase as a result of the dam removal (Reference 7), their business lines were not analyzed, as the vulnerability of these parameters is less relevant to the primary purpose of the submittal. Indicators considered within the WOWA score for Flood Risk Reduction representing changes to the flow characteristics of the river include: the coefficient of variation in cumulative annual flow; runoff elasticity, (i.e. the ratio of streamflow runoff to precipitation); and flood magnification, (i.e. how flood flow is projected to change in the future).

Based on results of USACE vulnerability assessment tool, relative to the other basins in the United States, the Kinnickinnic River Basin is not particularly vulnerable to impacts of climate change to flood risk for either the wet or dry subsets of traces representing the 2050 and 2085 epochs, as shown in Figure 4-1. Note that this result is qualitative only and does not imply that the watershed will not be affected by future changes in flood risk driven by climate change. The results simply imply that this watershed is not among the top 20% of HUC-04 watersheds indicated as being vulnerable to future flood risk in the continental United States. The WOWA score for The St. Croix River watershed, (HUC 0703), was lower for the dry subsets of traces, at 50.71, compared to the wet subset, at 52.46, in the year 2050. Scores for both subsets increased for the 2085 projection, by 2.13% and 7.08%, respectively. The primary driver of the vulnerability score for the dry subset of traces is runoff elasticity. The primary driver of the vulnerability score for the wet subset of traces is flood magnification.

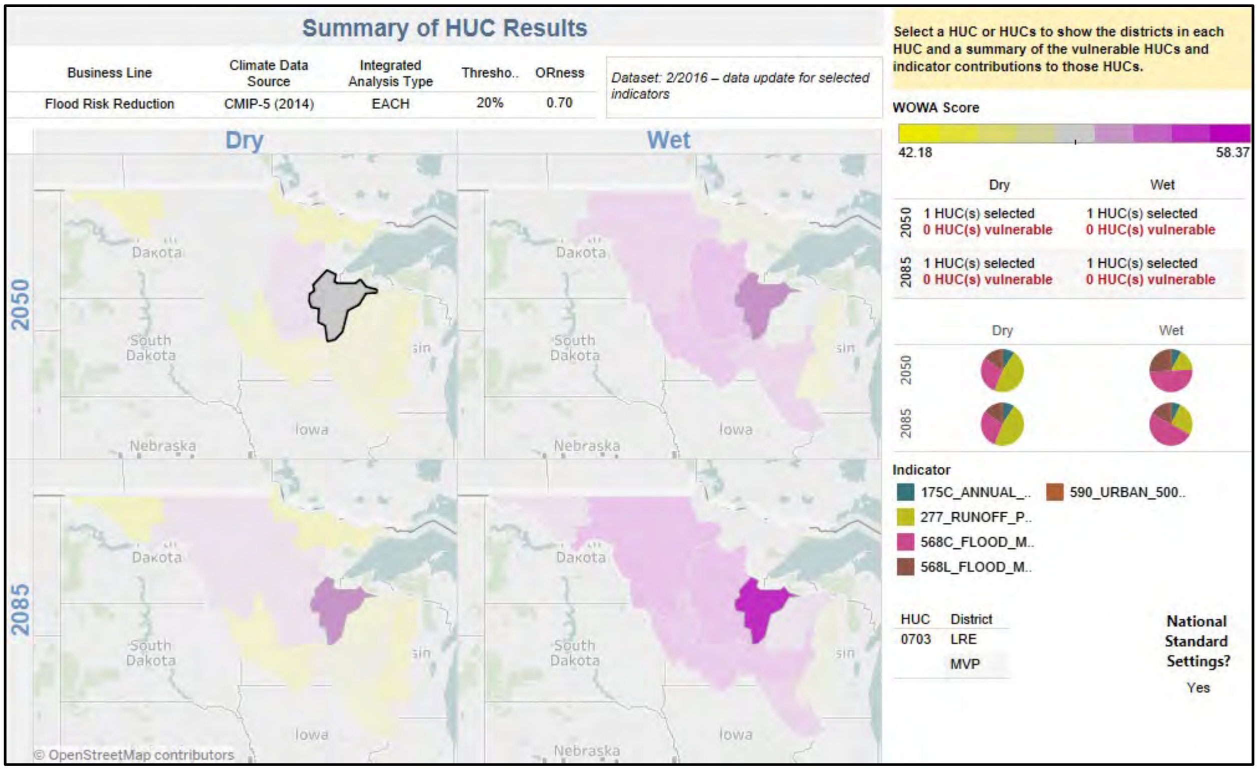


Figure 4-1. Projected Relative Vulnerability for the St. Croix Watershed (HUC 0703) with Respect to Flood Risk

5 Summary & Residual Risk

The consensus from the literature review is that temperature and precipitation is increasing within the region. The frequency and the intensity of extreme storms is increasing as well. Projections of future climate show a continued increase in temperature, precipitation, and the frequency of large storms. There is considerable variability and uncertainty associated with trends in observed and projected streamflow. A first order statistical analysis of observed and projected streamflow for the study area and a screening level vulnerability assessment of flood risk does not provide strong evidence that the hydrology in the basin is changing.

The risk that climate change could pose to the study area in terms of flood risk is described in Table 5-1. The proposed project will not impact flood risk in a detrimental way. The proposal to remove the hydropower structure and allow the river to return to a more natural state will serve to offset any potential negative impacts that climate change could induce in the study area in the future. For example, as described in Table 5-1, there is a low, qualitative likelihood that climate change might increase the risk of floods due to an increased frequency of extreme precipitation events. Removing the hydropower structure will result in a drop in water level in the study area. Thus, the dam removal will effectively reduce flood risk and offset any potential future increases in flood risk that might occur due to climate change.

Table 5-1. Potential Residual Risks

Project Feature	Trigger	Hazard	Harm	Qualitative Likelihood	Qualitative Justification for Likelihood Rating
Return to run-of-the-river conditions downstream of Junction Falls Dam	Increased precipitation year-round, increased frequency and intensity of extreme storms	Future flood volumes and peak discharges may increase relative to present day run-of-the-river conditions	Floods may reach higher elevations than what was experienced in the past	Low	Increases in temperature could potentially increase evapotranspiration and offset increases in flood flow. First order statistical analysis of streamflows in the basin do not provide strong evidence that basin hydrology is changing.

6 References

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Appendix B – Water Quality Study

River Falls Hydroelectric Project P-10489

Dissolved Oxygen and Temperature Monitoring

Updated Study Report on 2019 and 2020 Monitoring Seasons

Prepared for:

River Falls Municipal Utilities
River Falls, WI

January 2021

River Falls Hydroelectric Project, P-10489

Dissolved Oxygen and Temperature Monitoring

Updated Study Report on
2019 and 2020 Monitoring Seasons

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Background

River Falls (WI) Municipal Utilities is preparing an application for a new hydropower license for the River Falls Hydroelectric Project. The Project consists of two developments, from upstream to downstream Junction Falls and Powell Falls. Junction Falls Dam and Powell Falls Dam impound Lake George and Lake Louise respectively on the Kinnickinnic River. The entire Project is within the city limits of River Falls.

In response to resource agency requests the applicant conducted a two-year program to monitor summer dissolved oxygen and water temperatures in the Kinnickinic River in the project vicinity. An interim report presenting data collected at four locations in the summer of 2019 was prepared in January, 2020. After stakeholder consultation, an updated study plan was prepared for the summer of 2020. The present report covers both the 2019 and 2020 monitoring seasons. The 2019 season began in mid-July and ended in mid-September. In 2020, water quality monitors were deployed from May 15 to September 30, except for an interval in early July after a large flood event destroyed or displaced all of the monitoring instrumentation.

Study Procedure

Instrumentation installation, maintenance, and data downloads were conducted by personnel of Ayres Associates as described below.

Equipment

Four HOBO U26-001 continuous DO and temperature sensors with dataloggers were installed with auxiliary components including a data shuttle, base station, anti-fouling guard, sensor cap, and data management software. The product specifications for DO list an accuracy of 0.2 mg/L and monitoring range of zero to 30 mg/L. Temperature accuracy of the sensors was listed as 0.2 degrees Celsius and an operating range of -5 to 40 degrees C (23 – 104 degrees Fahrenheit). The Hobo sensors were calibrated prior to deployment using a 3-step lab calibration method described in the product documentation. The product documentation states that lab calibration is valid for 6 months after calibration. However, because all of the sensors and dataloggers were replaced in July the longest deployment period after lab calibration was approximately 11 weeks. Gain and offset adjustment values were determined from the elevations of the installation sites.

Independent "grab sample" readings were taken at the time of the Hobo datalogger downloads and recorded in the field. The purpose of the grab samples was to confirm the performance of the continuous sensors, develop drift corrections if necessary, and describe spatial variations in water quality, especially in Lake George. The instrument used in 2019 was a YSI Model 55 handheld oxygen and temperature meter. In 2020, a YSI Pro 20 instrument was used. Product specifications for the YSI Model 55 used in 2019 list a DO accuracy of 0.3 mg/L and a monitoring range of 0 to 20 mg/L. Temperature accuracy is listed as 0.2º C (0.4º F) with a range of -5º to 45º C (23º to 113º F). Product specifications for the YSI Pro 20 used in 2020 list a DO accuracy of 0.2 mg/L for a monitoring range of 0 to 20 mg/L and an accuracy of plus or minus 6 percent for a monitoring range of 20 to 50 mg/L. Temperature accuracy is listed as 0.3º C (0.5ºF) with a range of -5º to 55º C (23º to 131º F). The YSI meter was calibrated before the site visits using the manufacturer's recommended wet-sleeve "one touch" calibration method. In late July, some field readings suggested the YSI was not maintaining calibration and in August a second instrument (YSI

Pro ODO) was used to confirm the field readings. The duplicate readings indicated that the YSI Pro 20 was providing accurate readings and the late July inconsistencies did not reappear.

Monitoring Locations

The Hobo units (sensors and dataloggers) were placed at four locations as follows:

1. Project Inflow, upstream of Lake George in a free-flowing reach of river downstream from the Division Street bridge. This sensor recorded dissolved oxygen and temperature for flow entering the project area and prior to passage through the project impoundments, powerhouses or spillways. Flow in this location is shallow, fast-moving, and well mixed. The water depth at the sensor location was approximately 1.5 feet.

2. Lake George, the impoundment of Junction Falls Dam. The Hobo unit was installed approximately 600 feet upstream of Junction Falls Dam. According to the Lathrop-Lillie equation provided in the *Wisconsin 2020 Consolidated Assessment and Listing Methodology (WisCALM)* document (Wisconsin Department of Natural Resources, 2019, p.22), Lake George is considered a shallow, mixed (unstratified) water body. This calculation is based on a 16-acre surface area and 10-foot maximum depth as shown in the 2016 Inter-Fluve "Sediment Assessment Report" for Lake George. The depth at the sensor location was approximately three feet.

3. Junction Falls Outflow, downstream of Junction Falls Dam and powerhouse. The intent of this placement was to capture Lake George outflows while avoiding or minimizing effects from the South Fork of the Kinnickinnic, which enters on the opposite side of the river (southeast) from the powerhouse outfall. Grab samples were collected from both the South Fork outflow and the instrument location to provide a comparison between the streamflow sources. The instrument location was in a relatively deep (2.5 feet) and slow-moving pool below the dam.

4. Powell Falls Outflow, approximately 200 feet downstream from Powell Falls Dam. This is a free-flowing reach of river. Water depth at the sensor location was approximately 1.5 feet.

In 2019, the locations initially established were retained throughout the summer with the exception of the "Project Inflow" location, as discussed below. In 2020, public disturbance of the other installations was a much more persistent problem than in 2019, so some of the instruments were relocated or replaced in less visible and/or less accessible locations while preserving the general intent of the placements as described above. (The reason for the increase in apparent public interference is not known. Instruments were generally not stolen or destroyed, but on multiple occasions they were detached from their anchors, laid on the streambed, or left on the bank nearby).

Once installed, the Hobo unit locations were surveyed with a GPS. The Hobo locations are shown in Figures 1a (2019) and 1b (2020). In 2019, biweekly handheld meter measurements were made at the Hobo unit locations. Downloads and handheld meter readings were conducted somewhat more frequently (on average every ten days) in 2020 than in 2019. Each download visit included a check and cleaning of the Hobo sensor, sensor cap, and fouling guard.

In 2020, a YSI transect was also added across Lake George as indicated in Figure 1b. The 2020 study plan also called for longitudinal handheld meter measurements to be made downstream of Junction Falls and Powell Falls any time the measured dissolved oxygen at the continuous monitoring location below the dam read below 6 mg/L. This condition did not occur on any of the download/sampling visits, although the continuous record suggests it occurred on some occasions between download visits.

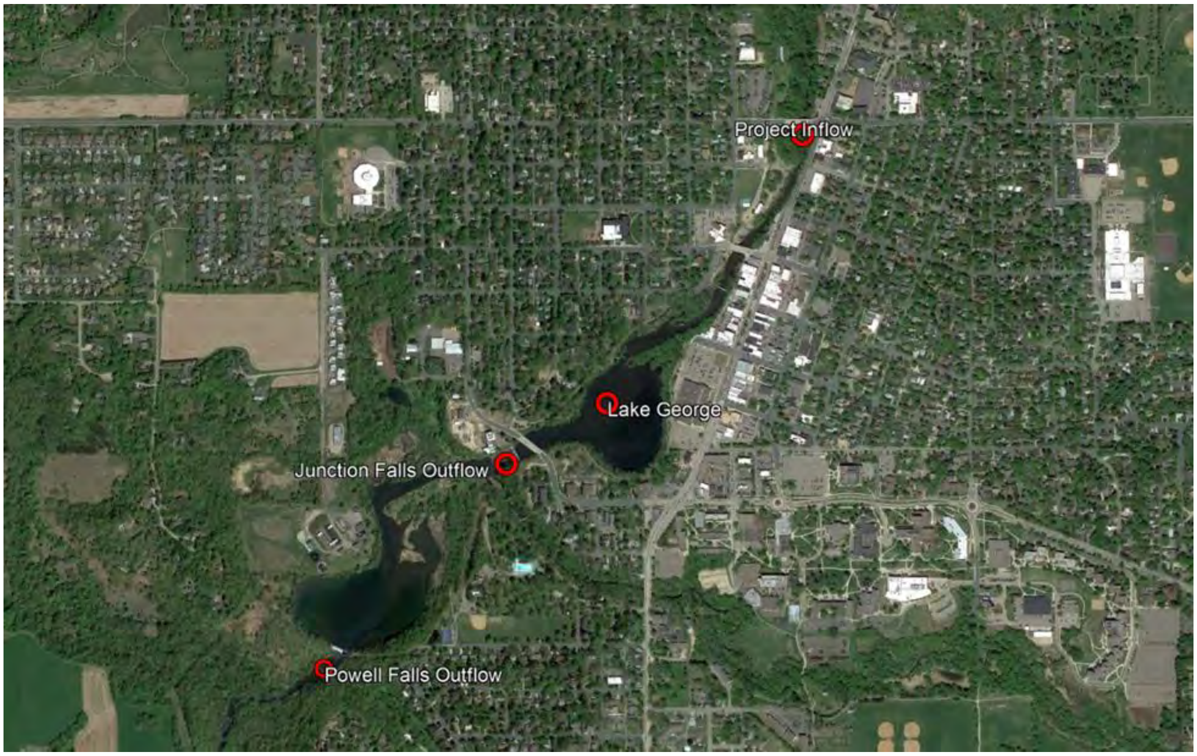


Figure 1a: Hobo Unit Locations (2019)

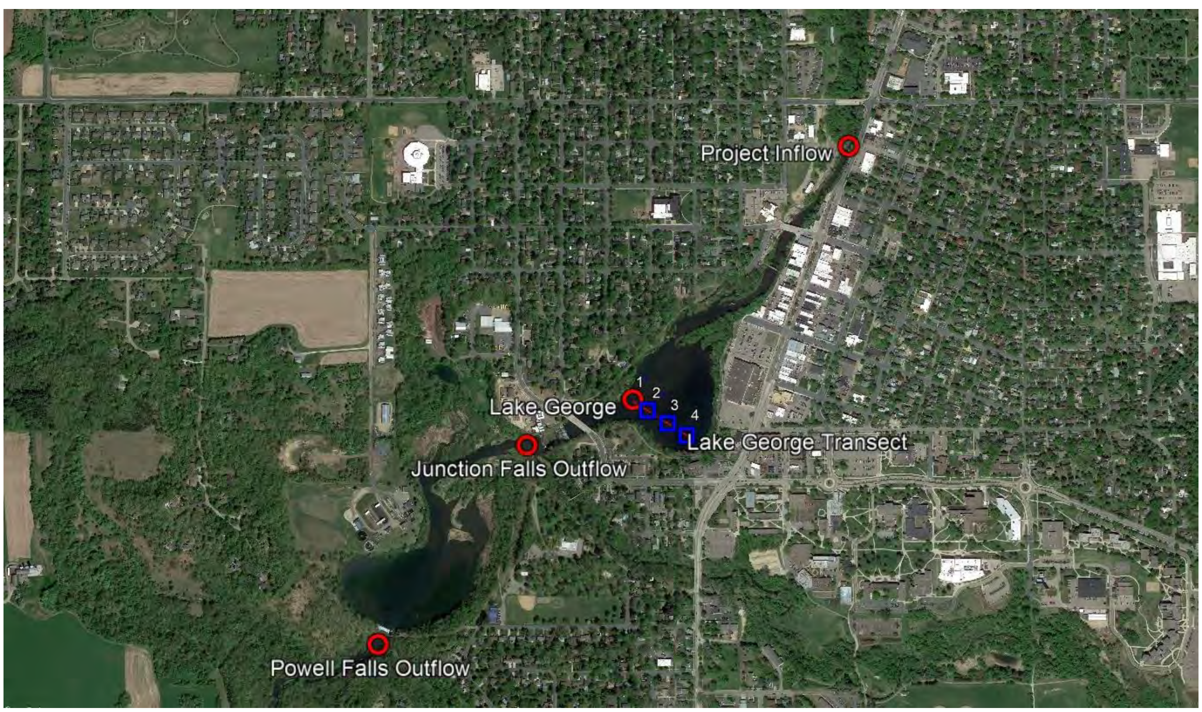


Figure 1b: Hobo Unit Locations (2020) (note new Lake George grab sample sites in blue)

Installation

Each sensor was attached to a slotted PVC pipe, anchored with one or more cinder blocks, and positioned approximately in the middle of the water column. Buoys were attached to the pipes to assist in retrieving the unit should it become detached from the anchor block. Figure 2 shows a typical installation.

Figure 2: Monitor installation downstream of Junction Falls Dam

The installations shown in Figure 2 were in place throughout the 2019 season. However, over the course of the summer of 2020, the PVC pipes at all but the Lake George location were eliminated as they seemed to attract public interference. The sensors were then attached to the cinder blocks themselves with no above-water visibility, positioned to maintain a mid-water-column vertical location.

Reading and Download Frequency

The Hobo dataloggers were programmed to record dissolved oxygen concentrations and water temperatures at 15-minute intervals, around the clock. Data were downloaded approximately every two weeks in 2019 and at one- to two-week intervals in 2020 as weather, flow conditions, and other instrument maintenance needs permitted. The Hobo sensors and fouling guards were cleaned at each visit and readings checked against the YSI meter data.

The “project inflow” monitoring location was problematic from a public disturbance perspective in both 2019 and 2020. In 2019, the anchor and buoy for the “project inflow” monitoring location unit were vandalized almost immediately upon setup, prior to deployment of the data logger. The datalogger was then installed with additional contact and security information but was then removed or stolen sometime between July 23 and August 2. The unit was then replaced in a less conspicuous location, with the result that very limited “project inflow” readings are available before August 2, 2019. The unit was also moved in June 2020 to a less visible downstream location.

On the night of June 28-29, 2020, a rainstorm occurred that reportedly produced up to eight inches of rain in some parts of the Kinnikinnic watershed. The peak reported flow at the USGS gaging station downstream of River Falls was approximately 6,300 cfs. In comparison, the January 2021 *Hydraulic and Hydrologic Analysis, River Falls Hydroelectric Project* (U.S. Army Corps of Engineers, St. Paul District) presents an estimated 20-year flood magnitude of 6,550 cfs at the USGS gage, but also notes there is significant uncertainty in this estimate. The June 29, 2020 flow recorded at the USGS gaging station was 35 percent larger than the next largest event in the 24-year systematic record, but smaller than non-gaged floods reported from 1894, 1934, and 1965.

Figure 3 shows the June 29, 2020 flood at the Junction Falls spillway (photo provided by River Falls Municipal Utilities).

Figure 3. June 29, 2020 Flood at Junction Falls

All four Hobo installations were lost and could not be recovered following the June 29 flood event. Replacements were ordered immediately and were installed on July 17. Therefore, no continuous data are available between June 19 (the date of the last download visit) and July 17, 2020.

Table 1 lists the Hobo unit locations, water depths, and recording dates.

Table 1: Dissolved Oxygen/Temperature 15-Minute Recording Locations and Dates

Location	Water Depth (ft) at first placement (7-18-2019)	Recording Dates	Comments
Project Inflow	2.2	7/18 - 7/23, 2019 8/2 - 8/5, 2019 8/6 - 9/17, 2019 5/15 - 6/19, 2020 7/17 – 10/2, 2020	Free flowing reach, water depth varied throughout recording period. Sensor was placed in PVC pipe in 2019. In 2020 it was initially placed in PVC pipe but later attached to cinder block approximately 1 foot off the streambed due to repeated disturbance by the public.
Lake George	4.2	7/18 – 9/16, 2019 5/15 – 6/19, 2020 7/17 – 10/2, 2020	Impounded reach above Junction Falls Dam
Junction Falls Outflow	3.9	7/18 – 9/17, 2019 5/15 – 5/29, 2020 6/12 – 6/19, 2020 7/17 – 10/2, 2020	Placed in pool near western shoreline to capture powerhouse/spillway outflows with minimal impact by South Fork Found removed from stream and left on streambank 6-12-2020.
Powell Falls Outflow	2.9	7/18 – 9/17, 2019 5/15 – 6/19, 2020 7/17 – 10/2, 2020	Free flowing reach, water depth varied throughout recording period. Some public disturbance; unit typically moved but left in the water.

Additional Data Collection

Additional data were collected as follows:

- Algae cover in Lake George was noted during data download visits. Algae cover was recorded photographically and visually estimated as a percentage of the lake's surface area.

- Independent measurements of dissolved oxygen and temperature were taken at the data logger sites during data download visits. These samples were taken within the top 18 inches of the water column using a YSI handheld temperature/DO meter.

-In Lake George, a vertical profile was sampled by taking YSI readings at depths near the top, center, and bottom of the water column. This was done in 2020 only, at the Hobo unit location and at three additional locations across a northwest-to-southeast transect as shown on Figure 1b.

- Daily average air temperatures for River Falls were retrieved from the Accuweather website (2019) and NOAA's online climate data repository (2020).

- Daily flows at USGS stream gage 05342000, located approximately eight river miles downstream of Powell Falls, were downloaded and plotted along with the water quality and air temperature data. The drainage area at the USGS gage is 23 percent larger than that at Powell Falls and 48 percent larger than that at Junction Falls. Therefore, the USGS gage flows should be seen as an index to the streamflow at the study location, not the actual local flow rate.

During the download visits at the Junction Falls and Powell Falls outflow monitors, field personnel were prepared to take additional downstream YSI readings if the dissolved oxygen concentrations in the dam's tailrace were found to be less than 6 mg/L. This condition did not occur during any of the site visits.

Applicable Water Quality Standards

The Kinnickinnic River is designated a Class I trout stream by the state of Wisconsin. Wisconsin's Administrative Code NR 102.04 states: *Dissolved oxygen in classified trout streams shall not be artificially lowered to less than 6.0 mg/L at any time, nor shall the dissolved oxygen be lowered to less than 7.0 mg/L during spawning season.*

For waters that are not designated trout streams, NR 102.04 specifies a minimum dissolved oxygen concentration of 5.0 mg/L.

Chapter NR 102.25 also presents monthly temperature standards for cold-water fisheries and for lakes and impoundments as shown in Table 2:

Table 2: Temperature Standards for Wisconsin Lakes and Cold-Water Streams (Wisconsin Administrative Code, Chapter NR 102)

Month	**Maximum Temperature Standard (degrees Fahrenheit)**		
	Ambient	**Sub-Lethal**	**Acute**
Lakes and Impoundments			
May	55	67	81
June	67	75	85
July	72	79	86
August	71	79	86
September	63	72	84
Streams - Cold Water Fisheries			
May	56	63	72
June	62	67	72
July	64	67	73
August	63	65	73
September	57	60	72

Ambient water quality is determined by a grab sample at a particular time and place, sub-lethal criteria are evaluated by weekly average maximum temperatures, and acute criteria are evaluated according to the daily maximum temperature.

Monitoring Results

15-Minute Dissolved Oxygen and Temperature Readings

Plots of dissolved oxygen concentration, water temperature, daily air temperature, percent dissolved oxygen saturation, and flow for the 2019 and 2020 seasons at each instrument location are included as Appendix A. Percent dissolved oxygen saturation was computed based on a barometric pressure of 750 mm Hg, representative of barometric pressures recorded at the Chanhassen, Minnesota NWS station.

The Appendix A plots also show the YSI grab sample readings.

Data Processing

Water temperatures recorded by the Hobo sensors and the YSI meter were consistent throughout the sampling seasons. At every location and every data download visit, the YSI dissolved oxygen reading at the time of retrieval and the initial Hobo reading after redeployment were also in good agreement. However, in some instances the dissolved oxygen concentrations recorded by the continuous Hobo sondes prior to retrieval did "drift" downward relative to the reading obtained at the end of the period with the YSI (and the reading obtained by the Hobo after cleaning). This was presumably due to sediment and/or algae impacting the Hobo sensor. Therefore, certain intervals in the 2020 Appendix A dissolved oxygen plots were corrected for drift. A drift adjustment was not applied to the 2019 data, because drift was not similarly apparent in the 2019 season.

The onset of the drift was identified visually by a shift in the plotted raw data typically beginning two or more days after the initial redeployment. The correction was a linear adjustment based on the difference between the last pre-retrieval Hobo reading, the YSI reading at the time of retrieval, and the first Hobo reading following cleaning and redeployment. Where possible the Hobo software's drift correction was used, but this did not always produce reasonable results. A "drift" period was then identified based on a visual inspection of the plotted raw data, and a correction was applied that increased linearly from zero at the beginning of the period to the measured offset (the difference between the last Hobo reading before retrieval and the first Hobo reading following cleaning and redeployment) at the end of the period.

In other instances, the Hobo records of dissolved oxygen concentration showed uncharacteristic patterns like sudden drops, large fluctuations, or flattened diurnal time series. However, these intervals did not lend themselves to a simple drift adjustment, either because there was not a consistent downward trend, or there was no significant disagreement with the YSI reading at the end of the recording period. These periods were plotted without adjustment, using a symbol flagging the data points as "suspect."

The following locations and periods in 2020 were adjusted using a linearly increasing drift correction factor, or were flagged as "suspect" data:

Project Inflow: No drift corrections; June 3-5, 2020, flagged as "suspect."

Lake George: Drift corrections May 24-29; June 1-11; June 14 -19; August 21-Sept 1, 2020; no "suspect" periods

Junction Falls Outflow: Drift correction May 19-20; missing data due to being removed from water May 29 –June 12; data flagged as suspect July 31 – August 6

Powell Falls Outflow: No drift corrections; flagged as suspect June 5 – 19, August 27 – 31, September 12 – 18; persistent issues with unit being displaced by public.

Summary of Seasonal Data

Table 3 summarizes the Hobo dissolved oxygen data in comparison to the above listed criteria, including the "suspect" readings from 2020. The applicable minimum dissolved oxygen concentration for cold water fisheries (trout streams) is 6 mg/L, as the study was conducted outside of the spawning season. Wisconsin's minimum dissolved oxygen concentration standard for lakes and impoundments is 5 mg/L.

Table 3: Summary of Recorded Dissolved Oxygen Concentrations

Location	Measured Dissolved Oxygen Range (mg/L) for Season	Percent of readings < 6.0 mg/L (trout stream standard)	Percent of readings < 5.0 mg/L (other water body standard)
Project Inflow	7.0 – 13.0 (2019) 1.4* – 14.5 (2020)	0 % 1.6%*	0 % 1.5%*
Lake George	0.0 – 13.0 (2019) 2.0 – 15.5 (2020)	37 % 12%	28 % 8%
Junction Falls Outflow	2.9 – 13.5 (2019) 2.4* – 12.4 (2020)	4 % 3%*	3 % 2 %*
Powell Falls Outflow	0.7 – 12.2 (2019) 0.0 – 15.0 (2020)	29 % 15%*	18 % 13%*
** lowest readings during period of "suspect" data*			

Tables 4 and 5 lists the maximum and average observed water temperatures by month, along with Wisconsin cold-water stream and lake criteria from Table 2. Temperatures representing periods in 2020 when the sensor was found to be removed from the water and recording air temperatures are omitted.

Table 4: Summary of Recorded Maximum 15 Minute (Acute) Temperatures

Month	Acute Water Temperature Criteria for Cold Water Stream/Lake, ºF		Maximum 15-minute Temperature, ºF			
	Stream	Lake	Project Inflow	Lake George	Junction Falls Outflow	Powell Falls Outflow
July 2019	73	86	64	78	78	80
Aug. 2019	73	86	63	65	65	82
Sept. 2019	72	84	63	62	63	66
May 2020	72	81	65	65	67	73
June 2020	72	85	65	68	69	72
July 2020	73	86	66	68	68	69
Aug. 2020	73	86	65	66	68	70
Sept. 2020	72	84	59	60	61	62

Table 5: Summary of Recorded Average Monthly (Ambient) Temperatures

Month	Ambient Water Temperature Criteria for Cold Water Stream/Lake, ºF		Monthly Average Water Temperature, ºF			
	Stream	Lake	Project Inflow	Lake George	Junction Falls Outflow	Powell Falls Outflow
July 2019	64	72	60	61	62	63
Aug. 2019	63	71	60	59	60	61
Sept. 2019	57	63	56	57	57	58
May 2020	56	55	57	57	58	59
June 2020	62	67	59	60	61	62
July 2020	64	72	61	62	63	63
Aug. 2020	63	71	59	60	61	62
Sept. 2020	57	63	54	54	55	55

Table 6 and Table 7, below, are provided to illustrate typical daily variations in time and space. Tables 6 and 7 provide “snapshots” of the monitor readings throughout the study reach at 4:00 a.m. and 4:00 p.m. at semi-monthly intervals. The same data are also included for the dates in each sampling season on which the highest water temperature and the lowest dissolved oxygen concentration were recorded downstream of Powell Falls Dam.

Table 6: Dissolved Oxygen Concentrations Through Study Reach, Selected Dates and Times

Date	Time	Dissolved Oxygen Concentration (mg/L)			
		Project Inflow	Lake George	Junction Falls Outflow	Powell Falls Outflow
July 20, 2019	4:00 a.m.	8.5	7.7	7.8	6.7
	4:00 p.m.	8.8	8.6	9.2	9.3
August 1, 2019	4:00 a.m.	N/A	6.3	7.6	7.7
	4:00 p.m.	N/A	7.6	11.1	9.2
August 10, 2019 *	4:00 a.m.	8.9	7.1	7.8	4.3
	4:00 p.m.	11.1	7.8	9.4	3.1
August 15, 2019	4:00 a.m.	8.7	6.6	8.4	5.4
	4:00 p.m.	11.1	8.8	11.2	4.9
August 31, 2019	4:00 a.m.	9.5	4.4	9.9	4.0
	4:00 p.m.	11.4	9.8	10.9	4.1
Sept. 15, 2019	4:00 a.m.	9.3	8.4	9.9	8.2
	4:00 p.m.	10.7	6.2	9.7	6.8
May 16, 2020	4:00 a.m.	9.6	9.6	9.8	10.8
	4:00 p.m.	14.0	12.5	11.7	12.6
June 1, 2020	4:00 a.m.	9.2	4.2	NA	9.3
	4:00 p.m.	10.9	9.2	NA	11.6
June 15, 2020	4:00 a.m.	9.3	5.7	10.0	3.9**
	4:00 p.m.	11.4	8.9	9.8	5.4**
July 18, 2020	4:00 a.m.	8.6	8.7	9.1	8.3
	4:00 p.m.	10.6	10.7	9.5	10.8
August 1, 2020	4:00 a.m.	8.8	9.0	7.8	8.3
	4:00 p.m.	10.5	11.2	8.6	10.3
August 6, 2020*	4:00 a.m.	9.0	9.0	4.8	5.0
	4:00 p.m.	12.0	12.9	9.9	12.6
August 15, 2020	4:00 a.m.	8.1	8.1	9.0	9.1
	4:00 p.m.	9.3	10.9	9.6	9.2
Sept. 1, 2020	4:00 a.m.	8.9	10.3	9.1	10.2
	4:00 p.m.	10.5	10.7	9.7	10.8
Sept 15, 2020	4:00 a.m.	9.3	9.2	9.7	0.6**
	4:00 p.m.	10.6	11.1	9.9	1.3**
Sept. 30, 2020	4:00 a.m.	9.6	9.4	9.9	9.4
	4:00 p.m.	10.8	11.0	10.1	11.6

* Date of minimum annual (reliable) recorded DO concentration at Powell Falls Outflow site
** Questionable reading but observed trends and/or YSI readings do not justify correction

Table 7: Water Temperatures Through Study Reach, Selected Dates and Times

Date	Time	Water Temperature (degrees Fahrenheit)			
		Project Inflow	Lake George	Junction Falls Outflow	Powell Falls Outflow
July 19, 2019*	4:00 a.m.	58	59	61	62
	4:00 p.m.	63	65	65	66
July 20, 2019	4:00 a.m.	60	61	63	64
	4:00 p.m.	60	61	62	63
August 1, 2019	4:00 a.m.	N/A	57	59	60
	4:00 p.m.	N/A	64	63	65
August 15, 2019	4:00 a.m.	58	58	60	60
	4:00 p.m.	61	62	63	64
August 31, 2019	4:00 a.m.	54	54	55	57
	4:00 p.m.	56	57	58	58
Sept. 15, 2019	4:00 a.m.	54	55	55	55
	4:00 p.m.	56	57	58	59
May 16, 2020	4:00 a.m.	54	54	54	56
	4:00 p.m.	56	56	57	57
June 1, 2020	4:00 a.m.	56	56	N/A	58
	4:00 p.m.	62	63	N/A	66
June 8, 2020*	4:00 a.m.	N/A	61	N/A	63
	4:00 p.m.	N/A	68	N/A	70
June 15, 2020	4:00 a.m.	57	57	57	59
	4:00 p.m.	60	60	62	62
July 18, 2020	4:00 a.m.	64	62	63	65
	4:00 p.m.	65	66	67	68
August 1, 2020	4:00 a.m.	58	58	59	60
	4:00 p.m.	60	61	62	63
August 15, 2020	4:00 a.m.	59	60	61	62
	4:00 p.m.	62	63	64	65
Sept. 1, 2020	4:00 a.m.	56	57	57	57
	4:00 p.m.	57	58	59	60
Sept. 15, 2020	4:00 a.m.	55	55	56	56
	4:00 p.m.	59	60	60	61
Sept. 30, 2020	4:00 a.m.	51	51	51	51
	4:00 p.m.	53	54	54	55
* Date of maximum annual (reliable) recorded water temperature at Powell Falls Outflow site					

Other Field Measurements

During the data download visits, grab samples using the YSI meter for dissolved oxygen and temperature were taken at the Hobo installation locations and (in 2020) at three additional sites in Lake George, as described in Figure 1b and Tables 8a – 8d. Additionally, the percent of algae cover on Lake George was visually estimated and photographed during each field visit. The data downloads and grab samples were always performed in the morning, usually between 9:00 and 11:00 a.m. A single YSI reading approximately 0.5 to 1 foot below the water surface was recorded at the project inflow, Junction Falls outflow, and Powell Falls outflow. In Lake George, vertical and transect profiles were recorded in 2020 as shown in Table 8b. The three depth ranges shown in Table 8b for the 2020 readings represent the top, middle, and bottom of the water column at the four sample sites. Site LG-2 was the shallowest location in the transect, with a maximum depth of 1 foot, and site LG-1 was the deepest, with a maximum depth of 3 feet. The maximum sampling depths changed somewhat due to sediment transport and redeposition during and after the late June flood event.

Table 8a: YSI Meter Field Measurements at Project Inflow Site

Date	Dissolved Oxygen (mg/L)	Water Temperature (ºF)
Aug. 2, 2019	5.9 *	57
Aug. 13, 2019	10.4	55
Sept. 4, 2019	9.5	56
Sept. 17,2019	10.2	56
May 29, 2020	9.1	58
June 12, 2020	9.1	57
June 19, 2020	8.3	58
July 17, 2020	8.8	59
July 24, 2020	8.2	58
Aug. 6, 2020	9.2	56
Aug. 21, 2020	10.0	58
Sept. 1, 2020	9.7	56
Sept. 18, 2020	11.6	49
Sept. 25, 2020	10.6	58
**atypical for this site; reason for low reading is unknown. Reading was repeated 150' upstream with a similar result. Similar YSI reading (6.0 mg/L) was taken in Lake George on the same morning.*		

Table 8b: YSI Meter Field Measurements at Lake George Monitoring Site and Transect
(LG-2, LG-3, LG-4 numbered from northwest to southeast, Fig. 1b)

Date	Depth (ft)	Site LG-1 (Hobo Unit Location)		Site LG-2 (2 vertical pts before flood; 1 after)		Site LG-3 (3 vertical pts before flood; 2-3 after)		Site LG-4 (3 vertical pts)		Algae Cover %
		DO (mg/L)	Water Temp (ºF)	DO (mg/L)	Water Temp (ºF)	DO (mg/L)	Water Temp (ºF)	DO (mg/L)	Water Temp (ºF)	
July 18, 2019	0.5 - 1	5.2	61							50
Aug. 2, 2019	0.5 - 1	6.2	59							30
Aug. 13, 2019	0.5 - 1	10.2	58							25
Sept. 4, 2019	0.5 - 1	4.6	58							25
Sept. 17, 2019	0.5 - 1	9.1	58							15
May 29, 2020	0.5 1 - 1.5 1.5 - 3	8.6 8.7 8.6	57 57 57	8.9 8.7	57 57	9.2 9.2 9.4	58 58 58	8.3 8.9 8.4	61 61 58	0
June 12, 2020	0.5 1-1.5 1.5 - 3	8.2 8.0 7.7	56 56 56	8.2 8.2	57 57	8.7 8.6 8.4	57 57 57	7.2 7.1 7.3	59 57 57	10
June 19, 2020	0.5 1-1.5 1.5 - 3	7.9 7.7 7.6	58 58 58	7.9 7.9	59 59	8.0 8.4 8.0	59 59 59	6.4 6.4 6.9	61 61 60	10
July 17, 2020	0.5 1-1.5 1.5 - 3	8.6 8.4 8.3	59 59 59	7.6	63	7.1 7.7	61 60	7.3 7.0 7.4	65 65 60	20
July 24, 2020	0.5 1-1.5 1.5 - 3	8.3 8.2 7.8	59 58 59	7.8	63	7.7 8.4 8.4	62 60 60	6.7 6.5 7.6	63 62 60	20
Aug. 6, 2020	0.5 1-1.5 1.5 - 3	10.4 10.2 10.1	57 57 56	11.1	63	10.1 9.8 9.3	63 63 64	9.3 8.3 7.8	64 62 61	30
Aug. 21, 2020	0.5 1-1.5 1.5 - 3	9.7 9.6 9.7	59 59 59	9.2	65	10.4 9.6	65 64	10.5 10.4 10.6	66 64 63	35
Sept. 1, 2020	0.5 1-1.5 1.5 - 3	10.5 10.3 10.3	58 57 57	13.6	62	15.2 16.9	65 65	11.1 11.2	63 63	40
Sept. 18, 2020	0.5 1-1.5 1.5 - 3	10.7 10.5 10.4	49 49 49	11.7	52	13.0 13.5	53 53	13.5 14.4	55 55	40
Sept. 25, 2020	0.5 1-1.5 1.5 - 3	10.5 10.3 10.1	55 55 55	11.0	61	11.1 11.7	60 59	12.8 13.1	61 61	35

Table 8c: YSI Meter Field Measurements at Junction Falls Outflow Site

Date	Dissolved Oxygen (mg/L)	Water Temperature (ºF)
July 18, 2019	5.2	63
Aug. 2, 2019	7.3	60
Aug. 13, 2019	8.8	59
Sept. 4, 2019	7.1	57
Sept. 17,2019	7.9	59
May 29, 2020	9.1	62
June 12, 2020	9.0	56
June 19, 2020	8.5	60
July 17, 2020	8.8	60
July 24, 2020	8.6	60
Aug. 6, 2020	9.3	58
Aug. 21, 2020	10.3	60
Sept. 1, 2020	9.5	50
Sept. 18, 2020	11.7	57
Sept. 25, 2020	10.7	47

Table 8d: YSI Meter Field Measurements at Powell Falls Outflow Site

Date	Dissolved Oxygen (mg/L)	Water Temperature (ºF)
Jul 18, 2019	4.0	61
Aug. 2, 2019	6.9	62
Aug. 13, 2019	8.5	59
Sept. 4, 2019	6.2	58
Sept. 17,2019	6.8	59
May 29, 2020	9.1	59
June 12, 2020	9.3	58
June 19, 2020	9.0	61
July 17, 2020	8.9	60
July 24, 2020	8.9	61
Aug. 6, 2020	9.0	58
Aug. 21, 2020	10.5	62
Sept. 1, 2020	10	57
Sept. 18, 2020	11.8	50
Sept. 25, 2020	10.0	47

Summary and Comments

The following general observations are based on the data summarized above and plotted in Appendix A.

- Flows entering the project area from the upper (unregulated) Kinnickinnic River consistently met state criteria for cold water fisheries, with dissolved oxygen concentrations, dropping below 7 mg/L very rarely. Temperatures in 2019 were consistently below 60º F, characteristic of a baseflow-dominated stream, and in 2020 below 65º F, except during one interval when the unit had been disturbed and the probe near or above the water surface.
- From the upstream to the downstream limits of the study area, measured water temperatures typically increased by 2 to 4 degrees F on a given sampling day (Table 7).
- Measured dissolved oxygen concentrations generally decreased from upstream to downstream in the study area, although the amount of decrease was highly variable (Table 6).
- In Lake George, the dissolved oxygen concentration dropped below 5 mg/L on several occasions in 2019, reaching near-zero concentrations late in the season. The 2020 data showed low dissolved oxygen concentrations in Lake George as well as likely instrument drift due to fouling in May and June, but a return to more river-like conditions (as well as fewer sensor issues) after the late June flood. This may be attributable to the flood's flushing out of bed sediments and biological material.
- Moving away from the apparent flow path through Lake George (YSI sites LG-2, LG-3, and LG-4) the effects of impoundment are apparent in terms of higher temperatures and higher-amplitude daily dissolved oxygen cycles (Table 8b). Vertical stratification was minor or absent, although the southeastern transect locations appeared somewhat less thoroughly mixed than the Hobo unit location. Field personnel accessing sites LG-1, LG-2, LG-3, and LG-4 by boat reported that some current was detectable at all four sites.
- The plots in Appendix A show that dissolved oxygen concentrations at the three sites in or downstream of the dams' impoundments dropped below 6 mg/L during some periods in 2019. Below Powell Falls and in Lake George, these occurrences were recorded throughout the sampling season, falling below the Class 1 trout stream standard in 29 percent and 37 percent of measurements respectively (Table 3). Below Junction Falls, they were limited to the end of the sampling season, in a period which coincided with exceptionally low readings in Lake George as well. It should be noted that the Junction Falls outflow records were probably impacted some by inflows from the South Fork, although placement of the continuous monitors attempted to minimize these effects.
- In 2020, reliable dissolved oxygen measurements fell below the 6.0 mg/L standard less frequently than in 2019. Even including those considered questionable, the percentage of sub-standard readings below Powell Falls and in Lake George dropped to 15 percent and 12 percent, respectively.
- The 2019 sampling season did not include extreme hydrometeorological conditions. Streamflows throughout the study period were in approximately the top 30 percent of baseflows recorded for their respective months, based on the USGS gage period of record. The largest runoff event to occur during the 2019 sampling period peaked at 580 cubic feet per second, about 35 percent of the estimated two-year flood at the gage site (USGS Scientific Investigations Report 2016-5140) . Daily average temperatures were moderate, ranging from 55 ºF to 75 ºF.
- The 2020 sampling season was also relatively cool and wet. Not accounting for the very large flood event in late June, average daily flows throughout the season were higher than normal and

similar to those in 2019. Also like 2019, there were no periods of exceptionally high air temperatures during the sampling season.

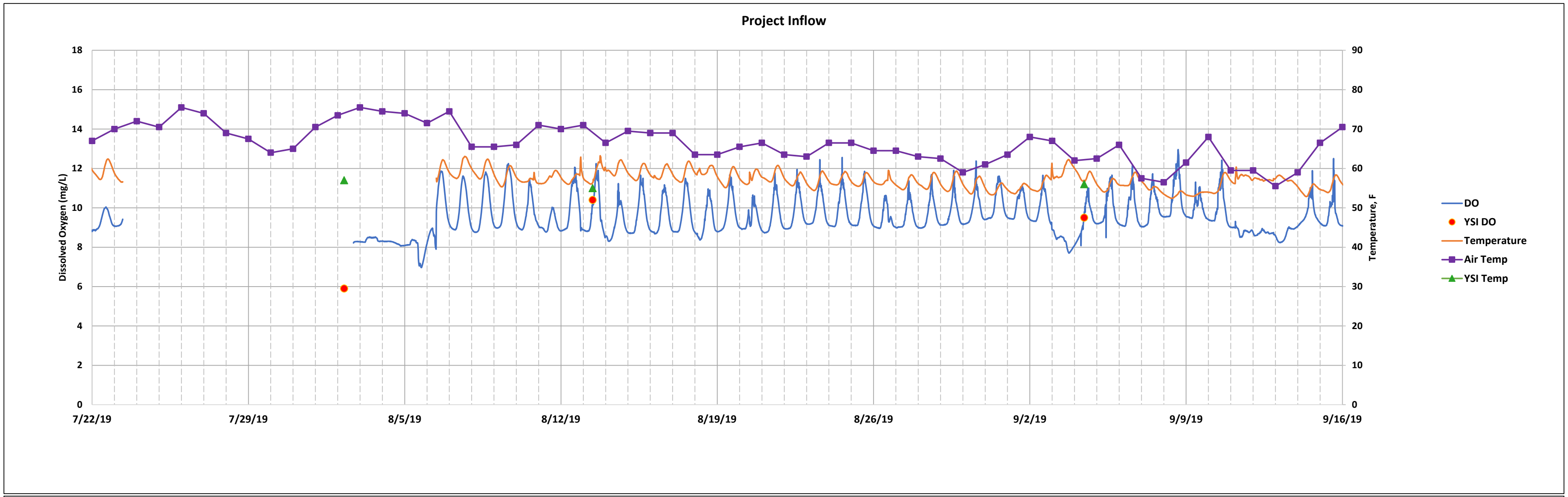
- The 2020 observations from Lake George and the Powell Falls outflow suggest that the June 29, 2020 flood may have led to a drop in the oxygen demand in the impoundments. The 2020 data from the Junction Falls outflow is inconclusive, as it is too discontinuous to support an assessment of the potential impacts of the June flood.

Appendix A

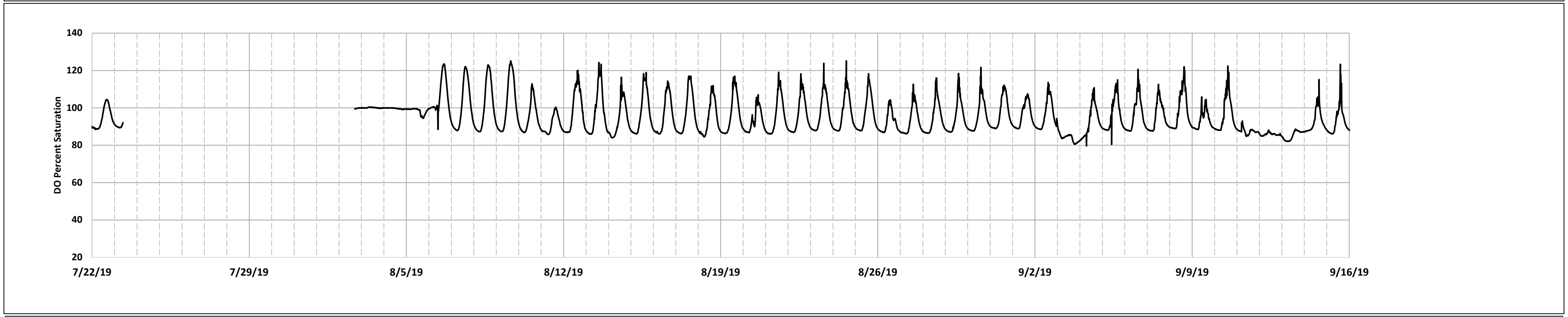
Data Time Series Plots

2019

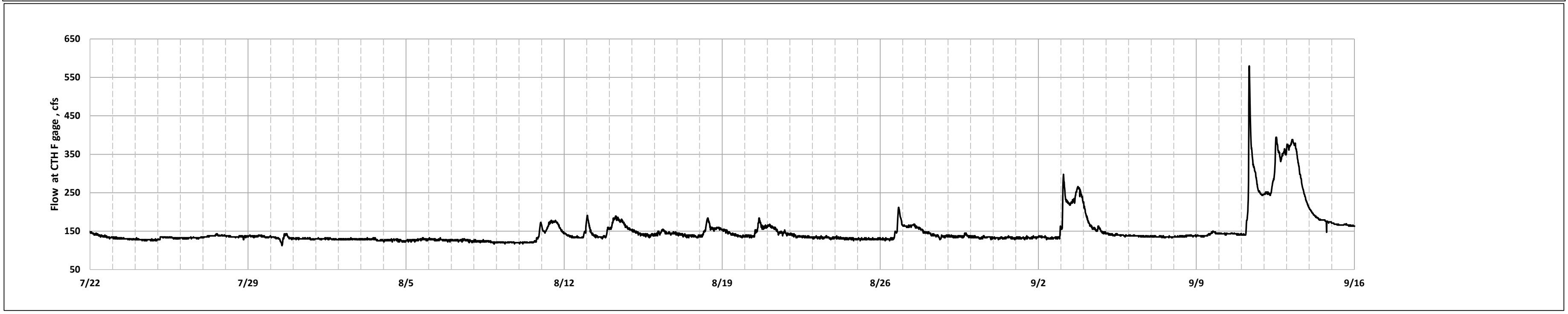
2020



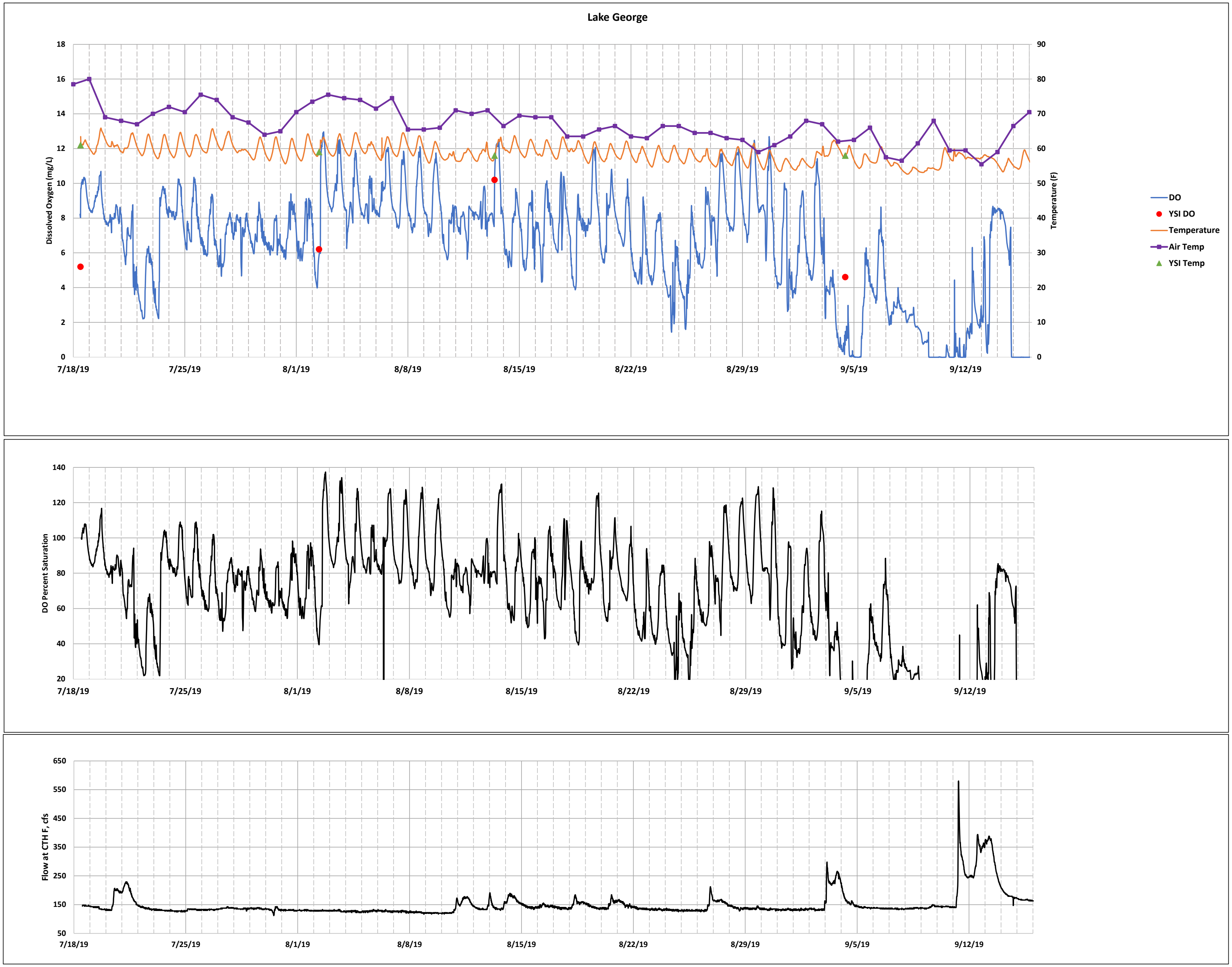
Project Inflow
Dissolved Oxygen (mg/L)
Temperature, F
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
80
90
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
8/26/19
9/2/19
9/9/19
9/16/19
DO
YSI DO
Temperature
Air Temp
YSI Temp



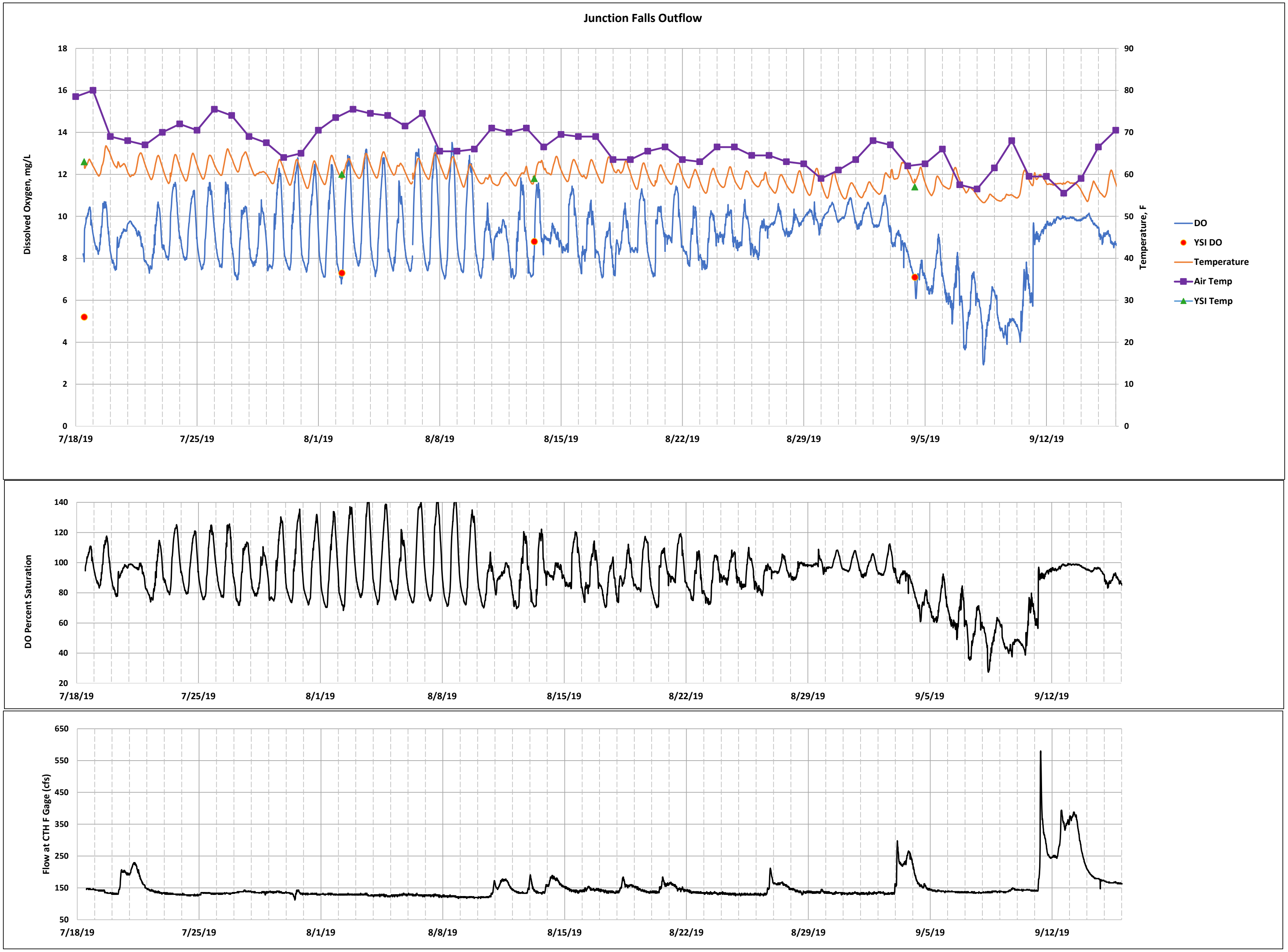
DO Percent Saturation
20
40
60
80
100
120
140
7/22/19
7/29/19
8/5/19
8/12/19
8/19/19
8/26/19
9/2/19
9/9/19
9/16/19



Flow at CTH F gage , cfs
50
150
250
350
450
550
650
7/22
7/29
8/5
8/12
8/19
8/26
9/2
9/9
9/16

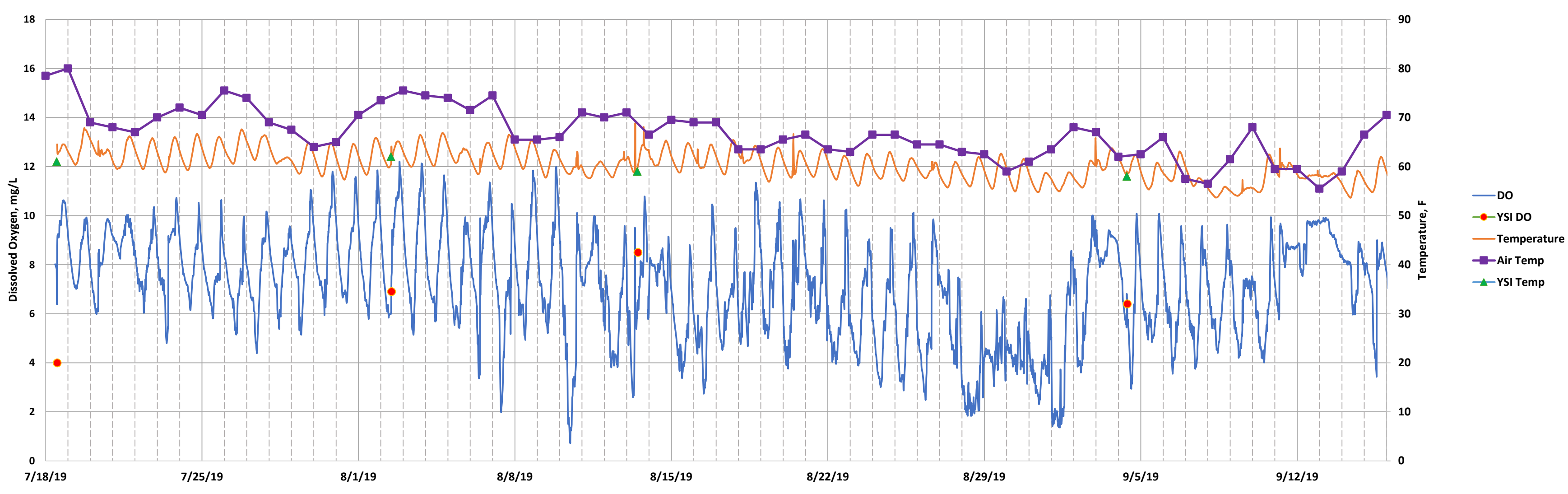


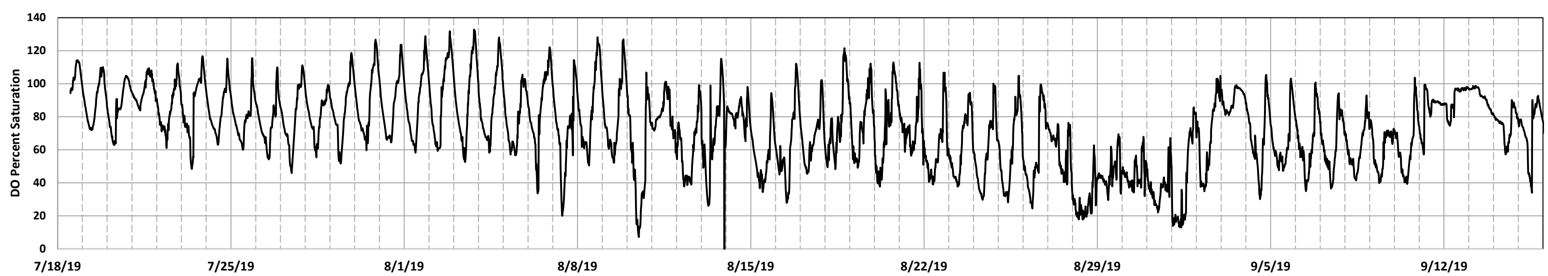
Lake George
Dissolved Oxygen (mg/L)
Temperature (F)
DO
YSI DO
Temperature
Air Temp
YSI Temp
18
16
14
12
10
8
6
4
2
0
90
80
70
60
50
40
30
20
10
0
7/18/19
7/25/19
8/1/19
8/8/19
8/15/19
8/22/19
8/29/19
9/5/19
9/12/19
DO Percent Saturation
140
120
100
80
60
40
20
Flow at CTH F, cfs
650
550
450
350
250
150
50

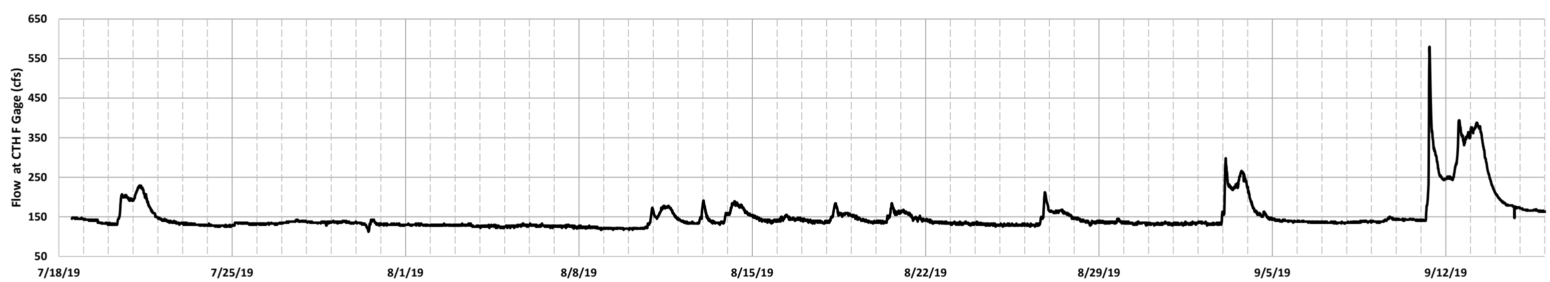


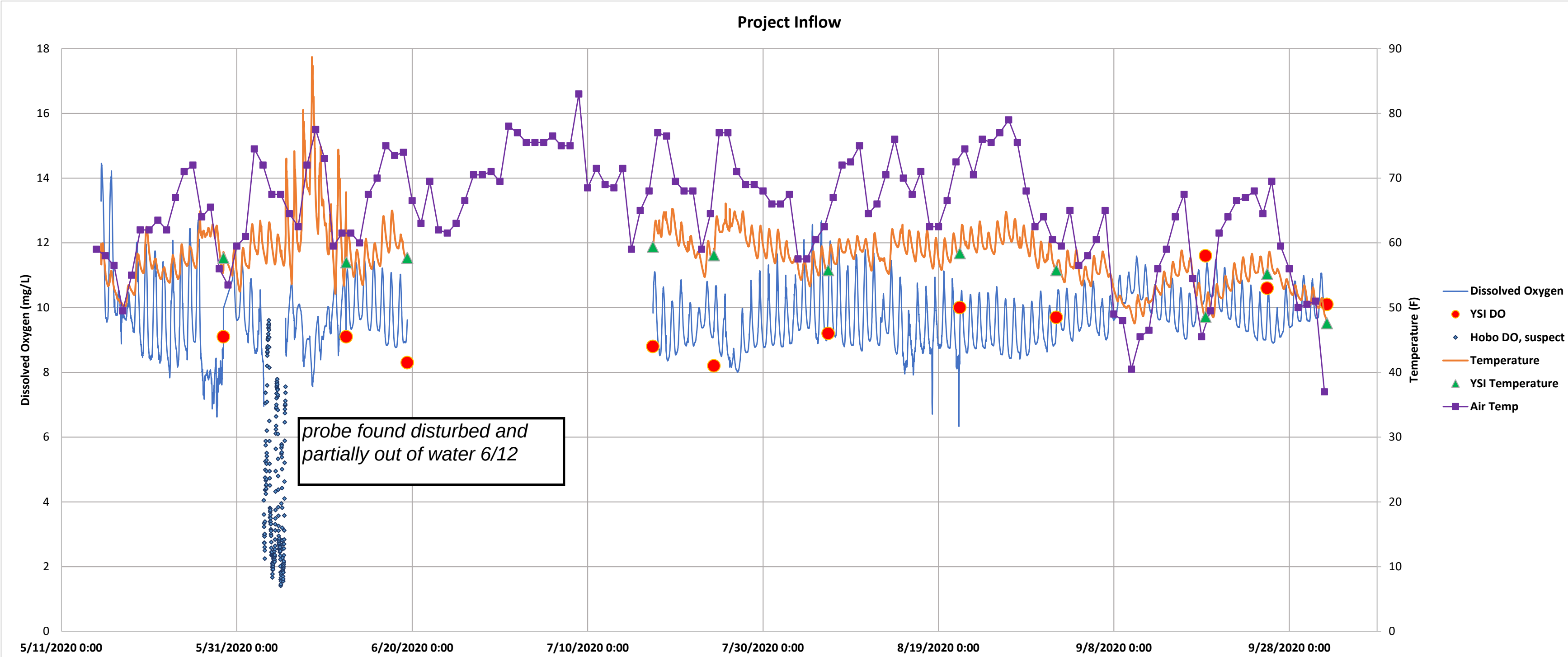
Junction Falls Outflow
Dissolved Oxygen, mg/L
Temperature, F
DO
YSI DO
Temperature
Air Temp
YSI Temp
18
16
14
12
10
8
6
4
2
0
90
80
70
60
50
40
30
20
10
0
7/18/19
7/25/19
8/1/19
8/8/19
8/15/19
8/22/19
8/29/19
9/5/19
9/12/19
DO Percent Saturation
140
120
100
80
60
40
20
Flow at CTH F Gage (cfs)
650
550
450
350
250
150
50

Powell Falls Outflow

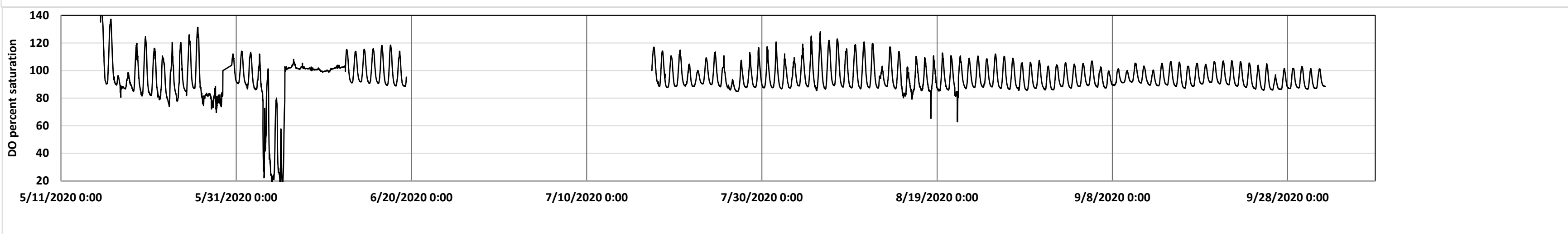




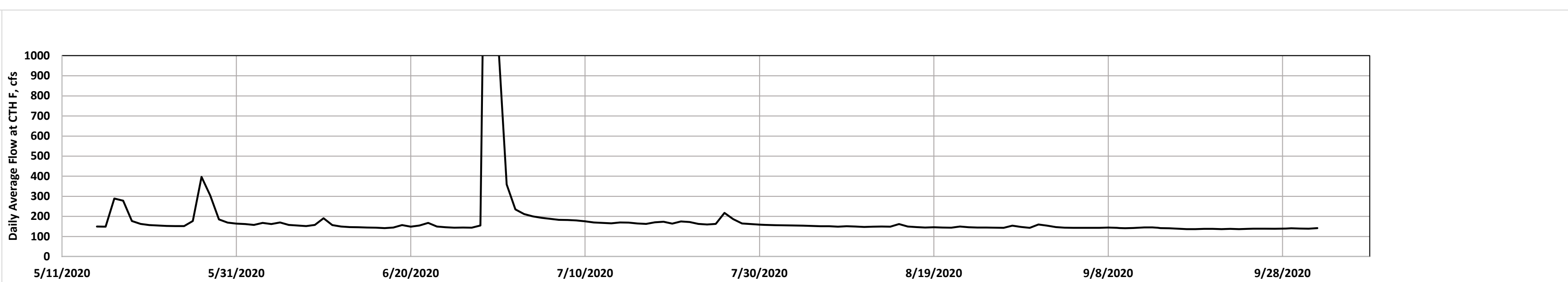




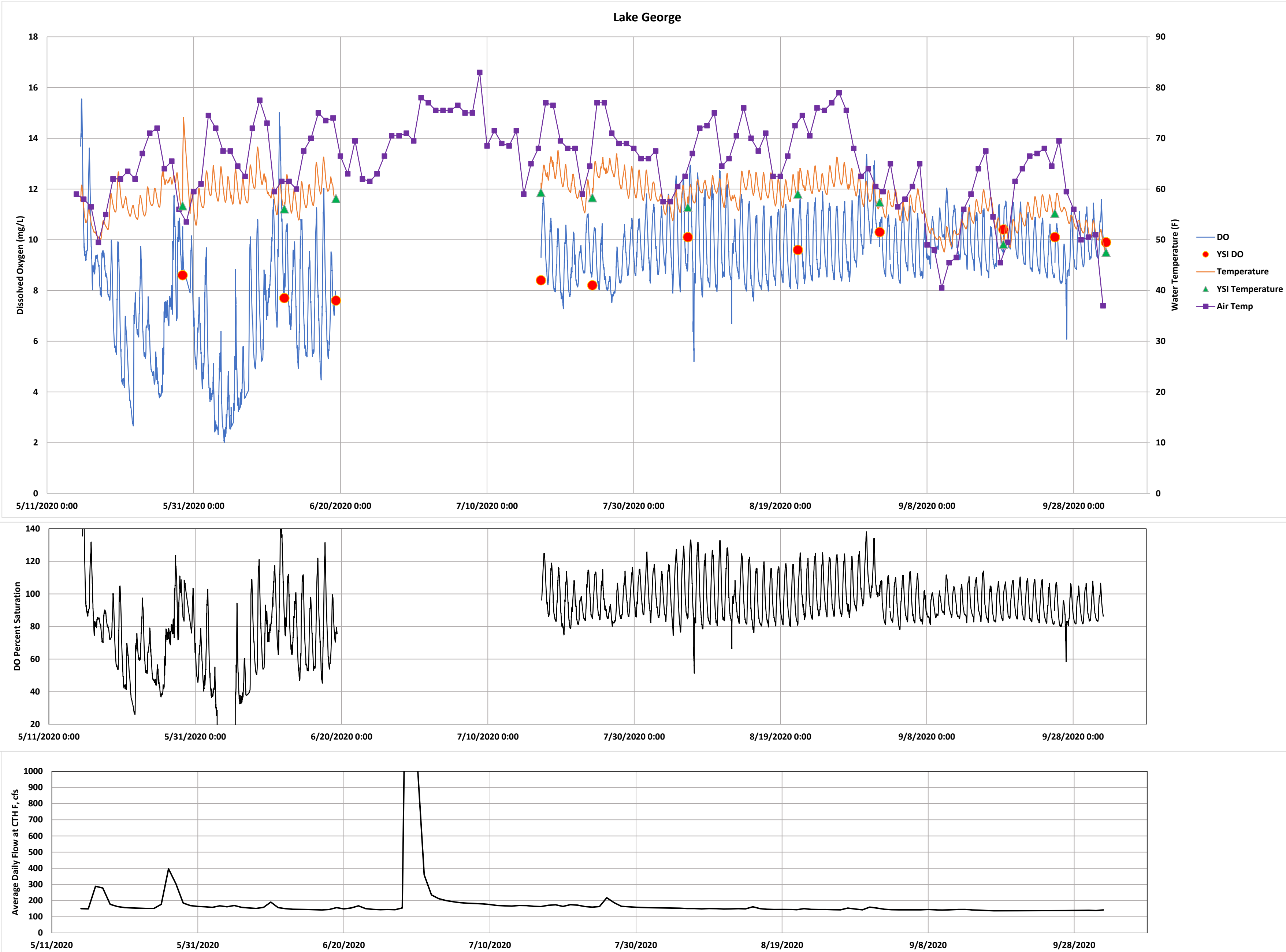
Project Inflow
Dissolved Oxygen (mg/L)
Temperature (F)
probe found disturbed and partially out of water 6/12
Dissolved Oxygen
YSI DO
Hobo DO, suspect
Temperature
YSI Temperature
Air Temp
5/11/2020 0:00
5/31/2020 0:00
6/20/2020 0:00
7/10/2020 0:00
7/30/2020 0:00
8/19/2020 0:00
9/8/2020 0:00
9/28/2020 0:00

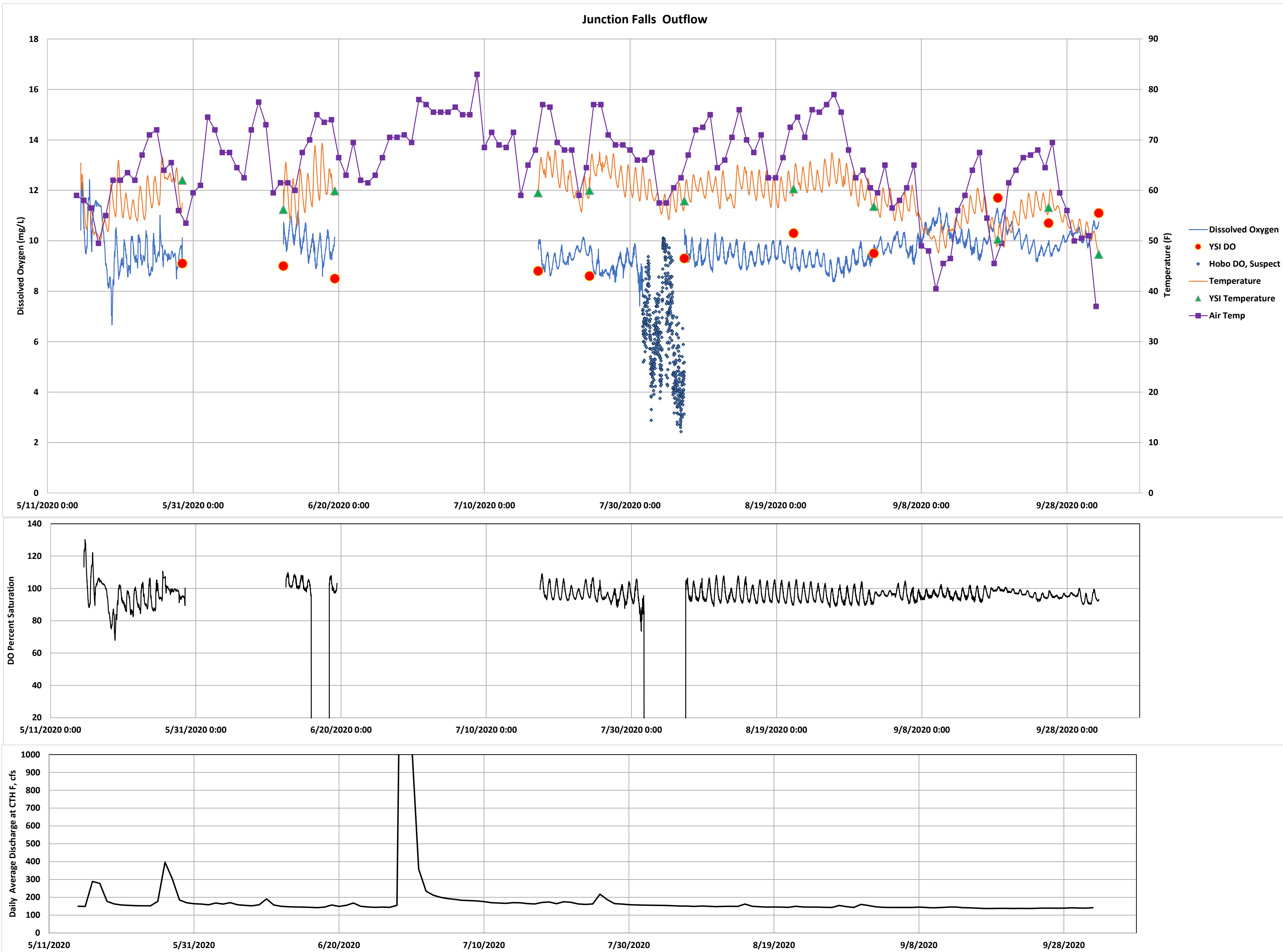


DO percent saturation
5/11/2020 0:00
5/31/2020 0:00
6/20/2020 0:00
7/10/2020 0:00
7/30/2020 0:00
8/19/2020 0:00
9/8/2020 0:00
9/28/2020 0:00

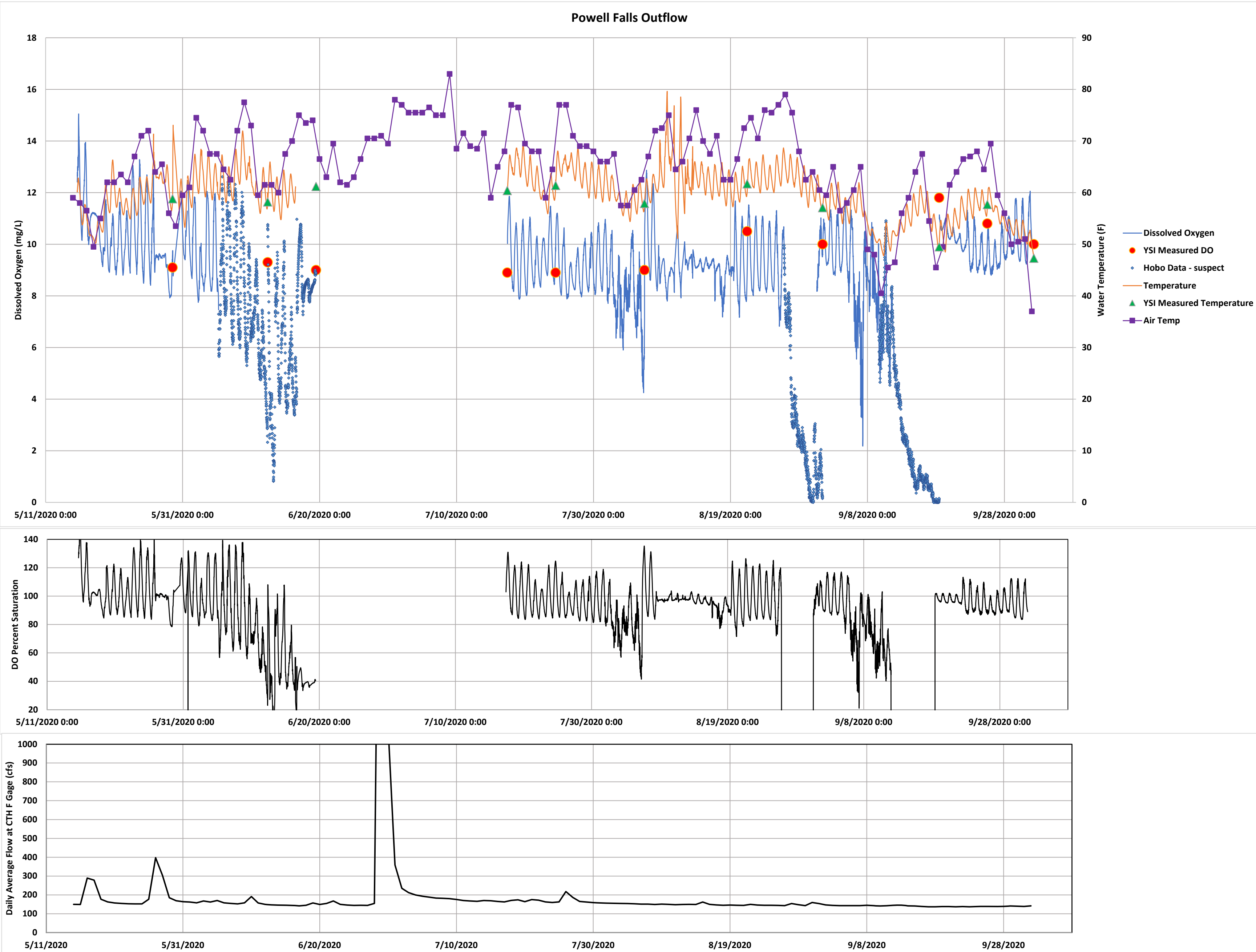


Daily Average Flow at CTH F, cfs
5/11/2020
5/31/2020
6/20/2020
7/10/2020
7/30/2020
8/19/2020
9/8/2020
9/28/2020


Lake George
Dissolved Oxygen (mg/L)
Water Temperature (F)
DO
YSI DO
Temperature
YSI Temperature
Air Temp
5/11/2020 0:00
5/31/2020 0:00
6/20/2020 0:00
7/10/2020 0:00
7/30/2020 0:00
8/19/2020 0:00
9/8/2020 0:00
9/28/2020 0:00
DO Percent Saturation
Average Daily Flow at CTH F, cfs
5/11/2020
5/31/2020
6/20/2020
7/10/2020
7/30/2020
8/19/2020
9/8/2020
9/28/2020



Junction Falls Outflow
Dissolved Oxygen (mg/L)
Temperature (F)
Dissolved Oxygen
YSI DO
Hobo DO, Suspect
Temperature
YSI Temperature
Air Temp
5/11/2020 0:00
5/31/2020 0:00
6/20/2020 0:00
7/10/2020 0:00
7/30/2020 0:00
8/19/2020 0:00
9/8/2020 0:00
9/28/2020 0:00
DO Percent Saturation
Daily Average Discharge at CTH F, cfs
5/11/2020
5/31/2020
6/20/2020
7/10/2020
7/30/2020
8/19/2020
9/8/2020
9/28/2020


Powell Falls Outflow
Dissolved Oxygen (mg/L)
Water Temperature (F)
Dissolved Oxygen
YSI Measured DO
Hobo Data - suspect
Temperature
YSI Measured Temperature
Air Temp
5/11/2020 0:00
5/31/2020 0:00
6/20/2020 0:00
7/10/2020 0:00
7/30/2020 0:00
8/19/2020 0:00
9/8/2020 0:00
9/28/2020 0:00
DO Percent Saturation
Daily Average Flow at CTH F Gage (cfs)
5/11/2020
5/31/2020
6/20/2020
7/10/2020
7/30/2020
8/19/2020
9/8/2020
9/28/2020

Appendix C – Lake George Shoreline Habitat Assessment

Final

Summary Report
River Falls Hydroelectric Project
Lake George Shoreline Habitat Assessment
River Falls, Wisconsin

Contract No.: W912ES20D0001
Delivery Order: W912ES20F0062

December 2020

US Army Corps of Engineers®
St. Paul District

FINAL

SUMMARY REPORT

RIVER FALLS HYDROELECTRIC PROJECT
LAKE GEORGE SHORELINE HABITAT ASSESSMENT
RIVER FALLS, WISCONSIN

Contract No. W912ES20D0001
Task Order W912ES20F0062

Prepared for:
U.S. Army Corps of Engineers, St. Paul District
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St. Paul, Minnesota 55101

Prepared by:
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8081 Innovation Park Drive
Baton Rouge, Louisiana 70820

December 2020

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EXECUTIVE SUMMARY

This summary report provides the background, materials and methods, and results of a Shoreline Habitat Assessment (SHA) conducted for Lake George, an impoundment located on the Kinnickinnic River in River Falls, Wisconsin. The Project Area includes a portion of the Kinnickinnic River south of Junction Falls Dam, the Lake George impoundment created by the dam, and another portion of the river directly upstream from the impoundment. The SHA was conducted by Gulf South Research Corporation for the U.S. Army Corps of Engineers, St. Paul District, on behalf of the City of River Falls, Wisconsin, on July 28 and 29, 2020. The SHA was implemented in accordance with the *Lake Shoreland & Shallows Habitat Monitoring Field Protocol* provided by the Wisconsin Department of Natural Resources. The protocol dictates assessment of a lake or impoundment using three habitat zones (riparian buffer zone, bank zone, and littoral zone) and recording data including percent riparian ground cover, presence of human structures/developments, runoff concerns, and aquatic vegetation.

The results of the SHA can be summarized as follows:

1. Riparian Buffer Zone (35 feet inland from bank): Approximately 75 percent of the riparian buffer zone was found to be occupied by natural vegetation. The other 25 percent was a combination of impervious surfaces, maintained lawns, and exposed soil or sand. Typical developed areas were associated with a public-use trail system. Runoff concerns included numerous point sources (usually storm water drains from surrounding areas), lawns or maintained areas which sloped towards the impoundment, and trails or paths leading towards the bank. Five buildings, a fishing pier, and boat takeout were also found to be present in the riparian buffer zone.
2. Bank Zone: The bank zone was mostly intact with sporadic rip rap found usually in locations associated with human developments such as bridges or adjacent roads. One concrete retaining wall was located along a portion of the upper Kinnickinnic River and another concrete retaining wall as part of the Junction Falls Dam infrastructure.
3. Littoral Zone (50 feet into the water from the bank): The littoral zone, or nearshore zone, was found to be shallow and containing relatively high densities of submerged aquatic plants and green algae. This zone was mostly lacking human structures with the exception of three bridge crossings (two road, one pedestrian), the Junction Falls Dam, and old remnant bridge abutments.

1.0 INTRODUCTION

The Powell Falls and Junction Falls Dams impound the Kinnickinnic River within the City of River Falls, Wisconsin. The River Falls Municipal Utilities (RFMU) is proposing to relicense the Junction Falls Development and decommission the Powell Falls development with dam removal through the Federal Energy Regulatory Commission (FERC). As part of these efforts, a shoreline habitat assessment (SHA) was required as one of a series of baseline studies to be conducted in the vicinity of the two dams on the Kinnickinnic River. Gulf South Research Corporation (GSRC) was contracted by U.S. Army Corps of Engineers (USACE), St. Paul District, on behalf of RFMU, to conduct the SHA for the Junction Falls Dam's impoundment, known as Lake George.

2.0 BACKGROUND

2.1 Location

Lake George is an impoundment on the Kinnickinnic River created by the Junction Falls Dam within the City of River Falls, Pierce County, Wisconsin. It is located approximately 10 miles upstream of the river's confluence with the St. Croix River, and 30 miles downstream from its headwaters in Erin Prairie Township, Wisconsin (Figure 1). Approximately 0.5-mile downstream from Junction Falls Dam is Powell Falls Dam, which forms a second impoundment known as Lake Louise. The Project Area for the Lake George SHA includes an upstream portion of the Kinnickinnic River north to West Division Street and a downstream portion of the river that terminates just south of the Junction Falls Dam (Figure 2).

The SHA protocol, released by the Wisconsin Department of Natural Resources (WI DNR), requires shoreline assessments to be implemented by parcel number (WI DNR 2020). The parcels assessed bordering the lake and/or river in the Project Area are shown in Table 1.

Table 1. Parcels Assessed for Lake George SHA

#	Parcel Number (No.)	Owner Name
1	276010120900[1]	City of River Falls
2	276010470100	City of River Falls
3	276010600100	Eunice Moody Restated Trust Agreement
4	276010600500	City of River Falls
5	276010600800	City of River Falls
6	276010970100	Neil Q Anderson
7	276010970400	Delbert & Charla Kusilek Trust Agreement
8	276010970500	Terrance L & Sharon M Tarras
9	276011030500 (SW)[2]	
10	276011030500 (C)[2]	City of River Falls
11	276011030500 (NE)[2]	
12	276011040100	City of River Falls
13	276011040200	City of River Falls
14	276011040400	City of River Falls
15	276011110600	Foster Associates, Inc.
16	276011120700	City of River Falls

Table 1, continued

#	Parcel Number (No.)	Owner Name
17	276011260300	Maxfield E Neuhaus
18	276011260600 (NE)[3]	City of River Falls
19	276011260600 (C)[3]	
20	276011260600 (S)[3]	

[1] Parcel No. 276010120900 abuts the shoreline in three distinct areas that are connected and is assessed as one parcel.
[2] Parcel No. 276011030500 is divided into three distinct polygons/segments along the shoreline, which were assessed separately and are designated as 'SW' = southwest; 'C' = central; 'NE' = northeast.
[3] Parcel No. 276011260600 is divided into three distinct polygons/segments along the shoreline, which were assessed separately and are designated as 'NE' = northeast; 'C' = central; 'S' = south.
Source: Geospatial data provided by USACE, St. Paul District (2020).

Portions of the shoreline do not have an associated parcel number (typically road or bridge crossings). These portions were assessed with a parcel number of 'none applicable'.

2.2 History of Development

The discovery of River Falls by Europeans is credited to Joel Foster and an indentured servant named Dick who came to the area in 1848 (City of River Falls website 2020). During the second half of the nineteenth century, the area was settled and infrastructure was built including a timber mill and a rock-filled dam at the location of the current Junction Falls Dam (Inter-Fluve 2017). The current dam is a concrete gravity dam built in 1920 by the City of River Falls (Inter-Fluve 2017). The dam was updated in 1962 and 1990.

The damming of the Kinnickinnic River at the Junction Falls Development created an impoundment of water now known as Lake George. Lake George occupies approximately 16 acres, most of which is east of the original river channel (Inter-Fluve 2017). As of 2016, Lake George had less than 10 percent of its storage capacity remaining because of sediment deposits (Inter-Fluve 2016).

Photograph 1. View of Junction Falls Dam and the adjoining powerhouse, facing northwest.

Around Lake George, as well as the adjacent upper reach of the Kinnickinnic River to the north and Lake Louise to the south, public use areas including biking/walking trails, benches, and water-access infrastructure have been developed for use by residents of the City of River Falls. Paved bike trails run along both sides of Lake George. While most of the parcels around the lake are maintained as a public recreation opportunity, parcels along the upper reach of the Kinnickinnic River are owned by private individuals and contain both businesses and residences. The City of River Falls surrounds the lake, including the city's downtown to the east/northeast of the lake and neighborhoods to the west. The Junction Falls powerhouse is located immediately west of Junction Falls Dam (Photograph 1).

K:\Projects\80380102_Shoreline_Survey_RiverFalls\GIS\Report\Figure_1_Project_Location.mxd

Figure 1. Project Location

Figure 2. Project Area

K:\Projects\80380102_Shoreline_Survey_RiverFalls\GIS\Report\Figure_2_Project_Area.mxd

3.0 MATERIALS AND METHODOLOGY

The following survey methodology follows the direction of the *Lake Shoreland & Shallows Habitat Monitoring Field Protocol* as provided by the WI DNR (WI DNR 2020). In-field assessments are described or designated by 'Loops' in the protocol manual, which are literal loops made around the lake's shoreline on foot or by boat with a focus on assessing particular attributes of the shoreline during each loop. GSRC environmental scientists Josh McEnany and Ross Hackbarth completed in-field surveys on July 28 and 29, 2020.

3.1 Preliminary Research and Mapping

Initial background research and mapping was conducted in order to prepare for in-field assessments. Background research focused on gaining an understanding of Lake George's history of development and geomorphic properties. Preliminary mapping began with obtaining geospatial data for the parcels surrounding the impoundment. The stretch of shoreline to be assessed was determined based on the boundaries of these parcels. A 35-foot buffer inland was created off of the shoreline to serve as the riparian buffer during assessments.

After determination of the extent of the assessment, three zones were established for analysis:

1) Littoral Zone: defined as the in-water area of the lake starting at the present water line and extending approximately 50 feet into the lake.
2) Bank Zone: the area between the top of the bank lip and the bank toe, which includes the ordinary high-water mark (OHWM).
3) Riparian Buffer Zone: begins at the top edge of the bank zone and extends inland 35 feet. Note that the actual riparian area or flood zone may extend further than 35 feet, but a 35-foot wide assessment area has been designated for standardization purposes (WI DNR 2020).

An example of these zones shown over aerial imagery for a single parcel along Lake George is provided in Figure 3.

Figure 3. Assessment Zones for Lake George SHA

3.2 Loop 1: Habitat Assessment

The first task completed for the SHA was a habitat assessment using the datasheet and guidance provided by the SHA protocol. GSRC completed the habitat assessment by walking one loop around the lake to inspect the riparian buffer zone and upland areas and another loop completed by kayak. The habitat assessment was recorded using a project-specific data dictionary loaded onto a Trimble GeoXT® handheld global positioning system (GPS) unit with sub-meter accuracy. These data were transferred to data sheets after in-field activities for reporting purposes.

The SHA datasheet is divided by the three assessment zones described earlier: littoral zone, bank zone, and riparian buffer zone. Data taken for each assessment zone are as follows:

- Riparian Buffer Zone: estimates of percent ground cover for natural vegetation and various disturbances; the number of human structures found in the 35-foot buffer; and runoff concerns such as trails and point source discharges (e.g., storm water drains).
- Bank Zone: Human structures built in the bank zone (e.g., erosion control structures) and visible erosion.
- Littoral Zone: Human structures built in the littoral zone (e.g., piers, boat lifts) and types of aquatic plants present.
- Exposed Lake Bed Zone (if applicable due to low water levels): types of plants growing on the exposed surface and disturbances to the exposed surface.

Estimates for percent cover in the Riparian Buffer Zone were divided into two layers: canopy and ground cover. The percent cover for the canopy layer can vary anywhere between 0 and 100. The canopy layer includes all trees equal to or greater than approximately 16 feet in height. The percent cover for ground cover must add up to a total of 100 percent cover by estimating five different types of cover: shrub/herbaceous (i.e., natural vegetation), impervious surface, manicured lawn, agriculture, and other (e.g., exposed soil or sand).

Refer to the *Lake Shoreland & Shallows Habitat Monitoring Field Protocol* manual for further details on the habitat assessment (WI DNR 2020).

3.3 Loop 2: Mapping Coarse Woody Debris

Due to the relatively small amount of woody debris found within the lake, Loop 2 activities were conducted concurrently with Loop 1 activities by kayak. As the Project Area was traversed by kayak, all woody debris (i.e., logs/tree limbs) greater than 4 inches in diameter and at least 5 feet in length were recorded using a Trimble handheld GPS unit. Two variables were documented for each piece of woody debris: 1) connectivity to shore (present/not present); and 2) branching (no branches, some branches, full canopy). All woody debris observed were submerged under water for at least five feet of the debris' length.

3.4 Loop 3: Photo-Documentation of Shoreline

A third loop was traversed to take photographs of the entire shoreline within the Project Area. Photographs were taken from a kayak approximately 50 feet from the shoreline and were spaced out so that the entire shoreline was documented. Geographic coordinates were recorded when each photograph was taken. Photographs were not able to be taken by kayak at the dam and south of the dam, so these photographs were taken from the opposite shoreline. The resulting photograph log shows the condition of the shoreline at the time of the assessment.

4.0 RESULTS

4.1 Environmental Conditions During Surveys

In-field assessments at Lake George were conducted on July 28 and 29, 2020. The weather conditions during surveys are provided in Table 2.

Table 2. Weather Conditions, River Falls, Wisconsin, July 28 to 29, 2020

Date	Temperature[1]			Precipitation[1]	Wind Speed[2]
	Minimum	Maximum	Average		
July 28	57	81	69.0	0.06	2-5 mph
July 29	57	81	69.0	0.00	2-5 mph

[1] Source: National Oceanic and Atmospheric Administration (NOAA) 2020
[2] Source: In-field readings from Kestrel handheld weather meter.

It should be noted that a major flood event occurred in the area including River Falls on June 29 and 30, 2020, approximately one month before the SHA occurred. According to NOAA data, 7.47 inches of rain were received, the majority of which fell in one large event (NOAA 2020). This flood event is likely to have caused significant change to previous environmental conditions, including pushing woody debris downstream and re-positioning sediment loads.

4.2 Loop 1: Habitat Assessment

A total of 20 SHA datasheets were completed for the Lake George habitat assessment. The datasheets for each parcel can be found in Appendix A. Note that two parcel numbers (Parcel Nos. 276011030500, 276011260600) each have three separate datasheets because the parcels have been split into distinct polygons or areas along the shoreline which were assessed separately (based on GIS data provided to GSRC by USACE, St. Paul District).

A total of 2.01 miles of shoreline were assessed along Lake George and the upper Kinnickinnic River (Table 3). This length includes the 20 parcels assessed as well as five sections between parcels that were not designated with any parcel number. The average parcel shoreline length excluding these five sections was 480.8 feet.

Further results of the habitat assessment are divided by habitat zone below.

4.2.1 Riparian Buffer Zone

4.2.1.1 Percent Cover in Riparian

The total area assessed within the riparian buffer zone was 8.31 acres (35 feet inland from the bank zone for length of 2.01 miles) (see Figure 2). As mentioned earlier, the entire periphery of Lake George is some form of public-use area or natural buffer to a public use area. South of Winter Street (see Figure 2), access to the river/impoundment is restricted because of the hazards associated with Junction Falls Dam and steep bluffs along the falls below the dam, as well as the operation of the power plant to the west.

Table 3. Parcel Length and Percent Cover in Riparian Zone

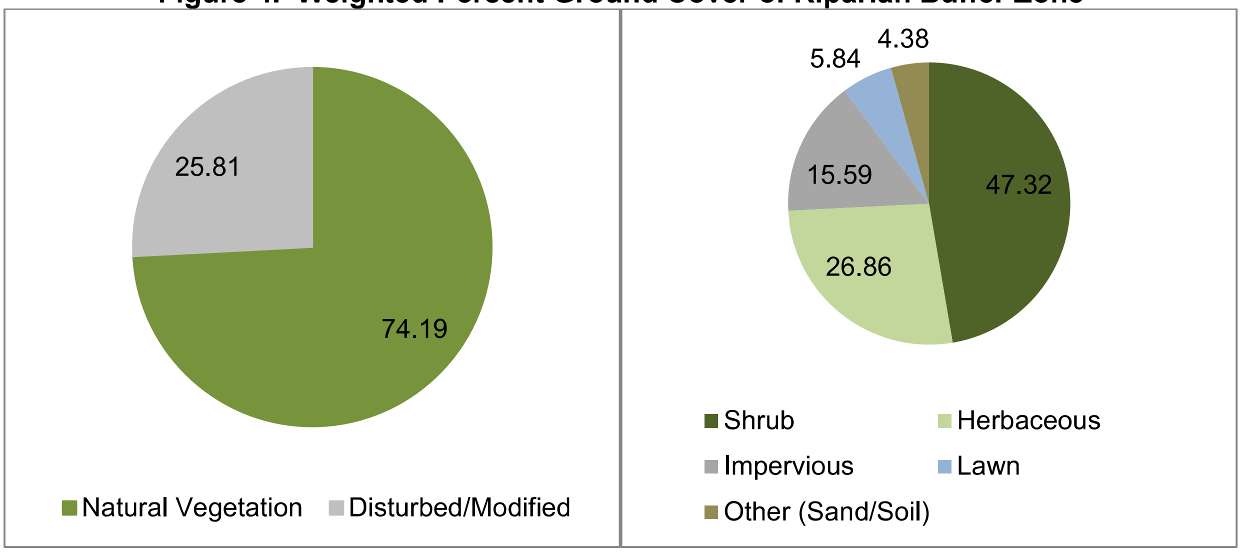
Parcel No.	Canopy	Shrub	Herb.	Impervious	Lawn	Agriculture	Other	Description (Other)	Total Disturbed	Length (ft)
276010120900	60	75	10	10	5	0	0		15	498.46
276010470100	100	40	60	0	0	0	0		0	279.05
276010600100	25	20	40	25	10	0	5	exposed sand/soil	40	272.75
276010600500	20	10	40	35	15	0	0		50	313.10
276010600800	20	15	30	25	20	0	10	exposed soil	55	280.88
276010970100	100	40	20	40	0	0	0		40	266.41
276010970400	20	20	20	60	0	0	0		60	44.63
276010970500	30	25	25	50	0	0	0		50	94.43
276011030500-NE	35	25	25	40	10	0	0		50	323.32
276011030500-C	60	30	20	5	10	0	35	exposed sand/soil	50	871.92
276011030500-SW	45	50	35	5	10	0	0		15	1,229.51
276011040100	30	25	15	5	55	0	0		60	156.56
276011040200	20	50	10	0	40	0	0		40	75.81
276011040400	15	85	10	5	0	0	0		5	1,145.23
276011110600	85	40	40	15	5	0	0		20	976.11
276011120700	80	45	45	0	10	0	0		10	413.33
276011260300	20	20	20	60	0	0	0		60	304.50
276011260600-NE	85	50	30	20	0	0	0		20	897.23
276011260600-C	100	70	20	0	0	0	10	exposed sand	10	1,184.71
276011260600-S	80	60	30	5	5	0	0		10	309.38
none[1]	0	0	0	100	0	0	0		100	54.91
none[1]	0	0	0	100	0	0	0		100	67.48
none[2]	80	40	40	20	0	0	0		20	406.64
none[1]	0	0	0	100	0	0	0		100	80.85
none[1]	0	0	0	100	0	0	0		100	68.83
AVERAGE	46.96	36.96	22.68	30.89	7.32	0.00	2.14	-	40.36	10,616.03 (2.01 miles)
WEIGHTED AVERAGE	58.72	47.32	26.86	15.59	5.84	0.00	4.38	-	25.81	-

[1] Road crossing (i.e., bridge).

[2] Section of land south of Parcel No. 276010970100 and north of Parcel No. 276011260300 in the northeast corner of the Project Area.

Based on percent cover estimates, the majority of the lake's riparian buffer zone is vegetated (See Table 3 and Figure 4). Areas containing natural vegetation consistently exhibited some combination of canopy (i.e., tree), shrub, and herbaceous vegetation layers. This is indicative of the forms of natural forest community that are present in the area. Approximately 58 percent of the riparian buffer zone was estimated to contain a tree canopy layer (Figure 5), while 74 percent contained a shrub and/or herbaceous layer (Figure 6). The determination of particular species composition or delineation of plant communities is not a component of the SHA protocol (WI DNR 2020).

Figure 4. Weighted Percent Ground Cover of Riparian Buffer Zone



Approximately one quarter of the riparian buffer zone exhibited significant disturbance or anthropogenic modifications. Typical disturbed areas include maintained lawns along Lake George intended for public use and paved trails used by bicyclists and pedestrians (Photograph 2).

Photograph 2. Typical forms of vegetated cover, manicured lawn, and impervious surface found in the Riparian Buffer Zone.

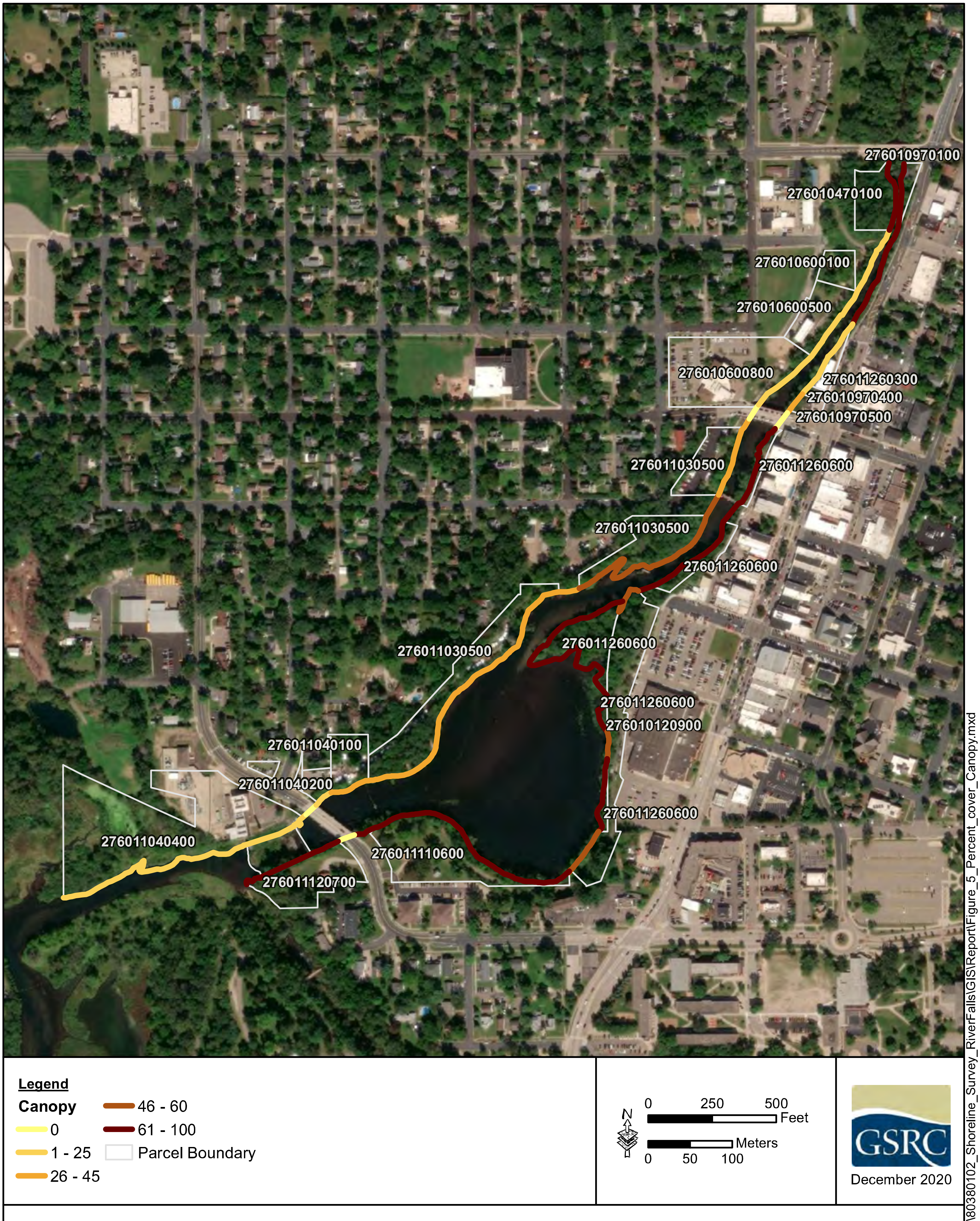


Figure 5. Percent Cover - Natural Vegetation (Canopy)

Figure 6. Percent Cover - Natural Vegetation (Shrub and Herbaceous)

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Impervious surfaces observed during the assessment were predominantly paved trails but also included portions of parking areas or buildings. "Other" ground cover recorded was exposed sand or soil. Exposed sand was found near the river bank in areas where sediment deposition is more prevalent. Exposed soil was typically some kind of human disturbance or area of washout from the previous month's floods. Figures 7 and 8 present maps of total disturbed ground cover and developed and/or maintained ground cover by parcel number, respectively (i.e., by assessment areas).

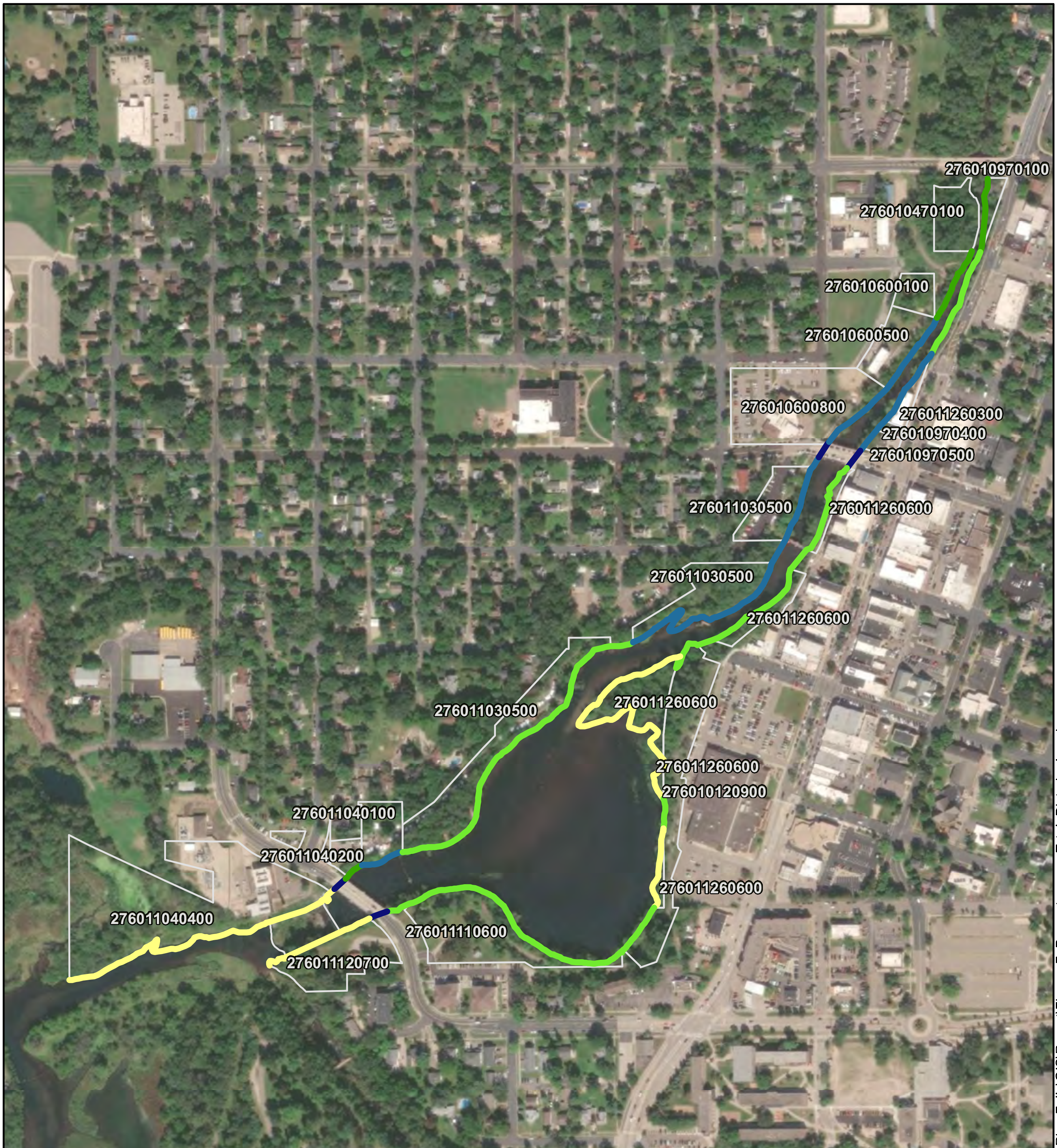
4.2.1.2 Human Structures in Riparian

Though primarily lacking development more extensive than trail systems, the Lake George and upper Kinnickinnic River riparian buffer zone contains sporadic structures as presented in Table 4 and Figure 9. None of the five buildings recorded in the 35-foot buffer were located along the Lake George shoreline. Rather, four buildings are located on the eastern side of the upper Kinnickinnic River, and the other building recorded was a portion of the Junction Falls Development's powerhouse which is found downstream (south) of the dam. Additional buildings are located in the parcels assessed but are found outside (i.e., further inland) of the designated riparian buffer zone. The boat ramp located on the western shoreline of Lake George is a gravel takeout with rip rap at the base (Photograph 3).

Photograph 3. Boat ramp on west side of Lake George.

Table 4. Human Structures in Riparian Buffer Zone

Parcel No.	Buildings	Boats on Shore	Fire Pits	Other	Description (Other)
276010120900	0	0	0	0	
276010470100	0	0	0	0	
276010600100	0	0	0	2	bench, light pole
276010600500	0	0	0	2	light poles
276010600800	0	0	0	1	bridge abutment
276010970100	1	0	0	1	adjacent road
276010970400	1	0	0	0	
276010970500	1	0	0	0	
276011030500-C	0	0	0	1	paved trail
276011030500-NE	0	0	0	3	bike rack, benches, trash cans
276011030500-SW	0	0	0	2	fishing pier, boat ramp
276011040100	0	0	0	2	benches
276011040200	0	0	0	0	
276011040400	1	0	0	1	dam-related infrastructure
276011110600	0	0	0	0	
276011120700	0	0	0	0	
276011260300	1	0	0	0	
276011260600-C	0	0	0	0	
276011260600-NE	0	0	0	0	
276011260600-S	0	0	0	1	paved trail
Totals (20 parcels)	5	0	0	16	-



Legend

Total Disturbed Percent Cover — Parcel Boundary

- 5 - 10
- 11 - 20
- 21 - 40
- 41 - 60
- 61 - 100

N

0 250 500 Feet

0 50 100 Meters

GSRC

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Figure 7. Percent Cover - All Disturbed Conditions (Impervious Surface, Lawn, and Exposed Soil/Sand)

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Figure 8. Percent Cover - Developed/Maintained (Impervious Surface and Lawn)

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Figure 9. Human Structures in Project Area

4.2.1.3 Runoff Concerns in Riparian and Entire Parcel

Runoff concerns and other inputs of water to the impoundment and river were considered for both the riparian buffer zone and the rest of the parcel outside of the buffer zone (i.e., further inland). Typical runoff concerns recorded were trails or roads leading to the lake and lawns or exposed soil sloping towards the lake (Table 5). Point sources, defined as specific identifiable sources of water or pollution input into the lake (e.g., storm water outflows), were found consistently around the lake. Due to the often hidden or obscured nature of point sources observed, it is possible that more exist along the lake and river edge that have been covered by debris, vegetation, or soil erosion (Photograph 4).

Photograph 4. Typical point source in riparian buffer zone.

Other examples of types of runoff concerns are provided in Photographs 5 through 7. Channelized water flow was minimal and on average less than 2 feet wide when found in the Project Area. Trails or designated paths leading to the lake were either portions of the walking path installed by the City or pedestrian-made dirt trails leading to fishing spots or lookouts along the Lake George bank.

Photograph 5. Top left – Paved path sloping to lake showing collected water.

Photograph 6. Top right – steep slope with maintained lawn and rip rap behind.

Photograph 7. Bottom left – signs of minor channelized (ephemeral) water flow coming from uphill.

Table 5. Runoff Concerns in Riparian Buffer Zone

Parcel No.	Point Source		Channelized Water/Gully[1]	Stair, Trail, Road		Lawn, Soil Sloping		Bare Soil[1]	Sand/Silt[1]	Other Runoff[1]
	Riparian	Upland		Riparian	Upland	Riparian	Upland			
276010120900	0	1	1	0	0	1	0	0	0	0
276010470100	0	0	1	1	0	0	0	1	1	0
276010600100	1	0	1	1	1	1	1	1	1	0
276010600500	0	0	0	0	0	1	0	0	1	0
276010600800	1	0	0	1	0	1	0	0	0	0
276010970100	1	0	0	0	0	1	0	0	0	0
276010970400	0	0	0	0	0	1	0	0	0	0
276010970500	0	0	0	0	0	1	0	0	0	0
276011030500-SW	0	0	0	1	0	1	0	1	0	0
276011030500-C	0	0	0	1	0	1	0	1	1	0
276011030500-NE	1	0	0	1	0	1	0	1	0	0
276011040100	0	0	0	1	0	1	0	0	0	0
276011040200	1	0	0	0	0	1	0	0	0	0
276011040400	0	0	0	0	0	0	0	1	1	0
276011110600	1	0	0	1	0	1	0	1	0	0
276011120700	0	0	0	1	0	1	0	0	0	0
276011260300	0	0	0	0	0	1	0	0	0	0
276011260600-NE	1	0	0	0	0	1	0	0	0	0
276011260600-C	0	0	0	0	0	1	0	0	0	0
276011260600-S	1	0	0	0	0	1	0	0	0	0
Totals (20 parcels)	**8**	**1**	**3**	**9**	**1**	**18**	**1**	**7**	**5**	**0**

[1] Parcels without a "Riparian" and "Upland" designation only had runoff concerns in the riparian buffer zone (i.e., no upland runoff concerns).

4.2.2 Bank Zone

Within the bank zone, which is the portion of shoreline between the upper bank lip and lower bank toe that typically contains the OHWM, anthropogenic modifications consisted of vertical retaining wall along two stretches and rip rap (Table 6). A retaining wall has been installed along the western bank of the dam and powerhouse (Parcel No. 276011040400) as well as a stretch of the eastern bank of the upper Kinnickinnic River (Photograph 8). Rip rap was found commonly associated with bridges, retaining walls, or steep portions of shoreline along the upper reach of the river. A short stretch of shoreline containing natural vegetation on the east bank of the river showed signs of erosion.

Photograph 8. Retaining wall along upper Kinnickinnic River.

Table 6. Human Structures in Bank Zone

Parcel No.	Vertical Retaining Wall (ft)	Rip Rap (ft)	Other Erosion Control (ft)	Artificial Beach (ft)	Bank Erosion (>1 ft)	Bank Erosion (<1 ft)
276010120900	0	0	0	0	0	0
276010470100	0	0	0	0	0	0
276010600100	0	0	0	0	0	0
276010600500	0	0	0	0	0	0
276010600800	0	40	0	0	0	0
276010970100	0	0	0	0	0	0
276010970400	0	0	0	0	0	0
276010970500	0	0	0	0	0	0
276011030500-C	0	0	0	0	0	0
276011030500-NE	0	125	0	0	0	0
276011030500-SW	0	10	0	0	0	0
276011040100	0	0	0	0	0	0
276011040200	0	40	0	0	0	0
276011040400	230	100	0	0	0	0
276011110600	0	0	0	0	0	0
276011120700	0	150	0	0	0	0
276011260300	125	150	0	0	0	0
276011260600-C	0	0	0	0	0	0
276011260600-NE	0	0	0	0	90	0
276011260600-S	0	0	0	0	0	0
Total Length (ft)	355	615	0	0	90	0

4.2.3 Littoral Zone

4.2.3.1 Human Structures in Littoral Zone

A total of seven human structures were recorded in the littoral zone (i.e., below the bank) that fit the 'Other' category on the SHA datasheet and can be described as follows:

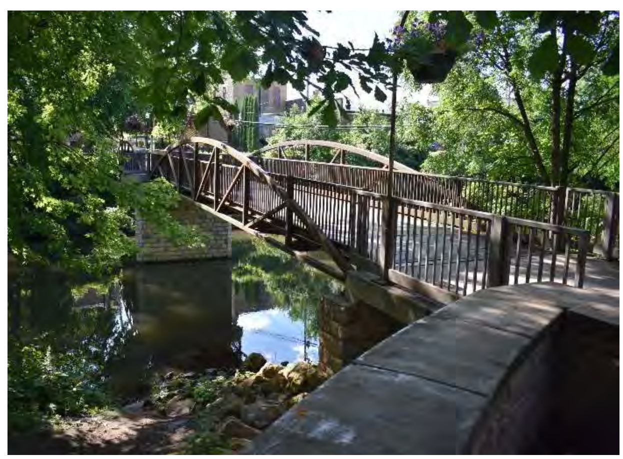
- 276010600800: 2 old bridge abutments
- 276011030500-NE: 1 pedestrian bridge
- 276011030500-SW: 1 fishing pier, 1 boat ramp (both begin in the riparian buffer zone and terminate in the littoral zone)
- 276011040400: 1 dam (Junction Falls Dam)
- 276011120700: 1 dam (Junction Falls Dam)

Two large road bridges (West Maple Street and Winter Street) are located between parcels and not noted in the list above, but these bridges are present in the littoral zone of the overall Project Area. Photographs 9 through 12 present examples of the human structures found in the littoral zone.

Photograph 9. Junction Falls Dam.

Photograph 10. Old bridge abutments.

Photograph 11. Fishing pier.



Photograph 12. Riverwalk foot bridge.

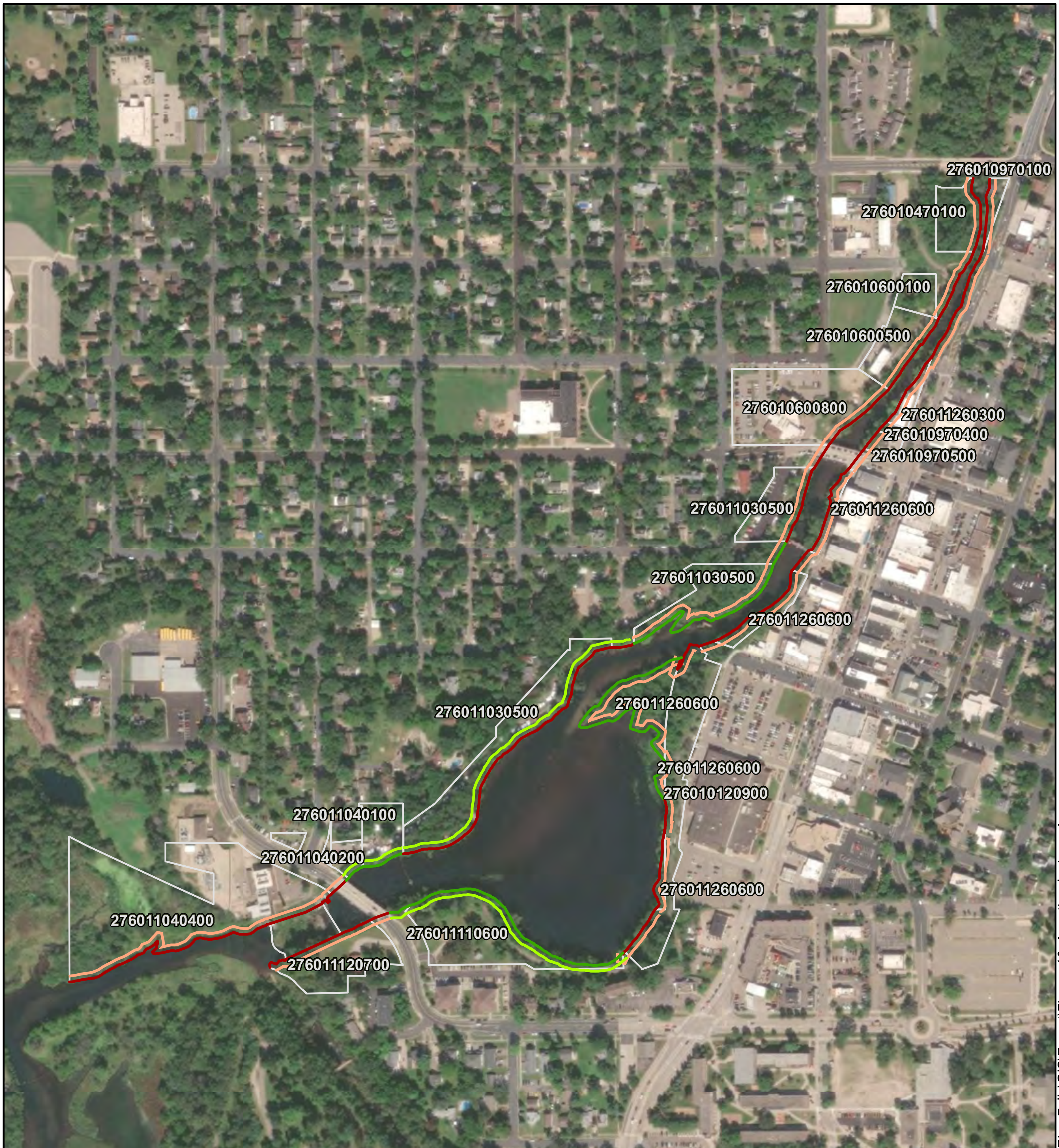
4.2.3.2 Aquatic Plants

Emergent and floating aquatic plants were observed in five parcels and four parcels, respectively. The parcels in which aquatic plants were observed typically bordered Lake George or the slower, wider section of the river immediately upstream (north) from Lake George (Figure 10). It should be noted that submerged aquatic plants are not included in the SHA, with an explanation given as "Plants growing only underwater (submergent) are not included in the survey because they may be difficult to observe." (WI DNR 2020). There is a high density of submerged aquatic plants in Lake George and also seasonally, green algae (Photograph 13). The results of a 2020 invasive aquatic plant species survey conducted by Inter-Fluve provide further information on the species composition and densities of aquatic plants in the impoundment (Inter-Fluve 2020).

Photograph 13. Green algae bloom on Lake George.

4.2.4 Exposed Lakebed Zone

No areas of exposed lakebed were observed during the assessment.



Legend

Emergent Aquatic Plants
- Not present
- Present

Floating Aquatic Plants
- Not present
- Present

Parcel Boundary

N

0 250 500 Feet

0 50 100 Meters

GSRC

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Figure 10. Emergent and Floating Aquatic Plants

4.3 Loop 2: Mapping Coarse Woody Debris

The results of mapping coarse woody debris are shown in Figure 11. A total of 34 pieces of large woody debris meeting the requirements of the SHA protocol were recorded. Geographic coordinates for these woody debris are provided in Table 7.

Table 7. Geographic Coordinates of Woody Debris

#	Woody Debris Category	Longitude (°)	Latitude (°)
1	Multiple branches, no connectivity*	-92.63202492	44.85588156
2	No branches, connectivity**	-92.63119819	44.85547225
3	Multiple branches, no connectivity	-92.63096164	44.85535162
4	Multiple branches, connectivity	-92.63091532	44.85689588
5	No branches, no connectivity	-92.630687	44.85704467
6	Multiple branches, no connectivity	-92.63063667	44.85515033
7	Multiple branches, no connectivity	-92.63058883	44.857113
8	Multiple branches, no connectivity	-92.63058555	44.8549954
9	Multiple branches, connectivity	-92.63050492	44.85503168
10	No branches, no connectivity	-92.62997139	44.857125
11	Multiple branches, connectivity	-92.6299691	44.8576564
12	Multiple branches, no connectivity	-92.62982545	44.85484835
13	Multiple branches, connectivity	-92.6295461	44.85787274
14	Multiple branches, no connectivity	-92.6295305	44.854914
15	No branches, no connectivity	-92.62945467	44.854917
16	No branches, no connectivity	-92.62936617	44.85506167
17	No branches, no connectivity	-92.62932005	44.85791585
18	Multiple branches, no connectivity	-92.62924317	44.8551155
19	No branches, no connectivity	-92.62917456	44.85516432
20	No branches, no connectivity	-92.62910468	44.85711636
21	No branches, no connectivity	-92.62909283	44.85534183
22	No branches, no connectivity	-92.6289935	44.85550433
23	Multiple branches, connectivity	-92.62896717	44.85651833
24	Multiple branches, connectivity	-92.62891081	44.85677133
25	No branches, no connectivity	-92.62852221	44.85793346
26	No branches, connectivity	-92.62750391	44.85841742
27	No branches, no connectivity	-92.62704823	44.85865786
28	No branches, no connectivity	-92.62677564	44.85902546
29	Multiple branches, no connectivity	-92.62651808	44.85985388
30	Multiple branches, no connectivity	-92.62628909	44.85967465
31	No branches, no connectivity	-92.62621451	44.85980283
32	No branches, no connectivity	-92.62606415	44.86017377
33	Multiple branches, no connectivity	-92.62603819	44.86001828
34	No branches, no connectivity	-92.62482831	44.86139544

*No connectivity = debris did not touch the shore
**Connectivity = debris touched the shore

Figure 11. Large Woody Debris in Lake George

Photograph 14 shows the typical form of woody debris found on the edge of Lake George. The largest congregation of woody debris occurred along the southern to southeastern shoreline of Lake George, likely because of patterns of water flow and deposition.

Photograph 14. Example of woody debris on the Lake George shoreline.

4.4 Loop 3: Photo-Documentation of Shoreline

A total of 157 photographs were taken to document the condition of the shoreline at Lake George. These photographs can be found in the photograph log provided in Appendix B. This appendix includes a map (Figure B-1) showing the location of each photograph as well as a table that provides the geographic coordinates for each photo point.

5.0 DISCUSSION

The shoreline within the Project Area has three distinct portions that are discussed separately here.

South of Junction Falls Dam, the shoreline changes rapidly from exposed bedrock waterfalls that have been modified by the installation of the dam, adjoining retaining wall, and powerhouse to a short "river reach" that leads to Lake Louise to the south. Lake Louise is the impoundment that has been created by installation of the Powell Falls Dam further south. This short stretch of channel between impoundments (Photograph 15) is likely to have become wider and shallower than pre-disturbance conditions, as is typical of river reaches where sediment transport has been impeded downstream and an impoundment has developed (Schmutz and Moog 2018). Swaths of reed canary grass (*Phalaris arundinacea*) dominate much of the northern shoreline of this reach. Channelized water drainages have developed that connect the river to wetlands that have established immediately to the north. It is possible that these wetlands developed in response to installation of the two dams.

Photograph 15. Stretch of river south of Junction Falls Dam.

Lake George is the second distinct portion of the Project Area and the focal point of this SHA study. The original river channel flowed near to the existing northwest shoreline (along Parcel No. 276011030500). When the dam was built, the impoundment was created to the south and east of the original channel in lower elevation floodplains or forests. Currently, the shoreline around the lake is mostly consistent in character (Photographs 16 and 17).

Photograph 16. View of southeast portion of Lake George shoreline.

Photograph 17. View of northwest portion of Lake George shoreline.

The majority of the riparian buffer zone is occupied by natural vegetation, albeit much of the vegetation shows some signs of disturbance. The paved walking/biking path (i.e., White Pathway) that runs along the impoundment on all sides is typically between 20 and 100 feet from the edge of the shoreline. Areas around the path are maintained as mowed lawn with amenities that include picnic tables, benches, one boat takeout (primarily intended for kayak takeout from the upper Kinnickinnic River), and one fishing pier. The path is connected into a loop by one pedestrian bridge over the upper Kinnickinnic River and sidewalks along the Winter Street bridge. Modifications within the current bank zone of Lake George are minimal. Rip rap has been placed as stabilization in some areas including under the Winter Street bridge and under the fishing pier located on the impoundment. Due to the shallow nature of most areas of Lake George, the littoral zone (i.e., nearshore zone) is similar in character to much of the open water zone. Floating and/or emergent vegetation are found in small stretches around the shoreline.

In accordance with RFMU's 2019 Revised Study Plan for the River Falls Hydroelectric Project (FERC P-10489), the feasibility of a short-term drawdown of water within the impoundment in order to consolidate sediment and stimulate plant growth was considered during the shoreline assessment. Data collected during this survey did not contribute substantially to the conclusion that a short-term drawdown was necessary within the next re-licensing period to remove sediment. It would be most efficient to perform a drawdown and sediment removal concurrently with dam removal, if dam removal is being considered after the next license term. To warrant a drawdown prior to future dam removal, Lake George would have to be at risk of completely filling with sediment. In order to determine whether the lake is at risk of complete sedimentation, necessary considerations include the current sediment level (Inter-Fluve 2016) and the rate of sedimentation. A second sediment study should be performed to obtain the rate of sedimentation, which could then be used to project when the lake would completely fill with sediment. A planned drawdown and associated sediment removal would be recommended prior to the estimated date calculated for when complete sedimentation of the lake would occur.

The third relatively distinct portion of the Project Area is a short stretch of the upper Kinnickinnic River directly north of Lake George (Photograph 18). Closer to Lake George, this stretch appears to be wider, shallower, and slower moving than prior to establishment of the impoundment due to sediment deposition. Further upstream, the river is found in its natural form.

Photograph 18. Kayakers on the Kinnickinnic River north of Lake George.

6.0 REFERENCES

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APPENDIX A
ASSESSMENT DATASHEETS

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010120900	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian	Percent	
Canopy	60	(0-100)
Shrub 75 Herbaceous 10		
Shrub/Herbaceous	85	
Impervious Surface	10	
Manicured Lawn	5	
Agriculture	0	
Other (e.g., duff, soil, mulch)	0	

Description: ______

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0

Description: ______

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		✓
Channelized Water Flow/Gully	✓	
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description: ______

Notes:

submerged vegetation

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description: ______

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010470100	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian	Percent
Canopy	100 (0-100)
Shrub 40 / Herbaceous 60	
Shrub/Herbaceous	100
Impervious Surface	0
Manicured Lawn	0
Agriculture	0
Other (e.g., duff, soil, mulch)	0

Description: ____

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0

Description: ____

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully	√	
Stair/Trail/Road to Lake	√	
Lawn/Soil Sloping to Lake		
Bare Soil	√	
Sand/Silt Deposits	√	
Other		

Description: ____

Notes:

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description: ____

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010600100	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				25	(0-100)
Shrub	20	Herbaceous	40		
Shrub/Herbaceous				60	
Impervious Surface				25	
Manicured Lawn				10	
Agriculture				0	
Other (e.g., duff, soil, mulch)				5	

Description: exposed sand/soil

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	2

Description: bench, light pole

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully	✓	
Stair/Trail/Road to Lake	✓	✓
Lawn/Soil Sloping to Lake	✓	✓
Bare Soil	✓	
Sand/Silt Deposits	✓	
Other		

Description:

Notes:

disturbance from paths to lake (possible fishing locations)

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010600500	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian			Percent
Canopy			20 (0-100)
Shrub	10	Herbaceous 40	
Shrub/Herbaceous			50
Impervious Surface			35
Manicured Lawn			15
Agriculture			0
Other (e.g., duff, soil, mulch)			0

Description:

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	2

Description: light poles

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits	✓	
Other		

Description:

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010600800	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian

		Percent
Canopy		20 (0-100)
Shrub 15	Herbaceous 30	
Shrub/Herbaceous		45
Impervious Surface		25
Manicured Lawn		20
Agriculture		0
Other (e.g., duff, soil, mulch)		10

Description: exposed soil

Human Structures in Riparian

	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	1

Description: bridge abutment

Runoff Concerns in Riparian or Entire Parcel

	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	✓	
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description:

Notes:

impervious surface includes retaining wall

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	40
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures

	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	2

Description: bridge abutments

Aquatic Plants

	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants

	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed

Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010970100	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				100	(0-100)
Shrub	40	Herbaceous	20		
Shrub/Herbaceous				60	
Impervious Surface				40	
Manicured Lawn				0	
Agriculture				0	
Other (e.g., duff, soil, mulch)				0	

Description:

Human Structures in Riparian	Number
Buildings	1
Boats on Shore	0
Fire Pits	0
Other	1

Description: road adjacent

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description:

Notes:

250-foot rock wall located in riparian zone just south of this parcel.

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010970400	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				20	(0-100)
Shrub	20	Herbaceous	20		
Shrub/Herbaceous				40	
Impervious Surface				60	
Manicured Lawn				0	
Agriculture				0	
Other (e.g., duff, soil, mulch)				0	

Description: ______

Human Structures in Riparian	Number
Buildings	1
Boats on Shore	0
Fire Pits	0
Other	0

Description: ______

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description: ______

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description: ______

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276010970500	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian

	Percent
Canopy	30 (0-100)
Shrub 25 Herbaceous 25	
Shrub/Herbaceous	50
Impervious Surface	50
Manicured Lawn	0
Agriculture	0
Other (e.g., duff, soil, mulch)	0

Description:

Human Structures in Riparian

	Number
Buildings	1
Boats on Shore	0
Fire Pits	0
Other	0

Description:

Runoff Concerns in Riparian or Entire Parcel

	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description:

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures

	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants

	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants

	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed

Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011030500-SW	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian

		Percent
Canopy		45 (0-100)
Shrub	50	Herbaceous 35
Shrub/Herbaceous		85
Impervious Surface		5
Manicured Lawn		10
Agriculture		0
Other (e.g., duff, soil, mulch)		0

Description:

Human Structures in Riparian

	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	2

Description: Fishing pier, boat ramp

Runoff Concerns in Riparian or Entire Parcel

	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	✓	
Lawn/Soil Sloping to Lake	✓	
Bare Soil	✓	
Sand/Silt Deposits		
Other		

Description:

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	10
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures

	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	2

Description: Fishing pier, boat ramp

Aquatic Plants

	Present
Emergents	
Floating	✓
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants

	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed

Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011030500-C	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				60	(0-100)
Shrub	30	Herbaceous	20		
Shrub/Herbaceous				50	
Impervious Surface				5	
Manicured Lawn				10	
Agriculture				0	
Other (e.g., duff, soil, mulch)				35	

Description: exposed sand/soil

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	1

Description: walking path

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	√	
Lawn/Soil Sloping to Lake	√	
Bare Soil	√	
Sand/Silt Deposits	√	
Other		

Description:

Notes:

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants	Present
Emergents	√
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011030500-NE		Observers	McEnany, Hackbarth (GSRC)	

RIPARIAN ZONE

Percent Cover in Riparian	Percent	
Canopy	35	(0-100)
Shrub 25 Herbaceous 25		
Shrub/Herbaceous	50	
Impervious Surface	40	
Manicured Lawn	10	
Agriculture	0	
Other (e.g., duff, soil, mulch)	0	

Description:

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	3

Description: bike rack, benches, trash cans

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	✓	
Lawn/Soil Sloping to Lake	✓	
Bare Soil	✓	
Sand/Silt Deposits		
Other		

Description:

Notes:

The impervious surface in riparian zone includes a foot bridge and retaining wall.

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	125
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	1

Description: bridge

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011040100	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian			Percent	
Canopy			30	(0-100)
Shrub 25	Herbaceous	15		
Shrub/Herbaceous			40	
Impervious Surface			5	
Manicured Lawn			55	
Agriculture			0	
Other (e.g., duff, soil, mulch)			0	
Description:				

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	2
Description: Benches	

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	✓	
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		
Description:		

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0
Description:	

Aquatic Plants	Present
Emergents	✓
Floating	✓
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011040200	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian			Percent	
Canopy			20	(0-100)
Shrub	50	Herbaceous 10		
Shrub/Herbaceous			60	
Impervious Surface			0	
Manicured Lawn			40	
Agriculture			0	
Other (e.g., duff, soil, mulch)			0	

Description: ______

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0

Description: ______

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description: ______

Notes:

storm water drain in rip rap

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	40
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description: ______

Aquatic Plants	Present
Emergents	✓
Floating	✓
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011040400	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian			Percent	
Canopy			15	(0-100)
Shrub	85	Herbaceous	10	
Shrub/Herbaceous			95	
Impervious Surface			5	
Manicured Lawn			0	
Agriculture			0	
Other (e.g., duff, soil, mulch)			0	

Description:

Human Structures in Riparian	Number
Buildings	1
Boats on Shore	0
Fire Pits	0
Other	1

Description: Dam structure

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake		
Bare Soil	√	
Sand/Silt Deposits	√	
Other		

Description:

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	150
Rip Rap	100
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	1

Description: dam

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011110600	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				85	(0-100)
Shrub	40	Herbaceous	40		
Shrub/Herbaceous				80	
Impervious Surface				15	
Manicured Lawn				5	
Agriculture				0	
Other (e.g., duff, soil, mulch)				0	

Description: ______

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0

Description: ______

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	✓	
Lawn/Soil Sloping to Lake	✓	
Bare Soil	✓	
Sand/Silt Deposits		
Other		

Description: ______

Notes:

submerged vegetation throughout

BANK ZONE

	Length (ft)
Vertical Sea Wall	10
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description: ______

Aquatic Plants	Present
Emergents	✓
Floating	✓
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011120700		Observers	McEnany, Hackbarth (GSRC)	

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				80	(0-100)
Shrub	45	Herbaceous	45		
Shrub/Herbaceous				90	
Impervious Surface				0	
Manicured Lawn				10	
Agriculture				0	
Other (e.g., duff, soil, mulch)				0	

Description: ______

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0

Description: ______

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake	✓	
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description: ______

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	150
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	1

Description: dam

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011260300	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent
Canopy				20 (0-100)
Shrub	20	Herbaceous	20	
Shrub/Herbaceous				40
Impervious Surface				60
Manicured Lawn				0
Agriculture				0
Other (e.g., duff, soil, mulch)				0

Description: ____________

Human Structures in Riparian	Number
Buildings	1
Boats on Shore	0
Fire Pits	0
Other	0

Description: ____________

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description: ____________

Notes:

BANK ZONE

	Length (ft)
Vertical Sea Wall	125
Rip Rap	150
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description: ____________

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011260600-NE	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent	
Canopy				85	(0-100)
Shrub	50	Herbaceous	30		
Shrub/Herbaceous				80	
Impervious Surface				20	
Manicured Lawn				0	
Agriculture				0	
Other (e.g., duff, soil, mulch)				0	
Description:					

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0
Description:	

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		
Description:		

Notes:

impervious surface includes foot bridge

BANK ZONE	Length (ft)
Vertical Sea Wall	0
Rip Rap	10
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	90
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0
Description:	

Aquatic Plants	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed	
Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011260600-C	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian				Percent
Canopy				100 (0-100)
Shrub	70	Herbaceous	20	
Shrub/Herbaceous				90
Impervious Surface				0
Manicured Lawn				0
Agriculture				0
Other (e.g., duff, soil, mulch)				10

Description: exposed sand

Human Structures in Riparian	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	0

Description:

Runoff Concerns in Riparian or Entire Parcel	Present in Riparian	Present out of Riparian
Point Source		
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description:

Notes:
submerged vegetation consistent throughout

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants	Present
Emergents	✓
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants	Present
Canopy	
Shrubs	✓
Herbaceous	✓

Disturbed	
Plants (Mowed or Removed)	✓
Sediment (Tilled or Dug)	

Date	7/28/2020	Lake Name	Lake George	WBIC	
Parcel ID	276011260600-S	Observers	McEnany, Hackbarth (GSRC)		

RIPARIAN ZONE

Percent Cover in Riparian

		Percent
Canopy		80 (0-100)
Shrub	60	Herbaceous 30
Shrub/Herbaceous		90
Impervious Surface		5
Manicured Lawn		5
Agriculture		0
Other (e.g., duff, soil, mulch)		0

Description:

Human Structures in Riparian

	Number
Buildings	0
Boats on Shore	0
Fire Pits	0
Other	1

Description: walkway/bike path around lake

Runoff Concerns in Riparian or Entire Parcel

	Present in Riparian	Present out of Riparian
Point Source	✓	
Channelized Water Flow/Gully		
Stair/Trail/Road to Lake		
Lawn/Soil Sloping to Lake	✓	
Bare Soil		
Sand/Silt Deposits		
Other		

Description:

Notes:

submerged vegetation consistent throughout; culvert as point source

BANK ZONE

	Length (ft)
Vertical Sea Wall	0
Rip Rap	0
Other Erosion Control Structures	0
Artificial Beach	0
Bank Erosion >1 ft face	0
Bank Erosion <1 ft face	0

LITTORAL ZONE

Human Structures

	Number
Piers	0
Boat Lifts	0
Boat Shelters	0
Swim Rafts/Water Trampolines	0
Boathouses (Over Water)	0
Marinas	0
Other	0

Description:

Aquatic Plants

	Present
Emergents	
Floating	
Plant Removal	

If Applicable (Low Water Level):
EXPOSED LAKE BED ZONE

Plants

	Present
Canopy	
Shrubs	
Herbaceous	

Disturbed

Plants (Mowed or Removed)	
Sediment (Tilled or Dug)	

APPENDIX B
PHOTOGRAPH LOG

Table B-1. Photo Point Coordinates

Photo Point No.	Parcel No.	X Coordinate (° Longitude)	Y Coordinate (° Latitude)
001	276010970100	-92.6243306	44.86247252
002	276010970100	-92.62434033	44.86238978
003	276010970100	-92.62437587	44.86233134
004	276010970100	-92.62437711	44.8622782
005	276010970100	-92.62436559	44.862231
006	276010970100	-92.62436512	44.86218341
007	276010970100	-92.62436635	44.86211453
008	276010970100	-92.6243843	44.86201683
009	276010970100	-92.62440271	44.86192047
010	276010970100	-92.62442577	44.86180094
011	None	-92.62449194	44.86167853
012	None	-92.62456312	44.86159453
013	None	-92.62462718	44.86149418
014	None	-92.62467965	44.86141094
015	None	-92.62471259	44.86135794
016	None	-92.62474741	44.86129982
017	None	-92.62481465	44.86118353
018	None	-92.62489524	44.86104441
019	None	-92.624947	44.86094624
020	None	-92.62503806	44.86084218
021	None	-92.62514118	44.86074188
022	276011260300	-92.62524259	44.86065835
023	276011260300	-92.62529538	44.86058945
024	276011260300	-92.62539059	44.86049083
025	276011260300	-92.62553541	44.860355
026	276011260300	-92.62560318	44.86025888
027	276011260300	-92.62572883	44.86014559
028	276010970400	-92.62584318	44.86006036
029	276010970500	-92.62592194	44.85998894
030	276010970500	-92.62603389	44.85989065
031	None	-92.62615724	44.859789
032	None	-92.62625853	44.8596934
033	276011260600	-92.6263884	44.85960551
034	276011260600	-92.62644057	44.85952501
035	276011260600	-92.62653255	44.85944702
036	276011260600	-92.6265377	44.85931422
037	276011260600	-92.62661738	44.85915237
038	276011260600	-92.6266501	44.85907735
039	276011260600	-92.62671157	44.8589684
040	276011260600	-92.62679622	44.85887532
041	None	-92.62688986	44.85878922
042	None	-92.62694849	44.85870532
043	276011260600	-92.62701976	44.85861154
044	276011260600	-92.62711881	44.85848895

Photo Point No.	Parcel No.	X Coordinate (° Longitude)	Y Coordinate (° Latitude)
045	276011260600	-92.62725845	44.85838091
046	276011260600	-92.62738986	44.85830868
047	276011260600	-92.6275165	44.85825504
048	276011260600	-92.627635	44.85821532
049	276011260600	-92.627791	44.85812586
050	276011260600	-92.62794163	44.85805413
051	276011260600	-92.62813386	44.85798063
052	276010120900	-92.62845772	44.85789045
053	276010120900	-92.6285595	44.85783172
054	276011260600	-92.62878113	44.85777517
055	276011260600	-92.6290069	44.8576799
056	276011260600	-92.62936645	44.85759958
057	276011260600	-92.62956563	44.85751499
058	276011260600	-92.62977108	44.85734649
059	276011260600	-92.6299834	44.85718753
060	276011260600	-92.62993514	44.85716332
061	276011260600	-92.62978341	44.85720805
062	276011260600	-92.62961723	44.85723819
063	276011260600	-92.62943268	44.85725928
064	276011260600	-92.62929399	44.85718182
065	276011260600	-92.62913336	44.85713232
066	276011260600	-92.62896112	44.85702014
067	276011260600	-92.62885894	44.85682729
068	276011260600	-92.6289773	44.85663482
069	276011260600	-92.62891741	44.85649882
070	276010120900	-92.62881415	44.85634997
071	276010120900	-92.62883398	44.85616468
072	276011260600	-92.6288744	44.85596229
073	276011260600	-92.62890169	44.85579968
074	276011260600	-92.62892847	44.85563622
075	276011260600	-92.62897837	44.85549214
076	276010120900	-92.62904798	44.85526817
077	276010120900	-92.62917487	44.8551442
078	276010120900	-92.6293482	44.85498191
079	276011110600	-92.62963085	44.85482873
080	276011110600	-92.62979264	44.85480887
081	276011110600	-92.62997696	44.85481765
082	276011110600	-92.63033441	44.85489494
083	276011110600	-92.63058377	44.85499861
084	276011110600	-92.63092653	44.8552183
085	276011110600	-92.63110905	44.85541555
086	276011110600	-92.63150939	44.85556159
087	276011110600	-92.63177521	44.85554884
088	276011110600	-92.63207992	44.85550251
089	276011110600	-92.63230189	44.85541084
090	276011040100	-92.63250898	44.85590449

Photo Point No.	Parcel No.	X Coordinate (° Longitude)	Y Coordinate (° Latitude)
091	276011030500	-92.63226494	44.85593615
092	276011030500	-92.63203608	44.85595763
093	276011030500	-92.63184347	44.85597337
094	276011030500	-92.6316813	44.85604234
095	276011030500	-92.63148587	44.85617087
096	276011030500	-92.63141195	44.85629958
097	276011030500	-92.6313192	44.8566228
098	276011030500	-92.63108413	44.85685198
099	276011030500	-92.63061663	44.85713544
100	276011030500	-92.63032344	44.85727877
101	276011030500	-92.63017119	44.8573728
102	276011030500	-92.63010505	44.85750901
103	276011030500	-92.6300487	44.85765826
104	276011030500	-92.62990065	44.85779719
105	276011030500	-92.62963251	44.85791109
106	276011030500	-92.62935491	44.85794732
107	276011030500	-92.62915202	44.85798783
108	276011030500	-92.62890064	44.8581077
109	276011030500	-92.62874159	44.85819014
110	276011030500	-92.62863436	44.85812226
111	276011030500	-92.62847123	44.85817474
112	276011030500	-92.62819467	44.85821199
113	276011030500	-92.62801608	44.85823874
114	276011030500	-92.62777855	44.85831617
115	276011030500	-92.62758938	44.8584147
116	276011030500	-92.62744556	44.85851672
117	276011030500	-92.62734887	44.85867857
118	276011030500	-92.62725049	44.85887594
119	276011030500	-92.62711348	44.8589998
120	276011030500	-92.62702399	44.85913669
121	276011030500	-92.62689385	44.85941367
122	276011030500	-92.62680712	44.85961214
123	None	-92.62664069	44.85982045
124	276010600800	-92.62646854	44.85996726
125	276010600800	-92.62629167	44.8600796
126	276010600800	-92.62608844	44.86020311
127	276010600800	-92.62587528	44.86033654
128	276010600500	-92.62570141	44.86047719
129	276010600500	-92.62560335	44.86056752
130	276010600500	-92.62550217	44.86066745
131	276010600500	-92.62537464	44.8607587
132	276010600500	-92.6252424	44.86089185
133	276010600500	-92.62509497	44.86104766
134	276010600100	-92.62487378	44.86136535
135	276010600100	-92.62471304	44.86158937
136	None	-92.62462359	44.86167491

Photo Point No.	Parcel No.	X Coordinate (° Longitude)	Y Coordinate (° Latitude)
137	None	-92.62456519	44.86174628
138	276010470100	-92.62452832	44.86182364
139	276010470100	-92.62449098	44.86189341
140	276010470100	-92.6244665	44.86198479
141	276010470100	-92.62445568	44.86205555
142	276010470100	-92.62445499	44.86212585
143	276010470100	-92.624455	44.86220248
144	276010470100	-92.62448477	44.86228354
145	276010470100	-92.62456145	44.86234431
146	276010470100	-92.62456337	44.86247736
147	276011040400	-92.63448129	44.85516278
148	276011040400	-92.63475281	44.85516798
149	276011040400	-92.6350254	44.85512365
150	276011040400	-92.63541993	44.85505885
151	276011040400	-92.63603683	44.8549514
152	276011040400	-92.63650026	44.85478429
153	276011120700	-92.63424871	44.85484442
154	276011120700	-92.63344852	44.85508581
155	276011040400	-92.63369448	44.85541656
156	276011040400	-92.63344109	44.85552211
157	276011040200	-92.63305709	44.85576312

Photo Point #1 (Parcel No. 276010970100)

Photo Point #2 (Parcel No. 276010970100)

Photo Point #3 (Parcel No. 276010970100)

Photo Point #4 (Parcel No. 276010970100)

Photo Point #5 (Parcel No. 276010970100)

Photo Point #6 (Parcel No. 276010970100)

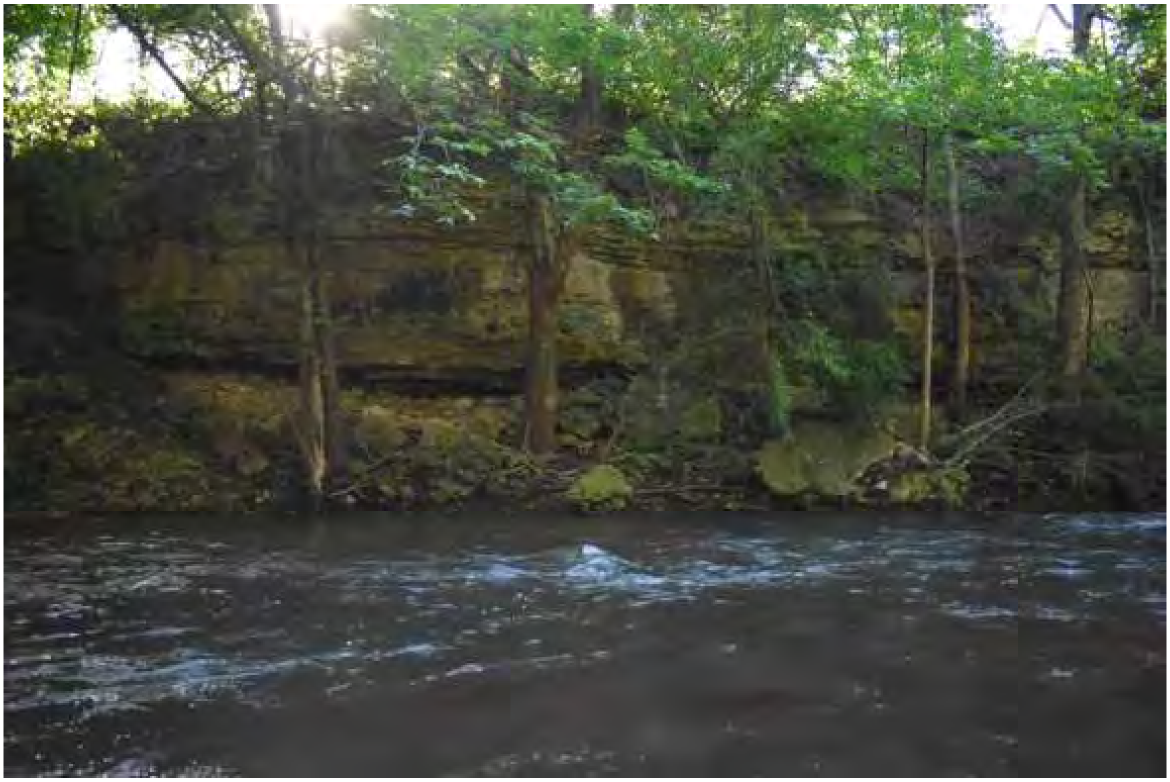

Photo Point #7 (Parcel No. 276010970100)

Photo Point #8 (Parcel No. 276010970100)

Photo Point #9 (Parcel No. 276010970100)

Photo Point #10 (Parcel No. 276010970100)

Photo Point #11 (Parcel No. – none applicable)

Photo Point #12 (Parcel No. – none applicable)

Photo Point #13 (Parcel No. – none applicable)

Photo Point #14 (Parcel No. – none applicable)

Photo Point #15 (Parcel No. – none applicable)

Photo Point #16 (Parcel No. – none applicable)

Photo Point #17 (Parcel No. – none applicable)

Photo Point #18 (Parcel No. – none applicable)

Photo Point #19 (Parcel No. – none applicable)

Photo Point #20 (Parcel No. – none applicable)

Photo Point #21 (Parcel No. 276011260300)

Photo Point #22 (Parcel No. 276011260300)

Photo Point #23 (Parcel No. 276011260300)

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Photo Point #136 (Parcel No. – none applicable)

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Photo Point #157 (Parcel No. 276011040200)

Appendix D – Mussel Survey

Privileged document – filed under separate cover

Appendix E – Aquatic Invasive Species Survey

Prepared for:

United States Army Corp of Engineers
–
Planning Assisstance to States (PAS)
Program

Investigate

Design

Restore

Project:

RIVER FALLS HYDROELECTRIC PROJECT AQUATIC INVASIVE SPECIES SURVEY
Contract W912ES20D0001

Inter-Fluve staff conducted an aquatic invasive species (AIS) survey on July 6-7, 2020, on behalf of the United States Army Corps of Engineers (USACE) Planning Assistance to States (PAS) Program- St. Paul District and River Falls Municipal Utilities in two impoundments located on the Kinnickinnic River in River Falls, Wisconsin (Figure 1). The two dams in the project area are the Junction Falls and Powell Falls Dams which are both currently licensed under FERC Permit No. 10489. The impoundments are commonly called Lake Louise and Lake George. Survey results indicate the presence of seven aquatic plant species, of these only curly-leaf pondweed (*Potamogeton crispus*) is considered invasive by the Wisconsin Department of Natural Resources (DNR) under Wisconsin Administrative Code Chapter NR 40.

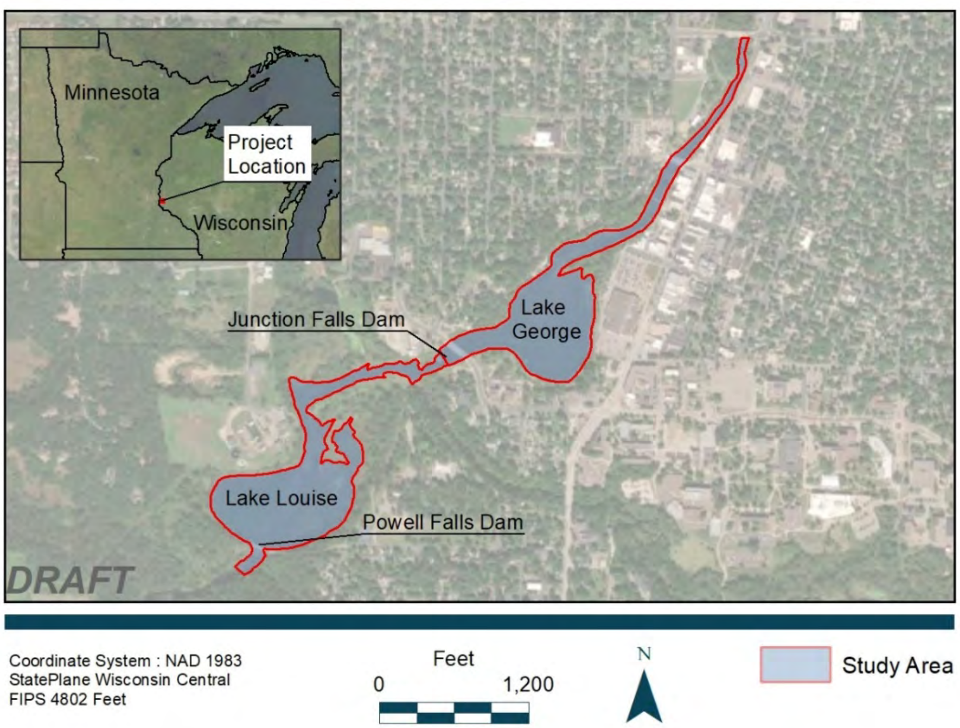


Figure 1: Location of the project area.

Table of Contents

1. Introduction

The Powell Falls and Junction Falls Dams impound the Kinnickinnic River within the City of River Falls, in Pierce County, Wisconsin, approximately 10 miles upstream of the river's confluence with the St. Croix River, and 30 miles downstream from its headwaters in Erin Prairie Township, Wisconsin. The dams create the downstream Lake Louise and the upstream Lake George, within the Powell Falls and Junction Falls Impoundments, respectively. The River Falls Municipal Utilities is proposing to relicense the Junction Falls Development and decommission the Powell Falls development with dam removal. As part of these efforts, an aquatic invasive species (AIS) survey was conducted in both impoundments.

2. Methods

An AIS survey was conducted by Inter-Fluve staff on July 6, 2020, on Lake George and July 7, 2020, on Lake Louise. Air temperatures varied between 70 and 90 degrees with cloud cover in the mornings clearing into the afternoons. Rain occurred on the morning of July 7. Maximum humidity was approximately 90 percent (%). The mean discharge at the United States Geological Survey (USGS) stream gage 05342000 located downstream of the project site at the County Road F crossing was 182 cubic feet per second (cfs) on July 6, 2020, and 125 cfs on July 7, 2020. Flooding on June 29, 2020, caused discharge to rise to a maximum of 6,220 cfs resulting in deposition within the sampled impoundments which may have buried formerly vegetated areas. However, aquatic vegetation along the impoundment margins, where vegetation has historically been most dense, did not visually appear affected by the flooding.

The aquatic vegetation survey methodology followed Hauxwell et al. (2010) and used a rope mounted rake sampler to sample vegetation. A double-sided rake was cast from a flat-bottom row boat into sampling locations based on a predetermined sampling grid consisting of 311 sample points. In Lake Louise, 162 sample points were collected, and in Lake George, 149 sample points were collected. An Apple iPad integrated global positioning system (GPS) was used to navigate to individual sampling locations. Rake fullness, a quantitative estimate based on vegetation coverage on the rake head, was rated as 1 -few, 2 – moderate, 3 - abundant (Figure 2). Visually estimated total and species-specific rake fullness was recorded directly onto the field form on the iPad. Individual species were collected in the field and preserved in a water filled bag for later identification.

Rake Fullness 1, typically Rake Fullness 2, typically Rake Fullness 3, typically

Figure 2: Typical photos used for rake fullness rating.

3. Results - General

Of the 311 initial sample sites, 291 sites were sampled. The 20 which were not sampled were located on recently deposited sand bars (17 sites), were located on rocky outcrops with unsafe access (2 sites), or were located onshore (1 site). Of the sampled sites, 197 contained aquatic vegetation with an average rake fullness of 1.64.

In total, seven aquatic plant species were identified in the two impoundments: sago pondweed (*Stuckenia pectinata*) which occurred at 65.48% of vegetated sample sites, curly-leaf pondweed (*Potamogeton crispus*) which occurred at 50.76% of vegetated sample sites, waterweed (*Elodea canadensis*) which occurred at 43.65%, coontail (*Cerstophyllum demersum*) which occurred at 24.87% of vegetated sample sites, duckweed (*Lemna Spp.*) which occurred at 3.55% of vegetated sample sites, floating pondweed (*Potamogeton natans*) which occurred at 0.51% of vegetated sample sites, and fine-leaf pondweed (*Stuckenia filiformis*) which occurred at 6.09% of vegetated sample sites. Of these species, only curly-leaf pondweed is considered invasive by the Wisconsin DNR under Wisconsin Administrative Code Chapter NR40.

4. Results – Powell Falls Impoundment

In Powell Falls Impoundment, also identified as Lake Louise, water clarity was relatively clear with the bottom observable in shallow areas. Average depth was estimated based on the length of submerged rope to be between 1 and 2 feet with the maximum estimated depth of 5 feet. Aquatic vegetation was generally most abundant within 0 to 2 feet deep water on the eastern and western sides of the ponded section of the impoundment. Narrower sections of the impoundment were largely devoid of vegetation. All observed aquatic vegetation species listed in section 3 were present. Sago pondweed was the most abundant aquatic vegetation and observed at 77.48% of sampled sites. Followed by curly-leaf pondweed (48.65%), common waterweed (39.64%), coontail (8.11%), ducked (6.31%), and floating-leaf pondweed (0.90%), and fine-leaf pondweed (0.90%).

Figure 3: Typical photo of Powell Falls Impoundment/Lake Louise.

5. Results – Junction Falls Impoundment

In the Junction Falls Impoundment, also identified as Lake George, water clarity was relatively clear with the bottom observable in shallow areas. Average depth was estimated based on length of submerged rope to be between 2 and 3 feet with the maximum estimated depth of 6 feet. Aquatic vegetation was generally most abundant within 0 to 2 feet deep water on the eastern side of the ponded section of the impoundment. Narrower sections of the impoundment were largely devoid of vegetation. Floating pondweed and duckweed were the only aquatic vegetation species listed in section 3 that were absent from the impoundment. Curly-leaf pondweed was the most abundant aquatic vegetation and observed at 50.00% of sampled sites. Followed by sago pondweed (46.74%), common waterweed (45.65%), coontail (43.48%), and fine-leaved pondweed (11.96%).

Figure 4: Typical photo of Junction Falls Impoundment/Lake George.

6. References

Hauxwell, et al., 2010. Recommended Baseline Monitoring of Aquatic Plants in Wisconsin: Sampling Design, Field and Laboratory Procedures, Data Entry and Analysis, and Applications. Available online: https://www.researchgate.net/profile/Michelle_Nault/publication/267832775_Recommended_Baseline_Monitoring_of_Aquatic_Plants_in_Wisconsin_Sampling_Design_Field_a 20190611-5044 FERC PDF (Unofficial) 6/11/2019 1:24:50 PM River Falls Hydroelectric Project Revised Study Plan FERC Project No. 10489 6-19 June 2019 nd_Laboratory_Procedures_Data_Entry_and_Analysis_and_Applications/links/54b98bc2 0cf2d11571a4b588/Recommended-Baseline-Monitoring-of-Aquatic-Plants-inWisconsin-Sampling-Design-Field-and-Laboratory-Procedures-Data-Entry-and-Analysisand-Applications.pdf?origin=publication_detail

7. Appendices

The following appendixes are included in this report and provide supporting documentation.

- Appendix A – Maps of Rake Fullness
- Appendix B – Rake Fullness Summary Statistics
- Appendix C – Plant ID Photos
- Appendix D – Raw Datasheets

Appendix A

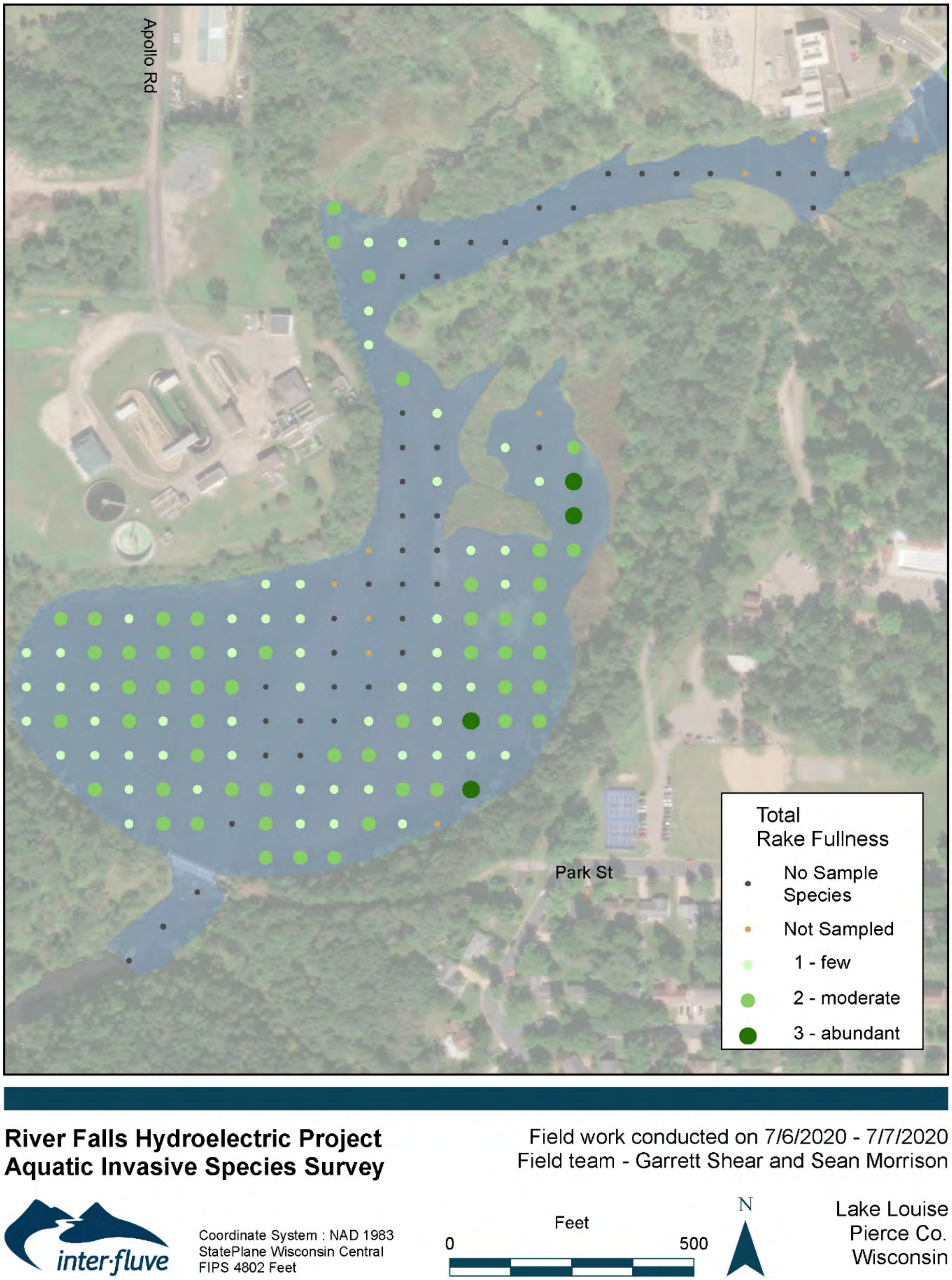


Figure A-1: Total rake fullness for Lake Louise.

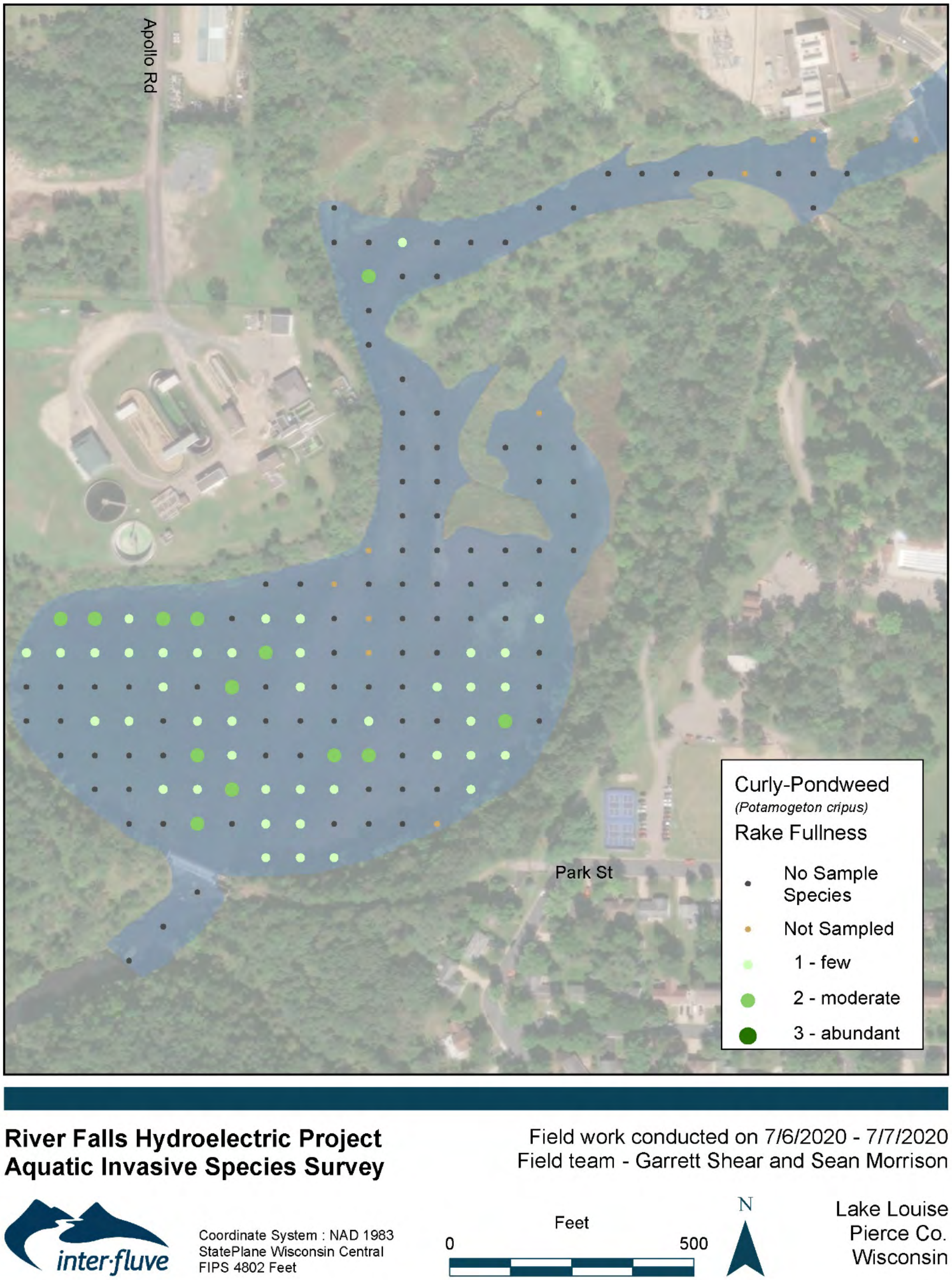


Figure A-2: Curly-leaf pondweed rake fullness for Lake Louise.

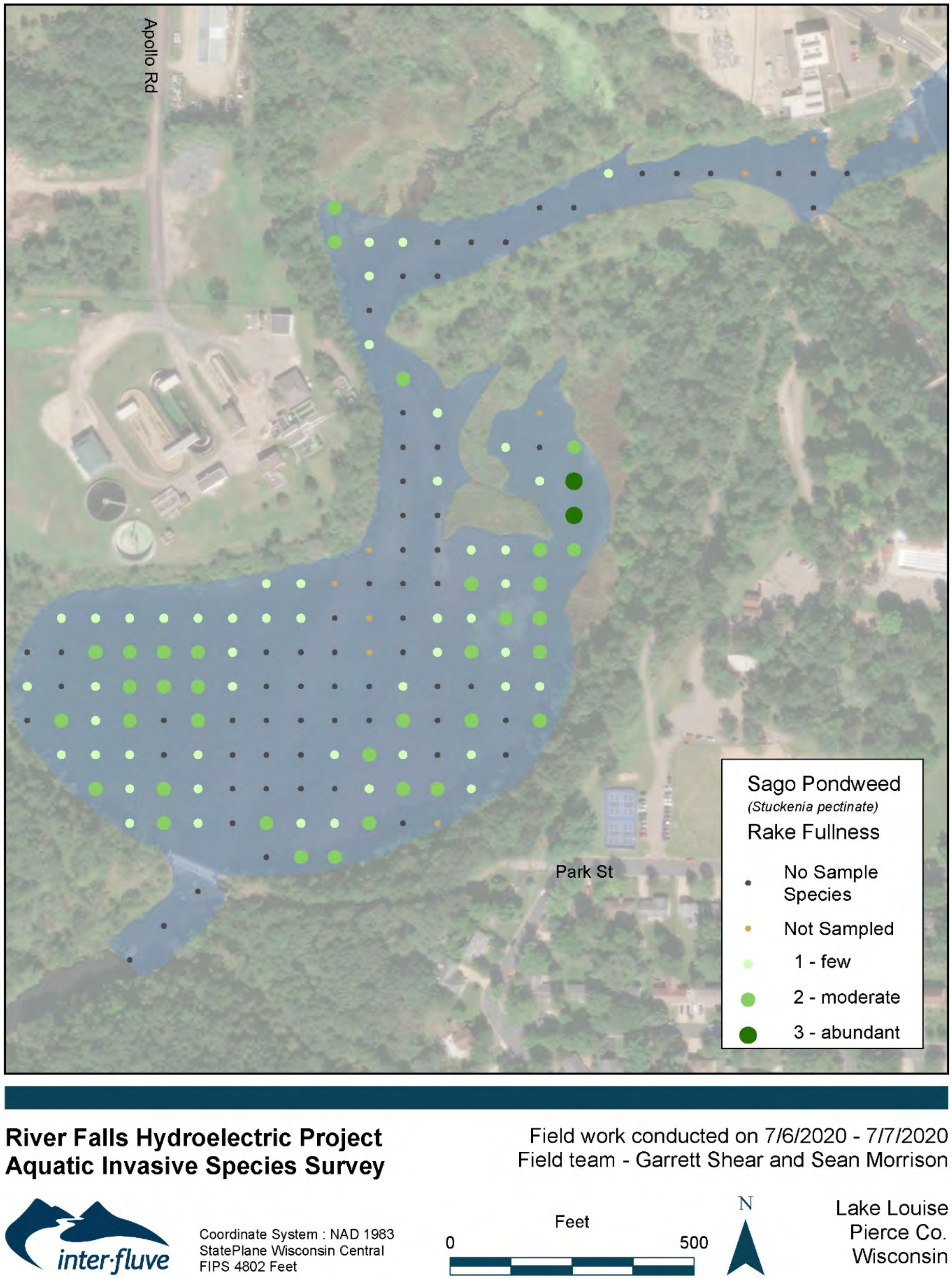


Figure A-3: Sago pondweed rake fullness for Lake Louise.

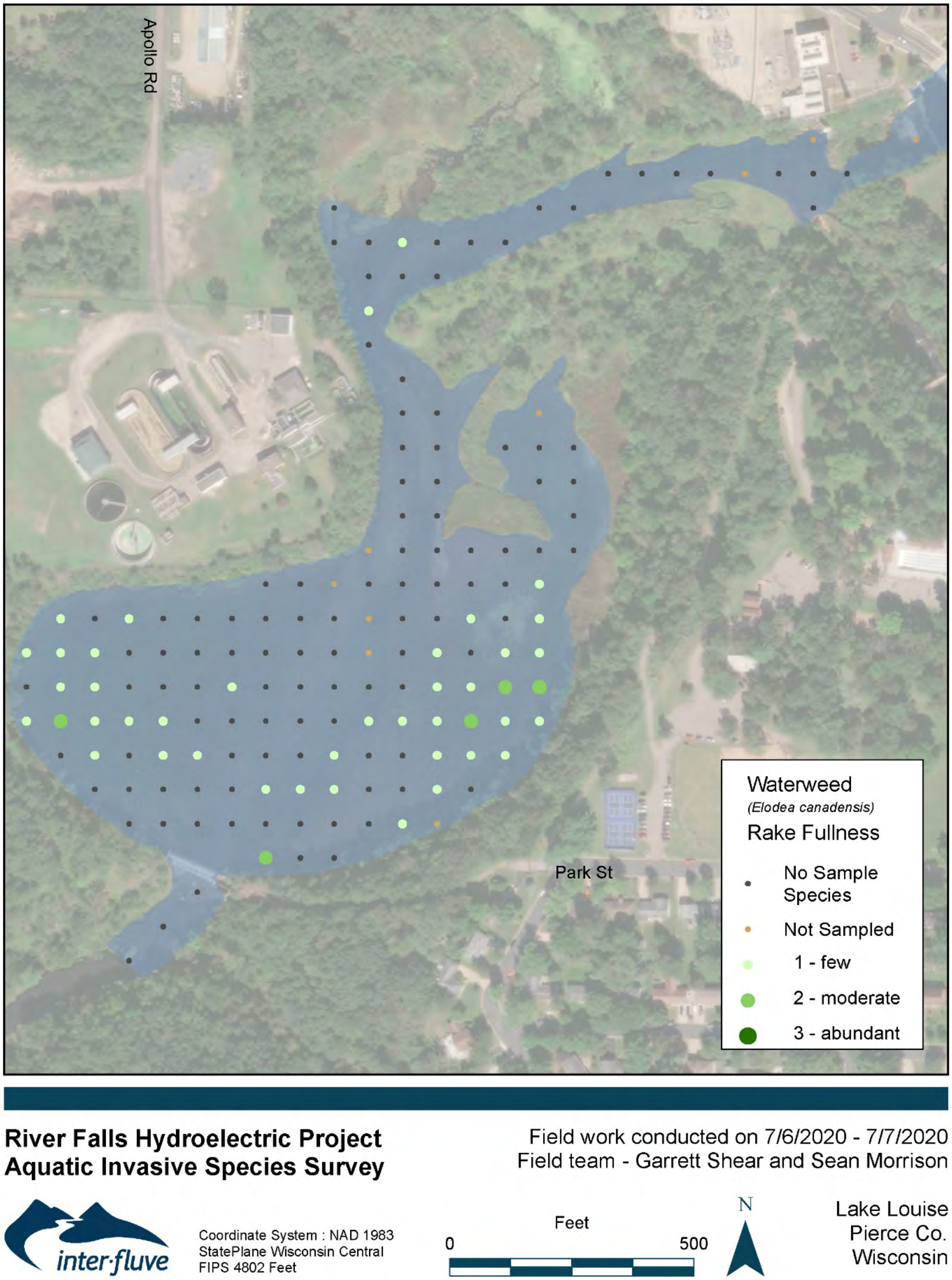


Figure A-4: Waterweed rake fullness for Lake Louise.

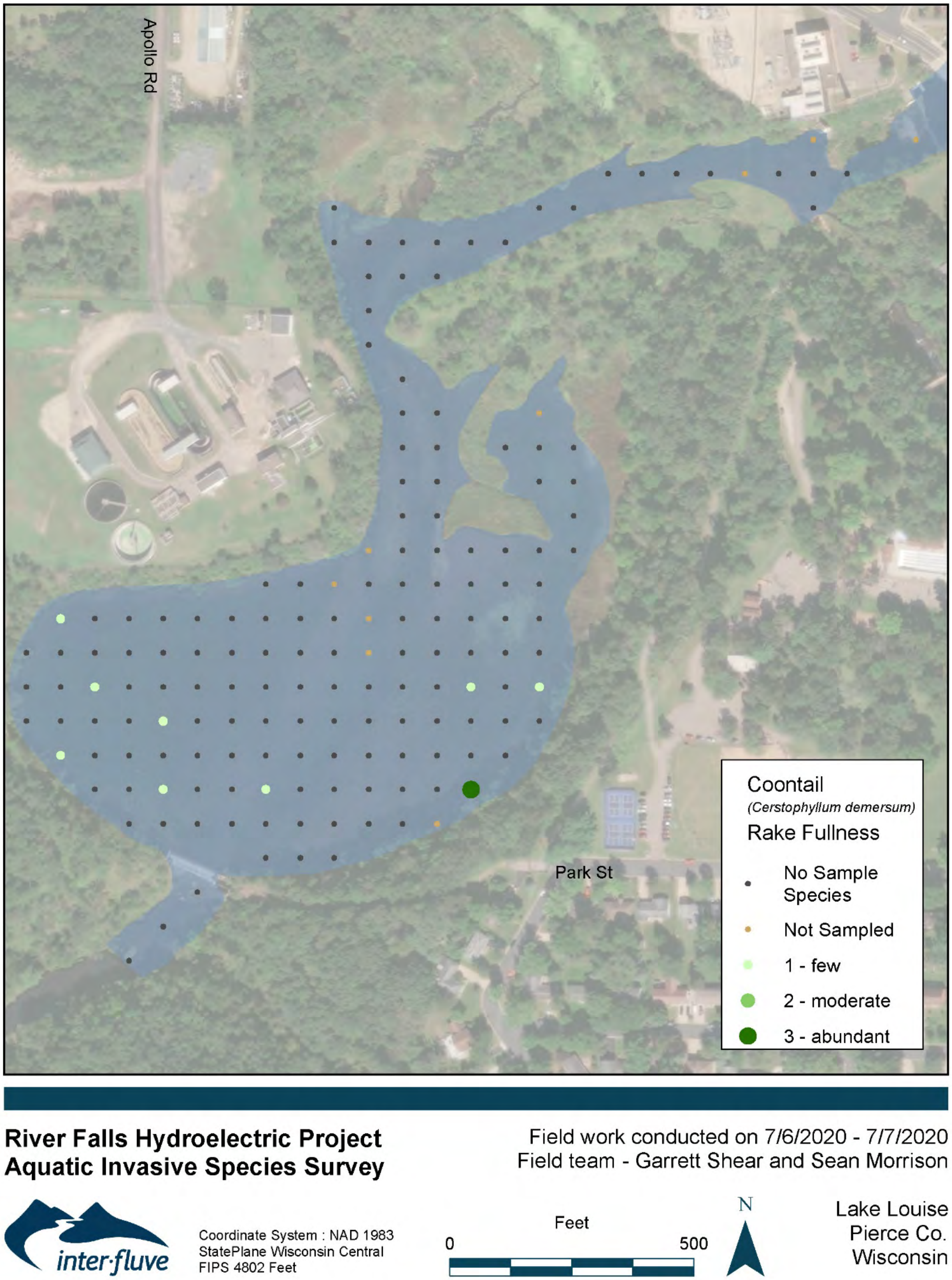


Figure A-5: Coontail rake fullness for Lake Louise.

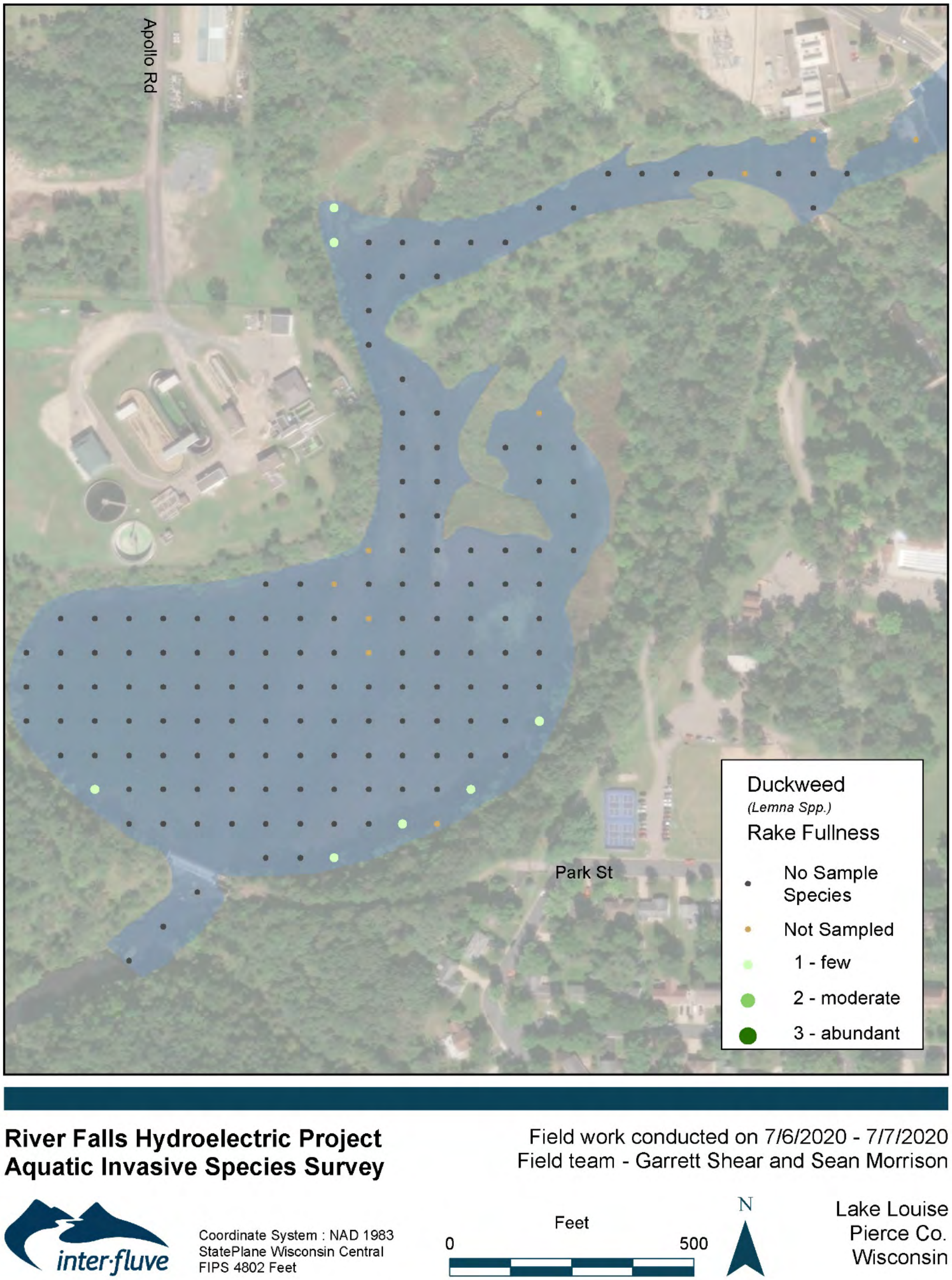


Figure A-6: Duckweed rake fullness for Lake Louise.

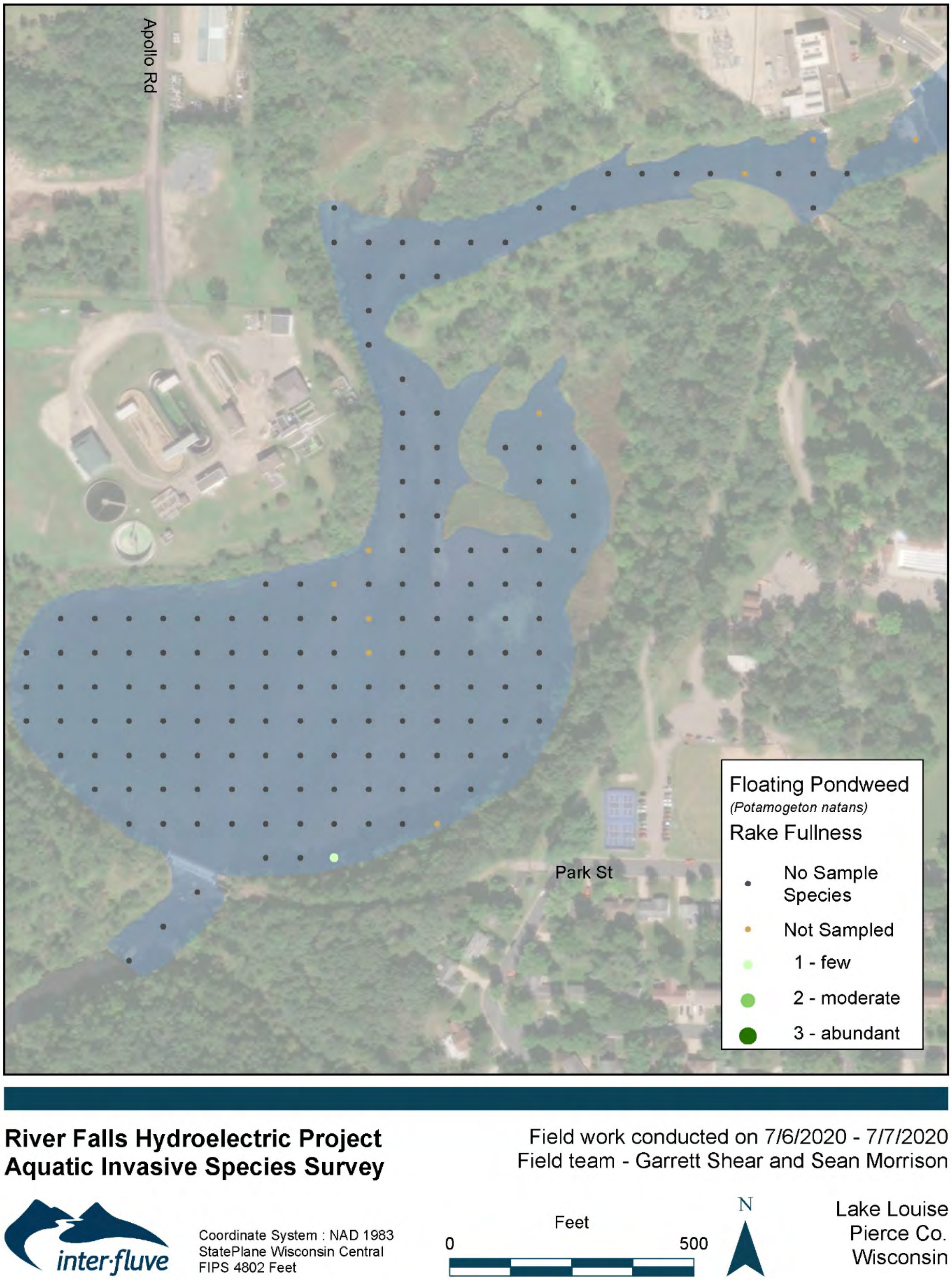


Figure A-7: Floating pondweed rake fullness for Lake Louise.

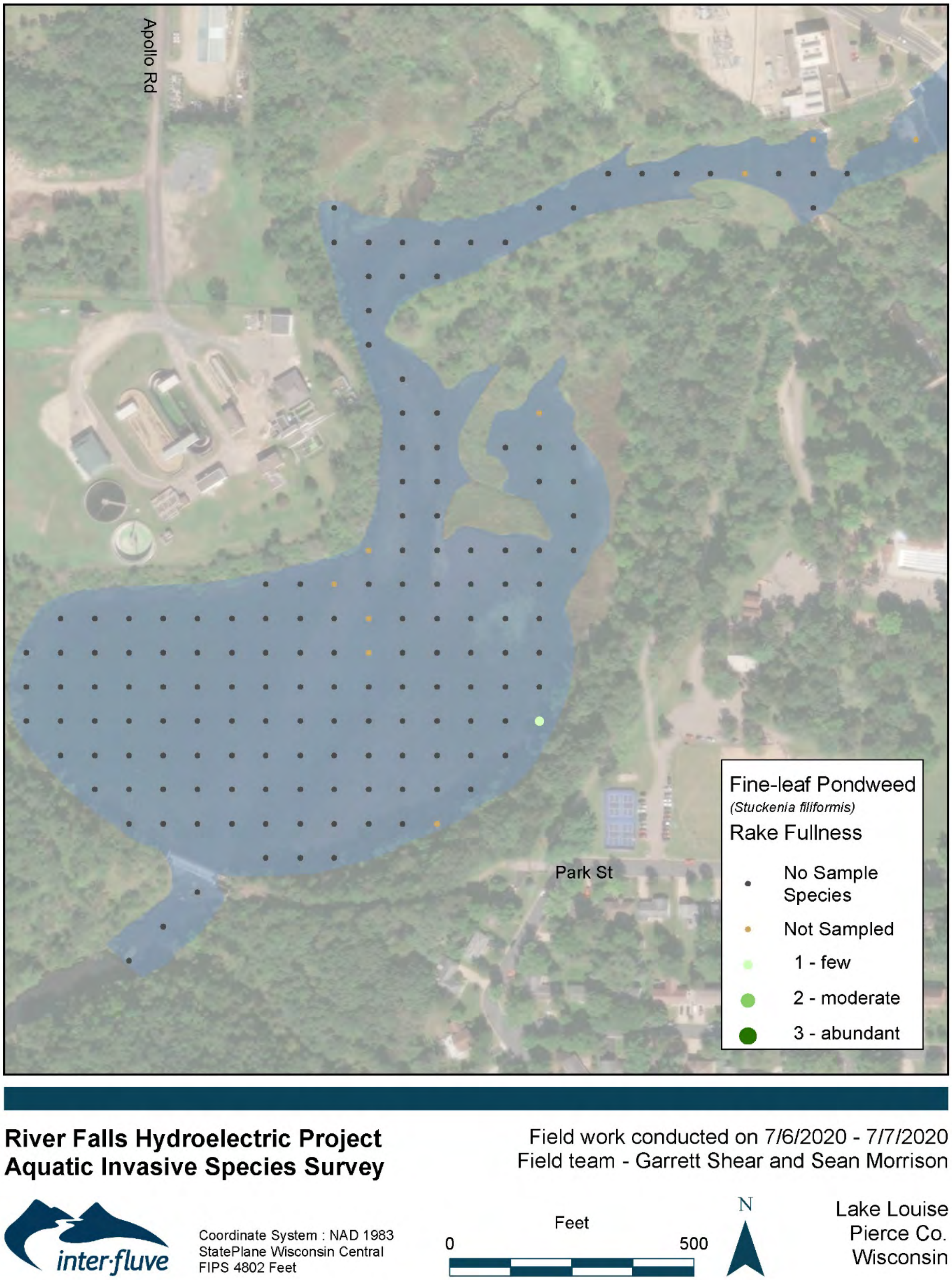


Figure A-8: Fine-leaf pondweed rake fullness for Lake Louise.

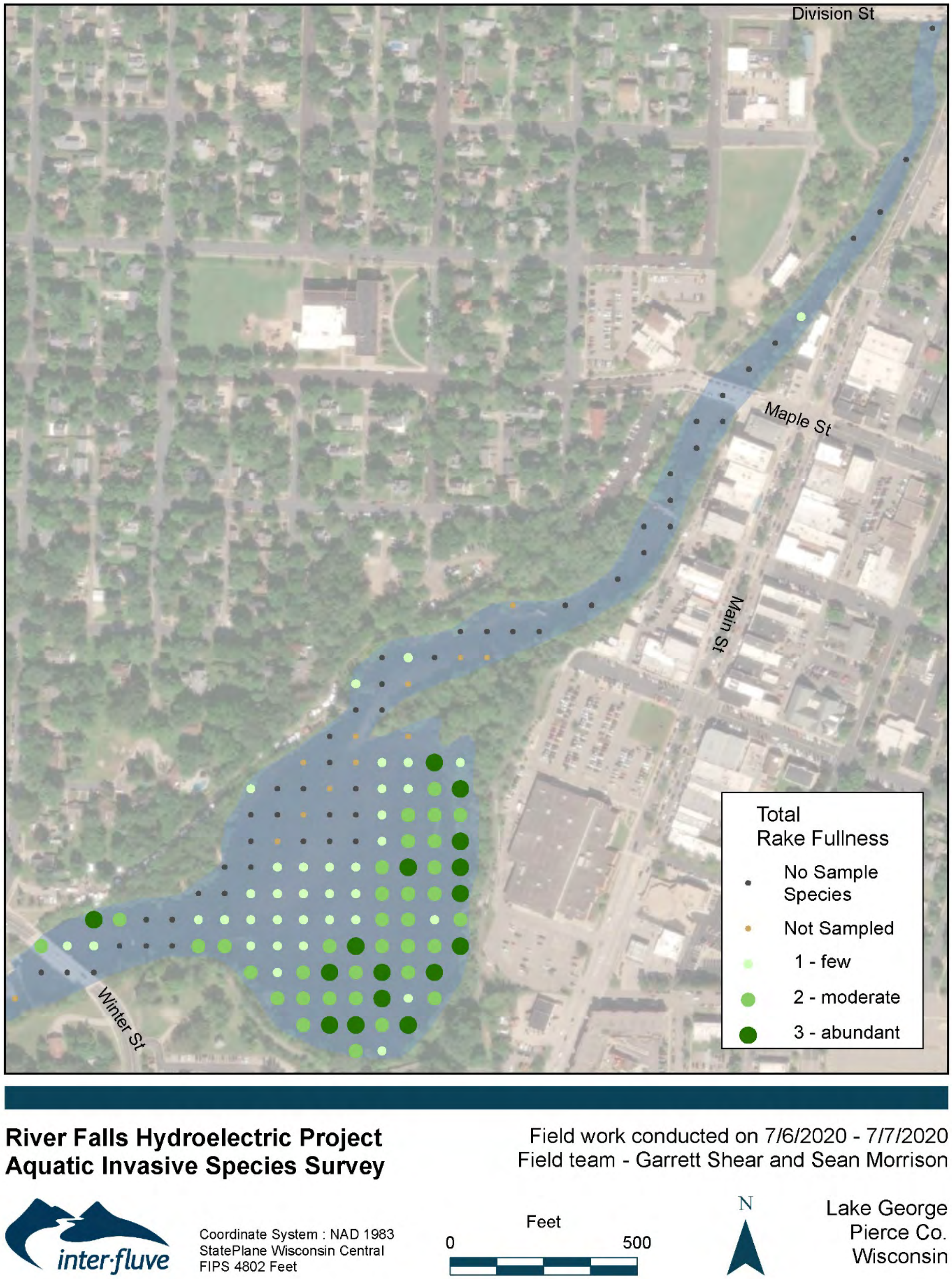


Figure A-9: Total rake fullness for Lake George.

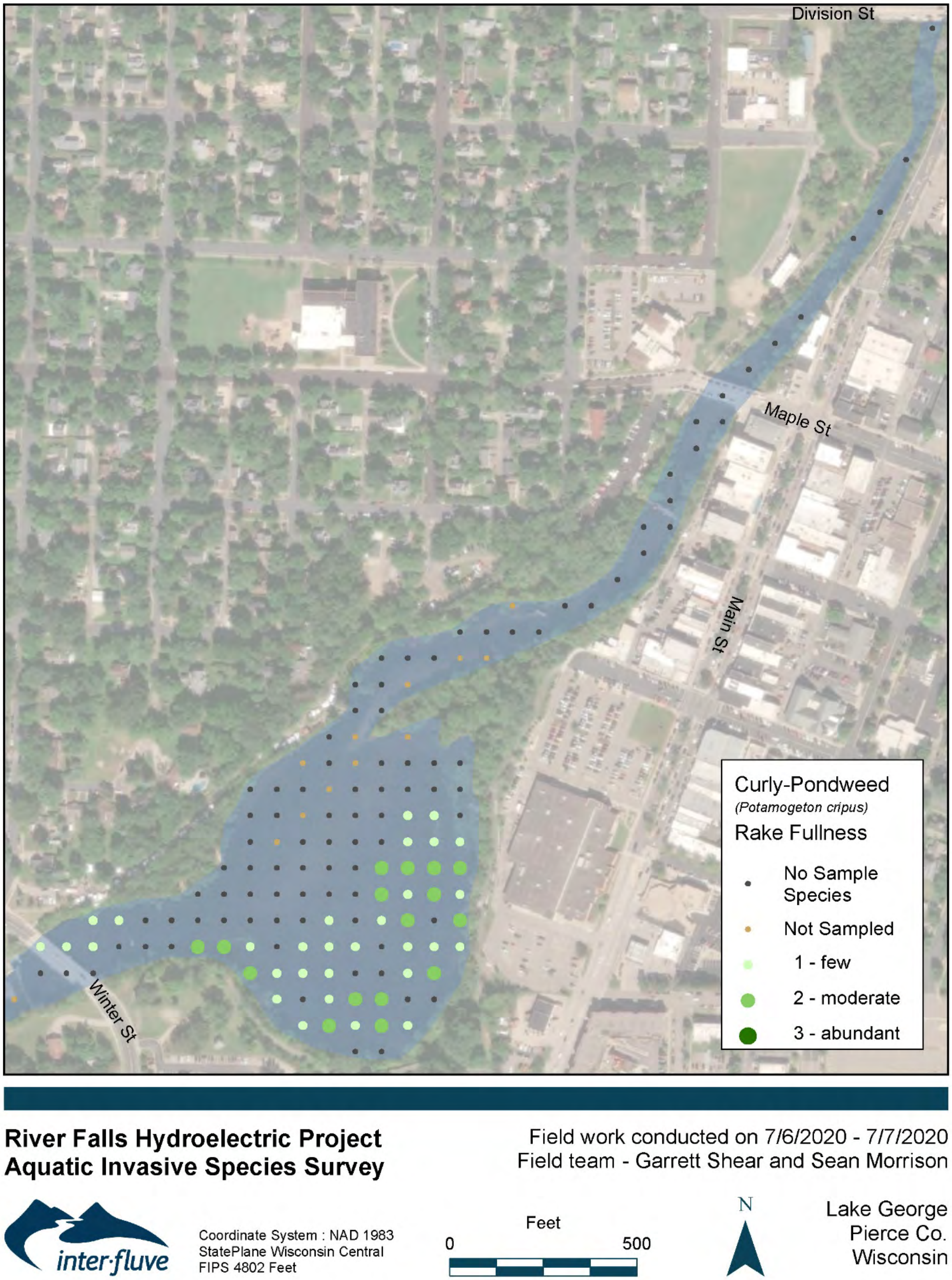
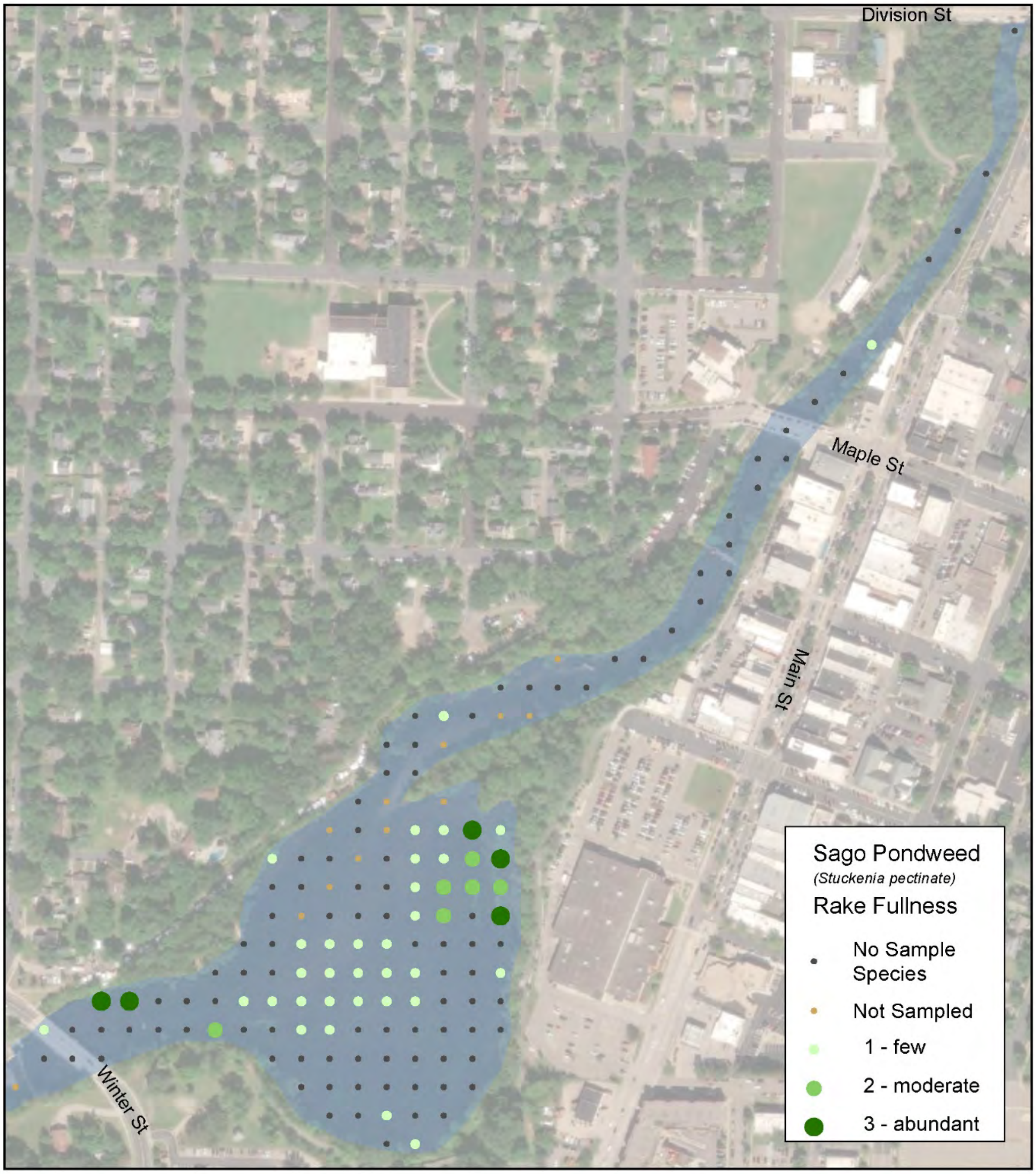


Figure A-10: Curly-leaf pondweed rake fullness for Lake George.



River Falls Hydroelectric Project
Aquatic Invasive Species Survey

Field work conducted on 7/6/2020 - 7/7/2020
Field team - Garrett Shear and Sean Morrison

inter·fluve

Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

Feet
0 500

N

Lake George
Pierce Co.
Wisconsin

Figure A-11: Sago pondweed rake fullness for Lake George.

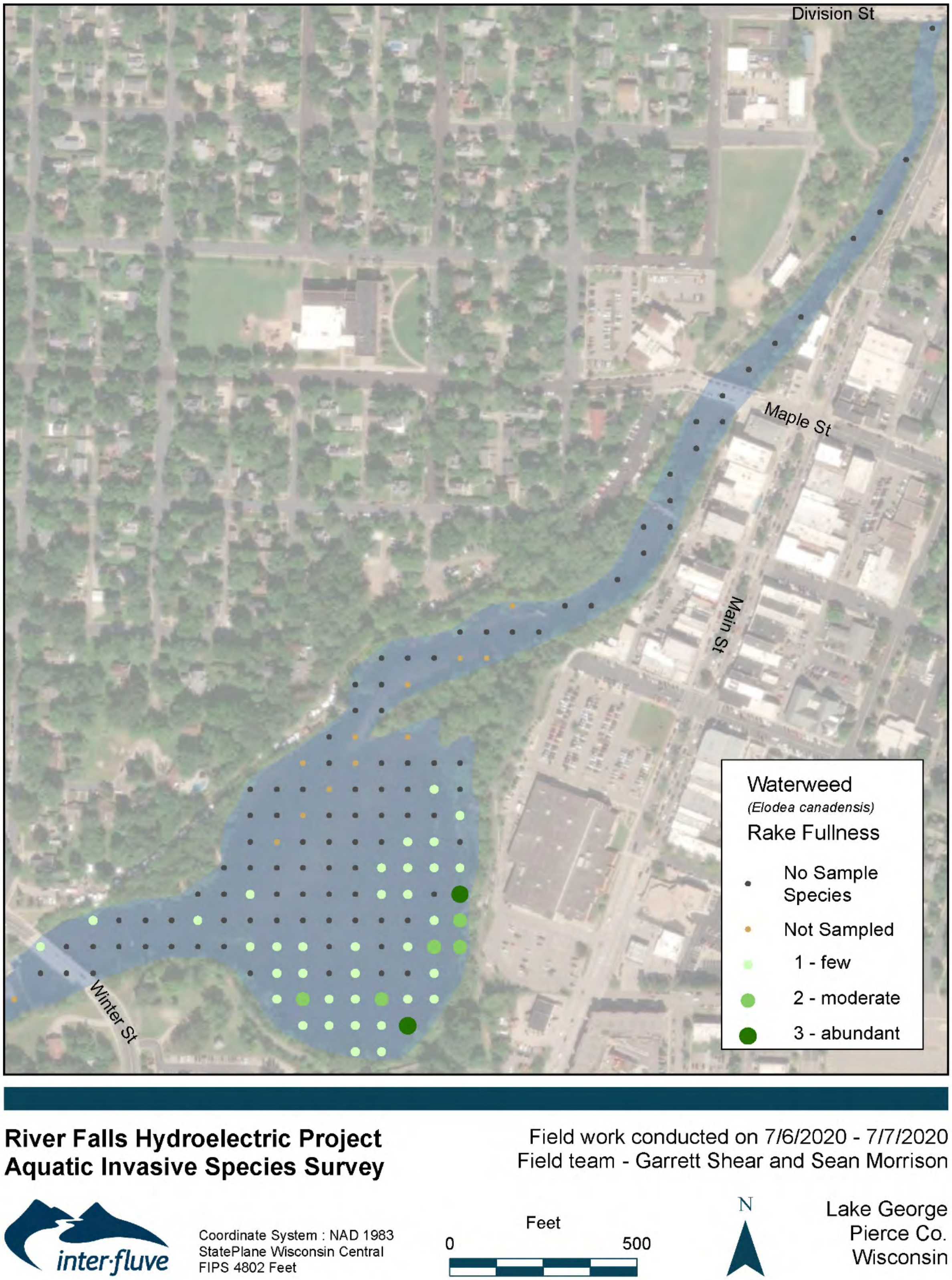


Figure A-12: Waterweed rake fullness for Lake George.

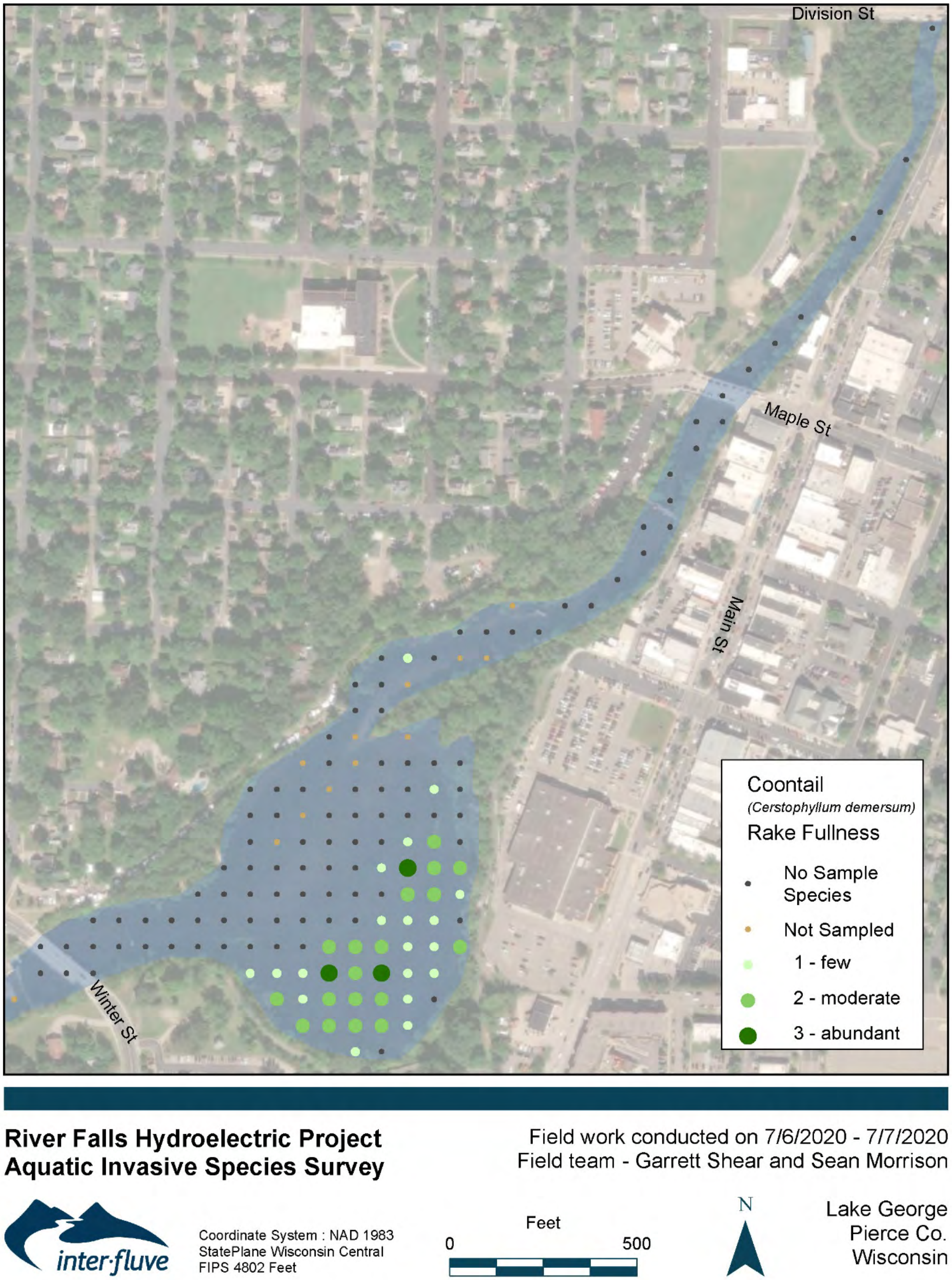


Figure A-13: Coontail rake fullness for Lake George.

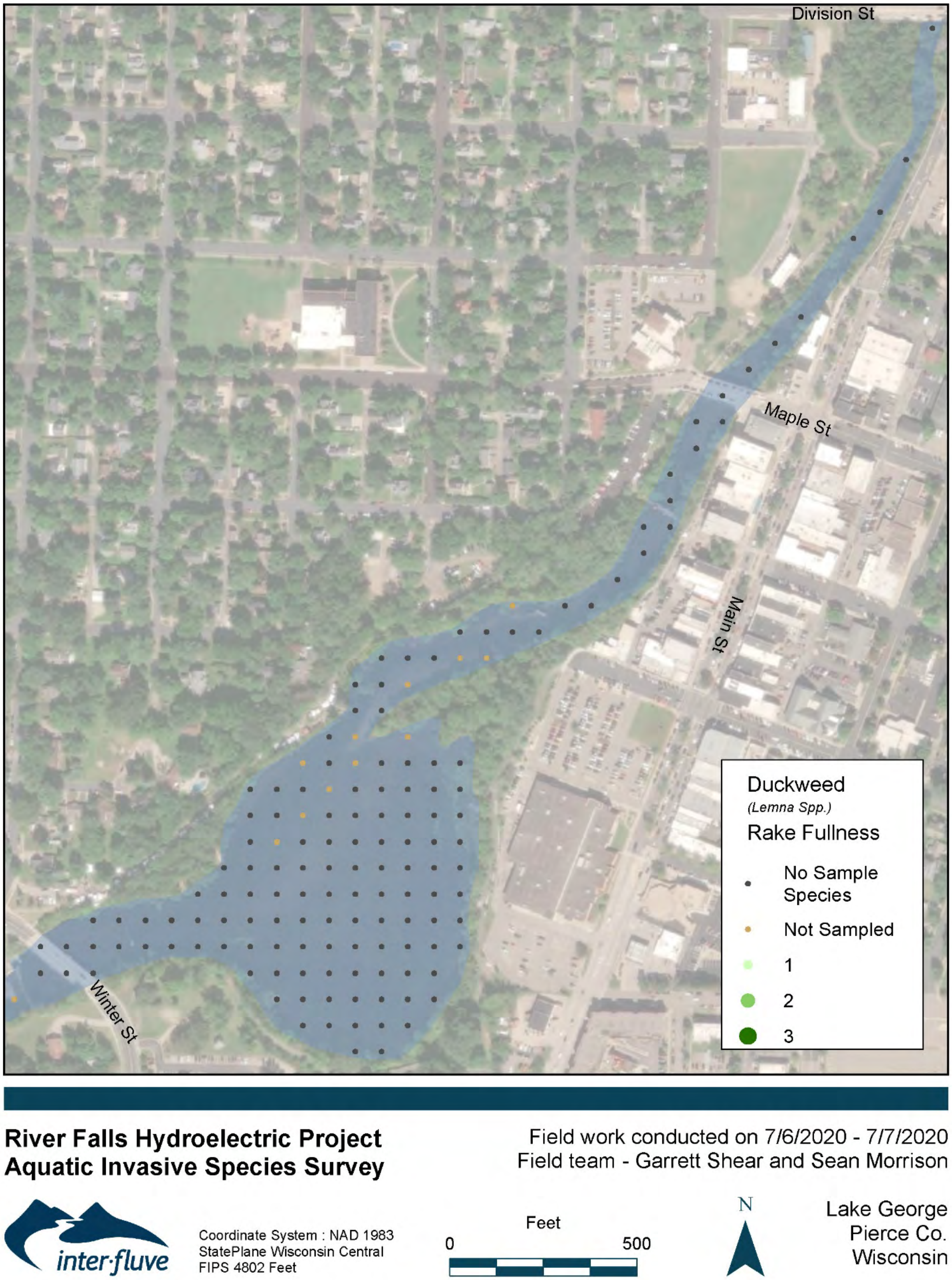


Figure A-14: Duckweed rake fullness for Lake George.

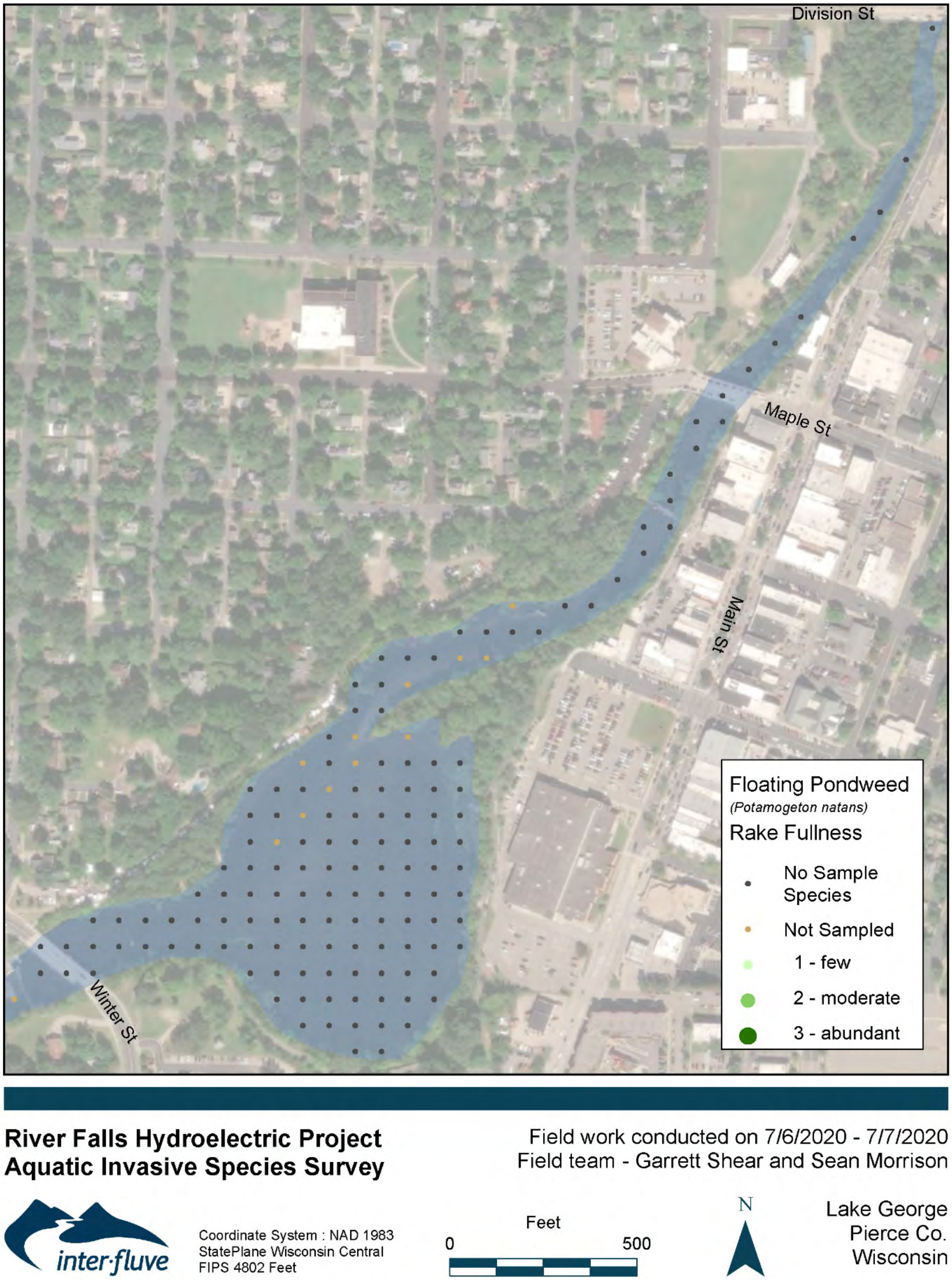


Figure A-15: Floating pondweed rake fullness for Lake George.

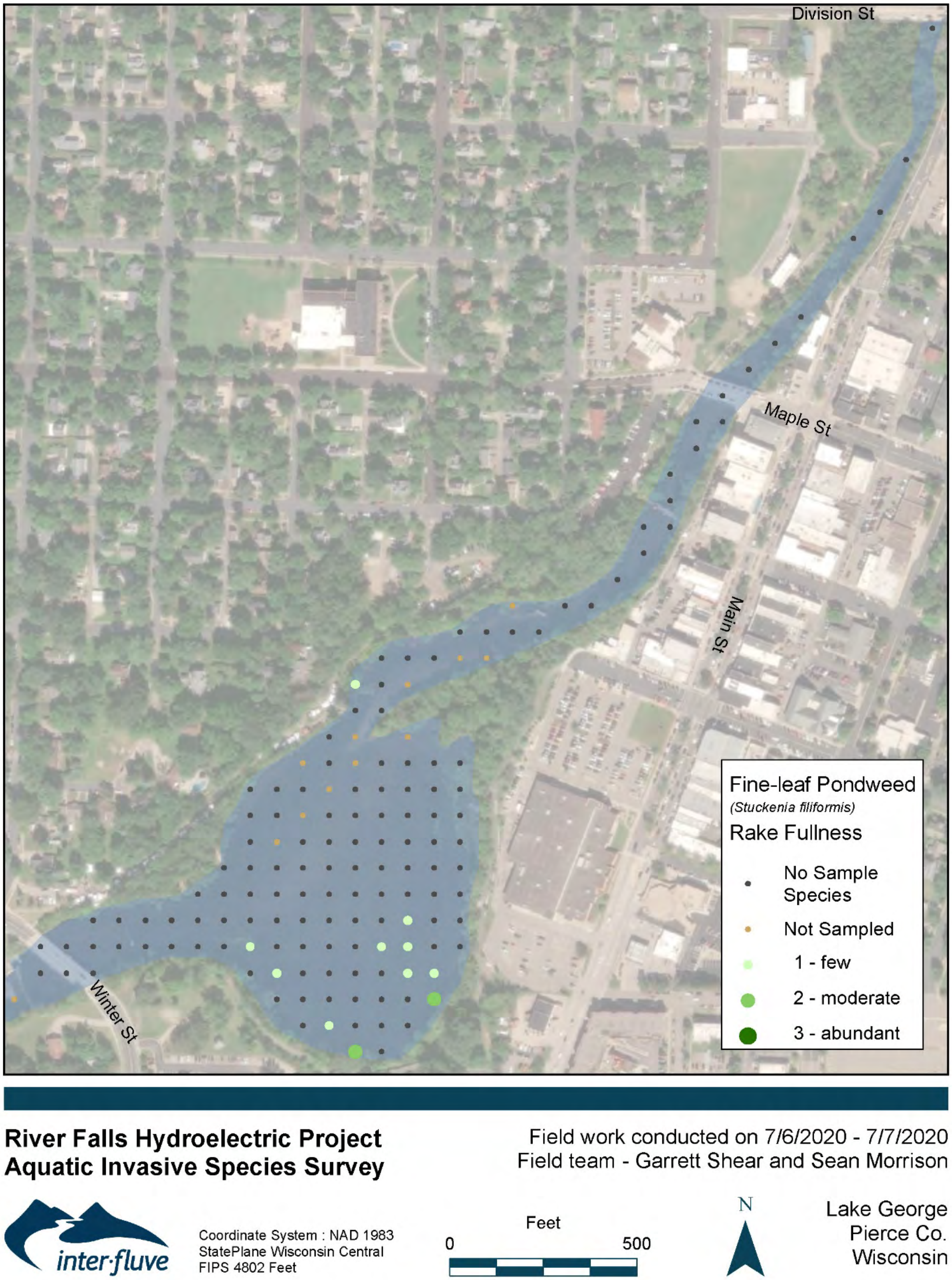


Figure A-16: Fine-leaf pondweed rake fullness for Lake George.

Appendix B

STATS

Lake Lake George and Lake Louise
County Pierce
WBIC None
Survey Date 7/6/2020-7/7/2020

INDIVIDUAL SPECIES STATS:

	Total vegetation	*Potamogeton crispus*, Curly- leaf pondweed	*Ceratophyllum demersum*, Coontail	*Elodea canadensis*, Common waterweed	*Lemna Spp.* Duckweed	*Potamogeton natans*, Floating-leaf pondweed	*Stuckenia filiformis*, Fine- leaved pondweed	*Stuckenia pectinata*, v Sago pondweed
Frequency of occurrence within vegetated areas (%)		50.76	24.87	43.65	3.55	0.51	6.09	65.48
Frequency of occurrence at sites shallower than maximum depth of plants		32.15	15.76	27.65	2.25	0.32	3.86	41.48
Relative Frequency (%)		26.0	12.8	22.4	1.8	0.3	3.1	33.6
Relative Frequency (squared)	0.25	0.07	0.02	0.05	0.00	0.00	0.00	0.11
Number of sites where species found		100	49	86	7	1	12	129
Average Rake Fullness	1.64	1.29	1.53	1.16	1.00	1.00	1.17	1.43
# visual sightings								
present (visual or collected)		x	x	x	x	x	x	x

SUMMARY STATS:

Total number of sites visited	**311**
Total number of sites with vegetation	**197**
Total number of sites shallower than maximum depth of plants	**311**
Frequency of occurrence at sites shallower than maximum depth of plants	**63.34**
Simpson Diversity Index	**0.75**
Maximum depth of plants (ft)**	**-**
Number of sites sampled using rake on Rope(R)	**291**
Number of sites sampled using rake on Pole(P)	**0**
Average number of all species per site (shallower than max depth)	**1.23**
Average number of all species per site (veg. sites only)	**1.95**
Average number of native species per site (shallower than max depth)	**0.91**
Average number of native species per site (veg. sites only)	**1.51**
Species Richness	**7**
Species Richness (including visuals)	**0**

STATS

Lake Lake George
County Pierce
WBIC None
Survey Date 7/6/2020-7/7/2020

INDIVIDUAL SPECIES STATS:

	Total vegetation	*Potamogeton crispus*, Curly- leaf pondweed	*Ceratophyllum demersum*, Coontail	*Elodea canadensis*, Common waterweed	*Lemna Spp.* Duckweed	*Potamogeton natans*, Floating-leaf pondweed	*Stuckenia filiformis*, Fine- leaved pondweed	*Stuckenia pectinata*, Sago pondweed
Frequency of occurrence within vegetated areas (%)		50.00	43.48	45.65			11.96	46.74
Frequency of occurrence at sites shallower than maximum depth of plants		30.87	26.85	28.19			7.38	28.86
Relative Frequency (%)		25.3	22.0	23.1			6.0	23.6
Relative Frequency (squared)	0.22	0.06	0.05	0.05			0.00	0.06
Number of sites where species found		46	40	42			11	43
Average Rake Fullness	1.77	1.35	1.60	1.21			1.18	1.37
# visual sightings								
present (visual or collected)		x	x	x			x	x

SUMMARY STATS:

Total number of sites visited	**149**
Total number of sites with vegetation	**92**
Total number of sites shallower than maximum depth of plants	**149**
Frequency of occurrence at sites shallower than maximum depth of plants	**61.74**
Simpson Diversity Index	**0.78**
Maximum depth of plants (ft)**	**-**
Number of sites sampled using rake on Rope(R)	**138**
Number of sites sampled using rake on Pole(P)	**0**
Average number of all species per site (shallower than max depth)	**1.34**
Average number of all species per site (veg. sites only)	**2.12**
Average number of native species per site (shallower than max depth)	**0.94**
Average number of native species per site (veg. sites only)	**1.64**
Species Richness	**5**
Species Richness (including visuals)	**0**

STATS

Lake Lake Louise
County Pierce
WBIC None
Survey Date 7/6/2020-7/7/2020

INDIVIDUAL SPECIES STATS:

	Total vegetation	*Potamogeton crispus*, Curly- leaf pondweed	*Ceratophyllum demersum*, Coontail	*Elodea canadensis*, Common waterweed	*Lemna Spp.* Duckweed	*Potamogeton natans*, Floating-leaf pondweed	*Stuckenia filiformis*, Fine- leaved pondweed	*Stuckenia pectinata*, Sago pondweed
Frequency of occurrence within vegetated areas (%)		48.65	8.11	39.64	6.31	0.90	0.90	77.48
Frequency of occurrence at sites shallower than maximum depth of plants		33.33	5.56	27.16	4.32	0.62	0.62	53.09
Relative Frequency (%)		26.7	4.5	21.8	3.5	0.5	0.5	42.6
Relative Frequency (squared)	0.30	0.07	0.00	0.05	0.00	0.00	0.00	0.18
Number of sites where species found		54	9	44	7	1	1	86
Average Rake Fullness	1.55	1.24	1.22	1.11	1.00	1.00	1.00	1.45
# visual sightings								
present (visual or collected)		x	x	x	x	x	x	x

SUMMARY STATS:

Total number of sites visited	**162**
Total number of sites with vegetation	**111**
Total number of sites shallower than maximum depth of plants	**162**
Frequency of occurrence at sites shallower than maximum depth of plants	**68.52**
Simpson Diversity Index	**0.70**
Maximum depth of plants (ft)**	**-**
Number of sites sampled using rake on Rope(R)	**153**
Number of sites sampled using rake on Pole(P)	**0**
Average number of all species per site (shallower than max depth)	**1.25**
Average number of all species per site (veg. sites only)	**1.82**
Average number of native species per site (shallower than max depth)	**0.91**
Average number of native species per site (veg. sites only)	**1.41**
Species Richness	**7**
Species Richness (including visuals)	**0**

Appendix C

Curly-leaf Pondweed (*Potamogeton crispus*)

Sago Pondweed (*Stuckenia pectinata*)

Waterweed (*Elodea canadensis*)

Coontail (*Cerstophyllum demersum*)

Duckweed (*Lemna Spp.*)

Floating Pondweed (*Potamogeton natans*)

Fine-leaf Pondweed (*Stuckenia filiformis*)

Appendix D

sampling point	Latitiude (need electronic copy of site locations)	Longitude (need electronic copy of site locations)	Dominant sediment type (M=muck, S=Sand, R=Rock)	Sampled holding rake pole (P) or rake rope (R)?	comments	Total Rake Fullness	*Potamogeton crispus* ,Curly-leaf pondweed	*Ceratophyllum demersum* , Coontail	*Elodea canadensis* , Common waterweed	*Lemna Spp. Duckweed*	*Potamogeton natans* , Floating-leaf pondweed	*Stuckenia pectinata* , Sago pondweed
1	-92.63953	44.850449	R	R								
2	-92.639269	44.850647	R	R								
3	-92.639008	44.850845	R	R								
4	-92.638477	44.85105	M	R		2	1		2			
5	-92.638207	44.851056	M	R		2	1					2
6	-92.637937	44.851062	M	R		2	1			1	1	2
7	-92.639565	44.851216	M	R		1						1
8	-92.639295	44.851223	M	R		2						2
9	-92.639025	44.851229	M	R		2	2					1
10	-92.638755	44.851235	M	R								
11	-92.638486	44.851241	M	R		2	1					2
12	-92.638216	44.851248	M	R		1	1					1
13	-92.637946	44.851254	M	R		1						1
14	-92.637676	44.85126	M	R		2						2
15	-92.637406	44.851266	M	R		1			1	1		
16	-92.637137	44.851273			terrestrial							
17	-92.639843	44.851402	M	R		2				1		2
18	-92.639573	44.851408	M	R		1						1
19	-92.639304	44.851415	M	R		2	1	1				2
20	-92.639034	44.851421	M	R		1	1					1
21	-92.638764	44.851427	M	R		2	2					
22	-92.638494	44.851433	M	R		2	1	1	1			
23	-92.638225	44.85144	M	R		1	1		1			
24	-92.637955	44.851446	M	R		1	1		1			
25	-92.637685	44.851452	M	R		1						1
26	-92.637415	44.851458	M	R		2						2
27	-92.637145	44.851464	M	R		2			1			2
28	-92.636876	44.851471	M	R		3	1	3		1		1
29	-92.640122	44.851588	M	R		1		1				1
30	-92.639852	44.851594	M	R		1			1			1
31	-92.639582	44.8516	M	R		1						1
32	-92.639312	44.851607	M	R		1			1			

33	-92.639043	44.851613	M	R		2	2		1			1
34	-92.638773	44.851619	M	R		1	1					
35	-92.638503	44.851625	M	R								
36	-92.638233	44.851631	M	R								
37	-92.637964	44.851638	M	R		2	2		1			1
38	-92.637694	44.851644	M	R		2	2					2
39	-92.637424	44.85165	M	R		1						1
40	-92.637154	44.851656	M	R		1	1		1			
41	-92.636884	44.851663	M	R		1	1		1			1
42	-92.636615	44.851669	M	R		1	1		1			
43	-92.6404	44.851773	M	R		1			1			
44	-92.640131	44.85178	M	R		2			2			2
45	-92.639861	44.851786	M	R		1	1		1			1
46	-92.639591	44.851792	M	R		2	1		1			2
47	-92.639321	44.851798	M	R		1		1	1			
48	-92.639051	44.851805	M	R		2	1					2
49	-92.638782	44.851811	M	R		1	1					
50	-92.638512	44.851817	M	R								
51	-92.638242	44.851823	M	R								
52	-92.637972	44.85183	M	R								
53	-92.637703	44.851836	M	R		1	1		1			
54	-92.637433	44.851842	M	R		2			1			2
55	-92.637163	44.851848	M	R		1			1			
56	-92.636893	44.851855	M	R		3	1		2			2
57	-92.636623	44.851861	M	R		2	2		1			
58	-92.636354	44.851867	M	R		2			1	1		2
59	-92.640409	44.851965	M	R		1						1
60	-92.640139	44.851972	M	R		1			1			
61	-92.63987	44.851978	M	R		1		1	1			1
62	-92.6396	44.851984	M	R		2						2
63	-92.63933	44.85199	M	R		2	1					2
64	-92.63906	44.851997	M	R		2						2
65	-92.63879	44.852003	M	R		2	2		1			1
66	-92.638521	44.852009	M	R								
67	-92.638251	44.852015	M	R		1	1					
68	-92.637981	44.852022	M	R								
69	-92.637711	44.852028	M	R								
70	-92.637442	44.852034	M	R		1						1
71	-92.637172	44.85204	M	R		1	1		1			
72	-92.636902	44.852046	M	R		1	1	1	1			
73	-92.636632	44.852053	M	R		2	1		2			1
74	-92.636362	44.852059	M	R		2		1	2			1
75	-92.640418	44.852157	M	R		1	1		1			
76	-92.640148	44.852163	M	R		1	1		1			
77	-92.639878	44.85217	M	R		2	1		1			2
78	-92.639609	44.852176	M	R		2	1					2
79	-92.639339	44.852182	M	R		2	1					2
80	-92.639069	44.852188	M	R		2	1					2
81	-92.638799	44.852195	M	R		1	1					1
82	-92.638529	44.852201	M	R		2	2					
83	-92.63826	44.852207	M	R		1	1					
84	-92.63799	44.852213	M	R								

85	-92.63772	44.85222			sand bar							
86	-92.63745	44.852226	M	R								
87	-92.637181	44.852232	M	R		1			1			1
88	-92.636911	44.852238	M	R		2	1					2
89	-92.636641	44.852245	M	R		2	1		1			1
90	-92.636371	44.852251	M	R		2			1			2
91	-92.640157	44.852355	M	R		2	2	1	1			1
92	-92.639887	44.852362	M	R		2	2					1
93	-92.639617	44.852368	M	R		1	1		1			1
94	-92.639348	44.852374	M	R		2	2					1
95	-92.639078	44.85238	M	R		2	2					1
96	-92.638808	44.852387	M	R		1						1
97	-92.638538	44.852393	M	R		1	1					1
98	-92.638268	44.852399	M	R		1	1					1
99	-92.637999	44.852405	M	R								
100	-92.637729	44.852412			Sand bar							
101	-92.637459	44.852418	M	R								
102	-92.637189	44.852424	M	R		1						1
103	-92.63692	44.85243	M	R		2			1			1
104	-92.63665	44.852436	M	R		2						2
105	-92.63638	44.852443	M	R		2	1		1			2
106	-92.638547	44.852585	M	R		1						1
107	-92.638277	44.852591	M	R		1						1
108	-92.638007	44.852597			Sand bar							
109	-92.637738	44.852603	M	R								
110	-92.637468	44.85261	M	R								
111	-92.637198	44.852616	M	R								
112	-92.636928	44.852622	M	R		2						2
113	-92.636658	44.852628	M	R		1						1
114	-92.636389	44.852635	M	R		2			1			2
115	-92.637746	44.852795			sand bar							
116	-92.637477	44.852802	M	R								
117	-92.637207	44.852808	M	R								
118	-92.636937	44.852814	M	R		1						1
119	-92.636667	44.85282	M	R		1						1
120	-92.636397	44.852827	M	R		2						2
121	-92.636128	44.852833	M	R		2						2
122	-92.637485	44.852993	M	R								
123	-92.637216	44.853	M	R								
124	-92.636136	44.853025	M	R		3						3
125	-92.637494	44.853185	M	R								
126	-92.637224	44.853192	M	R		1						1
127	-92.636415	44.85321	M	R		1						1
128	-92.636145	44.853217	M	R		3						3
129	-92.637503	44.853377	M	R								
130	-92.637233	44.853384	M	R								
131	-92.636694	44.853396	M	R		1						1
132	-92.636424	44.853402	M	R								
133	-92.636154	44.853408	M	R		2						2
134	-92.637512	44.853569	S	R								
135	-92.637242	44.853575	S	R		1						1
136	-92.636433	44.853594			sand bar							

137	-92.63752	44.853761	M	R		2						2
138	-92.637799	44.853947	M	R		1						1
139	-92.637808	44.854139	M	R		1			1			
140	-92.637817	44.854331	M	R		2	2					1
141	-92.637547	44.854337	M	R								
142	-92.637277	44.854343	M	R								
143	-92.638095	44.854516	M	R		2				1		2
144	-92.637825	44.854522	M	R		1						1
145	-92.637556	44.854529	M	R		1	1		1			1
146	-92.637286	44.854535	M	R								
147	-92.637016	44.854541	M	R								
148	-92.636746	44.854547	M	R								
149	-92.638104	44.854708	M	R		2				1		2
150	-92.636485	44.854746	M	R								
151	-92.636215	44.854752	S	R								
152	-92.634327	44.854795	R	R								
153	-92.63001	44.854895	M	R		2		1	1			
154	-92.62974	44.854901	M	R		1			1			1
155	-92.635954	44.85495	S	R								1
156	-92.635684	44.854956	S	R								
157	-92.635415	44.854962	S	R								
158	-92.635145	44.854969	S	R								
159	-92.634875	44.854975			Gravel bar							
160	-92.634605	44.854981	R	R								
161	-92.634335	44.854987	R	R								
162	-92.634066	44.854994	M	R								
163	-92.630558	44.855074	M	R		2	1	2	1			
164	-92.630289	44.855081	M	R		3	2	2	1			
165	-92.630019	44.855087	M	R		3	1	2	1			1
166	-92.629749	44.855093	M	R		2	2	2	1			
167	-92.629479	44.855099	M	R		3	1	1	3			
168	-92.634344	44.855179			Bedrock falls							
169	-92.633535	44.855198			Bedrock falls							
170	-92.630837	44.85526	M	R		2	1	2	1			
171	-92.630567	44.855266	M	R		2		1	2			
172	-92.630297	44.855273	M	R		2	1	2	1			
173	-92.630028	44.855279	M	R		2	2	2	1			
174	-92.629758	44.855285	M	R		3	2	2	2			
175	-92.629488	44.855291	M	R		1		1	1			
176	-92.629218	44.855297	M	R		2			1			
177	-92.633274	44.855396	M	R								
178	-92.633004	44.855402	M	R								
179	-92.632734	44.855408	M	R								
180	-92.631115	44.855446	M	R		2	2	1				
181	-92.630846	44.855452	M	R		1	1	1	1			
182	-92.630576	44.855458	M	R		2	1	1	1			
183	-92.630306	44.855464	M	R		3	1	3				
184	-92.630036	44.855471	M	R		2		2	1			
185	-92.629766	44.855477	M	R		3		3				
186	-92.629497	44.855483	M	R		2	1	1				
187	-92.629227	44.855489	M	R		3	2	1	1			
188	-92.633283	44.855588	M	R		2	1		1			1

189	-92.633013	44.855594	M	R		1	1					
190	-92.632743	44.8556	M	R		1	1					
191	-92.632473	44.855607	M	R								
192	-92.632203	44.855613	M	R								
193	-92.631934	44.855619	M	R								
194	-92.631664	44.855625	M	R		2	2					2
195	-92.631394	44.855631	M	R		2	2					
196	-92.631124	44.855638	M	R		1	1		1			
197	-92.630854	44.855644	M	R		1			1			1
198	-92.630585	44.85565	M	R		1	1		1			1
199	-92.630315	44.855656	M	R		2	1	2				
200	-92.630045	44.855663	M	R		3	1	2	1			
201	-92.629775	44.855669	M	R		2		2				
202	-92.629505	44.855675	M	R		2	1	1	1			
203	-92.629236	44.855681	M	R		2	1	1	2			
204	-92.628966	44.855687	M	R		3	1	2	2			
205	-92.632752	44.855792	M	R		3	1		1			3
206	-92.632482	44.855799	M	R		2	1					3
207	-92.632212	44.855805	M	R								
208	-92.631942	44.855811	M	R								
209	-92.631673	44.855817	M	R		1			1			
210	-92.631403	44.855823	M	R		1						1
211	-92.631133	44.85583	M	R		1						1
212	-92.630863	44.855836	M	R		1						1
213	-92.630593	44.855842	M	R		1						1
214	-92.630324	44.855848	M	R		1	1					1
215	-92.630054	44.855854	M	R		1						1
216	-92.629784	44.855861	M	R		2	1	1				1
217	-92.629514	44.855867	M	R		2	2	1				
218	-92.629244	44.855873	M	R		1		1	1			
219	-92.628975	44.855879	M	R		2	2		2			
220	-92.631681	44.856009	M	R								
221	-92.631411	44.856015	M	R								
222	-92.631142	44.856022	M	R		1			1			
223	-92.630872	44.856028	M	R		1						1
224	-92.630602	44.856034	M	R		1						1
225	-92.630332	44.85604	M	R		1						1
226	-92.630062	44.856046	M	R		1						1
227	-92.629793	44.856053	M	R		2	2		1			1
228	-92.629523	44.856059	M	R		2	1	2	1			
229	-92.629253	44.856065	M	R		2	2	2				
230	-92.628983	44.856071	M	R		3	1	1	3			1
231	-92.63142	44.856207	M	R								
232	-92.63115	44.856213	M	R								
233	-92.630881	44.85622	M	R		1						1
234	-92.630611	44.856226	M	R		1						1
235	-92.630341	44.856232	M	R		1						1
236	-92.630071	44.856238	M	R		1						1
237	-92.629801	44.856245	M	R		2	2	1	1			
238	-92.629532	44.856251	M	R		3	2	3	1			
239	-92.629262	44.856257	M	R		2	2	2	1			
240	-92.628992	44.856263	M	R		3	2	2	1			

241	-92.631159	44.856405	S	R								
242	-92.630889	44.856412			sand bar							
243	-92.63062	44.856418	M	R								
244	-92.63035	44.856424	M	R								
245	-92.63008	44.85643	M	R								
246	-92.62981	44.856436	M	R		1						1
247	-92.62954	44.856443	M	R		2	1	1	1			2
248	-92.629271	44.856449	M	R		2	1	2	1			
249	-92.629001	44.856455	M	R		3	1					3
250	-92.631168	44.856597	S	R								
251	-92.630898	44.856603	S	R								
252	-92.630628	44.85661			sand bar							
253	-92.630359	44.856616	M	R								
254	-92.630089	44.856622	M	R								
255	-92.629819	44.856628	M	R		1						1
256	-92.629549	44.856635	M	R		2	1					2
257	-92.629279	44.856641	M	R		2	1					2
258	-92.629009	44.856647	M	R		2			1			2
259	-92.631177	44.856789	S	R		1						1
260	-92.630907	44.856795	S	R								
261	-92.630637	44.856802	S	R								
262	-92.630367	44.856808			sand bar							
263	-92.630097	44.856814	M	R								
264	-92.629828	44.85682	M	R		1						1
265	-92.629558	44.856826	M	R		1						1
266	-92.629288	44.856833	M	R		2		1	1			2
267	-92.629018	44.856839	S	R		3						3
268	-92.630646	44.856993			sand bar							
269	-92.630376	44.857	M	R								
270	-92.630106	44.857006			sand bar							
271	-92.629836	44.857012	M	R		1						1
272	-92.629567	44.857018	M	R		1						1
273	-92.629297	44.857025	M	R		3						3
274	-92.629027	44.857031	M	R		1						1
275	-92.630385	44.857192	S	R								
276	-92.630115	44.857198			sand bar							
277	-92.629575	44.85721			Sand bar							
278	-92.630124	44.85739	S	R								
279	-92.629854	44.857396	M	R								
280	-92.630132	44.857582	S	R		1						
281	-92.629863	44.857588	S	R								
282	-92.629593	44.857594			sand bar							
283	-92.629871	44.85778	M	R								
284	-92.629602	44.857786	M	R		1		1				1
285	-92.629332	44.857792	R	R								
286	-92.629062	44.857798			sand bar							
287	-92.628792	44.857805			Gravel bar							
288	-92.629071	44.85799	M	R								
289	-92.628801	44.857997	M	R								
290	-92.628531	44.858003	M	R								
291	-92.628261	44.858009	M	R								
292	-92.62854	44.858195			Sand bar							

293	-92.628	44.858207	S	R								
294	-92.62773	44.858213	M	R								
295	-92.627469	44.858411	S	R								
296	-92.627208	44.85861	S	R								
297	-92.627217	44.858801	S	R								
298	-92.626947	44.858808	S	R								
299	-92.626956	44.859	S	R								
300	-92.626965	44.859191	M	R								
301	-92.626703	44.85939	M	R								
302	-92.626712	44.859581	S	R								
303	-92.626442	44.859588	S	R								
304	-92.626451	44.85978	M	R								
305	-92.62619	44.859978	M	R								
306	-92.625929	44.860176	M	R								
307	-92.625668	44.860374	S	R		1						1
308	-92.625154	44.860962	S	R								
309	-92.624893	44.86116	S	R								
310	-92.624641	44.86155	S	R								
311	-92.624415	44.862516	S	R								

Appendix F – Riverine Habitat Evaluation below Powell Falls

River Falls Hydroelectric Project Riverine Habitat Evaluation below Powell Falls

SUBMITTED TO

City of River Falls Municipal Utilities

January 2021

River Falls Hydroelectric Project Riverine Habitat Evaluation below Powell Falls

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1. Introduction

Powell Falls and Junction Falls Dams impound the Kinnickinnic River within the City of River Falls, Wisconsin, approximately 10 miles upstream of the river's confluence with the St. Croix River and 30 miles downstream from its headwaters in central St. Croix County. The Powell Falls Dam creates the downstream Lake Louise and the Junction Falls Dam creates the upstream Lake George. Both dams are currently licensed under Federal Energy Regulatory Commission (FERC) Project No. 10489. River Falls Municipal Utilities is proposing to relicense the Junction Falls Development and decommission the Powell Falls Development with dam removal. As part of these efforts, a riverine habitat survey was conducted downstream of the Powell Falls Dam to the river's confluence with the St. Croix River (Figure 1). Past habitat and geomorphic evaluations which partially cover the study area were completed by Inter-Fluve (2017) and the Wisconsin Department of Natural Resources (WDNR; 1998, 2015).

The purpose of this habitat evaluation is to document baseline habitat conditions prior to the proposed decommissioning and removal of the Powell Falls Dam. To evaluate habitat conditions, Inter-Fluve and Gulf South Research Corporation (GSRC) staff assessed and mapped mesohabitat features (pools, riffles, runs), large wood, sediment characteristics, channel dimensions, and floodplain deposits within the study area.

2. Background

The WDNR has determined that the Kinnickinnic River contains an exceptionally high quality and high-density brown trout population throughout the main stem. According to the WDNR, the Kinnickinnic River and South Fork of the Kinnickinnic River are considered outstanding Class I trout waters, and the Kinnickinnic River downstream of Powell Falls Dam is classified as an Outstanding Resource Water (WDNR 2015). The entire Kinnickinnic River outside of the impounded areas is designated as an Area of Special Natural Resource Interest (ASNRI). Brown trout densities and the number of large size trout (12 inches and greater) have been consistently above the 95 percentiles for the State of Wisconsin (WDNR 2015). During the 2015 survey, the survey station just downstream of the River Falls dams ranked in the 78th percentile among Wisconsin streams for adult brown trout Catch Per Effort (CPE; 937 fish/mile). Longer term (1996 –2014) trend data from the lower Kinnickinnic River show adult brown trout densities consistently greater than the 95th percentile.

The following paragraphs contain a summary of Hunt (1969), Miller (1974), Carline (1980), and Power (1992) and provide brief overview of trout habitat requirements. Three main habitat requirements for a natural trout population to exist are food, shelter, and reproductive substrate.

Trout are opportunistic feeders and will feed on a variety of prey ranging in size from small fish to terrestrial invertebrates. However, their main food source throughout the year are aquatic invertebrates. High quality aquatic invertebrate populations occur with diverse stream habitat conditions. In a stream, a variety of conditions including water velocity, streambed substrate, water depth, water temperature, bank material, and vegetation will create diverse aquatic invertebrate communities that will provide food for trout. Of particular importance to trout's diets are benthic (i.e., bottom-dwelling) macroinvertebrates, that are most abundant in areas with gravel and cobble substrate. Deposition of sand and other fine sediment can embed and bury gravel and cobble substrates, and can therefore limit benthic macroinvertebrate population densities.

Instream structures such as large boulders, undercut banks, overhead vegetation, and large wood, provide shelter for fish to hide from predators, ambush prey, and rest. Deep pools can also provide shelter or contribute to the effectiveness of sheltering structures. Because trout are visual predators and often compete with each other for limited food resources, complexity of habitat is important in maintaining visual separation.

Trout need a gravel substrate to lay their eggs to naturally reproduce. Female trout create nests, or redds, by excavating sand and silt from gravels with their tail. Redds are typically found just downstream of a pool (pool tail out) and upstream of a riffle. Eggs incubate in these well oxygenated gravel substrates until they are ready to hatch. Fry (newly hatched fish) emerge from the gravel and quickly move to low velocity stream areas with suitable food and complex shelter.

Rivers and riparian habitat are also of great importance to many native flora and fauna. Animals such as bats, deer, and waterfowl use rivers as travel corridors while many birds, amphibians, reptiles, fish, and mollusks also reside in rivers and riparian areas. The biodiversity within these areas is due to the diversity of habitat and ecologic resources offered by such systems. Diversity in soil types and hydrology in these systems leads to greater diversity in plant communities. The plant communities attract pollinators and other insect life which can be preyed upon by birds, amphibians, and other animals. Complexity within the channel of the river and on its banks also creates the variety needed for greater species diversity. Mollusks, crustaceans, and benthic macroinvertebrates all thrive in streams with greater variability in depth, flow, and substrate material. A wide range of bank shape and material leads to habitat improvements for animals such as muskrats, beavers, and turtles.

3. Methods

A habitat survey from Powell Falls to the confluence with the St. Croix River was conducted by Inter-Fluve and GSRC staff from September 21 to 24, 2020. Air temperatures varied between 60 and 80 degrees Fahrenheit and it was generally partly cloudy to clear. Rain occurred on the afternoon of September 22. The mean daily discharge at the United States Geological Survey (USGS) stream gage 05342000 located at the County Road F crossing varied between 136 and 138 cubic feet per second (cfs) which is within the typical baseflow for this river. Field data collection used the following methods:

- An Apple iPad with a Bad Elf Bluetooth global positioning system (GPS) receiver was used to collect the location of mesohabitat features, survey cross-section end points, and pebble count locations.
- At pools, riffles, and runs, the surveyors performed a visual estimate of the bankfull width, the length of unstable bank, canopy cover, and floodplain confinement. Bankfull depth was measured using a graduated rod carried by the observer. Where water velocity or depth was unsafe for surveying (e.g., excessively deep pools), the observer either estimated depth and/or measured as close to the thalweg as possible.
- For this habitat survey, “side-channels” are considered naturally wetted flow paths connected to the mainstem channel at their upstream and downstream ends at average annual flow. Side channel units were identified when the main channel split to form a stable island with soil or fine sediment accumulations and with establishing vegetation older than 2 to 3 years.

- A total station was used to collect relative elevations of cross-sections located across a minimum of two pools and two riffle/runs per subreach. Edge of water was surveyed and approximate bankfull elevation was determined based on topographic indicators.
- Bed material and bar material was assessed by pebble count in representative subreaches and visually estimated throughout all reaches. One pebble count of 100 clasts was conducted at a representative riffle in each study reach. In addition, a pebble count of 100 clasts was conducted on one depositional bar in each reach.
- Large wood pieces were counted along the length of the study area. For the purpose of this assessment, large wood is considered any piece of wood greater than 6 inches in diameter and greater than 4 feet long.
- Geotagged photos were collected at the approximate downstream terminus of each riffle and pool.
- River stations were developed based on the reach lines used in the desktop analysis completed by TRC (2019). The river stations measure the distance in feet upstream from the St. Croix River confluence (Station 0+00) and are used to locate the various features described in the evaluation. Maps showing river stations are provided in Appendix C.
- Errors (+/-) are given as 1 standard deviation about the mean of the data.

4. Reach Summaries

Five reaches below Powell Falls were delineated in a previous desktop analysis (TRC 2019). In the field, Inter-Fluve and GSRC staff selected a representative subreach in each reach and described, photographed, and surveyed the subreach. It should be noted, that though the selected subreaches are called “representative” per the Scope of Work, there is inherent heterogeneity within the individual reaches. Representative subreaches are rather intended to provide general insights into habitat forms and geomorphic processes occurring within the reach. Additional data on representative subreaches can be found in Appendix A, pebble count data can be found in Appendix B, field maps with stationing are provided in Appendix C, and field data and photographs can be found in Appendix D.

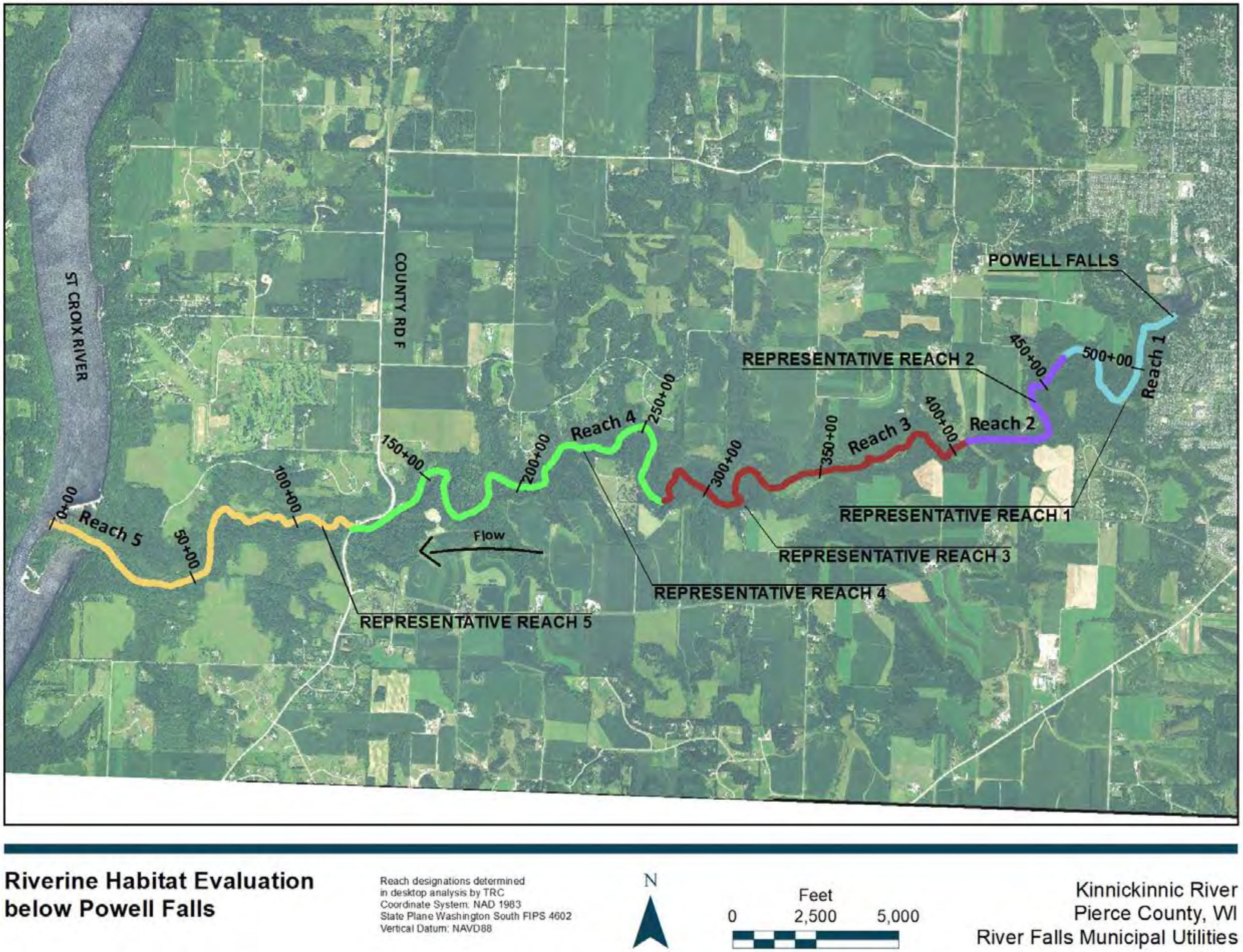

Figure 1: Location of riverine habitat evaluation study area with reaches delineated and showing location of representative reaches.

4.1 REACH 1

Reach 1 stretched from station 460+00 to 520+00. The downstream boundary was gradual (not at a distinct feature such as a road crossing) to Reach 2 and the upstream boundary was the Powell Falls Dam. The reach had a pool-riffle morphology and had a naturally confined floodplain. Large gravels and cobbles in riffles were on average 20% embedded. There was a bedrock-controlled riffle at station 512+00. Riverside trails were present on river left throughout the reach and were maintained to the Rocky Branch Confluence (station 448+00). There was an 800-foot long well-sorted sandy run downstream of the Rocky Branch Confluence. There were on average 0.6 large wood pieces located per 100 feet (32 large wood pieces per mile). There were 9 pools with an average residual depth of 2 feet, and average bankfull depth of 6 feet (+/- 1 foot). Typical pool-pool spacing was 700 feet. Approximately 20% of the channel was shaded by deciduous trees and shrubs. Typically, the reach contained relatively low density of habitat with few pieces of large wood, and few deep pools. Fish cover from vegetation was abundant. Bank erosion was limited. Fine sediment was present and typically embedded riffle material.

4.1.1 Representative subreach 1

Representative subreach 1 was from station 484+00 to 500+00. Banks in representative reach 1 were typically vegetated. From Station 489+80 to Station 500+00 (approximately 120 feet), the left bank was bare and likely actively eroding. Exposed bank sediments were composed of sandy loam. Streambanks were generally stable and active erosion was interpreted as a result of the natural lateral migration of the river channel in response to flood events. For approximately 450 feet on river left, the river ran adjacent to a maintained trail and near a historic lime kiln. This portion of the bank was stabilized with riprap below the ordinary high water. A 300-foot long, 40-foot wide vegetated island was present within the reach. The island was vegetated with reed canary grass and a cluster of four 3-to-6-inch diameter deciduous trees. Bankfull widths averaged 66 feet (+/- 4.5 feet), wetted width averaged 59 feet (+/- 3.4 feet), and bankfull thalweg depth averaged 4 feet (+/- 0.5 feet). Riffles were typically composed of poorly sorted sand to cobble with cobbles typically embedded by smaller material and had bankfull depths which averaged 2 feet. Depth of refusal on riffles was generally between 2 and 3 feet. Pools were typically composed of well sorted sand or gravel with residual depths of 2 feet (+/- 0.5 feet). Valley width was estimated to be 400 feet. Overbank sedimentation was common, with sediments composed of well sorted fine sand and typically deposited as sand sheets in low lying floodplain forest and were thickest in areas associated with the Rocky Branch. There was on average one large wood piece per 100 feet. This subreach contained a low density of habitat features with few large wood pieces and overhanging vegetation. Undercut banks were absent. Pools were typically shallow. The main habitat feature within this subreach was coarse riffle substrate and boulders associated with the riprap bank.

Figure 2: Typical photo collected at station 490+00 in representative subreach 1.

4.2 REACH 2

Reach 2 stretched from station 405+00 to 460+00. The upstream boundary was gradual, and the downstream boundary was an existing power line right-of-way. The reach had a pool-riffle morphology and had a naturally confined floodplain. The upstream portion of the reach (from station 428+00) had a pool-pool spacing of approximately 400 feet. Downstream of station 428+00, pool-pool spacing increased to approximately 1200 feet. Large gravels and cobbles in riffles were on average 20% embedded. There was a private access route on river right at station 432+00. There were on average 0.9 large wood pieces located per 100 feet (49 large wood pieces per mile). There were 8 pools with an average residual depth of 2 feet, and average bankfull depth of 7 feet (+/- 2 feet). Approximately 25% of the channel was shaded by deciduous trees and shrubs. Typically, the reach contained a low density of habitat features with few pieces of large wood, and few deep pools. Fish cover from vegetation was abundant along stream edges. Bank erosion was limited. Fine sediment was present and typically embedded riffle material.

4.2.1 Representative subreach 2

Representative subreach 2 was from station 434+00 to 444+00. Banks in representative subreach 2 were approximately 80% vegetated with alternating banks exposed. Where exposed, bank sediments consisted of poorly sorted sand and gravel. Streambanks were generally stable and active erosion was interpreted as a result of the natural lateral migration of the river channel in response to flood events. Bankfull widths averaged 67 feet (+/- 6.2 feet), wetted width averaged 63 feet (+/- 7.0 feet), and bankfull thalweg depth averaged 4 feet (+/- 1.3 feet). Riffles were typically composed of poorly sorted sand to cobble with cobbles typically embedded by smaller material and had bankfull depths which averaged 2.5 feet. Depth of refusal on riffles was generally between 1 and 2 feet. Pools were typically composed of well sorted sand or gravel with residual depths of 2 feet (+/- 1 foot). Valley width was estimated to be 450 feet. Overbank sedimentation was common with sediments composed of well sorted fine sand. A mid-channel bar was present near the upstream terminus of the reach and was composed of poorly sorted sand to boulders. There was on average 0.4 large wood pieces per 100 feet in this reach. This subreach contained a low density of habitat features with few large wood pieces, boulders, and overhanging vegetation. Undercut banks were absent. Pools were typically shallow. The main habitat feature within this subreach was coarse riffle substrate.

Figure 3: Typical photo collected at station 445+00 in representative subreach 2.

4.3 REACH 3

Reach 3 stretched from station 278+00 to 405+00. The upstream boundary was an existing power line right-of-way and the downstream boundary was gradual. The reach had a pool-riffle morphology and had a naturally confined to unconfined floodplain. Some pools were transitional with runs. Large gravels and cobbles in riffles were on average 10% embedded and some riffles were armored. There were approximately 5 pool-riffle sequences consisting of closely (approximately 200 feet) spaced riffles separated by short pools. These pool-riffle sequences were generally separated by long straight pools. There was cleared private land on river left from station 340+00 to 350+00. There was on average 1 large wood piece located per 100 feet (54 large wood pieces per mile). There were 17 pools with an average residual depth of 2 feet, and an average bankfull depth of 6 feet (+/- 1 foot). Approximately 20% of the channel was shaded by deciduous trees and shrubs. Typically, the reach contained a low density of habitat features with few pieces of large wood, and few deep pools. Fish cover from vegetation was abundant. Bank erosion was limited. Fine sediment was present and typically embedded riffle material.

4.3.1 Representative subreach 3

Representative subreach 3 was from station 305+00 to 316+00. Banks in representative reach 3 were approximately 60% vegetated with alternating banks exposed. Where exposed, bank sediments consisted of sandy loam overlaying poorly sorted sand and gravel or bedrock. Streambanks were generally stable and active erosion was interpreted as a result of the natural lateral migration of the river channel in response to flood events. Bankfull widths averaged 61 feet (+/- 10.1 feet), wetted width averaged 42 feet (+/- 16.7 feet), and bankfull thalweg depth averaged 4 feet (+/- 1.5 feet). Riffles were typically composed of poorly sorted sand to cobble with cobbles typically embedded by smaller material and had bankfull depths which averaged 2 feet. Depth of refusal on riffles were generally between 2 and 3 feet. Pools were typically composed of well sorted sand with residual depths of 2 feet (+/- 1 feet). Valley width was estimated to be 550 feet. Overbank sedimentation was common with sediments composed of well sorted fine sand and typically deposited as sand sheets on the inside of meander bends. Several mid-channel bars were presented and were composed of poorly sorted sand to cobbles with higher portions vegetated. There was on average 1.5 large wood pieces per 100 feet in this subreach. This subreach contained a low density of habitat features with few large wood pieces, boulders, and overhanging vegetation. Undercut banks were absent. Pools were typically shallow. The main habitat feature within this subreach was coarse riffle substrate.

Figure 4: Typical photo collected at station 315+00 in representative subreach 3.

4.4 REACH 4

Reach 4 stretched from station 121+00 to 405+00. The upstream boundary was gradual and the downstream boundary was the County Road F bridge. The reach had a pool-riffle morphology and had a naturally confined floodplain. Large gravels and cobbles in riffles were on average 10% embedded. Bedrock was exposed on the outside of meander bends and commonly hosted groundwater seeps. There were on average 0.2 large wood pieces located per 100 feet (12 large wood pieces per mile). There were 23 pools with an average residual depth of 2 feet, and an average bankfull depth of 8 feet (+/- 1 foot). Approximately 25% of the channel was shaded by deciduous trees and shrubs. Typically, the reach contained a moderate density of habitat features with abundant deep pools, bedrock, and boulder cover, but few pieces of large wood. Fish cover from vegetation was abundant. Bank erosion was limited. Fine sediment was present and typically embedded riffle material.

4.4.1 Representative subreach 4

Representative subreach 4 was from station 220+00 to 233+00. Banks in representative subreach 4 were 85% vegetated. Where exposed, bank sediments consisted of sandy loam overlaying poorly sorted sand and gravel. Streambanks were generally stable and active erosion was interpreted as a result of the natural lateral migration of the river channel in response to flood events. Bankfull widths averaged 67 feet (+/- 5.4 feet), wetted width averaged 60 feet (+/- 4.6 feet), and bankfull thalweg depth averaged 4 feet (+/- 0.2 feet). Riffles were typically composed of poorly sorted sand to cobble with cobbles typically embedded by smaller material and had bankfull depths which averaged 2.5 feet. Depth of refusal on riffles was generally between 3 and 4 feet. Pools were typically composed of well sorted sand with residual depths of 1 foot (+/- 0.5 feet). Bars were transitional between alternate and points bars and were composed of poorly sorted sand to cobbles with higher portions vegetated. Valley width was estimated to be 250 feet. There were on average 0.3 large wood pieces per 100 feet in this subreach. This subreach contained a low density of habitat features with few large wood pieces, boulders, and overhanging vegetation. Undercut banks were absent. Pools were typically shallow. The main habitat feature within this subreach was coarse riffle substrate.

Figure 5: Typical photo collected at station 229+00 in representative subreach 4.

4.5 REACH 5

Reach 5 stretched from station 0+00 to 121+00. The upstream boundary was the County Road F bridge and the downstream boundary was the St. Croix River confluence. There were two distinct reaches within reach 5. The upstream reach stretched from station 70+00 to 121+00. This reach consisted of a pool-riffle morphology with a naturally confined floodplain. The river location between station 180+00 and 115+00 at the time of the survey differed from the location shown in aerial photographs dated to 2018 (shown in Appendix C) and it was assumed that the June 2020 floods caused the avulsion of the river in this location. Massive sand deposits were present throughout this reach and large wood was abundant. Downstream of station 70+00 to the St. Croix River confluence the river had a run-riffle morphology with a naturally confined to unconfined floodplain. Sand was abundant in this reach and was commonly ripple marked. A graduated rod was driven 5 feet into the sandy bed substrate without hitting refusal. In reach 5, there were on average 2 large wood pieces located per 100 feet (105 large wood pieces per mile). There were 12 pools with an average residual depth of 2 feet, and an average bankfull depth of 9 feet (+/- 2 feet). The majority of large wood and all pools were located within the upstream reach. Approximately 20% of the channel was shaded by deciduous trees and shrubs. Typically, the upstream reach contained a relatively high density of habitat features with abundant deep pools, and pieces of large wood. Bank erosion was extensive. Fine sediment was present and typically embedded riffle material. Typically, the downstream reach contained a low density of habitat features with few pieces of large wood, and was absent of deep pools. Fish cover from vegetation was abundant. Bank erosion was limited. Fine sediment was present and typically embedded riffle material.

4.5.1 Representative subreach 5

Representative subreach 5 was from station 100+00 to 108+00. Banks in representative subreach 5 were 60% vegetated. Where exposed, bank sediments consisted of sandy loam. Streambanks were generally stable and active erosion was interpreted as a result of the natural lateral migration of the river channel in response to flood events. Bankfull widths averaged 100 feet (+/- 58.3 feet), wetted width averaged 71 feet (+/- 28.2 feet), and bankfull thalweg depth averaged 5 feet (+/- 0.8 feet). Riffles were typically composed of poorly sorted sand to cobble with cobbles typically embedded by smaller material and had bankfull depths which averaged 2.5 feet. Depth of refusal on riffles was generally greater than 5 feet. Pools were typically composed of well sorted sand with residual depths of 2 feet (+/- 1 feet). Point bars were composed of poorly sorted sand to gravels with higher portions vegetated. Valley width was estimated to be 300 feet. There were on average 1.8 large wood piece per 100 feet in this subreach. This subreach contained a low density of habitat features with few large wood pieces, boulders, and overhanging vegetation. Undercut banks were absent. Pools were typically shallow. The main habitat feature within this subreach was coarse riffle substrate.

Figure 6: Typical photo collected at station 106+00 in representative subreach 5.

5. Additional Observations

Additional observations which can be used to interpret geomorphic processes and subsequent habitat development were noted throughout all reaches. These observations provide a more comprehensive view of past and present fluvial processes occurring on the Kinnickinnic River which may influence the natural development of aquatic habitat.

A large flood occurred on the Kinnickinnic on June 29, 2020, which caused discharge to rise to a maximum of 6,220 cfs at the USGS gage on County Road F. Coarse and large wood racked against existing trees, and overbank deposits consisting of fine sand were noted throughout all reaches and were interpreted to be a result of the recent flood. Racked flood debris was up to 8 feet above the existing bankfull elevation, suggesting the maximum elevation of recent flooding (Figure 7). The

USGS gage at County Road F indicates that the gage height was over 10 feet higher than the normal gage height. Overbank sedimentation of fine sand was noted in all reaches and varied in thickness from less than 1 inch to 4 feet (Figure 8). The thickest deposits were typically associated with tributary confluences, particularly the Rocky Branch, or associated with gullies. These deposits were typically 1-2 feet thick but were up to 4 feet thick at the leading edge of sand sheets. Thinner deposits (typically less than 6 inches thick) were observed throughout the remainder of the floodplain.

Legacy sand deposits overlaying soil horizons were also noted, and were commonly associated with tributary gullies in Reach 4 (Figure 9). The surface of these areas was forested, so the deposition of the sand must be older than the trees currently growing on the surface. It was interpreted that the deposition of the sand on top of the soil horizon is a result of land clearing by Euro-American settlers which destabilized upland surfaces and caused sediment to wash into the Kinnickinnic Gorge where it was deposited on the floodplain. This is similar to observations in other Driftless Area streams (Dauwalter et al. 2019). The result of this historic deposition is a floodplain that has aggraded in areas and is now elevated above the natural floodplain. The river is still actively moving these legacy sediments downstream in addition to contemporary sediment inputs, and overtime will construct a new, lower floodplain.

Reed canary grass, an invasive species common in wetland areas throughout the country and in the upstream watershed, was present through all reaches of the Kinnickinnic survey and was typically present on point and mid-channel bars (Figure 10). Reed canary grass forms a monoculture stand in open floodplain and channel areas, shading out competing plants and limiting diversity and habitat for a variety of fauna. In addition, reed canary grass can stabilize what would normally be mobile sand and gravel bars, which results in increased roughness, decreased cross-sectional area and can increase bank erosion by forcing the channel away from the stabilized mid-channel bar.

Figure 7: Flood debris wracked behind several trees. Photo collected at station 334+00.

Figure 8: Sand deposited near the Rocky Branch confluence following recent floods. Photo collected at station 483+00.

Figure 9: Photo of cutbank showing pre-settlement soil horizon and post-settlement alluvial deposits. Photo collected at station 168+00.

Figure 10: Mid-channel bar showing colonization of reed canary grass and the stabilization of the bar. Photo collected at station 313+00.

6. Discussion and Conclusions

A summary of select field identified reach attributes is provided in Table 1. These attributes we analyzed to determine the habitat conditions in the study area.

Table 1: Summary table of select reach attributes.

Reach	**1**	**2**	**3**	**4**	**5**
Reach Length (ft)	6213	5488	12693	15693	12119
Bankfull Width Average (ft)	84	73	60	76	80
Average Bankfull Depth (ft)	5	6	5	7	7
Average Bankfull Pool Depth (ft)	6	7	6	8	9
Average Bankfull Riffle Depth (ft)	4	5	5	5	4
Average Residual Pool Depth (ft)	2	2	1	3	5
Floodplain type	Naturally Confined	Naturally Confined	Naturally Confined	Naturally Confined	Naturally Confined
Riffle Count	7	7	17	22	13
Pool Count	9	8	17	23	12
Run Count	1	1	1	0	4
Percent algae cover	57	47	38	21	6
Percent exposed bank	21	25	15	16	28
Percent macrophyte cover	1	0	2	0	2
Percent shade cover	19	25	21	24	17
Riparian landuse	forest	forest	forest	forest	forest
Percent embeddedness	18	22	11	8	6
Large Wood (LW) piece count	38	51	130	37	240
LW count per linear mile	32	49	54	12	105
LW count per 100 ft	1	1	1	0	2

In-stream habitat complexity was limited in the lower Kinnickinnic River. This study found that although the channel bed form was relatively stable, there was a general lack of complexity due to the absence of structure such as boulders, large wood and undercut banks. The June 2020 flooding may have contributed to plane bed conditions or lengthening of riffle features (reduced bed complexity), and impacted complexity by moving large wood downstream and relocating it from in channel to floodplain and upper bank areas.

Embedment and local deposition of fine sediment in the channel occurred following the most recent flooding. These effects appear to be temporary, but it was not possible to discern between post 2020 flood sediment inputs and annual sediment loads. Aggradation of floodplain areas by overbank sedimentation was noted, and was widespread. Pools were not completely filled with fine sediment, but residual pool depths were often limited to less than 2 feet. Limited pool depth due to sediment infilling was also noted in the Inter-Fluve (2017) geomorphic assessement, so this is likely a chronic problem in the lower Kinni and not a result of the 2020 flood.

Sand accumulation, the embedment of gravel substrate, and subsequent establishment of reed canary grass resulted in increased channel erosion in select locations. Embedment of gravel and cobble riffle substrate and overbank sedimentation was common in all reaches. In addition, buried soil horizons were observed in Reach 4. These observations are typical of a river unable to effectively transport existing sediment within the river channel and floodplain, but may also be a temporary result of large flood events. Increased sediment input from upstream, upland, and bank erosion may further fill existing pools thus limiting deep water habitat and increase embedment of coarse riffle substrate. Embedment of coarse river substrate is of special concern since it can negatively impact spawning habitat and macroinvertebrate densities. Subsequent surveys could determine annual versus event-based inputs. It should be noted, both bed complexity and in channel large wood will increase over time as smaller (5-yr flood events or less) floods redistribute both bed material and large wood.

Overbank sedimentation on floodplains as a result of recent flooding was observed. Overbank sedimentation, if widespread and rapid, limits floodplain connectivity by raising floodplain elevations (Knox 2006). This has been a consistent problem in Driftless Area streams since European settlement (Dauwalter 2019). In the lower Kinnickinnic River, it appears that the majority of post-

European settlement sediment accumulation was concentrated in alluvial fans near tributary gullies and was not widespread across the floodplain. In addition, the thickest deposits of recent overbank sediment were also associated with tributaries and gullies. This suggests that sediment coming from upland sources is typically transported through gullies and tributaries and stored in alluvial fans and deltas on the floodplain and that widespread floodplain aggradation, as observed in other Driftless Area streams, has not occured. This does not mean that floodplain aggradation will not occur in the future, especially if a large amount of sediment moves into the lower Kinnickinnic River.

The Kinnickinnic River supports a relatively high number of brown trout as compared to other regional streams. This may be driven partly by water quality, partly by the size of the stream, being larger than many regional trout streams, and partly by food abundance. The lower Kinnickinnic River, despite having low habitat complexity, has an abundance of gravel substrate. Gravel substrates hold the highest densities of macroinvertebrates as compared to other streambed material. Gravel bed rivers can also support high densities of spawning fish, which results in large numbers of juveniles. Because brown trout are both insectivores and piscivores, the combination of high macrovinvertebrate production and juvenile fish production may be resulting in high food densities that can support large numbers of trout despite marginal habitat cover. As the surrounding forests mature and large wood inputs increase, habitat complexity will subsequently increase and could positively impact fish populations. However, if an increase in sediment supply occurs (such as an unregulated release of sediment during dam removal) the sediment may bury gravel substrate with fine grain material and negatively impact fish populations.

The most significant factor limiting habitat for birds, reptiles, amphibians, and mammals was the predominance of invasive reed canary grass in the riparian area. Reed canary grass has formed understory monocultures in riparian areas and on mid-channel bars in all reaches. Reed canary grass stands stabilize formerly mobile substrate, increase roughness and decrease channel cross sectional area, all of which can drive increased bank erosion. In addition, since reed canary grass establishes itself as an understory monoculture, it can limit the regeneration of diverse plant assemblages and prevent the growth of trees and shrubs that provide shade and stabilize banks. Limiting sediment inputs from upstream and upland sources and planting native species in riparian areas will help the Kinnickinnic River continue to be a home to a diverse array of species.

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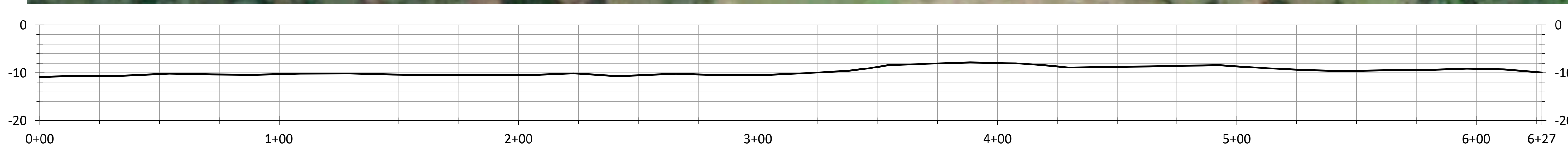
8. Appendix A – Representative Reach Surveys



LONGITUDINAL PROFILE

UNREFERENCED VERTICAL SCALE

NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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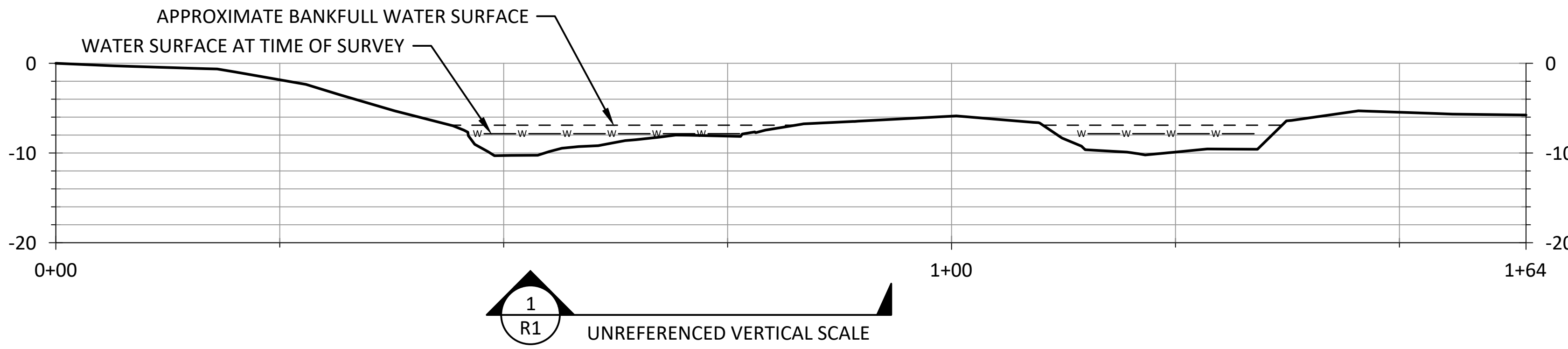
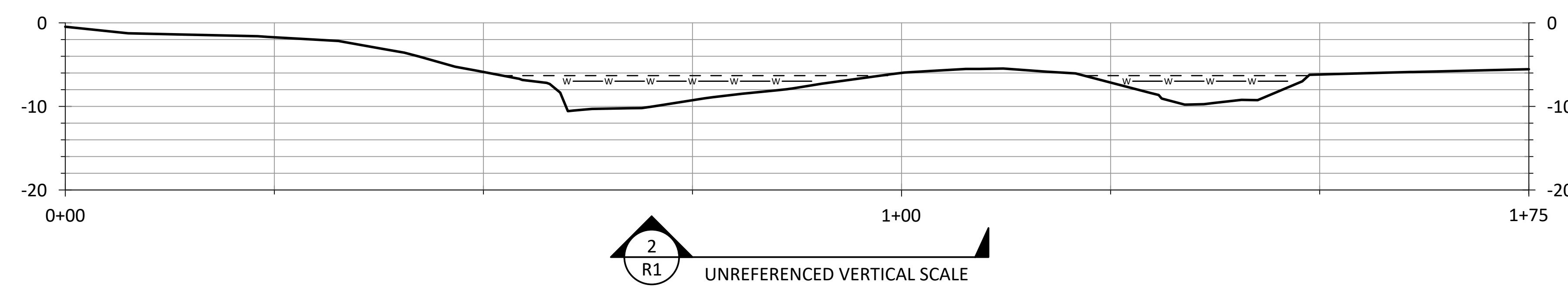
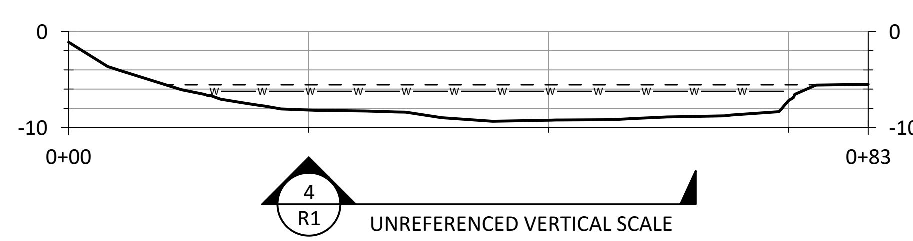
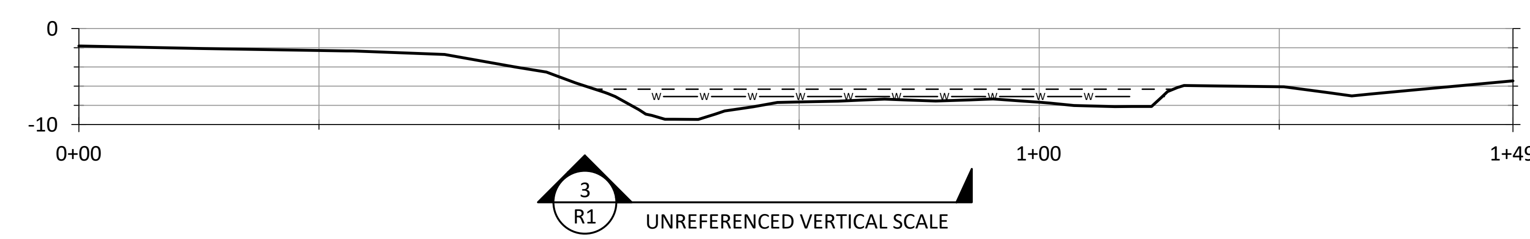
REPRESENTATIVE REACH 1









NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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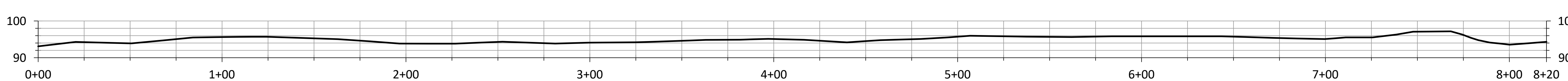
REPRESENTATIVE REACH 1
CROSS-SECTIONS



LONGITUDINAL PROFILE

UNREFERENCED VERTICAL SCALE

NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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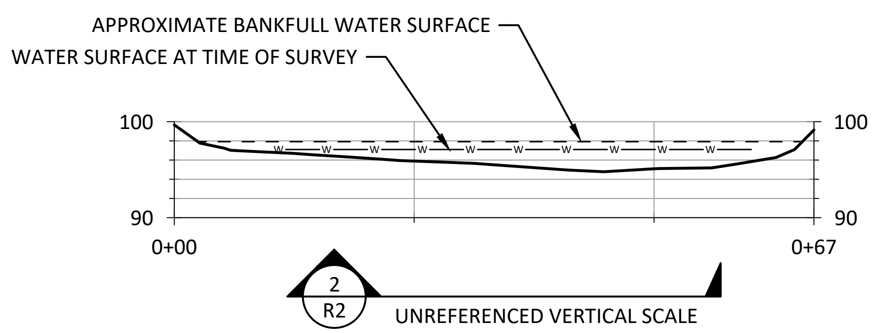
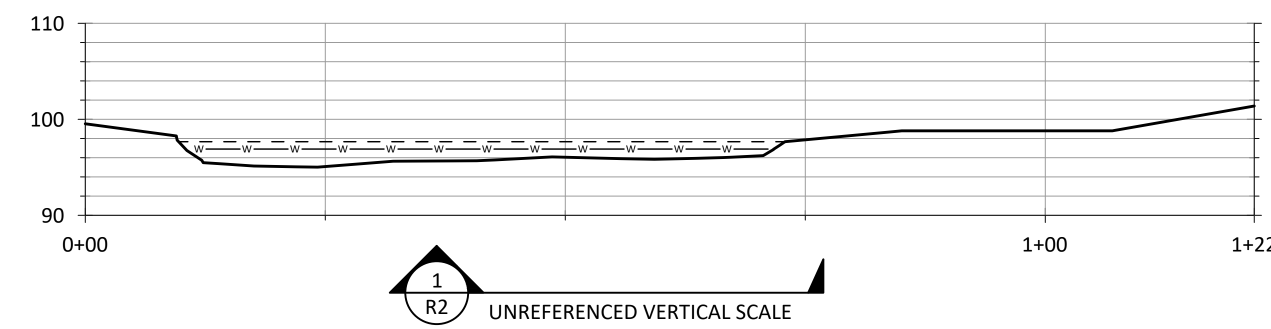
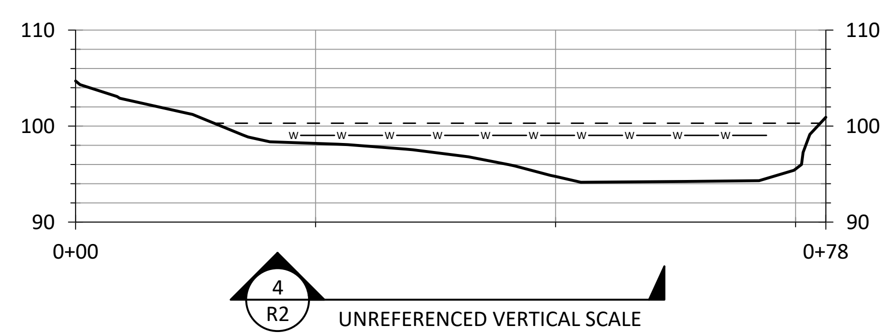
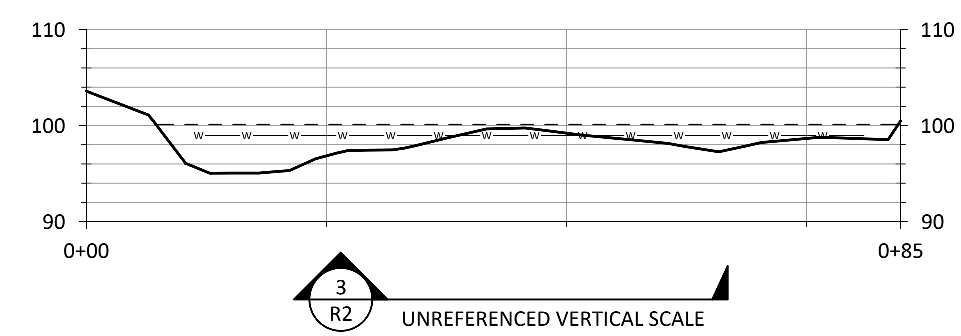
REPRESENTATIVE REACH 2









NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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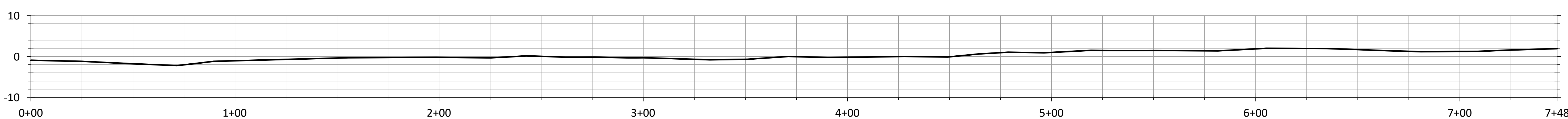
REPRESENTATIVE REACH 2
CROSS-SECTIONS



LONGITUDINAL PROFILE

UNREFERENCED VERTICAL SCALE

NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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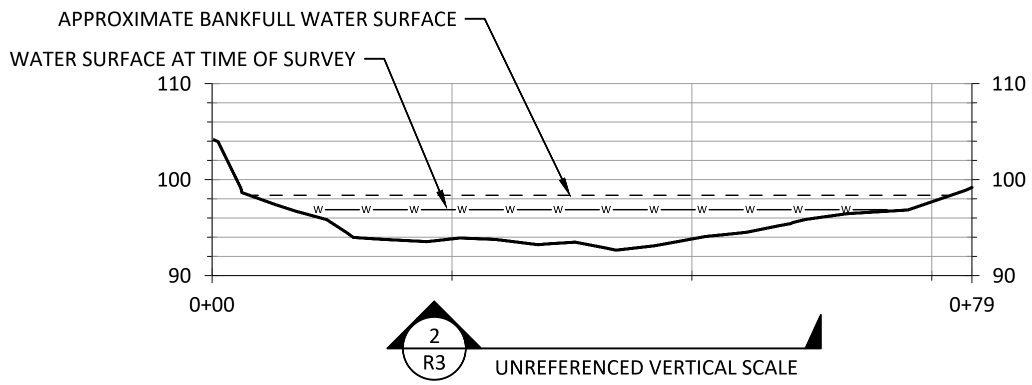
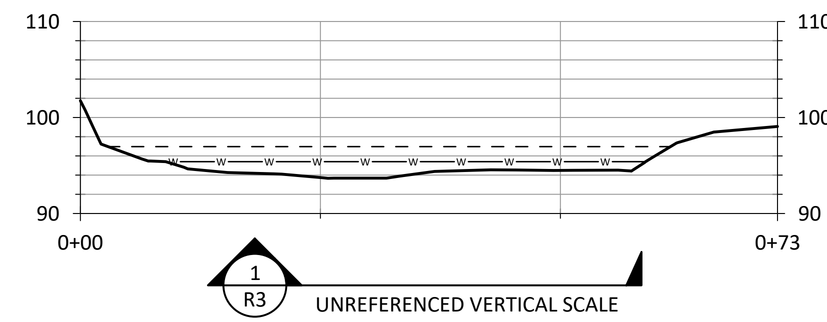
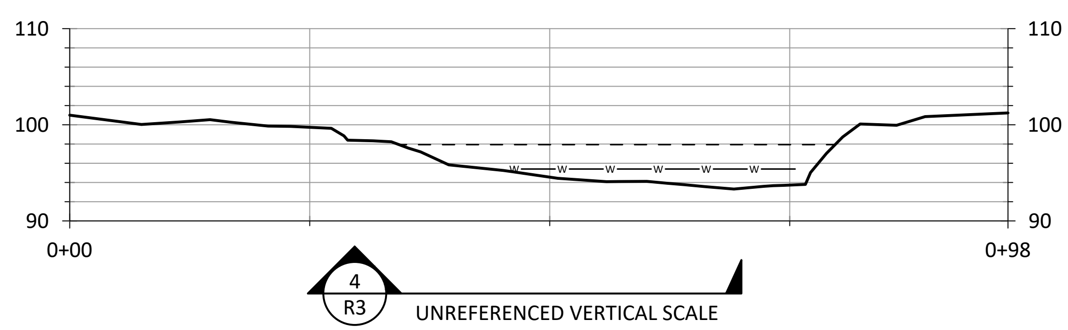
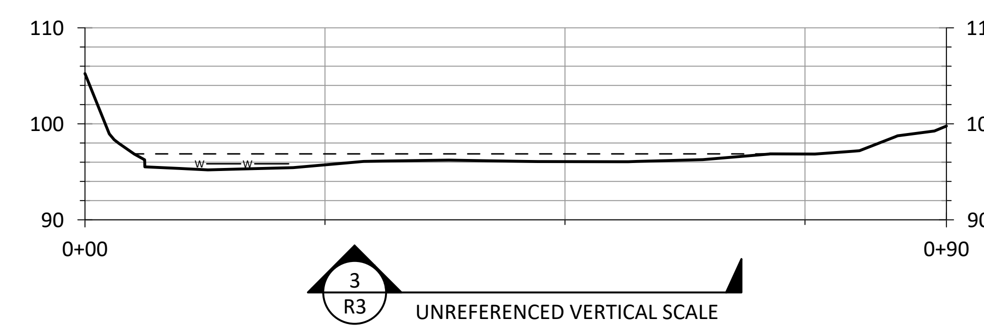
REPRESENTATIVE REACH 3









NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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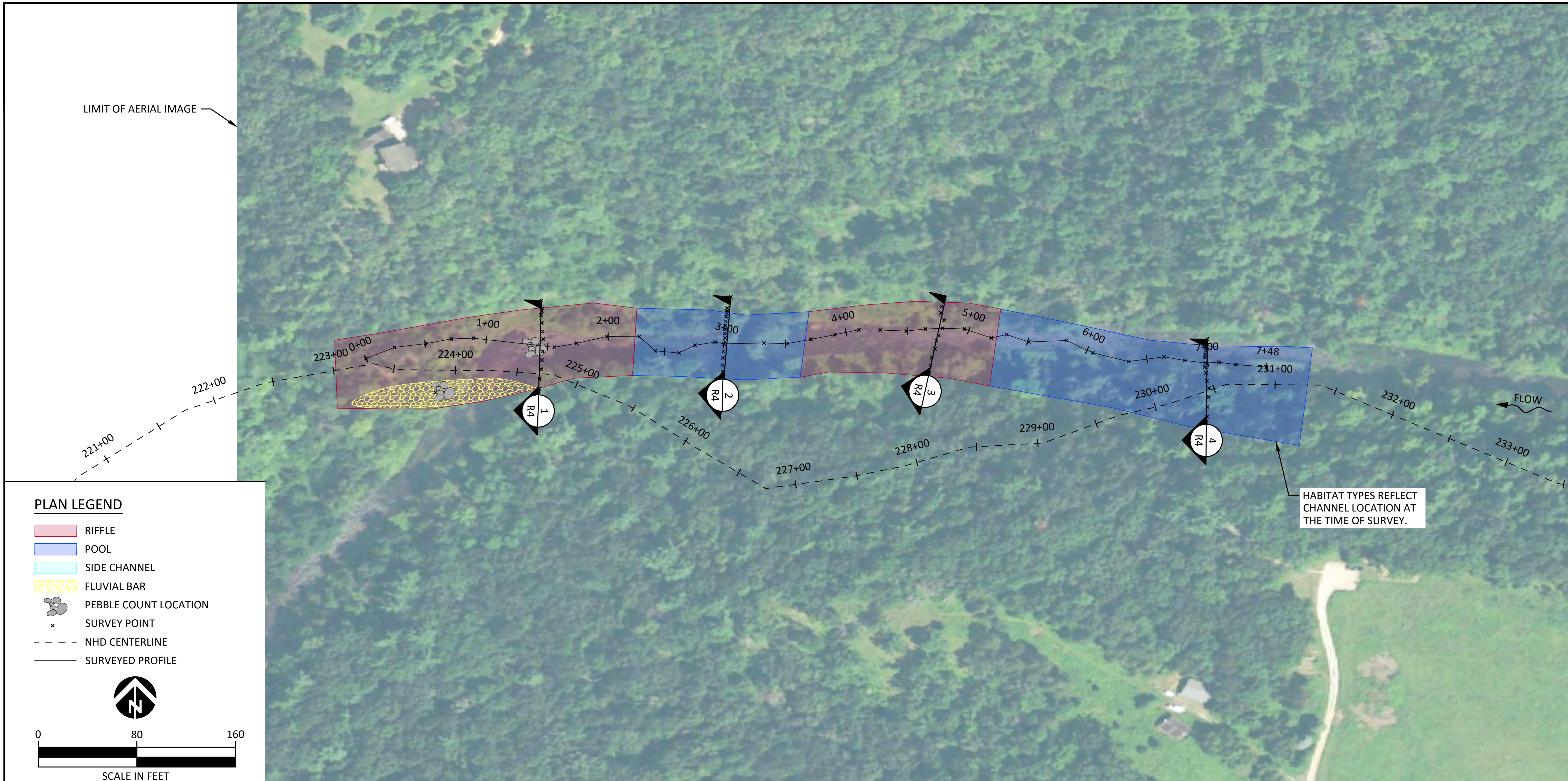
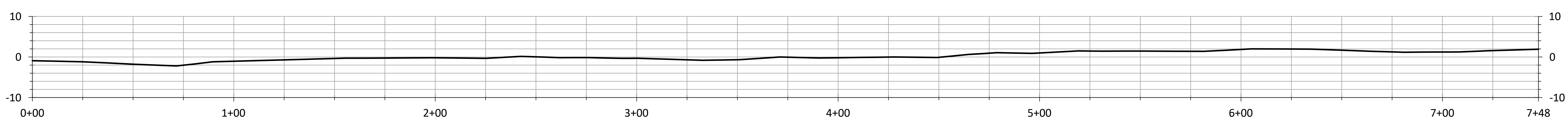
REPRESENTATIVE REACH 6
CROSS-SECTIONS





LONGITUDINAL PROFILE

UNREFERENCED VERTICAL SCALE

NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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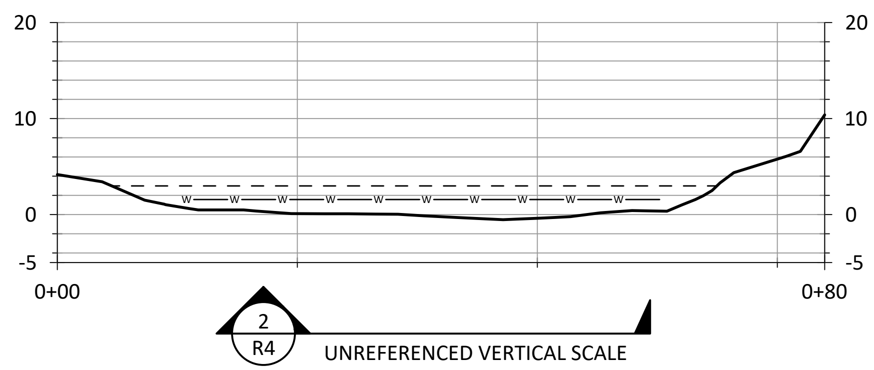
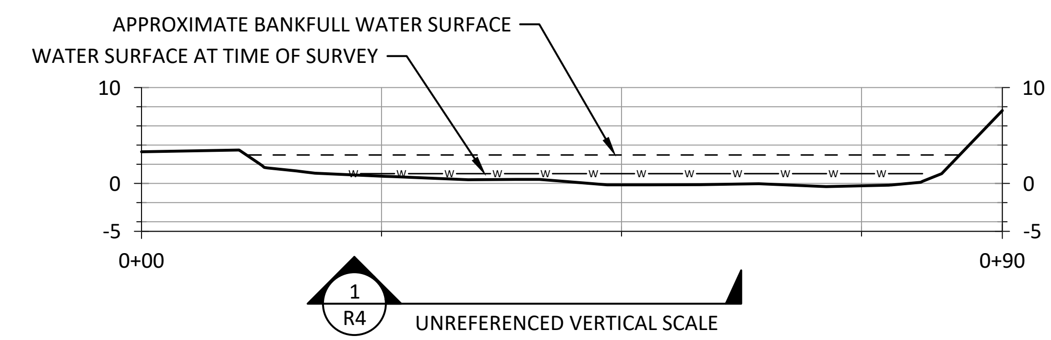
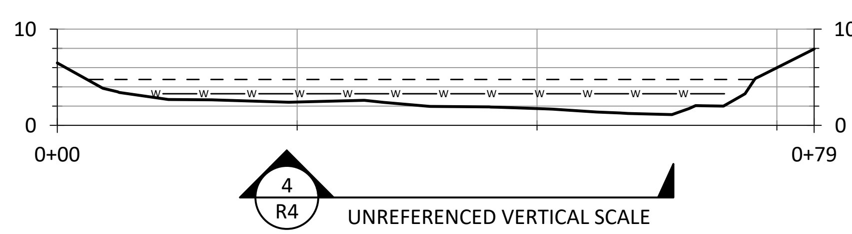
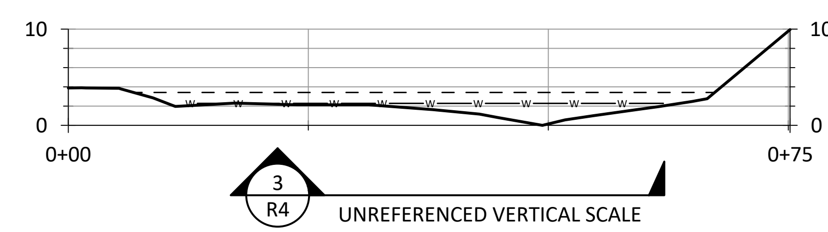
REPRESENTATIVE REACH 4









NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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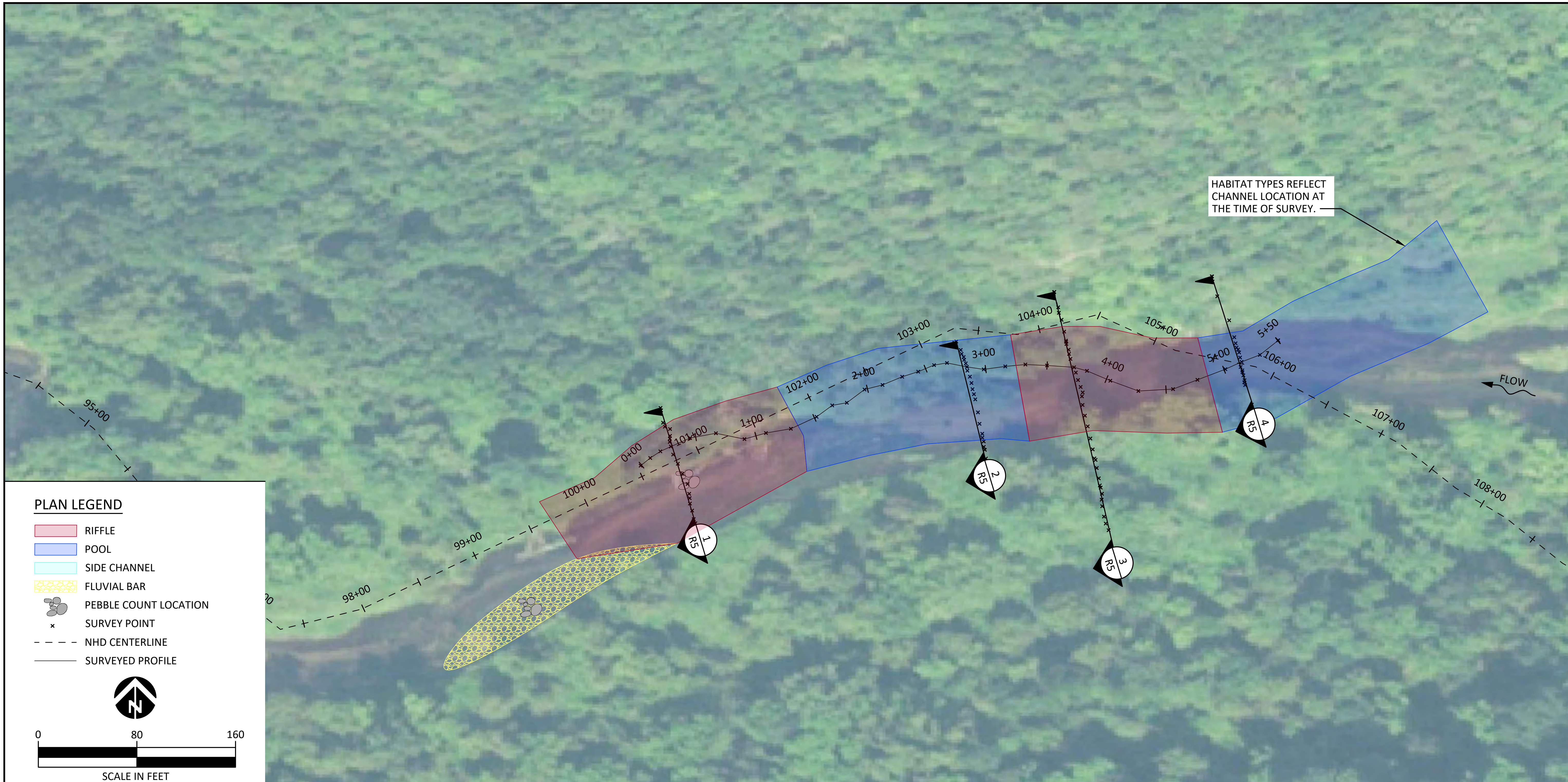
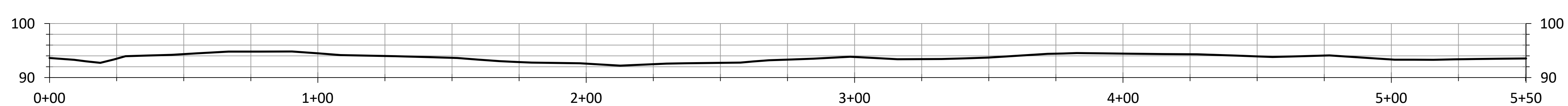
REPRESENTATIVE REACH 4
CROSS-SECTIONS

SHEET
8 OF 10





LONGITUDINAL PROFILE
UNREFERENCED VERTICAL SCALE

NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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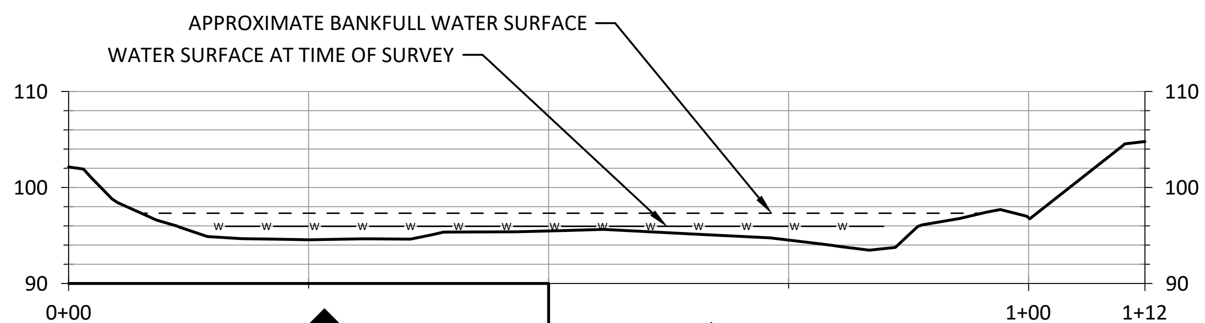
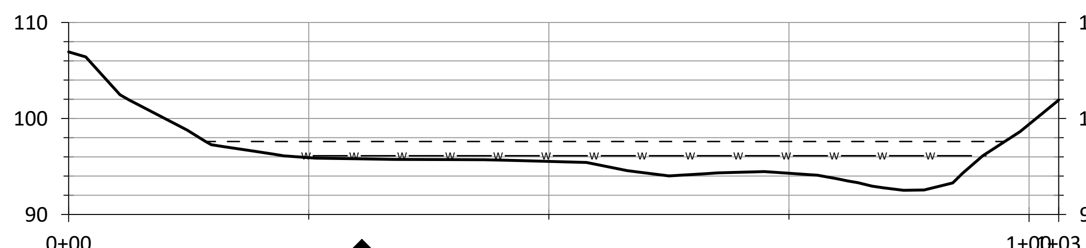
REPRESENTATIVE REACH 5



1
R5
UNREFERENCED VERTICAL SCALE



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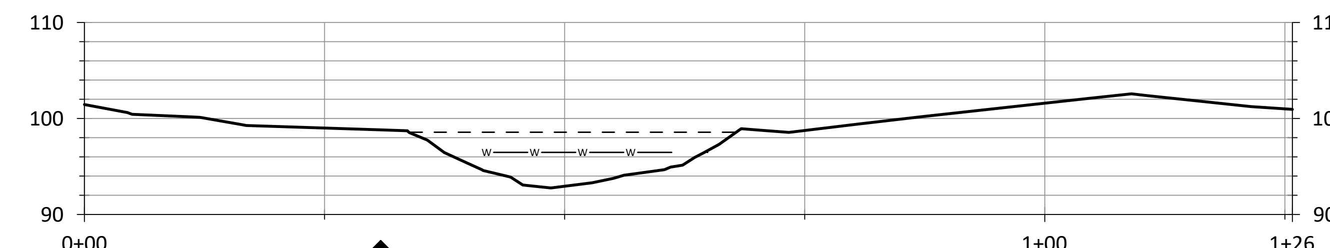
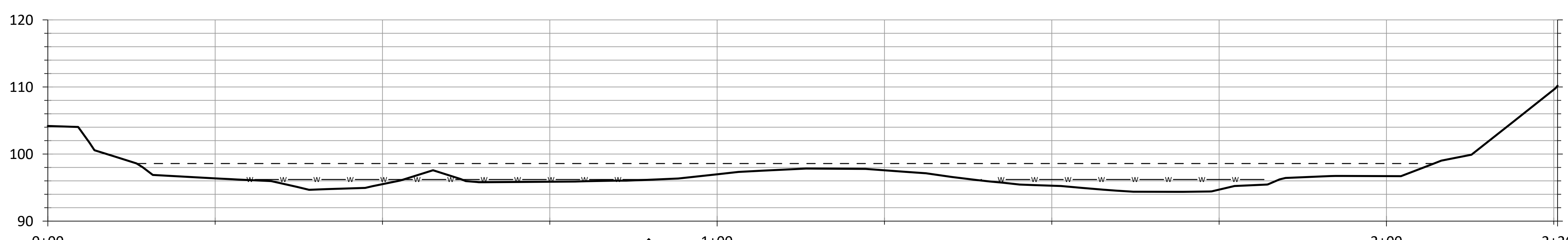
R5
UNREFERENCED VERTICAL SCALE



4
R5
UNREFERENCED VERTICAL SCALE



3
R5
UNREFERENCED VERTICAL SCALE

NOTE: FIELD WORK CONDUCTED BY SEAN MORRISON, GARRET SHEAR (INTER-FLUVE) AND ROSS HARRIS (GRSC) ON THE KINNICKINNICK RIVER BETWEEN 9/21/2020 AND 9/24/2020.

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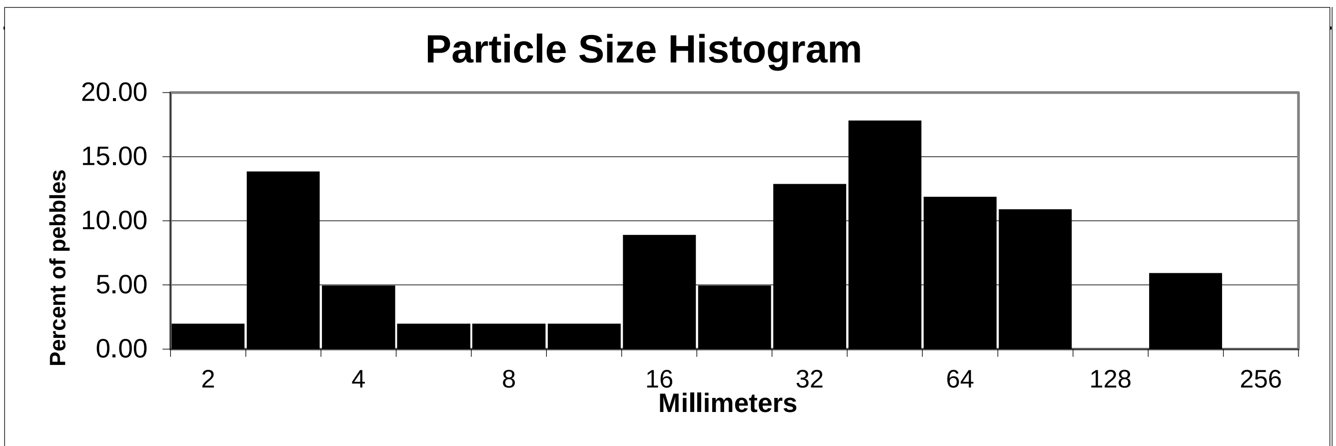
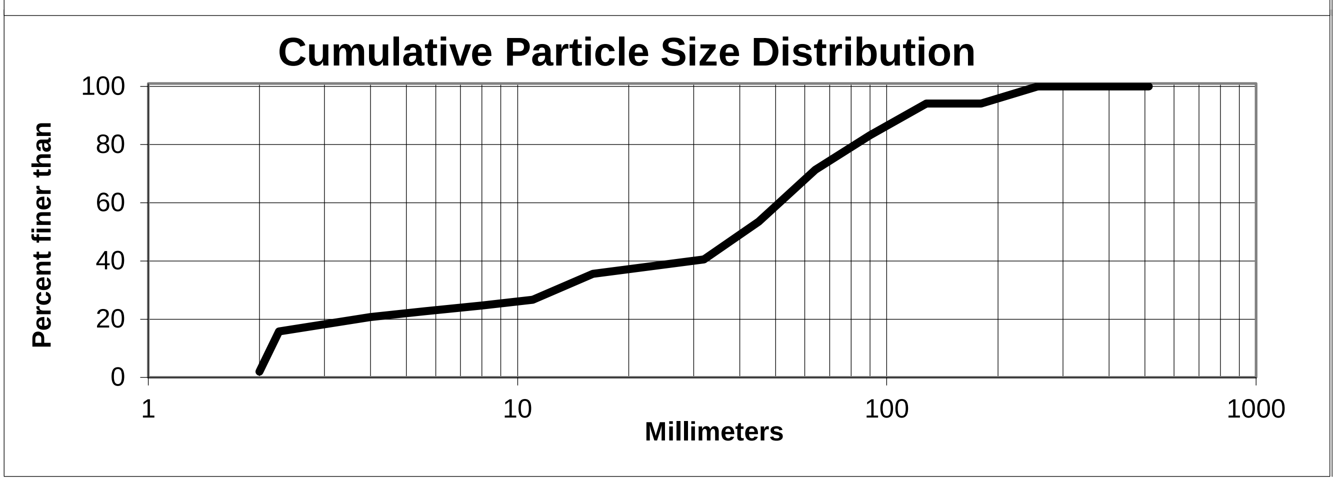
REPRESENTATIVE REACH 5
CROSS-SECTIONS

9. Appendix B – Pebble Counts

Pebble Count Name: Reach 1 Riffle
Sampling Method: Random Walk
Geomorphic Position: Riffle
Stratigraphic Position: Surface

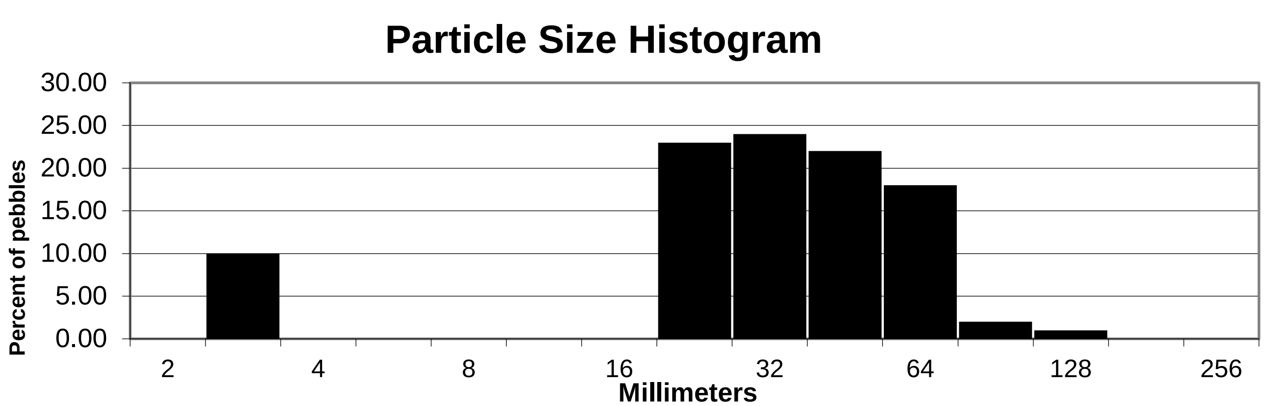
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	2	1.98	1.98
2.26	14	13.86	15.84
4	5	4.95	20.79
5.6	2	1.98	22.77
8	2	1.98	24.75
11	2	1.98	26.73
16	9	8.91	35.64
32	5	4.95	40.59
45	13	12.87	53.47
64	18	17.82	71.29
90	12	11.88	83.17
128	11	10.89	94.06
180	0	0.00	94.06
256	6	5.94	100.00
512	0	0.00	100.00
Total:	101	100	

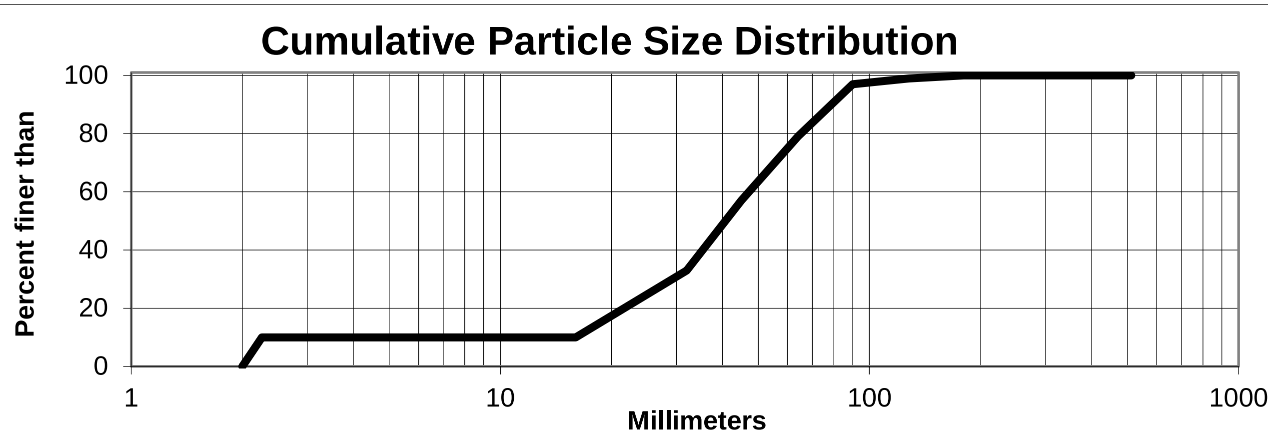




Pebble Count Name: Reach 1 Bar
Sampling Method: Random Walk
Geomorphic Position: Bar
Stratigraphic Position: Surface

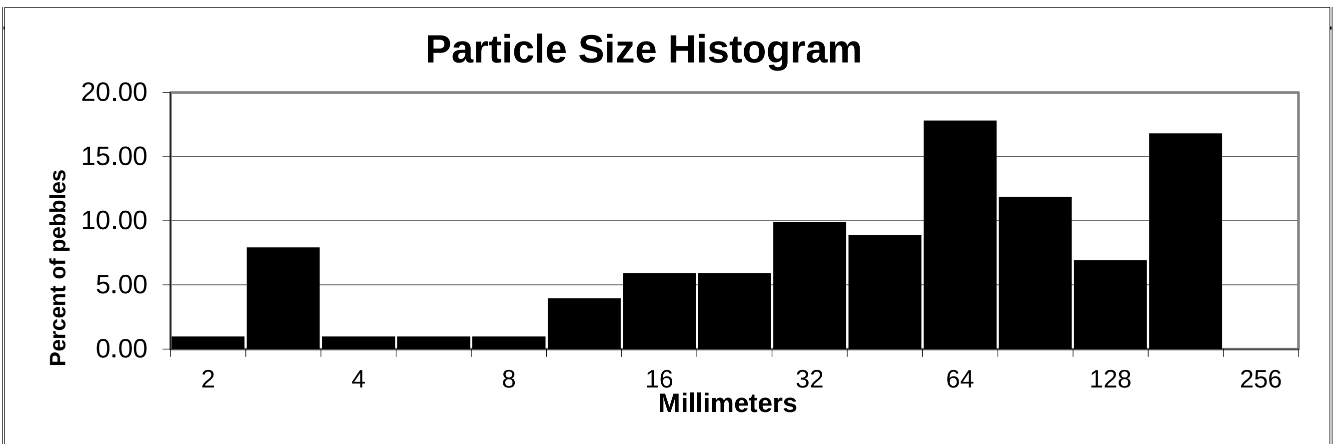
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	0	0.00	0.00
2.26	10	10.00	10.00
4	0	0.00	10.00
5.6	0	0.00	10.00
8	0	0.00	10.00
11	0	0.00	10.00
16	0	0.00	10.00
32	23	23.00	33.00
45	24	24.00	57.00
64	22	22.00	79.00
90	18	18.00	97.00
128	2	2.00	99.00
180	1	1.00	100.00
256	0	0.00	100.00
512	0	0.00	100.00
Total:	100	100	

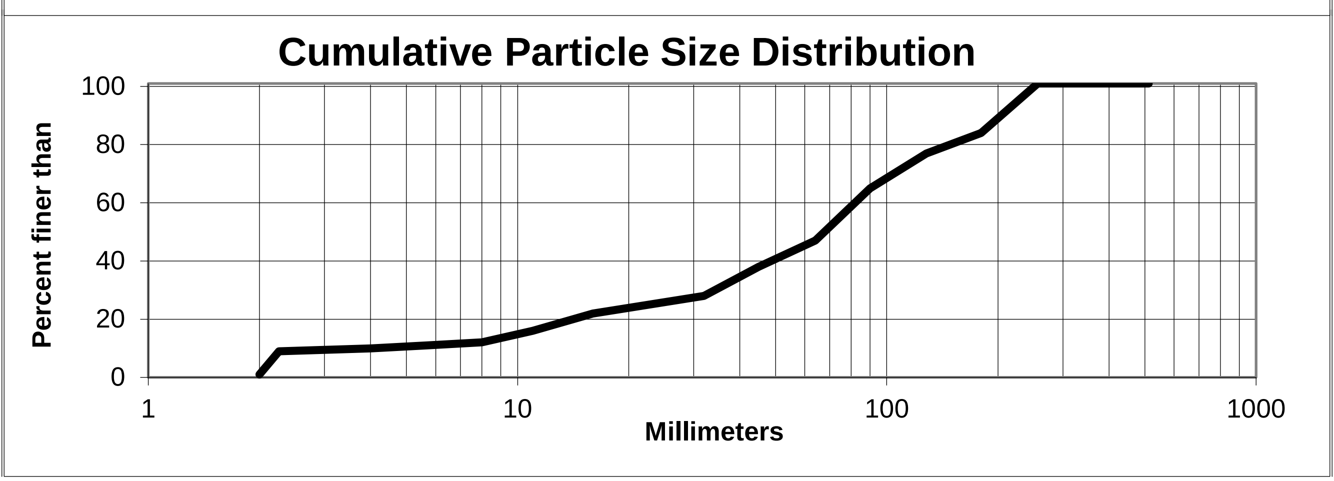




Pebble Count Name:	Reach 2 Bar
Sampling Method:	Random Walk
Geomorphic Position:	Bar
Stratigraphic Position:	Surface

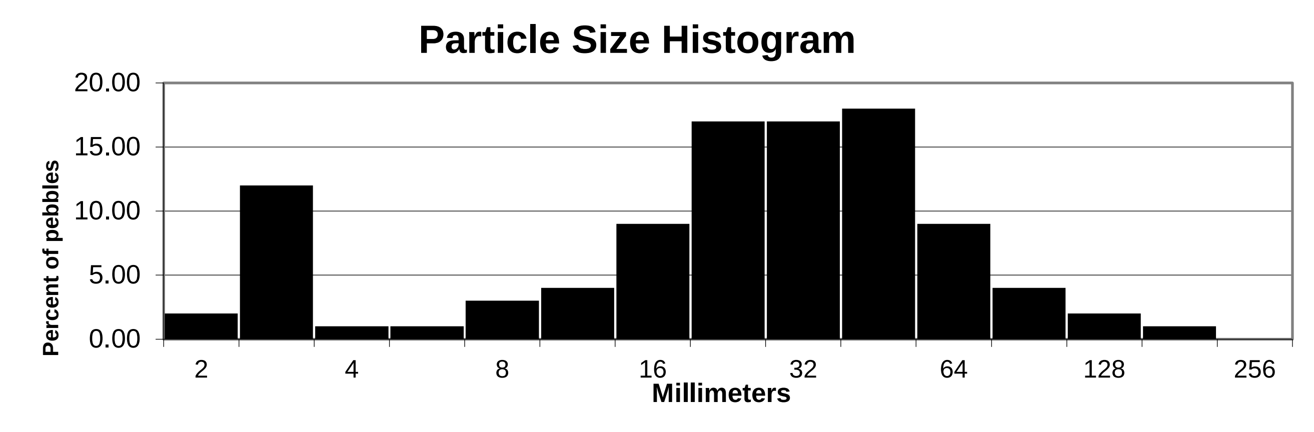
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	1	0.99	1.00
2.26	8	7.92	9.00
4	1	0.99	10.00
5.6	1	0.99	11.00
8	1	0.99	12.00
11	4	3.96	16.00
16	6	5.94	22.00
32	6	5.94	28.00
45	10	9.90	38.00
64	9	8.91	47.00
90	18	17.82	65.00
128	12	11.88	77.00
180	7	6.93	84.00
256	17	16.83	101.00
512	0	0.00	101.00
Total:	101	100	

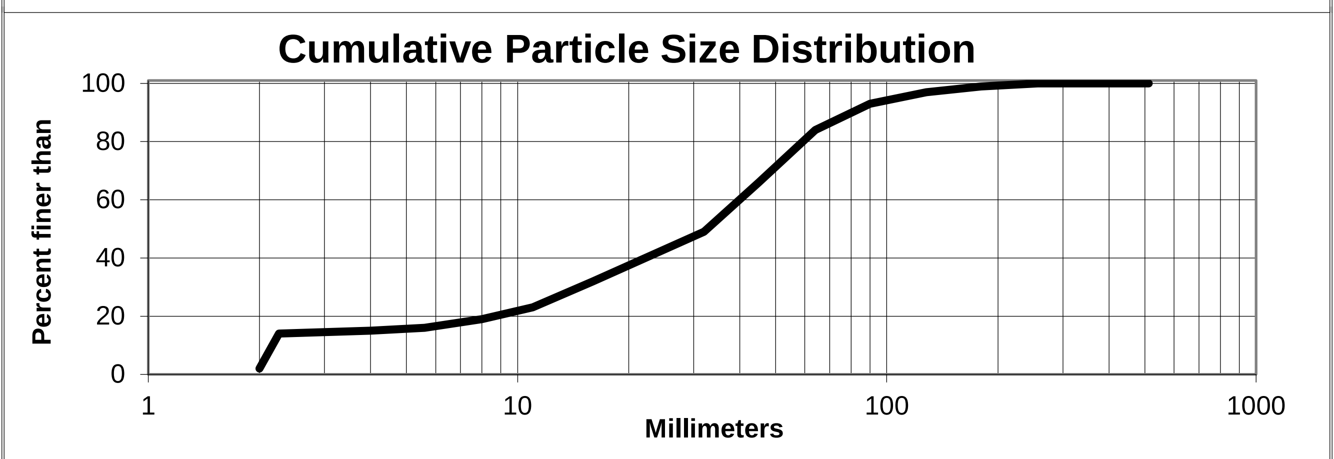




Pebble Count Name: Reach 2 Riffle
Sampling Method: Random Walk
Geomorphic Position: Riffle
Stratigraphic Position: Surface

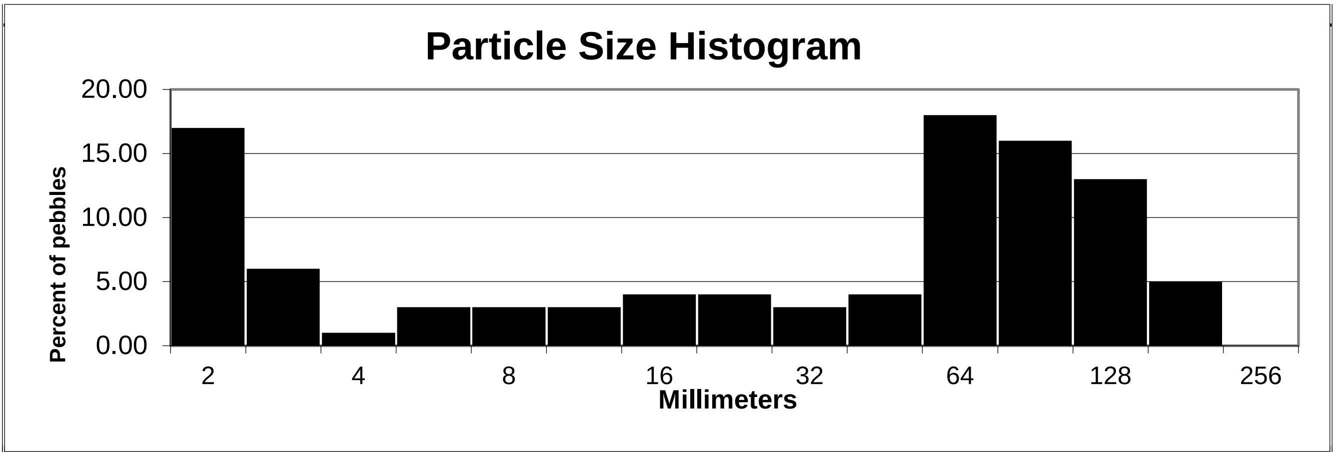
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	2	2.00	2.00
2.26	12	12.00	14.00
4	1	1.00	15.00
5.6	1	1.00	16.00
8	3	3.00	19.00
11	4	4.00	23.00
16	9	9.00	32.00
32	17	17.00	49.00
45	17	17.00	66.00
64	18	18.00	84.00
90	9	9.00	93.00
128	4	4.00	97.00
180	2	2.00	99.00
256	1	1.00	100.00
512	0	0.00	100.00
Total:	100	100	

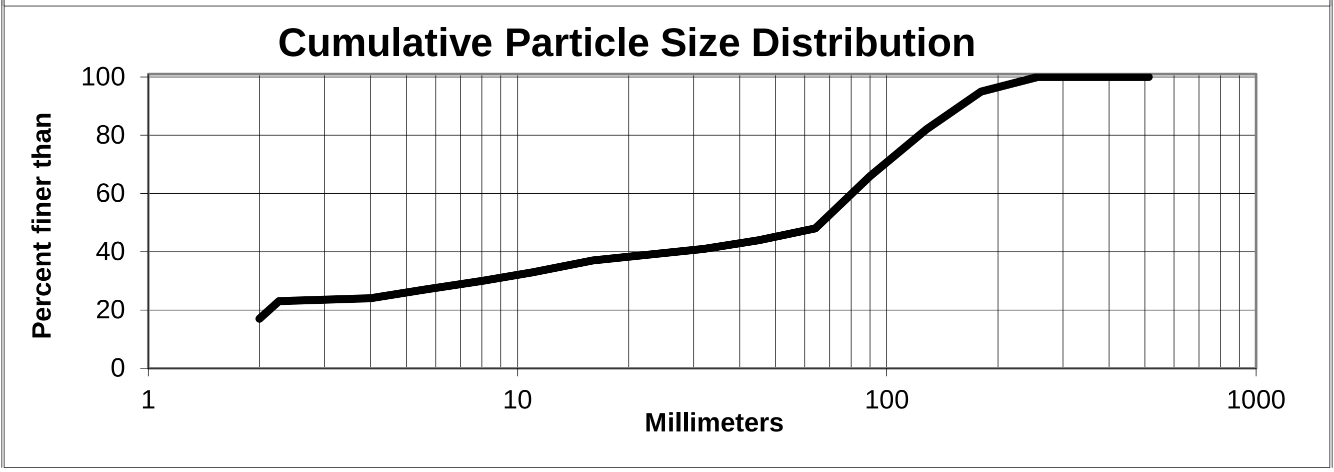




Pebble Count Name: Reach 3 Riffle
Sampling Method: Random Walk
Geomorphic Position: Riffle
Stratigraphic Position: Surface

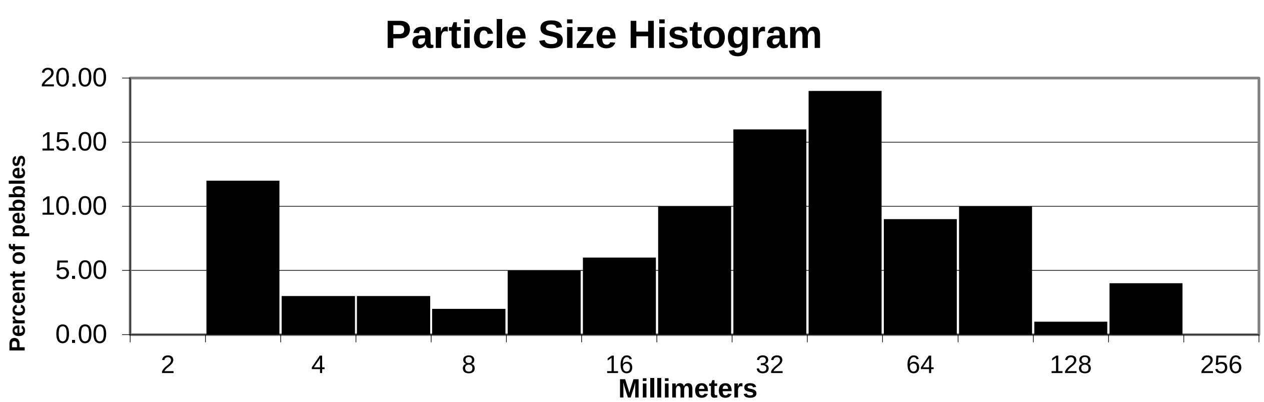
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	17	17.00	17.00
2.26	6	6.00	23.00
4	1	1.00	24.00
5.6	3	3.00	27.00
8	3	3.00	30.00
11	3	3.00	33.00
16	4	4.00	37.00
32	4	4.00	41.00
45	3	3.00	44.00
64	4	4.00	48.00
90	18	18.00	66.00
128	16	16.00	82.00
180	13	13.00	95.00
256	5	5.00	100.00
512	0	0.00	100.00
Total:	100	100	

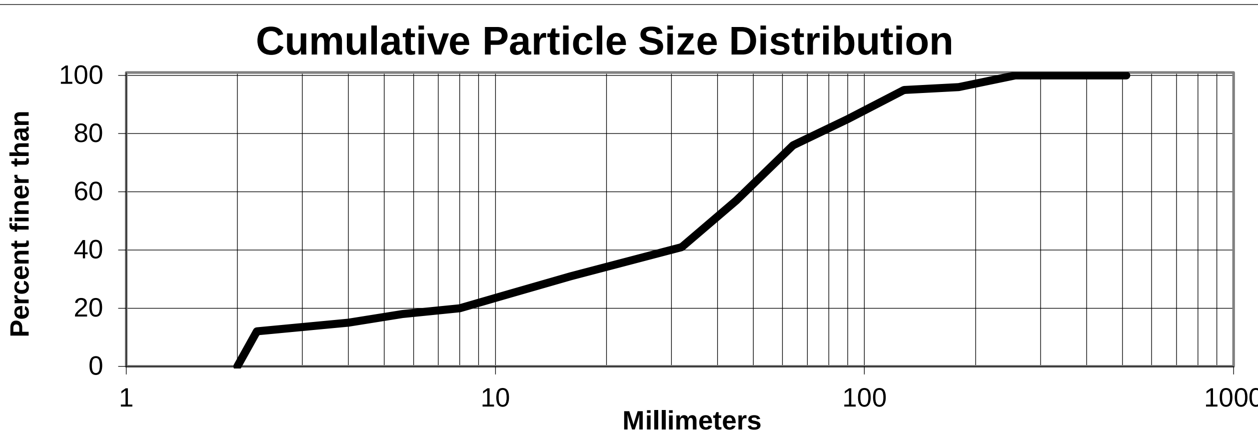




Pebble Count Name: Reach 3 Bar
Sampling Method: Random Walk
Geomorphic Position: Riffle
Stratigraphic Position: Surface

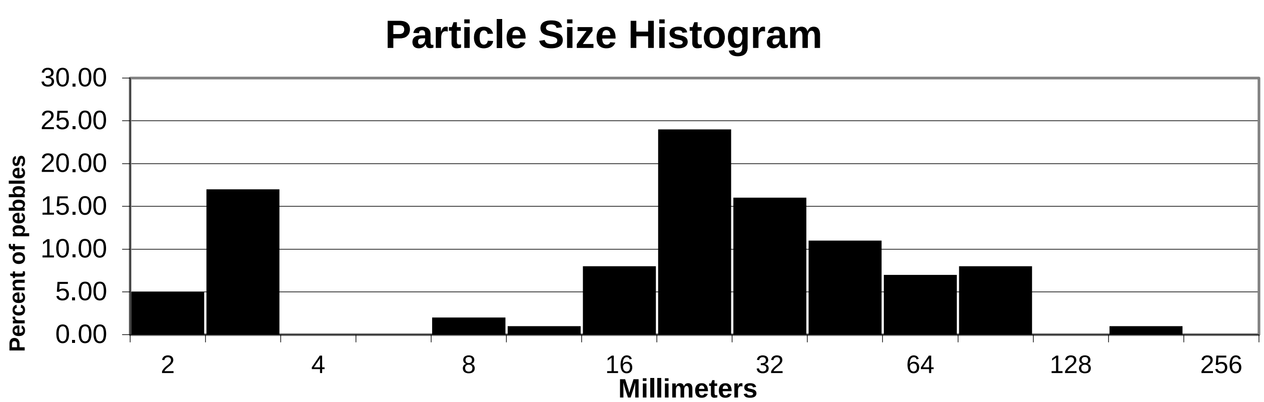
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	0	0.00	0.00
2.26	12	12.00	12.00
4	3	3.00	15.00
5.6	3	3.00	18.00
8	2	2.00	20.00
11	5	5.00	25.00
16	6	6.00	31.00
32	10	10.00	41.00
45	16	16.00	57.00
64	19	19.00	76.00
90	9	9.00	85.00
128	10	10.00	95.00
180	1	1.00	96.00
256	4	4.00	100.00
512	0	0.00	100.00
Total:	100	100	

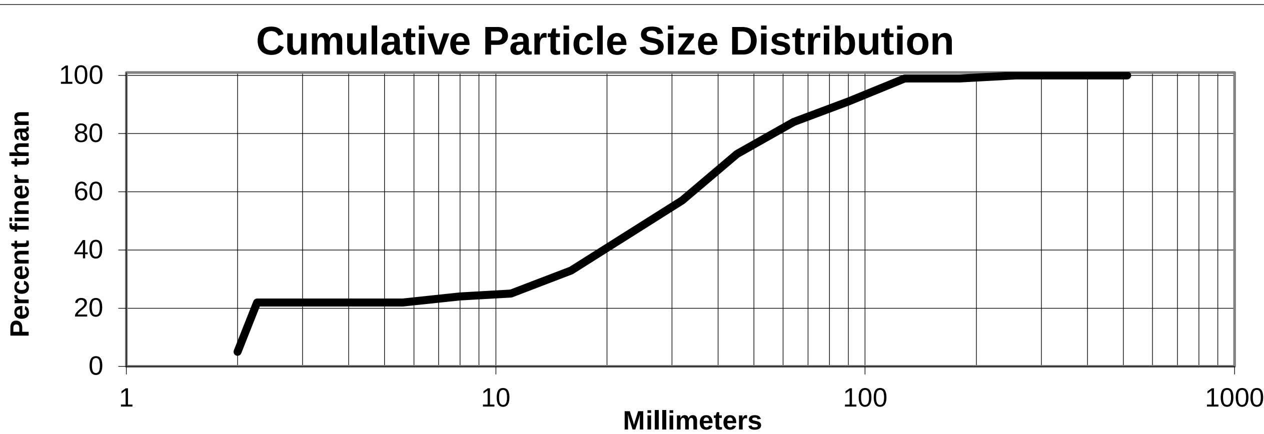




Pebble Count Name: Reach 4 Bar
Sampling Method: Random Walk
Geomorphic Position: Bar
Stratigraphic Position: Surface

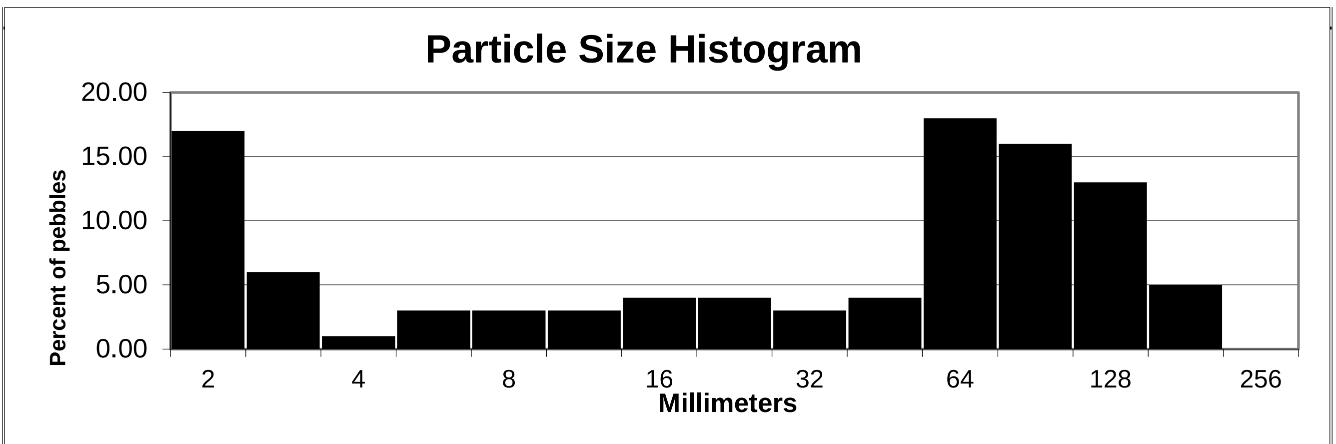
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	5	5.00	5.00
2.26	17	17.00	22.00
4	0	0.00	22.00
5.6	0	0.00	22.00
8	2	2.00	24.00
11	1	1.00	25.00
16	8	8.00	33.00
32	24	24.00	57.00
45	16	16.00	73.00
64	11	11.00	84.00
90	7	7.00	91.00
128	8	8.00	99.00
180	0	0.00	99.00
256	1	1.00	100.00
512	0	0.00	100.00
Total:	100	100	

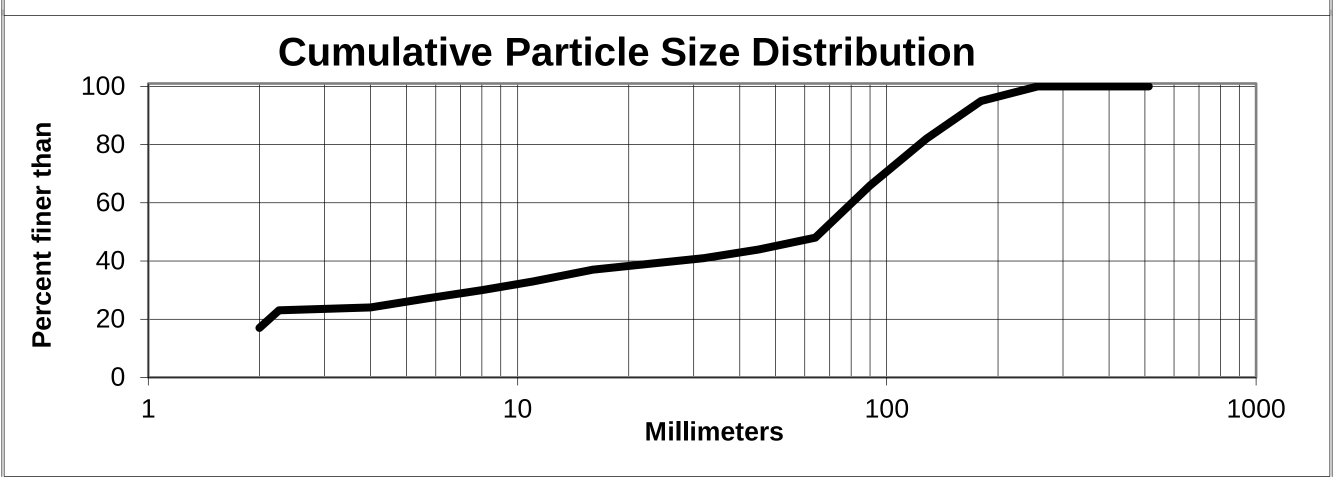




Pebble Count Name:	Reach 4 Riffle
Sampling Method:	Random Walk
Geomorphic Position:	Riffle
Stratigraphic Position:	Surface

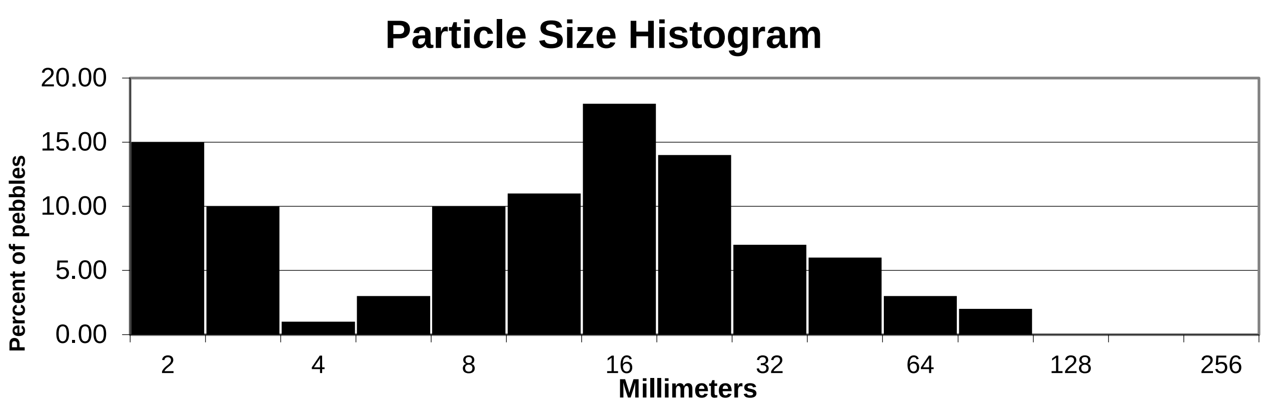
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	3	3.00	3.00
2.26	3	3.00	6.00
4	1	1.00	7.00
5.6	3	3.00	10.00
8	3	3.00	13.00
11	3	3.00	16.00
16	4	4.00	20.00
32	11	11.00	31.00
45	20	20.00	51.00
64	12	12.00	63.00
90	14	14.00	77.00
128	16	16.00	93.00
180	6	6.00	99.00
256	1	1.00	100.00
512	0	0.00	100.00
Total:	100	100	

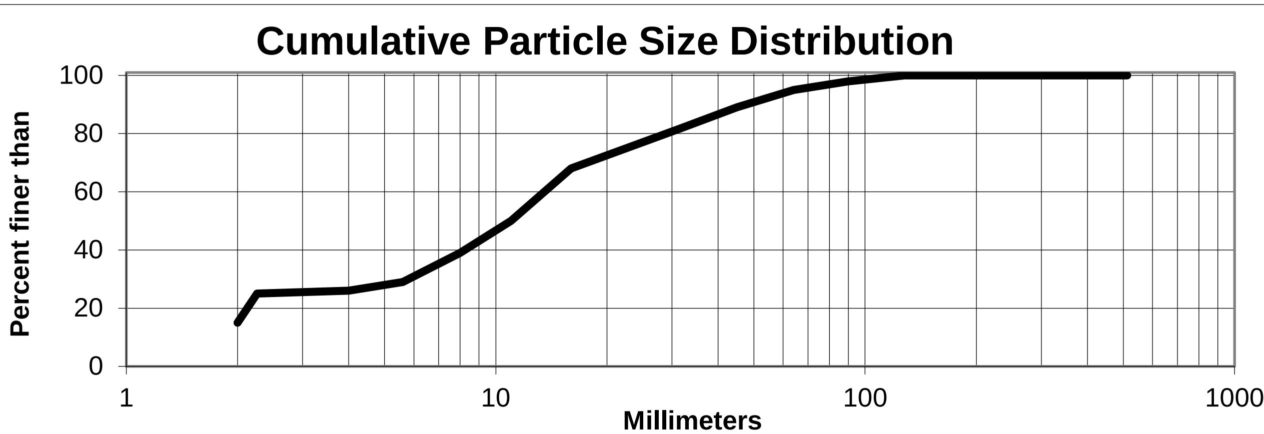




Pebble Count Name: Reach 5 Riffle
Sampling Method: Random Walk
Geomorphic Position: Riffle
Stratigraphic Position: Surface

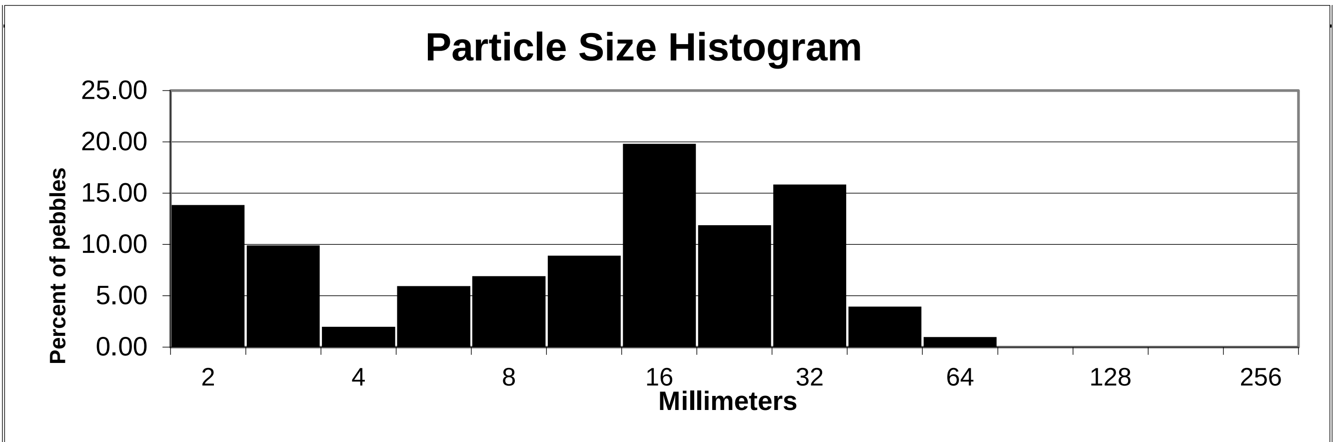
Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	15	15.00	15.00
2.26	10	10.00	25.00
4	1	1.00	26.00
5.6	3	3.00	29.00
8	10	10.00	39.00
11	11	11.00	50.00
16	18	18.00	68.00
32	14	14.00	82.00
45	7	7.00	89.00
64	6	6.00	95.00
90	3	3.00	98.00
128	2	2.00	100.00
180	0	0.00	100.00
256	0	0.00	100.00
512	0	0.00	100.00
Total:	100	100	

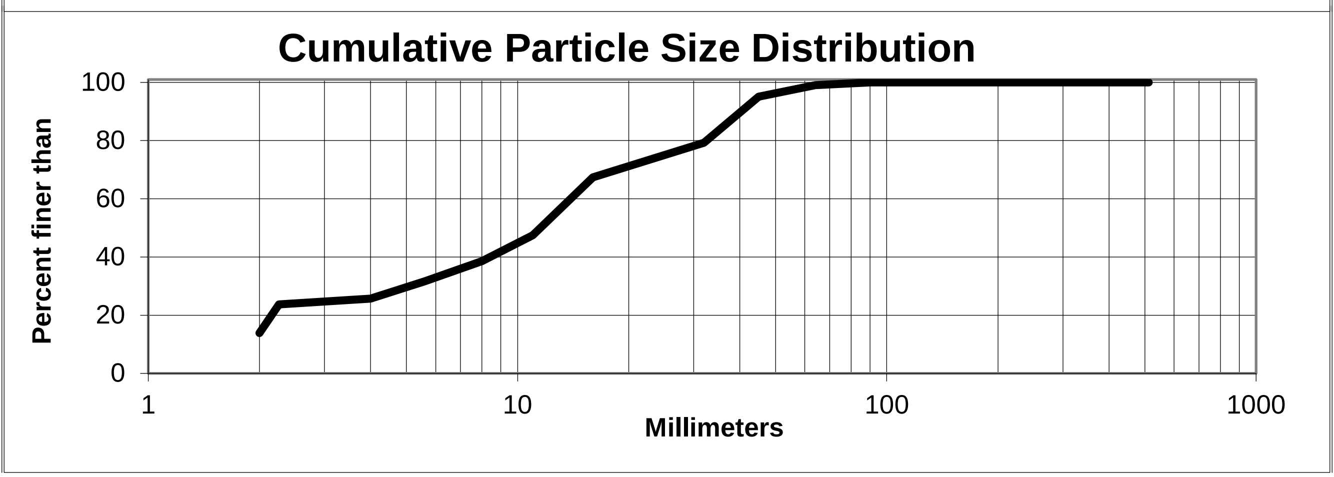




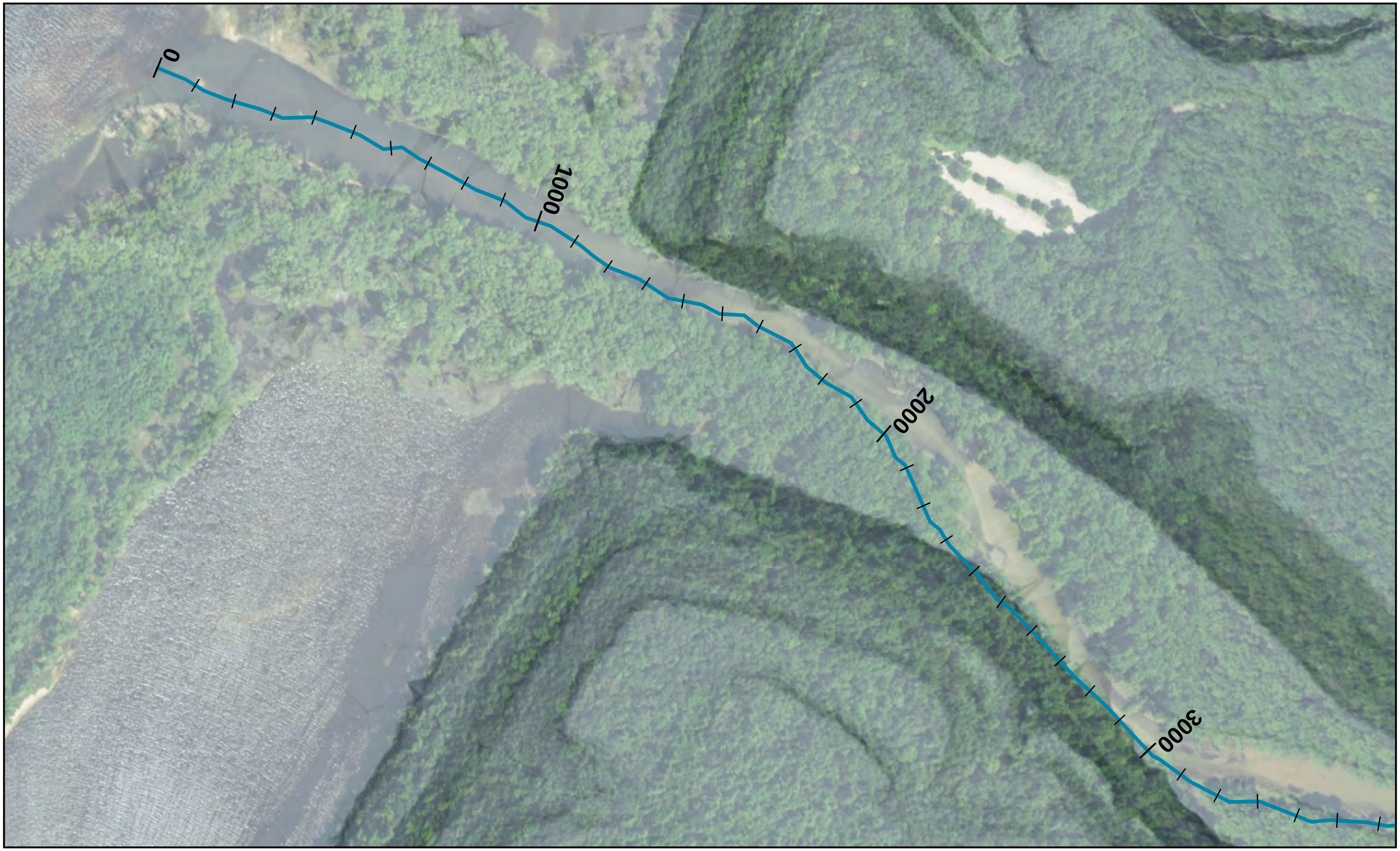
Pebble Count Name: Reach 5 Bar
Sampling Method: Random Walk
Geomorphic Position: Bar
Stratigraphic Position: Surface

Sediment size (mm)	Particle Count	Total Percent	Cumulative Percent
2	14	13.86	13.86
2.26	10	9.90	23.76
4	2	1.98	25.74
5.6	6	5.94	31.68
8	7	6.93	38.61
11	9	8.91	47.52
16	20	19.80	67.33
32	12	11.88	79.21
45	16	15.84	95.05
64	4	3.96	99.01
90	1	0.99	100.00
128	0	0.00	100.00
180	0	0.00	100.00
256	0	0.00	100.00
512	0	0.00	100.00
Total:	101	100	





10. Appendix C – Field Maps



Feet
0 500
Scale 1:4000

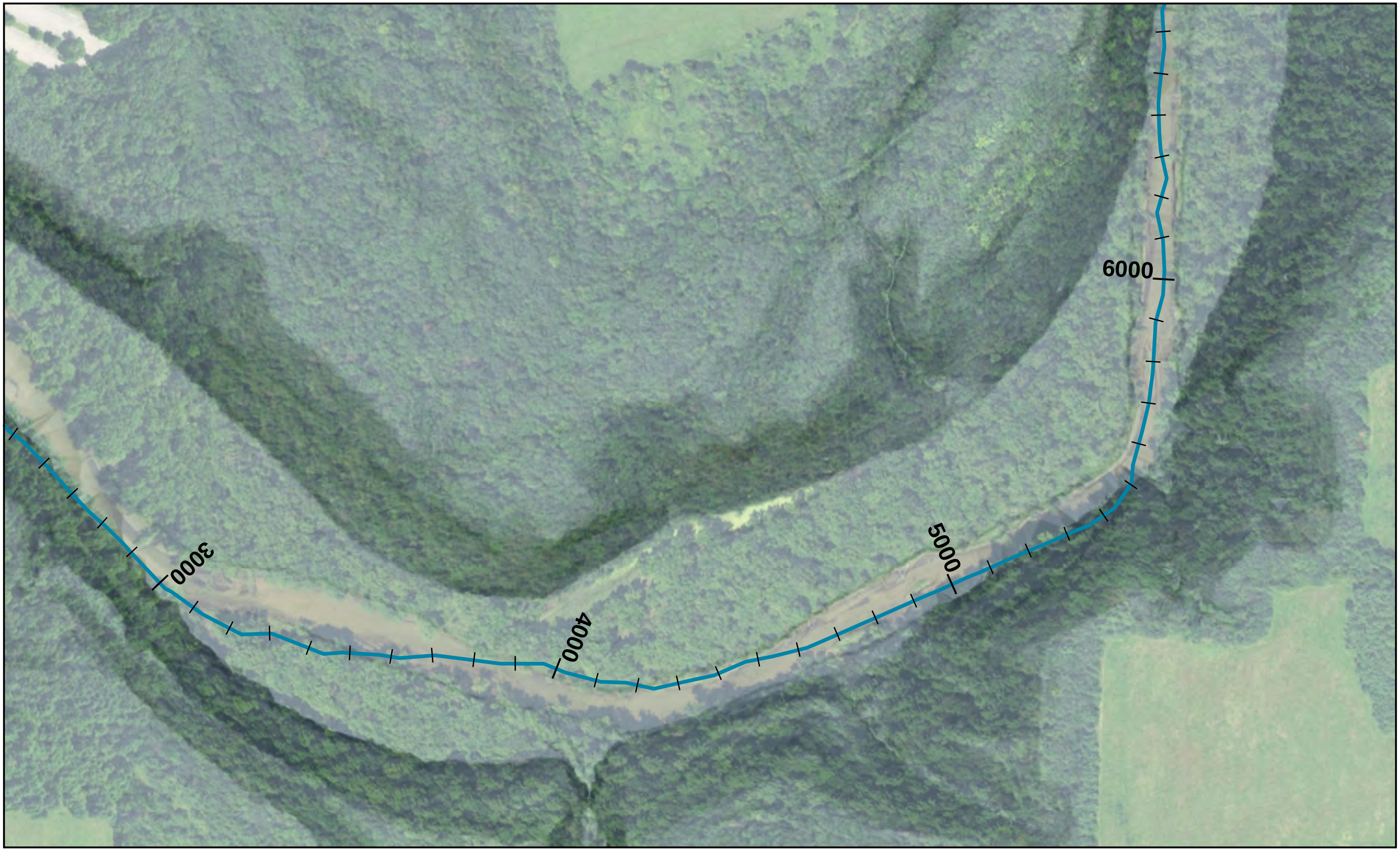
Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 1

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



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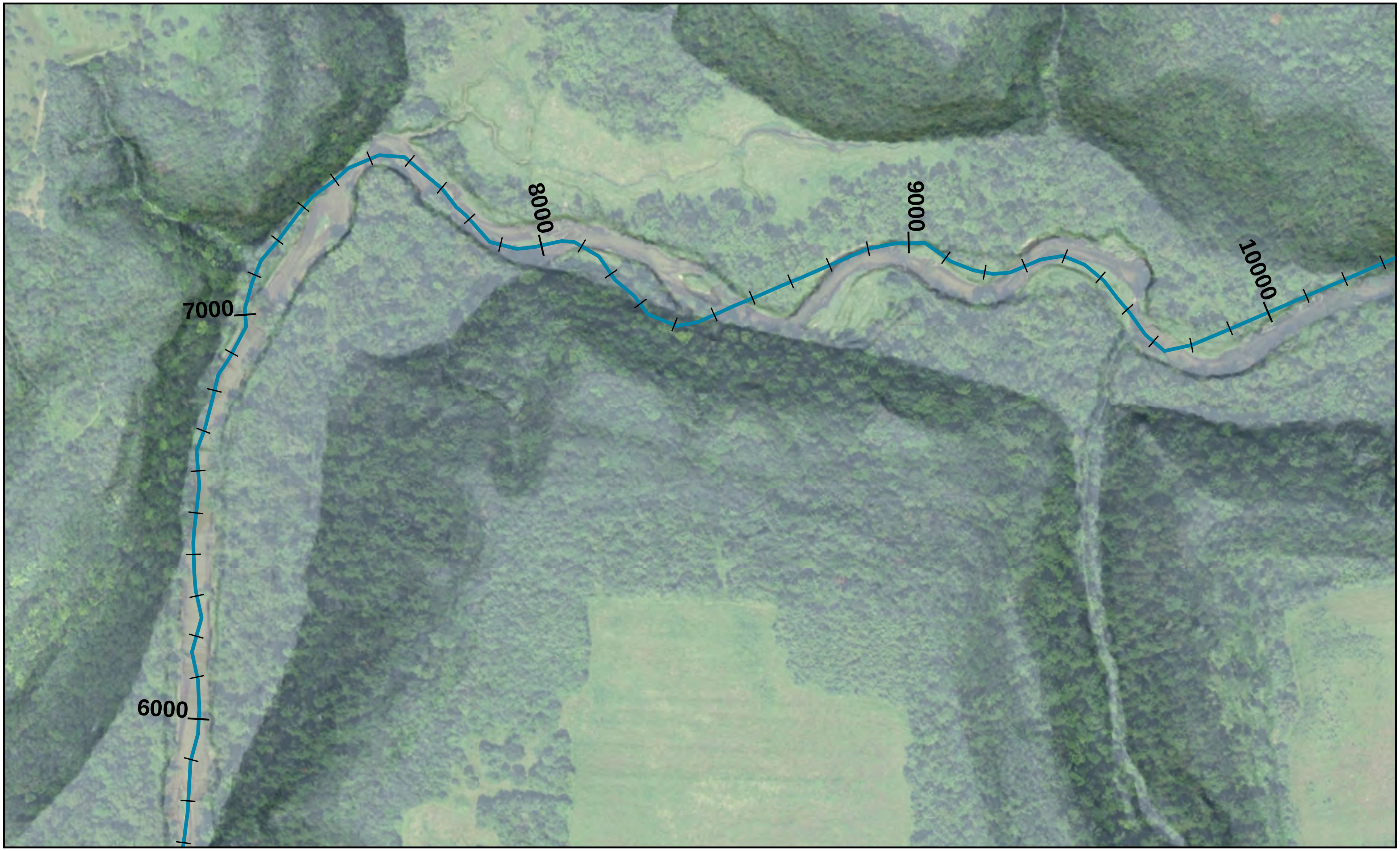
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 2

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



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Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 3

Notes:
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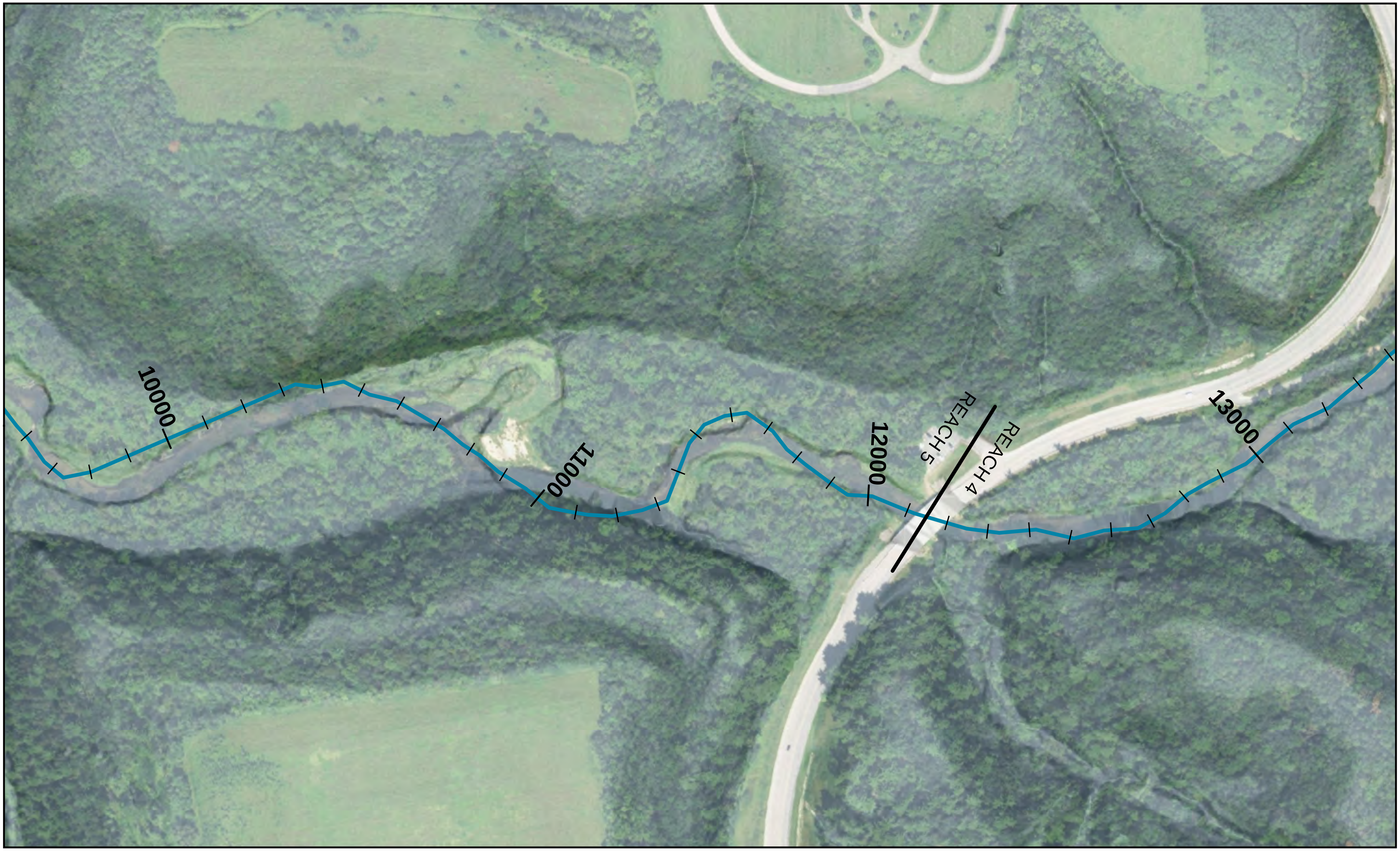
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



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Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 4

Notes:
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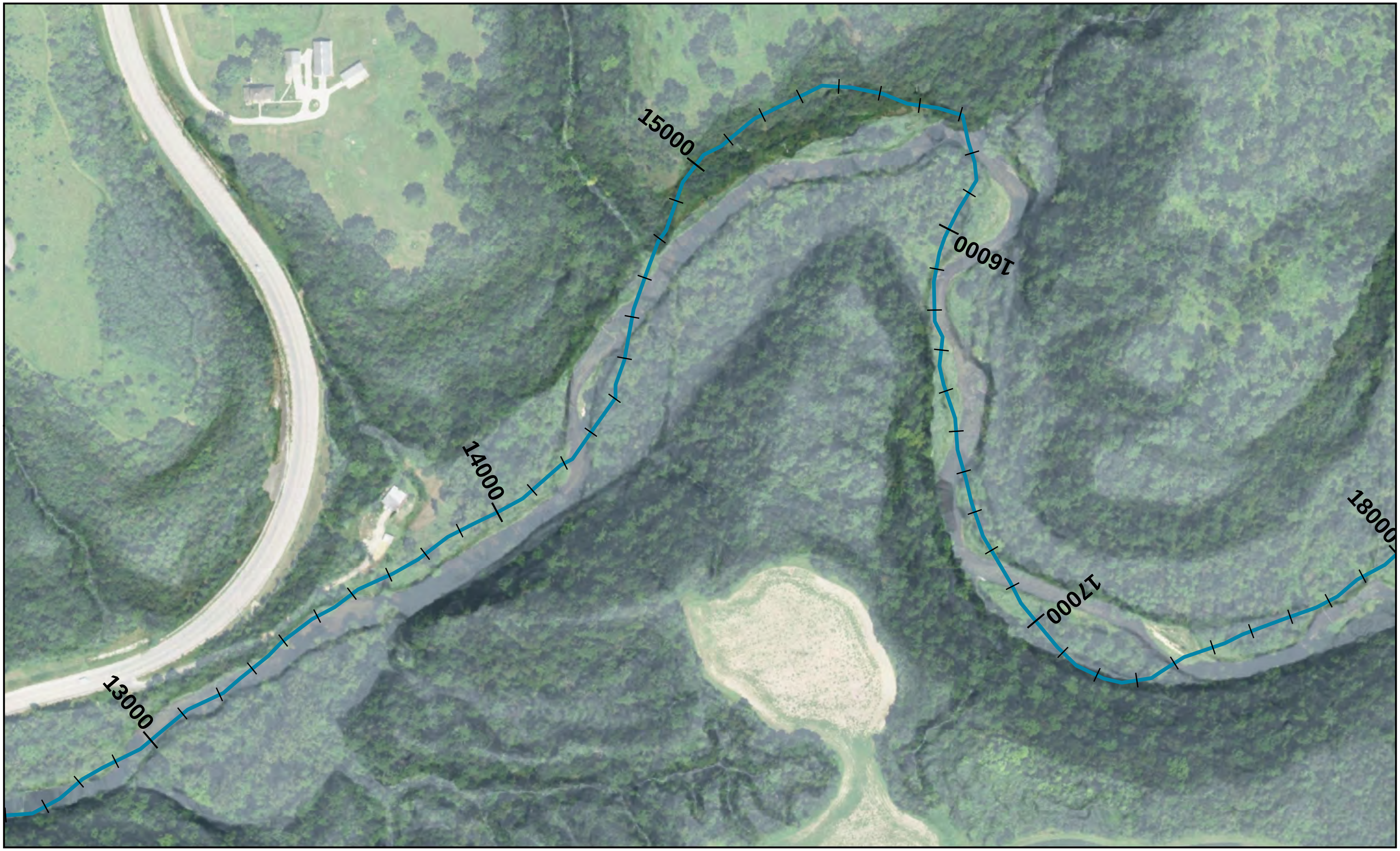
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



Feet

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Scale 1:4000

Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 5

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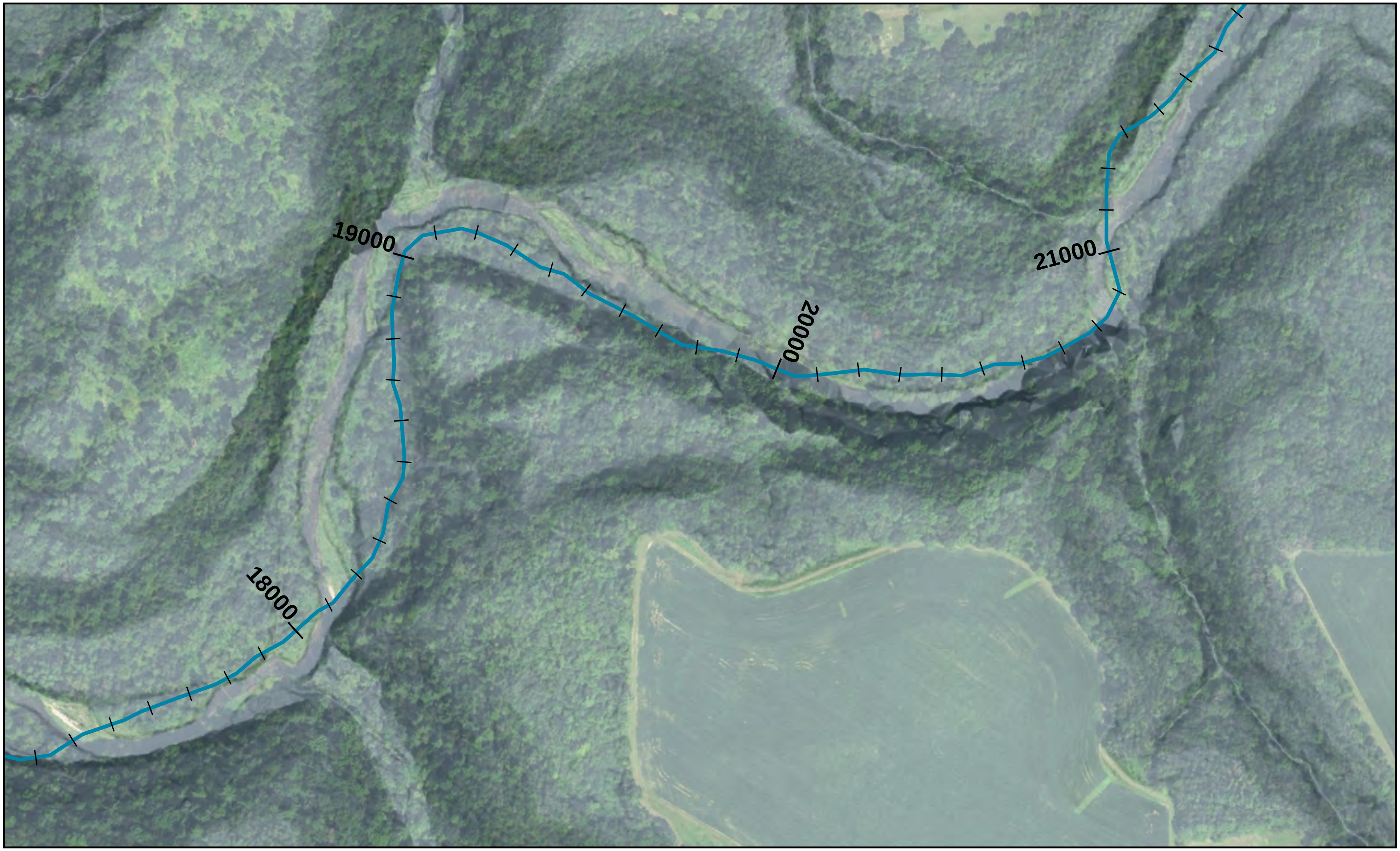
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



Feet

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Scale 1:4000

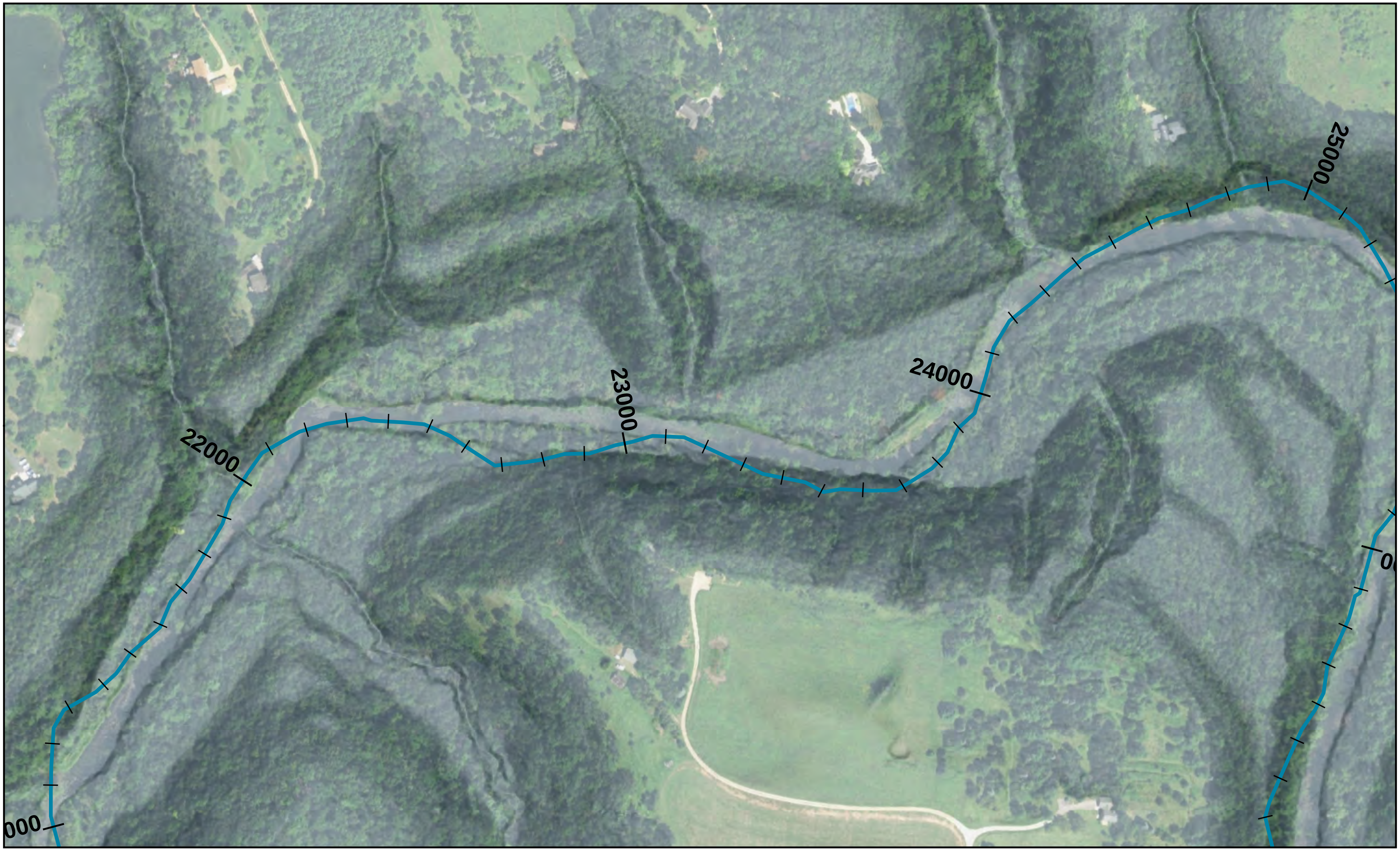
Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 6

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



Feet

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Scale 1:4000

Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

River Falls Habitat Assessment
Map 7

Pierce County
Wisconsin

Feet

0 500

Scale 1:4000

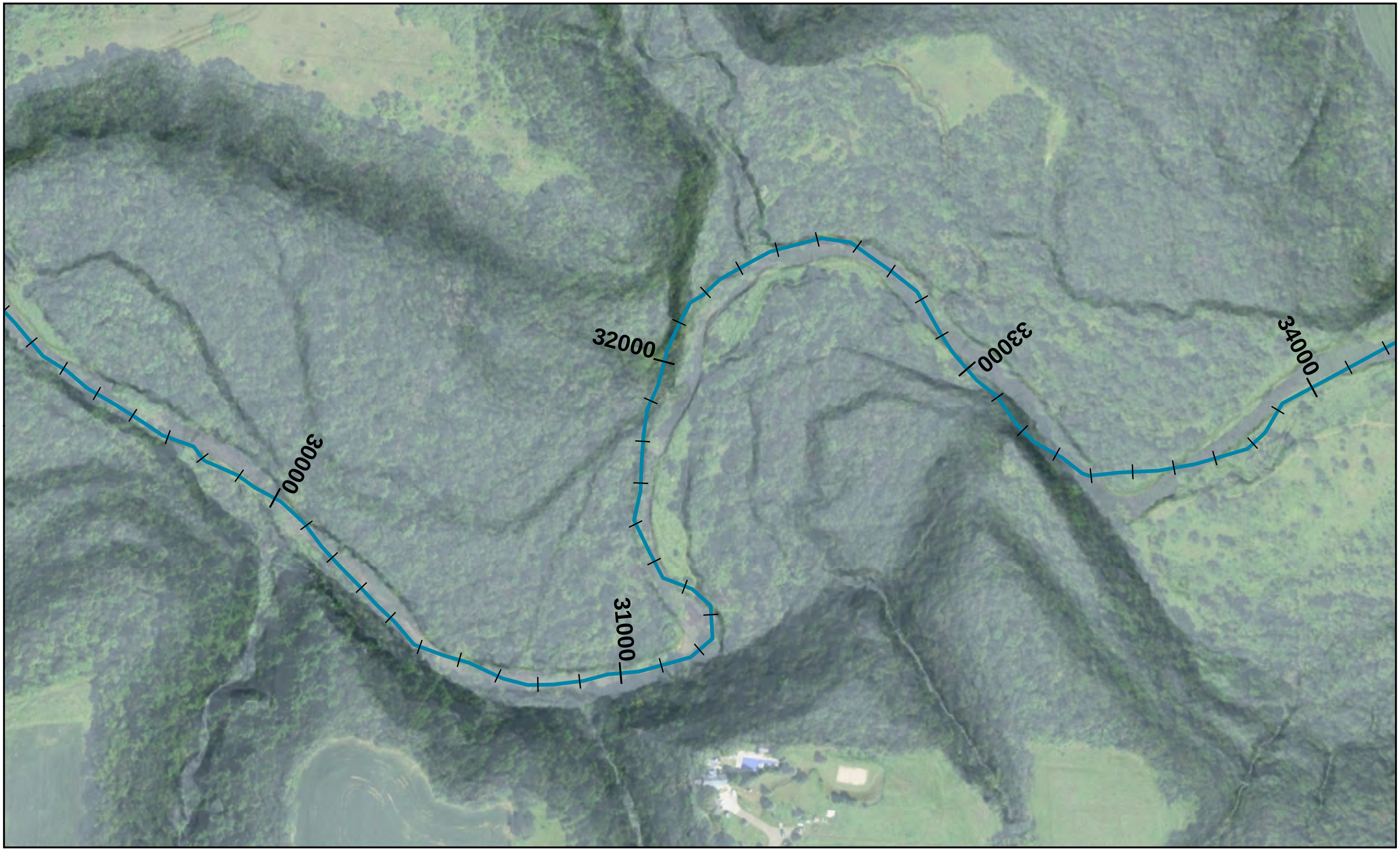
Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 8

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



Feet

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Scale 1:4000

Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 9

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin

Feet
0 500
Scale 1:4000

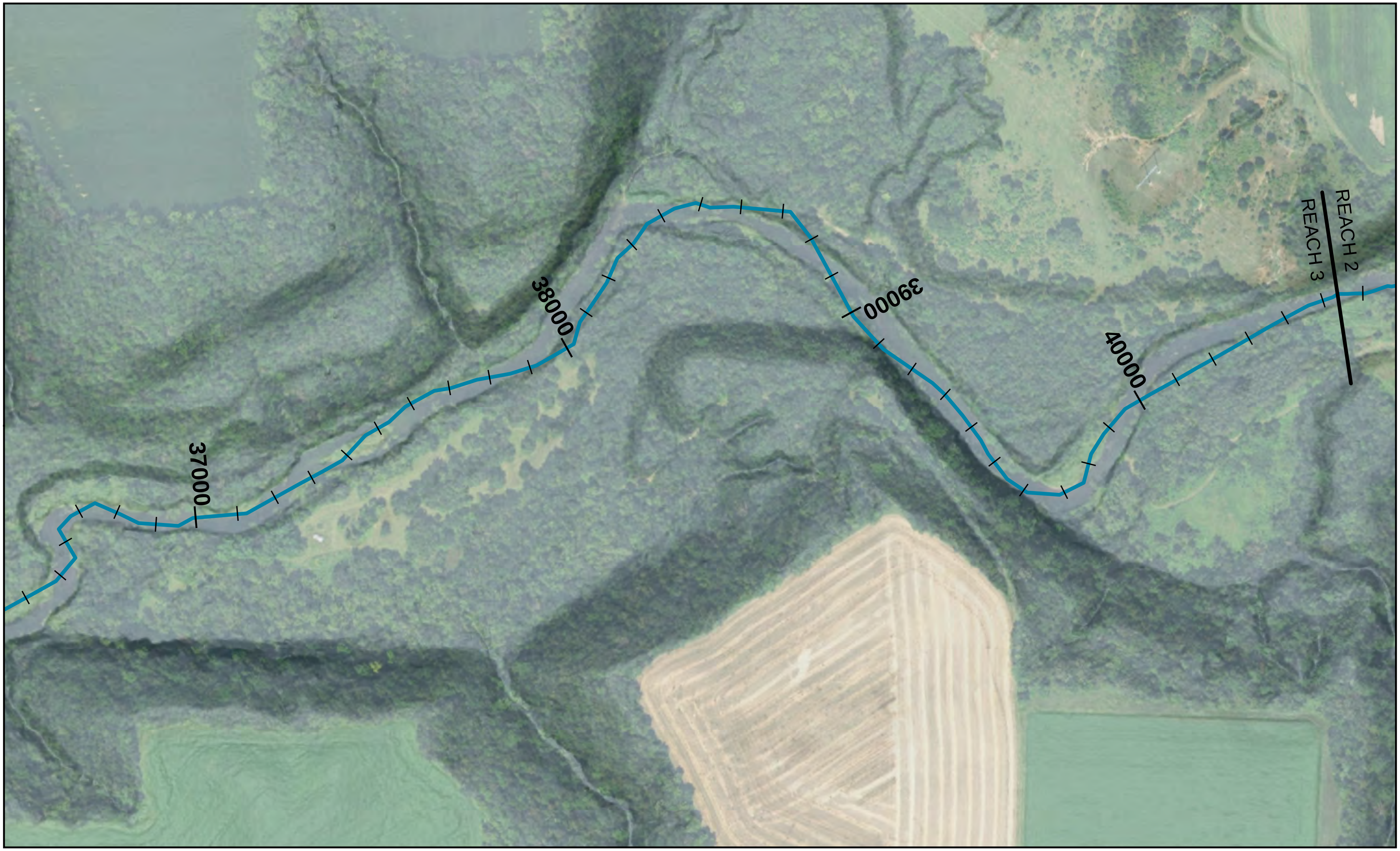
Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 10

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



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Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 11

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin

Feet

0 500

Scale 1:4000

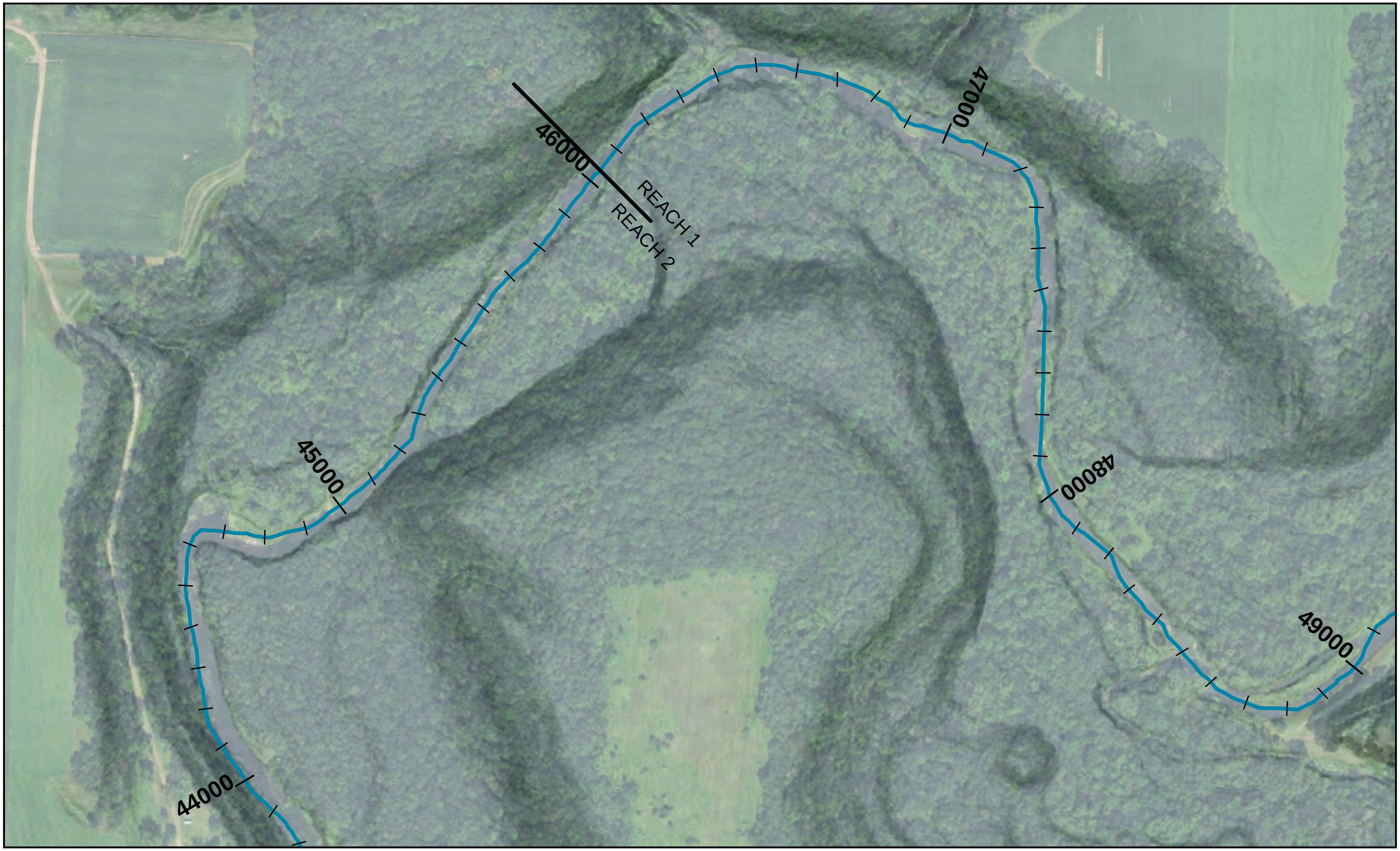
Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 12

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin



Feet
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Scale 1:4000

Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 13

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin

Feet
0 500
Scale 1:4000

Coordinate System : NAD 1983
StatePlane Wisconsin Central
FIPS 4802 Feet

N

River Falls Habitat Assessment
Map 14

Notes:
1. Aerial Imagery from Landsat 2018
2. LiDAR derived slope data collected 2015
3. River stationing derived from river centerline Riverine Habitat Evaluation below Powell Falls - Desktop Evaluation Summary

Pierce County
Wisconsin

11. Appendix D – Digital Deliverables

Digital deliverables include:

1 – Spreadsheet of habitat information, survey points, and pebble counts

2 – Digital photographs collected during the survey

Appendix G – Recreation Use Assessment
(Appendices filed separately due to file size)

Appendix H – Archeological Survey

FINAL

SUMMARY REPORT

RIVER FALLS HYDROELECTRIC PROJECT
RECREATION USE ASSESSMENT
RIVER FALLS, WISCONSIN

Contract No. W912ES20D0001
Task Order W912ES20F0071

December 2020

FINAL

SUMMARY REPORT

RIVER FALLS HYDROELECTRIC PROJECT
RECREATION USE ASSESSMENT
RIVER FALLS, WISCONSIN

Contract No. W912ES20D0001
Task Order W912ES20F0071

Prepared for:
U.S. Army Corps of Engineers, St. Paul District
180 5th Street E, Suite 700
St. Paul, Minnesota 55101

Prepared by:
Gulf South Research Corporation
8081 Innovation Park Drive
Baton Rouge, Louisiana 70820

December 2020

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EXECUTIVE SUMMARY

This summary report provides the background, materials and methods, and results of a recreation use assessment conducted for three recreation areas (survey areas) along the Kinnickinnic River in River Falls, Wisconsin. Two dams have been built on the river, Junction Falls Dam and Powell Falls Dam, which have created impoundments named Lake George and Lake Louise, respectively. The Project Area includes a portion of the Kinnickinnic River south of Powell Falls Dam, both dams and impoundments, and a portion of the river upstream from Lake George. The three survey areas within the Project Area are referred to as Glen Park Trails, Powell Falls Kayak Launch, and White Kinnickinnic Pathway.

The recreation use assessment was conducted by Gulf South Research Corporation for the U.S. Army Corps of Engineers, St. Paul District, on behalf of River Falls Municipal Utilities, Wisconsin, as part of the Federal Energy Regulatory Commission (FERC) licensing process, from June 27 to September 7 2020. Throughout the recreation use assessment, a detailed description of the Project Area was compiled through photographs, notes, and interviews. All amenities related to recreation use (e.g., picnic tables) or general public use (e.g., parking lots, sidewalks) were recorded. Spot counts, defined as tallies of observed recreation use as well as data on environmental conditions, were conducted for six hours each day during the 15-day recreation use assessment. In-person surveys were solicited from recreation users observed within the project's survey areas. User surveys were given in each survey area using standardized data sheets as outlined in the June 2019 River Falls Hydroelectric Project Revised Study Plan (RSP) and approved in FERC's Study Plan Determination.

The results of the recreation use assessment can be summarized as follows:

- The primary recreation activities that occur in the three survey areas are walking, dog walking, biking, canoeing/kayaking, fishing from shore, and fly fishing. The river is an attraction for primarily canoeing/kayaking and fishing, while the system of trails and related amenities around Lake George and Lake Louise provide an opportunity for more urban recreation (e.g., biking, picnicking).
- The average number of recreation users at each survey area were as follows: Glen Park Trails (9.77 users/hour), Powell Falls Kayak Launch (24.2 users/hour), and White Kinnickinnic Pathway (21.6 users/hour). Powell Falls Kayak Launch was predominantly used for canoeing/kayaking (40.5 percent of users) while Glen Park Trails and White Kinnickinnic Pathway were most popular for walking/running and dogwalking.
- The majority of respondents to the in-person recreation user survey were residents of River Falls (57 percent). Respondents rated the aesthetics or scenic views at Lake George, Lake Louise, Powell Falls, and Junction Falls as above satisfactory to excellent. Recreation users overwhelmingly felt that the recreation areas serve their interests and stated that they would use the areas again. The most commonly requested change to recreation amenities was installation of additional toilets or restrooms in the survey areas.
- A total of 25,014 summer "recreation days" were calculated for the Project Area. This total was calculated for a period of 108 days (Memorial Day weekend to Labor Day). Projected future demand for recreation in the River Falls area is estimated to increase minimally (7.5 percent increase by 2050).

1.0 INTRODUCTION

Two dams, known as the Powell Falls Dam and Junction Falls Dam, impound the Kinnickinnic River within the City of River Falls, Wisconsin. River Falls Municipal Utilities (RFMU) is proposing to relicense the Junction Falls Development and decommission the Powell Falls Development with dam removal through the Federal Energy Regulatory Commission (FERC). As part of these efforts, a recreation use assessment was required as one of a series of baseline studies to be conducted in the vicinity of the two dams on the Kinnickinnic River. Gulf South Research Corporation (GSRC) was contracted by the U.S. Army Corps of Engineers (USACE), St. Paul District, on behalf of RFMU, to conduct the recreation use assessment.

2.0 BACKGROUND

2.1 Location

The Junction Falls and Powell Falls Dams are located on the Kinnickinnic River within the City of River Falls, Pierce County, Wisconsin. Two impoundments, known as Lake George and Lake Louise, have been created by Junction Falls Dam and Powell Falls Dam, respectively. The series of dams and impoundments is located approximately 10 miles upstream of the river's confluence with the St. Croix River, and 30 miles downstream from its headwaters in Erin Prairie Township, Wisconsin (Figure 1). Powell Falls Dam is located 0.5-mile downstream from Junction Falls Dam. The Project Area for the recreation use assessment includes an upstream portion of the Kinnickinnic River north to West Division Street, Lake George, Lake Louise, and a downstream portion of the river south of Powell Falls Dam (Figure 2).

Photograph 1. View of Junction Falls Dam and the adjoining powerhouse, facing northwest.

Lake George occupies approximately 16 acres, most of which is east of the original river channel (Inter-Fluve 2017). Lake Louise is of similar size to Lake George, with additional seasonally-inundated wetlands along its northern shoreline. Around Lake George and Lake Louise, as well as the adjacent upper reach of the Kinnickinnic River to the north and lower reach to the south, public use areas including biking/walking trails, benches, and water-access infrastructure have been developed for use by residents of the City of River Falls. While most of the parcels (i.e., properties) around the impoundments are maintained as a public recreation opportunity, parcels along the upper reach of the Kinnickinnic River are owned by private individuals and contain both businesses and residences. The River Falls Wastewater Treatment Facility is located along the western shoreline of Lake Louise. The Junction Falls powerhouse is located immediately west of Junction Falls Dam (Photograph 1).

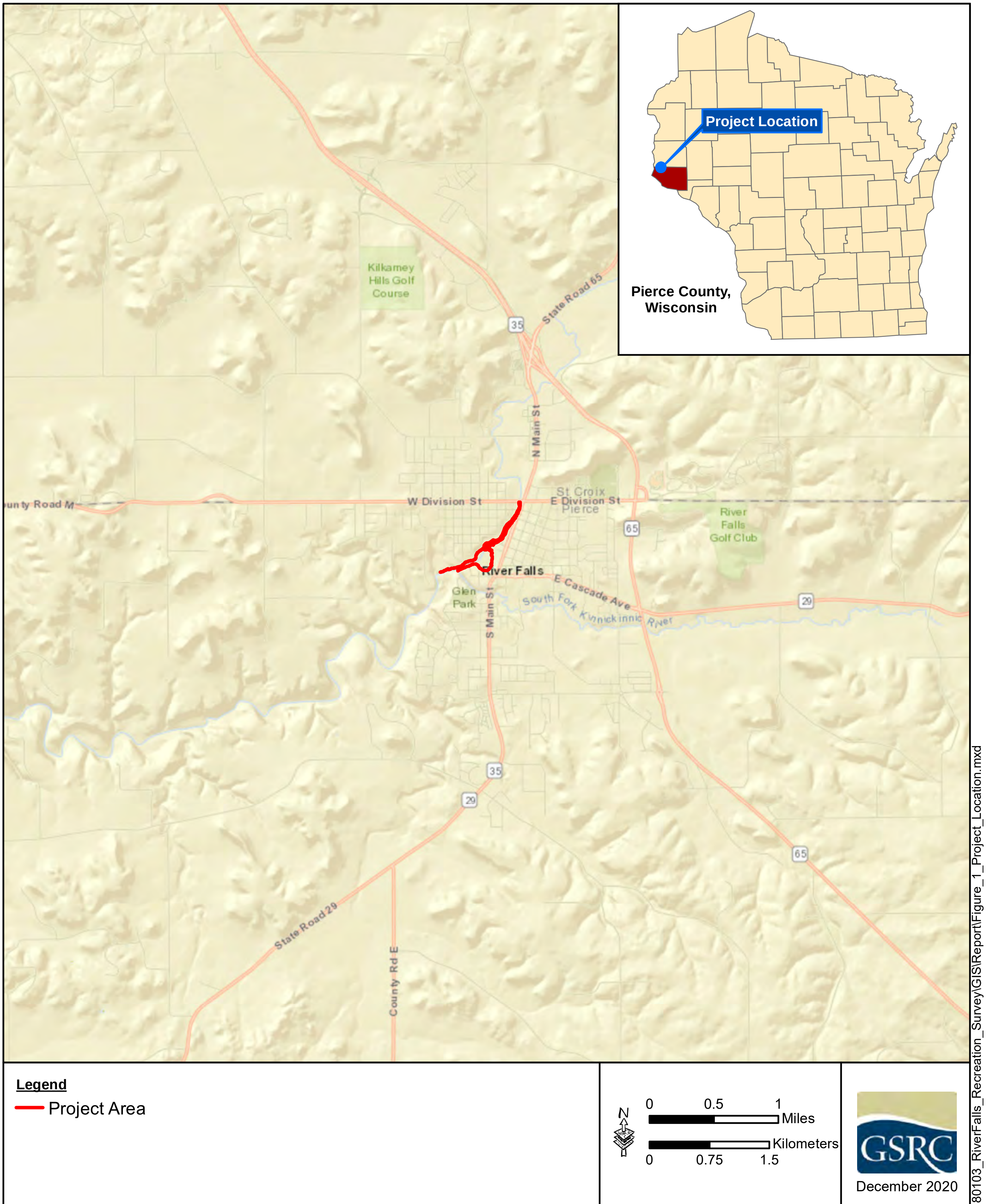

Figure 1. Project Location

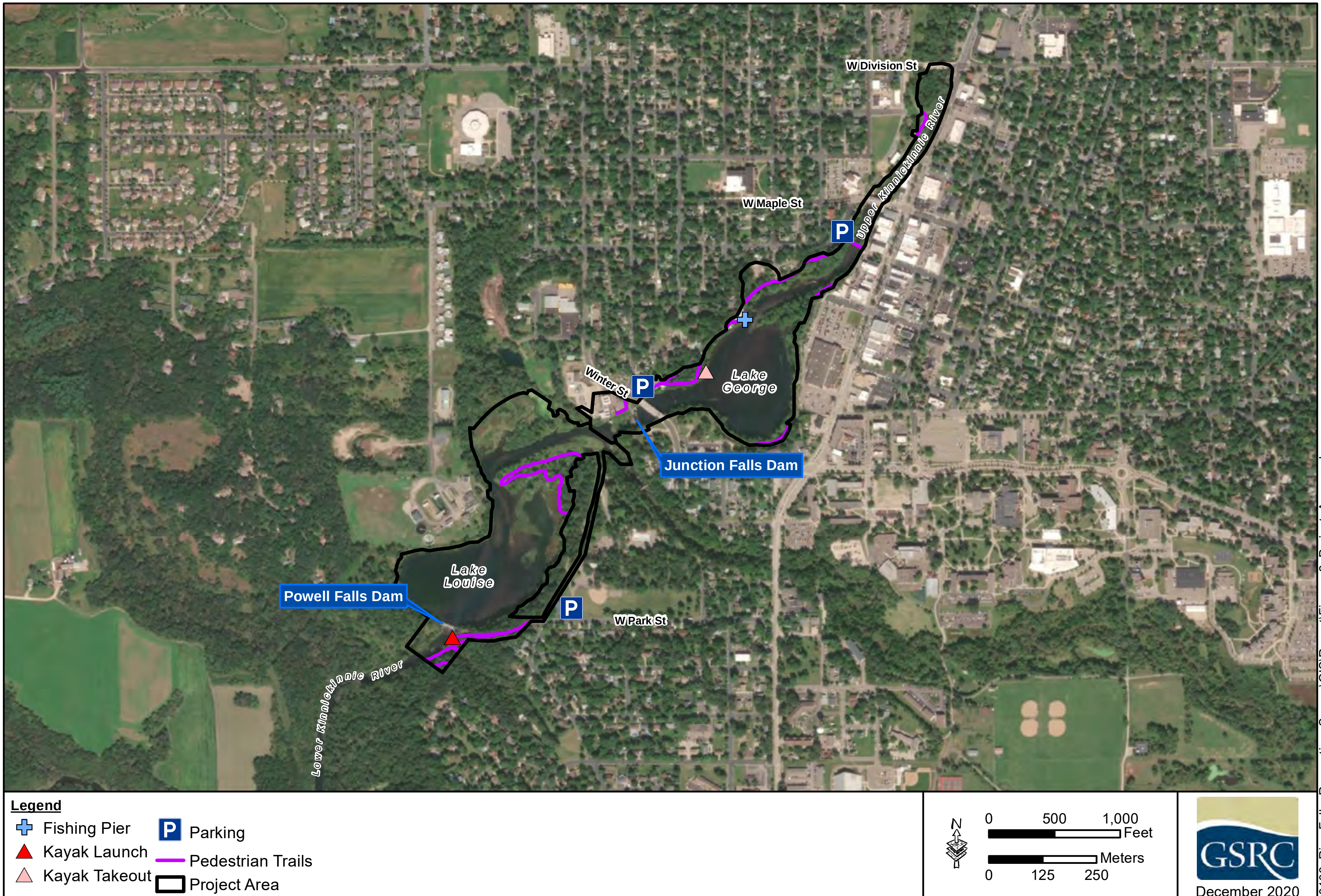

Figure 2. Project Area

3.0 METHODOLOGY

Within the Project Area, three focal survey areas were assessed for recreation activity. These survey areas, hereby referred to as the Powell Falls Kayak Launch, Glen Park Trails, and White Kinnickinnic Pathway, are discussed in greater detail in Section 4.0. Recreation surveys were conducted across an approximately four-month span (June to September 7, 2020 [Labor Day]) to best capture variations in recreation use dependent on environmental conditions for the busiest "recreation season" (i.e., summer/early fall). The specific dates of surveys are provided in Table 1. GSRC's surveyors were Ross Hackbarth and Christian Hicks. One surveyor was present per day to conduct the recreation use assessment. Memorial Day weekend was excluded from the schedule due to delays caused by the COVID-19 pandemic and the State of Wisconsin Department of Health Services Emergency Order #28, Stay at Home Order. One survey day was added in September to maintain a total of 15 survey days.

Table 1. Survey Dates for Recreation Use Assessment

Month	Date	Day of Week
June	27	Saturday
	28	Sunday
	29	Monday
	30	Tuesday
July	2	Thursday
	3	Friday
	4*	Saturday
	5	Sunday
	6	Monday
August	1	Saturday
	2	Sunday
	3	Monday
	4	Tuesday
September	6	Sunday
	7*	Monday
Total	**15 days**	**7 weekday, 6 weekend, 2 holiday**

* denotes holiday

3.1 Documentation of Project Area Amenities and Conditions

Throughout the recreation use assessment, a detailed description of the Project Area was compiled through photographs, notes, and interviews. All amenities related to recreation use (e.g., picnic tables) or general public use (e.g., parking lots, sidewalks) were recorded. The locations of amenities were recorded using a Garmin Oregon 650® handheld global positioning system (GPS) unit. Weather conditions were documented for each hour in which recreation surveys were conducted using a Kestrel 2500® weather meter. Further environmental conditions or general variables (e.g., water depth, extreme weather events) were recorded when encountered.

3.2 Spot Counts

Spot counts, or tallies of observed recreation use, were conducted for six hours each day during the 15-day recreation use assessment. Each day, six total one-hour spot counts were performed at the three survey areas, with two one-hour counts occurring at each area. During these counts, the number of people observed recreating was tallied by type of recreation activity. Typical recreation activities recorded were walking/running, dog-walking, biking, kayaking, and fishing. Additionally, the number of cars observed parked or arriving to park in designated parking areas for each survey area was recorded to obtain a second measure of recreation use rates. Recreation use was only recorded if observed within one of the designated survey areas. During each spot count, the surveyor walked from the associated parking area to the other end of the survey area to ensure that recreation activities across the entirety of the area were observed and recorded. When extra time permitted, the surveyor would stand at a point along the trail where people would be intercepted coming and going from their cars. The surveyor remained on the primary trail(s) whenever possible to ensure the highest probability of observing each recreation user in the survey area, though it cannot be guaranteed that every user was recorded.

3.3 Recreation User Surveys

In-person surveys were solicited from recreation users within the project's survey areas. User surveys were given in each survey area while spot counts were being conducted. A standardized recreation use survey form was filled out during each interview (Appendix A). The user survey forms were developed for the June 2019 River Falls Hydroelectric Project Revised Study Plan (RSP) and approved in FERC's Study Plan Determination. The survey form was designed to gather recreation use data including primary recreation activity, number of people in party, and opinions on the quality of amenities and recreation opportunities. All in-person surveys were taken anonymously. As many in-person surveys were given as possible during the one-hour periods used to conduct spot counts in each survey area. People were asked to take a survey only if they were observed recreating in the survey area. A preliminary question on the user survey asked if the respondent had "participated in a recreation survey here before". If the respondent replied yes and indicated they had taken the survey earlier in the year (i.e., 2020), the survey was not conducted a second time.

4.0 RESULTS

4.1 Project Area Amenities and Conditions

4.1.1 Environmental Conditions During Surveys

The weather conditions for in-field survey days are provided in Table 2. Due to daily variations in the hours in which spot counts were conducted and Kestrel weather meter recordings taken, the temperature and wind speed data in Table 2 should not be considered representative of the entire day, but rather of the period in which surveys occurred. Individual spot count weather data can be found in Appendix B.

Table 2. Weather Conditions During Surveys, River Falls, Wisconsin

Date	Temperature[1] (°F)			Precipitation[2] (in.)	Wind Speed[1] (mph)
	Minimum	Maximum	Average		
June 27	68	88	80.9	0.00	0-1 mph
June 28	70	86	79.8	0.00	1-3 mph
June 29	67	80	71.8	6.95	0-2 mph
June 30	81	90	86	0.52	2-5 mph
July 2	82	94	85.8	0.15	0-2 mph
July 3	78	93	87.0	0.03	0-2 mph
July 4	78	89	85.7	0.00	1-3 mph
July 5	79	90	87.5	0.00	0-2 mph
July 6	79	83	84.5	Trace	0-2 mph
August 1	76	80	78.0	0.00	0-2 mph
August 2	66	74	71.5	0.08	2-4 mph
August 3	70	78	74.5	0.00	1-3 mph
August 4	73	85	78.7	0.00	1-3 mph
September 6	64	80	72.7	0.03	6-12 mph
September 7	55	59	56.5	Missing	3-8 mph

[1] Source: In-field readings from Kestrel handheld weather meter.
[2] Source: National Oceanic and Atmospheric Administration (NOAA) 2020.

It should be noted that a major flood event occurred in the region including River Falls on June 29 and 30, 2020. According to NOAA data, 7.47 inches of rain were received, the majority of which fell in one large event (NOAA 2020). Although conditions returned to normal for most recreation amenities within two days, this flood event may have had impacts to recreation use in the coming weeks. For example, kayaking on the Kinnickinnic River may have had reduced usage numbers following the flooding if people were worried about the condition of the river. The flood is further discussed in the following two sections.

4.1.2 Project Area Recreation Amenities

All three focal survey areas (Powell Falls Kayak Launch, Glen Park Trails, White Kinnickinnic Pathway) and much of the adjacent vicinity has been designated as a public recreation use opportunity by the City of River Falls. The following are descriptions of the features within each survey area related to public use.

4.1.2.1 Glen Park Trails

The Glen Park Trails survey area is a series of paths (both paved and unpaved) that lead from Glen Park down to natural features or attractions around the river and Lake Louise. Specifically, the trails lead from the western and northwestern edges of the park down to the bottom of Junction Falls Dam where the South Fork Kinnickinnic River meets the main channel of the Kinnickinnic River (Figure 3). The trails also lead southwest to the northern bank of Lake Louise. These trails are part of a larger system of trails running through the Project Area and elsewhere in River Falls which are communicated to the public through a series of signboards and paper maps scattered throughout public use areas (primarily near parking lots).

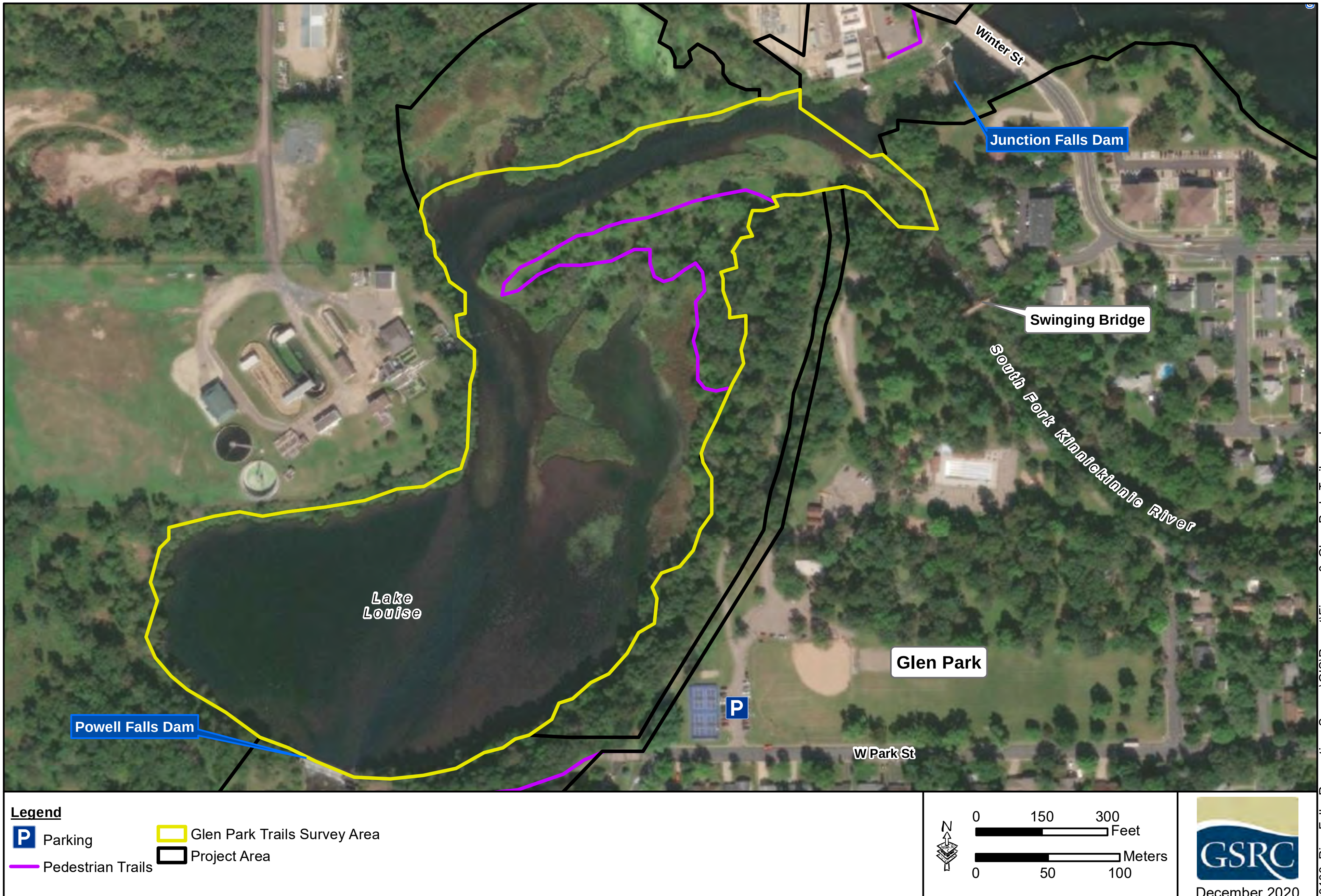

Figure 3. Glen Park Trails Survey Area

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Glen Park is one of two large city parks found in River Falls. The other large park is Hoffman Park, located to the northeast along East Division Street, which includes sports fields, recreation vehicle (RV) hook-ups, and the Mound Park trail system. Although outside of the Project Area for this recreation use assessment, Glen Park is an important recreation attraction that is directly adjacent to two of the project's survey areas. Glen Park has been recently refurbished in the last two years to include a new pavilion for social gatherings and a larger expanded parking lot. It also contains sports fields, a basketball court, picnic pavilions, a public swimming pool, and a splash park for children. In the far southwestern corner of the park is a pickleball court. The "Swinging Bridge", a pedestrian suspension bridge which has been placed on the National Register of Historic Places (NRHP), is located on the north side of Glen Park.

The trails within the survey area lead downhill from Glen Park to the river and floodplain below. A natural swimming hole exists at the confluence of the South Fork Kinnickinnic River and the main channel just below the dam and waterfalls. It should be noted that this is not formally designated as a swimming area by the City of River Falls. The paths lead to this swimming hole, as well as to the north shore of Lake Louise where people can observe wildlife, fish, or swim among other outdoor activities. Unofficial walking paths along the South Fork Kinnickinnic River lead upstream to small waterfalls and additional areas suitable for exploration. No other formal amenities (e.g., picnic tables, restrooms) exist in this area. The nearest restrooms can be found in Glen Park.

Photographs 2 through 5 show various features of the Glen Park Trails survey area.

Photograph 2. View of confluence of the Kinnickinnic River and South Fork Kinnickinnic River, with Junction Falls Dam in the background, facing north (June 29, 2020).

Photograph 3. Lake Louise viewed from its northeast shore within the Glen Parks Trail survey area (June 29, 2020).

Photograph 4. Paved trail within Glen Park Trails survey area leading to bottom of Junction Falls Dam, facing north (June 29, 2020).

Photograph 5. Walking path in Glen Parks Trail survey area leading to northeast shore of Lake Louise, facing southwest (June 29, 2020).

4.1.2.2 Powell Falls Kayak Launch

The Powell Falls Kayak Launch survey area consists of a segment of the trail system that connects River Falls to natural areas which have been maintained along the river. This segment of the trail system begins at the southwestern corner of Glen Park and continues downhill to the west, terminating at the river (Figure 4). The trail system continues outside of the Project Area to the south as it follows the river downstream. The segment of trail within the Powell Falls Kayak Launch survey area is predominantly used as a kayak launch point for the most popular kayak trip on the Kinnickinnic River, which begins at Powell Falls and ends at County Road F bridge crossing near the Kinnickinnic River's confluence with the St. Croix River.

The southwestern corner of Glen Park is an area of maintained lawn which is used as a kayak staging area. Here, two picnic tables have been installed and signs provide information on parking regulations and use of the trail as a kayak put-in. The trail to the river is a gravel and dirt path with steps installed on the steeper portion going down to the river. No other amenities have been installed except for a bench located up on a bluff overlooking Powell Falls Dam in the southern portion of the Project Area. Vegetation has obscured most of the view of the dam. The closest restrooms and drinking water sources for kayakers are located in Glen Park, which is outside of the survey area. Some street parking is available near the kayak launch staging area, as well as the large parking lot located in Glen Park. There is also an approximately 200-foot stretch of curbside parking directly adjacent to the kayak staging area which is limited to a 15-minute loading zone. All of these parking areas are outside of the survey area but used by people recreating within the survey area.

Photographs 6 through 11 depict the conditions and amenities found in the Powell Falls Kayak Launch survey area.

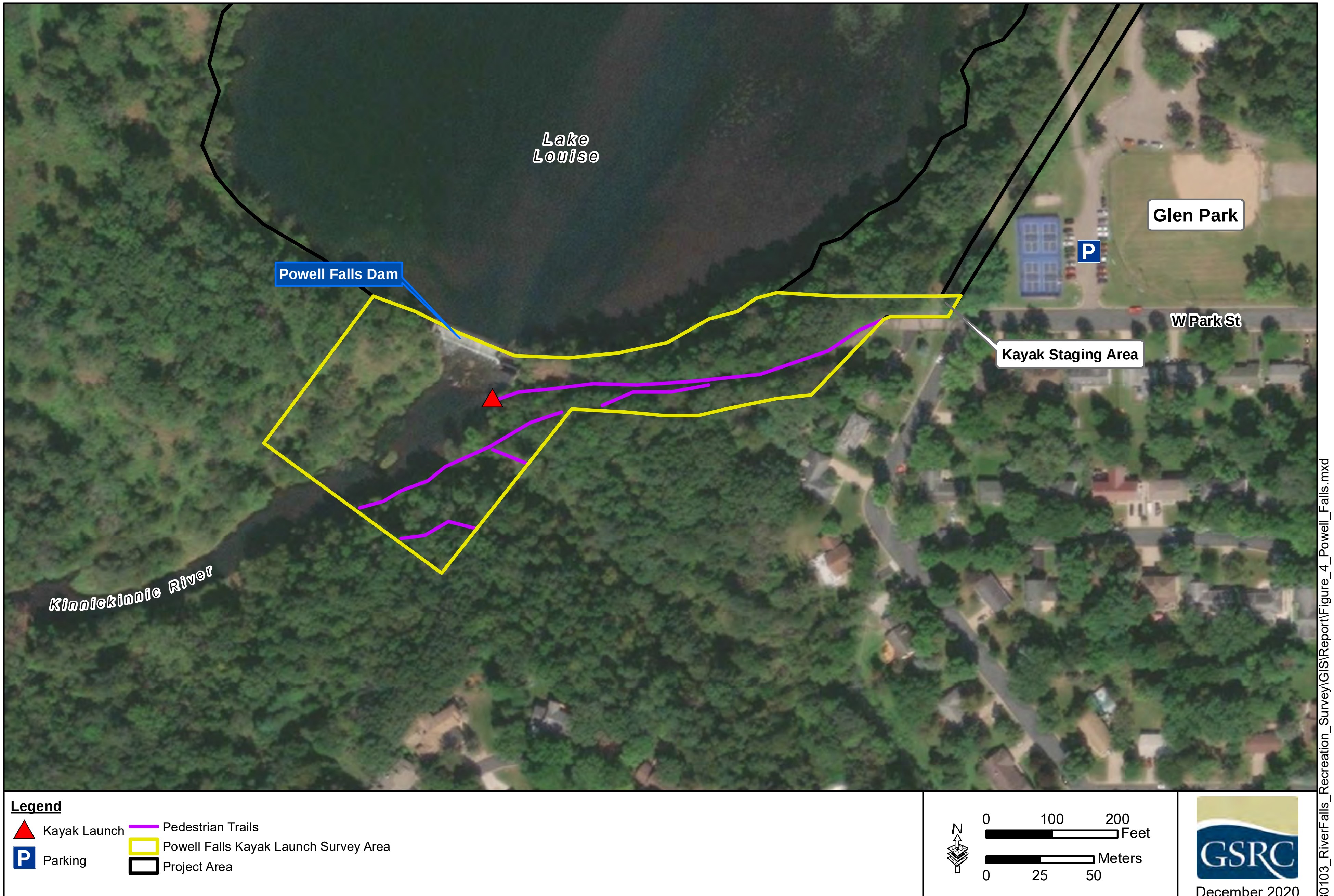
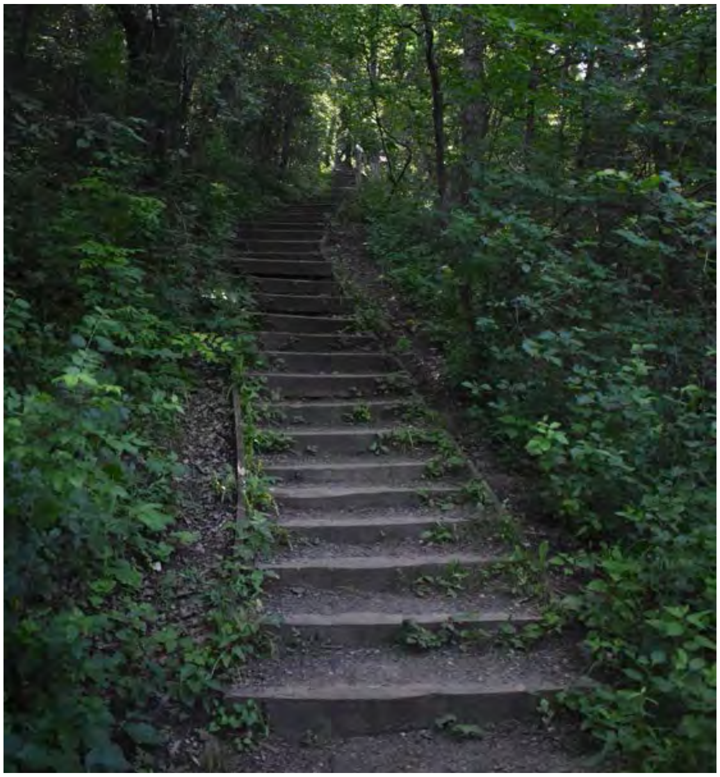


Figure 4. Powell Falls Kayak Launch Survey Area

Photograph 6. The Kinnickinnic River within the Powell Falls Kayak Launch survey area, kayak launch along the right, Powell Falls Dam in background, facing northeast (June 29, 2020).

Photograph 7. Southwest corner of Glen Park with kayak staging area in background, facing west (July 03, 2020).

Photograph 8. Entrance to trail leading to kayak launch, facing west (July 03, 2020).



Photograph 9. Steps leading down to kayak launch, facing east (July 03, 2020).

Photograph 10. View of White Kinnickinnic Pathway, a sitting area, and Lake George taken near Winter Street parking lot, facing east (June 29, 2020).

Photograph 11. Lake George as seen from the fishing pier located along White Kinnickinnic Pathway, facing southeast (June 29, 2020).

4.1.2.3 *White Kinnickinnic Pathway*

The White Kinnickinnic Pathway survey area is a large area inclusive of the Lake George impoundment which focuses on a section of River Fall's trail system along the northwest shore of the impoundment (Figure 5). The pathway is paved and intended for mixed use (i.e., walking, running, biking, rollerblading, strollers, wheelchairs, etc.). Areas of maintained lawn are found along most of the pathway and there are scattered benches and picnic tables that provide viewpoints of the lake. A kayak takeout is installed on the shoreline of Lake George. This takeout is a graded gravel ramp large enough for a small boat trailer. A wooden fishing pier is also located on the northwestern shoreline of Lake George. The pathway is typically found 20 to 100 feet away from the edge of Lake George.

Along the pathway, streetlamps have been installed for evening or nighttime use. There are two parking areas in proximity to the White Kinnickinnic Pathway: 1) a small 7-car lot just north of Winter Street in the southwestern portion of the survey area; and 2) a large 30+ car lot in Heritage Park south of Maple Street, which is outside of the survey area. Heritage Park, a small 1-acre park, is essentially a continuation of the White Kinnickinnic Pathway found immediately adjacent to the north.

Paved pathways can also be found along the eastern edge of Lake George and are connected to the White Kinnickinnic Pathway by sidewalks which cross a pedestrian bridge near the north side of the survey area and the Winter Street bridge on the southern edge of the survey area. The pathways on the east side of the impoundment are more consistently separated from the Lake George shoreline by a buffer of natural woodland vegetation. The elevation of the pathway is higher above the impoundment here.

Photographs 12 and 13 show the amenities present and survey area conditions of White Kinnickinnic Pathway during the recreation use assessment.

Figure 5. White Kinnickinnic Pathway Survey Area

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Photograph 12. Kayak takeout on Lake George shoreline, facing east (June 29, 2020).

Photograph 13. White Kinnickinnic Pathway facing north showing streetlamps and maintained lawn edges (June 29, 2020).

4.2 Spot Counts

Spot counts for recreation activity within each of the three survey areas were conducted for one-hour periods. Two one-hour counts were completed per day in each survey area for a total of six counts. These six one-hour counts were spread out each day with the intent of capturing various rates of recreation use from approximately 7:00 a.m. to 7:00 p.m. Table 4 shows the number of spot counts conducted at each survey area during each hour of the day. A spot count was designated for a specific hour (e.g., 9:00 a.m.) if that count occurred up to 15 minutes prior to the hour (e.g., 8:45 a.m.) and as late as 45 minutes after the hour (e.g., 9:45 a.m.). These hourly designations will be hereby referred to as "time blocks".

The results of spot count assessments are divided by survey area followed by a summary of overall spot count data.

4.2.1 Glen Park Trails

4.2.1.1 Recreation Activities

A total of 303 recreation users were observed within the Glen Park Trails survey area over the course of 31 one-hour spot counts (Table 3). The predominant recreation activity observed was walking or running, which included people who were exploring the area while not explicitly birding or nature observing (e.g., parents taking their children to play by the river bank). Note that "Fishing from Shore" typically indicates using a spinning rod while "Fly Fishing" indicates the use of a fly rod and tackle.

Table 3. Observed Recreation Activities at Glen Park Trails Survey Area

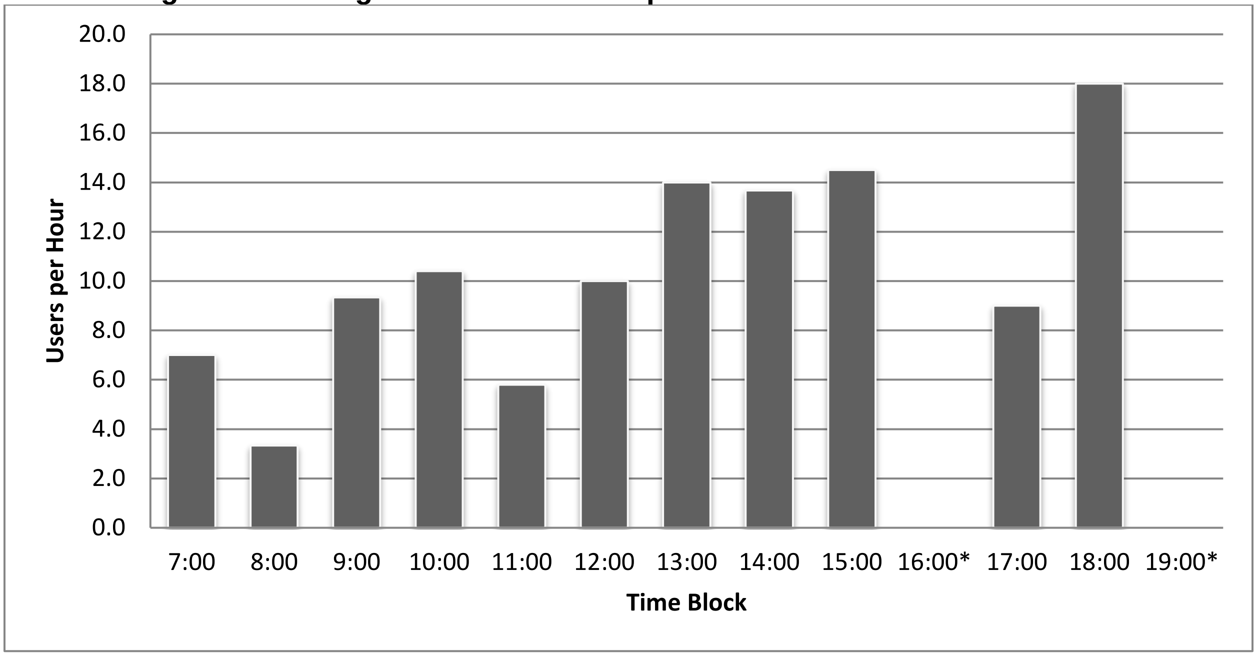
Rank	Recreation Activity	Users Observed	Users Per Hour
1	Walking/Running	224	7.23
2	Dog Walking	28	0.90
3	Swimming	16	0.52
4	Fishing from Shore	12	0.39
5	Fly Fishing	6	0.19
6	Biking	5	0.16
6	Photography	5	0.16
8	Picnicking	3	0.10
9	Canoeing/Kayaking	2	0.06
10	Flying a Drone	2	0.06
-	All Activities (Total)	303	9.77

The number of users per time block peaked in the late morning and early afternoon (Figure 6). Note that in Figure 6, 18.0 users per hour were recorded in the survey area for the 18:00 time block. The one count which occurred during this time block was conducted the day after a significant rain event when extreme flooding conditions were present. The high number of recreation users is likely due to people going down to the river and Lake Louise to look at the flooding conditions (pers. comm. with public). The number of recreation users observed per hour during weekends (11.3 users) was 32 percent higher than the number of users observed per hour on weekdays (8.5 users).

Table 4. Distribution of Spot Counts by Hour

Glen Park Trails													
	Weekday												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	-	1	1	2	4	-	1	1	2	-	1	1	-
	Weekend												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	2	2	1	2	1	-	2	1	-	-	2	-	-
	Holiday												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	-	-	1	1	-	1	-	1	-	-	-	-	-
Total for Survey Area	2	3	3	5	5	1	3	3	2	-	3	1	-
Powell Falls Kayak Launch													
	Weekday												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	1	-	2	2	1	3	1	2	-	1	1	1	-
	Weekend												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	-	1	2	1	3	1	-	-	1	-	-	2	-
	Holiday												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	-	1	-	1	1	1	-	-	-	-	-	-	-
Total for Survey Area	1	2	4	4	5	5	1	2	1	1	1	3	-
White Kinnickinnic Pathway													
	Weekday												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	-	-	-	1	2	1	3	2	2	2	-	-	-
	Weekend												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	1	-	2	2	2	1	2	-	1	-	-	-	2
	Holiday												
Time (hours)	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**
Number of counts	-	1	-	1	-	-	-	1	1	-	-	-	-
Total for Survey Area	1	1	2	4	4	2	5	3	4	2	-	-	2
Total for All Survey Areas	4	6	9	13	14	8	9	8	7	3	4	4	2

Figure 6. Average Recreation Users per Time Block at Glen Park Trails



* No spot counts conducted during this time block.

Recreation use by type of day (i.e., weekday, weekend, holiday) for Glen Park Trails is presented in Table 5.

Table 5. Recreation Users by Type of Day (Glen Park Trails)

Type of Day	Total Recreation Users	Recreation Users per Hour
Weekday	136	9.1
Weekend	144	12.0
Holiday	23	5.8

4.2.1.2 Parking

Parking for users of the Glen Park Trails survey area was difficult to isolate from other cars parked in Glen Park. The primary parking lot for Glen Park, which is outside of the survey area, is the closest parking opportunity for Glen Park Trail access (Photograph 14). This lot includes vehicles for people using only Glen Park amenities as well as overflow parking for the kayak launch point (Powell Falls Kayak Launch survey area). Thus, determining any association or correlation between the number of vehicles parked in the Glen Park parking lot and the number of active recreation users within the Glen Park Trails survey area is not possible without conducting in-person interviews of people parking cars. Further, many people interviewed during in-person surveys walked to one of the project's survey areas from the surrounding neighborhoods and did not utilize any parking.

Photograph 14. A portion of the large Glen Park parking lot, facing southwest.

During spot counts, the total number of cars initially observed in the Glen Park parking lot at the beginning of the count were recorded as well as any cars observed entering the lot. The average number of vehicles observed parking in Glen Park on weekdays was 26.6 vehicles, while the average number on weekends was 38.1 vehicles. This equals a 43 percent increase in traffic to the park during weekends.

4.2.2 Powell Falls Kayak Launch

4.2.2.1 Recreation Activities

Twenty-nine one-hour spot counts were recorded at the Powell Falls Kayak Launch survey area, during which time 703 recreation users were observed (Table 6). The average number of recreation users per hour was 24.2. Approximately 65 percent of recreation users observed at Powell Falls were either canoeing or kayaking (i.e., using the launch point to access the lower Kinnickinnic River). Fishing was also popular, with an average of over 2 individuals per hour observed fishing the river. Three individuals were observed walking down to the river and immediately returning to the parking area and said that they were simply looking at conditions on the river for fishing purposes.

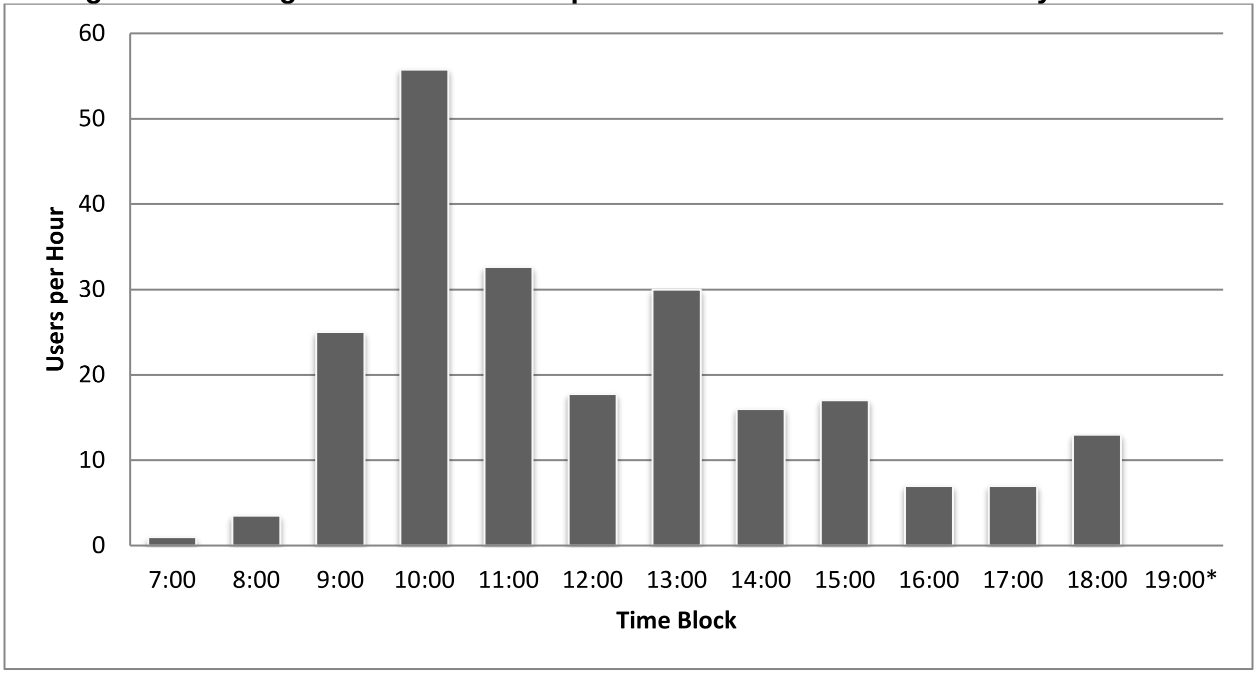
Table 6. Observed Recreation Activities at Powell Falls Kayak Launch Survey Area

Rank	Recreation Activity	Users Observed	Users Per Hour
1	Canoeing/Kayaking	458	15.80
2	Walking/Running	116	4.00
3	Fly Fishing	38	1.31
4	Dog Walking	33	1.14
5	Fishing from Shore	22	0.76
6	Biking	17	0.59
7	Swimming	9	0.31
8	Sightseeing	5	0.17
9	Scout River for Fishing	3	0.10
10	Photography	2	0.07
-	All Activities (Total)	703	24.2

The rate of recreation activity by time of day for the Powell Falls Kayak Launch survey area is shown in Figure 7. The highest number of recreation users were observed in the survey area during mid- to late-morning. The kayak outfitters who provide kayak rentals and rides for people who want to kayak the lower Kinnickinnic River typically met clients at the kayak launch between 10 a.m. and 12 p.m. to offload kayaks, further bolstering this pattern of activity (Photograph 15). The number of recreation users observed per hour during weekends (37.2) was 2.7 times greater than the number of users observed per hour on weekdays (13.75).

Photograph 15. Kayak outfitter parked at the Powell Falls staging area, facing south.

Figure 7. Average Recreation Users per Time Block at Powell Falls Kayak Launch



* No spot counts conducted during this time block.

Recreation use by type of day (i.e., weekday, weekend, holiday) for Powell Falls Kayak Launch is presented in Table 7.

Table 7. Recreation Users by Type of Day (Powell Falls Kayak Launch)

Type of Day	Total Recreation Users	Recreation Users per Hour
Weekday	217	15.5
Weekend	367	33.4
Holiday	119	29.8

4.2.2.2 Parking

Similar to the considerations of parking discussed above for Glen Park Trails (Section 4.2.1.2), parking for the Powell Falls Kayak Launch survey area is difficult to separate from parking for Glen Park as well as other purposes, due to the immediate proximity of the kayak staging area to Glen Park. Many people utilizing Powell Falls, particularly on weekends, park in the Glen Park parking lot. It was not possible to ascertain upon arrival at the survey area whether many of the cars parked there were from people using Glen Park or the kayak launch. For this reason, a measure of recreation use by parking activity was attempted by recording the number of vehicles either using the temporary 15-minute kayak loading zone parking or that had parked immediately east of the loading zone on West Park Street or immediately south of the loading zone on Bartosh Lane. The resulting number of vehicles observed per hour during weekends (12.0) was 6.45 times greater than the number of users observed per hour on weekdays (1.86). This number represents the propensity of people to utilize the street parking on busier weekend days when the Glen Park parking lot was more occupied. It should be noted that the Glen Park parking lot was never observed to be completely full.

4.2.3 White Kinnickinnic Pathway

4.2.3.1 Recreation Activities

A total of 648 recreation users were observed at the White Kinnickinnic Pathway survey area over the course of 30 one-hour spot counts (Table 8). White Kinnickinnic Pathway was a popular destination for walking, dog walking, biking, and skateboarding/rollerblading due to the smooth paved walkway and proximity to neighborhoods and downtown River Falls. Recreation users partaking in these activities were often observed crossing the Winter Street bridge and continuing east on the sidewalk towards the downtown or University of River Falls campus.

Table 8. Observed Recreation Activities at White Kinnickinnic Pathway Survey Area

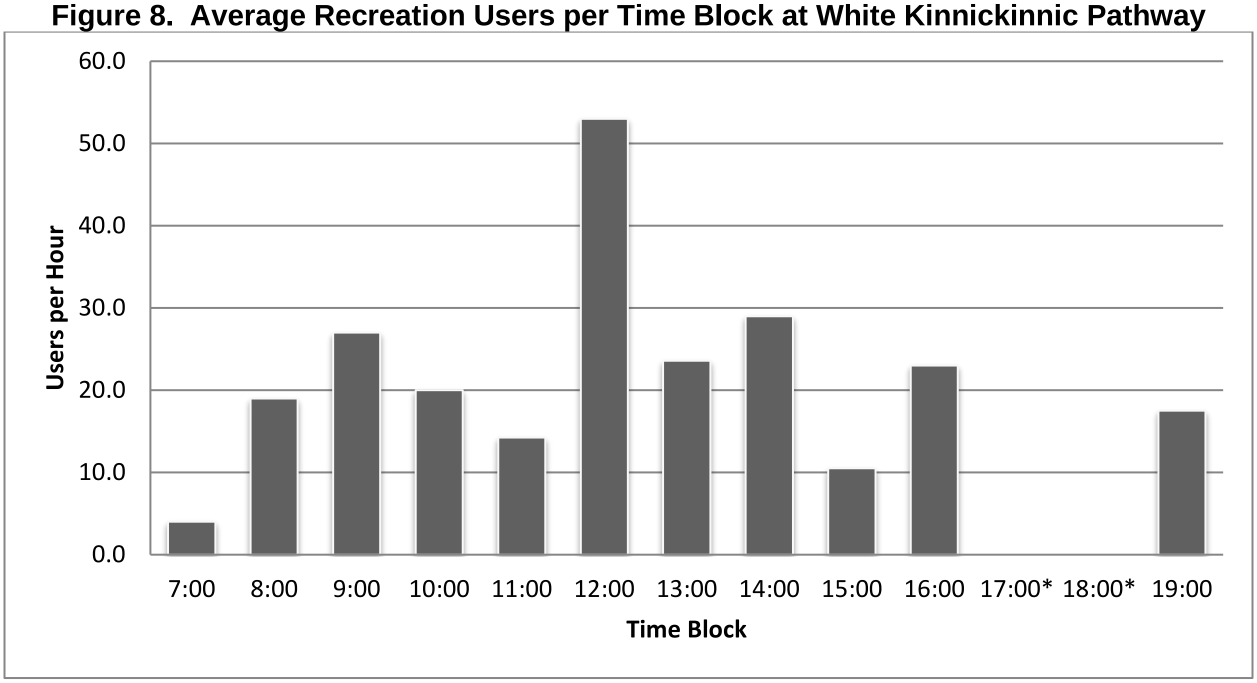
Rank	Recreation Activity	Users Observed	Users Per Hour
1	Walking/Running	288	9.60
2	Biking	132	4.40
3	Looking at Dam/Flooding	92	3.07
4	Dog Walking	80	2.67
5	Canoeing/Kayaking	25	0.83
6	Skateboarding/Rollerblading	9	0.30
7	Birding/Nature Observing	8	0.27
8	Fishing from Shore	5	0.17
9	Picnicking	4	0.13
10	Berry-picking	3	0.10
11	Sightseeing	1	0.03
12	Photography	1	0.03
-	All Activities (Total)	648	21.6

Two “Other” or custom categories were established for this survey area. “Berry-picking” was noted as a unique category as a family of three were observed specifically coming to the survey area to collect wild raspberries (confirmed by pers. comm.). “Looking at Dam/Flooding” was an event-specific category that was created after more than 7 inches of rainfall were received in River Falls over the course of one day. The day after the rain event, flood conditions were present along the river and impoundments, and many people came specifically to Junction Falls Dam to view the extent of the flooding (Photograph 16). This category was defined as the number of people that came and viewed the dam from an outlook between the dam and the municipal power plant (see the far southwestern corner of the survey area on Figure 5). Though an event such as this is infrequent, it is notable as an attraction that draws people to the survey area.

Photograph 16. People viewing flooding at Junction Falls Dam, facing southwest (June 29, 2020).

The usage rates per time block were fairly evenly distributed between morning and afternoon. Likely, people of different age classes and working statuses (e.g., retired vs. employed) utilized the pathway at different times dependent on their schedule. Note that the high usage rate during the 12:00 time block is due to incorporation of the "Looking at Dam/Flooding" data which were recorded during a unique event that only occurred once during the assessment period. Six of the 11 time blocks had usage rates between 17 and 27 users per hour.

Figure 8. Average Recreation Users per Time Block at White Kinnickinnic Pathway



* No spot counts conducted during this time block.

Recreation use by type of day (i.e., weekday, weekend, holiday) for White Kinnickinnic Pathway is presented in Table 9.

Table 9. Recreation Users by Type of Day (White Kinnickinnic Pathway)

Type of Day	Total Recreation Users	Recreation Users per Hour
Weekday	342	26.3
Weekend	242	18.6
Holiday	64	16.0

4.2.3.2 Parking

Measurements of parking for the White Kinnickinnic Pathway survey area were taken by documenting the number of vehicles parked in or arriving at the small parking lot just north of Winter Street and west of the river. This parking area is utilized almost entirely by people who are visiting the White Kinnickinnic Pathway survey area, including people who are staging a vehicle for a kayak trip on the upper Kinnickinnic River (note that this is a different kayak trip from the lower Kinnickinnic River trip associated with the Powell Falls Kayak Launch survey area). The parking rate for the White Kinnickinnic Pathway survey area was greater during the week (4.27 vehicles per hour) than on weekends (2.33 vehicles per hour). This is the only survey area for which the weekday parking rate exceeded the weekend parking rate. The parking lot was observed to be completely full (i.e., over capacity) only once over the course of 30 one-hour spot counts.

4.2.4 Spot Count Data for Entire Project Area

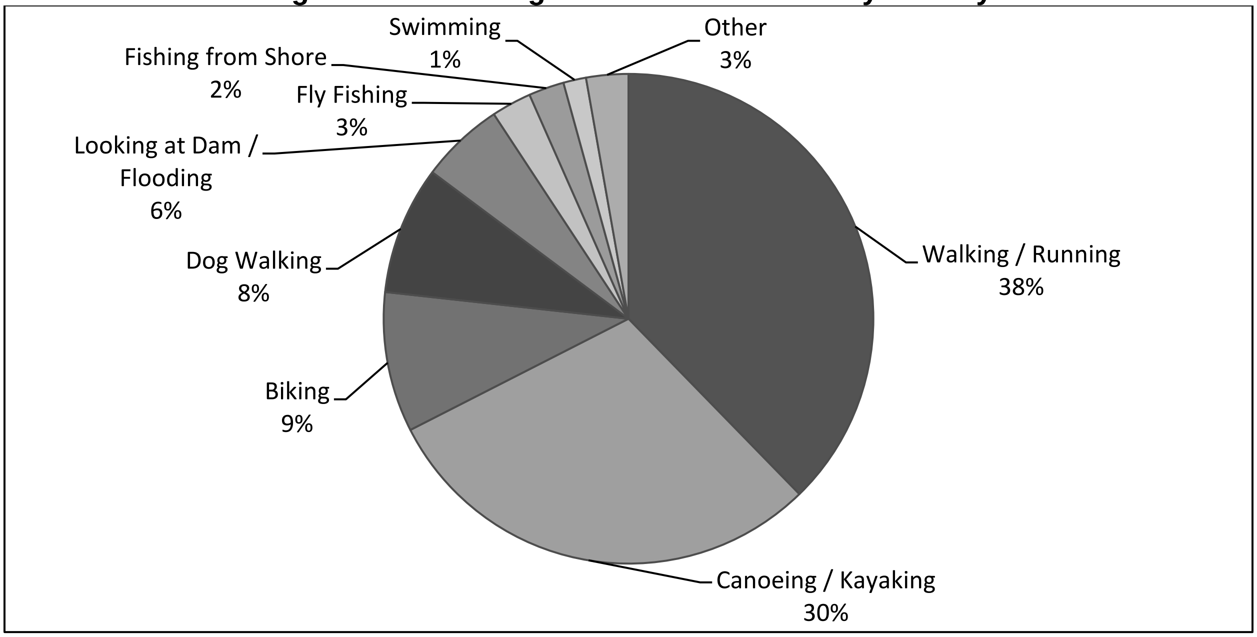
Rates of recreation use by activity across all three survey areas (i.e., the entire Project Area) are presented in Table 10. The highest rates of recreation use occurred for activities generally associated with outdoor city recreation (e.g., walking, dog walking, biking) and activities for which the Kinnickinnic River has a reputation for (kayaking and trout fishing).

Table 10. Observed Recreation Activities in Project Area

Rank	Recreation Activity	Users Observed	Users Per Hour
1	Walking/Running	628	6.98
2	Canoeing/Kayaking	485	5.39
3	Biking	154	1.71
4	Dog Walking	141	1.57
5	Looking at Flooding/Dam	92	1.02
6	Fly Fishing	44	0.49
7	Fishing from Shore	39	0.43
8	Swimming	25	0.28
9	Skateboarding/Rollerblading	9	0.10
10	Photography	8	0.09
11	Birding/Nature Observing	8	0.09
12	Picnicking	7	0.08
13	Sightseeing	6	0.07
14	Scout River for Fishing	3	0.03
15	Berry-picking	3	0.03
16	Flying a Drone	2	0.02
-	All Activities (Total)	1,654	18.4

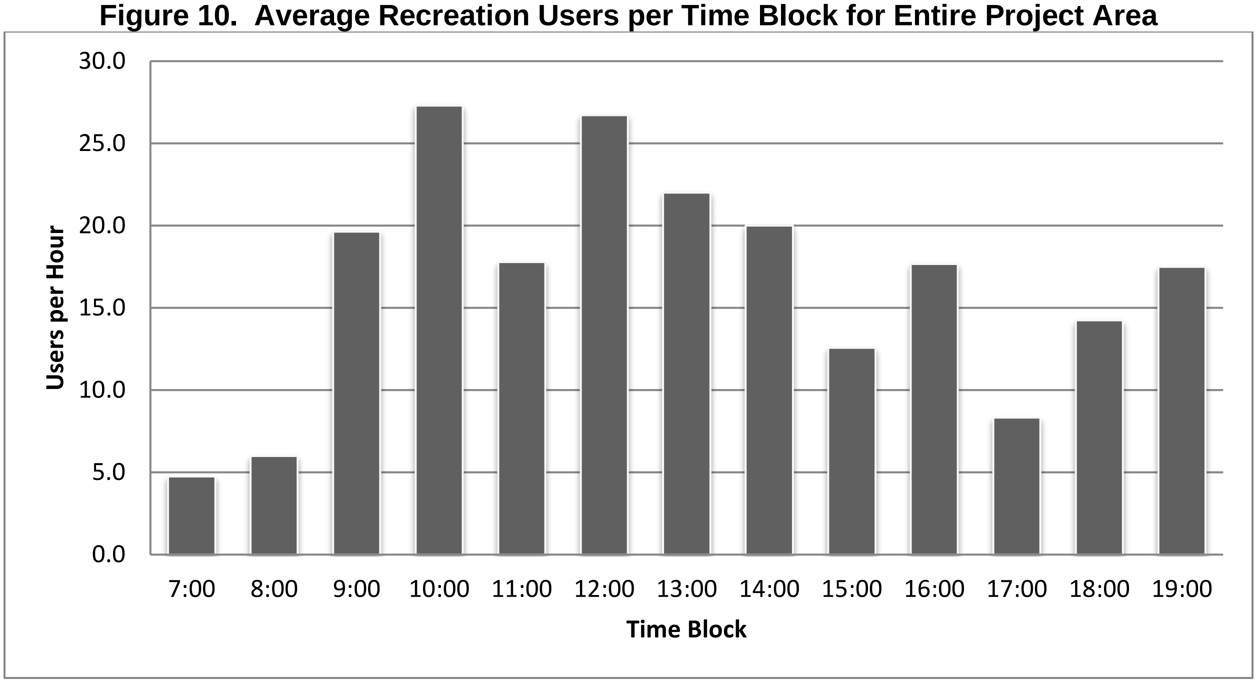
Figure 9 presents the percentage of total recreation activity for each activity that was observed occurring within the Project Area.

Figure 9. Percentage of Total Recreation by Activity



The average number of recreation users per hour (i.e., per time block) are presented in Figure 10. The highest usage rate in the Project Area occurred during mid- to late-morning and early afternoon, while the lowest usage rates occurred in the early morning hours.

Figure 10. Average Recreation Users per Time Block for Entire Project Area



* No spot counts conducted during this time block.

Recreation use by type of day (i.e., weekday, weekend, holiday) for the entire Project Area is presented in Table 11.

Table 11. Recreation Users by Type of Day (Project Area)

Type of Day	Total Recreation Users	Recreation Users per Hour
Weekday	686	16.7
Weekend	762	20.6
Holiday	206	17.2
All Days	1654	18.4

4.3 User Surveys

In-person recreation user surveys were solicited from people within all three survey areas all 15 days in which surveys occurred. A total of 112 people took an in-person survey out of 163 people asked to take the survey, resulting in an acceptance rate of 68.7 percent. Table 12 provides a breakdown of user surveys taken and solicited per day during the recreation use assessment. Completed user surveys can be found in Appendix A of this report.

Table 12. User Surveys Completed and Acceptance Rate

Date	Day	Yes	No
6/27/2020	Saturday	7	1
6/28/2020	Sunday	8	3
6/29/2020	Monday	7	2
6/30/2020	Tuesday	6	5
7/2/2020	Thursday	8	7
7/3/2020	Friday	10	3
7/4/2020	Saturday	10	0
7/5/2020	Sunday	7	2
7/6/2020	Monday	3	1
8/1/2020	Saturday	9	2
8/2/2020	Sunday	8	5
8/3/2020	Monday	8	3
8/4/2020	Tuesday	4	3
9/6/2020	Sunday	12	13
9/7/2020	Monday	5	1
Total (15 days)		**112**	**51**
Acceptance Rate (112/163)		**68.7 percent (%)**	

4.3.1 User Survey Data for Entire Project Area

The demographics of individuals who took the in-person survey, based on a limited number of questions at the beginning of the survey, are presented in Table 13. The majority of respondents were adults who were familiar with the Project Area. Approximately two-thirds of respondents lived in River Falls and numerous others lived in an adjacent zip code (Table 14). Visitors from Minnesota (particularly the Twin Cities area) were most often encountered at the Powell Falls Kayak Launch survey area. Twenty-two percent of respondents did not use a vehicle to access the Project Area. The survey area with the most visitors during spot counts (Powell Falls) was also the survey area with the most user survey respondents. The Glen Park Trails survey area had the least number of both visitors and survey respondents of the three survey areas.

Table 13. Demographics of Survey Respondents

Participated in recreation survey before?		Over 18?		Gender		How many in group?	
Yes	12.7%	Yes	98.3%	Male	44.1%	1-2	70.3%
No	87.3%	No	1.7%	Female	55.9%	3+	29.7%
Vehicle(s)?		**Resident of River Falls?**		**Ever visited Project Area before?**		**Survey Area observed in:**	
Yes	78%	Yes	62.7%	Yes	92.4%	GPT[1]	27.1%
No	22%	No	37.3%	No	7.6%	PFKL	42.4%
						WKP	30.5%

[1] Survey Areas: GPT = Glen Park Trails; PFKL = Powell Falls Kayak Launch; WKP = White Kinnickinnic Pathway

Table 14. Zip Code of Residence for Respondents

Zip Code	City	County	State	Number of Respondents
54022	River Falls	Pierce	Wisconsin	67
54016	Hudson	St. Croix	Wisconsin	3
55082	Stillwater/Oak Park	Washington	Minnesota	3
55125	St. Paul	Washington	Minnesota	3
54021	Prescott	Pierce	Wisconsin	2
54003	Beldenville	Pierce	Wisconsin	2
55124	n/a	Dakota	Minnesota	2
55303	Oak Grove	Anoka	Minnesota	2
55345	Minnetonka	Hennepin	Minnesota	2
54011, 54017, 53545, 52246, 52044, 33955, 54027, 54106, 54220, 54742, 54772, 54901, 55014, 55016, 55044, 55056, 55101, 55102, 55104, 55106, 55109, 55110, 55112, 55119, 55129, 55379, 55413, 55414, 55416, 55430, 58072, 75212				1

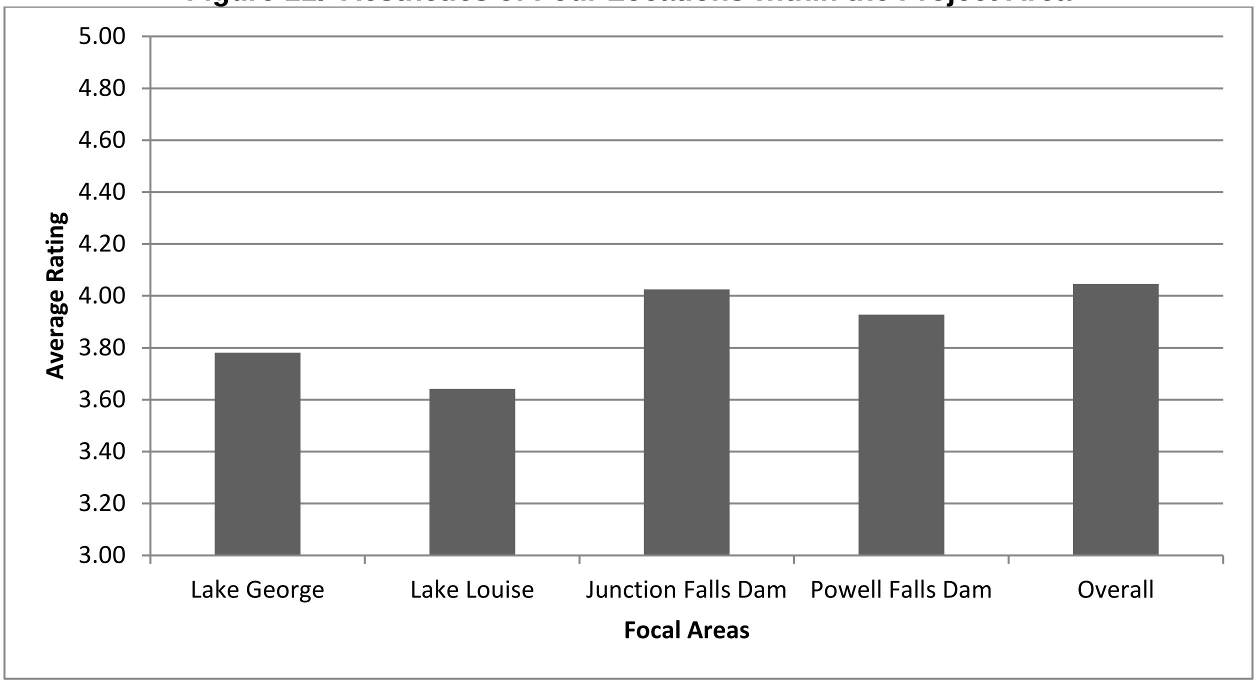
The zip code of residence for user survey respondents is provided for future recreation use projections. Only those zip codes that were recorded from multiple respondents have been provided further locational information.

The average respondent visited the Project Area 76.1 times per year, which can alternatively be described as once or twice per week. This mean average included nine respondents who had never been to the Project Area before (i.e., 0 times per year) and nine respondents who said that they visit the Project Area at least once per day (i.e., 365 or more visits per year). The most common response to this question was one time per year (14 of 118 respondents).

Respondents were asked to rate the aesthetics (i.e., quality of scenic views) at four locations within the Project Area: Lake George, Lake Louise, Junction Falls Dam, and Powell Falls Dam. The lowest value (1) indicated "Not Satisfied at All" while the highest value (5) indicated "Extremely Satisfied". If a respondent was not familiar with one of the four locations being rated, it was crossed out and assigned a value of "n/a". The average ratings of aesthetics for the four focal locations as well as an overall rating are shown in Figure 11. When asked to explain poor ratings for overall aesthetic quality at the Project Area, respondents typically noted that neither lake is attractive, and that it would be more aesthetically pleasing with the original waterfalls.

At the end of the survey (Question #21), respondents were given the opportunity to provide general, open-ended comments on recreation opportunities within the Project Area. Common responses included support for dam removal, support for preserving the dam(s), requests for more clean-up/maintenance, requests for improved accessibility (i.e., for the old, young, and disabled), complaints about too many tourists, and adding additional restrooms or other assorted amenities such as dog waste bags. Many respondents expressed contentment with the Project Area and stated that it should be kept the way it is. Further, some respondents stated that certain aspects of the Project Area such as the difficult access to Powell Falls Kayak Launch are beneficial because it reduces the amount of people in the Project Area. See Appendix A for the complete set of user survey responses.

Figure 11. Aesthetics of Four Locations within the Project Area



Additional results from user surveys are broken down by survey area below.

4.3.2 Glen Park Trails

A total of 32 participants responded to the user survey within the Glen Park Trails survey area. Select demographics for Glen Park Trails are presented in Table 15.

Table 15. Demographics of Glen Park Trails Respondents

Participated in recreation survey before?		Gender		How many in group?	
Yes	6.3%	Male	40.6%	1-2	84.4%
No	93.7%	Female	59.4%	3+	15.6%
Vehicle(s)?		**Resident of River Falls?**		**Ever visited Project Area before?**	
Yes	65.6%	Yes	68.8%	Yes	93.7%
No	34.4%	No	31.2%	No	6.3%

Respondents were asked to list which activities they partook in within the Project Area in addition to the primary activity for which they were participating in that day. This included listing each season (spring, summer, winter, fall) in which the respondent partook in that activity. The results for this survey question are shown in Table 16. The most common activities in which respondents participated at Glen Park Trails were walking and dog walking, followed by bicycle riding and photography. Note that the number for "Total of All Activities" may not equal the number of user surveys recorded in each survey area since respondents could mark multiple activities under the "This Trip" column for this question.

Table 16. User Survey Activities by Season (Glen Park Trails)

Activity	This Trip	Spring	Summer	Fall	Winter
Biking	2	14	18	14	5
Birding	2	11	13	12	4
Kayaking	-	2	4	2	-
Dog Walking	7	21	22	21	16
Fishing from Shore	4	6	7	5	1
Fly Fishing	1	3	2	2	1
Ice Fishing	-	-	-	-	-
Paddle Boarding/Tubing	-	-	-	-	-
Photography	2	13	14	13	9
Picnicking	-	-	3	-	-
Walking	17	36	45	36	19
Sightseeing	-	11	12	11	6
Cross-country Skiing	-	-	-	-	-
Sunbathing	-	-	-	-	-
Swimming	2	-	7	-	-
Flying a Drone	1	1	1	1	1
Fishing from Boat	-	1	1	1	1
Total of All Activities	**38**	**119**	**149**	**118**	**63**

A separate question asked the respondent to state their primary activity that day. The majority of people questioned at Glen Park Trails were either walking or dog walking (Table 17).

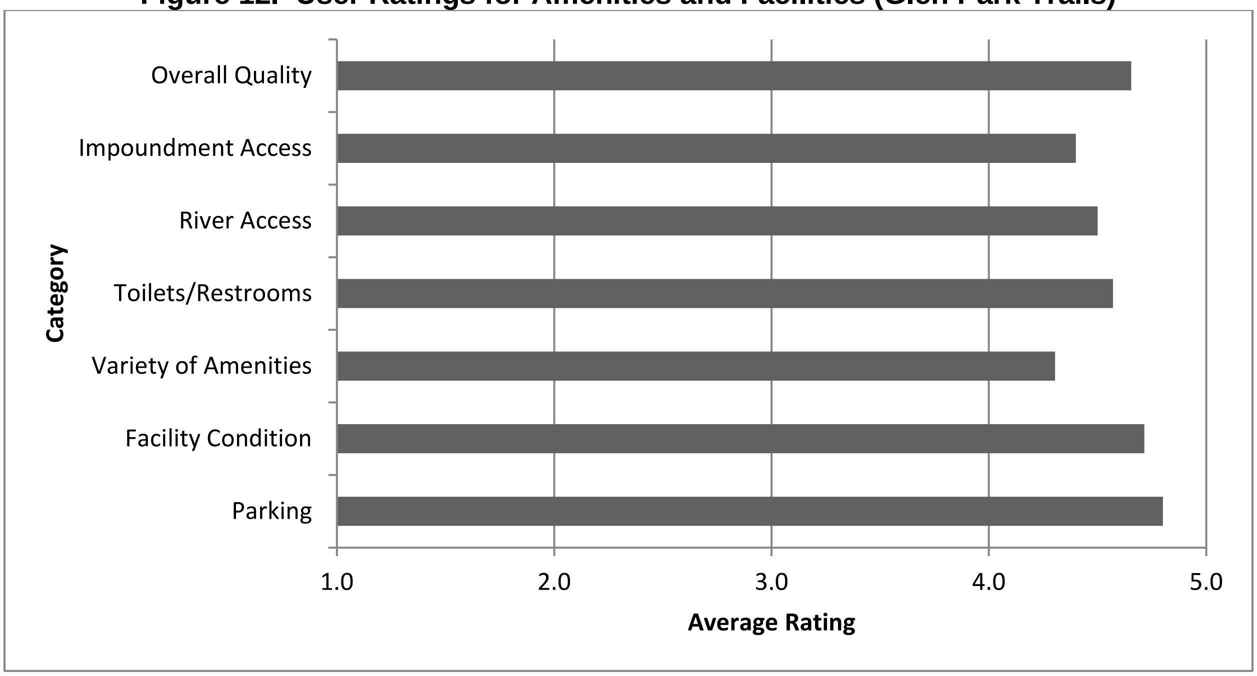
Table 17. User Survey Primary Activity at Glen Park Trails

Primary Activity	Number of Responses	Percent Total
Walking	15	47%
Dogwalking	5	16%
Fishing from shore	4	13%
Swimming	2	6%
Biking	1	3%
Bird watching	1	3%
Fly fishing	1	3%
Flying a Drone	1	3%
Kayaking	1	3%
Photography	1	3%
Total Responses	**32**	**-**

Respondents were then asked to rate particular amenities, aspects, or opportunities presented by the survey area. Ratings were given a numerical value of 1 to 5 with the definition for each number varying by survey question. Generally, a rating of 1 indicates “No Value”, “Poor”, or “Not Satisfied at All”, while a rating of 5 indicates “High Value”, “Excellent”, or “Extremely Satisfied”.

When asked to rate satisfaction with the available number of recreation facilities (Question #11), respondents gave an average answer of 4.3 (Moderately to Extremely Satisfied). Further ratings regarding the condition of amenities available in the Glen Park Trails survey area are summarized in Figure 12. A value of 1 corresponded to a rating of “Poor” for each question, while a 3 was “Fair” and a 5 was “Excellent”. Overall, responses to the condition of amenities available at Glen Park Trails were positive, with no average rating being less than 4.3. It should be noted that although Glen Park is outside of the survey area, people often would consider the amenities in the park while providing ratings. For example, some respondents stated that although there is not a restroom within the survey area, the close proximity of the Glen Park restrooms was acceptable. Respondents were given the option to reply Not Applicable (n/a), but many respondents still rated the amenities (i.e., restrooms) even though they were not present in the Project Area.

Figure 12. User Ratings for Amenities and Facilities (Glen Park Trails)



Additionally, respondents rated the Glen Park Trails survey area as an “Excellent” public recreation opportunity (4.6 out of 5). The survey area was rated for busyness at the time of visit from a 1 (“Not Crowded”) to a 5 (“Extremely Crowded”) and received an average rating of 2.6 (somewhat to minimally crowded). All respondents (100 percent) replied that the Glen Park Trails survey area serves their interests regarding recreation and that they would return to the area again for recreation purposes. Fifty-three percent of respondents at Glen Park Trails stated they were aware of a scenic view of value to the Project Area, with common answers including Foster’s Cemetery, both dams, and the Swinging Bridge. It should be noted that Foster’s Cemetery and the Swinging Bridge are located nearby but outside of the Project Area.

4.3.3 Powell Falls Kayak Launch

A total of 50 participants responded to the user survey within the Powell Falls Kayak Launch survey area. Select demographics for Powell Falls Kayak Launch are presented in Table 18.

Table 18. Demographics of Powell Falls Kayak Launch Respondents

Participated in recreation survey before?		Gender		How many in group?	
Yes	16%	Male	58%	1-2	62%
No	84%	Female	42%	3+	38%
Vehicle(s)?		**Resident of River Falls?**		**Ever visited Project Area before?**	
Yes	90%	Yes	48%	Yes	88%
No	10%	No	52%	No	12%

The results of the activity chart by season for the Powell Falls Kayak Launch survey area are shown in Table 19. Similar to spot count data, the results of the user survey activity question show that the Powell Falls Kayak Launch survey area is the predominate location for kayaking in the Project Area. It is also a popular destination for fly fishing and fishing from shore.

Table 19. User Survey Activities by Season (Powell Falls Kayak Launch)

Activity	This Trip	Spring	Summer	Fall	Winter
Biking	1	12	16	12	5
Birding	-	10	11	10	4
Kayaking	31	25	57	24	4
Dog Walking	7	26	27	25	19
Fishing from Shore	1	5	6	6	1
Fly Fishing	3	4	7	4	1
Ice Fishing	-	-	-	-	-
Paddle Boarding/Tubing	-	-	1	-	-
Photography	1	13	14	12	9
Picnicking	1	3	8	3	-
Walking	10	31	41	31	15
Sightseeing	1	11	13	12	6
Cross-country Skiing	-	-	-	-	1
Sunbathing	-	-	-	-	-
Swimming	-	3	15	12	-
Flying a Drone	-	1	1	1	1
Fishing from Boat	-	1	1	1	1
Snowshoeing	-	-	-	-	2
Total for All Activities	**56**	**145**	**218**	**153**	**69**

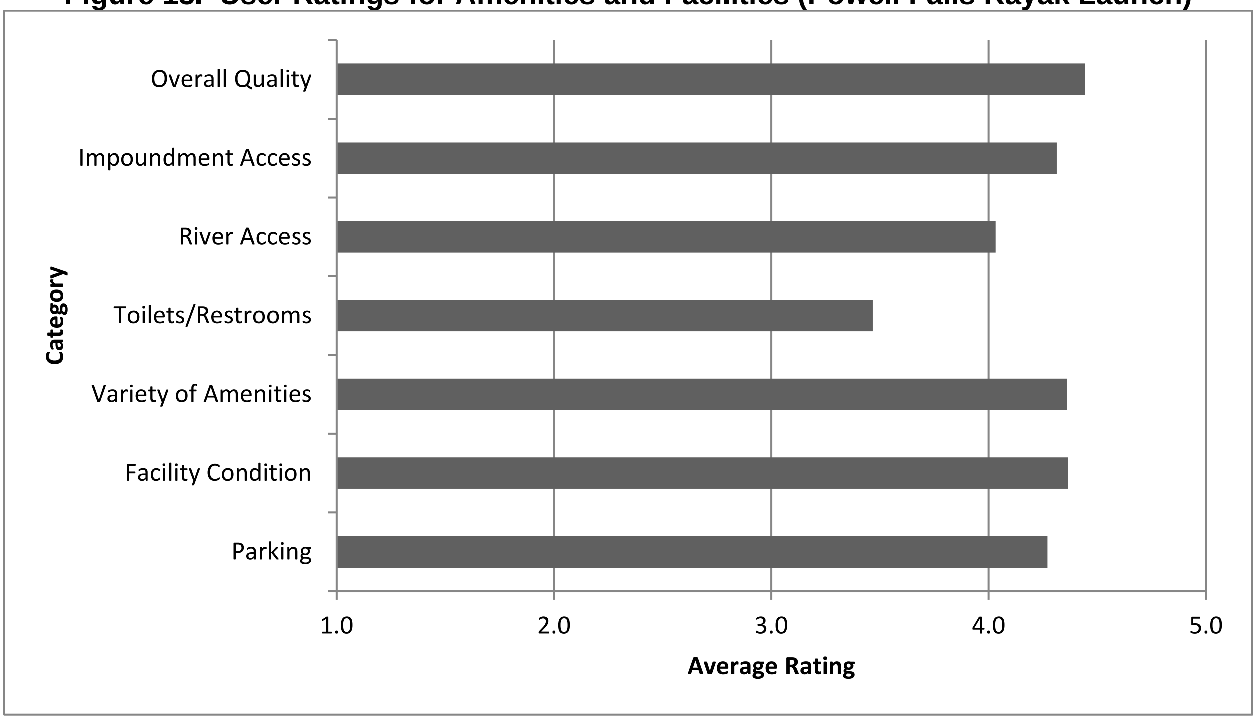
The predominate activity of recreation users interviewed at Powell Falls Kayak Launch survey area was canoeing or kayaking, including those people who had rented a kayak from one of the outfitters that work in the area (Table 20). Other people commonly used the trails that pass through the Powell Falls Kayak Launch survey area as walking paths.

Table 20. User Survey Primary Activity at Powell Falls Kayak Launch

Primary Activity	Number of Responses	Percent Total
Canoeing/Kayaking	25	54%
Dogwalking	7	15%
Walking	7	15%
Fly fishing	4	9%
Biking	1	2%
Fishing from shore	1	2%
Photography	1	2%
Total Responses	46	-

When asked to rate satisfaction with the available number of recreation facilities (Question #11), respondents gave an average answer of 4.3 (Moderately to Extremely Satisfied). Further ratings regarding the condition of amenities available in the Powell Falls Kayak Launch survey area are summarized in Figure 13. A moderate average score (3.5) for Toilets/Restrooms was received for the Powell Falls Kayak Launch survey area, likely due to peoples' unfamiliarity with the location of restrooms in Glen Park that are nearby but outside of the Project Area (i.e., short walking distance). Recommendations included adding a portable latrine to the kayak staging area.

Figure 13. User Ratings for Amenities and Facilities (Powell Falls Kayak Launch)



Additionally, respondents rated the Powell Falls Kayak Launch survey area as an "Excellent" public recreation opportunity (4.6 out of 5). The survey area was rated for busyness at the time of visit from a 1 ("Not Crowded") to a 5 ("Extremely Crowded") and received an average rating of 2.7 (somewhat to minimally crowded). Ninety-eight percent of respondents stated that they would return to the Powell Falls Kayak Launch survey area again for recreation purposes, while 100 percent of respondents stated that the survey area serves its purpose as a recreation opportunity. Forty-six percent of respondents at Powell Falls stated they were aware of a scenic view of value to the Project Area, with common answers including "the whole river", the dams, the waterfalls, and the Swinging Bridge.

4.3.4 White Kinnickinnic Pathway

A total of 36 participants responded to the user survey within the White Kinnickinnic Pathway survey area. Select demographics for White Kinnickinnic Pathway are presented in Table 21.

Table 21. Demographics of White Kinnickinnic Pathway Respondents

Participated in recreation survey before?		Gender		How many in group?	
Yes	13.9%	Male	27.8%	1-2	69.4%
No	86.1%	Female	72.2%	3+	30.6%
Vehicle(s)?		**Resident of River Falls?**		**Ever visited Project Area before?**	
Yes	27.8%	Yes	77.8%	Yes	97.2%
No	72.2%	No	22.2%	No	2.8%

The results of the activity chart by season for the White Kinnickinnic Pathway survey area are shown in Table 22. Based on survey results, White Kinnickinnic Pathway is most commonly used for walking, dog walking, and bicycle riding.

Table 22. User Survey Activities by Season (White Kinnickinnic Pathway)

Activity	This Trip	Spring	Summer	Fall	Winter
Biking	1	21	26	20	6
Birding	10	15	22	24	6
Kayaking	3	6	10	6	-
Dog Walking	10	29	32	28	22
Fishing from Shore	1	4	5	4	1
Fly Fishing	-	2	2	2	1
Ice Fishing	-	-	-	-	-
Paddle Boarding/Tubing	-	-	-	-	-
Photography	2	13	14	12	9
Picnicking	1	4	12	2	-
Walking	19	46	59	43	23
Sightseeing	4	15	18	15	8
Cross-country Skiing	-	-	-	-	1
Sunbathing	-	-	-	-	-
Swimming	-	-	4	-	-
Flying a Drone	-	1	1	1	-
Fishing from Boat	-	1	2	1	1
Berry-picking	1	-	1	-	-
Snowshoeing	-	-	-	-	2
Meditation	-	1	1	1	-
Public Events	-	1	1	-	-
Skateboarding	-	1	1	1	-
Total for All Activities	**52**	**160**	**211**	**160**	**80**

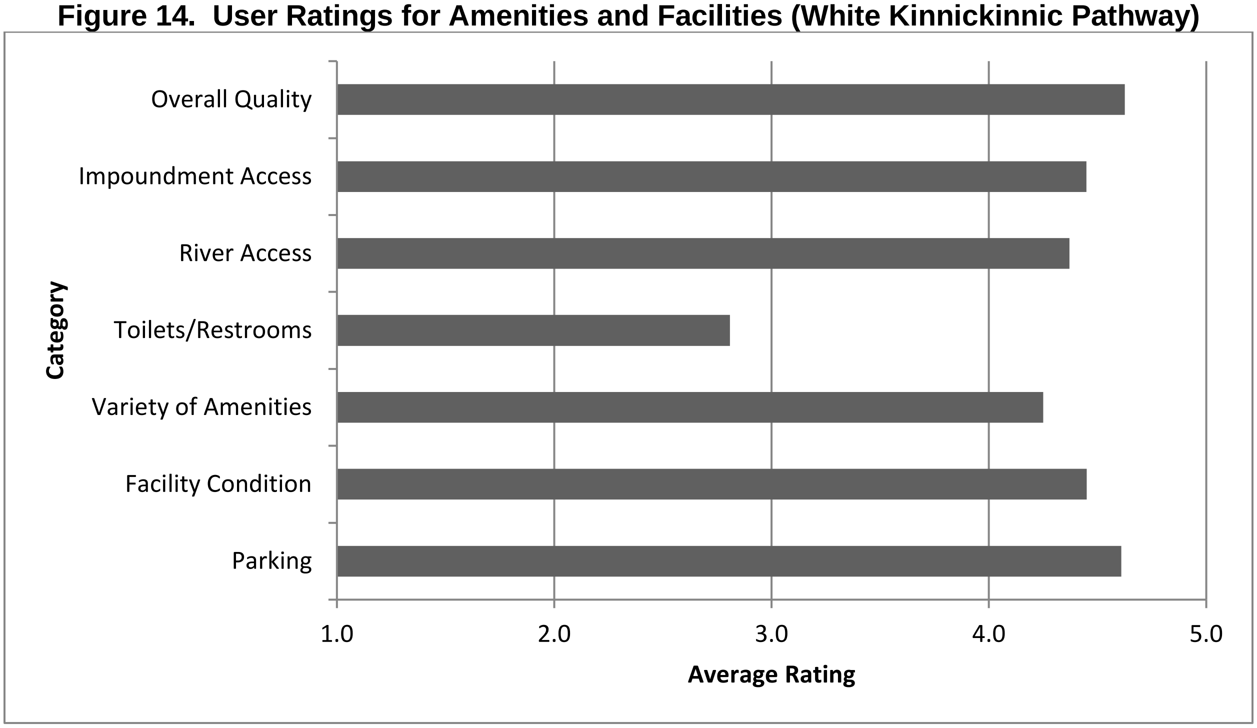
The most common primary recreation activities at the White Kinnickinnic Pathway survey area were walking and dog walking (Table 23). Respondents used White Kinnickinnic Pathway more commonly than the other two survey areas for activities such as nature observing, photography, and sightseeing.

Table 23. User Survey Primary Activity at White Kinnickinnic Pathway

Primary Activity	Number of Responses	Percent Total
Walking	14	39%
Dog Walking	8	22%
Canoeing/Kayaking	4	11%
Nature Observing	2	6%
Photography	2	6%
Sightseeing	2	6%
Berry-picking	1	3%
Biking	1	3%
Fishing from Shore	1	3%
Picnicking	1	3%
Total Responses	**36**	**-**

When asked to rate satisfaction with the available number of recreation facilities (Question #11), respondents gave an average answer of 4.1 (Moderately to Extremely Satisfied). Further ratings regarding the condition of amenities available at the White Kinnickinnic Pathway survey area are summarized in Figure 14. A below average score for the condition of Toilets/Restrooms was received for the White Kinnickinnic Pathway survey area (2.8 out of 5). Ratings for all other questions regarding amenities were favorable (>4 out of 5). People consistently noted the ease of parking either at the small Winter Street Parking Lot or the larger Heritage Park parking lot in order to access White Kinnickinnic Pathway.

Figure 14. User Ratings for Amenities and Facilities (White Kinnickinnic Pathway)



Respondents rated the White Kinnickinnic Pathway survey area as an "Excellent" public recreation opportunity (4.5 out of 5). The survey area was rated for busyness at the time of visit from a 1 ("Not Crowded") to a 5 ("Extremely Crowded") and received an average rating of 2.2 (somewhat to minimally crowded). All respondents (100 percent) replied that the White Kinnickinnic Pathway survey area serves their interests regarding recreation and that they would return to the area again for recreation purposes. Forty-seven percent of respondents at White Kinnickinnic Pathway stated they were aware of at least one scenic view of value to the Project Area, with common answers including the Swinging Bridge and Foster Cemetery.

5.0 DISCUSSION

5.1 Glen Park Trails

As a recreation area, the Glen Park Trails survey area offers opportunities for access to Junction Falls Dam, Lake Louise, and a portion of the river which is relatively undisturbed (the South Fork Kinnickinnic River). The impoundment of Lake Louise has created lake-like conditions, including wetlands along the shoreline. These conditions are different from natural river conditions. The impoundment provides habitat for certain animals (e.g., waterfowl) that otherwise would be less likely to inhabit the area. Conversely, the impoundment prevents sediment movement, raises water temperatures, and blocks the passage of aquatic animals up and down the river (Inter-Fluve 2016, Inter-Fluve 2017). These effects provide certain recreation opportunities while also taking away other opportunities. For example, the conditions in Lake Louise (and Lake George) are not ideal for trout species and thus fishermen, particularly fly fishermen, will likely go down river in search of trout. Additionally, the warmer, shallower water and backdrop of Junction Falls Dam provides an attractive location for swimmers and families to explore the water's edge.

In general, fewer people are aware of Lake Louise; only 60 out of 118 people who were asked to rate the aesthetic quality of the impoundment were aware of its location. This percentage was less than the number of responses for the other three locations rated for aesthetics. There is not a clear view of the impoundment from the busier areas of Glen Park, which is positioned at a higher elevation above the impoundment. During recreation surveys, no one was observed on the northeast bank of Lake Louise where the Glen Park Trails lead to the water's edge. In comparison, people were often observed exploring the South Fork Kinnickinnic River such as the area underneath the Swinging Bridge. Similar to Lake George, the build-up of algae and aquatic vegetation makes the impoundments less attractive to visitors. These factors limit the potential for Lake Louise to play a bigger role as an attractive recreation feature for the City of River Falls. Further, the general recreation opportunities provided by Lake Louise are all available within the White Kinnickinnic Pathway survey area in a similar form.

5.2 Powell Falls Kayak Launch

The Powell Falls Kayak Launch survey area is first and foremost a staging point for the popular kayak trip on the lower Kinnickinnic River. There are no formally designated public kayak launch points downstream from Powell Falls and both the Powell Falls Dam and Junction Falls Dam block kayakers traveling on the upper Kinnickinnic River from accessing the lower portion of the river. Powell Falls Dam provides some aesthetic attraction for most people (rating of 3.93 out of 5) and may also attract fishermen, but it creates no further recreation opportunities downstream from the dam. Many of the kayakers that visit from out of town were not familiar with Lake Louise or Lake George and are drawn entirely by the opportunity for kayaking or canoeing on the Kinnickinnic River.

The removal of Powell Falls Dam could induce some changes to the Powell Falls Kayak Launch survey area. For example, if a more convenient location for launching kayaks was established, such as the confluence of the South Fork Kinnickinnic River and main channel of the Kinnickinnic River (approximately 0.25 miles further north), people may cease to use the Powell Falls survey area as a kayak launch point. The trails would still be used by residents who spend time walking, biking, or sightseeing in the natural areas along the river. Conversely, if waterfalls remain present behind Powell Falls Dam, the Powell Falls Kayak Launch may become even busier as both a kayak launch point and a sightseeing opportunity.

Further, there are concerns at the Powell Falls Kayak Launch survey area regarding its attractiveness to visitors from outside of the county. Certain residents commented that the river gets too busy on weekends because of all the kayakers. Three kayak outfitters, including one who operates partly out of Minnesota, bring further traffic to the river through their business. While some respondents requested certain amenities be installed in the survey area, such as restrooms and an improved path to the river, other respondents preferred the current lack of development which may deter some people from visiting.

5.3 White Kinnickinnic Pathway

The system of trails and amenities found in the public use areas around Lake George, including White Kinnickinnic Pathway, were very popular with respondents during the recreation use assessment. With the exception of accessibility to toilets/restrooms, ratings of amenities were all above average to excellent (>4 out of 5). The White Kinnickinnic Pathway survey area received a rating of 4.5 out of 5 as a public recreation opportunity, and 100 percent of the respondents stated that the recreation area serves their interests and they would return to the area. The recreation amenities have been built around and integrated with Lake George, but in general the amenities are not dependent upon the impoundment.

Respondents, when asked to rate how busy the White Kinnickinnic Pathway survey area was, gave an average response of minimally crowded (2.2 out of 5). Overcrowding was never observed in the survey area. While some kayakers were observed sporadically coming from the upper Kinnickinnic River, the lower Kinnickinnic River kayak trip is the more well-known and popular destination. Thus, the demand for the kayak takeout on Lake George and the parking area north of Winter Street was never observed to be greater than the amenities' capacity to meet demand. Additionally, the White Kinnickinnic Pathway is well integrated with trails, paths, and sidewalks that branch out from Lake George in all directions, including along the river to the north, into the City of River Falls to the east and west, and south into Glen Park and the lower reaches of the river. Thus, there are many alternatives available for recreation users who are participating in walking/running, dog walking, biking, skateboarding/rollerblading, sightseeing, and photography. These alternatives ensure a minimal chance of future crowding along White Kinnickinnic Pathway.

5.4 Future Recreation Demand in the Project Area

One objective of this recreation use assessment is to provide an outlook regarding future demand for recreation within the Project Area. Specifically, an estimation of future demand for the length of the term of a new license (to 2050) is presented here. A pre-established alternative for representing user activity and future demand at a recreation area is the calculation of recreation days. A recreation day is defined by FERC as "each visit by a person to a development for recreational purposes during any portion of a 24-hour period" (FERC 2014). For the purposes of this report, recreation days will be calculated using per-hour observations of recreation activity and 13-hour days (i.e., daylight hours) to represent the period of use of the recreation areas. Further, recreation days will be calculated only for the "summer season", for which an extent of May 23 (Saturday of Memorial Day weekend) to September 7 (Labor Day) has been designated (108 total days). A calculation of total annual recreation days would require additional surveys during the spring, autumn, and winter seasons, as recreation use rates vary based on season. The formula for calculating recreation days is as follows:

Total Recreation Days = **([Average Weekday Users per Hour x 13 hours] x Number of Weekdays) + ([Average Weekend Users per Hour x 13 hours] x Number of Weekend Days) + ([Average Holiday Users per Hour x 13 hours] x Number of Holiday Days)**

For example, if an average of 8.0 users per hour on weekends were observed dog walking in Recreation Area "A" for a project, then that recreation area would have an average of 104 recreation days (8.0 users/hour * 13 hours) per day for that particular activity. If there were 104 weekend days for that particular study year, a calculation pf 10,816 recreation days for weekend dog walking in Recreation Area A would result.

In order to estimate future recreation demand at the Project Area (i.e., future estimated recreation days by activity), coefficients of projected population growth and recreation demand were obtained. Population growth projections were obtained for the River Falls area (zip code 54022) due to the majority of user surveys (67 of 188) reporting that the user resides in this zip code. Population growth projections from the State of Wisconsin Department of Administration (WI DOA) are shown in Table 24.

Table 24. Population Growth Estimates for River Falls, Wisconsin (Zip Code: 54022)

Year	2010	2020	2030	2040	2050[1]
Population	41,019	43,575	46,125	46,825	47,527
Estimated Growth	n/a	6.2%	5.9%	1.5%	1.5%
Population Growth Coefficient	n/a	1.062	1.059	1.015	1.015

Source: WI DOA 2020
[1] A projection was not provided for 2050; the growth projection for 2040 was repeated as an estimation.

In order to incorporate further variables into recreation use demand estimates, growth coefficients taken from the U.S. Forest Service's (USFS's) *Outdoor Recreation Trends and futures: A Technical Document Supporting the Forest Service 2010 RPA Assessment* (Cordell 2012). Per capita recreation growth coefficients were established in Cordell 2012 using a combination of variables, including income, age, gender, and ethnicity, in order to project national participation rates in recreation (Table 25).

Table 25. Per Capita Recreation Participation Growth Coefficients

Rank	Recreation Activity	2030	2040	2050
1	Walking/Running	1.023	1.038	1.056
2	Canoeing/Kayaking	0.914	0.896	0.891
3	Biking	1.001	1.014	1.038
4	Dog Walking	1.000	1.000	1.000
5	Looking at Dam/Flooding	1.000	1.000	1.000
6	Fly Fishing	0.948	0.927	0.910
7	Fishing from Shore	0.948	0.927	0.910
8	Swimming	1.013	1.024	1.040
9	Skateboarding/Rollerblading	1.000	1.000	1.000
10	Birding/Nature Observing	1.002	1.003	1.006
11	Photography	1.002	1.003	1.006
12	Picnicking	1.002	1.004	1.008
13	Sightseeing	1.002	1.003	1.006
14	Berry-picking	1.002	1.003	1.006
15	Scout River for Fishing	1.000	1.000	1.000
16	Flying a Drone	1.000	1.000	1.000

Source: Cordell 2012

Within the USFS report, growth coefficients are provided by type of activity. If an activity observed during this recreation use assessment did not fit a suitable category in Cordell 2012, a growth coefficient of 1.0 was assigned to the activity. To calculate projected recreation days until 2050, the following formula was used:

2020 recreation days * population growth coefficient * recreation participation coefficient

The results of projected summer recreation days are divided by type of day (i.e., weekends, weekdays, holidays) and recreation activity (Tables 26 through 28). A projection of future summer recreation days for the Project Area is show in Table 29.

Table 26. Projected Weekday Recreation Use for Project Area

Rank	Recreation Activity	2020 Recreation Assessment				Projected Summer Recreation Days		
		Users Observed[1]	Users Per Hour	Users Per Day[2]	Summer Recreation Days[3]	2030	2040	2050
1	Walking / Running	313	7.63	99.2	7,344.0	7,956.2	8,382.4	8,984.6
2	Looking at Dam / Flooding	92	2.24	29.2	2,158.6	2,286.0	2,320.3	2,355.1
3	Canoeing / Kayaking	91	2.22	28.9	2,135.2	2,066.7	1,879.5	1,699.8
4	Biking	79	1.93	25.0	1,853.6	1,964.9	2,022.3	2,130.7
5	Dog Walking	62	1.51	19.7	1,454.7	1,540.6	1,563.7	1,587.1
6	Fishing from Shore	15	0.37	4.8	352.0	353.3	332.5	307.1
7	Swimming	9	0.22	2.9	211.2	226.5	235.5	248.5
8	Skateboarding / Rollerskating	6	0.15	1.9	140.8	149.1	151.3	153.6
9	Photography	5	0.12	1.6	117.3	124.5	126.7	129.4
10	Fly Fishing	4	0.10	1.3	93.9	94.2	88.7	81.9
11	Birding/Nature Observing	3	0.07	1.0	70.4	74.7	76.0	77.6
11	Berry-picking	3	0.07	1.0	70.4	74.7	76.0	77.6
11	Scout River for Fishing	3	0.07	1.0	70.4	74.5	75.7	76.8
14	Picnicking	1	0.02	0.3	23.5	24.9	25.4	26.0
-	**Total**	**686**	**16.73**	**217.5**	**16,096**	**17,011**	**17,356**	**17,936**

[1] Seven weekdays were surveyed during 2020.
[2] Assumes 13 hours of recreation use per day (i.e., daylight hours)
[3] Seventy-four weekdays occurred during the Summer 2020 recreation period.

Table 27. Projected Weekend Recreation Use for Project Area

Rank	Recreation Activity	2020 Recreation Assessment				Projected Summer Recreation Days		
		Users Observed[1]	Users Per Hour	Users Per Day[2]	Summer Recreation Days[3]	2030	2040	2050
1	Canoeing / Kayaking	295	7.97	103.6	3,213.1	3,110.1	2,828.4	2,557.9
2	Walking / Running	254	6.86	89.2	2,766.5	2,997.2	3,157.7	3,384.6
3	Dog Walking	63	1.70	22.1	686.2	726.7	737.6	748.6
4	Biking	55	1.49	19.3	599.1	635.0	653.6	688.6
5	Fly Fishing	35	0.95	12.3	381.2	382.7	360.1	332.6
6	Fishing from Shore	24	0.65	8.4	261.4	262.4	246.9	228.1
7	Swimming	16	0.43	5.6	174.3	187.0	194.3	205.1
8	Sightseeing	6	0.16	2.1	65.4	69.2	70.2	71.3
9	Birding/Nature Observing	5	0.14	1.8	54.5	57.8	58.8	60.1
10	Picnicking	3	0.08	1.1	32.7	34.7	35.3	36.2
10	Skateboarding / Rollerskating	3	0.08	1.1	32.7	34.6	35.1	35.6
12	Flying a Drone	2	0.05	0.7	21.8	23.1	23.4	23.8
13	Photography	1	0.03	0.4	10.9	11.6	11.8	12.0
-	**Total**	**762**	**20.59**	**267.7**	**8,300**	**8,532**	**8,413**	**8,384**

[1] Six weekend days were surveyed during 2020.
[2] Assumes 13 hours of recreation use per day (i.e., daylight hours)
[3] Thirty-one weekend days occurred during the Summer 2020 recreation period.

Table 28. Projected Holiday Recreation Use for Project Area

Rank	Recreation Activity	2020 Recreation Assessment				Projected Summer Recreation Days		
		Users Observed[1]	Users Per Hour	Users Per Day[2]	Summer Recreation Days[3]	2030	2040	2050
1	Canoeing / Kayaking	99	8.3	99	297.0	287.5	261.4	236.4
2	Walking / Running	61	5.1	61	183.0	198.3	208.9	223.9
3	Biking	20	1.7	20	60.0	63.6	65.5	69.0
4	Dog Walking	16	1.3	16	48.0	50.8	51.6	52.4
5	Fly Fishing	5	0.4	5	15.0	15.1	14.2	13.1
6	Picnicking	3	0.3	3	9.0	9.6	9.7	10.0
7	Photography	2	0.2	2	6.0	6.4	6.5	6.6
-	**Total**	**206**	**17.2**	**206**	**618**	**631**	**618**	**611**

[1] Two holiday days were surveyed during 2020.
[2] Assumes 13 hours of recreation use per day (i.e., daylight hours)
[3] Three holidays occurred during the Summer 2020 recreation period.

Table 29. Projected Total Recreation Days for Project Area

Recreation Activity	2020 Recreation Assessment		Projected Summer Recreation Days		
	Users Observed	Summer Recreation Days	2030	2040	2050
Walking / Running	628	10,293.6	11,151.6	11,749.0	12,593.1
Canoeing / Kayaking	485	5,645.3	5,464.2	4,969.4	4,494.1
Biking	154	2,512.7	2,663.6	2,741.4	2,888.2
Dog Walking	141	2,188.9	2,318.1	2,352.8	2,388.1
Looking at Dam / Flooding	92	2,158.6	2,286.0	2,320.3	2,355.1
Fly Fishing	44	490.1	492.0	462.9	427.6
Fishing from Shore	39	613.4	615.8	579.4	535.1
Swimming	25	385.4	413.5	429.8	453.7
Skateboarding / Rollerskating	9	173.5	183.7	186.4	189.2
Birding/Nature Observing	8	124.8	132.5	134.9	137.7
Photography	8	134.2	142.4	145.0	148.0
Picnicking	7	65.1	69.1	70.4	72.1
Sightseeing	6	65.4	69.2	70.2	71.3
Berry-picking	3	70.4	74.7	76.0	77.6
Scout River for Fishing	3	70.4	74.5	75.7	76.8
Flying a Drone	2	21.8	23.1	23.4	23.8
Total	**1,654**	**25,014**	**26,174**	**26,387**	**26,932**
Percent Increase	**n/a**	**n/a**	**4.6%**	**0.8%**	**2.1%**

Based on these estimates, the increase of recreation demand for the entire Project Area over the course of a new license is minimal (7.5% from 2020 to 2050) and current recreation facilities, if deemed acceptable for the current recreation demand, are likely to be able to meet the recreation demand in the future. It should be noted that Cordell 2012 projections reduced canoeing/kayaking recreation demand in the future, which decreased the projected recreation days for the Powell Falls Kayak Launch survey area. The only concern voiced by respondents relating to overcrowding was that often on weekends the river is too busy with canoeing/kayaking traffic. If canoeing/kayaking demand on the Kinnickinnic River increases over the next 30 years, it is likely that modifications to current recreation amenities will need to be implemented. Since the river itself is the limiting factor for how many people can be kayaking at one time, measures may need to be taken to limit how many kayakers can access the river during certain busy periods.

There are additional indicators that overcrowding on the Kinnickinnic River due to canoe and kayak traffic may become an issue in the future. Of participants who took the user survey, the Powell Falls Kayak Launch survey area had the lowest percentage of River Falls residents (i.e., zip code 54022) (40%) when compared to White Kinnickinnic Pathway (72%) and Glen Park Trails (66%). A higher proportion of the recreationists that visit Powell Falls Kayak Launch to kayak the river are visitors from other areas and in particular, from the metropolis of Minneapolis and St. Paul, Minnesota, located approximately 40 minutes to the west of River Falls. This metropolis, known as the Twin Cities, is projected to grow at a faster rate than River Falls based on state projections (Minnesota State Demographic Center 2020) (Table 30). This population (and the populations of other surrounding counties) is an important source of recreation activity to the Powell Falls Kayak Launch survey area. If these urban areas continue to grow at a relatively high rate and the Kinnickinnic River remains a popular recreation destination, risks of overcrowding will become greater.

Table 30. Population Growth Estimates for Select Minnesota Counties

County	Estimated Growth (%)		
	2030	2040	2050
Hennepin	10.3	8.2	6.6
Ramsey	8.9	6.8	5.3
Washington	9.2	7.1	5.5

Source: Minnesota State Demographic Center 2020

5.5 River Flooding and COVID-19

It should be noted that two unexpected environmental variables were occurring or took place during the time period in which the recreation use assessment occurred.

The impacts to recreation use in River Falls from COVID-19 restrictions and the resulting changes in patterns of behavior will not be known until comparisons to previous years' data are implemented or larger regional or national data trends are obtained. As of December 2020, early data on COVID-19 impacts to outdoor recreation provided mixed results (Rice et al. 2020, Milwaukee Journal Sentinel 2020). Outdoor recreation usage rates may have increased due to people looking for alternatives to their typical indoor activities, which may not have been available during the assessment period because of COVID-19 lockdowns and restrictions. Alternatively, people may stay home more in general and look to avoid any public places or gatherings of people. During the course of the recreation survey, no park or public area closures within the Project Area occurred and kayak outfitters were observed too be operating each weekend. When the data compiled in this report are being reviewed in the future, potential impacts from COVID-19 should be considered.

The heavy rainfall and resulting flooding of the Kinnickinnic River on June 29 and 30, 2020, should be noted when considering the results of this report. Though the long-term impacts are likely to be minimal, it is likely that some people altered their recreation use patterns after flooding occurred, particularly in regards to kayak trips down the river. During the first week of July, multiple people came to the Powell Falls Kayak Launch survey area at least in part to view the river for kayaking and fishing conditions (pers. comm. with public). Other people may have canceled planned kayak trips due to concerns regarding the flooding. Shortly after flooding subsided, employees from two different kayak outfitters went up and down river respectively to clear woody debris and other blockages that may have impacted the ability for kayakers to successfully navigate the river.

Further, flooding changed the bank and near shoreline in all three survey areas to varying degrees and slightly damaged some recreation amenities at Powell Falls and Glen Park Trails (Photographs 17 and 18). Particularly at Glen Park Trails, the disturbances to the shoreline may have been aesthetically unattractive to recreation users or a safety concern, especially for children. These changes may have reduced the recreation usage rates at these survey areas in the short-term.

Photograph 17. Flood damage including debris pile-up and a washed-out trail at Powell Falls, facing north (July 1, 2020).

Photograph 18. Part of the paved path at Glen Park Trails destroyed by flooding, facing southwest (July 1, 2020).

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Appendix G Recreation Use Assessment

Appendix A - In-Person Recreation User Surveys
Appendix B - Comprehensive Spot Count Data Log
(filed separately due to file size)

Appendix H – Archeological Survey

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January 7, 2021

Kevin Westhuis
Utility Director
City of River Falls Municipal Utilities
222 Lewis St.
River Falls, WI 54022

Subject: **Phase I Archaeological Survey of the Shoreline at the Junction Falls Development, River Falls Hydroelectric Project (FERC #10489), Pierce County, Wisconsin**
TRC Project No. 350165
WIARC No. 262

Dear Mr. Westhuis:

The River Falls Hydroelectric Project (Project) is owned and operated by the City of River Falls Municipal Utilities (RFMU). The Project consists of two developments, the Junction Falls Development, which includes Lake George, and the Powell Falls Development, which includes Lake Louise. The Project is licensed by the Federal Energy Regulatory Commission (FERC). RFMU proposes to relicense the Junction Falls Development and decommission the Powell Falls Development with dam removal. Issuance of a new license for the continued operation and maintenance of the Junction Falls Development is defined as an undertaking and is, therefore, subject to the provisions of Section 106 and its implementing regulations at 36 CFR Part 800. Section 106 directs federal agencies to consider the effects of their undertakings on any resources that are listed, or eligible for listing, in the National Register of Historic Places (NRHP). The Cultural Resources Study is outlined in RFMU's River Falls Revised Study Plan (RSP) submitted on June 11, 2019 and FERC's Study Plan Determination dated July 11, 2019.

The first objective of the Cultural Resources Study (Study) was to determine the Area of Potential Effect (APE). The proposed APE includes the approximate FERC Project boundary and areas of potential land disturbance from Powell Falls decommissioning and removal activities. The proposed APE was divided into two parts, the Junction Falls APE and the Powell Falls APE. This distinction was made because the Junction Falls Development is proposed to be relicensed and the Powell Falls Development is proposed to be decommissioned with dam removal. The Wisconsin State Historic Preservation Office (SHPO) and FERC requested that the APE be divided in this way to facilitate Project review. On October 2, 2019, the Licensee sent a letter to the Wisconsin SHPO and tribes requesting review and comment on the proposed Project APE. The Wisconsin SHPO concurred by letter (October 10, 2019). No other responses were received.

The second part of this Study includes the Phase I Archaeological Survey, which is detailed in this report. The APE is shown on Figures 1 - 5. The APE is in Section 1, T27N, R19W in River Falls Township (Figure 1).

LITERATURE AND ARCHIVES RESEARCH

Literature and archives research were conducted prior to beginning archaeological fieldwork. The Wisconsin Historic Preservation Database (WHPD) does not show any archaeological sites in or adjacent to the Junction Falls APE. The 1947 Wisconsin Land Economic Inventory (WLEI) does not show any cultural or topographic features in the Junction Falls APE (Figure 2). The 1939 aerial shows the City of River Falls and the Project as it existed at that date (Figure 3). The 1848 GLO map shows the Kinnickinnic River, but nothing of cultural significance (Figure 4). The Junction Falls APE has not been surveyed for archaeological sites in the past. The Junction Falls APE as shown on the GLO (Figure 4) is at the correct location. The 1848 GLO was sketched 172 years ago and not specifically surveyed; therefore, the 1848 river alignment does not conform completely to modern map depictions.

Two earlier archaeological surveys were conducted within the Junction Falls APE. A 1984 survey for the Division Street bridge alternative project was limited to the floodplain due to construction disturbance from Division Street and urban development. Nothing of archaeological interest was found and no additional archaeological work was recommended (Barth 1984). A 2015 survey for a trail project along the north bank of the Kinnickinnic River from Heritage Park to Division Street, noted areas of disturbance from urban development. Nothing of archaeological interest was found and no additional archaeological work was recommended (Hodgson 2015).

In 1867 the first dam was built at Junction Falls and consisted of a rock filled timber dam used to generate power for a flour mill that was directly adjacent to the dam (City of River Falls 2018). In 1897 (Pierce County Historical Association 2020) the mill burned down, reportedly by arson fire to collect on the insurance. All that remains of the original 1867 mill is the smokestack (Pierce County Historical Society 2020, River Falls Journal 2018). In 1900, residents came together to create the River Falls Municipal Utilities and bought the Junction Falls Dam. During that same year, the Municipal Power Plant was built and provided the community with electricity and electric lighting (River Falls Municipal Utilities 2020). In 1920, the City of River Falls replaced the rock-filled timber dam with a concrete gravity dam. In 1923 a diesel generator was added but was removed sometime before 2020 (Pierce County Historical Association 2020). In 1948, a new powerhouse was built and during the early 1960s, the existing steel penstock was encased in concrete. Repairs and improvements have been made to the structures, but the penstock enclosed in concrete in the early 1960s and the powerhouse built in 1948 are still in use (River Falls Municipal Utilities 2020).

FIELDWORK

The purpose of the Phase I Archaeological Survey was to examine the shoreline of Lake George and shovel test, as needed, lands within the Junction Falls APE for archaeological sites that may be affected by Project operations. Part of the shoreline inspection requirement is to identify archaeological sites that might be affected by erosion[1]. Archaeological fieldwork was conducted on July 27-30, 2020. Figure 5 depicts the Junction Falls APE with shovel test and photo locations. Photos 1-6, included in Appendix A, characterize the Project environment in the Junction Falls APE along the shoreline.

TRC Archaeologists walked the shoreline and dug shovel tests on level, unexposed areas. Exposed banks and gravel bars were inspected for artifacts except on steep banks with a greater than 25 percent slope within the Junction Falls APE. Shovel tests were dug in vegetated ground surfaces abutting the shore.

Shovel testing is the excavation of shovel holes in a systematic grid-like fashion. The tests are dug in parallel lines called transects, with an interval within and between transects that is consistent and not greater than 15 meters, the maximum suggested interval by the Wisconsin Archaeological Survey guidelines for public archaeology in Wisconsin. Shovel tests, about 35 cm in diameter, are excavated to an undisturbed natural soil horizon, in order to reveal former human occupation surfaces. The depth of shovel tests varies with terrain, but it is based on the archaeologist's substantive knowledge of local archaeology and soil sequences for the area. All soil from each hole is screened through ¼ inch mesh hardware cloth and placed back into the hole. If artifacts are found, the location is marked with a GPS waypoint and marked for possible test excavation. Lands within the Junction Falls APE were shovel tested at 15-meter intervals.

The July 2020 survey[2] examined the shoreline and noted that short reaches of the impoundment bank had been stabilized with riprap, landscaping, and by other means. However, much of the shoreline is stable and well vegetated with areas protected by natural slow water environments, which allow emergent and submergent vegetation to buffer the shoreline.

Shovel tests were dug, where possible, in areas with less than 25 percent slope and dry soil. Most of the land associated with the shoreline was above the river along the shoreline edge, with sand and gravel bars at the base of the sloping shoreline. Shovel test soil profiles in the northern half of the

[1] Erosion is here defined as "banks that [are] not stabilized and [are] experiencing serious sheet erosion and down-drift with material freely flowing into the flowage. Such banks [are] usually losing topsoil and vegetation. Some vegetation [may] be present at the water's edge but it [covers] less than 50% of the total shoreline." This definition of Class III erosion is provided by Great Lakes Environmental Center, Inc. of Traverse City Michigan.

[2] In late June of 2020, due to heavy rainfall, the Kinnickinnic River and Lake George overflowed their banks. Despite this, the Lake George shoreline experienced little visible damage.

Lake George impoundment, at bank top, showed an A-Horizon of very dark brown 10YR 2/2 loam (0-20cm) over a B-Horizon of dark grayish brown 10YR 4/2 mottled with grayish brown 10YR 5/2 silty sand. Shovel test profiles in the southern half of the Junction Falls APE showed patches of disturbance caused by commercial development and the development of the park facilities. Intact soil profiles in this area showed very dark brown 10YR 2/2 loam (0-20cm) over limestone bedrock. Well vegetated areas below the shoreline were tested and soil profiles showed an A-horizon of 10YR 7/2 (0-70cm) over the water table. These soils are consistent with sand and gravel bars.

The combination of bank examination, surface collection of exposed gravel bars, and shovel testing did not yield any artifacts or archaeological sites in the Junction Falls APE.

RECOMMENDATION AND CONCLUSION

The Junction Falls APE consists of the Lake George impoundment, which was created by the construction of the Junction Falls Dam. The Junction Falls Development is licensed by the FERC and is subject to the provisions of Section 106 and its implementing regulations at 36 CFR Part 800. In July 2020, a Phase I Archaeological Resources Survey was conducted of the Lake George shoreline and lands within the Junction Falls APE. Archaeologists conducting surface observation did not encounter any areas of erosion and described the shoreline as well-vegetated and stable. The Phase I survey encountered areas of disturbance caused by recreational facilities development, but no archaeological sites or artifacts were noted. Shovel testing efforts did not encounter any artifacts.

No additional archaeological work is recommended until the time stipulated in the future Historic Resources Management Plan.

If we can provide additional assistance, I can be reached at 262-225-5105, or by email at AVanDyke@trccompanies.com.

Sincerely,

TRC

Allen P. Van Dyke

Allen P. Van Dyke
Principal Archaeologist

Attachments: 6 Photos and 5 Figures

cc: R. Klabacka-Williams, TRC
L. Brotkowski, TRC
L. Nordman, TRC

REFERENCES CITED

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Appendix A
Photos & Figures

Photo 1: Division Street Bridge at north end of Junction Falls APE. View to north.

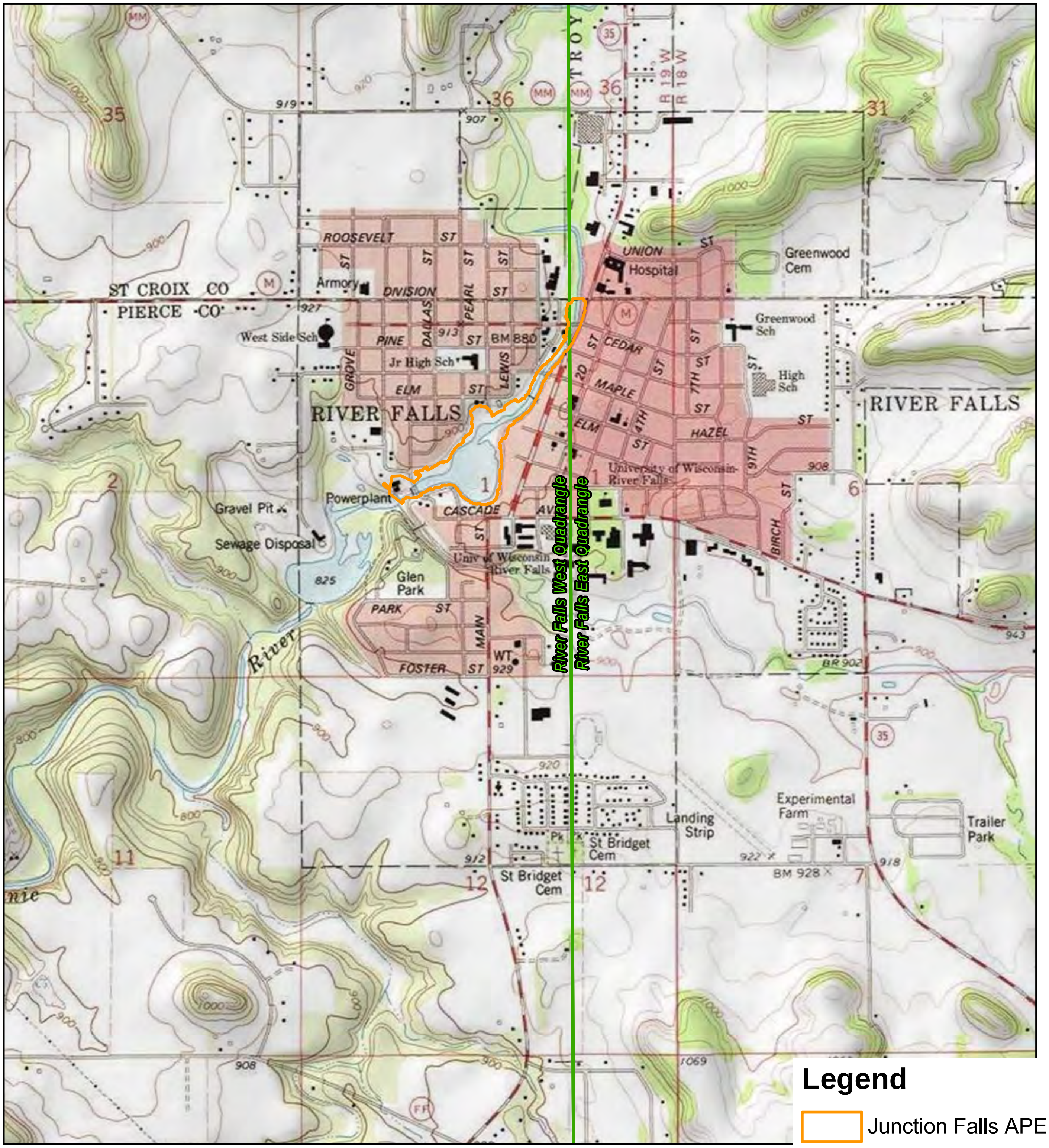
Photo 2: General character of northern reach of Junction Falls APE. View to southeast.

Photo 3: Typical sloped shoreline down to vegetated gravel bar. View to southeast.

Photo 4: Gravel bar along the midsection of Lake George. View to south.

Photo 5: Typical character of south end of Lake George. View to southwest.

Photo 6: Junction Falls Dam. View to northeast.



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

1 " = 2,000 '

1:24,000

0 | 0.45 | 0.9 | 1.35 Miles

150 N. PATRICK BLVD
SUITE 180
BROOKFIELD, WI 53045
PHONE: 262.879.1212

TRC - GIS

PROJECT:

RIVER FALLS HYDROELECTRIC PROJECT
JUNCTION FALLS
RIVER FALLS, WISCONSIN

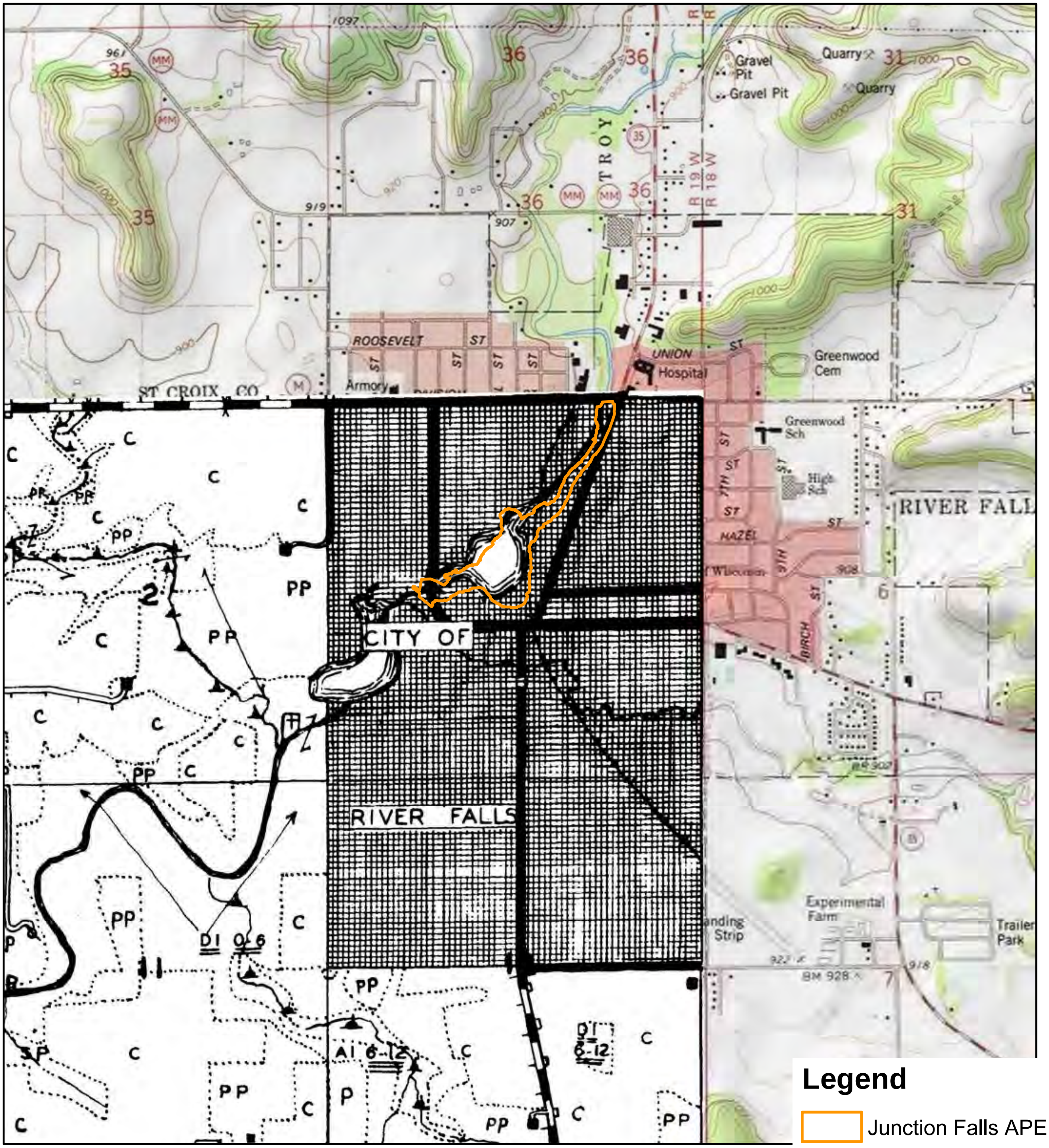
TITLE:

River Falls East & West 7.5' Quadrangles
Project Location

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 1

P:\River Falls - City\Cultural\GIS\Junction Falls\[rpt]_Figx_[Junction Falls]_8x11.mxd -- Saved By: AMCMAHON on 9/10/2020, 15:40:16 PM



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

1 " = 2,000 '

1:24,000

0 0.45 0.9 1.35 Miles

TRC

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BROOKFIELD, WI 53045
PHONE: 262.879.1212

TRC - GIS

PROJECT: **RIVER FALLS HYDROELECTRIC PROJECT**
JUNCTION FALLS
RIVER FALLS, WISCONSIN

TITLE:

1947 Wisconsin Land Economic Inventory

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 2

P:\River Falls - City\Cultural\GIS\Junction Falls\[rpt]_Figx_[Junction Falls]_8x11.mxd -- Saved By: AMCMAHON on 9/10/2020, 15:40:16 PM

Imagery From Wisconsin Historic Aerial Imagery Finder, (2020)

1 " = 917 '
1:11,000

0 0.2 0.4 0.6 Miles

TRC
150 N. PATRICK BLVD
SUITE 180
BROOKFIELD, WI 53045
PHONE: 262.879.1212
TRC - GIS

PROJECT: **RIVER FALLS HYDROELECTRIC PROJECT**
JUNCTION FALLS
RIVER FALLS, WISCONSIN

TITLE: **1939 Aerial Photograph**

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 3

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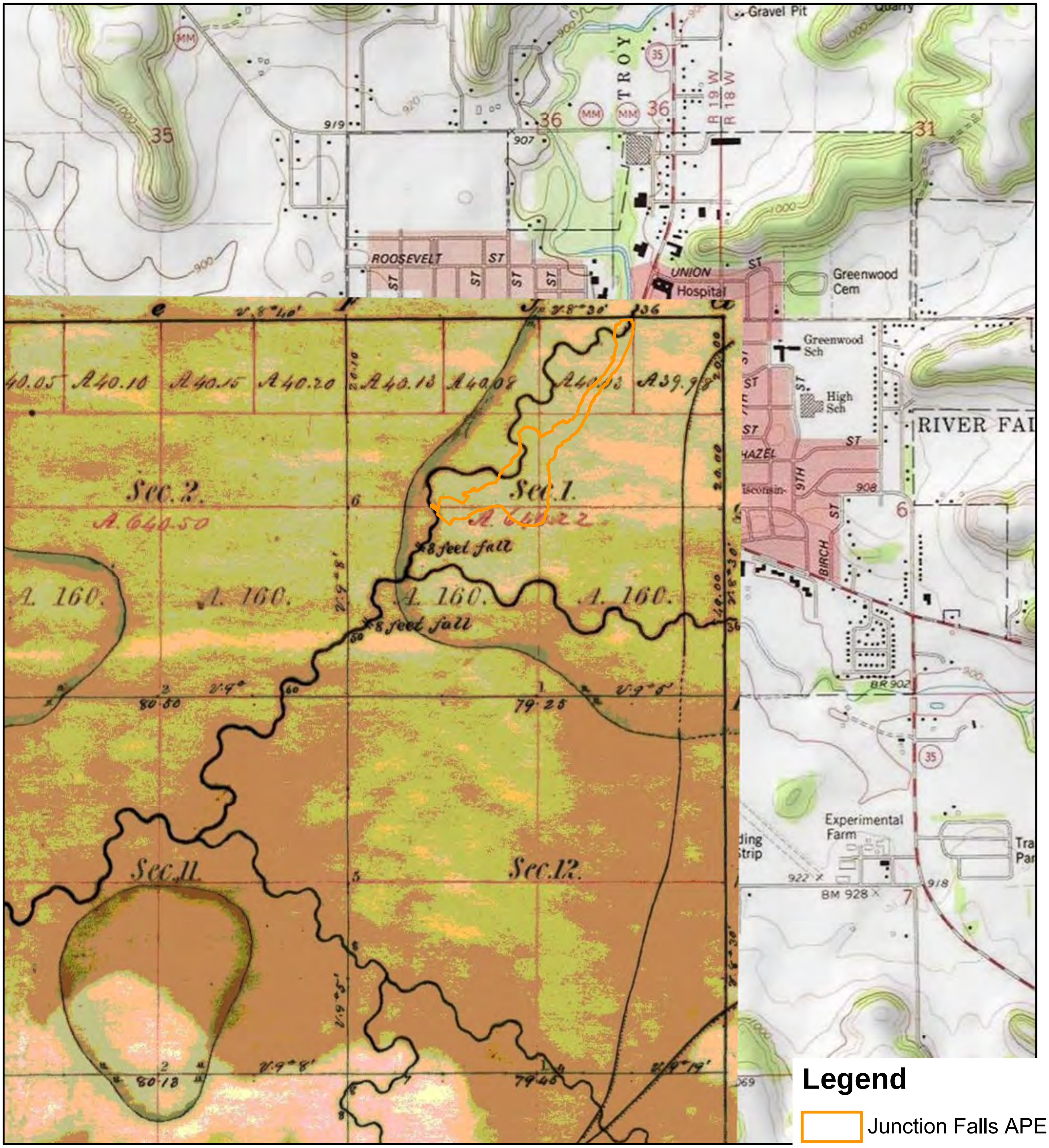

BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

1 " = 2,000 '
1:24,000

0 0.45 0.9 1.35 Miles

TRC
150 N. PATRICK BLVD
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BROOKFIELD, WI 53045
PHONE: 262.879.1212

TRC - GIS

PROJECT: **RIVER FALLS HYDROELECTRIC PROJECT
JUNCTION FALLS
RIVER FALLS, WISCONSIN**

TITLE: **1848 General Land Office Map**

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 4

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BASE IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, (2020)

1 " = 500 '
1:6,000

0 0.1 0.2 0.3 Miles

TRC

150 N. PATRICK BLVD
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PHONE: 262.879.1212

TRC - GIS

PROJECT:
RIVER FALLS HYDROELECTRIC PROJECT
JUNCTION FALLS
RIVER FALLS, WISCONSIN

TITLE:
Shovel Tests and Photo Locations

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	OCTOBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 5

P:\River Falls - City\Cultural\GIS\Junction Falls\[rpt]_Figx_[Junction Falls]_8x11.mxd -- Saved By: AMCMAHON on 10/8/2020, 10:15:48 AM

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January 7, 2021

Kevin Westhuis
Utility Director
City of River Falls Municipal Utilities
222 Lewis St.
River Falls, WI 54022

Subject: Phase I Archaeological Survey at the Powell Falls Development, River Falls Hydroelectric Project (FERC #10489), Pierce County, Wisconsin
TRC Project No. 350165
WIARC No. 263

Dear Mr. Westhuis:

The River Falls Hydroelectric Project (Project) is owned and operated by the City of River Falls Municipal Utilities (RFMU). The Project consist of two developments, the Junction Falls Development, which includes Lake George, and the Powell Falls Development, which includes Lake Louise. The Project is licensed by the Federal Energy Regulatory Commission (FERC). RFMU proposes to decommission the Powell Falls Development with dam removal that will also result in the permanent drawdown of Lake Louise. The removal of the dam is defined as an undertaking and is subject to the provisions of Section 106 and its implementing regulations at 36 CFR Part 800. Section 106 directs federal agencies to consider the effects of their undertakings on any resources that are listed, or eligible for listing, in the National Register of Historic Places (NRHP). The Cultural Resources Study (Study), which includes a Phase I Archaeological Survey, is outlined in the RFMU Revised Study Plan (RSP) filed on June 11, 2019 and FERC's Study Plan Determination dated July 11, 2019.

The first objective of the Study was to determine the Area of Potential Effect (APE). The proposed APE includes the approximate FERC Project Boundary and areas of potential land disturbance from Powell Falls decommissioning and removal activities. The proposed APE was divided into two part, the Junction Falls APE and the Powell Falls APE. This distinction was made due to the proposed action at the Project: The Junction Falls Development is proposed for relicensing while the Powell Falls Development is proposed to be decommissioned with dam removal. Both the Wisconsin State Historic Preservation Office (SHPO) and FERC requested that the APE be divided this way to facilitate Project review. On October 2, 2019, the Licensee sent a letter to the Wisconsin SHPO and tribes requesting review and comment on the proposed Project APE. The Wisconsin SHPO concurred with the APE by letter (October 10, 2019.) No other responses were received.

The second phase of this Study includes the Phase I Archaeological Survey (Survey), which is reported here. This report details the results of the archaeological survey of the APE as depicted in Figures 1 - 5. The Powell Falls APE is in Sections 1 and 2 of T27N, R19W in River Falls Township (Figure 1).

LITERATURE AND ARCHIVES

Literature and archives research were conducted prior to archaeological fieldwork. The Wisconsin Historic Preservation Database (WHPD) shows the Foster Cemetery (47PI589/BPI-0064) near the Powell Falls APE. The cemetery is outside of the Powell Falls APE and will not be affected by the dam removal.[1]

The 1947 Wisconsin Land Economic Inventory (WLEI) provides little information regarding natural or cultural resources in the vicinity except for the cemetery at the southwest end of the Powell Falls APE (Figure 2). The 1939 aerial photograph shows the City of River Falls, wooded areas, cultivated land, grasslands, and the Project as it existed at that date (Figure 3). The 1848 General Land Office (GLO) map shows the Kinnickinnic River, and two falls of eight feet each, now inundated by the lakes (Figure 4). The Powell Falls APE as shown on the GLO (Figure 4) is at the correct location, but the GLO is a sketch map drawn 172 years ago, not specifically surveyed; therefore, the 1848 river alignment does not conform completely to modern map depictions.

One archaeological survey was conducted within the boundary of the Powell Falls APE. A 1981 survey of a small drainage on the south side of the Kinnickinnic River, due south of the Powell Falls Dam, investigated the valley walls and floor for archaeological sites. None were found and no additional archaeological work was recommended (Barth 1981).

The Powel Falls Dam, a timber crib dam built in 1903, was the second dam built in the City of River Falls. In 1948, a powerhouse was built at the dam. In 1966, the dam was destroyed in a flood event. Since then, the dam has been repaired and improvements have been made to the structures. The 1948 powerhouse is still in use (River Falls Municipal Utilities 2020).

FIELDWORK

The purpose of the Survey was to inspect the shoreline of Lake Louise and shovel test, as needed, lands within the Powell Falls APE to discover archaeological sites that may be affected by the proposed action. Part of the shoreline inspection requirement is to identify archaeological sites that might be affected by erosion[2]. Archaeological fieldwork was conducted on July 27-30, 2020. Figure 5 depicts the Powell Falls APE boundary with shovel test and photo locations. Photos 1-8, included in Appendix A, characterize the Project environment in the Powell Falls APE along the shoreline.

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1 Chip Brown, Wisconsin SHPO, sent a shapefile of the cataloged location of the Foster Cemetery to RFMU on April 10, 2019. The cataloged location was determined to be outside of the Powell Falls APE.

2 Erosion is here defined as "banks that [are] not stabilized and [are] experiencing serious sheet erosion and down-drift with material freely flowing into the flowage. Such banks [are] usually losing topsoil and vegetation. Some vegetation [may] be present at the water's edge but it [covers] less than 50% of the total shoreline." This definition of Class III erosion is provided by Great Lakes Environmental Center, Inc. of Traverse City Michigan.

TRC archaeologists walked the shoreline and shovel tested where it was possible to do so, *i.e.*, on natural land surfaces with less than 25 percent slope at the bank top and within the Powell Falls APE. Exposed or eroding banks and gravel bars formerly underwater, were inspected for artifacts. Generally, unexposed ground surfaces bordering the shore were shovel tested.

Shovel testing is the hand excavation of small holes in a systematic grid-like fashion. The tests are dug in parallel lines, called transects, with an interval within and between transects that is consistent and not greater than 15 meters, the maximum allowable by Wisconsin Archaeological Survey guidelines for public archaeology. Shovel tests, about 35 cm in diameter, are excavated to an undisturbed natural soil horizon in order to reveal former human occupation surfaces. The depth of shovel tests varies with terrain, but it is based on the archaeologist's substantive knowledge of local archaeology and soil sequences for the area. All soil from each hole is screened through ¼ inch mesh hardware cloth and placed back into the hole. If artifacts are found, the location is marked with a GPS waypoint and marked for possible test excavation. Lands within the Powell Falls APE were shovel tested at 15-meter intervals.

To facilitate description, the Powell Falls APE was divided into four quadrants. The northwest quadrant consisted of the shoreline west of the Junction Falls Dam to just east and north of the River Falls Wastewater Treatment Facility property along the northern bank. The northeast quadrant was west of the Junction Falls Dam to east of the junction of the S. Kinnickinnic River Trail with W. Park Street along the southern bank. The southwest quadrant consisted of part of the northern shoreline that is adjacent to the River Falls Wastewater Treatment Facility property and ends at the Powell Falls Dam. The southeast quadrant was along the southern shoreline extending between the Powell Falls Dam to the west, to the junction of the S. Kinnickinnic River Trail with W. Park Street to the east.

The July 2020 survey[3] examined the shoreline and noted that the northwestern shoreline of Lake Louise is stable and well vegetated with areas protected by natural slow water environments, which allow emergent and submergent vegetation to buffer the shoreline. Shovel tests were dug where it was possible to do so, but large areas of standing water and marsh were encountered. Soil profiles in shovel tests generally showed an A-Horizon of black (10YR 2/1) sandy clay loam (0-15 cm) over a B-Horizon of dark gray (10YR 4/1) sandy clay loam.

The northeastern shoreline is marked with gravel bars and well vegetated and steeply sloped banks. Shovel tests were dug where possible in areas with less than 25 percent slope and dry soil. Shovel profiles showed varied stratigraphy: profiles near the dam were shallow with a dark brown (10YR 3/2) sandy loam (0-5cm) over bedrock; shovel tests west of the dam showed an A-horizon of brown

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[3] In late June 2020, due to a heavy rainfall event, the Kinnickinnic River and Lake Louise overflowed their banks. The well vegetated shorelines of Lake Louise experienced little damage. Modern debris was observed along the shoreline and caught in the trees and brush indicating the height of the flood stage water.

(10YR 5/3) sand (0-5 cm) over a B-horizon of black (10YR 2/1) sandy loam (5-30 cm). The water table was encountered at about 30 cm. The area had large gravel bars and showed disturbance caused by sewer construction as evidenced by a manhole in one of the gravel bars (Photo 3).

The southwestern and southeastern Lake Louise shoreline was steep but well vegetated. The shoreline sloped up from the water at about 70-80 degrees within the Powell Falls APE.

The Phase I survey continued along the existing transmission line south of the southern shoreline of the lake. Shovel tests in the western half of the corridor showed mixed soils and heavy disturbance related to earlier episodes of development and expansion at Glen Park. The eastern half of the corridor ran along a well vegetated valley wall that had a 60-70 percent slope which was not shovel tested.

About three acres of land below the dam were surveyed for the proposed dam removal with the Kinnickinnic River bisecting the three acres. Surface collection (also referred to as pedestrian survey), of the bluff tops and along the river edge noted that most of the area was steeply sloped (~80 percent). Shovel tests were dug where possible, even in areas with up to 40 percent slopes and dry soils. Shovel test profiles showed an A-Horizon of very dark brown (10YR 2/2) loam (0-30cm) over a B-Horizon of dark grayish brown (10YR 4/2) sandy loam. A single shovel test near the canoe launch and pedestrian trail on the south side of the river showed mixed, disturbed soils related to recreational use and landscaping.

The combination of bank examination, surface collection of exposed gravel bars, and shovel testing did not yield any artifacts or archaeological sites in the Powell Falls APE.

RECOMMENDATION AND CONCLUSION

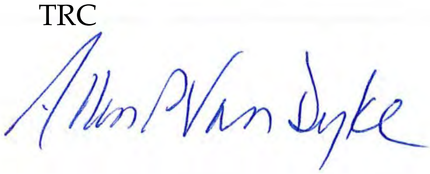
The Powell Falls APE includes the Lake Louise impoundment which was created by construction of the Powell Falls Dam. RFMU proposes to decommission the Powell Falls Development with dam removal and permanent draw down of Lake Louise. The Powell Falls Development is licensed by the FERC and is subject to the provisions of Section 106 and its implementing regulations at 36 CFR Part 800. TRC archaeologists conducted a Phase I Archaeological Survey of the shoreline of Lake Louise areas below the dam and lands within the Powell Falls APE. Walking observation did not encounter any areas of erosion but noted a well vegetated and stable shoreline. Approximately 50 percent of the shoreline was steeply sloped with slopes over 80 percent. Shovel testing encountered areas of disturbance attributable to recreational use, but artifacts or archaeological sites were not noted. Shovel tests in areas that contained more-or-less intact soils did not encounter any artifacts.

Archaeological sites or artifacts were not found; no additional archaeological work is recommended for the proposed project in the Powell Falls APE.

If we can provide additional assistance, I can be reached at 262-225-5105, or by email at AVanDyke@trccompanies.com.

Sincerely,

TRC



Allen P. Van Dyke
Principal Archaeologist - Midwest

Attachments: 8 Photos and 5 Figures

cc: R. Klabacka-Williams, TRC
L. Brotkowski, TRC
L. Nordman, TRC

REFERENCES CITED

Barth, Robert J.
1981 *An Archaeological Survey of the Proposed Improvements in Bartosh Park, City of River Falls, River Falls Township, Pierce County, Wisconsin*. Department of Sociology, University of Wisconsin – Eau Claire. Eau Claire, Wisconsin.

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Wisconsin Land Economic Inventory (WLEI)
2018 Wisconsin Land Economic Inventory Plat Maps. http://uwdc.library.wisc.edu/collections/EcoNatRes/WILandInv. Accessed July 10.

Appendix A
Photos & Figures

Photo 1: View of the shoreline of both the northwest and northeast quadrants. View to southwest.

Photo 2: View of the northwestern quadrant.. View to west – southwest.

Photo 3: A view of gravel bar and the sewer utility line within the northeastern quadrant. View to west.

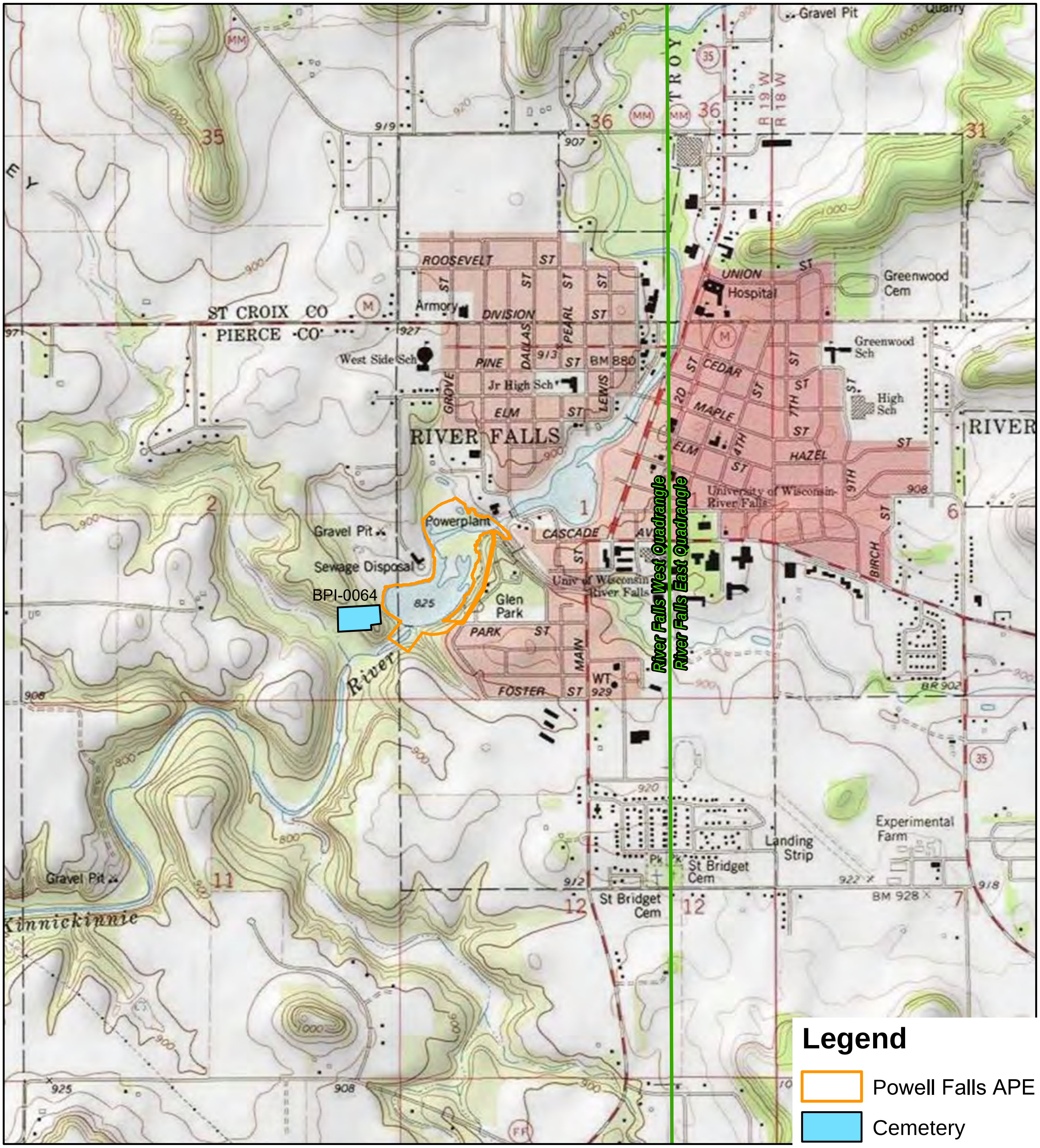
Photo 4: Overview of stable shoreline in the southeastern quadrant. View to southwest.

Photo 5: View of slope of shoreline in the southwestern quadrant. View to south.

Photo 6: Glen Park and recreational distrubance. View to southwest.

Photo 7: Wooded area below Powell Falls Dam. View to west.

Photo 8: Bank below Powell Falls Dam. View to southwest.



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

1 " = 2,000 '
1:24,000

0 0.45 0.9 1.35 Miles

TRC

150 N. PATRICK BLVD
SUITE 180
BROOKFIELD, WI 53045
PHONE: 262.879.1212

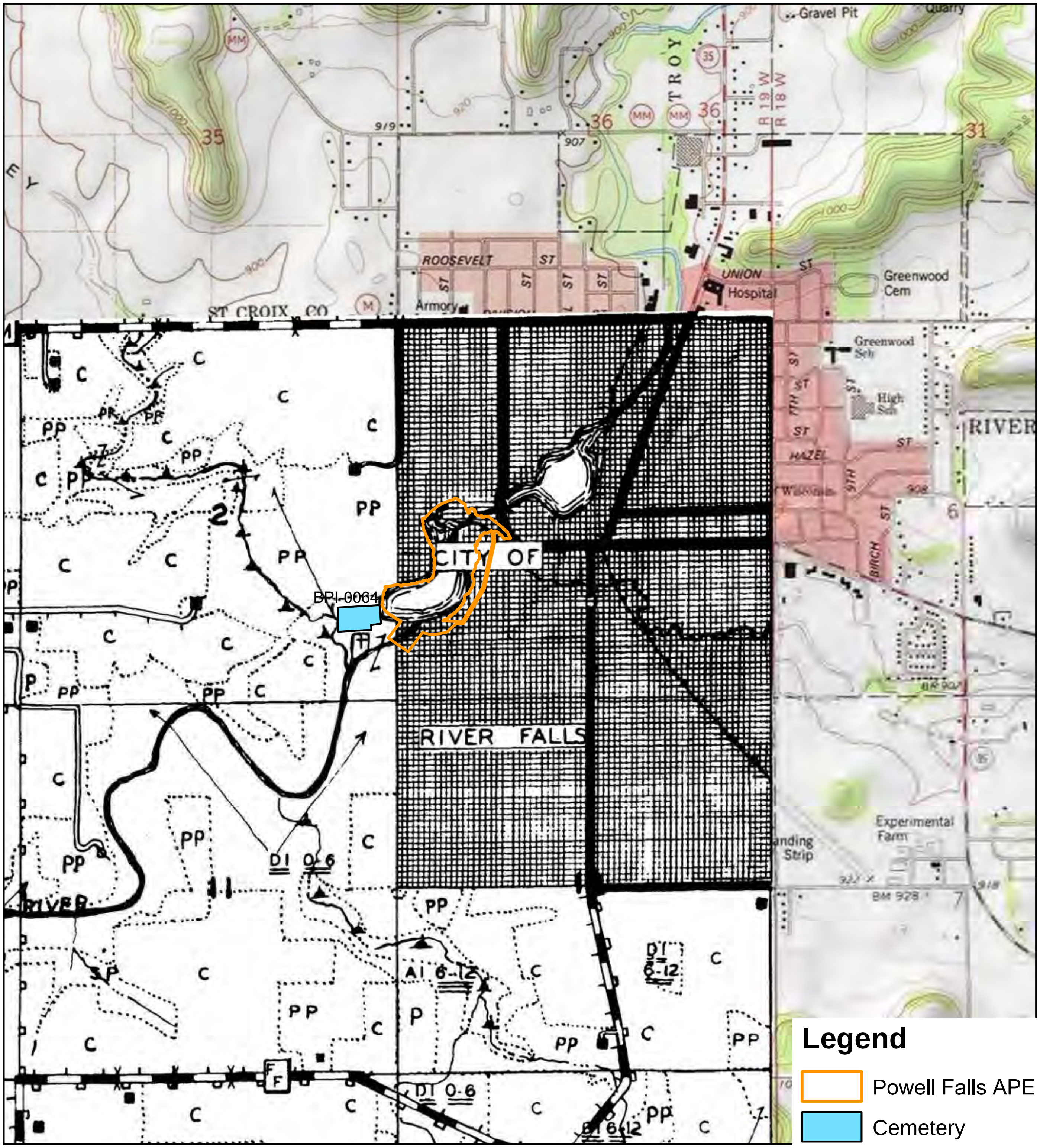
TRC - GIS

PROJECT: **RIVER FALLS HYDROELECTRIC PROJECT**
POWELL FALLS
RIVER FALLS, WISCONSIN

TITLE: **River Falls East & West 7.5' Quadrangles**
Project Location

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 1



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

1 " = 2,000 '
1:24,000

0 | 0.45 | 0.9 | 1.35 Miles

TRC
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BROOKFIELD, WI 53045
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TRC - GIS

PROJECT:
RIVER FALLS HYDROELECTRIC PROJECT
POWELL FALLS
RIVER FALLS, WISCONSIN

TITLE:
1947 Wisconsin Land Economic Inventory

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 2

Imagery From Wisconsin Historic Aerial Imagery Finder, (2020)

1 " = 917 '
1:11,000

0 0.2 0.4 0.6 Miles

TRC
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BROOKFIELD, WI 53045
PHONE: 262.879.1212

TRC - GIS

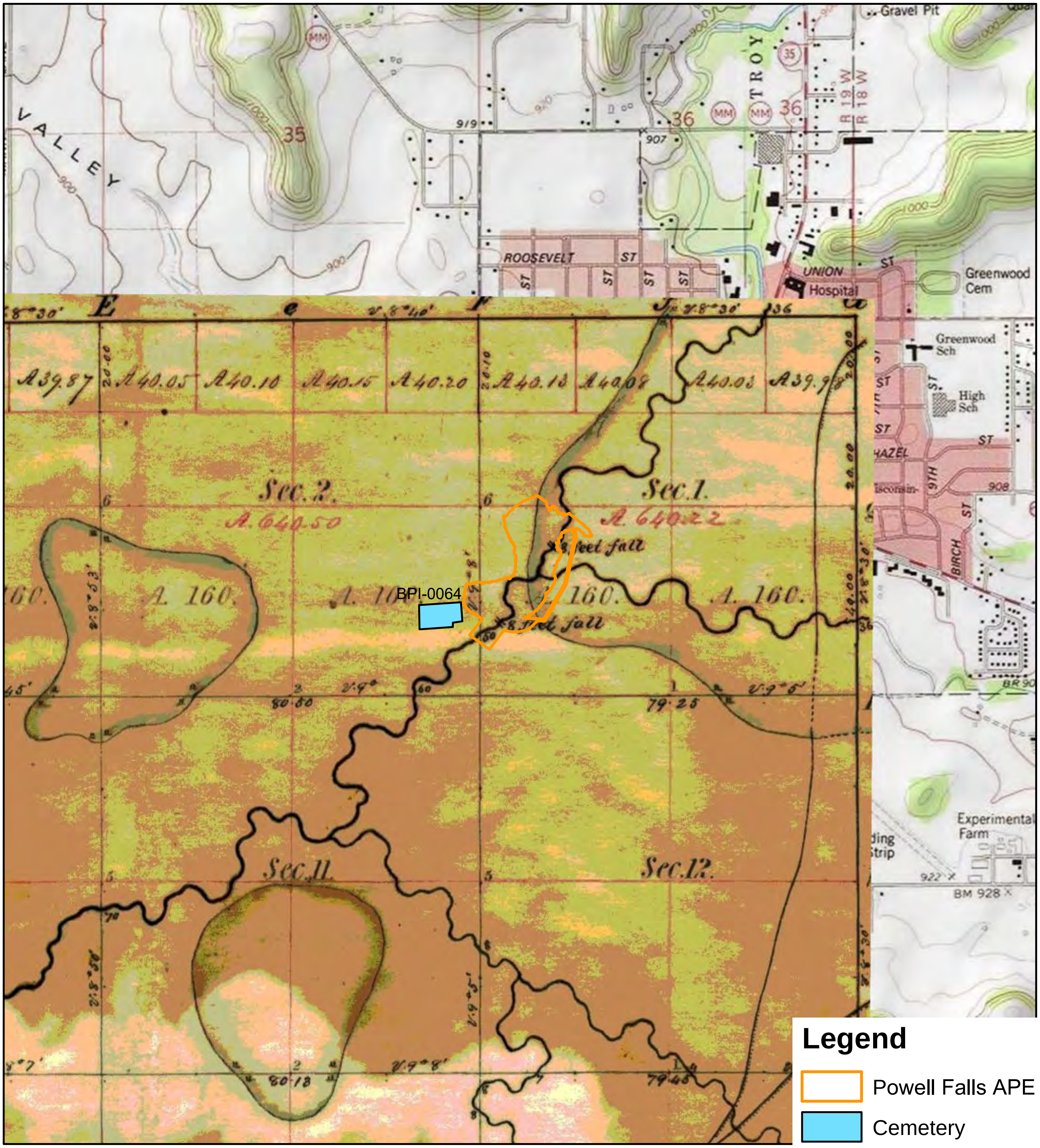
PROJECT:
RIVER FALLS HYDROELECTRIC PROJECT
POWELL FALLS
RIVER FALLS, WISCONSIN

TITLE:
1939 Aerial Photograph

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 3

P:\River Falls - City\Cultural\GIS\Junction Falls\[rpt]_Figx_[Junction Falls]_8x11.mxd -- Saved By: AMCMAHON on 9/10/2020, 15:40:16 PM



BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

1 " = 2,000 '
1:24,000

0 0.45 0.9 1.35 Miles

TRC

150 N. PATRICK BLVD
SUITE 180
BROOKFIELD, WI 53045
PHONE: 262.879.1212

TRC - GIS

PROJECT: **RIVER FALLS HYDROELECTRIC PROJECT POWELL FALLS RIVER FALLS, WISCONSIN**

TITLE: **1848 General Land Office Map**

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	SEPTEMBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 4

BASE IMAGERY FROM GOOGLE EARTH PRO & PARTNERS, (2020)

1 " = 500 '
1:6,000

0 0.1 0.2 0.3 Miles

TRC
150 N. PATRICK BLVD
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BROOKFIELD, WI 53045
PHONE: 262.879.1212

TRC - GIS

PROJECT: **RIVER FALLS HYDROELECTRIC PROJECT**
POWELL FALLS
RIVER FALLS, WISCONSIN

TITLE: **Shovel Tests and Photo Locations**

DRAWN BY:	A.MCMAHON
CHECKED BY:	R.KLABAKA-WILLIAMS
APPROVED BY:	A.VAN DYKE
DATE:	OCTOBER 2020
PROJ. NO.:	350165
FILE:	[rpt]_Figx_[Junction Falls]_8x11.mxd

FIGURE 5

P:\River Falls - City\Cultural\GIS\Junction Falls\[rpt]_Figx_[Junction Falls]_8x11.mxd -- Saved By: AMCMAHON on 10/8/2020, 10:37:30 AM

Appendix I – Sediment Study
(filed separately due to file size)

Appendix J – Powell Falls Decommissioning Plan
(filed separately due to file size)