



Lake George and Lake Louise Sediment Assessment Report

SUBMITTED TO
City of River Falls, WI

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Introduction

The City of River Falls currently holds a license from the Federal Energy Regulatory Commission (FERC) to operate the Junction Falls (Upper) and Powell Falls (Lower) hydroelectric facilities. The City recently completed an evaluation of the FERC relicensing process and is now pausing relicensing in order to fully evaluate alternatives. To this end, they contracted Inter-Fluve to evaluate existing sediment conditions in the upper and lower impoundments, Lakes George and Louise, respectively (Figure 1). The main focus of the work was to assess the quantity and quality of impounded sediment behind both dams, and to determine the potential volume of sediment that may be evacuated or need to be excavated in the event of dam removal.

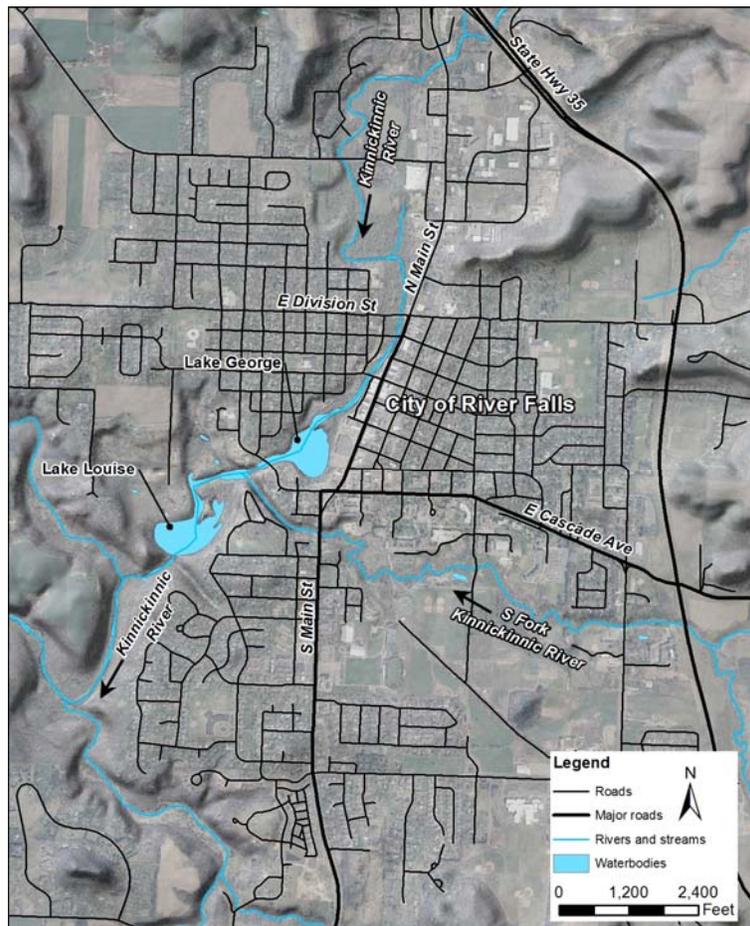


Figure 1. The Kinnickinnic River at River Falls showing the location of the two impoundments, Lake George and Lake Louise.

Sediment Volume Assessment

METHODS

Field assessment of existing impounded sediment composition and volume was completed using bathymetric surveys and sediment depth probing, also known as depth-to-refusal probing (Figures 2 to 4; Appendix A). This information was updated with coring data from the contaminant sampling effort. The bathymetric survey and refusal depth probing in Lake George consisted of 15 transects across the channel and impoundment bed with a survey-grade rtk-GPS unit (Figure 2). In Lake Louise, 15 GPS and refusal transects were supplemented with single beam sonar data to describe areas with deeper water. The sonar requires a minimum depth of three feet which was only present in the thalweg of Lake Louise. Extensive aquatic vegetation and shallow depths throughout the rest of Lake Louise and most of Lake George prohibited further use of sonar equipment.

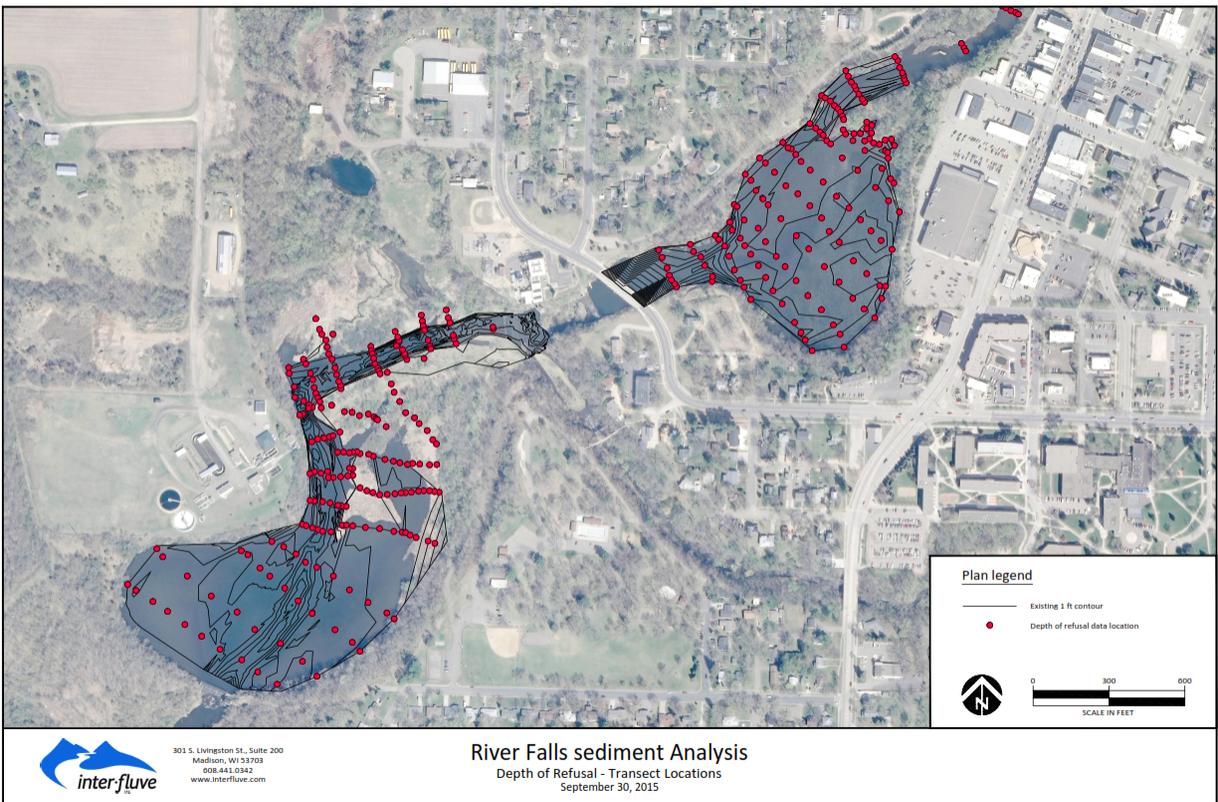


Figure 2. GPS and depth to refusal survey locations in Lake George (right) and Lake Louise (left). For more details, see Appendix A.

At each survey point along the GPS transects, a graduated rod was driven into the sediment until a resistant material (gravel, rock or clay) prohibited further advancement. This final depth is the “depth-to-refusal,” which typically represents a pre-dam channel bed or floodplain surface. In the River Falls impoundments, rock was the refusal material generally encountered along the expected pre-dam channel alignment. A firm, compact silt/clay layer was encountered in locations likely occupied by floodplain prior to dam construction.

Survey data were integrated in AutoCAD® Civil3D® to create an existing conditions surface of the impoundment beds (top of sediment surface) and a pre-dam surface based on the refusal data. The data were adjusted using the National Geodetic Survey’s Online Positioning User Service to relate the North American Vertical Datum of 1988 and the Wisconsin State Plane, Central (NAD83, US survey feet) coordinate system.

The difference between the existing and pre-dam surface models approximate total accumulated sediment volume in each impoundment. In Lake George, sediment accumulation in the three upstream cross sections was added by estimating sediment deposition along cross sections and multiplying by reach length.

We also estimated the expected volume of sediment to be mobilized if dam removal occurs. Based on general channel form of the Kinnickinnick River up- and down-stream of River Falls, a channel width of 55 feet was specified along the thalweg alignment identified from the DOR analysis. From the edge of this expected channel, the surface was graded upwards at a 3:1 (horizontal:vertical) slope until the existing bathymetric surface was reached. The 3:1 bank slope represents an idealized trapezoid for estimating purposes only, and does not necessarily represent the final bank configuration.

LAKE GEORGE

The total estimated volume of impounded sediment in Lake George was 166,800 cubic yards. Because depth to refusal probing does not directly determine the exact stratification line between historic floodplain and deposited sediment, this estimate is likely conservative and (or) provides an upper bound the stored sediment volume. This estimate includes sediment between the Winter St. Bridge and the E. Division St. Bridge. The majority of these sediments are sands (~80%) with a significant portion of fines (silts and clays; ~20%, see Appendix B for grain size data). Within the impoundment, sediment sizes are somewhat consistent. As the impoundment narrows at the upstream end of Lake George, the impounded sediments transition to sand. Although the wetted width upstream of the main pond suggests riverine conditions, there is little water surface gradient and sediments deposit easily.

Under a passive management scenario in Lake George, most of the mobilized sediment will likely come from the channel identified during the DOR assessment. If we assume the

delineated channel (i.e., 55 ft wide, 3:1 side slopes, historic pre-dam channel gradient) defines the area of sediment mobilization, an estimated 73,900 cubic yards of material could transport downstream. It should be noted that an evacuation channel with 3:1 side slopes represents an idealized trapezoid used for modeling and estimating purposes. The exact bank angle that would result depends on actual sediment character, cohesion and natural angle of repose, all of which will vary slightly throughout the impoundment. We estimate that the sediment evacuation volume will come from the west side of the impoundment, where the historic channel alignment is most likely to be recaptured. Although various drawdown scenarios can control the rate and volume of sediment loss to a degree, all of the sediment would likely mobilize as a headcut or nickpoint moves through the impoundment. This would happen regardless of the drawdown method. Under a staged drawdown, the sediment movement would be metered and occur more slowly, whereas under a rapid drawdown, the sediment would likely evacuate more rapidly. Sediment evacuation rates from rapid drawdown are not predictable, however, as sediment movement in rivers is event based, and not stochastic. It is unlikely that additional sediment would mobilize within Lake George as the refusal surface on the east half of the impoundment is perched relatively high compared with the thalweg along the west perimeter of the lake. During subsequent engineering phases, hydraulic analysis of proposed conditions can more accurately estimate the likelihood of sediment movement on the floodplain and downstream sediment transport volumes can be better defined.

Historic sedimentation in Lake George – Inter-Fluve compared the bathymetric data collected as part of the 2006 study and the data collected in 2015 as part of this effort. The results suggest possibly 0 - 1.0 feet of erosion along the eastern edge of the impoundment, and 2-3 feet of deposition in the main channel area. The remainder of the impoundment showed no significant change. Overall, it appears that the current impoundment has roughly the same or slightly less sediment than in 2006. We have no defined vertical datum for the 2006 study, and so the data and any conclusions regarding changes from 2006 to 2015 must consider a small amount of variation from actual. Most surveys use the standard NAVD88 vertical datum, and the difference between NAVD88 and NGVD29 is only 0.1 feet in Wisconsin. Although subject to interpretation and changing water levels, comparison of aerial photos of Lake George over the past several decades echo the survey data, and showed no obvious change in sediment deposition patterns.

LAKE LOUISE

The total estimated volume of impounded sediment stored in Lake Louise is 163,800 cubic yards. Sediment sizes vary depending on the sampling location, with the upstream channel portion of the impoundment comprising medium to coarse sand, but the pond samples consisting of roughly 65% sand and 35% fines (fines – less than 0.063 mm diameter (organics,

clay, and silt); Appendix B). Some of this incoming sand may be introduced from both the main stem and the South Fork Kinnickinnic River which enters the main stem just downstream of the upper dam. The majority of this sediment is in the lower two thirds of the impoundment. In the upstream reach just downstream of the bedrock control of the Lake George Dam (Junction Falls), where the channel width is 150 ft or less, relatively little sediment is stored, and most of the channel material is coarser sands or larger clasts. Larger cobbles perched on the floodplain suggests that this reach has been dredged in the past to deepen and straighten the channel between the Junction Falls Dam and the City's wastewater treatment plant, cutting off a large meander bend.

Based on a 55 ft wide channel along the alignment through the lowest refusal surface elevation, we estimate a sediment evacuation volume of approximately 45,100 cubic yards under a passive sediment management approach. It is unlikely that additional sediment outside of this channel area would mobilize within Lake Louise, given the stable, groundwater dominated hydrology and higher floodplain elevations. During subsequent engineering phases, hydraulic analysis of proposed conditions can more accurately estimate the likelihood of sediment movement on the floodplain.

For this estimate, we assume the Lake Louise channel going through the alignment as shown in Figure 3. Depth to refusal probing at location LL-C1 (Figure 4), just upstream of the dam, suggests a sediment depth from top of sediment to refusal (rock) as being 12.8 feet (refusal at elev. 806). Sediment vibrocoreing often has difficulty penetrating historic floodplains, and at this location, the vibrocore sampled to a depth around 4.5 feet below the sediment surface. This places the historic floodplain at elevation 814-816 ft, roughly 2 to 4 ft above the expected waterfall crest at around 812 ft. The exact waterfall crest elevation won't be known until dam removal, and the exact channel alignment may vary upon final design, but will not increase the total volume of expected sediment mobility. If the most recent historic channel is in fact down the center of the pond in accordance with existing bathymetry, then the evacuation volume will be reduced.

The total sediment volume expected to evacuate from the two impoundments is thus 119,000 cubic yards. This assumes no sediment storage within the Lake Louise impoundment. It is possible that some sediment storage could occur in the Lake Louise impoundment, particularly if flood events were to occur that could mobilize sand or finer particles to the lake margins where mobilized sediment could drop out of the water column. Sediment storage in Lake Louise would also be more likely if the Lake George impoundment was drawn down before the Lake Louise impoundment. Sediment deposition is dependent on sediment grain size, cohesion, channel velocity and depth during flows, channel slope (which changes as drawdown proceeds), flooding and drawdown method used.

Sediment transport dynamics are complex. With dam removal sediment transport modeling, it is possible to estimate how much storage could be realized under various input parameters for flow. However, such models are expensive to run (\$50,000 minimum) and are often no more accurate than simple geomorphic assessment ballpark estimates, and the hydrologic input parameters are conjecture. One can input a wet, normal or dry year scenario, but there is no way of predicting what kind of hydrologic year will actually occur.

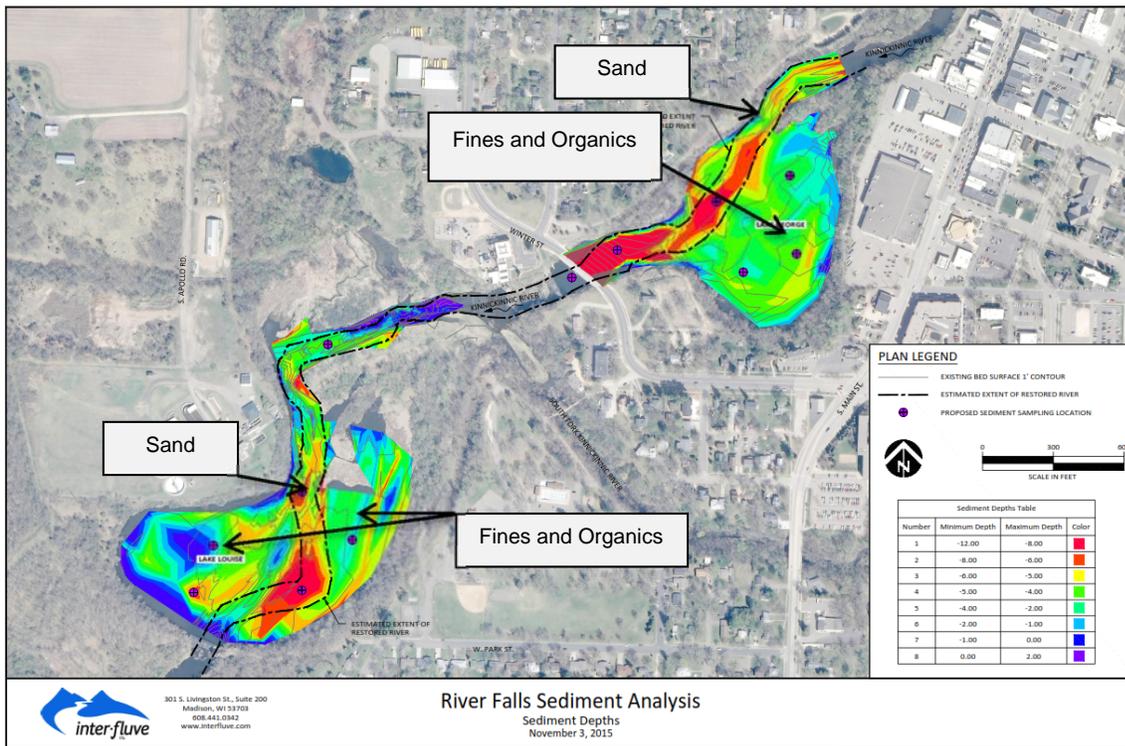


Figure 3. Topography/bathymetry and sediment thicknesses and types for the River Falls Impoundments. For more details, see Appendix A.

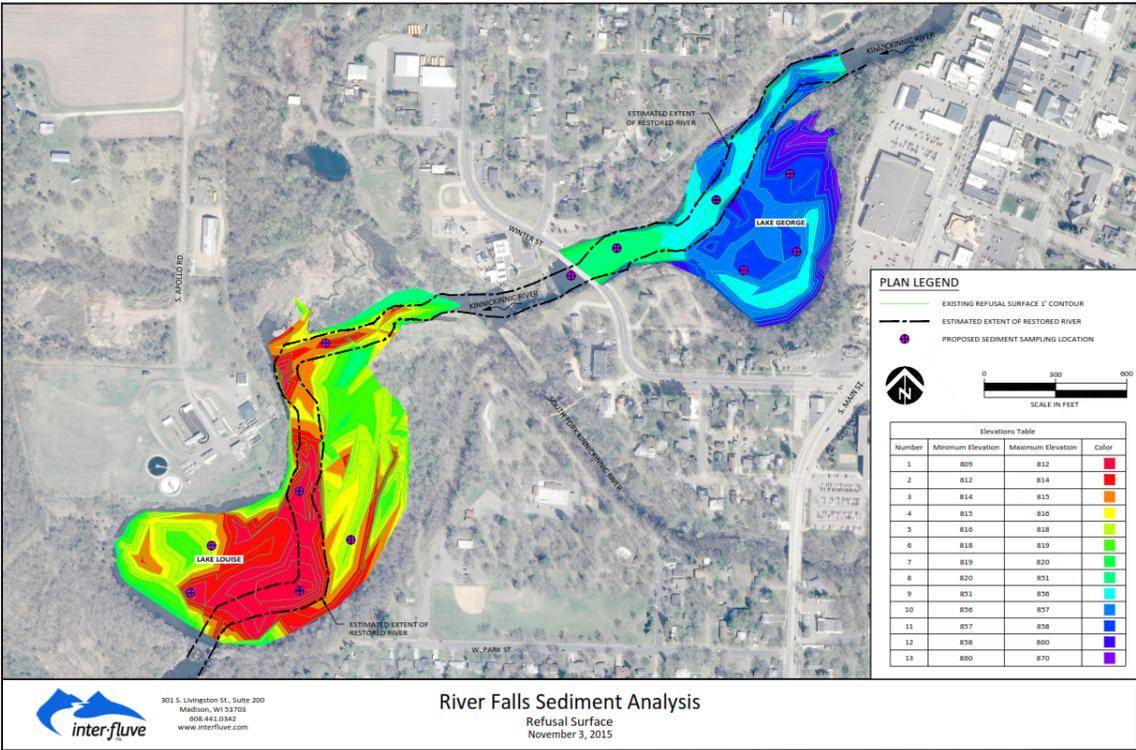


Figure 4. Depth of refusal surface for Lake George and Lake Louise. For more details, see Appendix A.

Sediment Contamination

The River Falls dams act as sediment traps. The reduced energy in the impoundment not only limits transport of coarse sediment, but also creates areas where fine material, including silt, clay, and organics, can fall out of suspension and accumulate. Pollutants often adsorb to fine material, so contaminant concentrations may be elevated in dam impoundments where these fine sediments accumulate, and lower in sand or gravel impoundments. To determine the contaminant sampling density and location appropriate for regulatory review, Inter-Fluve developed a sediment sampling plan and submitted the plan for review by the City of River Falls, the Wisconsin DNR and interested stakeholders. Comments were incorporated into the final Sediment Sampling Plan (Appendix C)

To assess the magnitude and distribution of sediment contamination in the River Falls Impoundments, sediment samples were collected at 12 locations, including six sites in each impoundment (Figure 5). The samples were analyzed for a range of inorganic (e.g., metals) and organic (e.g., PCBs, PAHs) pollutants as well as physical characteristics (Table 1).

DUE DILIGENCE SUMMARY

As part of the sediment sampling plan development, and to determine the appropriate sediment quality testing regime for Lakes George and Louise, Inter-Fluve completed a due diligence review of potential upstream contaminant sources. We reviewed watershed land use and potential point sources of contaminants such as large chemical users, historic spills, underground utilities, and storage tanks listed in various government databases. The following details the results of our search:

1. The Wisconsin Bureau for Remediation and Redevelopment Tracking System (BRRTS) is a searchable database containing information on the investigation and cleanup of potential and confirmed contamination to soil and groundwater. This search revealed 30 small incidents within the watershed upstream of the River Falls Dams, featuring primarily unleaded gasoline, oil, and VOCs. No major spills or incidents have occurred within the watershed, and the small sites have since been addressed and closed.
2. No USEPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) or No Further Remedial Action Planned (NFRAP) sites were found.
3. Of the 103 small waste quantity generator sites found in the Resource Conservation & Recovery Act of 1976 (RCRA) database, no major violations or outstanding corrections were found.
4. There were no Superfund sites on the National Priorities List (NPL).

The due diligence results indicate the likely presence of minor contamination typical of urban areas, including heavy metals and hydrocarbons. The agricultural land use in the watershed also suggests the presence of nutrients, and organochlorine pesticides and herbicides, including DDT, DDE, and derivatives. Some contaminants may also be released from the waste water treatment plant which discharges to the river directly upstream of Lake Louise.

The Inter-Fluve scope of work and budget did not allow for historic record searches of possible contaminants beyond those found in commonly used environmental databases such as RCRA and NPL. However, the sediment contaminant sampling suite included a wide range of chemicals commonly found in historical industrial and agricultural areas.

SAMPLE LOCATIONS AND METHODS

Sampling and sample handling methods were consistent with protocols and methods in Inter-Fluve's *Sediment Sampling for Dam Removal Projects* (Appendix B), based on EPA and WI state methods for sampling, and Wisconsin Administrative Code NR 347.06. Sample locations are shown in Figure 5. At the shallower sites (less than 5 feet of sediment), samples were collected

with a 3 inch diameter polycarbonate push corer, and included vertical, continuous lengths of the total sediment thickness. No layers or obvious transitions were observed in the sediment samples, but at each location, the samples were split into an upper 1 ft section (sample A) and the lower section (down to refusal; sample B) in order to differentiate contamination at the surface from contamination at depth. Splitting the samples in this manner allows us to assess contamination of the sediment that would likely be exposed if the dam is removed. One exception was sample LL-C1, where the sample was split where the sediment shifted from medium and fine sands in the upper 3 ft to coarse sand below. Upon retrieval, each sediment sample was thoroughly mixed in a stainless steel bucket, placed in containers supplied by the laboratory, and stored on ice until they reached the laboratory.

Sample collection in deeper parts of the impoundments and where sediment was too thick to sample manually was conducted from a pontoon boat mounted vibratory core sampler by Affiliated Researchers (East Tawas City, MI). A 3-inch diameter, 12 ft long polycarbonate tube fitted with a core catcher was driven by submersible vibrocore head until refusal for the equipment was reached. Sediment cores were retrieved, brought to the shore and then processed by Inter-Fluve personnel. Deep sediment cores showed no obvious stratification, and were separated into the top 2.0 feet, and the remaining sediment depth. Core depths for each sediment core are shown in Table 1.

The sediment sampling plan was reviewed by project partners the WDNR. A draft sampling plan was generated by Inter-Fluve based on Inter-Fluve's prior sediment sampling plan experience with impoundments in several states, including Wisconsin. The project budget for sampling would not allow for stratification sampling of all samples, so the final approved plan included stratification of only floodplain samples. Floodplain layers were separated for laboratory analysis, but channel cores were submitted to the laboratory as whole cores. Floodplain stratification generally showed more obvious detrital and organic layer, whereas channel cores showed poorly defined stratification.

Table 1. Coring depths

<i>Lake George</i>	Core Depth	Top layer stratification	Approx. depth to refusal
LG-C1	11.2 ft	2.0 ft	15 ft
LG-C2	10.2	2.0	13.7
LG-C3	8.3	2.0	11.4
LG-F1	4.0	1.0	5.0
LG-F2	3.8	1.0	5.0
LG-F3	4.5	1.0	5.0

Lake Louise

LL-C1	4.5	2.0	4.5
LL-C2	4.2	2.0	5.8
LL-C3	3.5	1.0	4.0
LL-F1	4.2	2.0	4.2
LL-F2	4.0	1.0	4.0
LL-F3	4.0	1.0	4.0

The samples were analyzed by CT Laboratories (Baraboo, WI) for a specific set of EPA priority pollutant metal and organic contaminants, as well as physical character using standard laboratory methods (Table 2).

It is noted that the upper core depth stratification varies from 1-2 feet. This stratification was based on site conditions. Clear sampling tubes were used to aid in identifying lamination or natural stratification. Where we observed a lamination or significant change from an upper organic layer to a denser layer below, we separated the samples accordingly in accordance with WDNR guidance. This was an attempt to isolate finer, more recently accumulated organic material from older, denser alluvially derived deposits and historic floodplain sediment.

Table 2. Analytical Parameters for Each Sample with > 5% Fines (i.e., <0.063 mm diameter)

Category	Specific Parameters	Laboratory Method
Metals	As, Cd, Cr, Cu, Pb, Ni, Zn Hg	EPA 6010C EPA 7471B
Organics	PCBs PAHs organochlorine pesticides Oil and Grease	EPA 8082A EPA 8310 EPA 8081B EPA 9071B
Physical	Particle size (sieve) Percent total organic carbon (TOC)	ASTM C136-84A L-Kahn/9060A

PCB – polychlorinated biphenyl

PAH-Polycyclic Aromatic Hydrocarbon

SEDIMENT GRAIN SIZE ANALYSIS

Active Channel Samples

Sample locations LG-C1, LG-C2, and LG-C3 were located along the main channel of Lake George, from about 300 ft downstream of the river's entrance into the impoundment to 80 feet upstream of the dam (Figure 5). In Lake Louise, LL-C1, LL-C2, and LL-C3 represent main channel conditions. LL-C3 lies 750 ft downstream from Junction Falls; LL-C2 lies at the mouth of the main pond, 500 ft downstream from the waste water treatment discharge; and LL-C1 is 330 ft upstream of the Powell Falls Dam. Like most of the Lake George sediments, the active channel samples are relatively similar sands and fines (sediment less than 0.063 mm in diameter), although a little finer than the rest of the impoundment. Lake Louise samples LL-C2 and LL-C3 are primarily sand with little finer material (<1%, except LL-C3B which had 6% fines). LL-C1 is much finer (40% silts and clays).

Floodplain Samples

"Floodplain samples" represent conditions that will likely be floodplain after dam removal. They currently occupy shallow areas of the reservoirs, away from the existing and expected active channels. Lake George floodplain samples include LG-F1, LG-F2, and LG-F3, which run along the east side of the impoundment. Materials are primarily sand with 20% fines. LL-F1, LL-F2, and LL-F3 represent Lake Louise sediment conditions. LL-F1 and LL-F2 are on the west side of the impoundment, south of the treatment plant, and LL-F3 is on the east side of the impoundment. LL-F1 and LL-F3 contain sand with ~35% silt and clay, but LL-F2 contains a higher percentage of sand.

CONTAMINANT CONCENTRATIONS

Several state regulations exist to protect aquatic wildlife and (or) humans that come into direct or indirect contact with the pollutants in rivers (see chapter 30, Wisconsin Statutes.; chapter NR 345, Wisconsin Administrative Code; and Chapter NR 347, Wisconsin Administrative Code). Aquatic wildlife, such as fish and macroinvertebrates, and humans can experience chronic and/or acute toxicity from direct contact with sediments in the water column or bed sediment. River sediments left exposed after dam removal or dredging can also pose risk of exposure. Direct contact to sediment pollutants by people may be possible depending on future landuse, burrowing animals may be exposed to contaminants, and runoff and infiltration can move both sediment-adsorbed and leached contaminants into groundwater and the river.

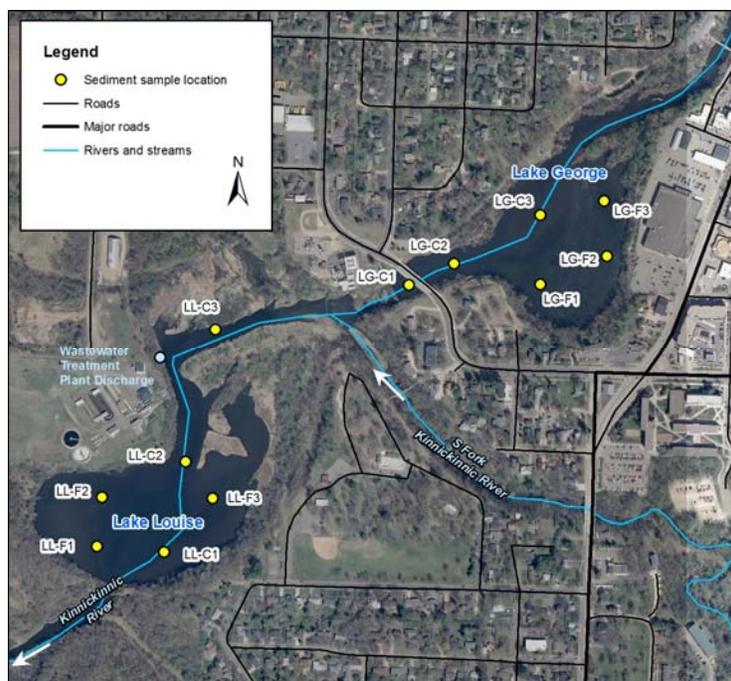


Figure 5. Sediment sampling locations within Lake George (LG) and Lake Louise (LL).

For sediment screening, the Wisconsin DNR uses census based sediment quality guidelines (CBSQGs) to determine the general ecological toxicity of sampled materials (WDNR 2003). If the sediment is mechanically dredged or removed, either to an on-site or off-site location, WDNR guidelines for disposal of dredged or excavated sediment or soils will need to be followed, and the thresholds governing their reuse may be determined by WDNR review (NR347, NR500 to 520). The CBSQGs include a lower (threshold effect concentration - TEC) and upper (probable effect concentration - PEC) effect level at which toxicity to benthic-dwelling organisms are predicted to be unlikely and probable, respectively. There is an incremental increase in toxicity as the contaminant concentrations increase between the TEC and PEC concentrations, with the MEC representing the mid-point effect concentration, although specific numerical values relating to the degree of toxicity are not derived. The TEC and PEC values act as a semi-quantitative descriptor system that provides a common basis of expressing relative levels of concern with increasing contaminant concentrations. We also included EPA screening levels for human health effects which are largely based on ingestion or inhalation of the materials at the given concentrations and do not represent environmental effects. The sediment quality data for the River Falls impoundments is provided in Appendix B.

These data suggest that the sediment within the ponds has contaminant concentrations generally less than their respective effects concentrations, although there were exceptions (noted below). Based on prior experience with Wisconsin impoundments, PCBs (Aroclors 1254

and 1260) were analyzed only in the upper floodplain cores, in accordance with WDNR recommendations. PCBs were detected in trace amounts in the Lake George and Lake Louise floodplain cores, with the concentration of Total PCBs in one core slightly exceeding the TEC. PAHs exceeded TECs in a few instances in both impoundments. In many cases, the detection limits exceeded threshold values so it is not possible to determine whether these compounds are causing impacts. Regulatory review of the contaminant values will be conducted and recommendations made regarding either additional testing or required handling of sediments.

In accordance with WDNR recommendations, organochlorine pesticide and herbicide sampling was completed in the LL-C2 sample only, as being representative of conditions downstream of the treatment plant effluent.

It is noted that 15 of the 18 PAH compounds had standardized detection limits (SDL) that were greater than the TEC, MEC and/or PEC values. Three factors modify the detection limits for solid-type sediment analysis matrix; the amount of sample used during preparation (if different from standard amount), the percent solids, and the dilution factor. The dilution factor is also applied to the SDL, which means that some analytes in a large array of chemicals will fall below the SDL. It is not possible for the laboratory to know which analytes may or may not end up having the SDL be exceeded. If desired, additional testing in future phases can clarify these contaminant concentrations.

Lake George Active Channel Sediments (LG-C1, LG-C2, LG-C3)

- Most of the inorganic analytes (trace metals) were detected within the active channel sediment, but concentrations were less than threshold effects concentrations (TEC) set by the Wisconsin DNR (WDNR 2003). The arsenic levels are elevated compared to EPA screening levels for human health concerns (which are primarily related to ingestion and inhalation).
- PCBs were not detected. Only one of three sampling sites was analyzed.
- Two PAHs, including benzo(a)pyrene at LG-C2 and pyrene at LG-C3, exceeded threshold effect concentrations. Ten PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene were detected but at levels below their respective TECs.

Lake George Floodplain Sediments (LG-F1, LG-F2, LG-F3)

- Most of the inorganic analytes (trace metals) were detected within the floodplain sediment, but concentrations are generally less than TECs. Mercury concentrations exceed the TEC at LG-F1B and LG-F3B (i.e., in the lower core sections) and lead

concentrations exceed the TEC at LG-F2B. Arsenic levels are consistently elevated compared to EPA screening levels for human health concerns, while hexavalent chromium levels EPA screening levels for human health concerns in 3 of 6 sediment core sections.

- PCBs were detected at levels less than EPA screening values, and total PCB concentrations at LG-F2A (upper core section) slightly exceed the TEC (0.062 mg/kg).
- Benzo(a)anthracene concentrations exceed the TEC at LG-F2A and LG-F2B. The pyrene concentration at LG-F2A (upper core section) exceeds the TEC. Other—PAH compounds, including benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, and phenanthrene were detected but at levels below their respective TECs. However, concentrations of benzo(a)pyrene consistently exceed EPA screening levels.

Lake Louise Active Channel Sediments (LL-C1, LL-C2, LL-C3)

- Most of the inorganic analytes (trace metals) were detected within the active channel sediment, but concentrations are generally less than TECs. However, a high concentration of arsenic was present at LL-C1, exceeding the probable effect concentration (PEC). The cadmium concentration at LL-C1 exceeds the TEC. Arsenic concentrations exceed EPA screening levels for human health concerns at all three sites.” According to the table, hexavalent chromium concentrations are less than detection limits; hence they cannot be compared to EPA RSLs (Residential).
- PCBs were not analyzed in Lake Louise active channel sediments.
- DDD levels exceeded the midpoint threshold effect concentrations (MEC) and Lindane levels exceeded the PEC. Other organochloro-pesticides and herbicides were below detection limits (sampled at LL-C2 only).
- Concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and phenanthrene exceed TECs at L:-C3, and flouranthene and pyrene exceed MECs. These contaminants were detected at levels lower than their respective TECs at the other two active channel locations. LL-C3 should be considered a site of concern.

Lake Louise Floodplain Sediments (LL-F1, LL-F2, LL-F3)

- Most of the inorganic analytes (trace metals) were detected within the **floodplain** sediment, but concentrations are generally less than TECs. However, concentrations of mercury and nickel exceed their respective TECs at LL-F1 and LL-F3. Arsenic levels at

LL-F1, LL-F2, and LL-F3 and hexavalent chromium levels at LL-F3 exceed their respective EPA screening levels for human health concerns.

- PCBs were not detected.
- Concentrations of benzo(a)anthracene, fluoranthene, phenanthrene, and pyrene exceed their respective PECs at LL-F2A, and the chrysene concentration exceeds its MEC at this location. The concentration of benzo(a)anthracene exceeds the TEC at LL-F1A. Additionally, benzo(a)pyrene concentrations exceed EPA screening level (residential) at LL-F1A and LL-F2B. Other PAH compounds, including, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene were detected in Lake Louise floodplain sediments but at levels below their respective TECs. Based on total PAH concentrations, LL-F2 may also be considered a site of concern.

Sediment Management Options

The following paragraphs give a preliminary summary of possible sediment management actions. If the dams remain in place, the negative effects of the dams will remain in place, including solar heating and warming of water, the continuing accumulation of fine sediment, accumulation of organic matter and emergent vegetation growth (e.g. cattails) in larger areas around the impoundments, and continued sub-optimal habitat and water quality for riverine species. If the dams remain in place, then Inter-Fluve recommends no action regarding sediment removal. Leaving the existing sediment in place reduces water residence time and reduces warming.

If the dams are to be removed, then sediment management can involve either active management, passive management, or a combination of active and passive sediment management techniques.

Active versus Passive Sediment Management

Passive sediment management involves removing the dam and allowing the impounded sediment to mobilize and stabilize without intervention. This approach is low cost, as it requires little work in the impoundment to control sediment or develop more natural channel characteristics. This option requires an unknown amount of time for the river to reach equilibrium, as the river must evolve through erosion and sediment migration that may vary from years to decades. This approach will also have a negative short term impact on downstream reaches as mobilized sediment can temporarily inundate habitat.

Under an active sediment management scenario, at least some of the sediment within the impoundment is mechanically removed and channel form and adjustment is controlled via

design and construction. Active management uses mechanical means to excavate sediment, create a stable channel form, and reestablish a higher degree of ecological function in a shorter time. These advantages are realized at a higher capital expense for the project.

Passive Sediment Management

Under a passive sediment management scenario, the dams would be breached or removed with little or no sediment management. The channel within the impoundments would freely adjust their slope and form via incision, widening, and meandering; and the resulting eroded sediment would flush downstream unimpeded. These adjustments would continue until the channel develops a form consistent with the flows and sediment regime imposed on it. The exact nature of sediment transport and downstream depositional patterns associated with sediment evacuation can be estimated through geomorphic assessment and expensive modeling, but is difficult to predict accurately. The rate of progression is event driven, meaning that sediment movement is governed by the magnitude and frequency of flows. These flows are statistically unpredictable.

The rate of sediment evacuation can be partially controlled by using a staged drawdown method of removal, in which only a portion of the dam's vertical height is reduced. Sediment in the upper impoundment is then allowed to transport either into the impoundment remaining, or downstream of the dam. Staged drawdown requires multiple mobilizations, and is thus more expensive, but can reduce environmental impacts by allowing sediment to meter out more slowly over time.

Once the sediment has moved out, and the channel has reached an equilibrium condition within the impoundment, both active and passive restoration methods can be used to construct habitat in and around the stream, and to revegetate the corridor.

For Lake George and Lake Louise, the existing channel through the impoundments is fairly well established. After removal, the channels would likely widen and possibly shift slightly to occupy the area predicted by the refusal depth and bathymetry survey analysis (Figures 2 to 4; Appendix A). Sediment in these areas is relatively fine; however, concentrations of arsenic and cadmium at LL-C1 exceed their respective PEC and TEC, and 10 PAH compounds exceed their respective TECs or MECs at LL-C3. The sediment and contaminants would have some short term impacts to downstream reaches that may persist for several years. However, these impacts need to be compared to the channel impacts within the impoundments over the entire life of the dams. Flows will largely be contained within the expected 55 ft wide historic channel, so any sediment not evacuated along the channel margin, such as within the rest of the pond, along the inside of bends, etc., would likely remain in place and revegetate. The sediment would revegetate over time, but invasive species such as reed canarygrass and *Phragmites* (giant reed grass) would likely dominate without intervention.

Active Sediment Management

The extreme version of this option includes removing all of the sediment in the impoundment, disposing of the removed material, and reconstruction of the channel and floodplain. This option is more costly, but it would result in the most immediate recovery of the stream, and would eliminate downstream impacts from dam removal.

Most projects lie along a spectrum between fully passive and fully active sediment management. Contaminant concerns often require spot treatment or removal of segments of deposition, thus precluding a completely passive approach. Cost implications often preclude a completely active management approach, and so some combination of the two management strategies is usually employed. Based on the current Kinnickinnic River impoundment morphology and contaminant distributions, passive management within the expected channel boundary combined with in-stream habitat enhancement and floodplain revegetation may be a viable option. If releasing the relatively low levels of sediment pollutants found in the main channel is undesirable, then localized areas of finer material within the expected post-dam channel area can be removed. This scenario may be desirable for the area around LL-C1 and LL-C3.

Sediment Management Costs

The cost of dam removal includes many factors, but is directly proportional to the size of the dam, the amount of associated infrastructure, and the volume and character of the impounded sediment needed to be actively removed. This study focused primarily on identifying contaminants in the sediment that could possibly trigger special handling requirements, which in turn affect the amount and thus the cost of *active* sediment management, but also have implications for passive sediment management. However, there may be other reasons for wanting to actively manage at least a portion of the sediment. The next phase of dam removal feasibility will examine other reasons, such as the following:

- Construction logistics – Demolition may require removing sediment from around the dam structure.
- Ecology – The impacts of transported sediment on mussels, macroinvertebrates and fish downstream of the dam must be assessed through sediment fate analysis. Short term impacts are then compared against long term benefits and incorporated into the final sediment management plan.
- Flooding – In rare cases, downstream sedimentation can impact flooding. Sediment transport analysis and hydraulic modeling are conducted to ensure that sediment accumulation does not affect regulatory flooding.

The unit cost for active sediment removal in a sandy impoundment typically ranges from \$20-\$40 per CY. This includes excavation and hauling to a nearby disposal facility. Using this range of costs, we have calculated the following preliminary potential costs for active sediment management for a variety of volumes. This assumes that special handling and disposal in a state or federally approved waste facility will not be applicable. Such requirements can increase the unit cost to \$100 –\$500 per CY. The amount of sediment to be removed depends on lake management goals under a dredging scenario, or river restoration ecological goals, floodplain restoration goals and permitting requirements under a dam removal scenario. The more likely dam removal scenario for the Kinnickinnic River would be a largely passive sediment management approach, with less than 10% of the total volume being actively managed during construction.

Table 3. Costs for active sediment removal, based on a unit cost of \$30 per CY.

Percentage of total assumed actively removed

Impoundment	Total Impoundment Volume (CY)	Percentage of total assumed actively removed			
		10%	25%	50%	100%
Lake George	73,900	\$ 221,700	\$ 554,250	\$ 1,108,500	\$ 2,217,000
Lake Louise	45,100	\$ 135,000	\$ 337,500	\$ 675,000	\$ 1,350,000

If the community wishes to dredge the impoundments for recreational use or to increase the water holding capacity of the dams, the same unit cost for dredging applies. Due to economies of scale, dredging costs may reduce with an increase in excavated volume. Total cost of such a dredging operation would depend on the amount of material desired to be excavated.

Summary

The sediments impounded within Lake George and Lake Louise area primarily fine to medium sands, with 20-40% silt, clay, and organics. The foreset bed or deltas at the upstream end of each impoundment are primarily medium to coarse sands. Sediment samples were collected at representative locations along the existing main channel and along the off-channel areas within each impoundment (Figure 5), and the collected material was analyzed for physical characteristics, metals, PCBs, organochlorine pesticides, and PAHs (Table 2). The main channel sediments in Lake George were relatively uncontaminated, although concentrations of two PAH compounds exceed their respective TECs (Appendix B). In the off-channel, floodplain sediments of Lake George, concentrations of mercury, lead, arsenic, hexavalent chromium, total PCBs, and three PAH compounds exceed TECs or EPA screening levels in some of the sediment core samples. In Lake Louise, the downstream channel sediments (LL-C1 and LL-C2) were relatively uncontaminated. However, a high concentration of arsenic was present at LL-C1,

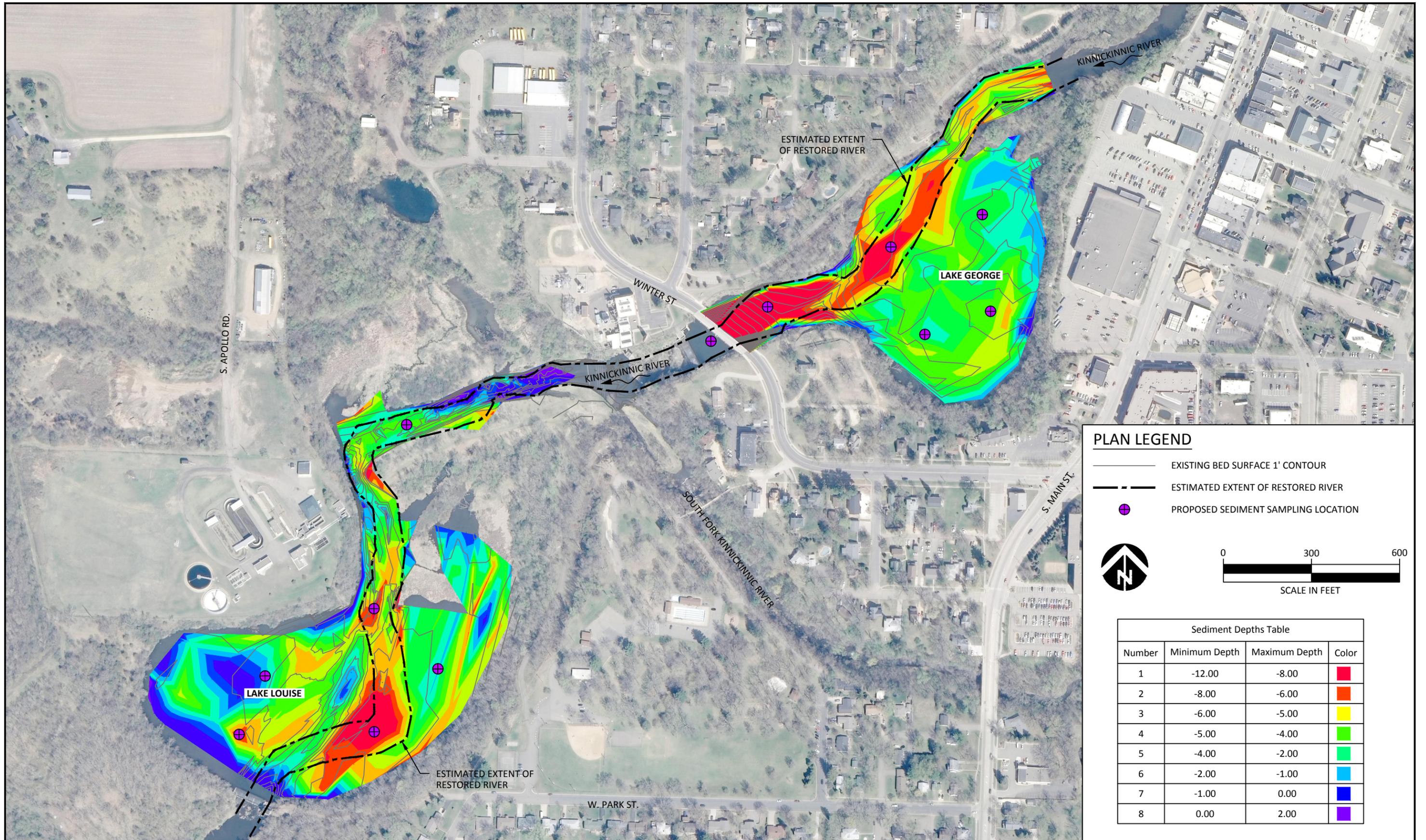
exceeding the probable effect concentration (PEC). The cadmium concentration at LL-C1 exceeds the TEC. Arsenic concentrations exceed EPA screening levels for human health concerns at all three sites. At LL-C3, concentrations of 10 PAH-compounds exceed their respective TECs and PECs, suggesting that this is a site of contaminant concern. In the Lake Louise floodplain sediments, concentrations of mercury, nickel, arsenic, and hexavalent chromium exceed their respective TECs or EPA screening levels. In addition, concentrations of seven PAH compounds exceed their respective TECs, MECs, PECs, or EPA screening levels. PAH contamination in the upper portion of sample LL-F2 is of particular concern.

Sediment management options will include some combination of active and passive sediment management as described above, but the actual management scenarios used in each case will depend on regulatory guidance regarding management of contaminants and ecological impacts. The following next steps will be important tasks in developing refined costs for sediment management under any scenario, including dam removal.

Next Steps

- Review of contaminant data will be completed by the Wisconsin DNR to determine possible sediment management scenarios and the need for any further sampling and testing, if any.
- If dam removal is pursued, a dam removal feasibility study can be completed to build on the sediment volume and quality assessment. Concept designs would be included in the feasibility study, which will also include structural review, dam removal construction logistics, and sediment management and water routing options during construction.

Appendix A – River Falls Impoundment Sediment Quantity and Sample Locations (Kinnickinnic River, WI)



PLAN LEGEND

-  EXISTING BED SURFACE 1' CONTOUR
-  ESTIMATED EXTENT OF RESTORED RIVER
-  PROPOSED SEDIMENT SAMPLING LOCATION




SCALE IN FEET

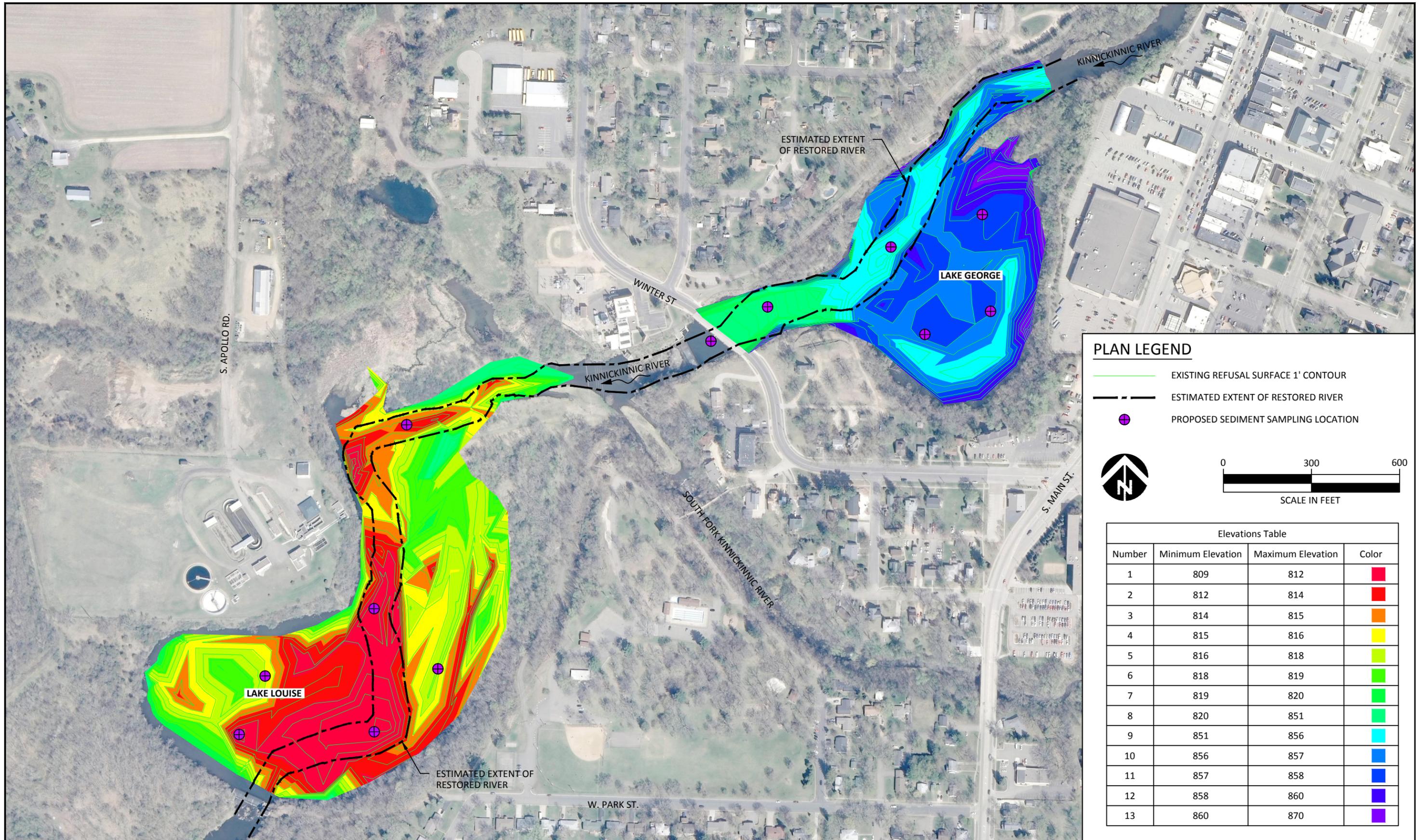
Sediment Depths Table			
Number	Minimum Depth	Maximum Depth	Color
1	-12.00	-8.00	
2	-8.00	-6.00	
3	-6.00	-5.00	
4	-5.00	-4.00	
5	-4.00	-2.00	
6	-2.00	-1.00	
7	-1.00	0.00	
8	0.00	2.00	



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River Falls Sediment Analysis

Sediment Depths
 November 3, 2015



PLAN LEGEND

- EXISTING REFUSAL SURFACE 1' CONTOUR
- ESTIMATED EXTENT OF RESTORED RIVER
- PROPOSED SEDIMENT SAMPLING LOCATION

SCALE IN FEET

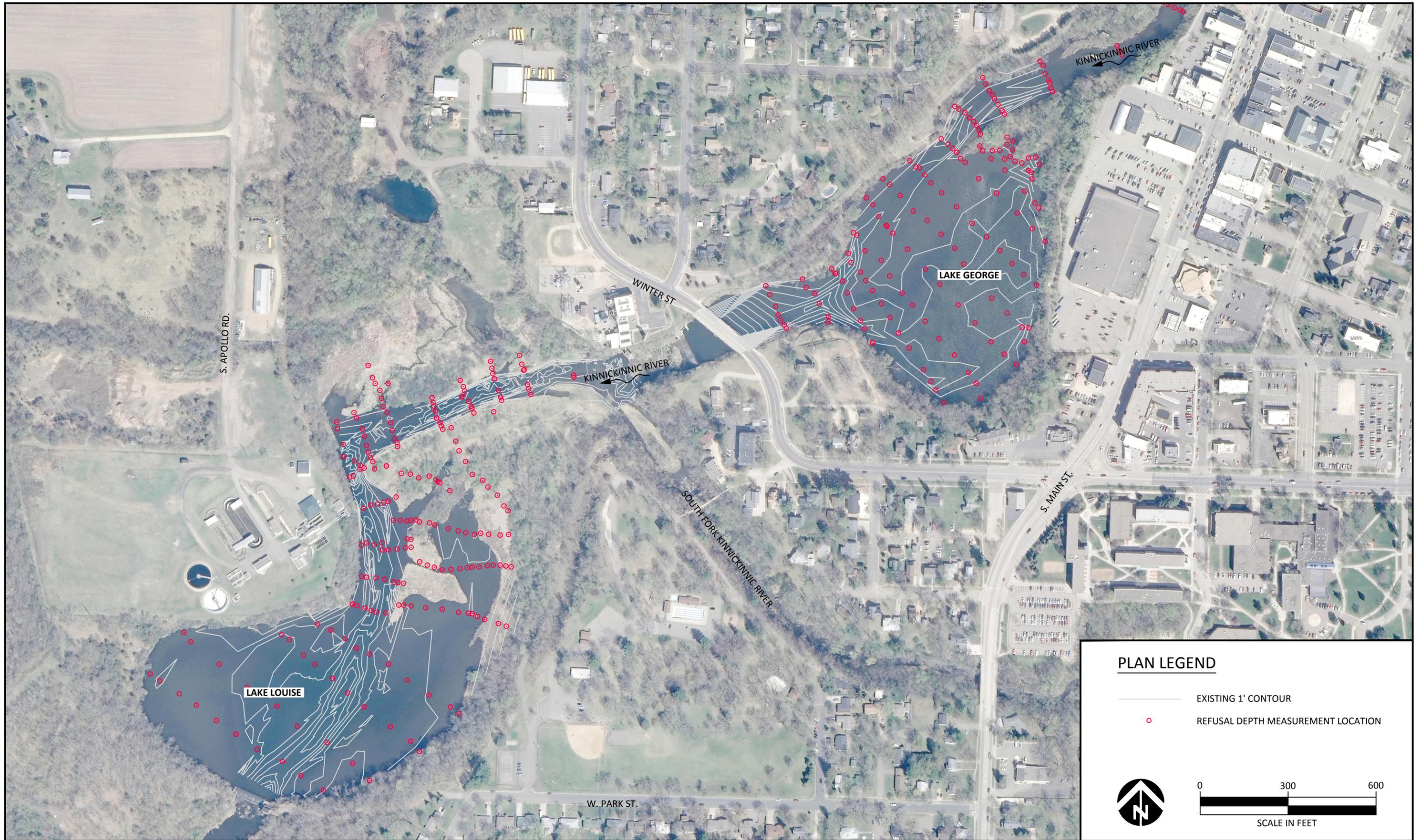
Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
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2	812	814	Red
3	814	815	Orange
4	815	816	Yellow
5	816	818	Light Green
6	818	819	Green
7	819	820	Green
8	820	851	Light Green
9	851	856	Cyan
10	856	857	Blue
11	857	858	Blue
12	858	860	Purple
13	860	870	Purple



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River Falls Sediment Analysis

Refusal Surface
 November 3, 2015



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River Falls Sediment Analysis

Refusal Measurement Locations

November 4, 2015



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River Falls Sediment Analysis

Sample Locations
 November 12, 2015

Appendix B – Inter-Fluve Sediment Sampling Plan

River Falls Dams

Final Sediment Sampling Plan

Submitted to:

Ray French
Management Analyst
City Hall
222 Lewis St.
River Falls, WI 54022

Prepared by:

Inter-Fluve Inc.



November 10th, 2015

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1. Introduction

The City of River Falls currently holds a license from the Federal Energy Regulatory Commission (FERC) to operate the hydroelectric facilities at the Junction Falls (Upper) and Powell Falls (Lower) Dams. The City recently completed an evaluation of the FERC relicensing process and is now pausing relicensing in order to fully evaluate alternatives and gather information to aid in the community decision process. To better understand the dam removal alternative and to fully assess risks associated with possible contamination in the existing impoundment sediment, the City of River Falls has contracted with Inter-Fluve to assess the quantity and character of the impounded sediment at both dams, and to determine the potential volume of sediment that may be evacuated or need to be excavated in the event of a dam removal.

In September 2015, Inter-Fluve staff surveyed the bathymetry and sediment depths in the impoundments at Junction Falls (Lake George) and Powell Falls (Lake Louise), and that information is presented here for review. This sediment sampling plan addresses contaminant testing and grain size analysis, both of which will aid in the development of a sediment management plan. A draft of the plan was submitted to the City and Wisconsin Department of Natural Resources (DNR). Following reviews by the City, the DNR and other residents, the draft plan was finalized in this document to be used as a basis for sampling.

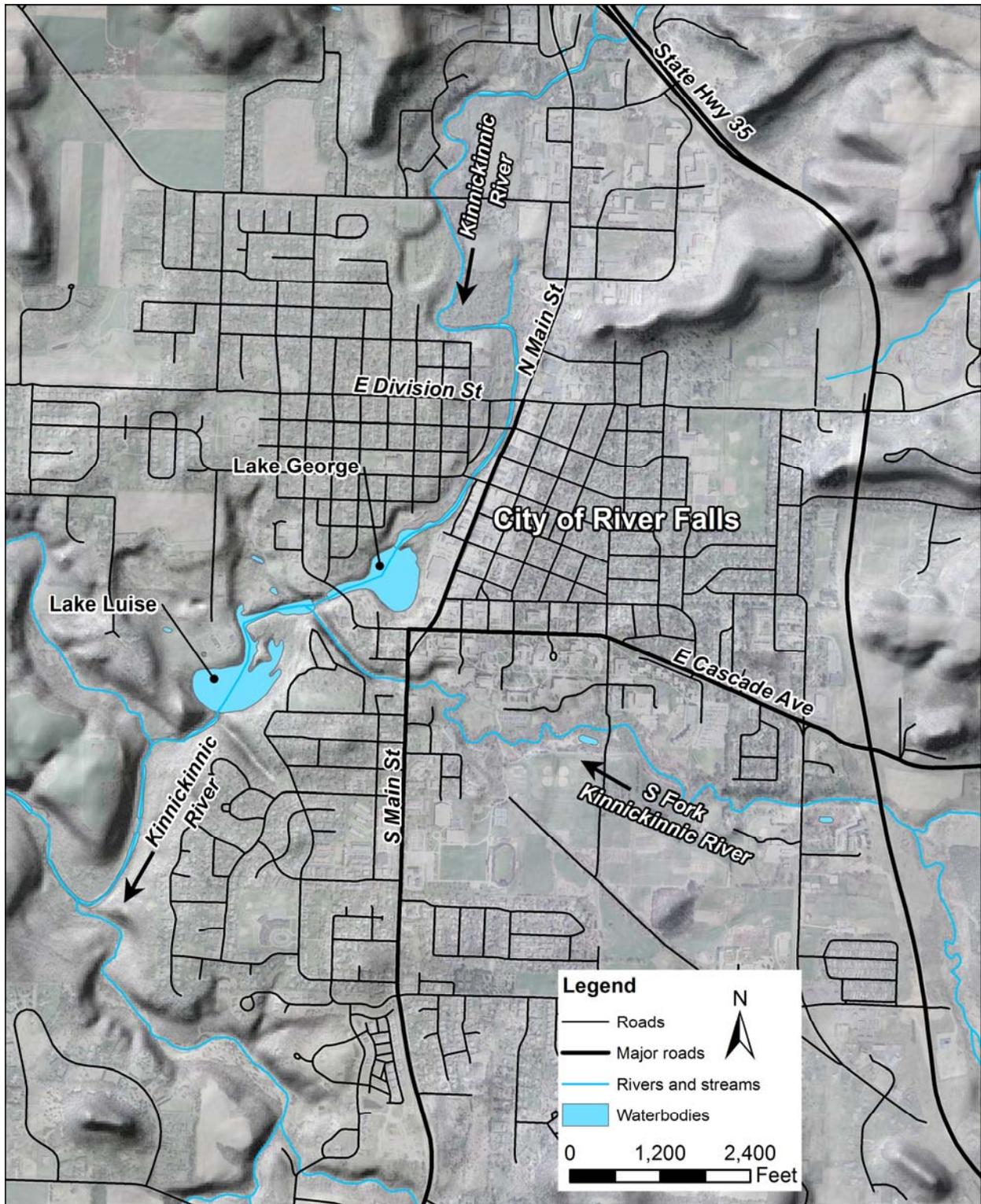


Figure 1. The Kinnickinnic River at River Falls showing the location of the two impoundments, Lake George and Lake Luise.

2. Due Diligence Summary

To determine the appropriate sediment quality testing regime, a due diligence review of potential contaminant sources was completed. Tables 2 and 3 below show a list of contaminants to be tested, and the standard tests to be performed.

We reviewed watershed land uses and potential point sources of contaminants such as large chemical users, historic spills, underground utilities and storage tanks. The Bureau for Remediation and Redevelopment Tracking System (BRRTS) is a searchable database containing information on the investigation and cleanup of potential and confirmed contamination to soil and groundwater in the State of Wisconsin. This search revealed 30 small incidents within River Falls that were addressed and closed. Additional closed sites were found throughout the watershed. Contaminants at the sites included unleaded gasoline, oil fertilizer, and VOCs. No major spills or incidents have occurred within the watershed.

No USEPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) or No Further Remedial Action Planned (NFRAP) sites were found. Of the 103 small waste quantity generator sites found under the Resource Conservation & Recovery Act of 1976 (RCRA), no major violations or outstanding corrections were found. There were no Superfund sites on National Priorities List (NPL).

The due diligence results indicate a likelihood of minor contamination typically found in urban areas, including heavy metals and hydrocarbons. Because we did not include an extensive review of historic land use in River Falls, we have included a wide sweep using the Priority Pollutant Metals identified by the EPA. Polyaromatic hydrocarbons (PAHs) are ubiquitous in urban areas, and should be expected in some concentration.

The agricultural land use in the watershed suggests also testing for nutrients, nitrates, and in select areas, organochlorine pesticides and herbicides, including DDT, DDE and derivatives.

Although not commonly found in smaller urban watersheds, polychlorinated biphenyls (PCBs) can be found downstream of pre-Clean Water Act industrial sites, and have been identified as a concern of local residents. Potential PCB concentrations will be analyzed in the upper 6.0 inches of cores taken from areas that would become exposed floodplain following dam removal.

Past industrial uses in the watershed are varied. Because the analytes being examined cover a broad range of common contaminants, it is unlikely that further investigation

into historical sources of contamination would be cost effective. Instead, we rely on the method of analysis and focus on the contaminants that we do find in the impoundments, if any are found.

3. Sediment Volume

3.1 METHODS

Field data collection consisted of bathymetric surveying and refusal depth probing. The bathymetric survey in Lake George involved manually surveying the channel and impoundment bed with a survey-grade rtkGPS unit. A series of 15 cross sections were surveyed to create an existing conditions surface of the bottom of the impoundment. Three additional cross sections were surveyed upstream of Lake George as sediment accumulation was evident up to the W. Maple St Bridge. At each survey location, we also measured sediment depth. This involved manually (by hand) driving a ½ inch diameter fiberglass rod into the sediment until a refusal layer was encountered. The type of material encountered at refusal was noted. Refusal material was determined by the abruptness of the rod stopping and the noise and vibration. Three classifications of material were delineated with this method based on validation at other sites: (1) cobble and larger rock, (2) gravels, and (3) sand or finer material. In locations where the pre-dam channel existed, cobble and larger rock was usually encountered at refusal. In locations that were likely floodplain areas prior to dam construction, a firm, compact layer (3) was encountered. The elevation of the refusal surface will be verified with vibracoring data during sediment sampling.

In Lake Louise, manual rtkGPS bathymetric and refusal data were collected as described for Lake George. In addition, the existing bathymetric data were supplemented with single beam sonar data to describe areas with deeper water. The sonar requires a minimum depth of three feet which was only present in the thalweg of Lake Louise. Extensive aquatic vegetation throughout the rest of Lake Louise and throughout most of Lake George prohibited further use of the sonar data.

Following field data collection, the survey data were integrated in AutoCAD® Civil3D® to create an existing conditions surface of the bottom of the impoundment and a pre-dam surface based on the refusal data. The data were adjusted using the National Geodetic Survey's Online Positioning User Service to relate the North American Vertical Datum of 1988 and the Wisconsin State Plane, Central (NAD83, US survey feet) coordinate system.

Boring data for the Winter St Bridge design were also incorporated into the digital surface models. This allowed us to extend the bathymetric and refusal surfaces in Lake George further downstream towards the dam.

Calculating the difference between the two surface models produced estimates of the total accumulated sediment volume in each impoundment. In Lake George, sediment accumulation in the three upstream cross sections was added by estimating sediment along cross sections and multiplying by reach length. We also estimated the expected volume of sediment to be mobilized if dam removal occurs. Based on reference reaches up- and downstream of the impoundments, a channel width of 55 feet was specified along the refusal surface thalweg alignment. From the edge of this expected channel, the surface was graded upwards at a 3:1 (horizontal:vertical) slope until the existing bathymetric surface was encountered. Because the impounded sediment encountered consists of highly mobile sand and finer fractions, we assume that the entire defined, post-removal channel volume will be mobilized downstream upon dam removal.

3.2 LAKE GEORGE

The total estimated volume of impounded sediment in Lake George was 149,000 cubic yards. This includes sediment between the Winter St Bridge and the E. Division St Bridge. The majority of sediments in Lake George are fine silts. As the impoundment narrows upstream of Lake George, the impounded sediments are primarily sand. Although the wetted width in this area suggests riverine conditions, there is little water surface gradient and sediments are easily deposited.

With dam removal, we expect about 58,500 cubic yards of sediment to transport downstream. It is unlikely that additional sediment would mobilize within Lake George as the east half of the impoundment refusal surface is perched relatively high compared with the thalweg along the west perimeter of the lake.

It should be noted that depth of refusal probing does not pick up all bedrock or other constraints, and is limited by point density. Any bedrock contacts, including the final waterfall crest elevation, may influence the total sediment volume. Thus, the sediment volume estimate may be conservative.

3.3 LAKE LOUISE

The total estimated volume of impounded sediment in Lake Louise was 162,000 cubic yards. Sediment grain sizes are predominantly silt but there is also more sand present than in Lake George. The more prevalent sand may be from the South Fork Kinnickinnic River that enters between the two dams. We also estimated about 58,000

cubic yards of sediment will mobilize with dam removal. The majority of this sediment is in the lower two thirds of the impoundment. In the upstream reach where the channel width is 150 ft or less, relatively little sediment is stored. Based on the presence of larger stones perched on the floodplain, it appears that this reach has been dredged in the past to deepen and straighten the channel upstream of the City's wastewater treatment plant.

It should be noted that depth of refusal probing does not pick up all bedrock or other constraints, and is limited by point density. Any bedrock contacts, including the final waterfall crest elevation, may influence the total sediment volume. Thus, the sediment volume estimate may be conservative.

4. Contaminant Sampling Plan

4.1 SEDIMENT AND POLLUTION EXPOSURE ROUTES

Sediment quality in both the mobile and immobile portions of the accumulated material is important, but the potential exposure routes are very different. The entire mobile portion of the sediment will eventually transport downstream unless it is excavated. During this transport, the material may be suspended in the water column or be transported along the channel bed during high flows while deposition would occur during low flows. Fish, macroinvertebrates and other wildlife as well as swimming, wading or boating humans may be exposed to this material and any associated pollutants. Further, pollutants that are associated with the material may end up in the food chain resulting in human exposure through ingestion. Due to these processes, the quality of the entire volume of sediment is important, and should be considered with respect to fish and wildlife as well as human incidental contact toxicity thresholds and bioaccumulation.

The immobile portion of the sediment would remain in place following dam removal and would likely be stabilized with vegetation. Though less accessible to most organisms than material that is transported in the river, there are several mechanisms for exposure to wildlife and people. Humans may come into contact with the top portion of the soil depending on proposed future land use of the newly exposed ground. Burrowing animals will come into contact with the top layers of the soil as well. Rainwater that infiltrates into these soils may pick up pollutants and carry them to the river where exposure routes would be similar to those for the mobile portion of the sediment. If the pollutant concentrations in these sediments may cause problems

through any of these exposure routes, alternative sediment management methods may be warranted.

4.2 SAMPLE LOCATIONS AND METHODS

We propose collecting a total of twelve (12) impoundment sediment samples to be taken at the locations indicated in Figure 2. This includes three samples within expected mobile portions of sediment in each impoundment (6 total or 3 in each impoundment). These samples are concentrated in areas where accumulated sediment depths are greatest. Three additional samples in each proposed exposed floodplain area (6 total or 3 in each impoundment) will be tested to characterize the immobile portion of the accumulated sediment. These samples are distributed throughout the remainder of the impoundments. For each of the proposed floodplain sample locations, we will stratify the material into two sub-samples: an upper layer with the top 6 inches of sediment, and a lower layer with all sediment below 6 inches to the refusal surface. Samples will be taken to the approximate depth of refusal as measured in the initial sediment probing.

Shallow sediment samples less than 5 feet deep will be retrieved using a polycarbonate silt sampler, Wildco® hand corer with extension or other hand coring device. Samples taken in deeper sediments will be retrieved with a boat mounted vibratory core sampler, piston corer or Geoprobe® (to be completed by a geotechnical subconsultant). Sampling and lab sample processing procedures will follow Inter-Fluve's internal guidelines based on Wisconsin, Massachusetts and USEPA sediment sampling recommendations (Inter-Fluve, Inc., 2007; see appendix). Pollutants to be tested are listed in

The following details should be noted:

- PCB testing will be conducted only in the top 6 inches of the floodplain cores, and in both the upper and lower core samples near the waste water treatment facility outfall in Lake Louise.
- Organochlorine pesticide and herbicide testing will be conducted only in the upper and lower core samples near the waste water treatment facility outfall in Lake Louise.
- Thalweg cores will not be stratified.
- Control samples will not be tested unless deemed necessary following sample results.
- TCLP samples will not be sequestered or tested at this time.

Table 1. The laboratory chain of custody will be documented.

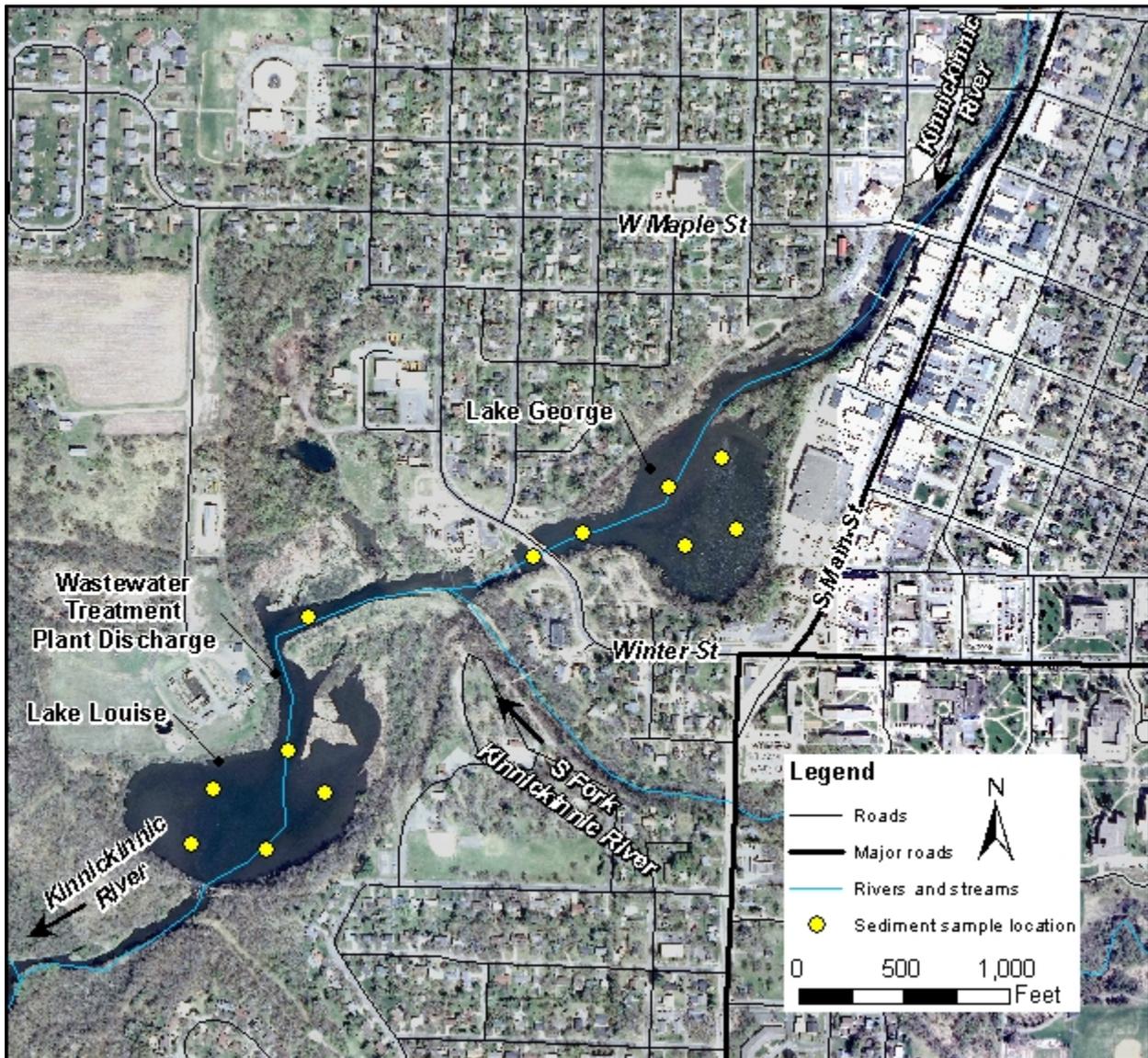


Figure 2. Proposed sediment sample locations (yellow points).

The following details should be noted:

- PCB testing will be conducted only in the top 6 inches of the floodplain cores, and in both the upper and lower core samples near the waste water treatment facility outfall in Lake Louise.

- Organochlorine pesticide and herbicide testing will be conducted only in the upper and lower core samples near the waste water treatment facility outfall in Lake Louise.
- Thalweg cores will not be stratified.
- Control samples will not be tested unless deemed necessary following sample results.
- TCLP samples will not be sequestered or tested at this time.

Table 1. Parameters to be analyzed – River Falls Dams.

Category	Specific Parameter
Metals	Arsenic, Cadmium, Chromium III/VI, Copper, Lead, Mercury, Nickel, Zinc
Organics	Polycyclic Aromatic Hydrocarbons (PAHs), Total Petroleum Hydrocarbons, Organochlorine pesticides and herbicides
Nutrients	Total Phosphorous, Nitrate, Nitrite, Ammonia, Total Kjeldahl Nitrogen (TKN)
Polychlorinated Biphenyls (PCBs)	To be analyzed at the wastewater treatment plant discharge location only.
Physical	Total organic carbon, moisture percent, grain size distribution, bulk density
Other	Toxicity Characteristic Leaching Procedure (TCLP), to be completed pending the initial contaminant results.

Table 3. Analytical Standards to be used

Metals*	EPA 6010C/7471
Hexavalent Chromium	EPA 3060A/7196A
Trivalent Chromium	Calc
PAHs	EPA 8310
GRO	WDNR Mod
DRO	WDNR Mod
Pesticides	EPA 8081

Herbicides	EPA 8141
TOC	L-Kahn/9060A
% Moisture	SM2540G
Grain Size (NO Hydrometer)	ASTM C136-84A
PCBs	EPA 8082
TCLP Extraction (Zero Headspace)	EPA 1311
TCLP Extraction (Non-Zero Headspace)	EPA 1311

*CT Laboratories LLC (Baraboo, WI)

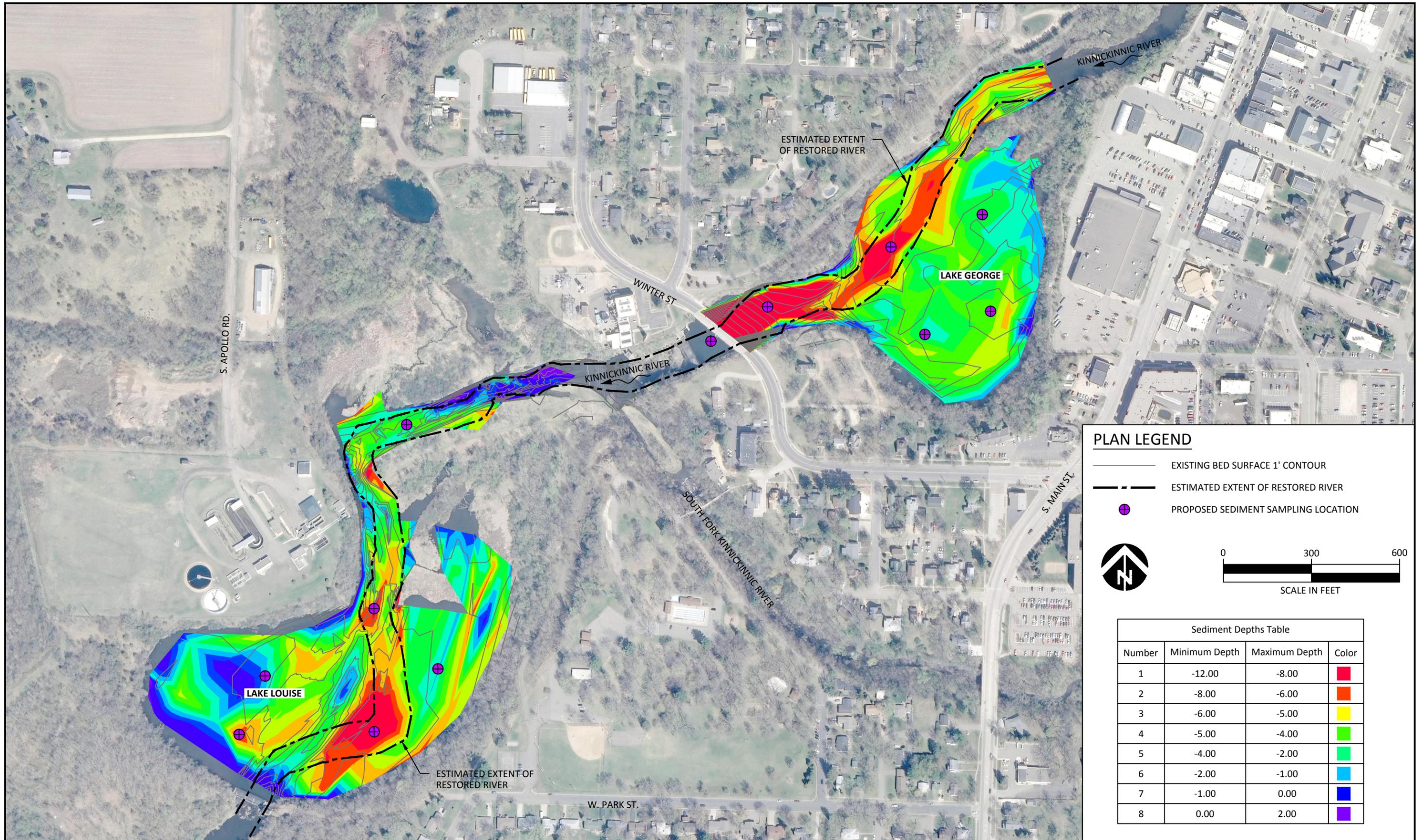
4.3 TOXICITY CHARACTERISTIC LEACHING PROCEDURES (TCLP)

TCLP testing assesses the ability of water to leach through sediment and into the groundwater. TCLP testing will only be performed for metals or organic compounds when the total concentrations in the sediment are above the theoretical levels at which the TCLP criteria may be exceeded. This will require further core sampling and laboratory analysis. For guidance, consult USEPA, Memorandum #316, "Notes on RCRA Methods and QA Activities," pp. 19-21, Gail Hanson, January 12, 1993.

5. References

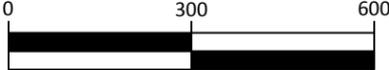
Inter-Fluve, Inc. 2007. *Sediment Sampling for Dam Removal Projects – General Sample Collection Guidelines for Contaminant Testing*. Internal company protocol, Madison, WI.

Appendix A – Impoundment Sediment Depths and Proposed Sample Locations



PLAN LEGEND

-  EXISTING BED SURFACE 1' CONTOUR
-  ESTIMATED EXTENT OF RESTORED RIVER
-  PROPOSED SEDIMENT SAMPLING LOCATION

SCALE IN FEET

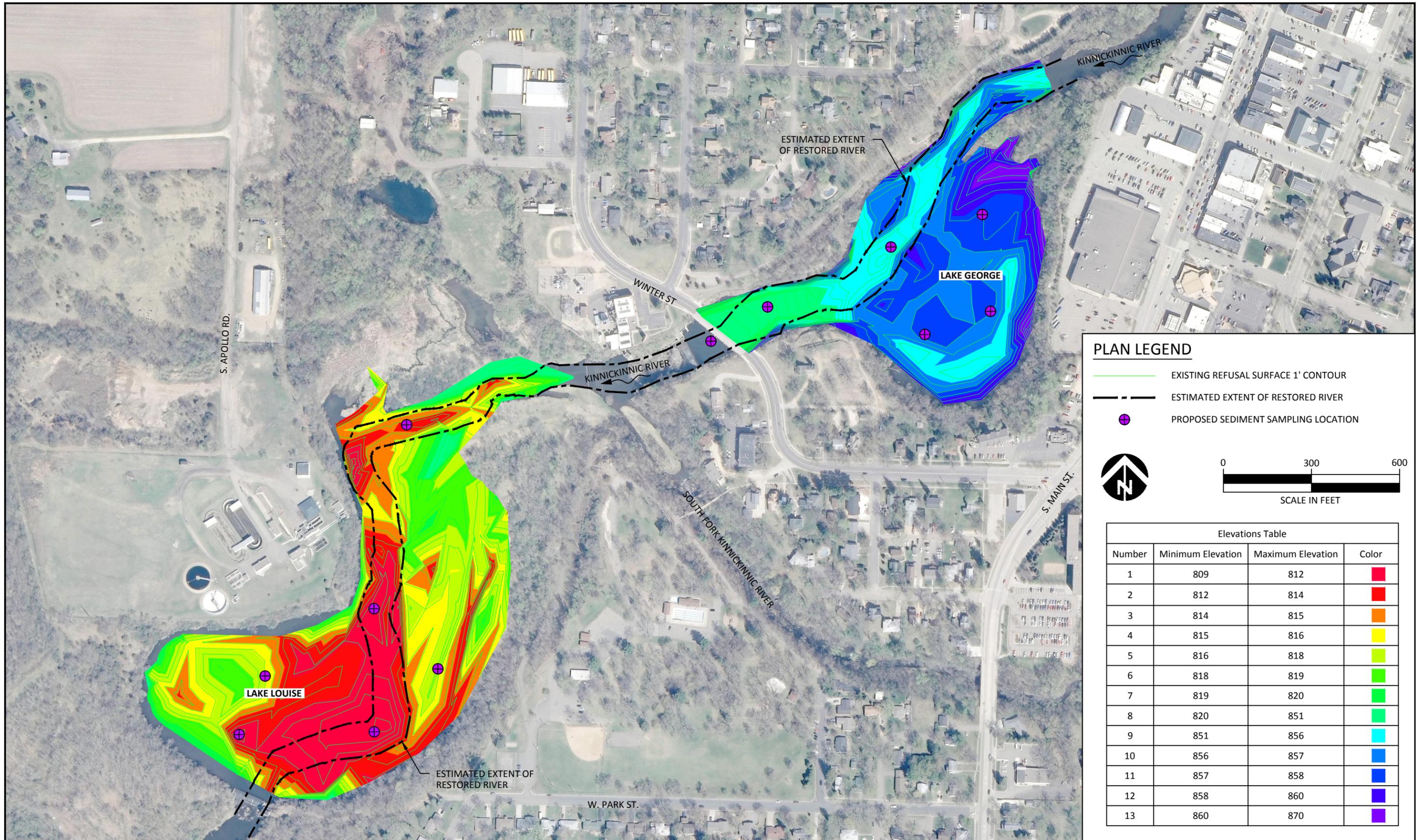
Sediment Depths Table			
Number	Minimum Depth	Maximum Depth	Color
1	-12.00	-8.00	Red
2	-8.00	-6.00	Orange
3	-6.00	-5.00	Yellow
4	-5.00	-4.00	Light Green
5	-4.00	-2.00	Green
6	-2.00	-1.00	Cyan
7	-1.00	0.00	Blue
8	0.00	2.00	Purple



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River Falls Sediment Analysis

Sediment Depths
 November 3, 2015



PLAN LEGEND

- EXISTING REFUSAL SURFACE 1' CONTOUR
- ESTIMATED EXTENT OF RESTORED RIVER
- PROPOSED SEDIMENT SAMPLING LOCATION

0 300 600
SCALE IN FEET

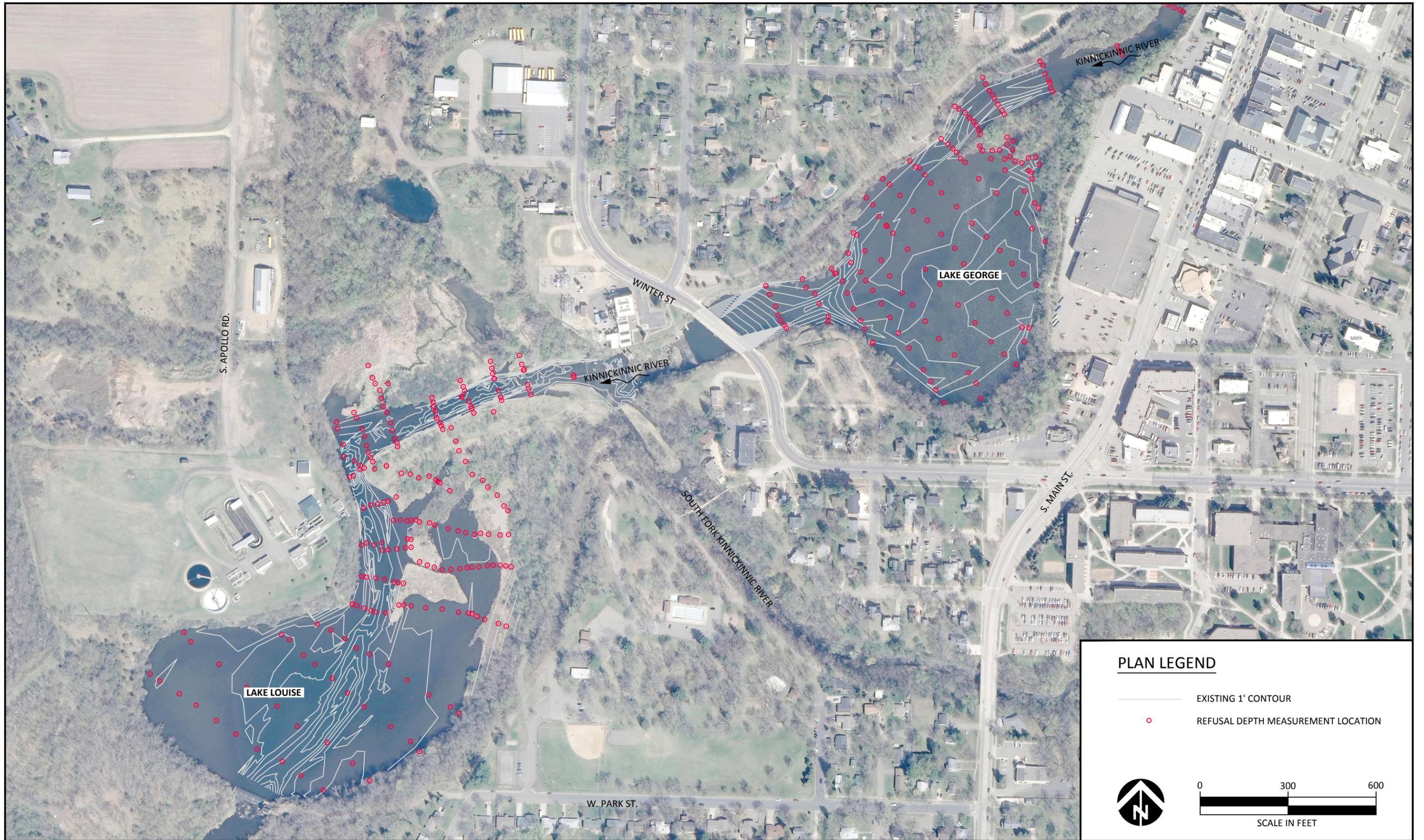
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9	851	856	Cyan
10	856	857	Blue
11	857	858	Blue
12	858	860	Purple
13	860	870	Purple



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River Falls Sediment Analysis

Refusal Surface
November 3, 2015



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River Falls Sediment Analysis

Refusal Measurement Locations

November 4, 2015

Appendix B – Inter-Fluve Sediment Sampling Protocol

Sediment Sampling for Dam Removal Projects

General sample collection guidelines for contaminant testing

April 25, 2007



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This document is intended as a general guideline for sampling sediment deposited upstream of dams in relation to Inter-Fluve projects involving dam removal or modification, where testing of potential contaminants is required.

These guidelines are taken largely from the State of Wisconsin sampling guidelines and are generally in accordance with standard protocols as presented in US- EPA-823-B-01-002, 2001, *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual*. Refer to the EPA manual for a more detailed discussion of study plans, collection, and processing of samples. Individual projects and states may have specific requirements, and individual laboratories may have alternative instructions for data collection.

This document covers sampling procedures, and does not address sampling experimental design. For more detailed guidance in designing statistically robust sampling plans, consult the US EPA and the local state environmental agency.

Part 1: General Sediment Sampling Procedure

1. Scope

1.1. This section describes general procedures for sediment sampling and the use of common sediment sampling equipment. Study goals may require additional or alternate equipment or procedures other than those discussed herein. Any procedure changes should be based on sound scientific and practical reasons and should ultimately help further the goals of the study without the loss of quality assurance and control.

2. Equipment and Supplies

2.1. Below is a suggested list of equipment needed for most sediment sampling efforts. This list suggests equipment that may be necessary for your project and should not be considered exhaustive. Equipment that is specific to a specialized type of sampling may be included only in the section describing the particular type of sampling.

2.2. Equipment Checklist

- Boat, anchor, motor, gas tank, tow vehicle
- Life jackets
- Protective clothing: boots, waders, gloves, rain gear, etc.
- First aid kit
- Mobile phone
- Maps: road and site maps
- Compass and measuring equipment
- Electronic location device (Loran or GPS)
- Field notebook and field sheets
- Waterproof pens and pencils
- Field measurement equipment (temperature, dissolved oxygen, etc.)
- Sample containers
- Sample labeling tape or paper and permanent marker
- Sediment pole for measuring depth
- Coring device and dredge or grab with adequate rope and extension poles (grab is backup for corer in sandy sediments), including extension poles.
- Slide hammer for corer
- Pliers, wrenches, etc. for adjusting equipment
- Mixing bowl and spoon
- Cleaning (decontamination) supplies (non-ionic detergent, tub, brushes, etc.)
- Wash bottles
- Ice chest and ice for cooling samples
- Extra rope

2.3. Equipment suitability for chemical analysis:

- 2.3.1. All equipment or sample containers that will come into contact with a sediment sample for chemical analysis should be constructed of materials that will not affect the concentration of contaminants in the sediment sample. In general, sediment samples to be analyzed for metals should not touch metallic surfaces (other than stainless steel), and samples for organic analysis should not contact materials that can react with organic substances. The level of care that needs to be taken with the materials used will depend on the level and types of contaminants associated with the sediment and the quality assurance needs and study goals.
- 2.3.2. For **organic analysis**, equipment and containers should be constructed of: *glass, teflon, polycarbonate, nylon, aluminum, galvanized steel, stainless steel or porcelain*. Acrylic core tubes are also acceptable for almost all sampling needs.
- 2.3.3. For **inorganic analysis**, equipment and sample containers should be constructed of: *glass, teflon, polyethylene polycarbonate, stainless steel or acrylic*.

3. **Basic Sediment Sampling Procedures**

3.1. Preparation

- 3.1.1. Sampling Plan - Sampling strategy decisions and sampling locations should be made well before going into the field, and should be designed to collect quality data that will best answer the questions or meet the goals of the study or monitoring program. Reconnaissance level or statistically robust screening level plans should be in place prior to field work. Decisions should be made ahead of time about sample location, number of replicates at each site (sampling strategy), and what chemical analyses to be performed on the samples. This will help ensure that appropriate and quality samples are collected.
- 3.1.2. Safety - All field staff should be aware of and fully understand the possible physical and chemical safety hazards posed by any site. Precautions should be taken to prevent exposure to contaminated sediments.
- 3.1.3. Equipment - Make all the preparations necessary to obtain suitable collecting equipment, protective clothing, vehicle and boat. Test and calibrate any equipment according to manufacturer's instructions. Record in the field notebook information about the instrument tests and calibrations including: dates, results and person testing the equipment. It may help to label sample containers for each site prior to sampling.

3.1.4. Cleaning Equipment - All equipment should be cleaned *before going into the field and between sites and samples* to prevent contaminating sediment samples. Equipment should be washed with clean scrub brushes using a non-phosphate detergent that leaves no residue when rinsed such as Alconox powdered or Liqui-nox liquid detergent (Liqui-nox is the EPA standard detergent for sampling apparatus). To properly clean equipment, wash apparatus thoroughly with detergent, then rinse 5-6 times with tap water and 3 times with deionized/distilled water if available. Rinse the apparatus with site water before taking the first sediment sample.

3.1.5. Field Observations - Take turbidity or Secchi readings first if possible, before the sediment is suspended by other sampling procedures. Record all field measurements and observations.

3.2. General Procedures in the Field

3.2.1. Turn on any equipment that needs to warm up (like a DO meter) first or before reaching the site.

3.2.2. Make sure all equipment is clean and ready to use.

3.2.3. When working from a boat, two or three anchors or spuds driven into the sediment in shallow water will help stabilize boat in breezy, open water conditions.

3.2.4. Each grab or core attempt, whether for a composite sample or replicates, should be taken from undisturbed sediment at the site. Avoid disturbing sediments with a boat motor or by walking on the site. Approach sites from downstream to avoid suspending sediment into the water column over the site.

3.2.5. Have container ready to accept entire sample quickly upon retrieval.

3.2.6. Label every sample container with a permanent marker on labeling tape on the side of the jar or wherever the label will not come off accidentally. Information on the label should include: **Sample #, replicate #, date, collector name** and **analysis type** (organic, inorganic).

3.2.7. Record all site information in a field notebook or on fieldsheets before leaving site. Information usually includes: field measurements, time and date, persons collecting samples, number and types of samples taken including field blanks, etc., labels assigned to each sample, and any general observations. Keep records of all samples, how they were labeled and any blanks or controls that are submitted for analysis.

3.3. Collecting Composite Samples

- 3.3.1. Composite samples are generally used to estimate the average concentration of the individual samples that make up the composite. Multiple grabs or cores for a composite sample should be taken from a relatively homogeneous sediment deposit (i.e., all grabs should be of similar sand/silt content). In some cases, composite samples are needed to generate sufficient sample volume for all analyses. It is best to know the rough boundaries of the sediment deposit or "site" before sampling.
- 3.3.2. Place each grab or core into a single mixing bowl (made of suitable material), remove any large objects such as sticks, leaves or stones, etc. and stir thoroughly with a spoon to homogenize. A single grab or core should be mixed at least two minutes. Multiple grab or core samples should be mixed five minutes or longer if necessary.
- 3.3.3. Fill sample jars with the sediment mixture by placing one spoonful sequentially into each jar until the jars are full (see section on sample containers). This sub-sampling system assures that each sample container contains a sample as similar as possible to the other containers.

3.4. Collecting Replicate Samples

- 3.4.1. Replicate samples can be obtained at different stages of the sampling for different purposes depending on the objectives of the study. A study plan should describe where and how much replication is necessary. The procedures described here are for collecting distinct field replicate samples where the object is to determine the variability within a deposit and compare one field site to another.
- 3.4.2. When collecting replicate samples to statistically compare sediment deposits, sample sites within each deposit should be randomly located for statistical comparisons to be valid.
- 3.4.3. Be sure each sample is taken from an undisturbed area of sediment
- 3.4.4. If the replicate samples are fairly similar, the equipment need only be rinsed with site water between samples. But, if the replicates are not similar, and some contain significantly more fines than others, then the core tube or dredge may need to be washed with a non-ionic detergent (see equipment) and rinsed in between samples to prevent cross-contamination and to keep replicate samples independent for valid statistical analysis of the data. Use a tub of water in the boat to wash equipment to prevent getting detergent in the site water while sampling.

4. Procedures for Core and Grab Sampling Devices

4.1. Sediment samples are most commonly collected using a coring device, dredge or grab sampler. The type of collecting equipment chosen will depend on sediment texture, site location (depth and current velocity), analyses to be performed and study goals. See **References** for more detailed discussion of the pros and cons of various sampling devices.

4.2. Piston Corer

4.2.1. Preparation and Scope

4.2.1.1. A corer allows excellent quantitative and qualitative sampling to a specified sediment depth with little disturbance of the sediment water interface. Samples can be separated or stratified by depth or color/texture to analyze distinct layers of sediment, although the sediment along the side of the core may smear as the core penetrates, slightly distorting the stratification of the sediment.

4.2.1.2. A corer may not be able to penetrate and/or retain very sandy substrates. Coring in high clay-content sediments where grabs won't work is possible if the water is not too deep, but may be difficult with a push corer and may require the use of a slide hammer or vibrating corer.

4.2.1.3. A large bore corer will provide a larger volume of sediment per attempt. This is important if discreet sample replicates are desired, and enough sample must be collected for a specific analysis or test. Even with the large bore core tube, samples may need to be combined to obtain enough sediment volume for the required analyses and/or tests.

4.2.1.4. A hand-operated, 3 inch diameter core sampler with an optional piston and extensions for deeper water can be effectively used in soft sediments with some silt/clay content in water up to ~30 ft deep. Core samplers may not be able to penetrate or retain very sandy sediments.

4.2.2. Collection Procedure

4.2.2.1. This procedure can be used for a push corer with or without a piston. A piston may not be necessary in high clay sediments. Disregard directions for use of the piston if piston will not be used.

4.2.2.2. Assemble the corer. Adjust the piston (the nut on the bottom adjusts piston diameter) so that it fits snugly. If the piston is too loose, it will not stay in place until the corer

reaches the sediment. If too tight, the piston will not move sufficiently when the corer is being pushed into the sediment, and compaction of the sediment core may occur.

- 4.2.2.3. Position the piston at the bottom of the core tube (open end), with the rope attached and threaded through the core head.
- 4.2.2.4. With the piston in place, let the core tube fill with water from the top, then lower the corer slowly and vertically to the sediment. If the piston falls out the bottom or moves up the core tube before reaching the sediment, tighten piston slightly and try again.
- 4.2.2.5. With the bottom edge of the corer and the piston in contact with the sediment in a vertical position, push the core tube into the sediment while maintaining some tension on the piston rope. The piston should remain at the sediment surface while the core tube moves into the sediment. In difficult sediments, it may be necessary to actually pull on the rope as the corer is pushed into the sediment. The object however is to maintain the piston in a fixed position at the sediment-water interface without compacting the sediment.
- 4.2.2.6. In hard or clay sediments where it is difficult to push the corer into the sediment by hand, a slide hammer designed specifically for the core sampler should be used. Do not pound on the core head or extension tubes with a hammer or anything else as this could break or damage the core head or other parts, and is generally less effective than the slide hammer.
- 4.2.2.7. After core is pushed to desired depth, pull up the corer slowly while maintaining the position of the piston by holding the piston rope in place. Even with the piston, some sediment may be lost from the bottom of the corer if the sediment is sandy. To help prevent sample loss, bring the corer into a horizontal position as it reaches the surface. A plug can also be inserted into the bottom of the sampler before removal from the water.
- 4.2.2.8. Place the corer on the work surface (boat or ice) over the receiving container. The sediment core can be extruded from the top or bottom of the core tube, depending on the purpose of the sample and study goals. Generally, cores collected for macroinvertebrate work should be extruded out the bottom, and cores collected for chemical analysis should be extruded out the top of the core tube if only part of the segment is needed to reduce contamination of the sample segment from other layers.

4.2.2.9. To extrude through the bottom, remove the sampler head, insert a pole through the top and push down on the piston eyebolt. Extrude the core into a waste container until the desired length of core remains, then extrude the remaining sediment into the sample container. To extrude through the top, remove the sampler head and place an extrusion pole and rubber plug at the bottom of the sampler and push sediment out through the top slowly. A premarked acrylic or polycarbonate (clear) core tube is helpful for measuring core lengths.

4.3. Grab Samplers

4.3.1. Preparation and Scope

4.3.1.1. Grab samplers rely on their own weight and gravity to penetrate the sediment as well as the leverage from the closing of the jaws. For this reason, they are not as efficient in water flowing over one meter per second. They normally take a discreet "bite" of sediment to a fairly consistent and measurable depth. Grabs often cause a shock wave upon descent which may disturb very fine sediment at the sediment-water interface.

4.3.1.2. Many grabs and dredges such as the petite Ponar and Ekman dredge can be used. These two can be hand operated from a suitably sized boat, preferably flat-bottomed. The Ponar is better suited to sampling hard or sandy sediments because of the greater ability to penetrate. The Ekman is more suited to sampling in soft sediments in low flow waters. Neither grab will effectively sample hard clays where a coring device or shovel such as a sharpshooter spade can be used.

4.3.1.3. Have a sample tub ready to receive sediment that is large enough to receive the entire contents of the sampler.

4.3.1.4. Understand and be careful of the closing mechanism and moving parts on a sampler.

4.3.2. Collection Procedure

4.3.2.1. Set closing mechanism and lower grab slowly to substrate, being careful to avoid a shock wave caused by too rapid of a descent near the sediment.

4.3.2.2. Initiate closure mechanism of grab. This is usually a messenger sent down the rope or a sharp pull on the rope.

4.3.2.3. When it feels like the grab has closed and contains sediment, raise grab at a steady rate and immediately position over large bucket. If jaws are not completely closed due to obstructions, discard entire grab contents away from sampling area and try again.

Make sure to move the sampling site at least several feet away from the previous attempt(s) to avoid sampling a disturbed area.

4.3.2.4. If the study dictates careful sampling for metals analysis, the middle portion of the sample not touching the metal grab can be collected with a teflon or plastic spoon, and the rest of the sample discarded.

4.3.2.5. Empty entire contents of grab into mixing bowl if sample needs to be mixed.

4.3.2.6. Place appropriate volume of sediment into sample container.

4.3.3. Quality Control Measures

4.3.3.1. Sediment samples should be collected from the reference or control sites first when possible to reduce the chances of cross-contamination from other sites.

4.3.3.2. All samples in a study should be handled identically, including using the same sampling equipment, stirring times, etc.

4.3.3.3. When collecting samples for chemical or toxicity tests, take appropriate measures to prevent contamination from other sources such as vehicle and boat motor exhaust or associated contaminants and other contaminated sites. The person operating the boat motor should either not handle sediment samples or make sure to put on clean gloves to prevent contamination from the motor.

5. References

- Baudo, R., Giesy, J., and H. Muntau, (Eds.). 1990. *Sediments: Chemistry and Toxicity of In-Place Pollutants*. Lewis Publishers, Boca Raton, FL.
- EPA. 1992. Sediment classification methods compendium. Office of Water, Washington, DC. EPA 823-R-92-006.
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- EPA. 1994. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates.
- Green, Roger H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley & Sons. New York. 257 pp.
- Klemm, D.J., P.A. Lewis, F. Fulk, and J.M. Lazorchak. 1990. Macroinvertebrate field and laboratory methods for evaluating the biological integrity of surface waters. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH 45268. EPA/600/4-90/030.

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Management.

Part 2: Collecting and Processing Samples for Chemical and Physical Analysis

1. Scope

- 1.1. Quality data can only be obtained from environmental samples that are properly collected, preserved and promptly shipped to the laboratory for analysis. The procedures involved in this process include: 1) collecting the samples using appropriate sampling techniques; 2) selecting proper sample containers; 3) preserving the samples immediately after collection either chemically or by cooling to 4°C, whichever is appropriate; 4) clearly identifying the samples and completing the corresponding laboratory sheets; and 5) carefully packaging and promptly shipping the samples to the laboratory for analysis.
- 1.2. Sediments for organic and inorganic chemical analyses are most often collected using grab, dredge or core methods. The chosen method should target the goals of the study plan and complement any other biological tests that may be conducted at the site or with sediments from the site. Samples slated for different types of physical and chemical analysis may need to be collected and handled in slightly different ways. The level of precautions that must be taken to prevent contamination of samples will depend on the type of analysis to be performed and the study objectives.

2. Equipment

- 2.1. Sample Containers - Samples for organic analysis and inorganic (metals) analysis must be in separate containers. Containers are prepared by and should be obtained from the laboratory doing the analyses. General guidelines are as follows:
 - 2.2. Sample Containers for Inorganic Analysis
 - 2.2.1. Sediment samples should be submitted to the laboratory in a container appropriate for the analyses requested.
 - 2.2.2. Metals - Samples that require metals analyses should be submitted either in 250 mL "metals" bottles or a glass quart mason jar with teflon lid. One 250 mL "metals" bottle (same as for water) provides enough sample to perform all of the routine metals analyses and solids analyses.
 - 2.2.3. Nutrients - Samples that require nitrogen, phosphorus and solids analyses should be submitted in 250 mL "nutrient" bottles or a glass quart mason jar with teflon lid.

2.2.4. Oil & Grease - Samples for Oil & Grease are analyzed by the inorganic section and must be in a glass quart jar with a teflon lined lid. Fill jar 3/4 full or more. Separate containers for metals or nutrients are not necessary if the glass quart jar is used.

2.2.5. Additional information can be obtained from:

East Coast

Tim Byrne
GeoLabs, Inc.
Sales Director/
Environmental Scientist
45 Johnson Lane
Braintree, MA 02184
P 1-781-848-7844
F 1-781-848-7811
C 1-781-420-1178

2.3. Sample Containers for Organic Analysis

2.3.1. Soil and sediment samples should be submitted to the laboratory in a container appropriate for the analyses requested.

2.3.2. Organics (PCBs, PAHs, etc.) - Samples for all regular organics analysis should be contained in glass quart jars with teflon lined lids. Jars should be 3/4 full or more. If analyzing for semi- or volatile organics fill jar completely so no air space exists.

2.3.3. Volatile Organic Carbon (VOC) and Gasoline Range Organics (GRO) - A 60 milliliter glass vial with a septum top should be used for soil and sediment samples that are to be analyzed for VOC and GRO. The laboratory will provide three pre-weighed sample vials for each sample site. The vials should be filled with sediment to the "Fill to here---" label (approx. 25g) found on the side of each vial. A water and methanol "trip blank" will be included in each sample mailer.

2.3.4. Diesel Range Organics (DRO) - A 60 milliliter glass vial should be used for soil samples that are to be analyzed for DRO. The laboratory will provide three preweighed sample vials for each sample site. The vials should be filled with soil to the "Fill to here---" label (approx. 25g) found on the side of each vial.

2.4. Samples for Bioassays and Chemical and Physical analyses

2.4.1. If chemical and/or physical analyses are required on sediment samples also slated for toxicity or bioaccumulation tests, the lab can perform the sediment homogenization and fill

sample jars for the chemical analyses from the same sediment that will be used for the bioassays. The testing lab should be contacted for information on appropriate sample containers and procedures.

2.5. Samples for Particle size analysis

2.5.1. Quart-size plastic bags (from the store) can be used for particle size samples. **Double bag** the sample and fill 1/2-3/4 full. Label **both** bags in permanent marker with Sample #, date and collector's name. Particle size analysis is usually contracted for every chemical analysis sample, but be sure to clarify this testing with the lab and collect sediment for this analysis.

2.6. Quality Control of Sample Containers

2.6.1. Quality control audits should be conducted for chemical analysis to verify that they are free from contaminants. These audits are performed before any bottles are approved for use. Because of the considerable effort expended in assuring the quality of sample bottles, it is important that they be used only for the parameters specified on the label.

2.6.2. To make sure appropriate procedures are used to prevent contamination, quality control information should be obtained from analysis laboratories when the contract for service is generated.

3. Cleaning Sediment Collection Equipment

3.1. The following steps for cleaning new or used sediment sampling equipment and containers are recommended by EPA (1994):

3.1.1. Soak 15 min in tap water, and scrub with detergent.

3.1.2. Rinse twice with tap water.

3.1.3. Rinse once with fresh, dilute (10% V:V) hydrochloric or nitric acid. To prepare a 10% solution of acid, add 10 ml of concentrated acid to 90 ml of deionized water.

3.1.4. Rinse twice with deionized water.

3.1.5. Rinse once with full-strength, pesticide-grade acetone (use a fume hood or canopy).

3.1.6. Rinse three times with deionized water.

3.1.7. Rinse field collection equipment with site water immediately before use. Lab equipment should be rinsed with test dilution water immediately before use in a test.

3.1.8. Clean equipment can be protected from contamination during transport (i.e., exhaust, pickup beds, boat motors, etc.) by wrapping in aluminum foil.

3.1.9. Quality control procedures to be followed at the sites should be written down for all field staff.

4. Sample Preservation

4.1. All sediment samples for chemical analysis should be preserved as soon as possible after collection by cooling to and **maintaining** a temperature of ~4°C (ice cold) by putting samples on ice in a cooler.

4.2. Keep samples shaded from sunlight to prevent breakdown of chemicals by UV light.

4.3. Ice packs should be included in each sample kit designed for VOC, GRO and DRO analysis, although samples should first be cooled to 4°C on ice. Plastic bottles can also be filled with water, frozen, and placed in the shipping container. Samples should be pre-chilled if these cooling materials are used for shipping.

4.4. For soil or sediment samples to be analyzed for GRO, it may be required to add 25 ml of premeasured methanol to two of the sample vials at the time of collection. (Vials of methanol should be provided by the lab) A third vial is used for determining moisture of the sample.

4.5. For soil samples to be analyzed for VOCs, the collector should consult the laboratory and the individual program needs for the appropriate preservation requirements which may include methanol preservation.

4.6. Contact the contracted laboratory for additional preservative requirements for specific parameter requests.

5. Packaging and Shipping

5.1. Cooling Samples

5.1.1. When cooling is required during shipping, the samples should be pre-cooled in an ice chest, and later placed in a field pack with a suitable quantity of ice or "Blue Ice". Ice should not be placed in the field pack loose. It should be securely sealed in a heavy plastic bag to prevent leakage during shipment. DO NOT USE metals bottles, nutrient bottles, or bottles designated for specific tests as ice containers.

5.2. Packing Samples

- 5.2.1. Properly packaging sediment samples for shipping is important for maintaining sample quality and safety of persons contacting the samples.
- 5.2.2. After collection, check each sample to make sure the container lid is securely closed and the sample is properly preserved. The exterior of each sample container should be wiped clean with a wet cloth.
- 5.2.3. Check all samples for secure, correct and complete labels that match the accompanying lab sheets (see below).
- 5.2.4. A whirl-pak or ziploc plastic bag should be used to protect the laboratory sheets from moisture damage during shipment. Dividers, included in the packs, help protect the sample bottles during shipment and should be used whenever possible. When sealing the field packs, secure all four sides of the lid by wrapping with reinforced tape. The tape should be completely wrapped around the pack to make sure that the lid is secure. When more than one field pack is needed to ship various sample portions from a single sampling site, tape the field packs together. This will prevent sample sorting errors and will allow the lab to match the bottles with the correct laboratory sheets.
- 5.2.5. A cooler lined with a polyethylene bag can be used instead of the foam pack if necessary, but be sure to pack sample jars to avoid breakage during shipping and handling.

5.3. Laboratory Sheets

- 5.3.1. Different laboratories may have their own lab sheets that should accompany all samples. Generally, lab sheets should include:
 - Sample identification
 - Sample description
 - Sampling program
 - Name and address of the person to whom the report should be sent
 - Last name of the sample collector
 - Field information
 - Tests (parameters) requested
- 5.3.2. The laboratory sheet is an important link between the laboratory and field personnel. The laboratory relies on the sheet to obtain the information necessary to prepare and analyze the sample properly.

5.4. Shipping Samples

- 5.4.1. If storage time limitations are recommended for the sample parameters, coordinate with the laboratory before collecting samples to let them know the sampling schedule.
- 5.4.2. Alert the receiving laboratory of any samples that are known or believed to contain high levels of specific contaminants, including an estimated concentration if possible. This can be done either over the phone before the samples arrive or with an enclosed written warning. The advanced notice allows the lab to handle highly contaminated samples in a way to prevent human exposure as well as cross-contamination of samples in the lab. Additionally, the lab will be able to process and analyze the samples more quickly if they know before analysis that the contaminant concentration is high.
- 5.4.3. Samples should be shipped with an "overnight" mail service or personally delivered to the laboratory for temporary storage so that the samples arrive before all of the ice melts in the shipping container. Monday, Tuesday or Wednesday are the best days to ship samples to assure they do not sit in a mail room with no refrigeration over the weekend. Even "overnight mail" can take longer than 24 hours, so Thursdays can be risky. DO NOT send samples on Fridays unless you have made previous arrangements with the lab.

5.5. Shipping Safety

- 5.5.1. If a sample bottle seal is questionable and no additional bottles are available, place the entire bottle in a whirl-pak (250 mL bottles only). This will contain the sample and prevent any preservative from contaminating other samples in the field pack.
- 5.5.2. The outside of the sample containers should be completely free of contaminated material before the samples are shipped. If this is not possible, the laboratory should be made aware of these samples before shipment.
- 5.5.3. If the submitter believes a sample contains a Department of Transportation (DOT) regulated material or hazardous material, refer to individual state shipping guidelines for hazardous materials.

6. References

- Baudo, R., Giesy, J., and H. Muntau, (Eds.). 1990. *Sediments: Chemistry and Toxicity of In-Place Pollutants*. Lewis Publishers, Boca Raton, FL.
- EPA. 1985. Sediment sampling quality assurance user's guide. Environmental Monitoring Systems Laboratory. Las Vegas, Nevada. EPA/600/4-85/048.

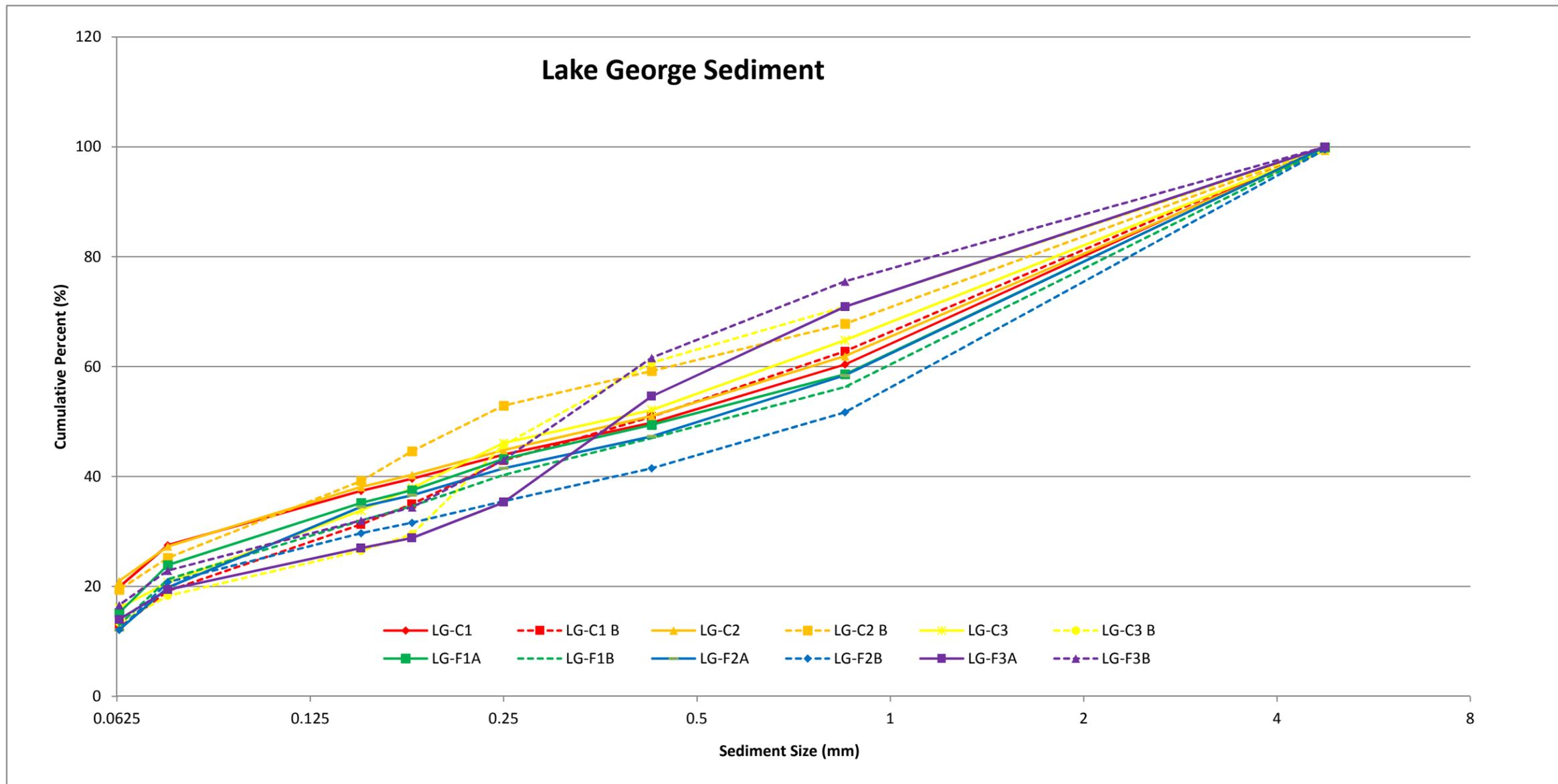
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Adapted from State of Wisconsin Sediment Sampling Guidelines

Appendix C – Contaminant Data

Appendix B - 1: Lake George Sediment Size Distributions

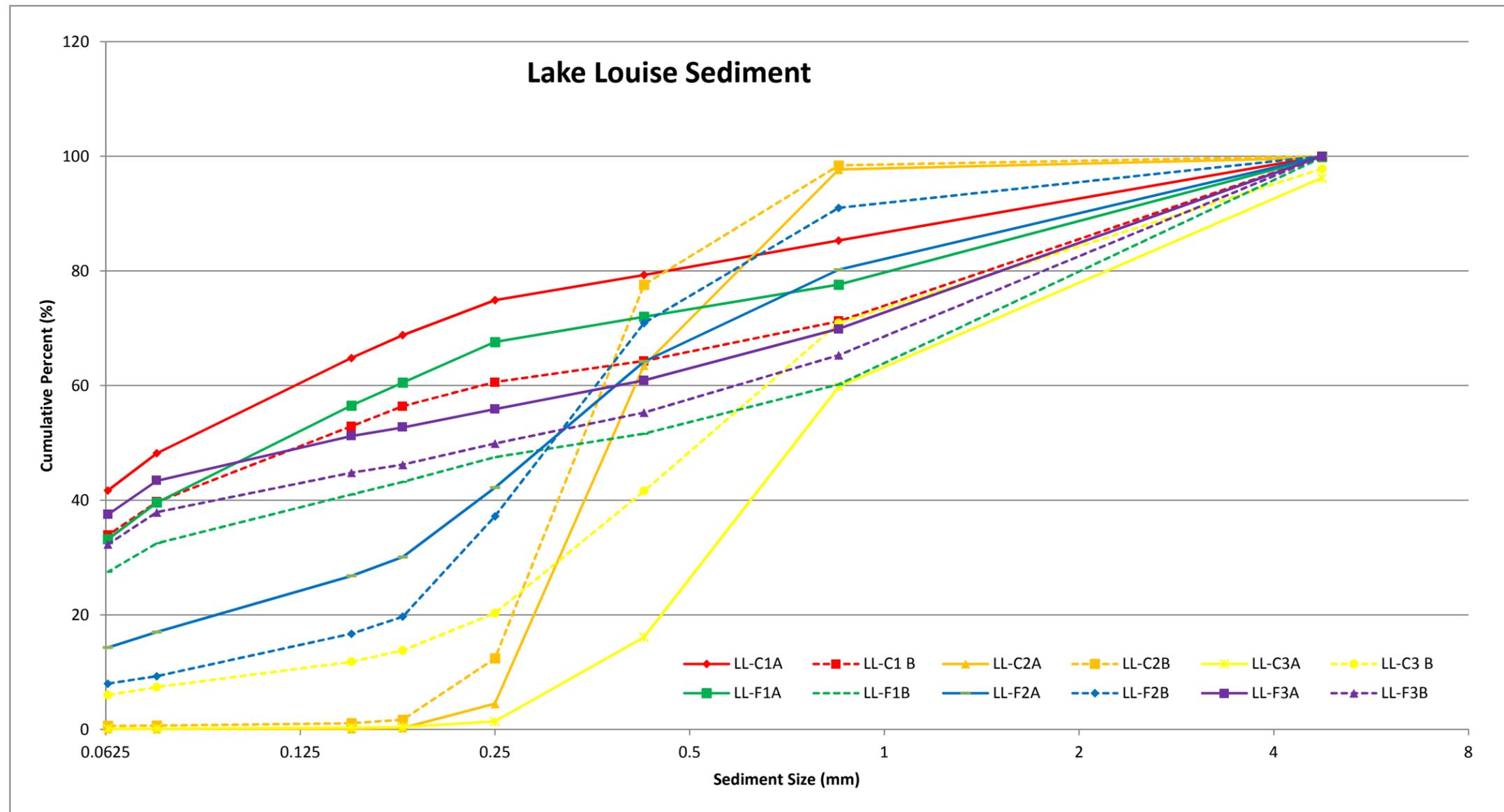
Method	Sieve	Diameter (mm)	Sediment Type	units	Sample Locations (ID)											
					LG-C1	LG-C1 B	LG-C2	LG-C2 B	LG-C3	LG-C3 B	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B
ASTM C136-84A	#4 Sieve	4.75	Fine Gravel	% passing sieve	100.0	99.9	99.3	99.8	99.5	99.7	99.9	99.6	100.0	99.5	100.0	100.0
ASTM C136-84A	#20 Sieve	0.85	Coarse Sand	% passing sieve	60.4	62.8	61.9	67.8	64.8	70.9	58.6	56.3	58.4	51.7	70.9	75.5
ASTM C136-84A	#40 Sieve	0.425	Medium Sand	% passing sieve	49.8	50.9	51.0	59.2	52.1	60.7	49.4	47.0	47.3	41.5	54.6	61.6
ASTM C136-84A	#60 Sieve	0.25	Medium Sand	% passing sieve	44.0	42.9	44.8	52.9	46.1	45.7	43.2	40.3	41.5	35.5	35.3	43.0
ASTM C136-84A	#80 Sieve	0.18	Fine Sand	% passing sieve	39.6	35.0	40.3	44.6	37.9	29.5	37.5	34.6	36.6	31.6	28.8	34.4
ASTM C136-84A	#100 Sieve	0.15	Very Fine Sand	% passing sieve	37.4	31.3	38.1	39.2	33.8	26.5	35.2	32.0	34.5	29.7	27.0	32.0
ASTM C136-84A	#200 Sieve	0.075	Very Fine Sand	% passing sieve	27.5	19.2	27.3	25.2	20.7	18.3	23.9	21.3	19.8	20.8	19.4	22.9
ASTM C136-84A	#230 Sieve	0.063	Silt	% passing sieve	19.9	12.5	21.0	19.4	16.1	13.4	15.2	13.0	12.1	12.1	14.0	16.6



Appendix C - 2: Lake Louise Sediment Size Distributions

Sample Locations (ID)

Method	Sieve	Diameter (mm)	Sediment Type	units	LL-C1A	LL-C1 B	LL-C2A	LL-C2 B	LL-C3A	LL-C3 B	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B
ASTM C136-84A	#4 Sieve	4.75	Fine Gravel	% passing sieve	100.0	100.0	99.7	100.0	96.2	97.8	99.9	99.8	100.0	100.0	100.0	100.0
ASTM C136-84A	#20 Sieve	0.85	Coarse Sand	% passing sieve	85.3	71.2	97.7	98.4	59.8	70.9	77.6	60.2	80.2	91.0	69.9	65.3
ASTM C136-84A	#40 Sieve	0.425	Medium Sand	% passing sieve	79.3	64.3	63.5	77.6	16.1	41.6	72.0	51.6	64.2	70.9	60.9	55.3
ASTM C136-84A	#60 Sieve	0.25	Medium Sand	% passing sieve	74.9	60.6	4.5	12.4	1.4	20.3	67.6	47.5	42.2	37.2	55.9	49.9
ASTM C136-84A	#80 Sieve	0.18	Fine Sand	% passing sieve	68.8	56.4	0.3	1.7	0.4	13.8	60.5	43.2	30.1	19.7	52.7	46.2
ASTM C136-84A	#100 Sieve	0.15	Very Fine Sand	% passing sieve	64.8	52.9	0.1	1.1	0.3	11.8	56.5	41.0	26.8	16.7	51.2	44.8
ASTM C136-84A	#200 Sieve	0.075	Very Fine Sand	% passing sieve	48.2	39.7	0.1	0.7	0.1	7.4	39.6	32.5	17.0	9.3	43.4	37.9
ASTM C136-84A	#230 Sieve	0.063	Silt	% passing sieve	41.7	33.9	0.1	0.6	0.1	6.0	33.2	27.5	14.3	8.0	37.5	32.3



River Falls Dams - Sediment Contaminant Analysis
CBSQG Comparisons - Data Normalized by TOC

River Falls, WI

Sampling Date: November 23, 2015



000	<i>Below Limit of Detection (detection limit shown in italics)</i>
000	Result Exceeds WI Sediment Quality Guidelines - TEC
000	Result Exceeds WI Sediment Quality Guidelines - MEC
000	Result Exceeds WI Sediment Quality Guidelines - PEC
000	Result Exceeds EPA RSLs for Industrial Sites
000	Result Exceeds EPA RSLs for Residential Sites

Constituent	units	Analytical Method	CAS #	WI CBSQG (TEC)	WI CBSQG (MEC)	WI CBSQG (PEC)	EPA RSL (Resident)	EPA RSL (Indust)	Lake George									
									Channel			Floodplain						
									LG-C1	LG-C2	LG-C3	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B	
Metals																		
Arsenic	mg/kg	EPA 6010C	7440-38-2	9.8	21.4	33	0.68	3	2.700	1.100	1.900	2.000	4.200	1.300	3.700	1.000	1.500	
Cadmium	mg/kg	EPA 6010C	7440-43-9	0.99	3	5	71	980	0.140	0.180	0.180	0.140	0.026	0.190	0.045	0.160	0.260	
Chromium	mg/kg	EPA 6010C	7440-47-3	43	76.5	110			15.100	14.000	18.100	10.400	21.100	12.500	18.900	14.300	13.700	
Hexavalent Chromium	mg/kg	EPA 3060A/7	18540-29-9				0.03	63	1.400	1.300	1.500	4.170	1.600	1.400	5.850	1.700	3.590	
Trivalent Chromium	mg/kg	EPA 6010C	16065-83-1				120000	1800000	15.000	14.000	18.000	6.000	21.000	13.000	13.000	14.000	10.000	
Copper	mg/kg	EPA 6010C	7440-50-8	32	91	150	3100	47000	11.500	11.200	14.100	8.600	18.000	11.500	16.500	12.400	13.100	
Lead	mg/kg	EPA 6010C	7439-92-1	36	83	130	400	800	11.600	15.000	18.100	18.700	22.100	34.500	38.600	31.100	29.900	
Mercury	mg/kg	EPA 7471B	7439-97-6	0.18	0.64	1.1	11	46	0.036	0.040	0.140	0.063	0.230	0.059	0.140	0.096	0.280	
Nickel	mg/kg	EPA 6010C	7440-02-0	23	36	49	1500	20000	9.000	8.500	10.600	6.700	16.900	7.900	13.300	9.800	9.200	
Zinc	mg/kg	EPA 6010C	7440-66-6	120	290	460	23000	350000	50.400	48.700	62.400	40.400	74.300	52.400	71.200	58.400	59.200	
PCBs									LG-C1	LG-C2	LG-C3	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B	
Aroclor-1016	mg/kg	EPA 8082A	12674-11-2				4	27		0.030		0.014		0.013		0.015		
Aroclor-1221	mg/kg	EPA 8082A	11104-28-2				0.2	0.83		0.025		0.012		0.011		0.013		
Aroclor-1232	mg/kg	EPA 8082A	11141-16-5				0.17	0.72		0.028		0.013		0.012		0.014		
Aroclor-1242	mg/kg	EPA 8082A	53469-21-9				0.23	0.95		0.028		0.013		0.011		0.014		
Aroclor-1248	mg/kg	EPA 8082A	12672-29-6				0.23	0.95		0.022		0.011		0.009		0.011		
Aroclor-1254	mg/kg	EPA 8082A	11097-69-1				0.22	0.74		0.018		0.009		0.039		0.024		
Aroclor-1260	mg/kg	EPA 8082A	11096-82-5				0.24	0.99		0.017		0.014		0.023		0.021		
Total PCBs	mg/kg			0.06	0.368	0.676						0.014		0.062		0.045		
PAHs									LG-C1	LG-C2	LG-C3	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B	
1-Methylnaphthalene	mg/kg	EPA 8310	90-12-0				18	73	0.097	0.528	0.269	0.212	0.190	0.931	0.915	0.111	0.119	
2-Methylnaphthalene	mg/kg	EPA 8310	91-57-6	0.0202	0.111	0.201	240	3000	0.087	0.482	0.238	0.192	0.171	0.850	0.814	0.102	0.107	
Acenaphthene	mg/kg	EPA 8310	83-32-9	0.0067	0.048	0.089	3400	33000	0.126	0.688	0.342	0.274	0.247	1.215	1.153	0.148	0.154	
Acenaphthylene	mg/kg	EPA 8310	208-96-8	0.0059	0.067	0.128			0.114	0.619	0.311	0.245	0.224	1.093	1.051	0.131	0.138	
Anthracene	mg/kg	EPA 8310	120-12-7	0.0572	0.451	0.845	17000	170000	0.033	0.177	0.089	0.072	0.065	0.312	0.298	0.038	0.039	
Benzo(a)anthracene	mg/kg	EPA 8310	56-55-3	0.108	0.579	1.05	0.15	2.1	0.066	0.032	0.090	0.068	0.070	0.156	0.123	0.078	0.096	
Benzo(a)pyrene	mg/kg	EPA 8310	50-32-8	0.15	0.8	1.45	0.015	0.21	0.078	0.204	0.121	0.062	0.070	0.131	0.126	0.059	0.007	
Benzo(b)fluoranthene	mg/kg	EPA 8310	205-99-2	0.24	6.82	13.4	0.15	2.1	0.102	0.069	0.115	0.048	0.013	0.061	0.061	0.055	0.008	
Benzo(g,h,i)perylene	mg/kg	EPA 8310	191-24-2	0.17	1.685	3.2			0.085	0.071	0.079	0.028	0.025	0.126	0.119	0.033	0.016	
Benzo(k)fluoranthene	mg/kg	EPA 8310	207-08-9	0.24	6.82	13.4	1.5	21	0.045	0.026	0.065	0.040	0.009	0.109	0.078	0.073	0.006	
Chrysene	mg/kg	EPA 8310	218-01-9	0.166	0.728	1.29	15	210	0.055	0.087	0.073	0.035	0.032	0.154	0.149	0.051	0.063	
Dibenzo(a,h)anthracene	mg/kg	EPA 8310	53-70-3	0.033	0.084	0.135	0.015	0.21	0.027	0.140	0.071	0.058	0.049	0.251	0.241	0.030	0.031	
Fluoranthene	mg/kg	EPA 8310	206-44-0	0.423	1.327	2.23	2300	22000	0.160	0.132	0.245	0.126	0.104	0.271	0.240	0.130	0.168	
Fluorene	mg/kg	EPA 8310	86-73-7	0.0774	0.307	0.536	2300	22000	0.027	0.140	0.071	0.058	0.049	0.251	0.241	0.030	0.031	
Indeno(1,2,3-cd)pyrene	mg/kg	EPA 8310	193-39-5	0.2	1.7	3.2	0.15	2.1	0.112	0.083	0.121	0.053	0.025	0.126	0.119	0.069	0.016	
Naphthalene	mg/kg	EPA 8310	91-20-3	0.176	0.369	0.561	3.6	18	0.056	0.298	0.155	0.120	0.106	0.526	0.508	0.066	0.067	
Phenanthrene	mg/kg	EPA 8310	85-01-8	0.204	0.687	1.17			0.064	0.053	0.125	0.045	0.079	0.093	0.092	0.068	0.012	
Pyrene	mg/kg	EPA 8310	129-00-0	0.195	0.858	1.52	1700	17000	0.155	0.092	0.289	0.134	0.137	0.231	0.183	0.111	0.159	
Total PAHs	mg/kg	EPA 8310		1.6	12.2	22.8			0.921	0.637	1.324	0.576	0.460	0.898	0.750	0.726	0.487	

River Falls Dams - Sediment Contaminant Analysis
CBSQG Comparisons - Data Normalized by TOC

River Falls, WI

Sampling Date: November 23, 2015



000	<i>Below Limit of Detection (detection limit shown in italics)</i>
000	Result Exceeds WI Sediment Quality Guidelines - TEC
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Constituent	units	Analytical Method	CAS #	WI CBSQG (TEC)	WI CBSQG (MEC)	WI CBSQG (PEC)	EPA RSL (Resident)	EPA RSL (Indust)	Lake George									
									Channel			Floodplain						
									LG-C1	LG-C2	LG-C3	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B	
Organochlorine Pesticides																		
4,4'-DDD	mg/kg	EPA 8081B	72-54-8	0.0049	0.0165	0.028	2.3	9.6										
4,4'-DDE	mg/kg	EPA 8081B	72-55-9	0.0032	0.017	0.031	2	9.3										
4,4'-DDT	mg/kg	EPA 8081B	50-29-3	0.0042	0.0336	0.063	1.9	8.5										
Aldrin	mg/kg	EPA 8081B	309-00-2	0.002	0.041	0.08	0.039	0.18										
alpha-BHC	mg/kg	EPA 8081B	319-84-6	0.006	0.0053	0.1	0.086	0.36										
alpha-Chlordane	mg/kg	EPA 8081B	5103-71-9															
beta-BHC	mg/kg	EPA 8081B	319-85-7	0.005	0.108	0.21	0.3	1.3										
Chlordane (Technical)	mg/kg	EPA 8081B	57-74-9	0.0032	0.0106	0.018	1.7	7.5										
delta-BHC	mg/kg	EPA 8081B	319-86-8															
Dieldrin	mg/kg	EPA 8081B	60-57-1	0.0019	0.032	0.062	0.034	0.14										
Endosulfan I	mg/kg	EPA 8081B	959-98-8				470	7000										
Endosulfan II	mg/kg	EPA 8081B	33213-65-9															
Endosulfan sulfate	mg/kg	EPA 8081B	1031-07-8															
Endrin	mg/kg	EPA 8081B	72-20-8	0.0022	0.1046	0.207	19	250										
Endrin aldehyde	mg/kg	EPA 8081B	7421-93-4															
Endrin ketone	mg/kg	EPA 8081B	53494-70-5															
gamma-Chlordane	mg/kg	EPA 8081B	5103-74-2															
Heptachlor	mg/kg	EPA 8081B	76-44-8				0.13	0.63										
Heptachlor epoxide	mg/kg	EPA 8081B	1024-57-3	0.0025	0.0093	0.016	0.07	0.33										
Lindane	mg/kg	EPA 8081B	58-89-9	0.003	0.004	0.005	0.57	25										
Methoxychlor	mg/kg	EPA 8081B	72-43-5				320	4100										
Toxaphene	mg/kg	EPA 8081B	8001-35-2	0.001	0.0015	0.002	0.49	21										
Chlorinated Herbicides									LG-C1	LG-C2	LG-C3	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B	
2,4-D	mg/kg	EPA 8151A	94-75-7				700	9600										
2,4-DB	mg/kg	EPA 8151A	94-82-6				510	6600										
2,4,5-TP	mg/kg	EPA 8151A	93-72-1				510	6600										
2,4,5-T	mg/kg	EPA 8151A	93-76-5				630	8200										
Dalapon	mg/kg	EPA 8151A	75-99-0				1900	25000										
Dicamba	mg/kg	EPA 8151A	1918-00-9	0.18		13	1900	25000										
Dichloroprop	mg/kg	EPA 8151A	94-75-7				700	9600										
Dinoseb	mg/kg	EPA 8151A	88-85-7				63	820										
Pentachlorophenol	mg/kg	EPA 8151A	87-86-5	0.15	0.175	0.2	1	4										
Picloram	mg/kg	EPA 8151A	1918-02-1				4400	57000										
Chloramben	mg/kg	EPA 8151A	133-90-4				950	12000										
Benazon	mg/kg	EPA 8151A	25057-89-0				1900	25000										
Acifluorfen	mg/kg	EPA 8151A	50594-66-6															
Other									LG-C1	LG-C2	LG-C3	LG-F1A	LG-F1B	LG-F2A	LG-F2B	LG-F3A	LG-F3B	
Total Organic Carbon	mg/kg	L-Kahn/9060	TOC						48300	43600	96600	20800	26300	24700	29500	24400	25300	
Total Organic Carbon	%								4.8	4.4	9.7	2.1	2.6	2.5	3.0	2.4	2.5	
Solids, Percent	%	EPA 8000C	SOLID						36.7	35.0	42.0	32.4	40.3	35.1	43.8	45.9	49.5	
Percent Moisture	%	SM 2540G	MOIST						63.3	65.0	58.0	67.6	59.7	64.9	56.3	54.1	50.5	
Gasoline Range Organics	mg/kg	WDNR GRO	GASCOMP						2.1	2.0	2.2	1.9	2.2	2.0	2.3	2.4	2.6	
Diesel Range Organics	mg/kg	WDNR DRO	DIESELCOMP						5.5	32.3	31.5	55.7	59.8	3.8	55.6	40.1	46.0	

No Data

No Data

36.7	35	42	32.4	40.3	35.1	43.8	45.9	49.5
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NOTES
 WI-Wisconsin DNR. 2003.Consensus-Based Sediment Quality Guidelines. Recommendations for Use and Applications. Interim Guidance. WT-732. 35pp. http://dnr.wi.gov/topic/brownfields/documents/cbsqg_interim_final.pdf
 ***EPA- Region 3 (Mid-Atlantic) Screening Values from multiple sources - <http://www.epa.gov/reg3hwm/risk/eco/btag/sbv/fw/screenbench.htm>

River Falls Dams - Sediment Contaminant Analysis
CBSQG Comparisons - Data Normalized by TOC

River Falls, WI

Sampling Date: November 23, 2015



Constituent	Units	Analytical Method	CAS #	WI CBSQG (TEC)	WI CBSQG (MEC)	WI CBSQG (PEC)	EPA RSL (Resident)	EPA RSL (Indust)	Lake Louise								
									Channel				Floodplain				
									LL-C1	LL-C2	LL-C3	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B
Metals																	
Arsenic	mg/kg	EPA 6010C	7440-38-2	9.8	21.4	33	0.68	3	35.400	4.700	4.000	2.000	4.500	1.300	0.820	7.100	4.900
Cadmium	mg/kg	EPA 6010C	7440-43-9	0.99	3	5	71	980	2.900	0.120	0.095	0.190	0.310	0.084	0.052	0.047	0.037
Chromium	mg/kg	EPA 6010C	7440-47-3	43	76.5	110			23.000	19.900	12.400	14.500	32.700	11.100	18.300	28.800	25.200
Hexavalent Chromium	mg/kg	EPA 3060A/7	18540-29-9				0.03	63	2.100	6.200	4.800	1.700	2.600	1.700	2.700	7.440	11.100
Trivalent Chromium	mg/kg	EPA 6010C	16065-83-1				120000	1800000	23.000	20.000	12.000	15.000	33.000	11.000	18.000	21.000	14.000
Copper	mg/kg	EPA 6010C	7440-50-8	32	91	150	3100	47000	28.000	10.700	8.800	12.900	28.000	10.100	13.800	24.200	21.900
Lead	mg/kg	EPA 6010C	7439-92-1	36	83	130	400	800	23.400	7.700	5.900	15.900	28.500	8.700	10.700	23.800	20.600
Mercury	mg/kg	EPA 7471B	7439-97-6	0.18	0.64	1.1	11	46	0.130	0.010	0.017	0.077	0.280	0.037	0.064	0.400	0.370
Nickel	mg/kg	EPA 6010C	7440-02-0	23	36	49	1500	20000	15.800	10.500	9.800	8.900	27.900	6.500	10.900	25.100	20.900
Zinc	mg/kg	EPA 6010C	7440-66-6	120	290	460	23000	350000	77.000	43.800	29.800	72.900	79.700	44.900	54.500	74.900	71.600
PCBs									LL-C1	LL-C2	LL-C3	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B
Aroclor-1016	mg/kg	EPA 8082A	12674-11-2				4	27				0.010		0.030		0.017	
Aroclor-1221	mg/kg	EPA 8082A	11104-28-2				0.2	0.83				0.009		0.030		0.014	
Aroclor-1232	mg/kg	EPA 8082A	11141-16-5				0.17	0.72				0.010		0.030		0.016	
Aroclor-1242	mg/kg	EPA 8082A	53469-21-9				0.23	0.95				0.009		0.030		0.015	
Aroclor-1248	mg/kg	EPA 8082A	12672-29-6				0.23	0.95				0.008		0.030		0.012	
Aroclor-1254	mg/kg	EPA 8082A	11097-69-1				0.22	0.74				0.006		0.030		0.010	
Aroclor-1260	mg/kg	EPA 8082A	11096-82-5				0.24	0.99				0.006		0.030		0.009	
Total PCBs	mg/kg			0.06	0.368	0.676											
PAHs									LL-C1	LL-C2	LL-C3	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B
1-Methylnaphthalene	mg/kg	EPA 8310	90-12-0				18	73	0.093	0.909	0.889	0.784	0.042	1.228	0.220	0.025	0.024
2-Methylnaphthalene	mg/kg	EPA 8310	91-57-6	0.0202	0.111	0.201	240	3000	0.084	0.818	0.778	0.700	0.038	1.096	0.196	0.022	0.021
Acenaphthene	mg/kg	EPA 8310	83-32-9	0.0067	0.048	0.089	3400	33000	0.119	1.182	1.111	1.008	0.056	1.623	0.285	0.031	0.031
Acenaphthylene	mg/kg	EPA 8310	208-96-8	0.0059	0.067	0.128			0.108	1.045	1.000	0.896	0.047	1.447	0.252	0.029	0.028
Anthracene	mg/kg	EPA 8310	120-12-7	0.0572	0.451	0.845	17000	170000	0.032	0.295	0.289	0.261	0.014	0.412	0.075	0.008	0.008
Benzo(a)anthracene	mg/kg	EPA 8310	56-55-3	0.108	0.579	1.05	0.15	2.1	0.047	0.039	0.567	0.319	0.009	1.228	0.016	0.007	0.007
Benzo(a)pyrene	mg/kg	EPA 8310	50-32-8	0.15	0.8	1.45	0.015	0.21	0.005	0.092	0.678	0.083	0.009	0.070	0.023	0.001	0.010
Benzo(b)fluoranthene	mg/kg	EPA 8310	205-99-2	0.24	6.82	13.4	0.15	2.1	0.006	0.069	0.516	0.053	0.003	0.083	0.014	0.002	0.002
Benzo(g,h,i)perylene	mg/kg	EPA 8310	191-24-2	0.17	1.685	3.2			0.037	0.118	0.441	0.104	0.006	0.167	0.029	0.004	0.003
Benzo(k)fluoranthene	mg/kg	EPA 8310	207-08-9	0.24	6.82	13.4	1.5	21	0.044	0.048	0.351	0.036	0.002	0.057	0.010	0.001	0.001
Chrysene	mg/kg	EPA 8310	218-01-9	0.166	0.728	1.29	15	210	0.042	0.150	0.536	0.129	0.007	0.732	0.036	0.004	0.007
Dibenzo(a,h)anthracene	mg/kg	EPA 8310	53-70-3	0.033	0.084	0.135	0.015	0.21	0.025	0.236	0.233	0.207	0.011	0.329	0.056	0.007	0.006
Fluoranthene	mg/kg	EPA 8310	206-44-0	0.423	1.327	2.23	2300	22000	0.112	0.179	1.378	0.187	0.021	2.728	0.051	0.020	0.016
Fluorene	mg/kg	EPA 8310	86-73-7	0.0774	0.307	0.536	2300	22000	0.025	0.236	0.233	0.207	0.011	0.329	0.056	0.007	0.006
Indeno(1,2,3-cd)pyrene	mg/kg	EPA 8310	193-39-5	0.2	1.7	3.2	0.15	2.1	0.078	0.118	0.594	0.104	0.009	0.167	0.045	0.003	0.003
Naphthalene	mg/kg	EPA 8310	91-20-3	0.176	0.369	0.561	3.6	18	0.052	0.500	0.494	0.448	0.023	0.702	0.121	0.014	0.013
Phenanthrene	mg/kg	EPA 8310	85-01-8	0.204	0.687	1.17			0.009	0.091	0.556	0.078	0.004	1.228	0.022	0.002	0.002
Pyrene	mg/kg	EPA 8310	129-00-0	0.195	0.858	1.52	1700	17000	0.106	0.149	1.467	0.194	0.013	3.447	0.035	0.014	0.012
Total PAHs	mg/kg	EPA 8310		1.6	12.2	22.8			0.518	0.575	7.082	0.783	0.061	9.364	0.170	0.045	0.053

River Falls Dams - Sediment Contaminant Analysis
CBSQG Comparisons - Data Normalized by TOC

River Falls, WI

Sampling Date: November 23, 2015



Constituent	units	Analytical Method	CAS #	WI CBSQG (TEC)	WI CBSQG (MEC)	WI CBSQG (PEC)	EPA RSL (Resident)	EPA RSL (Indust)	Lake Louise									
									Channel				Floodplain					
Organochlorine Pesticides									LL-C1	LL-C2	LL-C3	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B	
4,4'-DDD	mg/kg	EPA 8081B	72-54-8	0.0049	0.0165	0.028	2.3	9.6		0.018								
4,4'-DDE	mg/kg	EPA 8081B	72-55-9	0.0032	0.017	0.031	2	9.3		0.018								
4,4'-DDT	mg/kg	EPA 8081B	50-29-3	0.0042	0.0336	0.063	1.9	8.5		0.024								
Aldrin	mg/kg	EPA 8081B	309-00-2	0.002	0.041	0.08	0.039	0.18		0.027								
alpha-BHC	mg/kg	EPA 8081B	319-84-6	0.006	0.0053	0.1	0.086	0.36		0.015								
alpha-Chlordane	mg/kg	EPA 8081B	5103-71-9							0.015								
beta-BHC	mg/kg	EPA 8081B	319-85-7	0.005	0.108	0.21	0.3	1.3		0.015								
Chlordane (Technical)	mg/kg	EPA 8081B	57-74-9	0.0032	0.0106	0.018	1.7	7.5		0.268								
delta-BHC	mg/kg	EPA 8081B	319-86-8							0.012								
Dieldrin	mg/kg	EPA 8081B	60-57-1	0.0019	0.032	0.062	0.034	0.14		0.015								
Endosulfan I	mg/kg	EPA 8081B	959-98-8				470	7000		0.015								
Endosulfan II	mg/kg	EPA 8081B	33213-65-9							0.007								
Endosulfan sulfate	mg/kg	EPA 8081B	1031-07-8							0.009								
Endrin	mg/kg	EPA 8081B	72-20-8	0.0022	0.1046	0.207	19	250		0.009								
Endrin aldehyde	mg/kg	EPA 8081B	7421-93-4							0.012								
Endrin ketone	mg/kg	EPA 8081B	53494-70-5							0.008								
gamma-Chlordane	mg/kg	EPA 8081B	5103-74-2							0.008								
Heptachlor	mg/kg	EPA 8081B	76-44-8				0.13	0.63		0.009								
Heptachlor epoxide	mg/kg	EPA 8081B	1024-57-3	0.0025	0.0093	0.016	0.07	0.33		0.008								
Lindane	mg/kg	EPA 8081B	58-89-9	0.003	0.004	0.005	0.57	25		0.018								
Methoxychlor	mg/kg	EPA 8081B	72-43-5				320	4100		0.015								
Toxaphene	mg/kg	EPA 8081B	8001-35-2	0.001	0.0015	0.002	0.49	21		0.327								
Chlorinated Herbicides									LL-C1	LL-C2	LL-C3	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B	
2,4-D	mg/kg	EPA 8151A	94-75-7				700	9600		0.006								
2,4-DB	mg/kg	EPA 8151A	94-82-6				510	6600		0.012								
2,4,5-TP	mg/kg	EPA 8151A	93-72-1				510	6600		0.001								
2,4,5-T	mg/kg	EPA 8151A	93-76-5				630	8200		0.001								
Dalapon	mg/kg	EPA 8151A	75-99-0				1900	25000		0.015								
Dicamba	mg/kg	EPA 8151A	1918-00-9	0.18		13	1900	25000		0.001								
Dichloroprop	mg/kg	EPA 8151A	94-75-7				700	9600		0.005								
Dinoseb	mg/kg	EPA 8151A	88-85-7				63	820		0.002								
Pentachlorophenol	mg/kg	EPA 8151A	87-86-5	0.15	0.175	0.2	1	4		0.001								
Picloram	mg/kg	EPA 8151A	1918-02-1				4400	57000		0.001								
Chloramben	mg/kg	EPA 8151A	133-90-4				950	12000		0.001								
Benazon	mg/kg	EPA 8151A	25057-89-0				1900	25000		0.003								
Acifluorfen	mg/kg	EPA 8151A	50594-66-6							0.001								
Other									LL-C1	LL-C2	LL-C3	LL-F1A	LL-F1B	LL-F2A	LL-F2B	LL-F3A	LL-F3B	
Total Organic Carbon	mg/kg	L-Kahn/9060	TOC						34400	2200	1800	35700	21300	22800	21400	32100	32200	
Total Organic Carbon	%								3.4	0.2	0.2	3.6	2.1	2.3	2.1	3.2	3.2	
Solids, Percent	%	EPA 8000C	SOLID						52.8	84.8	80.8	46.4	66.6	47.0	67.8	62.4	60.7	
Percent Moisture	%	SM 2540G	MOIST						47.2	15.2	19.2	53.6	33.4	53.0	32.2	37.6	39.3	
Gasoline Range Organics	mg/kg	WDNR GRO	GASCOMP						2.8	8.5	6.8	2.4	3.9	2.5	4.0	3.5	3.3	
Diesel Range Organics	mg/kg	WDNR DRO	DIESELCOMP						65.9	13.3	10.1	18.2	40.9	8.9	45.6	33.2	75.6	

No Data

No Data

NOTES

WI-Wisconsin DNR. 2003.Consensus-Based Sediment Quality Guidelines. Recommendations for Use and Applications. Interim Guidance. WT-732. 35f

***EPA- Region 3 (Mid-Atlantic) Screening Values from multiple sources - <http://www.epa.gov/reg3hwm/risk/eco/btag/sbv/fw/screenbench.htm>