KIAP-TU-WISH CHAPTER TROUT UNLIMITED

Conserving, protecting, and restoring cold water fisheries and their watersheds in Polk, Pierce, and St. Croix Counties, Wisconsin.

Recommended Studies to Assess the Water Resource Impacts of City of River Falls (WI) Hydropower Facilities on the Kinnickinnic River

Kiap-TU-Wish Chapter of Trout Unlimited

December 28, 2018

Studies determined by the Kiap-TU-Wish Chapter of Trout Unlimited as necessary to be performed by the City of River Falls for the River Falls Hydroelectric Project in Pierce County, Wisconsin (FERC Project P-10489), consistent with 18 CFR 4.38(b)(5).

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Recommended Studies to Assess the Water Resource Impacts of City of River Falls (WI) Hydropower Facilities on the Kinnickinnic River

Study I. Temperature Impacts

Background Information:

The Kiap-TU-Wish Chapter of Trout Unlimited (Kiap-TU-Wish) has a goal of maintaining a healthy coldwater ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. However, the Kinnickinnic River is threatened by increased temperatures caused by the River Falls hydropower impoundments (Johnson 2018), a warming climate (Mitro et al. 2011; Johnson 2018), urban stormwater runoff (Johnson 1995), and reduced river flow due to groundwater withdrawals in the watershed (Juckem 2009). To better understand these threats to the coldwater ecosystem, Kiap-TU-Wish has been conducting temperature monitoring of the Kinnickinnic River since 1992. One of the primary objectives of this monitoring work is to evaluate the thermal impacts of the City of River Falls hydropower facilities on the Kinnickinnic River.

Kiap-TU-Wish temperature monitoring is conducted at five Kinnickinnic River sites (two upstream and three downstream of the City of River Falls hydropower facilities), and at three sites on Kinnickinnic River tributaries (Sumner Creek, South Fork of the Kinnickinnic River, and Rocky Branch Creek) (Figure 1). Monitoring is generally conducted during the mid-April to mid-October period each year; although monitoring has also been conducted during four winters (1995, 1998, 2003, 2006). Monitoring is conducted via the use of electronic instrumentation that continuously measures river temperatures at 10-minute intervals, generating approximately 22,000 temperature measurements/monitoring site/year.

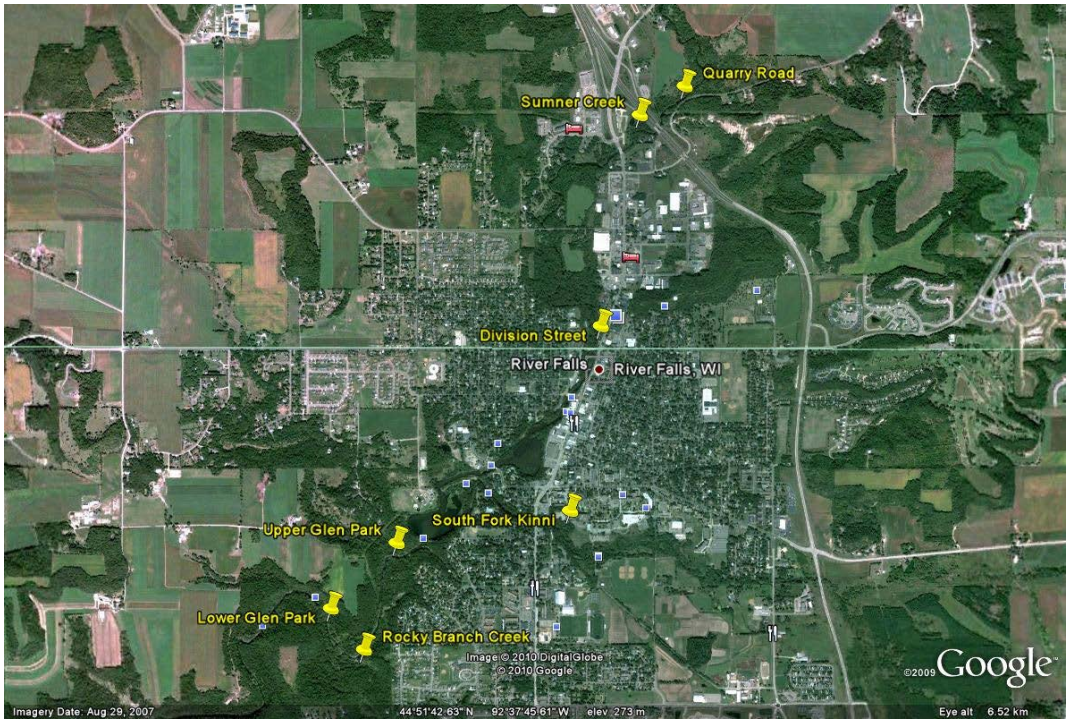

Figure 1. Kiap-TU-Wish temperature monitoring sites on the Kinnickinnic River and tributaries in River Falls, WI.

Evidence of Temperature Impacts:

- The two City of River Falls hydropower dams and impoundments (Lakes George and Louise) have transformed a 0.7-mile reach of the Kinnickinnic River from a coldwater to a warm water ecosystem. Lakes George and Louise are classified by the Wisconsin Department of Natural Resources (WDNR) as a warm water sport fishery (WWSF), while the remainder of the Kinnickinnic River is classified as a cold Class I trout fishery (WDNR, et al., 1999).
- The two City of River Falls hydropower impoundments (Lakes George and Louise) have a significant warming influence on the downstream Kinnickinnic River in the summer, and a cooling influence in the winter.
- The Nonpoint Source Control Plan for the Kinnickinnic River Priority Watershed Project (Kinni NPS Plan) (WDNR et al., 1999) notes (p. 94): "The downstream reach (below Lake Louise and Powell Dam)….has elevated water temperatures…caused by the two upstream impoundments and stormwater runoff". "The impoundments have an overall constant warming effect of about 3° C (5° F) on downstream water temperatures during base flow (Schreiber, 1998)."
- The Kinni NPS Plan (WDNR et al., 1999) notes about Lake George (p. 94): "Warming in the shallow areas tends to cause a general increase in downstream water temperatures".
- On average (1993-2013), the downstream Kinnickinnic River summer (June-August) temperature is 4.2° F higher than the upstream temperature (59.7° F upstream vs. 63.9° F downstream) (Johnson 2018; Kiap-TU-Wish, unpublished data).
- On average (1993-2013), the downstream Kinnickinnic River July temperature is 4.7° F higher than the upstream temperature (61.0° F upstream vs. 65.7° F downstream) (Johnson 2018; Kiap-TU-Wish, unpublished data).
- A climate vulnerability analysis of Kiap-TU-Wish data (1992-2009) by WDNR (Mitro, et al., 2011; Johnson 2018) noted that a warming trend is occurring at both upstream and downstream Kinnickinnic River sites. However, the warming trend is greater at downstream sites and begins at a much higher baseline temperature, indicating that the downstream Kinnickinnic River may be much more sensitive to future climate change impacts.
- Future climate change impacts (Mitro, et al., 2011) must be a critical consideration for evaluating future hydropower-related temperature impacts on the currently-impounded and downstream reaches of the Kinnickinnic River. With higher system-wide temperatures due to climate change, thermal impacts due to the hydropower impoundments will further exacerbate downstream warming, possibly creating future temperature regimes that are unsuitable for a coldwater ecosystem.

Recommended Study Elements to Evaluate Temperature Impacts:

The proposed removal of the Powell Falls Dam and associated Kinnickinnic River restoration by 2026 may reduce summer heating and winter cooling caused by Lake Louise, thereby improving the temperature regime of the lower Kinnickinnic River. However, re-licensing and the ongoing presence of the Junction Falls Dam and Lake George until 2035-2040 will continue to impose temperature impacts on the downstream river. To assess future temperature regimes created by these two scenarios, the following study of temperature impacts is recommended:

Ia. Conduct year-round temperature monitoring of Lakes George and Louise (1-2 years), to better understand in-lake temperature dynamics. In addition to lateral and longitudinal characterization of

temperature, vertical profiling work should be conducted to determine the extent of seasonal thermal stratification in the two hydropower impoundments.

Conduct additional winter temperature monitoring at upstream and downstream Kinnickinnic River sites, to better understand the winter temperature impacts of Lakes George and Louise.

Ib. Conduct thermal modeling of the Kinnickinnic River, to determine the extent to which dam removal would improve the temperature regime (lower the baseline temperature) in the currently-impounded and downstream river reaches, how far down river this temperature improvement would extend, and the amount of "thermal buffering capacity" created for protection against future climate change. With a lower downstream baseline temperature, the Kinnickinnic River could better utilize the significant groundwater inputs to the lower five miles of the river (river flow approximately doubles from Main Street in River Falls to County Road F near the river mouth). The thermal model could also be used to evaluate the temperature impacts of the hydropower impoundments (or absence thereof) under several future climate change scenarios, as outlined by WDNR (Mitro, et al., 2011). With enhancements and additional monitoring data (**Ia**), the existing U.S. Army Corps of Engineers (USACE) thermal model created for the Lake George Stormwater Treatment Concept Plan (City of River Falls 2005) could be used for this effort.

Goals and Objectives of the Temperature Impacts Study (Criterion #1)

The goal of this study is to quantitatively assess the current and future temperature impacts of the River Falls hydropower project on the Kinnickinnic River. Monitoring the temperature regime would provide further direct evidence of the thermal impacts of the two hydropower impoundments (Lakes George and Louise) on the Kinnickinnic River. The study objective is to obtain monitoring data from Lakes George and Louise and the Kinnickinnic River upstream and downstream of the hydropower project (**Ia**). The temperature monitoring data could then be used to adapt and apply the previously-developed thermal model CE-QUAL W2 (Noren 2003), to quantify future Kinnickinnic River temperature improvements associated with Powell Falls Dam removal and future temperature impacts caused by the continuing presence of the Junction Falls Dam and Lake George (**Ib**). With a warming trend already occurring in the Kinnickinnic River (Mitro, et al., 2011; Johnson 2018), the thermal model could also be used to determine whether climate change will further compound temperature impacts caused by the continuing presence of the Junction Falls Dam and Lake George.

Relevant Resource Management Goals (Criterion #2)

The Kinnickinnic River is designated by WDNR as a Class I trout stream. The resource management goal is to maintain a healthy coldwater ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. A suitable temperature regime is critical for achieving this goal.

Relevant Public Interest Considerations (Criterion #3)

The Kinnickinnic River is a nationally-renowned trout stream, a scenic river that supports considerable recreation by anglers, boaters, hikers, and other outdoor enthusiasts.

Existing Information and the Need for More Information (Criterion #4)

Since 1992, the Kiap-TU-Wish Chapter of Trout Unlimited has been conducting temperature monitoring of the Kinnickinnic River and three tributaries in the vicinity of River Falls, Wisconsin (see **Background Information**, above).

Using the Kiap-TU-Wish temperature monitoring data, Johnson (2018) evaluated the thermal impacts of the hydropower project on the Kinnickinnic River and summarized monitoring results. Mitro et al. (2011) also used the Kiap-TU-Wish data to assess the additional impact of climate change on the Kinnickinnic River. Noren (2003) applied Kinnickinnic River and River Falls stormwater temperature data to develop a CE-QUAL W2 numerical hydraulic model that simulates the effects of the hydropower impoundments and stormwater runoff on the Kinnickinnic River thermal regime.

Existing temperature data and the new monitoring data and thermal modeling generated by this study should be applied to quantitatively predict the future impacts of the River Falls hydropower project on the thermal regime of the Kinnickinnic River with Powell Falls Dam removal and the continuing presence of the Junction Falls Dam and Lake George.

Nexus to Project Operations and Effects and How Study Results Would Inform License Requirements (Criterion #5)

The proposed Powell Falls Dam removal and re-licensing for the continuing operation of the Junction Falls Dam and presence of Lake George would change the thermal regime of the Kinnickinnic River. The recommended temperature monitoring and thermal modeling would inform re-licensing requirements by providing quantitative information on the current and future thermal impacts of the hydropower project. There are a number of potential protection, mitigation, and enhancement measures (PM&E measures) that could reduce the adverse thermal effects of the project on the coldwater ecosystem of the Kinnickinnic River. These PM&E measures could become part of the re-licensing requirements.

Study Methodology and How It Is Consistent with Accepted Practice (Criterion #6)

Methods for conducting the recommended temperature monitoring of Lakes George and Louise and the Kinnickinnic River are standard limnological practices described by WDNR (2004), Hastings et al. (2011), Toohey et al. (2014), Dauwalter et al. (2017), and others. CE-QUAL W2 (Version 3.1) is a two-dimensional hydrodynamic and water quality model suitable for relatively long and narrow water bodies that exhibit vertical and longitudinal gradients. The original model, known as LARM (Laterally Averaged Reservoir Model), was developed by Edinger and Buchak (1975). Since then, the model was renamed CE-QUAL W2, and it has been continually updated by the U.S. Army Corps of Engineers Research and Development Center. In its present version 3.1, the model has been applied to successfully model lakes, reservoirs, estuaries, and rivers (Cole and Wells 2002).

Level of Effort and Cost of the Study, and Why the Study Is Needed (Criterion #7)

We estimate that the two-year water temperature monitoring component of this study (**Ia**) would cost $20,000. The monitoring would be conducted using commercially-available data-logging thermometers. Data would be downloaded and analyzed, with monitoring results presented in a brief report.

We estimate that application of the CE-QUAL W2 thermal model (**Ib**) to quantify current and future temperature impacts of the hydropower project would cost $75,000. Some fieldwork and perhaps some additional monitoring would be needed to quantify river flows and channel dimensions. Existing and new temperature data (via this study) would be used to adapt the previously-used CE-QUAL W2 model to allow simulation of the future thermal regime of the Kinnickinnic River, with Powell Dam removal and the continuing operation of the Junction Falls Dam.

The study is needed to provide a quantitative prediction of the effects of the hydropower project on the thermal regime of the Kinnickinnic River. The study would also be very beneficial for setting quantitative trigger points to initiate earlier removal of the Junction Falls Dam, to protect the coldwater ecosystem of the Kinnickinnic River, as described in the City of River Falls Resolution No. 6234, Paragraph v (Resolution Recommending Re-Licensing of Hydropower Project P-10489) (February 27, 2018).

Study II. Hydrologic Impacts

Background Information:

The Federal Energy Regulatory Commission (FERC) license for the City of River Falls hydropower project requires that a downstream "run-of-river" condition be maintained at all times. Maintaining a "run-of-river" condition is critical for protecting the Kinnickinnic River habitats that support healthy coldwater macroinvertebrate and trout communities. Sudden decreases in water flow can de-water macroinvertebrate habitats and trout redds, while sudden increases in water flow can de-stabilize the river channel, thereby increasing bank erosion, decreasing water clarity, and damaging in-stream habitat.

The United States Geological Survey (USGS) operates a Kinnickinnic River monitoring station (number 05342000) at County Highway F, near Kinnickinnic State Park, approximately five miles west (downstream) of River Falls. The station continuously measures river stage (water height) and flow at 15-minute intervals year-round, generating approximately 35,000 stage and flow measurements per year. A one-year record of flow data exists for the 1999 water year (October 1998-September 1999), while a continuous record of flow data exists from July 2002 to present. The City of River Falls, Kinnickinnic River Land Trust, and the Kiap-TU-Wish Chapter of Trout Unlimited provide annual cost-share funding to help support the ongoing operation of this station.

The City of River Falls measures and records the daily water levels of Lakes George and Louise.

During periods of stable river flow (baseflow), when precipitation and runoff are not occurring, the Kinnickinnic River hydrograph can be examined to determine whether the City of River Falls hydropower facilities are operating in a "run-of-river" mode, as required by the FERC license.

Evidence of Hydrologic Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 93-94): "The condition of the Kinnickinnic River downstream from the City of River Falls is worse than the condition upstream. Increased temperatures from the two lakes and flow fluctuations caused by dam management procedures contribute to adverse impacts on the Kinnickinnic River ecosystem".

- The Kinni NPS Plan notes (WDNR et al., 1999) (p. 94): "The downstream reach (below Lake Louise and Powell Dam)….is impacted….by flashy stream flows caused by urban runoff and hydropower manipulations".
- The Kinni NPS Plan notes (WDNR et al., 1999) (p. 8): "The impoundments were also shown to have significant impacts on stream flow during trash rack cleaning operations".
- On a number of occasions, recreational users along the lower Kinnickinnic River (downstream from River Falls) have noted sudden flow fluctuations that are likely attributed to irregular operation of the City of River Falls hydropower facilities. In one instance, a Kiap-TU-Wish Chapter member observed a dramatic decrease in Kinnickinnic River flow (from 126 cfs to 53 cfs) on July 11, 2008, during the 15:00-18:45 CDT time period, as measured at the USGS monitoring station (Figure 2). The WDNR (Marty Engel, personal communication) subsequently linked this flow irregularity to a gate malfunction at the lower hydropower facility (Powell Falls Dam).

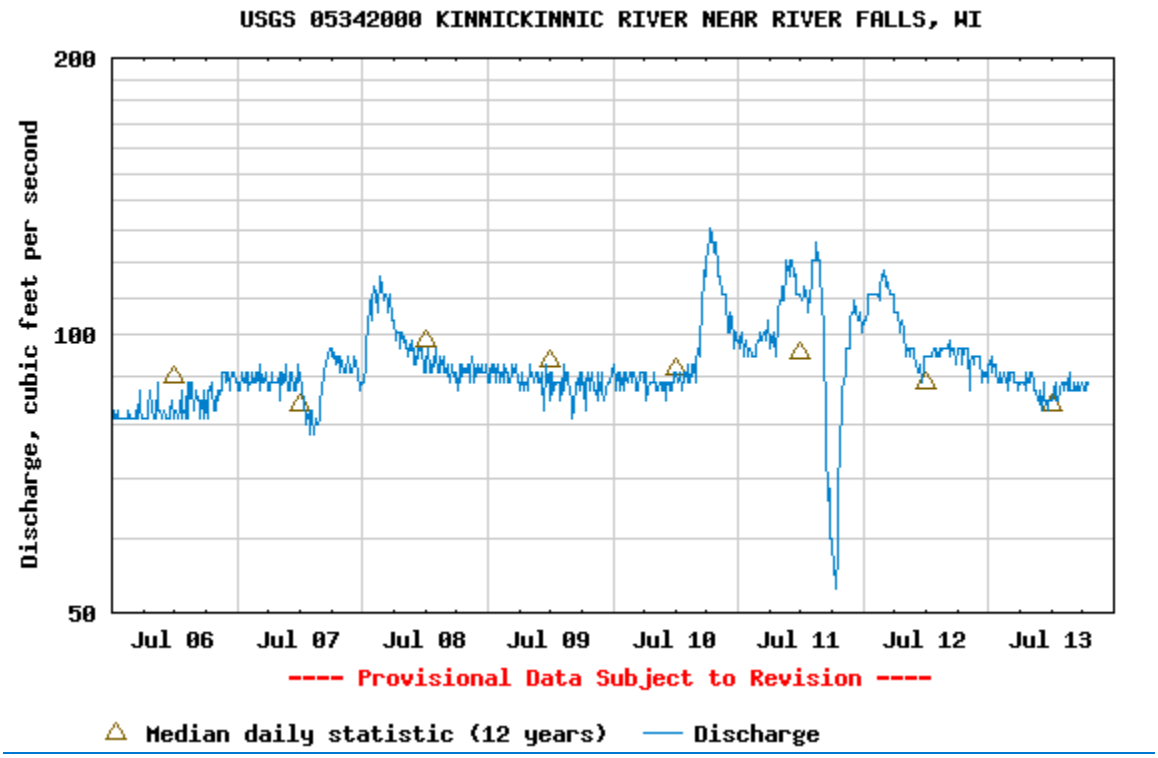

Figure 2. Hydropower-related Kinnickinnic River flow irregularity on July 11, 2008.

<u>Recommended Study Elements to Evaluate Hydrologic Impacts:</u>

Given these past observations of irregular Kinnickinnic River flows, the following study of hydrologic impacts is recommended, to determine whether the City of River Falls hydropower facilities have been maintaining a "run-of-river" condition, as required by the FERC license:

IIa. Using the 15-minute USGS Kinnickinnic River flow data, conduct a thorough assessment of the extent to which the City of River Falls hydropower facilities have maintained a "run-of-river" condition

during the 1999 and 2002-2018 periods. Examine the Kinnickinnic River hydrograph during periods of stable river flow (baseflow), when precipitation and runoff are not occurring, to determine the frequency, magnitude, and duration of flow and stage irregularities.

IIb. Assemble and review observational reports of flow irregularities by recreational users, the public, and other sources. These reports may have been received by the City of River Falls, WDNR, and/or FERC.

IIc. Correlate Kinnickinnic River flow irregularities with concurrent dam operation and maintenance practices. Obtain and review any pertinent records kept by the City of River Falls hydropower utility, to determine if the operation and/or maintenance of the hydropower facilities has resulted in abnormal (non "run-of river") flow conditions.

IId. Identify PM&E measures that would eliminate flow irregularities related to dam operation and maintenance.

Goals and Objectives of the Hydrologic Impacts Study (Criterion #1)

The goal of the hydrologic impacts study is to evaluate the extent to which operation of the River Falls hydropower project has maintained run-of-river flow conditions, as mandated by the FERC license. The study objectives are to analyze existing Kinnickinnic River flow data, in conjunction with dam operations and maintenance data **(IIa-IIb)**, to identify dam operation-induced flow irregularities (**IIc**), and to identify the PM&E measures needed to eliminate them **(IId**).

Relevant Resource Management Goals (Criterion #2)

The Kinnickinnic River is designated by WDNR as a Class I trout stream. The resource management goal is to maintain a healthy coldwater ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. A normal hydrologic regime is critical for achieving this goal.

Relevant Public Interest Considerations (Criterion #3)

The Kinnickinnic River is a nationally-renowned trout stream, a scenic river that supports considerable recreation by anglers, boaters, hikers, and other outdoor enthusiasts.

Existing Information and the Need for More Information (Criterion #4)

Via the USGS monitoring station, Kinnickinnic River flow and stage data are available at 15-minute intervals in 1999 and during the 2002-2018 period. Although River Falls Municipal Utilities has indicated that it maintains dam operation and maintenance records and impoundment stage data, this information does not appear to be publicly available. In spite of these two existing sources of information, there has not been an analysis of compliance with the FERC license requirement for the hydropower project to maintain a run-of-river condition.

Nexus to Project Operations and Effects and How Study Results Would Inform License Requirements (Criterion #5)

Past evidence suggests that operation of the River Falls hydropower project adversely affects river flow (see **Evidence of Hydrologic Impacts**, above). An analysis of existing information is needed to determine compliance with the FERC license requirement to maintain a run-of-river condition, and to identify the PM&E measures necessary to ensure that the River Falls hydropower project meets this license requirement.

Study Methodology and How It Is Consistent with Accepted Practice (Criterion #6)

The proposed study methodology is a desktop analysis, including an evaluation report, of USGS Kinnickinnic River flow data and concurrent River Falls Municipal Utilities dam operation and maintenance information, to identify the frequency, duration, and magnitude of dam operation-induced flow irregularities. Methodology for this study would be consistent with any past analyses by FERC or hydropower licensees to demonstrate compliance with the requirement to maintain a run-of-river flow condition.

Level of Effort and Cost of Study, and Why the Study is Needed (Criterion #7)

We estimate that the cost of the hydrologic impacts study (**IIa-IId**) would be $10,000. Given past observations of irregular Kinnickinnic River flows due to the River Falls hydropower project, this study is needed to evaluate the extent to which project operation has maintained run-of-river flow conditions, as mandated by the FERC license. However, this study would not be needed if: 1) The Powell Falls Dam is removed as scheduled by 2026; **and** 2) The Junction Falls Dam is upgraded with an automated penstock gate and trash rack cleaning system.

Study III. Water Quality Impacts

Background Information:

Very little water quality monitoring of the Kinnickinnic River and Lakes George and Louise has been conducted. WDNR (Schreiber, 1998) evaluated baseline water resource conditions in the Kinnickinnic River Watershed in 1996-1997, to inform the development of the Kinni NPS Plan (WDNR et al., 1999). However, the extent of water quality monitoring was minimal, and no recent assessment of water quality has been conducted by WDNR or other agencies.

Evidence of Water Quality Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): “Lake George is a shallow, eutrophic 18-acre impoundment that….is nearly filled with sediment and experiences summer algae blooms and turbidity”.
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): “Lake Louise is a shallow, eutrophic 15-acre impoundment that….is nearly filled with sediment and experiences summer algae blooms and turbidity”.

The two hydropower impoundments (Lakes George and Louise) have extended water residence times, creating in-lake water and sediment quality problems. In the presence of ample sunlight, favorably warm water temperatures, and adequate nutrient sources, summer algae blooms occur, creating unsightly (green) conditions, reduced water clarity, odors, possible human health impacts, and reduced oxygen concentrations (Figure 3).

Figure 3: Surface algae and shallow water conditions in Lake George (above) and Lake Louise (below)

The highly eutrophic conditions in both lakes severely limit their recreational use, in spite of their close proximity to the heart of River Falls. The extended water residence time also allows suspended sediment (silt) from upstream sources (both urban and agricultural) to accumulate in the lakes. Besides in-filling the lakes, the suspended sediment carries contaminants (phosphorus, trace metals, and organic compounds (PAHs and pesticides)) that are deposited in the lake bottom, with possible impacts on benthic invertebrates and fish. Large numbers of Canada geese and ducks congregate on Lakes George and Louise in the fall and winter, resulting in phosphorus, nitrogen, and bacterial loading to the lakes. Biological, chemical, and physical processes can transfer sediment contaminants to the overlying water column in the lakes, thereby causing in-lake and downstream water quality problems. For instance, increased water flows through the impoundments during storm runoff events can re-suspend the fine silt and contaminants from the lake bottom, with impacts on in-lake and downstream water quality. Water and sediment contaminants can also be transferred to biota through bioaccumulation and biomagnification processes, with implications for aquatic and human health (typically via fish consumption). Experience has shown that remediation of sediment contamination is often difficult, costly, time consuming, and disruptive to the local environment and community (Parkerton and Maruya, 2013).

Recommended Study Elements to Evaluate Water Quality Impacts:

The proposed removal of the Powell Falls Dam and associated Kinnickinnic River restoration by 2026 will substantially eliminate the current water quality impacts caused by Lake Louise, thereby improving water quality in the lower Kinnickinnic River. However, re-licensing and the ongoing presence of the Junction Falls Dam and Lake George until 2035-2040 will continue to create in-lake and downstream water quality impacts. To better assess the degraded water quality conditions in Lake George and evaluate downstream effects, the following study of water quality impacts is recommended:

III. Conduct seasonal (April-October) water quality monitoring of Lake George and at upstream and downstream Kinnickinnic River locations for two years, to better assess in-lake water quality problems and possible downstream water quality impacts. Water quality monitoring should be conducted during both baseflow and storm runoff conditions, to fully characterize in-lake and downstream impacts. Monitoring will also help determine whether applicable state water quality standards are being met (example: phosphorus standard of 75 ug/l, per WI Chapter NR 102). Monitoring of multiple water quality variables is recommended: dissolved oxygen, turbidity, suspended solids, nutrients (various forms of phosphorus and nitrogen), trace metals, bacteria, and chlorophyll (estimate of algal presence). Document the seasonal timing and spatial extent of floating algal mats on Lake George (such as those in Figure 3), using weekly photography. In addition to longitudinal water quality characterization at upstream, in-lake, and downstream locations, in-lake vertical profiling work and/or continuous monitoring of dissolved oxygen, temperature, pH, and conductivity should be conducted, to determine the extent of stratification and dynamic changes (daily, weekly, monthly) that occur in Lake George. With possible decreased in-lake dissolved oxygen concentrations due to eutrophication and increased sediment oxygen demand, an upstream-downstream comparison of diel oxygen fluctuations should also be conducted via continuous monitoring.

Goals and Objectives of the Water Quality Impacts Study (Criterion #1)

The goal of the water quality impacts study is to evaluate the effects of the River Falls hydropower project on water quality in Lake George and downstream in the Kinnickinnic River. The study objective is to obtain

water quality monitoring data from Lake George, and from upstream and downstream locations in the Kinnickinnic River. The monitoring data will be analyzed to evaluate the water quality condition of Lake George and assess any downstream impacts on the Kinnickinnic River (**III**).

Relevant Resource Management Goals (Criterion #2)

The Kinnickinnic River is designated by WDNR as a Class I trout stream. A key resource management goal is to maintain a healthy coldwater ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. An additional resource management goal is to provide an aesthetic and recreational river in the heart of River Falls, for ready access and enjoyment by residents and visitors. Good water quality is critical for achieving both of these resource management goals.

Relevant Public Interest Considerations (Criterion #3)

The Kinnickinnic River is a nationally-renowned trout stream, a scenic river that supports considerable recreation by anglers, boaters, hikers, and other outdoor enthusiasts. The City of River Falls is currently engaging the community in a Kinnickinnic River corridor planning process (Kinni Corridor Project), to develop a long-term vision, plan, and implementation strategy for river corridor improvements that benefit hydrologic conditions, ecological values and best practices, floodplain restoration and flood control, economic development opportunities, and recreational opportunities. Although Lakes George and Louise are prominent features along the river corridor, both lakes have water quality problems that limit their future usefulness.

Existing Information and the Need for More Information (Criterion #4)

As noted above (**Background Information)**, very little water quality monitoring of the Kinnickinnic River and Lakes George and Louise has been conducted. As such, more information is needed to determine the water quality impacts of the River Falls hydropower project on Lake George and the Kinnickinnic River.

Nexus to Project Operations and Effects and How Study Results Would Inform License Requirements (Criterion #5)

Past evidence suggests that operation of the River Falls hydropower project adversely affects water quality in Lakes George and Louise (see **Evidence of Water Quality Impacts**, above); but little water quality information is available to determine the extent of the problem and compliance with state water quality standards. However, FERC re-licensing requires state water quality certification by the WDNR. The recommended study will provide information on the water quality impacts of the River Falls hydropower project and suggest PM&E measures that may be needed to improve Lake George water quality.

Study Methodology and How It Is Consistent with Accepted Practice (Criterion #6)

Standard physical and chemical limnological practices (Green et al. 2015; MPCA 2014) would be used to conduct the recommended water quality monitoring of Lake George and the Kinnickinnic River. A combination of discrete sampling and continuous monitoring would be conducted during baseflow and storm runoff conditions, to temporally and spatially characterize multiple water quality variables: dissolved oxygen, temperature, pH, conductivity, turbidity, suspended solids, nutrients (various forms of phosphorus

and nitrogen), trace metals, bacteria, and chlorophyll (estimate of algal presence). WDNR has developed guidelines for the deployment of continuous dissolved oxygen meters, including data evaluation and storage.

Level of Effort and Cost of Study, and Why the Study is Needed (Criterion #7)

We estimate that the cost of a two-year water quality impacts study (**III**) would be $70,000. The study is needed to determine how the continuing operation of the Junction Falls Dam affects water quality in Lake George and the Kinnickinnic River. The study could also suggest PM&E measures that may be needed to improve Lake George water quality.

Study IV. Sediment Impacts

Background Information:

The extended water residence times in Lakes George and Louise allow suspended sediment (silt) from upstream sources (both urban and agricultural) to accumulate in both lakes. Besides in-filling the lakes, the suspended sediment carries contaminants (phosphorus, trace metals, and organic compounds (PAHs and pesticides)) that are deposited in the lake bottom, with possible impacts on water quality, benthic invertebrates, and fish.

In 1989-1990, the City of River Falls collected a limited number of sediment core samples from Lake George, with analysis of trace metals, organic compounds, and total Kjeldahl and ammonia nitrogen (City of River Falls, unpublished data).

More recently, Inter-Fluve (2016) conducted a sediment study of Lakes George and Louise for the City of River Falls. The study estimated the volumes and types of sediment that have accumulated in both lakes, and bathymetric lake maps were created. The study also assessed the magnitude and distribution of sediment contamination in Lakes George and Louise, with sediment core samples analyzed for inorganic (trace metals) and organic (PCBs and PAHs) pollutants. Finally, the study estimated the volumes of sediment that would be mobilized from the river channels of Lakes George and Louise with passive dam removals.

Evidence of Sediment Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): “Lake George is a shallow, eutrophic 18-acre impoundment that….is nearly filled with sediment and experiences summer algae blooms and turbidity”.
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): “Lake Louise is a shallow, eutrophic 15-acre impoundment that….is nearly filled with sediment and experiences summer algae blooms and turbidity”.
- During their historical presence in River Falls, Lakes George and Louise have substantially filled with sediment. The estimated volume of impounded sediment in Lake George is 166,800 cubic yards, consisting of 80% sands and 20% silts and clays. The estimated volume of impounded sediment in Lake Louise is 163,800 cubic yards, consisting of 65% sands and 35% silts and clays (Inter-Fluve 2016).
- Concentrations of some contaminants in the sediments of Lakes George and Louise exceed Wisconsin sediment quality guidelines (SQGs) established to protect aquatic life, and Environmental Protection

Agency (EPA) regional screening levels (RSLs) established to protect human health (Inter-Fluve 2016). In Lake George, several trace metals (lead and mercury) and organic compounds (3 PAH congeners and total PCBs) exceed SQGs, while several trace metals (arsenic and hexavalent chromium) and an organic compound (2 PAH congeners) exceed RSLs. The extent of sediment contamination is greater in Lake Louise, where several trace metals (arsenic, cadmium, mercury, and nickel) and organic compounds (4-4' DDD, lindane, and 11 PAH congeners) exceed SQGs, while several trace metals (arsenic and hexavalent chromium) and an organic compound (4 PAH congeners) exceed RSLs.

Removal of the Powell Falls Dam (by 2026) and eventual removal of the Junction Falls Dam (by 2035-2040) have the potential to mobilize sediment from Lake Louise and Lake George, respectively. With passive sediment management after dam removal, an estimated 45,100 cubic yards of Lake Louise sediment could be transported downstream, while an estimated 73,900 cubic yards of Lake George sediment could be transported downstream (Inter-Fluve 2016).

The transport of sediment after dam removal has the potential to impact the downstream Kinnickinnic River and its riparian areas. Sediment impacts could include episodic high concentrations of suspended solids, affecting macroinvertebrates and fish, and siltation of critical aquatic habitats for periphyton, macrophytes, macroinvertebrates, and fish (including spawning habitat). Depending on sediment transport distance, high concentrations of suspended solids and siltation could also impact freshwater mussels in the St. Croix River, including the federally-endangered species Higgin's Eye Pearly Mussel (*Lampsilis higginsi*), Snuffbox (*Epioblasma triquetra*), and Spectaclecase (*Cumberlandia monodonta*).

The downstream movement of sediment from Lakes George and Louise would be accompanied by adsorbed phosphorus, adding to the phosphorus load that the Kinnickinnic River contributes to the St. Croix River at Lake St. Croix. In August 2012, the EPA approved the final Total Maximum Daily Load (TMDL) for phosphorus in Lake St. Croix (eastern Minnesota and western Wisconsin). The Lake St. Croix TMDL report (MPCA and WDNR 2012) calls for a significant reduction in phosphorus loading from St. Croix River tributaries, including the Kinnickinnic River.

As noted above (see **Evidence of Sediment Impacts**), concentrations of some contaminants in the sediments of Lakes George and Louise exceed Wisconsin sediment quality guidelines (SQGs) established to protect aquatic life. These contaminants may be toxic to aquatic life in Lakes George and Louise, and when transported downstream, they may also have adverse impacts on aquatic life in the lower Kinnickinnic River and the St. Croix River.

Inter-Fluve (2017) examined the feasibility of removing the two River Falls hydropower dams and recommended potential sediment management practices to limit the downstream impacts of sediment transport.

Re-licensing of the River Falls hydropower project and the continuing operation of the Junction Falls Dam would retain Lake George for an extended time period before dam removal in 2035-2040. As noted above (see **Evidence of Sediment Impacts**), Lake George is a shallow, eutrophic impoundment that is nearly filled with sediment and experiences summer algae blooms and turbidity. High nutrient loading from the agricultural watershed, River Falls stormwater runoff, and waterfowl make Lake George highly eutrophic, with unsightly mats of algae present during much of the open-water season (Figure 3). In addition, the

unconsolidated, fine sediment in Lake George is readily re-suspended by wind, carp, and river currents, creating turbid water conditions. Due to excessive algal levels and turbid water conditions, very little submersed or emergent aquatic vegetation grows in Lake George. The shallow water and poor water quality constrain public use, such that minimal water-based recreation occurs on Lake George, despite its close proximity to downtown River Falls. Project re-licensing with the continuing operation of the Junction Falls Dam demands an examination of ways to improve water quality conditions in Lake George for the duration of its existence. One option for doing so involves temporary water drawdown in the lake, to consolidate sediment and stimulate the germination of perennial aquatic plants (Kenow et al. 2016).

Recommended Study Elements to Evaluate Sediment Impacts:

The proposed removal of the Powell Falls Dam and associated Kinnickinnic River restoration (by 2026) will potentially create downstream impacts caused by the mobilization of Lake Louise sediment and its associated contaminants (phosphorus, trace metals, and organic compounds). In addition, re-licensing and the ongoing presence of the Junction Falls Dam and Lake George (until 2035-2040) will continue to create in-lake and downstream water quality impacts. To assess sediment problems related to removal of the Powell Falls Dam and evaluate options for improving the degraded water quality conditions in Lake George, the following study of sediment impacts is recommended:

IVa. Using the results of the Inter-Fluve sediment study (2016) and feasibility report on dam removal (2017) as guidance, conduct additional sediment core sampling and analysis in Lake Louise, to better quantify the locations and volume of sediment with contaminants of concern (those exceeding Wisconsin SQGs and EPA RSLs). Sediment contaminants to be analyzed should include phosphorus, trace metals, and organic compounds (PCBs and PAHs). More detailed information on locations of contaminants of concern, contaminant levels, and the volume of contaminated sediment is necessary to inform the development of a sediment management plan that will minimize the impacts of Powell Falls Dam removal. The impacts of contamination may occur when Lake Louise sediment is transported downstream, moved offsite for disposal or re-use, and/or re-distributed in floodplain areas during Kinnickinnic River restoration work. Inter-Fluve (2017) notes that permit regulations for dam removal will likely require re-sampling and testing of lake areas where sediment contaminant concentrations exceed thresholds of concern. At that point, WDNR can also provide guidance on the extent of additional sediment sampling and analysis in Lake Louise.

IVb. Develop a sediment management plan that identifies the best practices needed to minimize sediment impacts during and after removal of the Powell Falls Dam, including Kinnickinnic River restoration work. Such impacts may be associated with downstream mobilization of sediment and its associated contaminants, as well as surficial exposure of sediment contaminants after lake drawdown. The management plan should also identify the best practices needed to minimize contamination impacts if Lake Louse sediment is moved offsite and/or re-distributed in floodplain areas during Kinnickinnic River restoration work. The Inter-Fluve feasibility report (2017) notes the importance of sediment management in conjunction with dam removal and river restoration projects.

IVc. Use a numerical hydraulic model (RMA-2 with Sed 2D) (Nairn, et al. 2006) to simulate and quantify the downstream mobilization of sediment that may occur during and after removal of the Powell Falls Dam. The sediment management plan (**IVb**) will help inform the assumptions needed for model development and application. Apply the model to: 1) Estimate the extent of sediment deposition in the

Kinnickinnic River channel, the riparian areas, and the St. Croix River at Lake St. Croix; 2) Simulate the concentrations and duration of elevated suspended solids levels in the lower Kinnickinnic River and Lake St. Croix; and 3) Estimate the quantity of contaminants delivered to the lower Kinnickinnic River and Lake St. Croix.

IVd. Determine the feasibility of improving water quality conditions in Lake George via a short-term drawdown of the water level, which will consolidate the sediment and stimulate the growth of perennial aquatic plants. In addition to improving water quality, establishment of perennial aquatic plants would also provide critical in-lake habitat for fish and wildlife.

Goals and Objectives of the Sediment Impacts Study (Criterion #1)

The goals of the sediment impacts study are: 1) Assess the sediment problems associated with removal of the Powell Falls Dam and restoration of the Kinnickinnic River; and 2) Evaluate options for improving the degraded water quality conditions in Lake George. Study objectives are: 1) Conduct additional sediment core sampling and analysis in Lake Louise, to better quantify the locations and volume of sediment with contaminants of concern **(IVa**); 2) Develop a sediment management plan that identifies the best practices needed to minimize sediment impacts during and after removal of the Powell Falls Dam, including Kinnickinnic River restoration (**IVb**); 3) Use a hydraulic model to simulate and quantify the downstream mobilization of sediment that may occur during and after removal of the Powell Falls Dam (**IVc**); and 4) Determine the feasibility of improving water quality conditions in Lake George via a short-term drawdown of the water level, which will consolidate the sediment and stimulate the growth of perennial aquatic plants (**IVd**).

Relevant Resource Management Goals (Criterion #2)

The Kinnickinnic River is designated by WDNR as a Class I trout stream. A key resource management goal is to maintain a healthy coldwater ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. Resource management goals for the St. Croix River include reducing phosphorus loading to improve water quality, and protecting the diverse fish and mussel populations, including several federally-endangered mussel species. Managing the sediment impacts associated with dam removal projects is critical for achieving all of these resource management goals.

Relevant Public Interest Considerations (Criterion #3)

The Kinnickinnic River is a nationally-renowned trout stream, a scenic river that supports considerable recreation by anglers, boaters, hikers, and other outdoor enthusiasts. The St. Croix River is a National Wild and Scenic River that is extensively used for recreational purposes.

Existing Information and the Need for More Information (Criterion #4)

As described above (**Background Information**), past studies of the sediment characteristics in Lakes George and Louise have been conducted by the City of River Falls (1989-1990) and Inter-Fluve (2016). The Inter-Fluve study determined that concentrations of some contaminants in the sediments of Lakes George and Louise exceed Wisconsin sediment quality guidelines (SQGs) established to protect aquatic life, and Environmental Protection Agency (EPA) regional screening levels (RSLs) established to protect human

health. However, more detailed information on locations of contaminants of concern, contaminant levels, and the volume of contaminated sediment in Lake Louise is necessary to inform the development of a sediment management plan that will minimize the impacts of Powell Falls Dam removal. Inter-Fluve (2016, 2017) estimated the volume of sediment that could be mobilized with passive management during Powell Falls Dam removal. However, application of a hydraulic flow and sediment transport model is needed to quantify the extent of sediment mobilization and its downstream impacts. Finally, with re-licensing and the ongoing presence of the Junction Falls Dam and Lake George (until 2035-2040), options need to be evaluated for improving the degraded water quality conditions in Lake George.

Nexus to Project Operations and Effects and How Study Results Would Inform License Requirements (Criterion #5)

The proposed removal of the Powell Falls Dam (by 2026) and the eventual removal of the Junction Falls Dam (by 2035-2040) will potentially create downstream impacts caused by the mobilization of sediment and its associated contaminants. In addition, re-licensing and the ongoing presence of the Junction Falls Dam and Lake George (until 2035-2040) will continue to create in-lake and downstream water quality impacts that need to be addressed. The recommended studies would inform PM&E measures that are needed to remediate sediment impacts related to dam removal and improve water quality conditions in Lake George.

Study Methodology and How It Is Consistent with Accepted Practice (Criterion #6)

Methods for conducting additional core sampling and contaminant analysis of Lake Louise sediment are those used and described by Inter-Fluve (2016).

Development of a sediment management plan that identifies the best practices needed to minimize sediment impacts during and after removal of the Powell Falls Dam will likely be a permit requirement, to be completed with WDNR oversight, input, and approval. Furthermore, the allowance for sediment to be released downstream will require a WDNR waters permit and WDNR fisheries input (Inter-Fluve 2016).

The numerical hydraulic flow and sediment transport model is a standard tool that was developed by the U.S. Army Corps of Engineers and has been widely used to simulate river flow and sediment transport. This approach has been applied to assess sediment mobilization associated with dam removal projects on many rivers worldwide (Nairn et al. 2006).

Numerous studies have evaluated the effectiveness of lake drawdown as a method to consolidate sediment and establish perennial aquatic plants. This has become a standard practice to improve water quality and aquatic habitat in regulated rivers worldwide, with demonstrated success in the Upper Mississippi River and impoundments in Wisconsin and Minnesota (Kenow et al. 2016).

Level of Effort and Cost of Study, and Why the Study is Needed (Criterion #7)

Additional core sampling and contaminant analysis of Lake Louise sediment (**IVa**) is estimated to cost $25,000. Development of a sediment management plan to minimize the sediment impacts associated with Powell Falls Dam removal (**IVb**) is estimated to cost $25,000. Application of the hydraulic flow and sediment transport model to evaluate the downstream impacts of sediment mobilization (**IVc**) is estimated to

cost $75,000. Evaluation of lake drawdown as a method to improve water quality and aquatic habitat in Lake George (**IVd**) is estimated to cost $5,000. The sediment impacts study is needed to fully evaluate and minimize sediment problems related to removal of the Powell Falls Dam, and to evaluate options for improving the degraded water quality conditions in Lake George.

Study V. Biological Impacts

Background Information:

Regular WDNR fisheries surveys (1996, 2004-2018) have been conducted at Kinnickinnic River locations upstream and downstream from the two City of River Falls hydropower impoundments. However, no WDNR fisheries surveys have been conducted in Lakes George and Louise (Marty Engel, WDNR, personal communication).

Occasional macroinvertebrate surveys have been conducted by the WDNR (1995-1998), University of Wisconsin-River Falls (1997, 1999, 2001), and the City of River Falls (2004-2012), at Kinnickinnic River locations upstream and downstream from the two City of River Falls hydropower impoundments (Garry, 2006). However, no known macroinvertebrate surveys have been conducted in Lakes George and Louise.

Evidence of Biological Impacts:

- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 36): "The entire main stem of the Kinnickinnic River is classified by WDNR as a cold Class I trout fishery. The two impoundments in the City of River Falls, Lake Louise and Lake George, support a warm water sport fishery (WWSF)".
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): "Lake George….has a limited warmwater and coldwater sport fishery consisting of largemouth bass, panfish, and brown trout".
- The Kinni NPS Plan (WDNR et al., 1999) notes (p. 94): "Lake Louise…. has a limited warmwater and coldwater sport fishery consisting of largemouth bass, panfish, and brown trout. The lake also supports a significant carp population".
- The temperature, hydrologic, and water quality conditions created by the two City of River Falls hydropower impoundments have significantly impacted a 0.7-mile reach of a coldwater resource, as evidenced by the classification of Lakes George and Louise by WDNR as warmwater sport fisheries.
- Concentrations of some contaminants in the sediments of Lakes George and Louise exceed Wisconsin sediment quality guidelines (SQGs) (Inter-Fluve 2016), suggesting that these areas of contamination may be directly toxic to aquatic life, especially benthic macroinvertebrates. If mobilized as a result of dam removal, these sediment contaminants may also have adverse impacts on aquatic life in the lower Kinnickinnic River and the St. Croix River.

The primary impact of the River Falls hydropower project on Kinnickinnic River ecology is the dramatic conversion of a coldwater river system to warmwater impoundments (Lakes George and Louise) upstream of the dams. Due to changes in temperature and hydrologic regimes, water quality, and sedimentation, the impacts of these two impoundments have profoundly affected the river's biological communities, including fish, macroinvertebrates, aquatic plants, and river-related wildlife.

Recommended Study Elements to Evaluate Biological Impacts:

The proposed removal of the Powell Falls Dam and associated Kinnickinnic River restoration (by 2026) will substantially eliminate the current biological impacts caused by Lake Louise and greatly improve the health of biological communities in the restored river reach. However, re-licensing and the ongoing presence of the Junction Falls Dam and Lake George until 2035-2040 will continue to create in-lake and downstream biological impacts. To better assess the degraded biological conditions in Lakes George and Louise and evaluate downstream effects, the following study of biological impacts is recommended:

Va. Conduct a comparative assessment of available Kinnickinnic River fisheries and macroinvertebrate survey results from locations upstream and downstream of Lakes George and Louise, to determine if downstream biological impacts are evident, especially via alterations in aquatic community composition and abundance. Multiple biotic metrics and indices can be used to make this comparison. If existing data are insufficient and/or do not reflect current conditions, conduct additional biological surveys of fish and macroinvertebrates communities at Kinnickinnic River locations upstream and downstream from the two lakes.

Vb. Conduct fisheries and macroinvertebrate surveys of Lakes George and Louise, to characterize current biological conditions and assess the in-lake biological impacts of these two hydropower impoundments, especially via alterations in aquatic community composition and abundance. Compare the in-lake fish and macroinvertebrate communities with those at upstream and downstream Kinnickinnic River locations (**Va**).

Vc. Conduct Kinnickinnic River surveys of aquatic vegetation (periphyton and macrophytes) at locations upstream and downstream of the two City of River Falls hydropower impoundments, to evaluate the extent to which increased downstream temperatures, nutrient availability, and primary productivity have enhanced nuisance growths of aquatic vegetation, potentially impacting habitat quality for trout and macroinvertebrates (BC Ministry of Environment, Lands, and Parks, 2001; DeNicola, 1996).

Vd. Conduct aquatic macrophyte surveys of Lakes George and Louise, to determine the species composition, abundance, and spatial distribution of submersed and emergent aquatic plants.

Ve. Through survey work, determine the extent to which Lakes George and Louise may be harboring aquatic and terrestrial invasive species, as defined by Wisconsin's invasive species rule (NR 40). This information is needed to evaluate any risks posed for other portions of the Kinnickinnic River and to develop appropriate management strategies.

Vf. Coordinate with the WDNR, Minnesota Department of Natural Resources, the U.S. Army Corps of Engineers St. Paul District, the U.S. Fish and Wildlife Service, the National Park Service, and the U.S. Geological Survey Upper Midwest Environmental Science Center to obtain the most recent information about the species composition and the spatial extent of freshwater mussels in the lower Kinnickinnic River, and in the St. Croix River (Lake St. Croix) at locations downstream of the Kinnickinnic River confluence. Determine the presence of federally-listed and state-listed threatened and endangered mussel species. If existing data are insufficient and/or do not reflect current conditions, conduct additional biological surveys of mussel presence in the lower Kinnickinnic River and the St. Croix River. Information on mussel presence can be used in conjunction with model

simulations of sediment mobilization associated with dam removal (**IVc**), to assess the impacts of dam removal on the Kinnickinnic and St. Croix River mussel communities.

Vg. To evaluate improvements in physical and chemical conditions and biological communities in the Kinnickinnic River as a result of dam removal and river restoration, conduct pre- and post-restoration monitoring of the 0.7-mile Kinnickinnic River reach currently impacted by Lakes George and Louise. Establish monitoring goals and objectives and develop a monitoring plan that can identify key changes in temperature regime, habitat, water quality, sediment characteristics, and biological communities. Study elements **Ia**, **III**, **IVa**, and **Va-Ve** may serve in part as documentation of pre-restoration temperature, water quality, sediment, and biological conditions. However, additional pre-restoration monitoring may be needed, depending on the recommendations in the monitoring plan.

Goals and Objectives of Biological Impacts Study (Criterion #1)

The goal of the biological impacts study is to evaluate the effects of the River Falls hydropower project on biological communities in Lakes George and Louise, and in the Kinnickinnic and St. Croix Rivers. Study objectives are: 1) Conduct biological surveys of fish, macroinvertebrates, and aquatic vegetation in Lakes George and Louise, and at Kinnickinnic River locations upstream and downstream from the two lakes (**Va-Vd**); 2) Determine whether aquatic invasive species are present in Lakes George and Louise and pose risks for other portions of the Kinnickinnic River (**Ve**); 3) Determine whether freshwater mussels (including federally-listed and state-listed threatened and endangered species) are present in the lower Kinnickinnic River and at downstream St. Croix River locations, thereby posing a risk for impacts on mussels due to sediment mobilization associated with dam removal (**Vf**); and 4) Evaluate future improvements in physical and chemical conditions and biological communities in the Kinnickinnic River, as a result of dam removal and river restoration (**Vg**).

Relevant Resource Management Goals (Criterion #2)

The Kinnickinnic River is designated by WDNR as a Class I trout stream. A key resource management goal is to maintain a healthy coldwater ecosystem that supports naturally-reproducing brown and brook trout populations in the Kinnickinnic River. An important resource management goal for the St. Croix River is to protect the diverse fish and mussel populations, including several federally-endangered mussel species. Managing the biological impacts associated with the River Falls hydropower project and future dam removal is critical for achieving both of these resource management goals.

Relevant Public Interest Considerations (Criterion #3)

The Kinnickinnic River is a nationally-renowned trout stream, a scenic river that supports considerable recreation by anglers, boaters, hikers, and other outdoor enthusiasts. The St. Croix River is a National Wild and Scenic River that is extensively used for recreational purposes. Recreational opportunities in both river corridors depend heavily on healthy and diverse biological communities.

Existing Information and the Need for More Information (Criterion #4)

As described above (**Background Information**), very limited information exists about the biota of the Kinnickinnic River, with nearly a complete lack of information about biological communities in Lakes

George and Louise. The information on biological impacts of the River Falls hydropower project is needed to inform the re-licensing process. With re-licensing and the ongoing presence of the Junction Falls Dam and Lake George until 2035-2040, options need to be evaluated for improving the degraded water quality and biological conditions in Lake George and managing the presence of any invasive species. In addition, information about biological communities is needed to assess the impacts and benefits of removing the Powell Dam (by 2026) and the Junction Falls Dam (by 2035-2040).

Nexus to Project Operations and Effects and How Study Results Would Inform License Requirements (Criterion #5)

The near-term removal of the Powell Falls Dam (by 2026) and the eventual removal of the Junction Falls Dam (by 2035-2040) will affect aquatic life in the Kinnickinnic and St. Croix Rivers. The proposed biological studies would inform PM&E measures that are needed to protect aquatic life in the Lower Kinnickinnic and St. Croix Rivers during dam removal. In addition, re-licensing and the ongoing presence of the Junction Falls Dam and Lake George (until 2035-2040) will continue to create in-lake and downstream water quality and biological impacts. Surveys of aquatic life in Lake George would inform PM&E measures that are needed to remediate these impacts and improve in-lake conditions.

Study Methodology and How It Is Consistent with Accepted Practice (Criterion #6)

Numerous standardized protocols are available for surveying biological communities in lakes, rivers, and riparian corridors. Protocols for surveying fish populations can be found in Plafkin, et al. (1989), Lyons, et al. (1996), and WDNR (2001 and 2007). Protocols for monitoring macroinvertebrates include those provided by Hilsenhoff (1987 and 1988), Plafkin, et al. (1989), WDNR (2000), MPCA (2017), and Garry (2017). Scott, et al. (2002), Hauxwell, et al. (2010), and Bowden, et al. (2017) document protocols for monitoring macrophytes. Additional protocols for monitoring a wide variety of riparian area elements can be found in MPCA (2002) and MDNR (2007). WDNR protocols should be used for surveys of aquatic invasive species (WDNR 2012) and freshwater mussels (WDNR 2015). Methodologies for conducting this study of biological impacts should be consistent with the protocols described above and others using acceptable, standardized practices.

Level of Effort and Cost of Study, and Why the Study is Needed (Criterion #7)

We estimate that the biological surveys of the Kinnickinnic River and Lakes George and Louise, including surveys of fish, macroinvertebrates, macrophytes, and invasive species (**Va-Ve**), will cost $70,000. The cost for compilation and evaluation of available information on freshwater mussel presence in the St. Croix River (**Vf**) is estimated to be $10,000. Pre- and post-restoration monitoring of the Kinnickinnic River reach currently impacted by Lakes George and Louise (**Vg**) is estimated to be $50,000.

The study of biological impacts is needed to assess the effects of re-licensing and the continuing operation of the Junction Falls Dam (until 2035-2040), and to evaluate the impacts and benefits of removing the Powell Dam (by 2026) and the Junction Falls Dam (by 2035-2040). Study information can also be used to develop any PM&E measures and license requirements that are needed to comply with federal and state endangered species laws, control any aquatic and/or terrestrial invasive species found in the project area, and improve the degraded water quality conditions in Lake George.

Study Design and Implementation

All of the study elements recommended above (in Studies I-V) should be designed and conducted by qualified water resource professionals, including those in consulting firms, water resource agencies, and non-governmental organizations with expertise and knowledge of the subject matter. This is especially critical for those study elements needed to gain federal and/or state regulatory approval for project re-licensing. Faculty and students at the University of Wisconsin River Falls also have the expertise to help design and implement some of the recommended study elements.

The study protocols used for monitoring, data collection, and/or analysis should be consistent with those used by water resource agencies (Minnesota Pollution Control Agency, Minnesota Department of Natural Resources, Metropolitan Council Environmental Services, Wisconsin Department of Natural Resources, National Park Service, U.S. Geological Survey, U.S. Environmental Protection Agency) and/or as documented in peer-reviewed literature and reports (see **References**, below).

The study costs noted are best estimates of the resources needed to complete them; however these costs can be better quantified after detailed study designs have been completed. Some cost efficiencies can likely be achieved by bundling study elements that are similar in design and logistics. If study costs are a concern for the City of River Falls, City staff should meet with all stakeholders who submit study requests, to assess options that would minimize costs yet achieve the desired study outcomes.

Kiap-TU-Wish would greatly appreciate the opportunity to work with the City of River Falls and their water resource consultants on study design, selection of appropriate protocols and methodologies, and data analysis.

From the Nonpoint Source Control Plan for the Kinnickinnic River Priority Watershed Project:

"This plan does not take a position relative to the future of the dams in River Falls. However, it is important to recognize that the dams do create both positive and negative impacts for the ecosystem and human users of the watershed that should be analyzed prior to major reinvestment in the future."

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