Line 5 Wisconsin Segment Relocation Project

Wisconsin Department of Natural Resources

Docket # IP-NO-2020-2-N00471

Enbridge Reponses to DNR Information Request Dated March 10, 2023

Attachment 2

U.S. Army Corps of Engineers Data Request Response dated January 19, 2023

Julie Kloss Molina
Sr. Environment Advisor

tel 218 591 8920
Julie.Kloss@enbridge.com

Enbridge Energy, Limited Partnership
11 E. Superior St., Suite 125
Duluth, MN 55802

January 19, 2023

Bill Sande
Lead Project Manager
USACE Hayward Regulatory Field Office
10637 Hayward Court, Unit 2
Hayward, Wisconsin 54843

RE: Enbridge Energy, Limited Partnership
Line 5 Wisconsin Segment Relocation
Responses to Data Requests dated December 6, 2022
Regulatory File No. 2020-00260-WMS

Dear Bill:

Thank you for your work and the work of the U.S. Army Corps of Engineers (USACE) in preparing an Environmental Assessment (EA) for the Line 5 Wisconsin Segment Relocation Project. This letter provides information requested by the USACE on December 6, 2022 to complete development of the draft EA.

Set forth below please find the individual requests from the December 6, 2022 letter, by Enbridge's response to each request.

If you have questions about the information presented in the attached materials, please contact me at (218) 591-8920.

Sincerely,

Julie Kloss Molina

Julie Kloss Molina
Sr. Environment Advisor
Enbridge Energy, Limited Partnership

Enclosures: Data Request Responses

cc: Ben Callan, WDNR
Adam Mednick, WDNR

Enbridge Line 5 Wisconsin Segment Relocation Project
Responses to U.S. Army Corps of Engineers Data Request dated December 9, 2022
Regulatory File # 2020-00260-WMS

Data Request Question 1: *The location of the proposed horizontal direction drill (HDD) of the White River is remote and access appears to be difficult. Please provide an evaluation of alternative installation methods and locations, which clearly addresses the practicability of the alternative crossing method(s) and locations and provides a comparison of environmental considerations. Describe measures to reduce the potential for an inadvertent release of drilling fluid at this location and describe specific measures that you would employ to respond in the event of an inadvertent release of drilling fluid. We further ask that you address other measures suggested by the public or other agencies and indicate your rationale for including or excluding them.*

Data Request Question 1 Response:

EVALUATION OF ALTERNATIVE CROSSING METHODS AT THE WHITE RIVER

While somewhat remote, Enbridge has determined that the proposed horizontal directional drill ("HDD") location for the White River is accessible via the proposed right-of-way and temporary access roads and that the location can be reached by the equipment necessary for large diameter pipe installation, including drilling equipment. As described in Enbridge's application and subsequent filings, two advantages of the HDD method are that most of the workspace for the drill operation is set back from the water's edge and that the pipeline can be installed under the waterbody without disturbing its bed or banks. However, to be successful, an HDD operation requires large additional temporary workspaces at the drill entry and exit locations for staging and equipment. It also requires suitable subsurface geology conductive to drilling; relatively flat topography for pipe fabrication; and a relatively straight cleared area of right-of-way on the drill exit side to fabricate the pipe segments to be pulled back under the river. All of these conditions exist at the proposed White River crossing location, making the proposed HDD a feasible crossing technique. The primary concern with an HDD drilled crossing is the potential for an inadvertent return surfacing at some location other than the drill entry and exit locations. Changing the location will not mitigate this risk, and the geology at the proposed White River crossing location has been determined to be suitable for an HDD.

Enbridge has evaluated other crossing techniques along the proposed pipeline alignment at the White River. Those methods include open cut (wet trench), dry crossing (dam and pump or flume), coffer-dam, and direct pipe. Enbridge does not propose to use a cofferdam system to cross any waterbodies as this method introduces higher safety risks with having personnel in an open excavation within the streambed to complete tie-in welds.

The use of open cut or dry crossing methods are not practicable and would require increased impacts to the aquatic and natural environment (e.g., sedimentation) if used at the White River crossing for installation of the Relocation pipe. The primary methods other than HDD that Enbridge proposes to use for flowing waterbodies are the dam and pump method and the flume method. Both of these methods, which are described in Enbridge's application and supplemental materials, use dams to temporarily isolate the construction workspace from the flow of the waterbody, but unlike the HDD method require excavation of the surface of the waterbody bed and banks to create the trench into which the pipe is installed. However, because the stream flow is isolated from the work area, the dam and pump and flume pipe methods only result in a temporary small release of sediment when the upstream and downstream dams are installed/removed and the streamflow is restored to the bed of the waterbody. This sedimentation is minor, of short duration, and generally localized to the crossing area. Given the width and flow of the White River, it is impractical to use either the dam and pump or flume pipe methods at the proposed crossing location. Thus if Enbridge does not use the HDD method, it would likely propose an open-cut (wet trench) crossing of the river. An open cut (wet trench) crossing would require not only the excavation of the bed and banks of the river but also would result in much higher concentrations of suspended sediments in the waterway than either the HDD or other dry crossing methods, both in terms of total amount of sediment suspended and transported as well as the duration of the sedimentation event. Additionally, unlike the proposed HDD, both the open cut (wet trench) and dry crossing methods described above would require significant workspace within the forested floodplain of the White River to accommodate equipment, materials, and spoil storage, resulting in greater environmental disturbance. For these reasons, the HDD method is the environmentally-preferred crossing method for the White River.

ALTERNATIVE WHITE RIVER CROSSING LOCATIONS

Enbridge initially evaluated an alternative White River crossing location that would have placed the pipeline beneath the reservoir upstream of the hydroelectric dam on the White River located on State Highway 112. Although technically feasible as an HDD crossing, this location would place the pipeline in close proximity to the dam and would pass beneath wild rice waters, which could be affected in the event of an inadvertent release of drilling mud. Use of a dry crossing method would not be feasible at this location due to water depth, flow rates, and distance across the feature. However, it would be technically feasible, as an alternative to the HDD method, to cross the reservoir using an open cut technique with barge mounted equipment (depending on the depth of the reservoir at the time of construction); however, this method would result in increased sediment suspension in wild rice waters. Regardless of how it would be crossed, any crossing of this reservoir at this location would also require approval from the Federal Energy Regulatory Commission ("FERC") because the location falls within the federally-permitted hydroelectric project regulated by FERC. Based on these factors, Enbridge determined that there was no technical or environmental advantage to crossing the White River at the reservoir location.

Enbridge also evaluated a crossing of the White River further upstream of the proposed location along proposed Route Alternative RA-02. Information for RA-02 was provided in Enbridge's original permit application and supplemental filings. Any crossing of the river on this alignment would use either the HDD or open cut technique and would have advantages and disadvantages similar to those described for alternative crossing methods along the proposed route (e.g., risk of an inadvertent return for an HDD and increased sedimentation for an open cut). Most river crossing locations between RA-02 and the proposed crossing location would have the potential to impact the White River Fishery Area, which is owned by the State of Wisconsin and managed as a multiple use area for trout fishing, hunting, canoeing, and similar outdoor recreational and educational opportunities. Use of the open cut (wet trench) method or dry crossing method could result in sediment transport into the White River Fishery Area. Similarly, an inadvertent release of drilling mud could potentially impact the White River Fishery Area.

Enbridge did not evaluate a crossing location between Highway 112 and Highway 13. This area was excluded from further review after Enbridge determined that any alternative locations between these highways would not take advantage of co-location with the existing utility corridor, would place the route closer to the Bad River Reservation, and would be more difficult to access, as the area is remote as compared to the proposed route. However, Enbridge did evaluate one potential route located east of Highway 13. This route was presented in the route alternatives section of the application materials as Route Alternative RA-01. Although RA-01 follows an existing utility line and therefore benefits from co-location with existing right-of-way, analysis of the White River crossing along the RA-01 alignment places the pipeline route closer to the Bad River Reservation border and would require crossing of the Wild River Wildlife Area, a State Wildlife Management Area.

MEASURES TO REDUCE THE POTENTIAL FOR INADVERTENT RETURNS AND THE IMPACT OF INADVERTENT RETURNS

Enbridge has internal construction standards that are used in conjunction with experience from specialized HDD design firms to develop site-specific plans for each HDD. The primary measure to prevent inadvertent releases during an HDD operation is to carefully assess geotechnical data for a crossing and to develop a crossing design taking that data into account. Enbridge's designs incorporate and consider geotechnical information documenting subsurface geology, topography between the entry and exit locations as well as workspace for pipe fabrication, required depth below river bottom, pipe diameter and associated installation radius and drilling mud hydraulics. For this Project, Enbridge conducted preconstruction geotechnical investigations to design and confirm the suitability of the subsurface material for HDD. In concert with those carefully-developed designs, Enbridge will use a highly experienced HDD company with years of experience successfully completing drills to help plan, design and execute each drill. These plans will include all requirements set forth in Wisconsin Technical Standard 1072 for Horizontal Directional Drilling. Enbridge further evaluated the designs and events of the recent Line 3 Replacement Project in Minnesota with its HDD design engineering firm to assess modifications to the Project designs to further reduce the likelihood of an inadvertent return. Enbridge made modifications to the Project HDD designs as appropriate.

Enbridge will also complete a pre-construction visit at the site at least 2 weeks prior to initiating HDD setup and operations to determine if additional materials and equipment will be needed. This will reduce the potential for surprises including inadvertent returns and improve the speed and effectiveness of the contractor response to any inadvertent return that may occur.

Lastly, Enbridge will implement Inadvertent Release Response Plans that provide site-specific information regarding features crossed by each HDD and containment and recovery response measures tailored to site-specific conditions. These plans require the continuous monitoring and control of drilling mud consistency, drilling mud injection pressures, alignment of the bit, qualifications of individuals on site, and inspection staff on site. As part of the drilling process, the drilling contractor will continuously monitor drilling mud pressures, drilling mud volume being pumped, and drilling mud volume returning (drilling mud circulation). Changes or discrepancies in these reading can indicate that an inadvertent return is occurring. If the HDD operator identifies a sustained loss of fluid pressure or circulation, the contractor will: (1) shut down drilling progress; (2) immediately notify the construction inspector of the assumed position of the drill tool; and (3) increase monitoring along the drill path to look for signs of an inadvertent release to the surface.

Enbridge's Drilling Fluid Response, Containment, and Notification Procedures

The information below elaborates on measures to be implemented if an inadvertent release of drilling fluid occurs despite best efforts to prevent that occurrence. Prior to the commencement of drilling operations, construction personnel involved will be informed as to the responsible party or parties for release containment and response. Enbridge will verify that the contractor has the appropriate response personnel and containment equipment on site for each drill prior to initiating the drill and throughout the drilling process.

Use of Safe and Approved Materials

The HDD drilling fluids/mud consists primarily of water mixed with inert bentonite clay. Under certain conditions, an additive may need to be mixed with the drilling fluids/mud for viscosity or lubricating reasons. Only agency-approved additives will be used and a Safety Data Sheet for the drilling fluid additives will be maintained on-site at each active HDD.

On-Site Inspection during Construction

Early detection is key to minimizing the area of potential impact from an inadvertent release. During construction of a drilled crossing, Enbridge will monitor the drill by implementing the following best management practices ("BMPs") that allow for the early detection of drilling fluid loss and cessation of operations until such loss can be located and remedied. This procedure will occur regardless of seasonality. If fluid loss has been detected, physical surveys as described below will be conducted to determine if the fluid has migrated to the surface, and the appropriate corrective actions will be implemented. Specifically, the HDD operator will:

- Maintain 24-hour operations, which can help maintain consistent drilling fluid circulation and monitoring.
- Continuously monitor and maintain a log of drilling mud volume balance (mud in = mud out).
- Maintain drilling fluid circulation at entry and exit endpoints to ensure that cuttings are:
  - Being carried out of the hole and
  - Properly segregated from the re-used drilling fluid.
- Monitor in real-time the annular drilling fluid pressures during drilling, and record pressures every minute.

If a sustained loss in fluid pressure or loss of circulation occurs, the HDD operator will:

- Shutdown the drilling progress promptly;
- Notify the construction inspectors of the assumed position of the drill tool; and
- Visually inspect by walking or using a boat the appropriate portion of the drill path where the drill tool is located to determine if an inadvertent return occurred.

Additionally:

- Enbridge will inform construction inspectors on what to watch for and will make them aware of the importance of timely detection and response actions for any release of drilling fluid.
- Construction inspectors will have appropriate, operational communication equipment (e.g., radio and cell phones) available at all times during installation of the HDD crossing, with the ability to communicate directly with the HDD operator.
- At least one full-time personnel will continuously monitor the drill path by inspecting land surfaces and the waterbodies for surface releases of drilling fluid during drilling, reaming, and pipe installation procedures. The inspector will also walk the drill path to monitor for surface seepage, sinkholes, and settlement. In addition, flowing streams shall be monitored both upstream and downstream of the drill path. If an inspector notices inadvertent return

conditions, shutdown will occur immediately. Enbridge will provide adequate lighting of the drill path to allow for monitoring during 24-hour continuous operation.

- Construction inspectors, Environmental Inspectors, and Enbridge HDD on-site personnel have the authority to order installation of containment structures, if needed, and to require additional response measures if deemed appropriate.
- Enbridge will promptly contact the appropriate agencies, including the Wisconsin spill hotline, promptly of a surface inadvertent release.

Containment, Response, and Cleanup Equipment

Containment, response, and cleanup equipment will be available on both sides of an HDD crossing location prior to commencement to assure a timely response in the event of an inadvertent release of drilling fluid. Containment and response equipment will include, but not be limited to:

- straw bales and staking;
- pre-filled sandbags;
- turbidity curtain (type to be specified in the site-specific Inadvertent Release Response
- Plans);
- silt fence;
- plastic sheeting and/or geotextile fabric;
- shovels, brooms, buckets, and other appropriate hand tools;
- pumps and sufficient hose;
- fluid storage tanks;
- vacuum truck on-site prior to and throughout the drill execution;
- one small boat (type/motorization to be specified in site-specific Inadvertent Release Response Plans);
- light plant/generator; and,
- any other equipment specified by Enbridge based on site visit and specified in the site specific Inadvertent Release Response Plans.

Actions in Response to Inadvertent Returns

In the event an inadvertent drilling fluid release is observed, Enbridge will assess to determine the amount of fluid being released and potential for the release to reach sensitive resource areas (e.g., wetlands and waterbodies). Response measures will vary based on location of inadvertent release as discussed below. The location of the inadvertent release will be documented by the Environmental Inspector (“EI”) with the site name, size of release, initial date of release, and Global Positioning System (“GPS”) location. The EI will photograph the release site and include it with the daily inspection report. Enbridge will coordinate containment, response, cleanup and reporting activities with the applicable agencies.

If a release occurs outside of the authorized construction workspace, Enbridge will mobilize on foot lightweight containment materials (e.g., straw bales, silt fence, sand bags) to the release location to promptly isolate the drilling fluid. Once drilling fluid has been contained, Enbridge will determine if equipment access is necessary to aid in the response, and will initiate agency consultations for developing alternate access, as necessary.

Upland Locations

Response measures in the event of a drilling fluid release in upland locations include the following:

- The EI will evaluate the release to determine if containment structures are warranted and if they will effectively contain the release.
- If the amount of the surface release is not great enough to allow the practical physical collection from the affected area, it will be diluted with clean water and/or the fluid will be allowed to dry and dissipate naturally.
- Earthen or sandbag berms, silt fence, and/or hay bales will be installed to contain small releases and prevent migration of drilling fluid.
- Enbridge will remove excess fluid at a rate sufficient to prevent an uncontrolled release.

Wetland Locations

(This section also applies to areas immediately adjacent to wetlands and waterbodies, such as stream banks or steep slopes, where drilling fluid releases could quickly reach surface waters.)

In the event of a drilling fluid release in wetlands or adjacent areas:

- The EI will evaluate the release, and the appropriate containment measures will be implemented.
- Enbridge will evaluate the recovery measures to determine the most effective collection method.
- If the amount of the surface release exceeds that which can be contained with hand-placed barriers, small collection sumps (less than 5 cubic yards) may be utilized to collect released drilling fluid for removal by the use of portable pumps and hoses.
- Low ground pressure equipment (e.g., UTV, argo, morooka) will conduct limited passes to assist personnel carrying containment materials to the release location.
- Temporary access will be supported by construction matting installed during clearing within the wetland areas.
- If the amount of the surface release is not great enough to allow the practical physical collection from the affected area without causing additional impacts, with approval from both Enbridge Environment and Construction Management, the drilling fluid may be diluted with clean water and/or the fluid will be allowed to dry and dissipate naturally.
- Excess fluid will be held within the containment area and removed using pumps or other appropriate measures at a rate sufficient to maintain secure containment.
- Recovered fluid will be stored in a temporary holding tank or other suitable structure out of the floodplain and/or wetland for reuse or eventual disposal in an approved off-site location.

Waterbody Locations

In the event of a drilling fluid release in a waterbody:

- The EI will evaluate the release, and the appropriate containment measures will be implemented.
- Enbridge will evaluate the recovery measures to determine the most effective collection method.

The containment methods utilized will depend on the size of release, water depth, flow velocity, and location of the release. In aquatic environments, bentonite may harden, effectively sealing the inadvertent release location. In this event, response activities will be limited or unnecessary.

However, if drilling mud were to enter the water column, the typical response tactic will be to erect an isolation containment environment using the materials identified in Table 1-1, or their equivalent, to facilitate a spill response team's ability to contain and collect excess drilling mud. Containment is not always feasible for in-stream releases, especially in waterbodies with significant currents.

Drilling fluid recovery methodology in waterbodies is not as variable as containment measures. When such measures effectively isolate the release from the stream flow, pumps or other appropriate measures are used to recover drilling fluid. When the release location cannot be isolated after initial in-stream containment installation, drilling fluid that has settled from the water column typically collects in the acute upstream angle of the containment tool, and recovery efforts will be localized to that location.

Table 1-1
Inadvertent Return Containment Methods for Variable In-Stream Conditions

Water Conditions		Distance from Water's Edge		
Flow Velocity	**Water Depth**	**0 - 10 Feet**	**10 - 20 Feet**	**Greater Than 20 Feet**
Still/Slow (Less Than 1 ft/sec)	0 - 2 feet	Sandbag isolation structure; vertical culvert	Sandbag isolation structure; vertical culvert	Sandbag isolation and structure; vertical culvert
	2 - 5 feet	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers and plastic sheeting	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers and plastic sheeting	Turbidity curtain; vertical culvert; bladder dams
	Greater than 5 feet	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers	Turbidity curtain; vertical culvert; bladder dams
Slow/Moderate (1 - 3 ft/sec)	0 - 2 feet	Sandbag cofferdam; vertical culvert	Sandbag cofferdam; vertical culvert; geotextile pipeline weights cofferdam; jersey barriers with plastic sheeting	Sandbag cofferdam; vertical culvert; geotextile pipeline weights; bladder dams
	2 - 5 feet	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers and plastic sheeting	Turbidity curtain; geotextile pipeline weights cofferdam; vertical culvert; bladder dams; water gates (as upstream diversion aid)	Turbidity curtain; bladder dams; water gates (as upstream diversion aid)

	Greater than 5 feet	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; water gates (as upstream diversion aid)	Turbidity curtain; geotextile pipeline weights; bladder dams; water gates (as upstream diversion aid)	Turbidity curtain; bladder dams; water gates (as upstream diversion aid)
Moderate/Rapid (Greater Than 3 ft/sec)	0 - 2 feet	geotextile pipeline weights cofferdam; vertical culvert; jersey barriers and plastic sheeting	geotextile pipeline weights cofferdam; vertical culvert; jersey barriers and plastic sheeting	Turbidity curtain; sand bags, bladder dams; water gates (as upstream diversion aid)
	2 - 5 feet	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers and plastic sheeting	Turbidity curtain; geotextile pipeline weights; bladder dams; water gates (as upstream diversion aid)	Turbidity curtain; bladder dams; water gates (as upstream diversion aid)
	Greater than 5 feet	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; water gates (as upstream diversion aid)	Turbidity curtain; geotextile pipeline weights; bladder dams; water gates (as upstream diversion aid)	Turbidity curtain; geotextile pipeline weights; bladder dams; water gates (as upstream diversion aid)

Agency Notification and Resumption of Suspended HDD Operations

The EI will be promptly notified of all drilling fluid releases, who will then immediately notify Enbridge Environment and Construction Management. The EI, Construction Management, and Enbridge Environment will coordinate communications with all appropriate regulatory agencies.

If notifications are necessary during non-business hours, they will be conducted according to prior arrangements made between Enbridge and the regulatory agencies. Follow-up notifications will be made as necessary and practicable.

If containment measures are functioning, and the circumstances and potential impacts of the release are understood, Enbridge will resume HDD operations.

Cleanup

The following measures will be adhered to/implemented as appropriate:

- Drilling fluid will be cleaned up by hand using hand shovels, buckets, and soft-bristled brooms as possible without causing extensive ancillary damage to existing vegetation.
- Clean water washes may also be employed if deemed beneficial and feasible.
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or ancillary damage to existing and adjacent vegetation.
- Material will be collected for temporary storage prior to removal from the site to an Enbridge-approved disposal location or a licensed disposal facility.
- The EI will regularly evaluate the potential for secondary impact from the cleanup process and cleanup activities will be terminated if physical damage to the site is deemed to exceed the benefits of removal activities. This decision will be made in consultation with the appropriate regulatory agencies and/or Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity.

Restoration and Post-Construction Monitoring

Following cleanup, restoration and revegetation of affected areas will be completed according to all applicable local, state, and federal permits and Enbridge's Environmental Protection Plan ("EPP"). Enbridge will monitor the release site as appropriate to assure adequate restoration.

Reporting and Documentation

Enbridge will record the following information in the event of an inadvertent release:

- Date and time of the release;
- Name of Contractor executing the HDD and names of personnel on-site and their roles, including EIs and Independent Environmental Monitors;
- Stage of the HDD operation (e.g., pilot hole, ream pass number, type of reamer);
- Description of site-specific conditions at release site (e.g., upland, wetland, vegetation, slope, sensitive features);
- GPS coordinates as close as possible to the center of the inadvertent release;
- Photograph of the inadvertent release location, and photographs of the release;
- Description of the size of the release (volume and area);
- Identification of any drilling mud additives present in the release;
- Description of how the release was contained, including how access was achieved;
- Description of how the release was cleaned up, the volume of the recovered material, and the area that was completely cleaned up, including description of how access was achieved;
- Description of any released material that was not cleaned up, including why access was not achieved, the volume of the material that could not be recovered, and the area that was not accessible to clean up;
- Description of corrective actions implemented to avoid additional inadvertent release (e.g., complete pilot hole, incorporation of additives); and
- Description of additional monitoring efforts taken to detect additional potential releases (e.g., additional monitor on site).

Enbridge has also developed staging and site-specific erosion control plans for HDD entry and exit locations. These include perimeter controls around the HDD work areas. Additional perimeter controls may be added or proposed perimeter controls modified as directed by the Enbridge EI at the time of site development. Implementation of the site-specific erosion and sediment controls will minimize the risk of sediment migrating from the work site into the White River following storm events.

Data Request Question 2: *Please provide site-specific inadvertent release response plans for all waterways proposed to be crossed by HDD or direct bore methods of pipeline installation. These plans must discuss measures taken to reduce potential for an inadvertent release and describe specific measures that you would employ to respond in the event of an inadvertent release of drilling fluid.*

Data Request Question 2 Response:

Enbridge has worked with its HDD contractor to develop site-specific inadvertent release response plans for the proposed trenchless crossings (HDD and Direct Pipe). Those plans are included as Attachment 2-A.

Data Request Question 3: *Please provide additional information to allow our agency to better understand the alternatives considered for crossing several specific waterbodies, as well as any potential risks or adverse effects which may occur within these resources. This information should describe how the waterbodies would be monitored, and how you propose to identify the need for and methods to address any remedial activities which may be identified.*

a. Please provide an evaluation of alternative trenchless installation methods for the following resources when proposed to be crossed by open cut methods: designated trout streams, tributaries to designated perennial trout streams, 303(d) listed waters, Area of Special National Resource Interest (ASNRI) streams, and waters that flow downstream to the Bad River Reservation and are listed as Exceptional and Outstanding Resource Waters (ERWs & ORWs). As part of this evaluation, please include an assessment which describes the practicability of the alternative crossing method(s) and provides a comparison of anticipated environmental effects. Please pay careful attention to the designations for listing these waterbodies and how the proposed construction activities could potentially impair designations for these waters.

b. Please provide an updated plan for monitoring construction-related risks that may impair the waterways listed in 2.a. at a minimum. We have received a draft water quality monitoring plan from you and appreciate your proposal to monitor perennial waterways. However, additional information is still required. Please define, and provide the rationale for, proposed baseline monitoring timeframes and post-construction monitoring timeframes. Additional details and rationale about the monitoring distance from the crossings should be included, as well information describing your consideration of monitoring locations at downstream connection points where effects may be aggregated. Many of the waterways along the route include fine grain substrates which may have the potential to affect benthic macroinvertebrate communities when suspended sediment settles out of the water column. Please describe how the monitoring would establish a baseline for parameters of concern, and what deviations measured would be considered outside a normal fluctuation. Lastly, describe what actions would be taken to address monitoring results which suggest a need for remedial action. We strongly recommend additional coordination with our agency prior to submittal of a final document.

Data Request Question 3.a. Response:

Enbridge identified 15 locations at which a trenched crossing is proposed for waterways designated as one or more of the following: designated trout streams, tributaries to designated perennial trout streams, 303(d) listed waters, Area of Special Natural Resource Interest ("ASNRI") streams, and waters that flow downstream to the Bad River Reservation and are listed as Exceptional and Outstanding Resource Waters ("ERWs" & "ORWs"). Both the Marengo River and Trout Brook will be crossed by the Project and are classified as 303(d) listed waters; however, they will be crossed by horizontal directional drill (HDD) or Direct Pipe, so were therefore omitted from this response.

A summary of each crossing and an explanation why the HDD or Direct Pipe method is not appropriate or preferred are presented in table 3-1 below. Use of either method would have the potential to avoid instream and riparian impacts adjacent to the waterbodies but as noted on the table, the additional workspace required for use of trenchless methods may impact other wetlands and waterbodies. It should also be noted that Enbridge has not conducted geotechnical studies for any of the waterbodies listed on the table since these have not been proposed as HDD or Direct Pipe crossings. As such, the suitability of the subsurface geology for trenchless construction at these locations is unknown; if unsuitable, could be another reason against the use of a trenchless method.

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
Bay City Creek	Sase006p	0.63	DC	303(d) impaired for total phosphorus	12 ft; 14 ft; sand	The Project does not cross any other waterbodies within the Bay City Creek watershed.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route crosses the creek under a powerline and then bends away from the crossing alignment on both sides of the creek to parallel the existing powerline corridor. An HDD would require a modification to the Project route that would require addition forest clearing. Additonal temporary right-of-way (ROW) would be necessary for pipe fabrication, which could impact new wetlands. Additionally, there are two existing pipeline corridors on the north side of the crossing that would restrict workspace availability. The proposed dry crossing method will not increase phosporous impairment and will minimze in-stream sedimentation. Any of the sandy substrate that is disturbed will settle out quickly. Based on literature, modelling results, and the sandy substrate, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality. Bay City Creek is listed as impaired for phosporous. The specific source of the impairment is unknown, but it is likely that the exceedance of total phosphorus in Bay City Creek is due to application of fertilizers on agricultural fields along the creek and/or from other land use practices and runoff entering the stream as it flows through the City of Ashland, downstream of Enbridge's proposed crossing location. Installation of the proposed pipeline will not be an increased source of phosporous and runoff will be controlled by instllation of extensive erosion controls per Enbridge's EPP.

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
Beartrap Creek	sasb007i	2.91	OC/DC	ASNRI-PNW; ORW	6; 10; gravel, sand, silt/clay	The Project does not cross any unnamed tributaries to Beartrap Creek but it crosses Little Beartrap Creek(sasa047i) and several Little Beartrap Creek tributaries, which collectively flow into Beartrap Creek approximately 5.9 miles downstream of the proposed Beartrap Creek crossing . Little Beartrap Creek all of the Little Beartrap Creek tributaries are either intermittent or ephemeral at the proposed crossing locations and will be crossed using a dry crossing methods if there is any flow.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The flow is intermittent at the proposed crossing location and it is likely there will be no flow at time of crossing. The workspace required for an HDD would likely increase the impact on some wetlands including forested wetlands and the pipe fabrication area could increase the activies in and duration of construction in some wetlands. The proposed crossing method (either crossing when there is no flow or using a dry crossing method if there is flow) will minimize in-stream sedimentation and most of the substrates that are disturbed will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated ASNRI-PNW or ORW status of waterbody.
UNT of Marengo River	sasd011p	7.99	DC	*Perennial tributary of trout stream*	9, 15, sand, silt/clay	This unnamed tributary to the Marengo River(sasd011p) joins the Marengo River approximately 4.2 miles downstream of the proposed sasd011p crossing. The Marengo River will be crossed using a trenchless method.	The narrow width of the waterbody is unsuitable for a long HDD crossing. Extra workspace would be required for an HDD, which could increase wetland impacts on the north side of the crossing. If drilled from this side, additional wetland area would likely be impacted; if pipe fabrication is performed on the north side, it would increase the activities in and duration of construction in some wetlands. There is also a residence close to the crossing location. Residents of this home would be subjected to a prolonged period of HDD noise during drilling. The proposed dry crossing method will minimize in-stream sedimentation and most of the

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
							substrates that are disturbed will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
UNT of Brunsweiler River	sasc1006p	14.73	DC	*Perennial tributary of trout stream*	8; 30; sand	This unnamed tributary to the Brunsweiler River (sasc1006p) joins the Brunsweiler River approximately 2.19 miles downstream of the proposed sasc1006p crossing. Two other waterbodies that are crossed by the pipeline, an ephemeral stream (sasc1009e_x2) and an intermittent waterbody (sasa1028i), join and then flow into sasc1006p approximately 0.35 miles downstream of the sasc1006p crossing and approximately 1.84 miles upstream of the combined confluence of these streams with the Brunsweiler River. Both of these waterbodies will be crossed using a dry crossing method if they are flowing. The Brunsweiler River will be crossed using a trenchless method approximately 3.53 miles upstream of the confluence of sasc1006p and the Brunsweiler River .	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on both sides of the creek and there is no suitable HDD pipe string fabrication area on the proposed ROW. The additional temporary ROW for an HDD could impact one or more waterbodies depending on whether it is located north or south of the crossing. It may also impact areas of upland forest and if located on the north side the fabrication of the pipeline string for the HDD could require a temporary road closure. The proposed dry crossing method will minimize in-stream sedimentation and any disturbance of the sandy substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
UNT of Trout Brook	sasc1003p_x1	15.86	DC	*Perennial tributary of trout stream*	8; 50; sand	This unnamed tributary to Trout Brook (sasc1003p_x1) joins Trout Brook approximately 1.24 miles downstream of the proposed sasc1003p_xl crossing. Trout Brook will be crossed using a trenchless method and this crossing is 1.76 miles upstream of the confluence of the sasc1003p_x1 and Trout Brook.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on both sides of the creek and there is no suitable HDD pipe string fabrication area on the proposed ROW. The additional temporary ROW for an HDD would impact upland forest, a waterbody and wetlands, including possibly forested wetlands. Additionally, if the fabrication of the pipe string was located on the south side of the crossing, the HDD would likely require a temporary road closure. There is also a residence close to the crossing location. Residents of this home would be subjected to a prolonged period of HDD noise during drilling. The proposed dry crossing method will minimize in-stream sedimentation and any disturbance of the sandy substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
UNT of Silver Creek	sasd1015p	19.83	DC	*Perennial tributary of trout stream*	8;15; cobble, sand	This unnamed tributary to Silver Creek (sasd1015p) flows into Silver Creek approximately 0.66 mile downstream of the proposed sasd1015p crossing. Silver Creek will be crossed using a trenchless method.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on both sides of the creek and there is no suitable HDD pipe string fabrication area on the proposed ROW. The additional ROW necessary for an HDD would impact upland forest and temporarily block several trails. It could also impact wetlands if the pipe string fabrication was on the north side of the crossing.

Table 3-1 Special Designation Waterways with Trenched Crossings							
USGS Name	**Feature ID**	**Milepost**	**Crossing method**	**Agency classification**	**OHWM width; bank width; substrate**	**Confluence with other waterbodies crossed by Project**	**Reason trenchless method was rejected**
							The proposed dry crossing method will minimize in-stream sedimentation and any disturbance of the sandy and cobbly substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
UNT of Silver Creek	sase005p_x2	20.61	DC	*Perennial tributary of trout stream*	9; 9; Gravel, sand	This unnamed tributary to Silver Creek (sase005p_x2) flow into sasd1015p. The sase005p_x2 crossing is approximately 1.88 miles upstream of the proposed sasd1050p crossing. As such it is approximately 2.54 miles upstream of where the combined tributaries flow into Silver Creek. Silver Creek will be crossed using a trenchless method.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on both sides of the creek and there is no suitable HDD pipe string fabrication area on the proposed ROW. The additional ROW necessary for HDD drilling operation and pipe fabrication could impact forested wetlands and additional upland forest. The proposed dry crossing method will minimize in-stream sedimentation and any disturbance of the sandy and gravelly substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
UNT of Silver Creek	sasv004p	21.28	DC	*Perennial tributary of trout stream*	5; 5.5; Cobble, gravel, organic	This unnamed tributary to Silver Creek (sasv004p) flows into sase005p_x2 approximately 0.84 miles upstream of the proposed sase005p_x2 crossing. As such it is approximately 2.92 miles upstream of where the combined tributaries flow into Silver Creek will be crossed using a trenchless method.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on the north side of the creek and there is no suitable HDD pipe string fabrication area on that side of the proposed ROW. The additional ROW necessary for HDD drilling and pipe fabrication, depending on which sides they are located on could impact new wetlands on the north side or increase the activities and duration of impacts on the south

Table 3-1 Special Designation Waterways with Trenched Crossings							
USGS Name	**Feature ID**	**Milepost**	**Crossing method**	**Agency classification**	**OHWM width; bank width; substrate**	**Confluence with other waterbodies crossed by Project**	**Reason trenchless method was rejected**
							side of the crossing. There is also a residence close to the crossing location. Residents of this home would be subjected to a prolonged period of HDD noise during drilling. The proposed dry crossing method will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
UNT of Krause Creek	sasv020p	22.01	DC	*Perennial tributary of trout stream*	6; 8; Cobble, gravel, sand, silt/clay	This unnamed tributary to Krause Creek (sasv020p) converges with Krause Creek approximately 0.3 mile downstream of the proposed sasv020p crossing. However, there does not appear to be direct channel flow between the two as they are separated by a wetland. Additionally, Krause Creek will be crossed using a trenchless method upstream of the confluence of sasv020p and Krause Creek.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on both sides of the creek and there is no suitable HDD pipe string fabrication area on the proposed ROW. The additional ROW necessary for HDD drilling could impact forested wetlands if it is located on the south side of the crossing. Locating the pipe string fabrication area on the south side could also impact forested wetlands. If located on the north side, it would require a temporary road closure. There is also a residence close to the crossing location. Residents of this home would be subjected to a prolonged period of HDD noise during drilling. The proposed dry crossing method will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
							water quality or the designated trout status of waterbody.
UNT of Bad River	sasa008p	23.72	DC	*Perennial tributary of trout stream*	5; 7; Organic	This unnamed tributary to the Bad River (sasa008p) flows into the Bad River approximately 0.5 mile downstream of the proposed sasa008p crossing and approximately 1.0 mile downstream of the proposed Bad River crossing. The Bad River will be crossed using a trenchless method approximately 1.0 mile upstream of the confluence of sasa008p and the Bad River.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The area of available workspace on the south side of the waterbody is limited due to steep and side-sloping terrain and may be insufficient to conduct an HDD. The additional ROW necessary for HDD drilling and pipe string fabrication could impact forested wetlands and riparian habitat. A temporary road closure would also likely be required to fabricate the pipe string for the HDD. The proposed dry crossing method will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
UNT of Gehrman Creek	sasa004p	28.39	DC	*Perennial tributary of trout stream*	8; 10; Cobble, gravel, sand	This unnamed tributary to Gehrman Creek (sasa004p) flows into Gehrman Creek approximately 1.1 miles downstream of the proposed sasa004p crossing. Gehrman Creek will not be crossed by the Project.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline alignment also bends west side of the crossing and the pipe string fabrication area could not be located on the proposed ROW on this side. The additional workspace for the HDD would require the clearing of upland forest and a temporary road closure would also likely be required to fabricate the pipe string for the HDD. The proposed dry crossing method will minimize in-stream sedimentation and any disturbance of the cobbly, gravelly, sandy substrate will settle out quickly. Based on literature and modelling results,

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
							the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
Camp Four Creek	sasw005	29.81	OC/DC	Class II Trout, ASNRI-PNW	6; 12; Cobble, gravel, silt/clay, organic	Camp Four Creek (sasw005) flows into Tyler Forks. The Camp Four Creek crossing is approximately 2.68 miles upstream of its confluence with Tyler Fork. Camp Four Creek will be crossed using a dry crossing if there is flow. Tyler Forks will be crossed using a trenchless method approximately 6.45 miles upstream of the Camp Four confluence with Tyler Forks.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline alignment also bends west side of the crossing and the pipe string fabrication area could not be located on the proposed ROW on this side. The flow of the waterbody is intermittent at proposed crossing location and there will likely be no flow at time of crossing. The workspace required for an HDD would likely impact and increase activities and the duration of construction in some wetlands including forested wetlands, and some waterbodies. The proposed crossing method (either crossing when there is no flow or using a dry crossing method if there is flow) will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated ASNRI-PNW or trout status of waterbody.
UNT of Feldcher Creek	sirb010p	30.67	DC	*Perennial tributary of trout stream*	5; 10; Cobble, gravel, silt/clay	This unnamed tributary to Feldcher Creek (sirb010p) flows into Feldcher Creek approximately 1.53 miles downstream of the proposed sirb010p crossing. However, it is unclear if there is direct channel flow between the two as they	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline alignment also bends east side of the crossing and the pipe string fabrication area could not be located on the proposed ROW on this side. The additional workspace required for an HDD would impact forested uplands and could impact forested

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
						appear to be separated by a wetland. Approximately 1.0 mile downstream of the confluence of the tributary and Feldcher Creek, Feldcher Creek flows into Tyler Forks. Tyler Forks will be crossed using a dry crossing method. . Tyler Forks will be crossed using a trenchless method approximately 5.5 miles upstream of the confluence of Feldcher Creek and Tyler Forks.	wetlands. The fabrication of the pipe string could also require a temporary road closure. The proposed dry crossing method will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.
Feldcher Creek	WDH-103	31.76	DC	Class II Trout, ASNRI-PNW	<10; <10; Cobble, gravel, silt/clay	Feldcher Creek (WDH-103) flows into Tyler Forks approximately 2.16 miles downstream of the proposed pipeline crossing of Feldcher Creek. Tyler Forks will be crossed using a trenchless method approximately 5.5 miles upstream of the confluence of Feldcher Creek and Tyler Forks.	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline alignment also bends on the west side of the crossing, and the pipe string fabrication area could not be located on the proposed ROW on this side. The additional workspace required for an HDD would impact forested uplands and would likely impact forested wetland if the pipe string fabrication area was located on the west side of the crossing. The remote and isolated location of the crossing area could increase the difficulty of access for an HDD. The proposed dry crossing method will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated ASNRI-PNW or trout status of waterbody.
UNT of Vaughn Creek	sird009p	39.00	DC	*Perennial tributary of trout stream*	2; 2.5; Sand, silt/clay	This unnamed tributary to Vaughn Creek (sird009p) flows into Vaughn Creek	The narrow width of the waterbody is unsuitable for a long HDD crossing. The pipeline route bends away from the crossing alignment on both sides of

Table 3-1
Special Designation Waterways with Trenched Crossings

USGS Name	Feature ID	Milepost	Crossing method	Agency classification	OHWM width; bank width; substrate	Confluence with other waterbodies crossed by Project	Reason trenchless method was rejected
						approximately 1.48 miles downstream of the proposed sird009p crossing. Vaughn Creek will be crossed using a trenchless method approximately 1.22 miles upstream of the confluence of sird009p and Vaughn Creek. .	the creek and there is no suitable HDD pipe string fabrication area on the proposed ROW. The additional ROW necessary for HDD drilling operation and pipe fabrication could impact wetlands including forested wetlands. There is also a residence close to the crossing location. Residents of this home would be subjected to a prolonged period of HDD noise during drilling. The presence of a powerline and railroad in the vicinity could also complicate an HDD crossing. The proposed dry crossing method will minimize in-stream sedimentation and most of the disturbed substrate will settle out quickly. Based on literature and modelling results, the proposed crossing method will have only a minor and localized effect, and will not impact stream-wide water quality or the designated trout status of waterbody.

OHWM = Ordinary High Water Mark; ORW = Outstanding Resource Water; ASNRI-PNW = Area of Special Natural Resource Interest – Priority Navigable Waterways; OC = Open Cut (wet trench); DC = Dry Crossing (flume or dam-and-pump); 303(d) = Water listed as impaired under Section 303(d) of the Clean Water Act

Enbridge's response to Data Request 5 provides a comparative assessment of the suitability and impacts of the proposed trench and trenchless crossing methods, and explains the process Enbridge followed to select a crossing method. As indicated in that response, Enbridge believes the open cut (wet trench) crossing method would result in the greatest environmental impact if flowing water is present. To avoid the potential for these increased impacts, Enbridge decided to only use the open cut method at streams where no flow is present at the time of crossing. As such, impairment to any special designations will be avoided or minimized under this scenario.

Enbridge proposes to use either the dam and pump or flume method at the smaller, flowing waterbodies listed in table 3-1. These methods, while slightly different (in that one is passive and employs flumes and the other is active and relies on pumps), are functionally similar and provide a comparable level of waterbody and water quality protection. Both methods isolate the work area from the stream flow and minimize sedimentation. This is achieved by limiting the suspension and transport of sediments to short periods of time when the dams and flume are installed and removed, and the stream flow is restored across the work area after installation of the pipeline.

While the HDD method avoids cutting the bed and banks of a waterbody, this method has specific requirements (e.g., longer duration, need for large additional workspace for equipment and pipe string fabrication, and suitable topography and subsurface conditions), that limit its feasibility in some areas without resulting in additional resource impacts. The HDD method also requires a minimum crossing length of 1,280 feet for 30-inch outside diameter pipe. A crossing length of 1,280 feet or greater for the narrow waterways listed above is not warranted and may not be feasible without additional ROW, and suitable topography and subsurface geology. Moreover, as described in the table, use of the HDD method at many of the 15 waterbodies could have additional wetland and waterbody impacts due to the additional workspace required for drilling and pipe string fabrication. These additional impacts would offset any environmental advantages of the HDD. Additionally, further use of the HDD method would result in extension of the Project construction schedule to accommodate the additional time required to complete an HDD, resulting in longer disturbance to resources near the HDD locations that would remain disturbed until the HDDs could be completed.

Data Request Question 3.b. Response:

As stated in Enbridge's Draft Water Quality Monitoring Plan, prior to construction Enbridge will collect baseline water quality data from perennial streams that will be crossed by the pipeline centerline during construction of the Project, as well as select intermittent streams (if water is present at the time of construction). Enbridge identified 30 streams for preconstruction water quality sampling. Enbridge will collect grab samples at each pipeline crossing location approximately 5 days prior to start of the stream crossing. Samples will be analyzed for dissolved oxygen ("DO"), pH, conductivity, temperature, chemical oxygen demand ("COD"), turbidity (field measurement) and total suspended solids ("TSS"). COD and TSS analysis will be completed by a certified laboratory using standard analytical methodologies. DO, pH, conductivity, and temperature measurements will be collected in the field using standard analytical methodologies. During construction Enbridge will collect samples at approximately 100 feet upstream and downstream of the crossing where Enbridge has secured landowner permission for off ROW access, or will access the sample site from the waterbody where safe stream conditions allow (i.e., depth). Samples will be collected during the installation of temporary dams and during the removal of the temporary dams. The upstream sample collection distance of 100 feet was chosen so it would be above the influence of construction-related activities but close enough to the crossing to minimize the potential for additional non-construction related inputs that could distort the results. These upstream samples will provide baseline water quality information for each crossing at the actual time of the pipe installation. The downstream sampling location was selected to be representative of stream conditions below the construction work area. The modelling conducted by RPS indicates that most of the suspended sediments will settle close to the crossing area. Enbridge believes 100 feet downstream is sufficiently close to register any effects but far enough downstream to allow for uniform mixing of any elevated sediments within the water column and stream width. The 100 foot distance also takes into account the potential access limitations at each respective waterbody. Enbridge's landowner agreements for construction and operation of the pipeline workspace do not include authorization to use or access any portions of the property or stream farther from the crossing area. Enbridge also has to consider safety and the protection of its employees, contractors, and construction personnel. Sampling locations that require bushwacking along or walking in the stream for a considerable distance away from the proposed workspace would increase the hazards and risks. Additionally, walking up and down the stream bed to access sampling locations could result in additional sedimentation and environmental disturbance that could affect the results.

Enbridge will collect additional water quality samples at the first downstream public road crossing when:

- Field turbidity sample results (Nephelometric Turbidity Unit or "NTU"[1]) are greater than 5 NTUs over upstream level when the upstream levels are 50 NTUs or less; or,
- When the downstream NTU readings are greater than 10 percent above upstream NTU readings when the upstream readings are greater than 50 NTUs.

Similar to the access restrictions at the proposed crossing locations, Enbridge can only use public access points such as road crossings or points where Enbridge has acquired landowner permission to collect additional water quality samples further downstream.

Regarding potential need for additional water quality monitoring locations at downstream connection points where "effects may be aggregated", Enbridge has assessed locations where stream confluences occur downstream of the individual waterbody crossings. The results of this assessment are presented in Table 3-1. There is a potential for some aggregated effects due to hydrological connections between some of the proposed waterbody crossings. For example, one tributary to Silver Creek on Table 3-1 is crossed twice. Also, a number of streams on Table 3-1 either flow into other waterbodies that are crossed by the Project or receive waters from other upstream waterbodies that are crossed by the Project. The modelling performed by RPS, indicates that the elevated TSS levels and deposition of sediments resulting from the proposed dry crossing methods would be finite, of short duration, and highly localized (see additional discussion of RPS' modelling in responses to Data Request 4, 5, and 8). This suggests cumulative or aggregated effects would only occur if two crossings are in close hydrological proximity and occur at the same time. As indicated on Table 3-1, most of the proposed crossings are not in close hydrological proximity to other crossings. Of those that are in close hydrological proximity, Enbridge would avoid crossing these streams at the same time. It should also be noted that many of the final receiving waterbodies of the crossings listed on Table 3-1 would be crossed by a trenchless method, which would avoid or minimize the risk of aggregated effects at these crossings. Enbridge's proposed mitigation measures and implementation of its EPP would further reduce the potential for any aggregated effects.

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[1] A Nephelometric Turbidity Unit ("NTU") is a measure of the opaqueness of a fluid due to the presence of suspended solids (inorganic or biological). The higher the concentration of suspended solids in the water, the higher the turbidity is and the dirtier it looks.

Enbridge is still coordinating with the respective agencies on a final Water Quality Monitoring Plan. Enbridge will submit the final plan following agency discussions.

<u>Data Request Question 4:</u> *The Environmental Protection Agency (EPA) has identified the Kakagon-Bad River Sloughs and the Bad River as Aquatic Resources of National Importance (ARNIs). Please describe measures that would be employed to monitor and address potential sedimentation and other water quality impairments to these waters which may result from construction-related activities. We anticipate addressing this comment may expand the minimum number of waters proposed for monitoring in comment 3 above. In addition to addressing the ARNIs identified, please describe how you propose to meet Bad River Band's narrative and numeric water quality standards (WQS) as part of your proposed construction activities.*

Data Request Question 4 Response:

As explained in the response below, sedimentation impacts resulting from pipe installation at water crossings are expected to be localized, limited in duration, and less than TSS concentrations resulting from less than storm-related events. Modelled TSS concentrations (resulting from any installation method) are expected to meet the Bad River Band's water quality standards before reaching the Reservation and will thus not degrade downstream water quality. No sedimentation impacts will occur to the Bad River as a result of the proposed HDD at that location; if an inadvertent return were to occur during the HDD process at the Bad River, TSS concentrations of released drilling fluid, based on modeling, would be expected to diminish to concentrations below the Bad River Band's water quality standards before reaching the Reservation. Because the Kakagon-Bad River Sloughs are located far downstream from any pipe installation locations, all TSS concentrations at the location of the Sloughs will be expected to meet the Bad River Band's water quality standards as a result of all pipe installation activities. To ensure that TSS concentrations are consistent with modelled TSS levels and meet applicable water quality standards, Enbridge will implement a Water Quality Monitoring Plan, as described further below.

POTENTIAL EFFECTS OF THE PROJECT ON WATER QUALITY

The primary water quality parameter affected by pipeline construction is a short-term increase in TSS: (a) during active instream construction that are re-suspended from the stream bed during the installation of aquadams or other barriers and when crossings are re-flooded after completion of the crossing, or (b) as a result of an unexpected inadvertent return of drilling fluid during an HDD. As discussed in Enbridge's application materials and supplemental information, increased sedimentation and turbidity can temporarily reduce dissolved oxygen levels in the water column and can re-suspend materials within the stream bed sediments. The extent of impacts from sedimentation and turbidity would depend on sediment loads, stream flows, stream bank and streambed composition, sediment particle size, and the duration of the disturbances[2].

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[2] U.S. Environmental Protection Agency. 2003. Developing Water Quality Criteria for Suspended and Bedded Sediments (SABS): Potential Approaches. A. U.S. EPA Advisory Board Consultation. Draft. U.S. EPA Office of Water and Office of Science and Technology. August 2003. Available online at: https://www.epa.gov/sites/production/files/2015-10/documents/sediment-report.pdf

Assessment of Sediment Release and Transport Resulting from Pipe Installation Activities

To evaluate the potential of the Project to impact water quality, and to inform the need for monitoring and where the monitoring should take place, Enbridge contracted RPS to conduct a quantitative assessment of sediment dispersion from planned waterbody crossing activities. RPS analyzed the potential effects of sediment using SSFATE, a computational sediment dispersion modeling tool that was developed jointly by RPS and the U.S. Army Corps of Engineers ("USACE") to simulate sediment resuspension and deposition. This model has been used extensively in the United States and internationally to assess the potential impacts of sediment releases. The SSFATE model provided information to assess the potential concentrations of sediment (TSS) within the water column in exceedance of background values, the downstream extent of elevated concentrations, and the depositional footprint of sediments that may be caused by both planned and accidental discharges of sediment due to installation techniques of the relocated pipeline as it crosses the range of water bodies within the Project area.

Specifically, RPS modeled 18 hypothetical sediment release scenarios in SSFATE to assess the magnitude and timing of potential concentrations of sediment within the water column (i.e., TSS) on top of background values (referred to as "in exceedance of") and the depositional footprint of sediments that may be caused by discharged sediment from installation (planned construction and accidental discharges) of the Project as it crosses the range of waterbodies within the Project area. Background values represent TSS levels in the waterbodies prior to and without pipe installation activities.

The analysis modeled: (1) potential sediment releases associated with instream construction using dry trenching methods[3] in small to medium watercourses along the pipeline route; and (2) sedimentation resulting from the release of drilling fluid during an HDD that results in an unexpected inadvertent return into large watercourse crossings being crossing using the HDD technique. Specifically, with respect to dry trenching methods RPS looked at small watercourses of 5 feet (1.5 meters) width and 1 foot (0.3 meter) depth and medium watercourses of 25 feet (7.6 meters) width and 3 feet (0.9 meter) depth and simulated downstream sediment transport under a range of river flow conditions representative of a June-August construction period (flows ranging from 0.16 to 0.39 meters/second). While a successful HDD will not result in any sedimentation impacts to a water crossing, RPS also modeled an inadvertent return occurring at large watercourses, including the Bad River. The goal of RPS' study was to identify temporary or permanent impacts on water quality parameters of concern (specifically TSS) upon installation of the proposed watercourse crossings.

Sediment Analysis Results

The results of RPS' analysis, which are specified in greater detail in the RPS report, indicate that the increased TSS concentrations in the water column caused by use of the dry crossing method or an unexpected inadvertent return during an HDD would be localized, limited in duration and not degrade water quality (both at the site of the crossing and downstream). While Wisconsin Department of Natural Resources ("WDNR") holds a water quality standard of 40 mg/L for TSS associated with construction dewatering activities, RPS identified a more conservative (i.e., more protective) representative calculated threshold of 19 mg/L TSS (based upon the measured relationship between turbidity and TSS within the Bad River) that correlates to the Bad River Band's water quality standard for turbidity within

[3] Enbridge does not propose to cross any flowing waterbodies using the open cut (wet trench) crossing method. Give that this method will not be used while water is flowing in the crossed waterbody, this method will not result in any TSS impacts to water quality.

the exterior boundaries of the Reservation. Further details regarding RPS's method for calculating this 19 mg/L representative calculated threshold is provided in the RPS report.

As explained below, and as explained in further detail in the RPS report, TSS levels resulting from pipe installation at water crossings are expected to be below the 19 mg/L TSS representative calculated threshold before reaching the Reservation boundary. All increased TSS levels resulting from construction would be temporary only (not permanent), and far less than TSS levels that result during storm-related events.

Dry Crossing Methods: Use of a dry crossing method would increase the suspension and downstream transport of sediment. As modelled, crossings in small and medium watercourses are expected to be completed within 20-32 hours, respectively, and would actively release sediment for a total of 4 hours (small) and 10 hours (medium). Associated increases in TSS concentrations would generally follow the same timing of the installation and removal activities, quickly attenuating after the sediment disturbances cease.

The sediment loads in the watercourses produced initially larger TSS concentrations near the installation site (up to 132 mg/L) due to the conservatively large assumed amount of sediment that was re-suspended and the shallow watercourse depths (1-3 ft deep). However, TSS concentrations predicted downstream of the trenched installations (e.g., 500-1,000 m) were on the order of <1 to 30 mg/L for the small watercourse and <1 to 10 mg/L for the medium watercourse. These levels are consistently below background conditions for the anticipated construction period of June-August, and would be expected to have a lesser magnitude and more brief effect on TSS in the water column than storm-related events, which would be expected to have a greater and more enduring effects on TSS in the water column than the proposed installation activities. As compared to storm-related events that can cause TSS values to exceed hundreds to thousands of mg/L over long periods of time, waters crossed by the Project would be expected to have TSS concentrations near the installation site up to 132 mg/L, which would decrease below 19 mg/L approximately 1,000 meters downstream of the crossing and last only 4-10 hours per crossing. By 1,000 m (or 1 km) downstream, the TSS predictions were below the more conservative representative calculated threshold of 19 mg/L. This TSS concentration is expected to last on the order of tens of minutes to hours at any specific location over the course of approximately one day as the TSS is transported downstream. Therefore, TSS concentrations are predicted to be well below the calculated threshold for all watercourses represented by the simulated small and medium watercourse scenarios by the time any suspended sediments reached the Reservation boundary.

HDD: TSS impacts would not occur for any pipe successfully installed via an HDD. TSS impacts could, however, occur as a result of an unexpected inadvertent return, which would cause TSS levels to rise as a result of the release of drilling fluid (bentonite) in the water column. As noted above, RPS modelled a potential inadvertent release occurring at the Bad River, which EPA has identified as an Aquatic Resource of National Importance ("ARNI"). The effect of a hypothetical inadvertent return would be somewhat greater as compared to TSS levels resulting from a dry crossing method, but would also be temporary, of short duration and confined to a relatively short downstream distance of the crossing.

If an unexpected inadvertent release of drilling fluid in a waterbody were to occur, the greatest deposition would be near the release location, as well as toward the center of the river channel. Modeling results indicate that a discharge into the watercourse is expected to produce initially large TSS concentrations near the release site (more than 20,000 mg/L) due to the large volume of drilling fluid (bentonite) that could hypothetically be released in a relatively short period of time. However, TSS concentrations are expected to decrease quickly – for example, at distances 500-1,000 m downstream, RPS modelled TSS concentrations between 10-300 mg/L, which is less or of similar magnitude to background conditions and also less than TSS levels typically caused by storm-related events. By 2,000 m (or 2 km) downstream, TSS predictions for all scenarios were below the more conservative representative calculated threshold of 19 mg/L. Levels above the representative calculated threshold of 19 mg/L lasted on the order of hours at any specific location over the course of one to two days as the TSS was transported downstream.

Nearly all of the discharged drilling fluid resulting from an unexpected inadvertent return eventually settles within the model domain, regardless of river flow rate. The greatest deposition is expected to occur near the release location, as well as toward the center of the river channel. Based on the modeling, the distance and area covered by deposition above 5-10 mm thickness would be greatest for an inadvertent return release during the final reaming pass under low flow conditions. The model predicted deposition at this level would extend up to 40 m downstream of the release location. While the model predicted very large areas of deposition less than the 0.1 mm reporting threshold, no deposition above that threshold was predicted past 400 m downstream, well upstream of the Bad River Reservation boundary.

Compliance with the Bad River Band's Water Quality Standards: As noted above, all TSS concentrations would be less than TSS levels resulting from storm-related events and are less than or similar to background TSS levels in the waterbodies crossed by pipe installation activities. Because the Proposed Route crosses the various watercourses in the Project area at distances between 2.1 km and 23.9 km (1.3 and 14.9 miles) upstream of the Reservation boundary, TSS concentrations, as modeled by RPS, are expected to be below the more conservative representative calculated threshold of 19 mg/L by the time any suspended sediments from trenching installations (or an inadvertent return on the Bad River) reach the Reservation boundary.

Accordingly, while EPA has identified the Bad River as an ARNI, its crossing via HDD will be expected to result in no impact; or in the unexpected case of an inadvertent return, the release of drilling fluid into the Bad River would be temporary, isolated, and be less than 19 mg/L before reaching the Reservation boundary. Sedimentation impacts resulting from pipe installation (whether via dry crossing methods or HDD) are expected to have no impact on the Kakagon-Bad River Sloughs, which are located many more miles downstream within the Reservation. Any TSS plumes in waterbodies crossed by the Project are expected to be temporary in any given location and would therefore not pose a permanent impact to downstream waters, whether individually or cumulatively. Also, because: (a) TSS levels are the primary water quality parameter affected by pipeline construction, and (b) TSS levels resulting from construction will not exceed the representative calculated threshold on waters within the Reservation, all other Bad River water quality standards (whether numeric or narrative) would be complied with and downstream water quality would not be degraded as a result of pipe installation activities.

Please also see Enbridge's response to Data Request Question 5, which provides further information regarding temporary discharges into waterbodies associated with different pipeline crossing methods. Please also see Enbridge's response to Question 8, which provides further information regarding the potential for proposed regulated activities to cause degradation by disrupting life stages of aquatic life, fish spawning, and wildlife dependent on these systems. These responses further demonstrate that appropriate methods have been chosen for the waterbodies that will crossed by the Relocation, and water quality (including the aquatic environment) will not be degraded as a result of construction activities.

PROPOSED CROSSING METHODS FOR TRIBAL ORW/OTRW

The Project will cross six waterbodies designated by the Bad River Band of Lake Superior Chippewa ("Bad River Band") as Outstanding Resource Waters ("ORW"): White River, Marengo River, Bear Trap Creek, Brunsweiler River, Tyler Forks, and Vaughn Creek. The Project will also cross the Bad River, which has sections within the exterior boundaries of the Reservations designated as both ORW as well as Outstanding Tribal Resource Waters ("OTRW"). However, the Project will not cross any of these waterbodies within the Bad River Reservation. The closest crossing of a Tribal designated OWR/OTRW waterbody to the Reservation is over 2.4 river miles (3.8 km) upstream of the exterior Reservation boundary.

Enbridge proposes to cross all Tribal ORW/OTRW waters, with the exception of Bear Trap Creek, using a trenchless crossing technique (HDD or Direct Pipe). Provided there is not an inadvertent return of drilling fluid into the water, Enbridge's use of a trenchless method will avoid direct impacts to existing water quality as there will be no instream construction disturbance, or disturbance of the respective stream banks. Based on field observations, Bear Trap Creek is an intermittent waterbody at the crossing location. Enbridge proposes to cross Bear Trap Creek, located approximately 8.6 river miles (13.8 km) upstream of the Bad River Reservation, while no flow is present or using a dry crossing technique if water is present and flowing at the time of construction. Use of the dry crossing technique will limit potential downstream sedimentation impacts to the period of instream construction activities associated with the installation and removal of temporary dams. Enbridge does not propose to cross any flowing waterbodies using the open cut (wet trench) crossing technique. Additional details regarding these methods and their potential impacts to water quality are included in the discussion of sedimentation impacts above and in Enbridge's Data Request Question 5 response.

PROPOSED MITIGATION FOR TRIBAL ORW/OTRW WATERBODIES

As discussed above, Enbridge proposes to cross all waterbodies listed in Table 4-1 using a trenchless crossing technique with the exception of Bear Trap Creek, which Enbridge proposes to cross while no flow is present or by creating a dry crossing if there is flowing water at the time of construction. Refer to Enbridge's response to Data Request Question 5 for descriptions of dry crossing techniques. As explained above, use of the trenchless technique avoids instream disturbance and will have no impact on Bad River Band's designated uses or numeric water quality standards. As discussed in Enbridge's application materials and supplemental materials, Enbridge will clear and maintain a 30 to 50 foot wide corridor along the easement between the entrance and exit locations of the trenchless crossings (Enbridge proposes to maintain a 50 easement at the Tyler Forks crossing). Clearing and maintenance of the permanent easement will result in a change in riparian habitat from the existing to open habitat; however, no wetland fill will be required.

In addition to the utilization of the low impact crossing methods described above and in Data Request Question 5 and 8, Enbridge will avoid and minimize impacts on waterbodies by implementing the applicable measures described in its EPP and additional requirements identified in applicable permits and approvals from the USACE and the WDNR. Enbridge's EPP outlines construction-related environmental policies, procedures, and mitigation measures Enbridge developed for its pipeline construction projects based on their experience during construction. It meets or exceeds applicable federal, state, and local environmental protection and erosion control specifications, technical standards, and practices. Enbridge will avoid and minimize the potential for spills that could impact water quality by implementing the spill prevention, containment, and controls measures as outlined in its EPP.

Enbridge's implementation of the proposed mitigation and crossing methods will ensure that the Project meets the Bad River Band's numeric and written water quality standards.

WATER QUALITY MONITORING

Enbridge's water quality monitoring plan has been developed based upon an analysis of the potential effects of the proposed action on water quality, including potential effects of the various proposed crossing methods as well as the applicable water quality standards that need to be maintained.

Enbridge will implement a Water Quality Monitoring Plan to confirm the predicted modelling results and ensure the Bad River Band's water quality standards are maintained. A copy of Enbridge's draft Water Quality Monitoring Plan was previously submitted to the USACE and other agencies for review and comment. The major elements of the plan are summarized below.

Prior to construction Enbridge will collect baseline water quality data from perennial streams that will be crossed by the pipeline centerline during construction of the Project, as well as select intermittent streams (if water is present at the time of construction). Enbridge has identified the following 19 waterbodies and tributaries of waterbodies that will cross upstream of the Bad River Reservation that will be included in the preconstruction water quality sampling program: Beartrap Creek, White River, Marengo River, Brunsweiler River, and unnamed tributary to the Brunsweiler River, Trout Brook, and unnamed tributary to Trout Brook, Billy Creek, an unnamed tributary to Billy Creek, Silver Creek, three unnamed tributaries to Silver Creek, Bad River, an unnamed tributary to the Bad River, Tyler Forks, Potato River, Vaugh Creek, and an unnamed tributary to Vaugh Creek.

Enbridge will collect grab samples at the pipeline crossing location of each of these waterbodies approximately 5 days prior to start of the stream crossing (if stream flow is present) as a baseline measurement. Samples will be analyzed for dissolved oxygen ("DO"), pH, conductivity, temperature, chemical oxygen demand ("COD"), turbidity (field measurement) and TSS. COD and TSS analysis will be completed by a certified laboratory using standard analytical methodologies. DO, pH, conductivity, and temperature measurements will be collected in the field using standard analytical methodologies.

Two of the 19 waterbodies listed above are identified under Section 303(d) of the Clean Water Act as impaired:

- sasc1012p - Trout Brook (fecal coliform); and,
- sase1020p - Marengo River (fecal coliform).

One additional waterbody crossed by the Project is listed as a Section 303(d) waterbody (Bay City Creek – listed for exceedance of total phosphorus standards); however, this waterbody does not flow into the Bad River Reservation. The water quality parameters will include those described above as well as analysis for the respective impairment. Photographs will be taken (upstream, downstream, and across) to document physical conditions at each site.

Active Construction Sampling

During instream construction, Enbridge will collect water quality samples for analysis of the same parameters within 100 feet upstream of the crossing. Enbridge will also collect water quality samples approximately 100 feet downstream of the crossing (or approximately 100 feet downstream of the discharge point where the dam and pump method is used) where Enbridge has secured landowner permission for off right-of-way access, or will access the sample site from the waterbody where safe stream conditions allow (i.e., depth). Samples will be collected during the installation of the temporary dams and removal of the temporary dams.

Enbridge will collect additional water quality samples at the first downstream public road crossing when:

- Field turbidity sample results (NTU[4]) are greater than 5 NTUs over upstream level when the upstream levels are 50 NTUs or less; or,
- When the downstream NTU readings are greater than 10 percent above upstream NTU readings when the upstream readings are greater than 50 NTUs.

A table and maps of the proposed sampling locations (which includes the 19 waterbodies discussed here as well as several other waterbodies) are included in Attachment A of Enbridge Water Quality Monitoring Plan.

Post Construction Sampling

Following completion of instream construction activities, Enbridge will complete streambank restoration/stabilization and restore natural stream flow through the construction workspace. Enbridge will then collect daily water quality samples for three additional days upstream of the crossing location and downstream of the crossing location at approximately the same locations as the active construction samples. Enbridge will collect additional samples at one-week post construction and one-month post construction.

Horizontal Directional Drills and Direct Pipe Crossings

In the event of an in-stream inadvertent return, Enbridge will collect water samples upstream of the crossing location and 100 feet downstream of the inadvertent return location where Enbridge has secured landowner permission for off right-of-way access. Additionally, Enbridge will collect water samples at each public road crossing downstream of the instream inadvertent return location to the exterior boundary of the Bad River Reservation. Samples will be collected from the stream bank where public rights-of-way allow or will be collected from the respective bridge. Enbridge notes that changes in downstream water quality may be due to inputs from tributaries where the confluence of the tributary and the primary waterbody being sampled occurs upstream of the sampling location.

Enbridge will notify the Bad River Band of an in-stream inadvertent return and will work with the Bad River Band to obtain permission to collect additional water samples within the Reservation boundary at public road crossing locations if upstream sampling locations indicate that downstream migration of suspended sediments associated with an inadvertent return progress into the Bad River Reservation. Samples will be collected every six hours from each location following discovery of an instream inadvertent return. Once the in-stream inadvertent return has been successfully stopped and/or contained, water quality samples will be collected from each location daily for an additional five days at each sampling location described above. Collected samples will be analyzed for DO, pH, conductivity, temperature, COD, turbidity (field measurement), and TSS.

Enbridge will finalize and resubmit the Water Quality Monitoring Plan following further discussions with the respective agencies.

[4] A Nephelometric Turbidity Unit ("NTU") is a measure of the opaqueness of a fluid due to the presence of suspended solids (inorganic or biological). The higher the concentration of suspended solids in the water, the higher the turbidity is and the dirtier it looks.

Data Request Question 5: *Please provide additional information and analysis on the potential effects of temporary discharges into waterbodies associated with different pipeline installation methods. Describe the analysis used to determine the proposed method of installation for each specific waterbody crossing or groups of waterbody crossings, identify the anticipated effects and risks associated with the proposed waterbody crossing method and how those risks would be managed to reduce adverse effects to the aquatic ecosystem including water quality. Please provide the equivalent information and analysis for each feasible and practicable potential alternative crossing method for each waterbody or groups of waterbodies and compare the anticipated effects of the alternative crossing method to the proposed crossing method.*

Data Request Question 5 Response:

Evaluation of Pipeline Waterbody Crossing Methods

Enbridge evaluated a variety of different crossing methods depending on the type and characteristics of the waterbody being crossed. The methods Enbridge evaluated were the open-cut (wet-trench), dry crossing (flume or dam-and-pump), HDD, and Direct Pipe methods. Enbridge did not consider crossing any waterbodies using a cofferdam system as this method introduces higher safety risks with having personnel in an open excavation within the streambed to complete tie-in welds. Enbridge determined which method it would use based on the characteristics of the waterbody to be crossed and the suitability and advantages and disadvantages of each of the waterbody crossing method. Enbridge identified and considered the applicability and relative advantages and disadvantages of each crossing method. These are summarized in table 5.1 and evaluated further in the text below.

Table 5.1
Applicability and Advantages and Disadvantages of Pipeline Waterbody Crossing Methods

Method	Description	Applicability	Advantages	Disadvantages
Open Cut (Wet Trench)	Open-cut crossing technique that involves trenching through the waterbody while water continues to flow across the instream work area.	Generally suitable for small, non-fishery streams, such as agricultural ditches and intermittent waterways, as well as larger waterbodies where other crossing methods are not practical. In Wisconsin, these are primarily waterbodies located within large, saturated wetlands, and waterbodies with beaver dams.	Rapid construction / installation No need for specialized equipment Compatible with granular substrates and some rock Minimizes period of instream activity Generally maintains streamflow Maintains fish passage Relatively short duration of sediment release (<24 hours)	Requires implementation of erosion and sediment control devises to mitigate potentially high sediment release during excavation and backfilling Instream stockpiling of spoil on wide watercourses May interrupt streamflow

Table 5.1
Applicability and Advantages and Disadvantages of Pipeline Waterbody Crossing Methods

Method	Description	Applicability	Advantages	Disadvantages
Dry Crossing—Dam and Pump	Create a dry work area by damming the flow up and downstream of the crossing and pumping water around. Dam materials may include, but are not limited to, sand bags, aqua dams, sheet piling, or street plates.	Generally suitable for streams with low flow and defined banks where fish passage is not of concern. Generally works best in non-permeable substrate and preferred for crossing meandering channels.	Limited sediment release Maintains streamflow Minimal release and transport of sediment downstream that is not likely to result in negative effects to fish and fish habitat. Relatively dry working conditions May be adapted for non-ideal conditions Hose can be routed around area of construction May reduce trench sloughing and trench width	Minor sediment release during dam construction, dam removal, and as water flushes over area of construction Slow construction / installation resulting in extended period instream and prolonged sediment release Fish salvage may be required from dried-up reach Short-term barrier to fish movement Specialized equipment and materials Slow construction / installation Hose(s) may impede construction traffic Seepage may occur in coarse, permeable substrate Susceptible to mechanical failure of pumps

Table 5.1
Applicability and Advantages and Disadvantages of Pipeline Waterbody Crossing Methods

Method	Description	Applicability	Advantages	Disadvantages
Dry Crossing—Flume	Create a dry work area by damming the flow up and downstream of the crossing and installing flume to convey water. Dam materials may include, but are not limited to, sand bags, aqua dams, sheet piling, or street plates.	Generally suitable for crossing relatively narrow streams that have straight channels and are relatively free of large rocks and bedrock at the point of crossing where fish passage is of concern. The waterbody should have defined banks and channel with solid, fine-textured substrate.	Limited sediment release Maintains streamflow May allow fish passage Minimal release and transport of sediment downstream that is not likely to result in negative effects to fish and fish habitat Allows for flushing of substrates Relatively dry or no flow working conditions May be adapted for non-ideal conditions May reduce trench sloughing and trench width	Minor sediment release during dam construction, removal and as water flushes over area of construction Slow construction / installation Fish salvage may be required from dried-up reach Short-term barrier fish passage if water velocity in culvert is too high Difficult to trench and lay pipe, especially large diameter pipe, under flume pipe Work area may not stay dry in coarse, permeable substrate Seepage may occur in coarse, permeable substrate

Table 5.1
Applicability and Advantages and Disadvantages of Pipeline Waterbody Crossing Methods

Method	Description	Applicability	Advantages	Disadvantages
Horizontal Directional Drilling (or other similar trenchless method such as guided bore)	Place a rig on one side of the waterbody and drill a small-diameter pilot hole under the waterbody along a prescribed profile. Upon completion of the pilot hole, the Contractor uses a combination of cutting and reaming tools to accommodate the desired pipeline diameter. Drilling mud is necessary to remove cuttings and maintain the integrity of the hole. The Contractor then pulls the pipe section through and welds the adjoining sections of pipe on each side of the waterbody.	Generally suitable to cross sensitive or particularly deep, wide, or high-flow waterbodies and depends on site-specific topography and the local geologic substrate. Typically drilling is not feasible in areas of glacial till or outwash interspersed with boulder and cobbles, fractured bedrock, or non-cohesive coarse sands and gravels. This method requires a minimum crossing length of 1,280 feet for 30-inch outside diameter pipe with 56 feet of depth and 90 feet bottom tangent. The minimum length assumes similar elevations on each side of the crossing.	No sediment release unless an inadvertent return occurs Minimal bank and approach slope disturbance No streambed disturbance unless an inadvertent return occurs Maintains normal streamflow Maintains fish passage Significantly reduces cleanup and restoration in between entry and exit points May be able to construct during sensitive fisheries restricted-activity windows	Potential for inadvertent release of drilling fluids in unconsolidated gravel, coarse sand, and fractured bedrock and clays Requires ATWS on both sides of the crossings to stage construction, fabricate the pipeline, and store materials Tree and brush clearing is necessary to install guide wires for monitoring and steering the drill bit Requires obtaining water to formulate the drilling fluid as well as hydrostatic testing Success depends on substrate Requires specialized equipment Slow construction / installation Limited drilling radius that is allowed for pilot hole Pull string area along the alignment for the same length of the crossing to allow continuous pullback Drill stem may get "stuck in the hole" and tools can get lost, especially on large diameter reams No guarantees that drill will be successful May damage coating / pipe during pullback

Notes: ATWS = additional temporary workspace
Source: Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association, 2005.

Open Cut (Wet Trench) Method

As described in the table above, the open cut wet method is generally suitable for small, non-fishery streams, such as agricultural ditches and intermittent waterways, as well as larger waterbodies where other crossing methods are not practical. In Wisconsin, these are primarily waterbodies located within large, saturated wetlands, and waterbodies with beaver dams. The open-cut (wet trench) crossing technique involves trenching through the waterbody while water continues to flow across the instream work area. The open cut (wet trench) method:

- allows for rapid construction / installation of the pipeline compared to other methods;
- does not require any additional specialized equipment (other than what is used for standard construction;
- is compatible with granular substrates and some rock;
- minimizes period of instream activity;
- generally maintains streamflow if flow is present;
- maintains fish passage if relevant;

However, it also:

- results in more sedimentation of the waterway, both in terms of total sediments released and the duration of the sedimentation event, than dry crossing methods.
- requires the bed and banks to be trenched;
- may require instream stockpiling of spoil in wide watercourses if equipment is unable to reach the middle of the waterbody from the banks; and
- it may interrupt streamflow.

As described in the Sediment Discharge Modeling Assessment that was prepared by RPS to evaluate the potential fate and transport of sediments disturbed during pipeline installation, the open cut (wet trench) crossing method would result in the highest concentration of suspended sediments. RPS reported that short term suspended sediment concentrations downstream of open-cut wet pipeline watercourse crossings have been observed at levels from <1 to 11,000 mg/L (Reid and Anderson, 1999), which is considerably higher than the other crossing methods Enbridge evaluated. At wide waterbodies this method would likely also require Enbridge to operate equipment within the flowing water.

Largely for the reasons discussed above including avoiding substantial releases to sediment during trenching and backfilling and the need to operate trenching and backfilling equipment in flowing water, Enbridge has chosen to limit (i.e., only use) the open cut (wet trench) construction technique to cross small, narrow waterbodies and ditches that have no flow at the time of the crossing[5].

<u>Dam and Pump and Flume Dry Crossing Methods</u>

The dam and pump, and flume methods offer comparable protection but differ slightly in terms of suitability and required equipment. The dam and pump method is generally suitable for streams with low flow and defined banks where fish passage is not of concern. It generally works best in non-permeable substrate and is preferred for crossing meandering channels. The flume method is generally suitable for crossing relatively narrow streams that have straight channels and are relatively free of large rocks and bedrock at the point of crossing where fish passage is of concern. Additionally, the waterbody should have defined banks and channel with solid, fine-textured substrate.

[5] It should be noted that Enbridge will have equipment onsite to conduct a dry-ditch crossing of these waterbodies should any of these dry waterbody begin to flow during construction.

Both methods involve construction of temporary dams consisting of sandbags, inflatable dams, aqua-dams, sheet piling, and/or steel plates upstream and downstream of the proposed trenchline to isolate the work area from the stream flow. These dams will extend across the entire streambed and will be built to a height to withstand the highest water levels anticipated at the time of construction. The water upstream of the upper dam will either be pumped around the work zone or directed into one or more flume pipes that extend across the work area to maintain normal flows. This will isolate the work areas from the waterbody and allow Enbridge to excavate the trench, install and backfill the pipe, and restore the bed and banks under relatively dry conditions.

The trench across the waterbody will be excavated by equipment operating from the bank or banks. At present and because these methods will not be used at the widest waterbodies, Enbridge does not anticipate the need for any of the trenching or backfilling equipment to work within actively flowing water. The width of the trench in waterbodies will vary depending on the depth of the trench, soil type, and soil saturation at each crossing location. Enbridge estimates that the width at the bottom of the trench would be a minimum of 42 inches up to approximately 72 inches. The width at the top of the trench would be a function of depth versus soil stability at that specific location, but may be approximately 15 to 20 feet in width. Enbridge will minimize the width of the trench in waterbodies by minimizing the length of time the excavated ditch is open to reduce the potential for slumping and/or ditch cave-ins. Excavated trench spoil will be placed on the bank above the high water mark and used to backfill the trench after the pipeline is installed. A prefabricated segment of pipeline sized to extend across the entire width of the waterbody will be placed into the trench under the dam and pump hose or flume using side-boom tractors or similar equipment. Concrete coating, pipe sacks, or set-on weights will be used, as necessary, to provide negative buoyancy for the pipeline, which will then be backfilled using native material. Once the trench is backfilled, the bed and banks will be restored as near as practicable to preconstruction contours and stabilized in accordance with Enbridge's EPP and applicable waterbody crossing permits. Stabilization measures will include seeding, installation of erosion control blankets, or installation of riprap materials, as appropriate. Excavated material not required as backfill to reestablish the streambed profile or stream banks will be removed and disposed of at upland disposal sites. In each case and for each method, Enbridge will adhere to measures specified in Enbridge's EPP and additional requirements specified in waterbody crossing permits.

The primary advantages of both the dam and pump and flume methods over an open cut (wet trench) method are that they would:

- reduce sedimentation to minor, short term releases, which would be limited to the short periods primarily when the dams and flume are installed and removed and when flow is restored across the work area following installation of the pipe crossing;
- avoid potential interruption of streamflows; and
- allow the pipeline crossing work area to be isolated from the stream flow and performed in relatively dry working conditions.

The primary disadvantages of the dam and pump and the flume methods compared to open cut (wet trench) method are that they:

- require specialized equipment (e.g., dam materials, pumps, flumes);
- may create a short-term barrier fish passage;
- entail slower construction; and

- complicate installation of the pipeline, either because pumps are needed to maintain flows or the difficulty of threading of the pipeline under the flume.

As previously mentioned, the dam and pump and flume methods are comparable and similar with respect to impacts on and protection of water quality. Additionally, other than the long-term clearing of vegetation on the maintained right-of-way, both methods would only have a minor and short-term waterbody effects. As described in the Sediment Discharge Modeling Assessment that was prepared by RPS to evaluate the potential fate and transport of sediments disturbed during pipeline installation, sediment concentrations downstream of dry trenched crossings, which use dams to isolate the work area from the stream flow, largely limit sedimentation to the periods of dam installation and removal, and generally result in much lower short term downstream sediment concentrations than comparable open cut (wet trench) crossings. TSS concentrations predicted by RPS for dry crossings farther downstream of the installations (e.g., 500-1,000 m) were on the order of <1 to 30 mg/L for the modelled small watercourse and <1 to 10 mg/L for the modelled medium watercourse, which was consistent with the magnitude of TSS exceedances observed in actual measurements collected during installation of the Guardian pipeline in 2008 (see the RPS report). RPS also concluded that the proposed dry crossing installation activities would have a lower magnitude and shorter duration effect on TSS in the water column than natural storm-related events, which can cause TSS values to exceed hundreds to thousands of mg/L over periods of time that are longer than these installation periods. Finally, the modelling results suggests that no deposition above 5 mm would be expected in small watercourses, and the majority of deposition that does occur would be within 17 m downstream of the installation site. For the medium watercourse scenarios, RPS' modelling predicted that depositions above 5 mm would extend, at most, 3 m downstream, and the majority of deposition that does occur would be within 30 m downstream of the installation site.

For these reasons, Enbridge proposes to cross the smaller, narrower flowing waterbodies using either the dam and pump or flume dry crossing method. As previously discussed, the dam and pump method is generally most suitable for streams with low flow and defined banks where fish passage is not of concern. It generally works best in non-permeable substrate and is preferred for crossing meandering channels. The flume method in contrast is generally best for crossing relatively narrow streams that have straight channels and are relatively free of large rocks and bedrock at the point of crossing, and/or where fish passage is of concern. Where the flume method is used, the waterbody should have defined banks and channel with solid, fine-textured substrate. Enbridge's contractor will decide which method to use in the field based on the regulatory requirements and the site-specific conditions at the crossing during the time of construction.

Horizontal Directional Drill Method

HDD is conducted by placing a drill rig in a relatively large additional temporary workspace ("ATWS") on one side of the waterbody and drilling a small-diameter pilot hole from the drill entry point under the waterbody along a prescribed profile to the drill exit point. To do this, a drill bit will be attached to a hollow drill pipe that is turned by a drilling machine at the ground surface. To start each HDD, the operator will use a smaller bit, typically a 12-inch bit, attached to a steering device called a SUB. The SUB will be magnetically coupled to guide wires that are run above ground on either side of the drill, allowing the operator to steer the bit. Once the pilot hole has been completed, larger drill bits will be attached to the drill stem and run through the pilot hole to ream out the bore to the desired size. The drilling operation will be facilitated by drilling mud, which is a combination of water, bentonite clay and other additives. The drilling mud will be circulated to cool the bit and carry spoil back to the surface for screening, before is it recirculated. Typically, several reaming passes of increasing size will be required to create a bore hole large enough for the pipeline. The bore hole will be reamed larger than the product pipe to ensure it can be pulled back into the reamed hole without getting stuck. Before the bore hole is completed, the pipe segment to be installed in the hole will be fabricated on the opposite side of the crossing from the drill rig. When the bore hole is completed, a pulling head will be attached to the product pipe and it will be "pulled back" into the hole to complete the bore. The pull string will be welded, inspected, hydro tested and coated in advance of being pulled back into the reamed hole to the drill rig. After the pull string of pipe is installed, the contractor will weld it onto the adjoining sections of pipe on each side of the waterbody.

As described in table 5-1, the HDD method is generally suitable to cross sensitive or particularly deep, wide, or high-flow waterbodies where the site-specific topography and the local geologic substrate are suitable. It is generally unsuitable and not used for narrow waterbody crossings, particularly for large diameter pipelines which require long HDDs. For a 30-inch outside diameter pipe, the minimum HDD crossing length is approximately 1,280 feet with 56 feet of depth and a 90 foot bottom tangent. Typically drilling is also not feasible in areas of glacial till or outwash interspersed with boulder and cobbles, fractured bedrock, or non-cohesive coarse sands and gravels.

The advantages of the HDD method compared to open cut methods are that:

- it avoids or reduces construction caused sedimentation more than either wet trench or dry crossing methods provided there is not an inadvertent return of drilling fluid into the waterbody;
- there is no streambed or bank disturbance unless an inadvertent return occurs;
- there are no potential streamflow or fish passage effects; and
- it reduces the amount of cleanup and restoration necessary between the HDD entry and exit points.

The disadvantages of the HDD method compared to open cut methods include that:

- there is a potential for inadvertent release of drilling fluids, particularly in unconsolidated gravel, coarse sand, and fractured bedrock and clays;
- it requires large cleared ATWS on both sides of the crossings to stage construction, fabricate the pipeline, and store materials;
- it requires water to formulate the drilling fluid as well as hydrostatic testing;
- its success depends on substrate;
- it requires specialized equipment;
- it slows construction / installation of the crossing;
- it must be a fairly long to accommodate the drilling radius limitations, which make shore drills infeasible;
- it requires a long flat or gently sloped staging area the same length of the crossing to fabricate the pipe string and allow continuous pullback of the pipe;
- it requires relatively similar elevations on the drill entry and exit sides;
- the pipe coating / pipe may be damaged during pullback

As previously mentioned one advantage of the HDD method is that it either avoids or reduces construction caused sedimentation more than other dry crossing methods provided there is not an inadvertent return of drilling fluid into the waterbody. If there is an inadvertent return, the effect of water quality would depend on the volume of drilling fluid released to the water and the size and flow of the waterbody it enters. RPS modelled the effects of an inadvertent return to the Bad River to estimate the potential impact of a spill within any of the large waterbodies that Enbridge proposes to HDD. The modelling indicates that the discharge into the watercourse would initially produce large TSS concentrations near the release site (more than 20,000 mg/L) due to the large volume of drilling fluid (bentonite) released in a relatively short period of time. The highest concentrations would occur during a large release volume associated with a Final Ream Pass[6] under low river flow conditions, where dilution and dispersion would be lowest. Under this scenario, predicted TSS concentrations farther downstream (e.g., 500-1,000 m) would be on the order of 10-300 mg/L. On the low end, the TSS concentrations would likely be on the same order as those anticipated for the dam and pump or flume methods, but on the high end would likely exceed those methods. The modelling however, indicates that the concentrations associated with an HDD related inadvertent return would likely still be smaller or of similar magnitude to that typically caused by storm-related events, which can cause TSS to exceed hundreds to thousands of mg/L over longer periods of time that are longer than these installation periods.

Based on the RPS modelling, it is predicted that nearly all of the discharged bentonite would eventually settle regardless of river flow rate. The greatest deposition would occur near the release location, as well as toward the center of the river channel. The distance and area covered by deposition above 5-10 mm thickness would be greatest for an inadvertent return release during the final reaming pass under low flow conditions, and the model predicted deposition at this level extended up to 40 m downstream of the release location. While the model predicted very large areas of deposition less than the 0.1 mm reporting threshold, no deposition above that threshold was predicted past 400 m downstream.

Based on the criteria listed in table 5-1, the results of Enbridge's studies, and the analysis described above Enbridge proposes to use the HDD method at the 12 waterbodies listed in table 5-2.

[6] RPS estimates the bentonite load rate for the final reaming pass (11.0 MT/h) would be approximately twice that of the pilot hole (5.5 MT/h).

Table 5.2
Proposed Horizontal Direction Drill Waterbody Crossings

Primary Crossing Feature	Near Milepost	Crossing Method
White River	4.0	HDD
Deer Creek	6.4	HDD
Brunsweiler River	14.1	HDD
Highway 13/UNT Brunsweiler River [a]	15.2	HDD
Trout Brook	16.6	HDD
Billy Creek	17.3	HDD
Silver Creek	19.1	HDD
Krause Creek	22.3	HDD
Bad River	24.2	HDD
Tyler Forks	34.0	HDD
Potato River	37.9	HDD
Vaughn Creek	39.6	HDD

[a] UNT Brunsweiler River will be crossed as part of the Highway 13 HDD and is not an HDD specific to the waterbody crossing itself

Direct Pipe Method

The Direct Pipe installation method will be used to cross the Marengo River near milepost 11.4. The direct pipe method is another trenchless construction method that is similar to HDD, but it also combines with processes related to microtunnelling. The Direct Pipe installation method is a single continuous process that allows the trenchless installation of a pre-fabricated pipeline segment to occur simultaneously with the development/advancement of the bore hole. This method differs from HDD in that a much larger initial cutterhead is used, eliminating the reaming process, and the product pipe is used as the means to advance the drilling head through the drill profile. The pipe and cutting head are advanced by use of a thruster, which pushes the cutting head and pipe segments forward. The drilling head mechanism includes the cutting head as well as the motors used to turn the cutting head. The mud motors use drilling mud that is pumped through a hose that runs inside the pipe back to the pumps to hydraulically rotate the cutting head and cut the bore path. Mud from the outlet of the mud motors is then jetted into the rock face to cool the cutting teeth and sweep the cut material away from the face and into the exhaust mud line that is also inside the product pipe. This exhaust mud line carries the spoil from the drilling face back to the mud tanks where the mud and debris are separated through screens and shakers, the clean mud is then recirculated down the hole and the process is repeated. The drilling head is fitted with instrumentation and steering rams that provide data for the operator, allowing them to steer the cutting head as it is advanced. Once through to the exit point, the steering head is removed from the product pipe and the drill is complete.

Similar to the HDD method, the Direct Pipe method is generally suitable to cross sensitive or particularly deep, wide, or high-flow waterbodies where the site-specific topography and the local geologic substrate are suitable. It is generally unsuitable and not used for narrow waterbody crossings, particularly for large diameter pipelines.

The advantages of the Direct Pipe method compared to open cut methods are that:

- it avoids or reduces construction caused sedimentation more than either wet trench or dry crossing methods provided there is not an inadvertent return of drilling fluid into the waterbody;
- there is no streambed or bank disturbance unless an inadvertent return occurs;

- there are no potential streamflow or fish passage effects;
- direct pipe installations may be shorter and shallower than HDD installations;
- it reduces the amount of cleanup and restoration necessary between the Direct Pipe entry and exit points; and
- has a wide range of subsurface conditions that it can be used in where other trenchless methods may not be preferable/feasible (e.g., areas of glacial till or outwash interspersed with boulder and cobbles, fractured bedrock, or non-cohesive coarse sands and gravels).

The disadvantages of the Direct Pipe method compared to open cut methods include that:

- there is a potential for inadvertent release of drilling fluids;
- it requires large cleared ATWS on both sides of the crossings to stage construction, fabricate the pipeline, and store materials;
- it requires water to formulate the drilling fluid;
- it requires specialized equipment within limited quantity and availability within the United States;
- it slows construction / installation of the crossing;
- it must be a fairly long to accommodate the drilling radius limitations;
- it requires a long flat or gently sloped staging area the same length of the crossing to fabricate the pipe string and allow continuous pullback of the pipe;
- it requires relatively similar elevations on the entry and exit sides;
- it requires anchoring horizontally and vertically as well as installation of thrusting blocks to accommodate the forces associated with the pipe and cutting tool advancement; and,
- the pipe coating / pipe may be damaged during installation.

As previously mentioned one advantage of the Direct Pipe method is that it either avoids or reduces construction caused sedimentation more than other dry crossing methods provided there is not an inadvertent return of drilling fluid into the waterbody. If there is an inadvertent return, the effect of water quality would depend on the volume of drilling fluid released to the water and the size and flow of the waterbody it enters, similar to the process described above for the HDD method

Direct pipe installations may be shorter and shallower than HDD installations because the bore hole is continuously cased, thereby limiting the risk of hole collapse and the inadvertent release of drilling fluids.

Comparative Analysis

Based on the differences described above, Enbridge believes the open cut (wet trench) crossing method would result in the greatest environmental impact if flowing water is present. This is because it would require trenching and pipe installation within the waterbody while water is flowing across the work area. Although it would shorten the duration of the crossing, the direct and prolonged contact of equipment and other materials with the disturbed soils and substrates would result in the greatest amount of sediment being suspended and transported downstream. To avoid the potential for these increased impacts, Enbridge decided to only use the open cut (wet trench) method at streams where no flow is present at the time of crossing.

Enbridge proposes to use either the dam and pump or flume method at smaller flowing waterbodies, which constitute the majority of the proposed pipeline crossings. These methods, while slightly different (in that one is passive and employs flumes and the other is active and relies on pumps), are functionally similar and provide a comparable level of waterbody and water quality protection. Both isolate the work area from the stream flow and minimize sedimentation by limiting the suspension and transport of sediments to short periods of time when the dams and flume are installed and removed and the stream flow is restored across the work area after installation of the pipeline. Sediment concentrations downstream of dry trenched crossings, which use dams (e.g., sandbags, coffer dams, steel plate) to isolate the trench, are generally much lower than open cut wet crossings (Reid et al., 2002). Moreover, RPS modeling indicates that the added TSS from dry trenched crossings would be temporary and of short duration; and of the same or less magnitude than the natural variability in TSS of each system and well below natural TSS concentrations associated with spring freshets and summer storm events. RPS' modelling also predicts that the deposition of sediments would be minor and localized to the downstream proximity of the crossing area.

Where dam and pump or flume methods are not feasible or practicable because the depth or width of the waterbody is too great or the volume of the anticipated flow is too high, bed and bank restoration is anticipated to be challenging; geotechnical studies indicate an elevated potential for scour or channel movement; and where even greater minimization of potential impacts is warranted, Enbridge proposes to use a trenchless method, primarily the HDD method. The trenchless installation methods will avoid cutting the bed and banks, and increase the distance of disturbed workspace from the waterbody, and thus potentially further minimize the risk of sedimentation. However, as described above, these methods have specific requirements (longer duration, need for large additional workspace for equipment and pipe fabrication, and suitable topography and subsurface conditions), that limit the feasibility in some areas. A trenchless method also carries the risk of an inadvertent return. Based on this, Enbridge believes that, even if feasible, the environmental benefits of the trenchless methods at narrow low flowing waters are relatively small compared to other dry crossing methods, and could be negated if there were an inadvertent return within the waterbody.

Regardless of crossing method, Enbridge will avoid and minimize impacts on waterbodies by implementing the applicable measures described in its EPP and additional requirements identified in applicable permits and approvals from the USACE and the WDNR. Enbridge's EPP outlines construction-related environmental policies, procedures, and mitigation measures that Enbridge developed for its pipeline construction projects based on its experience during construction. It meets or exceeds applicable federal, state, and local environmental protection and erosion control specifications; technical standards; and practices.

The Contractor will leave at least a 20-foot buffer (from the ordinary high water mark ("OHWM")) of undisturbed herbaceous vegetation on all stream banks during initial clearing, except where grading is necessary for bridge installation, or where applicable regulations and/or permit conditions restrict. The Contractor may cut and remove woody vegetation within this buffer during clearing, leaving the stumps and root structure intact. The Contractor will leave non-woody vegetation and the soil profile\intact until they are ready to begin trenching the stream crossing. The Contractor will properly install and maintain sediment control measures at the 20-foot buffer line adjacent to streams immediately after clearing and prior to initial ground disturbance.

Where necessary, ATWS will be used to accommodate additional equipment and materials associated with waterbody crossings. Enbridge designed ATWS to be at least 50 feet away from the OHWM if topographic or other physical conditions, such as stream channel meanders, allow; and if safe work practices or site conditions do not allow for a 50-foot setback, ATWS will be no closer than 20 feet from the OHWM, subject to site-specific approval.

Data Request Question 6: *As we have discussed in regular meetings with you, additional information and analysis is needed regarding construction-related risks to aquifers. Please identify where aquifers are located with proximity to Corps regulated activities and describe measures that would be taken to minimize the potential for inadvertent aquifer breaches due to construction activities.*

Data Request Question 6 Response:

Enbridge completed multiple studies to identify areas along the proposed pipeline route with potential shallow confined aquifers. This included analysis of publicly available aquifer information; analysis of publicly available well records in the project area; review of geologic, hydrologic, and topographic setting; and field investigations.

As part of its engineering and constructability analysis, Enbridge conducted extensive geotechnical investigation in 2020. The geotechnical investigations were primarily targeted towards "HDD/Direct Pipe crossings and valve settings. Groundwater levels were estimated based on the moisture level observed within geotechnical boring samples and were measured at the end of each boring where possible. This investigation documented multiple areas where shallow unconfined groundwater was encountered.

Aquifer breaches during construction occur where the construction activities extend deep enough to penetrate the confining layer above an aquifer. Enbridge reviewed the project route and determined the maximum depth of construction activities along the route. Maximum depth of construction activities included HDD locations, areas where sheet piling may be used, valve site locations, and crossings of existing utilities as examples.

Enbridge also completed aquifer analysis studies in 2022. The studies looked at publicly available aquifer information, analysis of publicly available well records in the Project area, and/or review of geologic, hydrologic, and topographic setting.

The depth of construction analysis was combined with the aquifer analysis to determine areas where confined aquifers may be encountered by construction activities, confirming that there are no areas with "High Likelihood" of encountering artesian conditions. The majority of the project alignment was defined as having a "low likelihood" of encountering aquifers with artesian conditions. Limited areas were defined as having "Moderate Likelihood" for encountering artesian conditions. This ranking does not mean artesian conditions are present or will be encountered during construction; it only means that there are enough contributing conditions to proceed with some caution and possibly perform some additional investigations.

In 2022, Enbridge conducted additional subsurface investigations along the Proposed Route utilizing hand probes and hand augers to verify areas that may require sheetpile, to identify rock depth, and to assess the potential for confined aquifer conditions in the "Moderate Likelihood" ranking areas. These additional subsurface investigations indicated artesian conditions will not be encountered at the planned construction depths. Based on geotechnical analysis, it is unlikely the proposed HDDs will encounter confined aquifers. However, it the HDD encounters a confined aquifer, the HDD installation methodologies can control/seal the drill path as drilling progresses.

Data Request Question 7: *Please provide additional information and analysis on potential adverse water quality and hydrological effects of blasting in waterbodies and wetlands. Specifically, provide an evaluation of alternative installation methods in each of these areas, which clearly addresses the practicability of the alternative crossing method(s) and provide a comparison of environmental effects. Describe measures that would be implemented to minimize the risks associated with blasting in waterbodies and wetlands, including how baseline and post-construction monitoring would inform the need for corrective or mitigative measures. The locations of aquatic resources proposed for blasting must be identified on maps and provided along with your analysis.*

Data Request Question 7 Response:

As previously submitted, Enbridge anticipates that blasting will be required for portions of pipeline route where bedrock is present at or within the trench depth. Blasting is expected to be necessary in several wetlands and waterbodies, which are crossed by the pipeline route within these shallow bedrock areas. Enbridge is finalizing information on blasting areas and will provide location information and a list of wetlands/waterbodies where blasting is likely under separate cover.

Crossing methods

There are two primary methods to establish a trench in areas with shallow bedrock, excavation by mechanical means without blasting and excavation (i.e., fracturing the bedrock) by mechanical means with blasting. Mechanical means of rock removal without blasting include equipment such as excavator-mounted hydraulic ram/hammers, rotary trenching machines, track-mounted rippers, rock saws, or similar equipment. The practicability of excavating a trench using only mechanical means is dependent on the type and hardness of the bedrock crossed. Mechanical only excavation methods are practicable in soft (paralithic) bedrock, but generally impracticable in hard (lithic) bedrock such as that found in the Project area. Enbridge had determined that excavation using only mechanical methods is likely not practicable in shallow bedrock areas along the Project route due to the hardness of the bedrock.

Environmental Effects

The limited blasting required for installation of a pipeline through shallow bedrock areas is different than the blasting applications used for large-scale rock blasting typically used for larger-scale applications such as leveling large areas at construction sites, building roadways, or for production blasting (open pit) used in quarry and industrial non-metallic mining. Trench blasting is more confined than a normal open pit blast and results in lower explosives consumption per cubic feet of blasted rock. The diameter of trench blast holes is normally smaller, which provides better distribution of the explosive in the rock, avoids excessive overbreak outside the width of the trench, and helps avoid high peak overpressure (noise) and high peak particle velocity (vibration) readings. Trench blasting is controlled with a “precision blast design” by a certified blasting professional.

Although Enbridge has determined that excavation using only mechanical means is not practicable in shallow bedrock areas along the proposed Project route, Enbridge has evaluated potential impacts associated with mechanical rock excavation compared to blasting. As noted above, the ability to excavate a trench using only mechanical means is dependent on the type and hardness of the bedrock crossed. The harder the bedrock requiring removal is, the longer the construction process becomes to remove the material using only mechanical methods (assuming it is soft enough to be removed by only mechanical means). The slower speed of mechanical construction would (1) increase the duration of rock removal noise impacts at a given location from seconds (for blasting) to days or weeks; (2) increase the duration of vibration impacts; (3) increase the overall construction duration resulting in a longer period between initial ground disturbance and final restoration; and (4) increase equipment air emissions due to the extended work duration and additional equipment needs.

Mechanical only rock removal techniques would produce a vibration with a consistent frequency for long periods of time (days to weeks, depending on site conditions); as such, mechanical rock removal techniques would potentially result in increased impacts from vibrations and frequencies for longer periods of time. While trench blasting would produce a higher vibration than mechanical methods, it would be a one-time event lasting for a very short period of time (milliseconds), and its frequency could be adjusted through timing of the blast to further minimize associated impacts. The increase in vibration duration using mechanical only excavation techniques could potentially result in increased turbidity associated with groundwater discharges in the Project area due to the vibration causing a suspension of fine material in the water. If used to trench across shallow bedrock in a waterbody, the slower speed of mechanical only methods would extend the time of instream disturbance; increase the duration of vibration in the streambed; and increase the length of time that the stream flow would need to be pumped around the isolated construction work area, which would in turn prolong the duration of impeded fish and other aquatic organism passage. Additionally, extending the time period of instream construction would increase the potential risk of leaks in the temporary dams, which could result in downstream turbidity and sedimentation. A longer crossing duration would also increase the chance of a storm event during the crossing timeframe, which might overwhelm the temporary dams and the contractor's ability to move stream water around the isolated construction work area.

Potential Blasting Impacts

The impacts of blasting on surface water and groundwater resources could include:

- Temporary increases in turbidity in well water and/or springs near the construction right-of-way.
- Fracturing of the rock, temporarily affecting local groundwater flow patterns and groundwater yield of nearby wells and springs around the blast site.
- Temporary alternation of surface runoff flow if temporary ground upheaval occurs as result of blasting.
- Although blasting does not typically result in large, aboveground explosions, it could potentially cause small amounts of flyrock to land in freshwater resources, temporarily disturbing substrate sediment and increasing turbidity. Additionally, flyrock from blasting deposited beyond the limits of the construction area could accumulate and create a layer of fill on top of native wetland soils, crush vegetation, and diminish water storage capacity.
- The introduction of contaminants associated with blasting residue, such as nitrogen.
- Effects on aquatic biota in the blasting area.

The effects of blasting on aquatic biota varies by species (Yelverton et al., 1975)[7], but generally relatively small organisms and those close to the blast or near the sediment surface experience higher mortality (Yelverton et al., 1975; Munday et al., 1986[8]). Non-lethal effects may include eye distension,

[7] Yelverton, J.T., D.R. Richmond, W. Hicks, H. Saunders, and E.R. Fletcher. 1975. The relationship between fish size and their response to underwater blast. Lovelace Foundation for Medical Education and Research Topical Report, DNA 3677T, Albuquerque, NM. Prepared for the Defense Nuclear Agency

[8] Munday, D.R., G.L. Ennis, D.G. Wright, D.C. Jeffries, E.R. McGreer, and J.S. Mathers. 1986. Development and evaluation of a model to predict effects of buried underwater blasting charges on fish populations in shallow water areas. Canada Technical

hemorrhage, hematuria, and damage to bodily systems (Hastings and Popper, 2005[9]; Godard et al., 2008[10]; Carlson et al., 2011[11]; Martinez et al., 2011[12]).

Potential pipeline related blasting impacts, such as changes in water levels and/or turbidity in shallow aquifers, tend to be localized and temporary since water levels quickly re-establish equilibrium and turbidity levels rapidly subside following blasting, trenching, pipeline installation, and backfilling. Enbridge will avoid or minimize groundwater impacts by implementing construction techniques described in its construction and restoration plans, such as using temporary and permanent trench plugs. Following construction, Enbridge will restore the ground surface to original contours as closely as practicable and restore vegetation on the right-of-way to establish surface drainage and recharge conditions as closely as possible to those prior to construction.

Clearing and grading of stream banks, blasting, instream trenching, trench dewatering, and backfilling could each result in temporary, local modifications of aquatic habitat including sedimentation, increased turbidity, and decreased dissolved oxygen concentrations. These impacts would be limited to the period of instream construction, and conditions would return to normal shortly after stream restoration activities are completed. These impacts will be mitigated using best management practices included in the EPP.

Sedimentation and increased turbidity can occur as a result of in-stream construction activities including blasting, trench dewatering, or stormwater runoff from construction areas and access roads. In slow moving waters, increases in suspended sediments (turbidity) may increase the biochemical oxygen demand and reduce levels of dissolved oxygen in localized areas during construction. Suspended sediments also may alter the chemical and physical characteristics (e.g., color and clarity) of the water column on a temporary basis. Enbridge's EPP includes procedures to minimize potential impacts associated with construction.

Proposed Blasting Minimization Techniques

Project blasting will be done in accordance with all applicable federal, state and local laws and regulations applicable to obtaining, transporting, storing, handling, blast initiation, ground motion monitoring, and disposal of explosive materials and/or blasting agents. These include:

- Bureau of Alcohol, Tobacco and Firearms – 27 C.F.R. § 181 (Commerce in Explosives). Occupational Safety and Health Administration – 29 C.F.R. § 1926.90 (Safety and Health Regulations for Construction Blasting and Use of Explosives
- Pipeline Hazardous Material Safety Administration – 49 C.F.R. § 177 (Carriage by Public Highway)

Report of Fisheries and Aquatic Sciences. No. 1418, Vancouver, BC, Department of Fisheries and Oceans, Habitat Management Division.

[9] Hastings, M.C. and A.N. Popper. 2005. Effects of sound on fish. Prepared for the California Dept. of Transportation. Subconsultant to Jones & Stokes; California Department of Transportation Contract No. 43A0139, Task Order 1. January 28, 2005.

[10] Godard, D.R., L. Peters, R. Evans, K. Wautier, P.A. Cott, B. Hanna, and V. Palace. 2008. Histopathological assessment of the sub-lethal effects of instantaneous pressure changes (IPC's) on rainbow trout (Onchorhynchus mykiss) early life stages following exposure to detonation under ice cover. Environmental Studies Research Funds Report No. 164, Winnipeg. 93 p.

[11] Carlson, T., G. Johnson, C. Woodley, J. Skalski, and A. Seaburg. 2011. Compliance monitoring of underwater blasting for rock removal at Warrior Point, Columbia River Channel Improvement Project 2009/2010. Pacific Northwest National Laboratory Completion Report (PNNL-20388). Prepared for the U.S. Army Corps of Engineers.

[12] Martinez, J.J., J.R. Myers, T. J. Carlson, Z.D. Deng, J.S. Rohrer, K.A. Caviggia, and M.A. Weiland. 2011. Design and implementation of an underwater sound recording device. Sensors 11:8519-8535.

- Explosives and Blasting Agents – OSHA, 29 C.F.R § 1910.109 (Safety in the Workplace When Using Explosives)
- Department of Energy– 18 C.F.R. § 2.69 (Guidelines to be Followed by Natural Gas Pipeline Companies in the Planning, Locating, Clearing and Maintenance of Right-of-Way and the Construction of Above Ground Facilities)

Enbridge proposes to implement the project-specific *Blasting Plan* that was developed in accordance with industry-accepted standards for the use, storage, and transportation of explosives and is consistent with applicable federal, state, and local codes, ordinances, and permits; manufacturers' prescribed safety procedures; and industry practices. Enbridge will adhere to strict safety precautions during blasting and will exercise care to prevent damage to nearby structures, utilities, wells, springs, and other important resources. Blasting will only be conducted during daylight hours. Enbridge will implement controlled blasting using small, localized detonations and low-force charges that are designed to transfer the explosive force only to the rock that is designated for removal. This method results in a small scale, controlled, rolling detonation with limited ground upheaval and does not typically result in large, aboveground explosions. The potential effect of flyrock would be minimized to a minor impact through the use of blasting mats and other measures identified in the Project Blasting Plan.

Due to the controlled nature of blasting associated with pipeline trench excavation, Enbridge does not anticipate that bedrock fractures will create a potential conduit that could drain shallow, near surface groundwater from wetland areas or result in long term or permanent changes to the hydrology of any wetland. Additionally, Enbridge will install trench breakers to prevent preferential flow down the backfilled ditchline in accordance with Enbridge's EPP. Use of trench breakers to prevent preferential flow down the backfilled ditch line is an industry and USACE recognized best management practice[13]. Following pipeline placement and backfilling, groundwater levels are expected to return to pre-construction elevations and flow paths.

To minimize the potential release of contaminants, such as nitrogen compounds associated with blasting materials, Enbridge will adhere to strict management of nitrogen-based explosives during the storage, handling, transportation, bore-hole loading, and detonating phases of blasting. The Project will use only packaged explosives (no bulk explosives will be used) with proven resistance to water infiltration to prevent leaching of soluble materials from the explosives. The use of packaged explosives will reduce the potential for spills and minimize the exposure of explosive products to wet weather and groundwater conditions. The type of explosive product used, and the associated blasting pattern will be selected to maximize the effectiveness of the blasting process to accomplish the desired results while minimizing the mass of explosives required thereby minimizing the potential amount of residual (unconsumed) blasting material. The types of explosives that may be used will have the best available detonation properties, low residual waste profiles, and higher safety and reliability of detonation. The Project's blasting contractor will communicate with the drillers to obtain geological information for each shot and will adjust the mass of explosives accordingly. Explosives will not be primed until immediately before use and will not be allowed to lay overnight in drilled holes (unless completion of the detonation is delayed due to weather or other events).

In-stream Minimization Techniques

For flowing waterbody crossings that may require blasting due to shallow bedrock, Enbridge will initiate the dry crossing method (i.e., dam and pump) prior to blasting to isolate the workspace and blasting

[13] U.S. Army Corps of Engineers. Little Rock District. Sediment and Erosion Control Guidelines for Pipeline Project.

area from natural streamflow. Installation of the temporary instream dams is expected to disperse mobile aquatic organisms away from the crossing area before the blast is conducted and minimize propagation of the blast energy. However, non-mobile aquatic organisms within the isolated stream segment would be affected by the blast.

For waterbody blasts, as for all blasting, the contractor will use only specialized trench-blasting explosives that do not contain perchlorate or ammonium nitrate fuel oil to avoid the discharge of remnant residues into the waterbody.

Enbridge's goal will be to initiate excavation within 72 hours of blasting and Enbridge will maintain active stream isolation throughout the entire construction process (unanticipated event such as inclement weather or safety related stand-downs may delay the start of excavation). Prior to backfilling, Enbridge will install trench breakers within the adjacent upland area (location to be based on site-specific conditions) to prevent subsurface flow of water (either from the waterbody or to the waterbody). Enbridge will restore the bed and banks of each waterbody as near as practicable to preconstruction conditions, will seed the disturbed areas of the stream bank and install erosion blankets above the ordinary high water mark in accordance with its EPP to minimize potential bank erosion prior to returning waterflow to the isolated segment of the stream.

For small, non-flowing waterbody crossings and waterbodies that are dry at the time of construction and are located in areas of shallow bedrock, Enbridge proposes to install temporary upstream and downstream dams to isolate the area of excavation/blasting prior to blasting as a proactive method to minimize the potential for downstream sediment migration should the waterbody begin to flow following blasting and prior to instream construction. Enbridge will initiate the open-cut crossing method within five days following blasting. Enbridge will have equipment and materials on site ready to initiate a dry crossing technique should the stream begin to flow following blasting.

Prior to backfilling, Enbridge will install trench breakers within the adjacent upland area (location to be based on site-specific conditions) to prevent subsurface flow of water (either from the waterbody or to the waterbody). The bed and banks of each waterbody will be restored as near as practicable to preconstruction conditions prior to removal of the upstream and downstream temporary dams. Enbridge will seed the disturbed areas of the stream bank and install erosion blankets above the ordinary high water mark to minimize potential bank erosion.

After the pipeline is installed and appropriate padding is placed around the pipe, blast rock would be returned to the trench to the top of the original bedrock elevation. Large rock not suitable for use as backfill would be hauled off to an approved disposal location or used as beneficial reuse, per landowner or land management agency approval and as required by permit requirements.

Where in-stream blasting would be conducted, the waterbody substrate would be restored to natural grade after pipe installation is complete in accordance with the Project Environmental Protection Plan ("EPP").

Post Construction Monitoring

Enbridge's proposed Wetland and Waterbody Restoration and Post-Construction Monitoring Plan ("Monitoring Plan") includes special provisions for monitoring sensitive resource areas (wetlands and waterbodies) where blasting was required to install the pipeline through shallow bedrock areas. Enbridge's post-construction wetland and waterbody monitoring plan is designed to identify changes to these features following construction.

Post Construction Waterbody Monitoring

Enbridge proposes to monitor each waterbody annually for a period of five years post construction to identify potential additional reclamation measures due to sparse bank vegetation, unstable banks or observed erosion of stream banks, and/or stream elevation differences (higher/lower streambed over the ditchline). This information will be compared to baseline data collected prior to construction, including:

- civil survey elevation information along the proposed centerline of each stream starting and extending approximately 50 feet back from the top of each stream bank (where stream depth and velocity allows for safe access);
- additional photographs documenting upstream, downstream and of each bank crossing at the proposed centerline;
- visual assessment of streambed characteristics (observed streambed materials and characteristics such as gravel, cobble, riffles, pools);
- visual assessment of fish habitat such as undercut banks, instream structures (e.g., logs), potential spawning gravel; and
- visual evidence of bank erosion at or near the proposed centerline crossing

During the first year of post-construction monitoring, Enbridge will evaluate each open cut (wet trench) and/or dry crossing and visually compare stream conditions to preconstruction baseline information to determine if post-construction conditions are similar to pre-construction conditions. Additionally, Enbridge will assess the progression of bank revegetation and document any restoration site concerns. If differences are identified during the post construction monitoring of waterbodies, Enbridge will coordinate with the respective agencies to develop a site-specific restoration/reclamation plan. Enbridge's Operations will also conduct frequent aerial patrols of the pipeline right-of-way in accordance with federal frequency requirements. Aerial patrol personnel are trained to look for potential erosion and/or changes at streams that could affect the pipeline such as scouring, new beaver dam impoundments, or similar changes. If identified during aerial patrols, Enbridge would dispatch ground personnel to investigate the locations further.

Post Construction Wetland Monitoring

Enbridge's proposed wetland monitoring plan will evaluate success of wetland revegetation within disturbed areas associated with pipeline construction as well as observed for changes to adjacent wetland areas potentially associated with alternation of natural surface or subsurface drainage conditions. These observations will include identifying upslope ponding or changes to wetland vegetation potentially due to pipeline construction as well as observing potential hydrology and vegetation changes downslope due to altered hydrology. As with waterbodies, if such situations are identified during the post construction monitoring of wetlands, Enbridge will coordinate with the respective agencies to develop a site-specific restoration/reclamation plan.

Enbridge understands that the USACE may request additional baseline data at select wetland locations to document groundwater information upslope and downslope of the proposed pipeline centerline in wetlands that have been documented as having groundwater discharge. Collection of additional baseline information may include the installation of groundwater monitoring wells prior to construction. Enbridge will continue to coordinate with the USACE on the potential need for groundwater monitoring wells and locations. Where groundwater monitoring wells may be requested, Enbridge would attempt to acquire landowner permission for installation of the wells and associated access. Each location would be recorded using GPS.

Data Request Question 8: *Please provide additional information and analysis regarding the potential for proposed regulated activities to cause degradation by disrupting life stages of aquatic life, fish spawning, and wildlife dependent on these systems. Describe how an evaluation of baseline conditions and post-construction restoration and monitoring at waterbody crossings would inform measures taken to minimize the potential for construction-related effects on the biological characteristics of the aquatic ecosystem, including fish, crustaceans, mollusks, and other aquatic organisms and other wildlife. As appropriate, your response should include a discussion about potential for habitat fragmentation and any potential synergistic effects to species which use riverine and riparian areas. Attachment N of Environmental Impact Report (Revised August 2020 EIR) provides typical stream restoration examples. Please provide additional information that describes which restoration method you propose to utilize for each Corps-regulated waterway crossing. Use site-specific crossing plans for waterways that illustrates the baseline condition of each waterway (bank height, bank width, water depth) to inform how the streambed and banks would be restored post-construction.*

Data Request Question 8 Response

Sediment and Turbidity

As discussed in Enbridge's application materials and supplemental information, increased sedimentation and turbidity can displace and impact fisheries and aquatic resources. Suspended sediments can adversely affect submerged macrophytes by reducing light available for photosynthesis by plants. Suspended sediments settling out on the bottom of waterbodies can cover spawning beds and other habitats as well as smother fish eggs and benthic biota. Sediment deposition onto streambeds can alter stream bottom characteristics such as converting sand, gravel, or rock substrate to finer grain materials. Habitat alterations can reduce juvenile fish survival, spawning habitat, and benthic community diversity and health. Increased turbidity can also temporarily reduce dissolved oxygen levels in the water column and reduce respiratory functions in stream biota. Turbid conditions can also reduce the ability for biota to find food sources or avoid prey, and cause physiological effects in fish, such as gill clogging. The extent of impacts from sedimentation and turbidity would depend on sediment loads, stream flows, stream bank and streambed composition, sediment particle size, and the duration of the disturbances (EPA, 2003).

However, few studies have evaluated the effects of pipeline crossings on aquatic ecosystems. Moreover, the papers that have been published specific to pipeline construction, such as Reid and Anderson, 1999, have generally looked at the effects of open cut (wet trench) crossings not the more protective methods proposed by Enbridge for crossing flowing waterbodies. Still, these investigations are useful for extrapolating some conclusions regarding the potential impacts of the proposed pipeline.

The majority of aquatic effects associated with pipeline construction are the result of instream construction and the erosion associated with runoff of disturbed soils from adjacent uplands, both of which can increase the suspension and downstream deposition of sediment in watercourses. The documented downstream effects of open cut (wet trench) crossings include increases in embeddedness of the streambed and changes to streambed composition and channel morphology. Other potential pipeline impacts include alteration of the habitat at the crossing location as a result of trenching and backfilling and associated changes in bank composition and riparian vegetation.

Reid and Anderson, 1999 evaluated the effects of 27 open cut (wet trench) waterbody crossings. They reported that suspended sediment levels increased rapidly with the onset of instream construction and peaked during trenching (in some cases in the range of several thousand mg/L,), and to a lesser degree during blasting and backfilling. The increase in suspended sediment resulting from pipeline construction depends on the size and flow of the waterbody, the bed material, and sediment particle settling rate (Long *et. al.* 1998). Narrow waterbody crossings are completed more quickly and disturb less bed material than the crossings of wider waterbodies. Low flows can result in minimal dilution and high suspended sediment concentrations but also minimal downstream transport and deposition of sediments. Streambeds comprised primarily of clay and silt sized particles can generate persistent plumes of high turbidity. Alternatively, sediments from disturbed beds consisting of large particles of gravel and sand settle out downstream close to the construction area.

Although not consistently reported, some studies have also reported reductions in the abundance of benthic invertebrate and fish communities have been observed downstream of open-cut (wet trench) pipeline waterbody crossings. Reid and Anderson, 1999, suggested that these observed effects were likely the result of emigration of organisms out of the affected downstream areas and reduction in the suitability of habitat due to sedimentation associated with the use of open-cut crossings.

Given the use of dry crossings for the Project, any increase in the concentration of suspended sediment concentration and downstream deposition of sediments as a result of pipeline construction would be short term. The increases in suspended sediment would be primarily limited to the period of instream construction and multiple post-construction monitoring studies of downstream streambed conditions have found that sediments deposited downstream as a result of pipeline construction are completely removed within 6 weeks to 2 years of construction.

Any effects on benthic and fish communities are also expected to be short term. As reported by Reid and Anderson, 1999, where these effects are seen, they are typically transient and most studies have reported recovery to post-construction conditions within one year of construction.

Given that Enbridge proposes to avoid open cut (wet trench) crossings and will cross most streams using a substantially less impactful dry crossing technique, Enbridge does not anticipate any substantial, widespread, or long-term effects on benthic invertebrate or fish communities.

To mitigate these potential impacts, Enbridge would only conduct open cut (wet trench) crossings without installing dams for waterbodies that are dry (no water present) or that have no perceptible flow. Open cut crossings that are dry at the time of construction would have no downstream migration of sediment associated with construction of the crossing as no flowing water would be present. Enbridge will cross waterbodies that have perceptible flow using either a trenchless or dry crossing method.

Several factors can influence the effectiveness of dry crossing techniques, the levels of sediment and turbidity produced are typically short term and minor. As described in response to Question 5, Enbridge hired RPS to complete a Sediment Discharge Modeling Assessment, a copy of which has been provided to the USACE under separate cover. The results of RPS' modeling evaluation support the findings of earlier studies that some downstream sediment transport may occur during waterbody crossings, but the effects will be of short duration and minor. As described in the Sediment Discharge Modeling Assessment, Enbridge's use of dry trenched crossing methods will result in short term periods of sedimentation during the installation and removal of temporary dams, but much of the effect would be of shorter duration and result in lower downstream sediment concentrations than open cut (wet trench) crossings. RPS predicted that TSS concentrations for dry crossings 500 to 1,000 m downstream of the installations would be on the order of <1 to 30 mg/L for a small watercourse and <1 to 10 mg/L for a medium watercourse. RPS also concluded that the proposed dry crossing installation activities would have a lower magnitude and shorter duration effect on TSS in the water column than natural storm-related events, which can cause TSS values to exceed hundreds to thousands of mg/L over periods of time that are longer than these installation periods. The RPS modelling results also indicate that no deposition greater than 5 mm would occur downstream of dry crossings. In small watercourses the majority of sediment deposition would be less than 5mm in depth and would travel no farther than 17 m downstream of the installation site. In medium watercourses, RPS' modelling predicts that depositions above 5 mm would extend, at most, 3 m downstream of the crossing, and that the majority of deposition would occur within 30 m downstream of the installation site.

The likely range of effects on aquatic resources in the Project area are also discussed in the Sediment Discharge Modeling Assessment. Additionally, the impacts can be approximated by applying the predicted suspended sediment to the Newcombe and Jensen, 1996, model. Results from this model suggest a very low probability of fish mortality from construction, with local crossing area impacts consisting of mostly sublethal effects (e.g., short-term physiological stress and reduction of feeding), and limited habitat degradation.

Since Enbridge will restore the bed and banks using native material, the sediment flush is anticipated to be similar to natural stream conditions following a rain event. Between the dams of dry crossings and in non-flowing waterbodies where standing water is present, it is anticipated that there would be increased turbidity and sedimentation in the crossing vicinity, potentially decreasing the dissolved oxygen if standing water is present, and potentially suffocating eggs and larvae of aquatic species and benthic invertebrates. These effects could temporarily degrade the quality of the habitat in the immediate crossing area, making it unsuitable for spawning and rearing activities. However, because there is no flow, these effects would be localized to the trench area and are not expected to extend downstream of the crossing locations. Moreover, based on previous studies, Enbridge expects the areas directly impacted within the construction workspace will be rapidly recolonized as a result of emigration and new egg deposition from adults within days to months (Brooks and Boulton, 1991; Matthaei and Townsend, 2000)

Blasting

Blasting may be necessary in some waterbodies where there is shallow bedrock. As discussed above, blasting has the potential to increase sedimentation, although not to the extent of trenching. It can also have direct impacts on aquatic organisms in the vicinity of the blast. The direct effects of blasting on aquatic biota varies by species (Yelverton et al., 1975), but include death generally for relatively small organisms and higher mortality for those close to the blast or near the sediment surface (Yelverton et al., 1975; Munday et al., 1986). Non-lethal effects may include eye distension, hemorrhage, hematuria, and damage to bodily systems (Hastings and Popper, 2005; Godard et al., 2008; Carlson et al., 2011; Martinez et al., 2011).

Enbridge will implement its *Blasting Plan* to minimize impacts on aquatic species. Additional details regarding the measures of this plan were included in Enbridge's application and are described in response to Data Request Question 7. In addition to the plan, Enbridge has committed to conducting blasting under no flow conditions or where flow is present after the upstream and downstream dams (see the dry crossing methods) are installed and the area to be blasted is isolated. Enbridge will also be utilizing matting to minimize noise and vibration and will adhere to the time of year restrictions and/or waivers where applicable.

Loss of Streambank Cover

Streamside vegetation, large woody debris, rocks, undercut banks, high flow channels, and floodplains collectively form riparian habitat. Riparian habitat provides valuable structure and opportunities for fish and stream biota. Both open-cut and dry crossing (trenching) methods will temporarily remove some of this habitat and potentially cause locally elevated water temperatures and reduced levels of dissolved oxygen, making the locations less suitable for aquatic biota. Consequently, fish and other stream biota will likely be displaced to similar habitat upstream or downstream of the pipeline crossing.

As previously stated, Enbridge proposes to limit the clearing of riparian trees and other vegetation to include only what is necessary to safely construct and operate the pipeline. Enbridge designed the proposed workspace to minimize impacts on riparian vegetation by narrowing the width of its standard construction right-of-way at most waterbody crossings to 95 feet. Enbridge is also proposing to use the HDD and Direct Pipe methods at several waterbodies, which will further reduce the width of clearing adjacent to these waterbodies. After construction is complete, streambeds and banks will be stabilized and restored to preconstruction conditions to the fullest extent possible using native materials. Streambed structures such as rock and gravel will be returned to the stream, and the stream banks will be revegetated. It is expected that streambed biota, such as invertebrates that serve as food sources for fishes, will recolonize the affected areas within days to months (Brooks and Boulton, 1991; Matthaei and Townsend, 2000), although the recolonization for some species could take longer (Wallace, 1990). Additionally, Enbridge will only maintain a 50-foot-wide easement in herbaceous vegetation following construction. The remaining temporary workspace will be allowed to revegetate, permitting the re-establishment of woody vegetation. This will limit the overall long-term impacts associated with loss of riparian habitat to a small portion of each stream, reducing longer term negative effects to aquatic biota and wildlife dependent on these systems.

Changes to Channel Morphology

Where open cut methods are utilized, trenching and backfilling will impact the bed and banks of waterbodies. These effects are expected to be temporary, however, longer term alterations to channel morphology have been reported at some pipeline crossing locations (Reid and Anderson 1999). These included increased channel width and reduced water depth at the crossing location, and meanders 2 to 4 years after construction. Enbridge will minimize the risk for longer term effects by employing BMPs during construction including reestablishing as near as practicable the original elevation and contours of the bed and banks and installing erosion controls and revegetating disturbed areas to stabilize stream banks and adjacent areas. Enbridge will also conduct post-construction monitoring to evaluate the success of stream bed and bank restoration (see Monitoring Plan). Any adverse changes that are observed will be documented and any changes that are determined to be a risk to the pipeline or environment will be rectified.

Habitat Fragmentation

The clearing of vegetation and creation of a pipeline right-of-way will fragment forest, riparian, and aquatic habitats. Enbridge provided additional information regarding potential forest fragmentation in its comments to the WDNR's *Draft Environmental Impact Statement* (comments submitted on April 15, 2022). Enbridge is providing those comments to the USACE as Attachment 8-A. The fragmentation of riparian habitats (including wetlands) will be similar to those described in the April 15, 2022, comments. The fragmentation of aquatic habitats will be minor and limited in size and duration. As described above, the open cut (wet trench) and dry crossing construction methods will directly impact the bed and banks of waterbodies. These methods have the potential to increase the suspension and downstream transport of sediments, and the potential for erosion in adjacent areas. These effects, in turn, could contribute to the temporary fragmentation of aquatic habitat. However, as described above, Enbridge's proposed crossing methods and mitigation measure including the restoration of streambed and banks, will minimize the scale (affected area) and duration of aquatic habitat fragmentation.

Aquatic and Terrestrial Nuisance and Invasive Species

The introduction or transfer of aquatic invasive species from one waterbody to another is a risk when using the same equipment in multiple waterbodies or when equipment travels through multiple waterbodies. The introduction of aquatic invasive species has the potential to change the health and natural diversity of watersheds within the Project area. Enbridge will control the potential transport of invasive aquatic species through adherence to federal and state-specific regulations for preventing the land transport of such species, by primarily utilizing municipal sources for HDDs, hydrostatic testing, and dust control, and, where sourced from surface waters, by discharging hydrostatic test waters into well vegetated upland areas. As described in response to Question 12, only one of the waterbodies affected by the Project has been documented to contain aquatic invasive species. Specifically, Tyler Forks, has been documented to contain the Banded Mystery Snail (*Vivaparus georgianus*). Enbridge proposes to cross this waterbody using the HDD method and to install a clear span bridge; therefore, no equipment is expected to come into contact with the water as part of pipeline installation. Enbridge has proposed Tyler Forks as a source for hydrostatic test water appropriation. Water withdrawn from Tyler Forks will be discharged into an upland discharge structure near Tyler Forks and will not be discharged into other streams. Infested waterbodies will be addressed in accordance with the language provided in Section 4.0 of Enbridge's EPP and Invasive and Noxious Species Management Plan ("INS Plan") (Attachment 8-B).

A stated in response to Data Request Question 12, Enbridge conducted field surveys and documented 23 different invasive species along the survey corridor. Enbridge will control invasive terrestrial and riparian species in accordance with its INS Plan and the language provided in Section 4.0 of Enbridge's EPP. Specific measures of this plan include : identification of infested areas; pre-treatment controls (application of herbicide, hand pulling, or mechanical measures such as mowing); cleaning of equipment prior to arrival at the construction site; using timber mats where appropriate to prevent equipment from contacting and picking up and transporting invasive plants; segregating topsoil in all infested areas; using weed-free erosion control materials; conducting routine monitoring; and restoring disturbed areas following installation of the pipeline. These measures will promote the establishment of desirable plant species and deter the spread of invasive plant species.

Spill Prevention, Control, and Countermeasures

Accidental spills of construction-related fluids (e.g., oil, gasoline, or hydraulic fluids) into waterbodies could result in water quality impacts that affect fish and other aquatic organisms in adjacent streams, if present. The potential impact would depend on the type and quantity of the spill, and the dispersal and attenuation characteristics of the waterbody. An inadvertent release of fuel or equipment fluids could have acute impacts on fish and aquatic species including direct mortality, altered behavior, changes in physiological processes, or changes in food sources. In turn, ingestion of large numbers of contaminated fish or aquatic species could impact other species located higher in the food chain that prey on this biota.

To reduce the potential for surface water contamination and resulting impacts on aquatic life, Enbridge will implement the measures in its EPP, which include BMPs to minimize the potential for accidental releases and measures that would be implemented to clean up any releases. Some of these BMPs include conducting routine inspections of construction equipment, tanks, and storage areas to help reduce the potential for spills or leaks; restricting refueling and the handling of hazardous materials to greater than 100 feet from wetland and waterbody resources; and the use of secondary containment around all containers and tanks.

Streambank Restoration Methods

Enbridge's proposed streambank restoration measures are described in the Environmental Information Report ("EIR"). Table 1 in Appendix N of Enbridge's August 28, 2020, supplements the EIR references specific figures depicting the streambank restoration methods for 12 waterbodies. The streambank restoration method for all other waterbodies except those that will be crossed by trenchless methods will be in accordance with Figure 6 of Appendix N. The baseline conditions that were recorded for each of these waterways during Enbridge's field delineations is included on the table that is part of Enbridge's response to Data Request Question 3. Enbridge has also prepared site-specific profile drawings for perennial waterbodies crossed by the pipeline centerline using a dry crossing technique (Attachment 8-C).

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Data Request Question 9: *Describe whether riprap or other fill material would be permanently discharged below the ordinary high-water mark of waterways for post-construction restoration as such discharges require permit authorization.*

Data Request Question 9 Response:

As indicated in Enbridge's application materials, after the pipeline is installed Enbridge will:

- restore streambeds as near as practicable to its pre-construction condition, with no impediments to normal water flow; and
- restore the streambanks as near as practicable to pre-construction conditions, unless the original slope is determined to be unstable.

It is Enbridge's intent to restore streambed and streambanks as near as practicable to preconstruction conditions using native material excavated from the bed and banks of each waterbody. Once the bank is reestablished, the disturbed areas will be seeded in accordance with Enbridge's EPP and stabilized with erosion control blanket material. If native bank material is determined not to be suitable for reconstructing the banks due to soil properties, instability, or potential for significant bank erosion, Enbridge may stabilize disturbed streambanks with rock riprap or other bank protection methods, with appropriate agency approval.

Enbridge provided typical stream restoration drawings along with its August 2020 application update materials (see Attachment N of the August 2020 EIR). Attachment N of the Environmental Impact Report includes a table (Table 1) listing locations where Enbridge anticipates the need for either riprap or other bank bioremediation methods based on an engineering field review of each crossing. Enbridge has developed site-specific drawings for final stabilization at these locations (see Attachment 9-A). Additional waterbodies may require enhanced bank stabilization methods depending on site-specific conditions at the time of construction. If additional enhanced bank stabilization methods are necessary, Enbridge will coordinate with the respective agencies to determine the most appropriate stabilization method.

Data Request Question 10: *Our review of wetland functional assessments in the field have revealed that portions of the proposed route are located within high-quality forested wetlands or wetland complexes with apparent groundwater discharge, such as springs and seeps. Please identify all areas where pipeline installation is proposed in these wetland types and hydrogeologic settings and evaluate where adjustments to the route alignment could avoid or minimize construction-related effects to these areas. We are happy to meet with you to discuss any questions about locations we have identified in our review. The evaluation provided to our agency must describe the practicability of realigning, including opportunities for use of non-aquatic areas and other aquatic areas with less adverse impact, considering logistics, technical feasibility, and cost. Where your analysis indicates route adjustments cannot be made to avoid or minimize regulated construction activities in high-quality forested wetlands and/or groundwater discharge wetlands, you must describe actions to minimize potential primary and secondary effects resulting from construction-related activities. Describe how baseline and post-construction vegetation and hydrology monitoring upgradient and downgradient of proposed pipeline crossing would inform the need for corrective action or additional compensatory mitigation.*

Data Request Question 10 Response:

Locations of High-quality Forested Wetlands or Wetland Complexes with Apparent Groundwater Discharge

Enbridge conducted wetland and waterbody surveys during the 2019 and 2020 field seasons following the methodology described in the 1987 US AC E Wetlands Delineation Manual[14] and Regional Supplement for the Northcentral and Northeast Region[15]. Wetland delineations involved collecting sample transects from upland to wetland and recording this information on standardized wetland determination data forms. Additionally, each collected wetland sample point was classified using the Cowardin system, a simple hierarchical national classification system. The community mapping of the wetland features was also based on the assigned Cowardin classification. A secondary classification was also assigned for each wetland sample point using the Eggers and Reed[16] classification system. The latter system is much more specific than the Cowardin system, focused on wetland plant communities of Minnesota and Wisconsin. However, the Eggers and Reed classification system is broad compared to other relevant classification systems, such as the native plant community classification system used in Wisconsin[17].

The wetland determination data forms specifically reference the area being sampled. However, this measure alone does not address the condition and functional value of that sample area or the entire feature. As such, field crews evaluated each wetland using the Wisconsin Wetland Rapid Assessment

[14] Environmental Laboratory. (1987). "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

[15] U.S. Army Corps of Engineers. 2011. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, C. V. Noble, and J. F. Berkowitz. ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

[16] Eggers S. D., Reed D. M., Reed D. M. 2015 Wetland Plants and Plant Communities of Minnesota and Wisconsin, Version 3.2. U.S. Army Corps of Engineers, St. Paul District.

[17] Epstein, E.E. 2017. Natural communities, aquatic features, and selected habitats of Wisconsin. Chapter 7 in The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131H 2017, Madison

Methodology ("WSRAM")[18], determining the functional value, floristic integrity, condition assessment of the wetland assessment area and buffer, and assessment of potential impacts. The floristic integrity assessment was focused on primary questions pertaining to invasive species cover, strata, Natural Heritage Information plant community ranking, and relative frequency of the plant community within the watershed. Excluded from this assessment was the optional documentation of vascular plant species and cover/abundance.

Enbridge completed additional vegetation surveys during the 2022 field season on a subset of wetlands within the current Project area to expand the assessment of floristic integrity. This subset of wetlands was restricted to those that ranged in quality from moderate to high based on the data collected during the initial wetland delineation field efforts (2019-2020). This report is provided under separate cover.

Enbridge would like to meet with the USACE to discuss the data that has been collected regarding high quality wetlands/wetland complexes with apparent groundwater discharge. Following this meeting, Enbridge will prepare a set of maps and associated tables of these areas.

Potential for Workspace Adjustments or Route Realignments

The proposed Project will cross an area of Wisconsin with numerous and large wetland systems. As previously stated in Enbridge's application materials and supplemental information filings, it is not feasible to avoid all wetland and waterbody impacts associated with construction of a linear project such as the proposed Project. Enbridge's evaluation of major route alternatives demonstrates this fact. As described in its application materials, Enbridge evaluated a number of different routes in order to select the proposed route. Enbridge did not field delineate these alternative routes but did conduct desktop analyses, which indicate that all of these other routes cross and would impact a substantial number of wetlands. Given the preponderance of forested wetlands in the region, the wetlands affected by these other routes would include many high-quality forested wetlands.

After selecting the proposed route as environmentally preferable to other major route alternatives, Enbridge conducted extensive wetland and waterbody field surveys along a corridor encompassing the proposed alignment. The corridor evaluated by these field surveys (which was typically between 300 and 500 feet wide) was intentionally wider than the proposed workspace. Enbridge attempted to minimize resource disturbance within this corridor to the extent practicable and adjusted the proposed route where feasible and agreeable by the landowners. Enbridge also modified and reduced construction workspace where practicable to avoid sensitive wetland resource while still maintaining adequate room to safely construction the Project. Where impacts could not be avoided, Enbridge will minimize impacts through BMPs and implementation of its EPP. Enbridge has also developed a Compensatory Wetland Mitigation Plan ("Mitigation Plan") to offset both permanent and temporary wetland impacts. Enbridge believes that the proposed route provides the least environmentally damaging practicable alternative. Route and/or workspace modifications on minimize impacts to specific resource areas would likely shift impacts to other sensitive resource areas, and increase the overall length of the route. This would increase the acreage of land disturbed and the duration of construction. Any changes to the route would also require initiating new landowner approvals (Enbridge has secured all required landowner approvals for the proposed route), require new surveys if there is workspace beyond the existing survey corridor, increase overall Project costs, and result in Project delays.

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18 https://dnr.wisconsin.gov/topic/wetlands/methods.html#:~:text=The%20Wisconsin%20Wetland%20Rapid%20Assessment,wetland%20performs%20a%20given%20function. Accessed December 2022.

Actions to Minimize Potential Primary and Secondary Effects Resulting from Construction-related Activities

The primary impact of pipeline construction and right-of-way maintenance activities on wetlands is the temporary removal of wetland vegetation during active construction and the conversion of forested and shrub-scrub wetland vegetation to emergent wetland vegetation within the permanent right-of-way. Pipeline construction also requires soil disturbance associated with excavation, installation, and backfilling of the pipeline ditch. There is also a potential for impacts on groundwater-surface water hydrology particularly in the vicinity of blasting, or as a result of changes in topography. These effects would be greatest during and immediately following construction and most, with the exception of vegetation and habitat impacts, will cease after the trench is backfilled, contours are restored, and erosion controls are installed. Longer term impacts include the conversion of forested and shrub-scrub wetland to emergent wetland within the permanent easement.

Upon completion of construction, Enbridge will revegetate disturbed areas in accordance with the EPP unless otherwise directed by landowners or land managing agencies. Timely restoration of the construction right-of-way and reseeding with an appropriate seed mix will minimize the duration of vegetative disturbance. Active revegetation measures and rapid colonization by annual and perennial herbaceous species in the disturbed areas will restore most vegetative cover within the first growing season. Enbridge will allow woody shrubs and trees to recolonize the temporary construction right-of-way and extra workspaces as described in the EPP. As natural succession proceeds in these areas, the early successional or forested communities present before construction will eventually reestablish. Enbridge will also employ BMPs to control the introduction and spread of noxious weeds and invasive plant species as described in the EPP and Invasive and Noxious Species Management Plan. The Project will result in the permanent conversion of forested and shrub-scrub wetlands to emergent wetland within the maintained easement for operational purposes, including facilitating aerial inspections, preserving pipeline integrity, and providing access for maintenance or emergency work in compliance with federal regulations.

Enbridge will minimize impacts on adjacent vegetation through adherence to soil erosion control measures and by confining clearing activities to the approved Project workspaces. As stated in Enbridge's application materials, Enbridge has reduced the width of the construction right-of-way from 120 feet to 95 feet wide in wetlands, where practicable based on site-specific conditions

To protect wetland soils, Enbridge will install construction matting (where necessary) and/or use low ground weight equipment to minimize the potential for soil mixing (rutting) and compaction. Enbridge also proposes to segregate up to 1 foot of topsoil over the trench line in unsaturated wetlands. Segregated topsoil, which contains native seeds and root stock, will be stored separate from other spoil materials and will be spread over the disturbed area following trench backfilling. During backfilling, efforts will be taken to restore the natural ground contour and restore surface drainage patterns as close to preconstruction conditions as practical. To minimize the potential for preferential subsurface water flow along the backfilled ditchline, Enbridge will install trench breakers within the trench at wetland-upland boundaries prior to backfilling. These efforts will restore the natural hydrology to the wetland as well as to adjacent, undisturbed wetlands.

Proposed Monitoring to Inform the Need for Corrective Action or Additional Compensatory Mitigation

Enbridge has developed a Monitoring Plan to assess the success of restoration efforts following completion of construction activities. As part of the Monitoring Plan, Enbridge will visit each wetland affected by the Project during the first growing season after construction. Enbridge will record general conditions in each wetland including: presence and distribution of hydrophytes and estimated cover; presence/absence of invasive species and estimated cover; natural indicators such as wildlife observations (incidental); visual evidence of rutting, compaction, or erosion; status of erosion controls; elevation changes; off-road vehicle activity; and other third-party disturbances[19]. Enbridge will take representative photographs in each wetland to document first year post-construction conditions.

In addition to the collection of the baseline information described above, Enbridge will establish 1-meter by 1-meter random plot locations (1-meter quadrat locations to be selected by field personnel during the first monitoring season) in 50 percent of the low and medium functional value wetlands, and in all of the high functional value wetlands. The exception would be in wetlands located between the HDD entry and exit points where Enbridge reduced the construction right-of-way to 30 feet and activities were restricted to only vegetation clearing, which will be maintained as part of the permanent easement, for these areas, Enbridge will conduct only a post construction walk-over inspection. No plots would be established in these wetlands.

The location of each plot will be recorded by GPS and marked on aerial photographs in order to maintain consistent plot locations for the duration of the monitoring program. The same plots will be assessed each year, generally around the same time of year. At a minimum, one plot will be established for approximately every half-acre of affected wetland in the right-of-way. For example, a wetland that is between 0 and 1.0 acre in size will have at least two plots; a wetland that is at least 1.0 acre but less than 1.5 acres in size will have at least three plots; and a wetland that is at least 1.5 acres but less than 2.0 acres on the right-of-way will have at least four plots.

The species within each plot will be identified and recorded and the dominant species will be noted. Hydrologic indicators will be identified and the presence/absence of invasive species within the plot will be documented. Where forested wetlands are allowed to regenerate naturally, tree regrowth or natural recruitment will be documented on data sheets. The percent cover for each species, as well as the total percent cover by native hydrophytes, total percent cover for the entire plot, and relative percent of native hydrophytes will be estimated.

Additional Measures in High Functional Value Wetlands

In addition to the data collection discussed above, timed-meander surveys will be conducted in high functional value and medium functional value with high floristic quality wetlands, as well as select wetlands adjacent to Areas of Special Natural Resource Interest (“ASNRI”) waterbodies. The field surveyors will select an assessment area within each wetland that is representative of the wetland overall. Within this area, the surveyors will conduct the timed-meander survey. This will involve identifying within a specified amount of time the plant species within each assessment area and categorizing each species relative abundance (e.g., abundant, common, occasional, uncommon, rare) and percent areal cover within the assessment area.

Data will be recorded on data forms that will be used along with photographs to document the progress of restoration and compare previous seasons of monitoring. Sample data forms are provided in Appendix B.

[19] Other third-party disturbances could include excavations, filling, tree clearing, and livestock grazing.

Seeps and Groundwater Discharge Wetlands Where Blasting Occurred

Prior to the start of construction, Enbridge will work with the respective agencies to identify select wetlands to install monitoring wells upslope and downslope of these types of wetlands where blasting is anticipated.

Monitoring wells will be installed in nests to allow for the determination of groundwater flow direction and to assess if there are changes in groundwater conditions upgradient and downgradient of the pipeline. Each nest will consists of at least 3 monitoring wells installed in a triangular pattern with at least one of the monitoring wells located on the opposite side of the pipeline. It is anticipated that the monitoring wells will be constructed of 2-inch, 10-slot, screened polyvinyl chloride ("PVC") or stainless-steel pipe with a point (for direct push of the well into the soil) equipped with a 2-inch solid riser. Either the riser pipe or the expandable plug is vented to allow atmospheric equilibrium to develop in the well.

Wells will be monitored using non-vented, pressure-based loggers (e.g. In-SiteTM or HOBO®), installed in the wells and programmed to record absolute pressure at 1-hour intervals. Barometric pressure data will be collected using pressure-based loggers programmed to record absolute pressure at 1-hour intervals installed in an above-ground vented well riser. One barometric pressure logger will be installed in a monitoring well at each of the following milepost monitoring ranges: 996.0-996.1; 1074.7-1075.0; and 1105.1-1105.9. Water levels will be measured manually by a water level meter (e.g., Solinst®) at least bi-annually during installation and retrieval of the water level loggers from the monitoring wells. The wells will be resurveyed on an annual basis.

Data loggers will be installed following spring thaw and retrieved after the end of each growing season. Enbridge will continue to collect data on an annual basis during construction and post-construction during the frost-free period or until the performance standards have been met and reviewed by the applicable agencies. Where performance standards at specific sites have not been met by year 5 of monitoring, Enbridge, in consultation with the agencies, may extend monitoring at those sites.

During each monitoring visit, Enbridge will photograph and record the locations of each groundwater seep/discharge and wetland blasting area and note the hydrological characteristics of each area. Any seep or discharge that cannot be relocated will be noted, and any wetland, seep or discharge that has moved or exhibits modified hydrology compared to baseline information will be recorded and described.

Enbridge will continue to monitor the revegetation of affected wetlands annually for up to 5 years to assess wetland restoration, as described in the Year 1 Post Construction Monitoring effort. Wetland monitoring during years 3 and 5 will also focus on both landscape level and on-the-ground assessments of whether hydrology on and the off-right-of-way are similar and consistent with the baseline conditions identified during pre-construction field surveys. Enbridge will also revisit any areas of crowning or subsidence, or other sites identified during years 1 and 3 monitoring where restoration did not meet the performance standards established in Section 3.8. If possible the subsequent monitoring will be performed during the same season/time of year as the Year 1 monitoring.

Wetland Success Criteria

Wetland restoration shall be considered successful if all of the following criteria are satisfied:

- vegetation in the monitored wetland is at least 70 percent of either the baseline cover documented in the wetland prior to construction, or at least 70 percent of the cover in adjacent unaffected wetland areas;
- there is no evidence of adverse changes to baseline hydrology and drainage;

- wetland topography is restored to baseline conditions and similar to the topography of adjacent undisturbed wetland areas;
- the percent cover of invasive species within the construction workspace is similar to or less than the percent cover in adjacent undisturbed areas outside of the construction workspace and within the same community type.
- if natural rather than active revegetation was used, the plant species composition and distribution is consistent with early successional wetland plant communities in the affected ecoregion; and
- the presence, density, and distribution of invasive vegetation species is less than or similar to pre-construction baseline conditions.

Post-Construction Restoration and Corrective Actions

Enbridge will work closely with the USACE and the WDNR to determine success or additional steps if performance standards are not reached after the planned monitoring is completed. Post-construction restoration activities will be adaptive, based on the results of monitoring, changing site conditions (e.g., land use) and geared toward the final goal of restoring pre-construction characteristics of the resource (i.e., vegetation and hydrology). In determining whether corrective action is needed, Enbridge will evaluate the potential resource impacts from conducting the additional restoration compared to taking no action with continued monitoring.

Not every potential corrective action can be determined at this time but possible corrective measures that may need to be implemented include:

- Installation of additional erosion controls or sediment barriers to stabilize soils and capture or redirect runoff;
- Re-grading or re-contouring to address topography or hydrology issues;
- Implementation of integrated approaches to invasive or noxious weed infestations as outlined in Enbridge's Invasive and Noxious Species Management Plan and in accordance with Section 4.0 of Enbridge's EPP;
- Reseeding and/or the addition of soil amendments, or supplementing the original seed mix to meet success criteria;
- Supplemental plantings of tree and/or shrubs in selected areas to enhance stabilization or vegetation diversity.

Enbridge will address site stabilization issues that are identified during post-construction monitoring. Erosion and sediment control BMP deficiencies that have the potential to allow silt-laden water to enter wetlands or waterbodies will be prioritized and promptly addressed to prevent resource impacts. If the selected erosion and sediment control BMP is not effective at a particular location (e.g., continued failure), other solutions will be evaluated, such as re-contouring an area to alleviate a drainage flow pattern that is causing erosion or adding additional erosion and sediment control BMPs to divert drainage to a well-vegetated area.

Examples of topography or hydrology-related issues that may require additional restoration include: unexpected ponding, unexpected drainage, and/or disruptions to flow patterns causing changes in pre-construction wetland hydrology. Corrective actions, such as regrading or re-contouring, will be implemented if crowning, subsidence, or the restored grade is determined to be interfering with the goal of re-establishing vegetative communities according to the local eco-type, or pre-construction wetland hydrology including affects to adjacent undisturbed wetlands. Where such issues are identified, Enbridge will reference pre-construction baseline data including available pre-construction ground elevation data, vegetation data, and pre-construction photographs.

Corrective actions for unexpected alterations to groundwater flow related to changes in topography may include regrading or re-contouring. Actions that may require additional temporary impacts on a wetland or waterbody will be conducted according to pertinent permit requirements and in consultation with applicable agencies.

If the cover of invasive species within a particular community type is higher within the construction workspace compared to the percent cover of the same species in adjacent undisturbed areas outside of the construction workspace or within the construction workspace as documented by pre-construction surveys, Enbridge will manage the issue in accordance with its Invasive Species Management Plan.

Monitoring may determine that some areas have not successfully revegetated after the first growing season. Causes for seeding failure include poor germination or insufficient seeding take as a result of weather conditions, soil conditions, disturbance from cattle or wildlife, competition from invasive species, or erosion. Enbridge will reseed areas that are not adequately revegetated during the monitoring period. Changes in hydrology can also prevent successful restoration. If impacts on hydrology are identified, Enbridge will take actions to investigate the cause and restore the hydrology. Other actions may also be taken across Project areas that are not meeting the restoration goals include regrading to restore proper elevations, fertilizing low nutrient soils, decompacting soils, setting up exclusion areas to stop grazing or foraging, implementing Enbridge's Invasive Species Management Plan, and/or supplementing seed mixes.

Data Request Question 11: *As we have previously discussed with you, quantitative vegetation surveys must be completed in high-quality wetlands. The wetland functional assessments that you completed utilizing the Wisconsin Rapid Assessment Methodology (WSRAM) provides for a qualitative assessment of wetland quality. The quantitative survey information will inform post-construction restoration, monitoring, and compensatory mitigation requirements. We are happy to meet with you to discuss any questions about locations of these resources we have identified in our review.*

Data Request Question 11 Response:

As stated in Enbridge's response to Data Request Question 10, Enbridge conducted wetland and waterbody surveys during the 2019 and 2020 field seasons following the methodology described in the 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual[20] and Regional Supplement for the Northcentral and Northeast Region[21]. Wetland delineations involved collecting sample transects from upland to wetland and recording this information on standardized wetland determination data forms. Additionally, each collected wetland sample point was classified using the Cowardin system, a simple hierarchical national classification system. The community mapping of the wetland features was also based on the assigned Cowardin classification. A secondary classification was also assigned for each wetland sample point using the Eggers and Reed[22] classification system. The latter system is much more specific than the Cowardin system, focused on wetland plant communities of Minnesota and Wisconsin. However, the Eggers and Reed classification system is broad compared to other relevant classification systems, such as the native plant community classification system used in Wisconsin[23].

The wetland determination data forms specifically reference the area being sampled. However, this measure alone does not address the condition and functional value of that sample area or the entire feature. As such, field crews evaluated each wetland using the Wisconsin Wetland Rapid Assessment Methodology ("WSRAM")[24], determining the functional value, floristic integrity, condition assessment of the wetland assessment area and buffer, and assessment of potential impacts. The floristic integrity assessment was focused on primary questions pertaining to invasive species cover, strata, Natural Heritage Information plant community ranking, and relative frequency of the plant community within the watershed. Excluded from this assessment was the optional documentation of vascular plant species and cover/abundance.

Enbridge completed additional vegetation surveys during the 2022 field season on a subset of wetlands within the current Project area to expand the assessment of floristic integrity. This subset of wetlands

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[20] Environmental Laboratory. (1987). "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

[21] U.S. Army Corps of Engineers. 2011. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, C. V. Noble, and J. F. Berkowitz. ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

[22] Eggers S. D., Reed D. M., Reed D. M. 2015 Wetland Plants and Plant Communities of Minnesota and Wisconsin, Version 3.2. U.S. Army Corps of Engineers, St. Paul District.

[23] Epstein, E.E. 2017. Natural communities, aquatic features, and selected habitats of Wisconsin. Chapter 7 in The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131H 2017, Madison

[24] https://dnr.wisconsin.gov/topic/wetlands/methods.html#:~:text=The%20Wisconsin%20Wetland%20Rapid%20Assessment,wetland%20performs%20a%20given%20function. Accessed December 2022.

was restricted to those that ranged in quality from moderate to high based on the data collected during the initial wetland delineation field efforts (2019-2020). This report is provided as Attachment 11-A.

Enbridge would like to meet with the USACE to discuss the data that has been collected regarding high quality wetlands.

Data Request Question 12: *Executive Order 13112, as amended by Executive Order 13751, requires executive departments and agencies to take steps to prevent the introduction and spread of invasive species, and to support efforts to eradicate and control invasive species that are established. Therefore, we require that you provide an Invasive Species Management (INS) Plan that outlines management strategies to minimize the spread of INS identified within the proposed construction workspace and access roads. The INS Plan must outline management strategies that would be implemented prior to construction, during construction, restoration, and post-construction monitoring.*

Data Request Question 12 Response:

Enbridge conducted surveys in 2021 for state-listed invasive species, pursuant to the Wisconsin Chapter NR 40 Invasive Species Rule, within the Project's proposed workspaces including mainline workspaces, access roads, valve areas, and pipe yards. The surveys were specific to regulated plant species in the restricted category, which is a list of 63 species (Attachment 12-A). Enbridge also reviewed public information for other aquatic invasive species (non-vegetative) that are known to be present in waterbodies crossed by the Project. Sources reviewed by Enbridge include:

https://dnr.wi.gov/lakes/invasives/aisbywaterbody.aspx

Aquatic Invasive Species - Ashland County (wi.gov)

https://dnr.wi.gov/lakes/invasives/AISByWaterbody.aspx?location=26

Vegetation

Enbridge's field surveys document 23 different invasive vegetation species at over 900 locations throughout the survey area. The species, plant type, and number of observed occurrences are listed in Table 12-1.

Table 12-1

Invasive Species Occurrences

Scientific Name	Common Name	Plant Type	Occurrences
Aegopodium podagraria	Bishop's goutweed	Herbaceous	1
Alliaria petiolata	Garlic mustard	Herbaceous	4
Berberis thunbergii	Japanese barberry	Woody/Shrub	2
Campanula rapunculoides	Creeping bellflower	Herbaceous	2
Caragana arborescens	Siberian peashrub	Woody/Shrub	1
Centaurea jacea	Brown knapweed	Herbaceous	19
Centaurea stoebe	Spotted knapweed	Herbaceous	102
Cirsium arvense	Canada thistle	Herbaceous	165
Cirsium palustre	European marsh thistle	Herbaceous	9
Coronilla varia	Crown vetch	Herbaceous	12
Epipactis helleborine	Helleborine orchid	Herbaceous	3
Euphorbia esula	Leafy spurge	Herbaceous	9

Table 12-1

Invasive Species Occurrences

Scientific Name	Common Name	Plant Type	Occurrences
Frangula alnus	Glossy buckthorn	Woody/Shrub	36
Galeopsis tetrahit	Hemp nettle	Herbaceous	59
Lonicera complex	Non-native honeysuckles	Woody/Shrub	72
Lythrum salicaria	Purple loosestrife	Herbaceous	2
Myosotis scorpioides	Aquatic forget-me-not	Herbaceous	42
Pastinaca sativa	Wild parsnip	Herbaceous	15
Rhamnus cathartica	Common buckthorn	Woody/Shrub	160
Robinia pseudoacacia	Black locust	Woody/Shrub	4
Tanacetum vulgare	Tansy	Herbaceous	201
Typha complex	Hybrid cattail	Herbaceous	83
Valeriana officinalis	Garden heliotrope/Valerian	Herbaceous	18

Aquatic Invertebrates

Based on publicly available data, only one of the waterbodies that the Project crosses has been documented to contain an aquatic invasive species. This waterbody is Tyler Forks, which has been documented as containing the Banded Mystery Snail (*Vivaparus georgianus*). Enbridge proposes to cross this waterbody using the HDD method and to install a clear span bridge; therefore, no equipment is expected to come into contact with the water as part of pipeline installation. Enbridge has proposed Tyler Forks as a source for hydrostatic test water appropriation. Water withdrawn from Tyler Forks will be discharged into an upland discharge structure near Tyler Forks and will not be discharged into other streams. Enbridge's EPP contains best management practices to minimize potential impacts to aquatic species associated with water withdrawal.

Treatment and Control

The introduction of invasive species has the potential to change the health and natural diversity of watersheds within the Project area. As discussed in Data Request Response #8, the noxious weed infestations listed above will be addressed in accordance with its Invasive and Noxious Species Management Plan (see Attachment 8-B) and in accordance with Section 4.0 of Enbridge's EPP. Enbridge will control the potential transport of invasive aquatic species through adherence to federal and state-specific regulations for preventing the land transport of such species, by primarily utilizing municipal sources for HDDs, hydrostatic testing, and dust control, and, where sourced from surface waters, by discharging hydrostatic test waters into well vegetated upland areas within the appropriation source watershed.

Specific measures of this plan include: identification of areas with INS species; pre-treatment controls for those areas (application of herbicide, hand pulling, or mechanical measures such as mowing); cleaning of equipment prior to arrival at the construction site; using timber mats where appropriate to prevent equipment from contacting and picking up and transporting invasive plants; segregating topsoil in all areas with INS species; using weed-free erosion control materials; conducting routine monitoring;

and restoring disturbed areas following installation of the pipeline. These measures will promote the establishment of desirable plant species and deter the spread of invasive plant species.

To control the potential spread of Banded Mystery Snail Enbridge proposes to cross Tyler Forks using the HDD method and to install a clear span bridge; therefore, no equipment is expected to come into contact with the water as part of pipeline installation. Enbridge has proposed Tyler Forks as a source for hydrostatic test water appropriation. Water withdrawn from Tyler Forks will be discharged into an upland discharge structure near Tyler Forks and will not be discharged into other streams.

Post Construction Monitoring

Enbridge's Monitoring Plan (Attachment 12-B) describes Enbridge's proposed monitoring of wetlands for potential introduction and/or expansion of existing invasive vegetation. In accordance with the Monitoring Plan, Enbridge will record general conditions in each wetland including: presence and distribution of hydrophytes and estimated cover; presence/absence of invasive species and estimated cover; natural indicators such as wildlife observations (incidental); visual evidence of rutting, compaction, or erosion; status of erosion controls; off-road vehicle activity; and other third-party disturbances[25]. Enbridge will take a representative photograph in each wetland to document post-construction conditions.

Wetland restoration will be considered successful if all of the following criteria are satisfied:

- vegetation in the monitored wetland is at least 70 percent of either the baseline cover documented in the wetland prior to construction, or at least 70 percent of the cover in adjacent unaffected wetland areas;
- there is no evidence of adverse changes to baseline hydrology and drainage;
- wetland topography is restored to baseline conditions and similar to the topography of adjacent undisturbed wetland areas;
- if natural rather than active revegetation was used, the plant species composition and distribution is consistent with early successional wetland plant communities in the affected ecoregion;
- presence, density, and distribution of invasive vegetation species is less than or similar to pre-construction baseline conditions.

Enbridge will work closely with the WDNR and the USACE to determine success or additional steps if performance standards are not reached after the first three years of monitoring. Additional seeding and/or control measures may be conducted if deemed necessary to achieve restoration goals. Any seeding and control measures will be done in accordance with the EPP and permit requirements.

[25] Other third-party disturbances could include excavations, filling, tree clearing, and livestock grazing.

***Data Request Question 13**. In addition to the information requested above regarding route alignment adjustments, we request additional information on the initial alternatives analysis provided in Section 4 of the Supplemental Information in your application, along with Section 3 of the EIR. Please provide the following:*

***Data Request Question 13.a**. Address any changes to your analysis of the No Action Alternative since your application.*

Data Request Question 13.a. Response:

The No Action Alternative remains the continued operation of Line 5 along the existing route through the Bad River Reservation. Enbridge notes that litigation concerning Line 5's crossing of the Bad River Reservation remains ongoing. *See Bad River Band of the Lake Superior Tribe of Chippewa Indians of the Bad River Reservation v. Enbridge Energy Co., Inc., et al*., No. 3:19-cv-00602-wmc (W.D. Wis. July 23, 2019). As a result of its consideration of issues/arguments presented to it to date, the court has stated that it will not issue any order requiring the immediate shut down of Line 5 as a remedy for the Band's trespass claims. *See id*. at ECF No. 360 (Sept. 7, 2022) ("the court must deny the Band's request .as an immediate shutdown of the pipeline would have significant public and foreign policy implications"); (10/27/22 AM Trial Transcript at 13:16-13:18) ("it was clear I [am not] willing to consider an immediate shutdown of the pipeline ..."). A final order by the court remains forthcoming. Absent the court's forthcoming order directing otherwise, it is Enbridge's intention to operate Line 5 within the Bad River Reservation until the Relocation is placed into service.

***Data Request Question 13.b**. For system alternatives, address the potential for use of existing pipelines in combination with one another and with other transportation means (truck, rail), for conveyance of all or a portion of the substances transported in the existing Line 5.*

Data Request Question 13.b. Response:

There are no existing pipelines (whether used with one another and/or in combination with other transportation modes) to transport all of the petroleum products carried by Line 5 from Superior, Wisconsin to Sarnia, Ontario and to points in between. Before addressing Question 13.a, it is important to first explain the volumes of petroleum products that are transported by Line 5 to delivery locations, as is addressed in Section I below. Section II addresses the unavailability of existing pipelines to transport Line 5 volumes, including in combination with other existing transportation modes.

I. <u>Overview of Line 5 Volumes</u>

In the context of the petroleum products pipeline industry, Line 5 is a large pipeline with a total capacity of 540,000 barrels per day ("bpd"). On an annual average basis, Line 5 transports approximately 80,000 bpd of natural gas liquids ("NGLs", composed primarily of propane and butane) and approximately 460,000 bpd of light crude. Line 5 usage has always remained at or around its average capacity of 540,000 bpd since 2013, when capacity on the pipeline was expanded from 490,000 bpd to address increased shipper demand.

<u>NGL Transport on Line 5</u>: The annual average of approximately 80,000 bpd of NGLs that are transported on Line 5 are essential to meeting the demand for propane and butanes in Michigan and Ontario. During some winter months, Line 5 deliveries exceed 100,000 bpd of NGLs. It is unusual for any crude oil pipeline also to transport NGLs, like Line 5. By batching NGLs in the pipeline with crude oil, Line 5 provides "just-in-time" deliveries of propane to meet increased demands in winter months, which is a

transportation advantage that cannot be replicated by existing infrastructure in the region. The NGLs transported by Line 5 originate in Western Canada and are shipped by the Enbridge Mainline pipelines to Superior, from where they are transported to facilities known as "fractionators," which break down the NGLs into their constituent parts, propane and butane. The fractionators, each operated by Plains (which are partially owned by Pembina Pipeline Corporation), are located in Superior, Wisconsin; Rapid River, Michigan; and Sarnia, Ontario. For the markets they serve, each of these facilities is the largest single source of propane in the region, and the propane they produce is primarily used for heating homes and businesses. The butanes produced at the very large Sarnia facility are used in a variety of industrial applications noted further below.

Line 5 is the only existing source of NGLs for these fractionators. Line 5 is also the only Enbridge pipeline that is physically able to transport NGLs downstream of Superior, Wisconsin to these fractionators (other Enbridge pipelines, such as Lines 6, 14, 61, 78 that are located south of Superior are not capable of transporting NGLs). Once fractionated, the Line 5 NGLs produce approximately 60,000 bpd of propane and 20,000 bpd of butanes.

While Line 5 does not transport NGLs directly to the Superior, Wisconsin fractionator, the NGL volumes received by that Plains facility are available only as a result of Line 5's operation; if Line 5 did not transport NGLs beyond Superior, it would not be economically viable for Enbridge to transport NGLs via its mainline system to only the Superior fractionator. The Superior fractionator is responsible for producing, based on NGL volumes enabled by Line 5's operation, about 7 percent of the total propane supply for Wisconsin and Minnesota, and a much higher percentage of propane supply for just northern Wisconsin and Minnesota.

At Rapid River, there is a Plains fractionator that extracts propane from the NGLs, and returns the unneeded butane fraction to Line 5. As noted, the Rapid River fractionator is entirely reliant on Line 5 NGL volumes for its feedstock; it has no other source for NGLs. It is also responsible for producing (from the Line 5-transported NGLs) 65% of the propane needed for residential heating and other essential uses in the Upper Peninsula in Michigan.

The remainder of the NGLs transported on Line 5 via the Straits are delivered to the very large Plains' fractionator in Sarnia, which produces both propane and butanes. As noted, the Sarnia fractionator is entirely reliant on Line 5 NGL volumes for its feedstock; it has no other source for NGLs. The Sarnia fractionator services the Michigan and Eastern Canada propane markets, and the butanes are key feedstocks for regional petrochemical facilities and refineries, including use as fuel additives and for other industrial purposes. The Sarnia fractionator, which is the largest in eastern Canada, supplies virtually all of the propane consumed in Ontario and about 56% of the propane needs for Michigan's Lower Peninsula. Plains has disclosed that, on an annual basis, its Sarnia facility produces approximately 800 million gallons of propane and approximately 400 million gallons 21,000 bpd of butanes.[26] This volume exceeds annual propane/butane demand in Ontario, resulting in exportation of excess volumes back to the United States. Plains has, for example, disclosed that it sells approximately 13,000 bpd of propane from the Sarnia fractionator directly in Michigan. The annual demand for propane in Michigan is approximately 25,000 bpd, so the Plains propane sales alone from the Sarnia fractionator supplied about 56% of the Lower Peninsula propane demand.

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[26] Statistics Canada. Table 25-10-0026-01 Supply and demand of natural gas liquids, annual https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=2510002601.

Plains has stated that any failure on the part of Line 5 to continue to reliably deliver these NGL volumes to its fractionators in Superior, Rapid River, and Sarnia will result in their closure, and the concomitant loss of propane to consumers in the region.

Line 5 Crude Oil Volumes: Apart from its crucial role in NGLs transport, Line 5 is also a major source of crude oil supply for refineries in Michigan, northern Ohio, western Pennsylvania, Ontario, and Quebec. In 2021, Midwestern refineries processed 3,753,000 bpd. Of this amount, almost 99 percent of all refinery crude oil receipts were delivered by pipeline, with the small balance delivered by barge and truck.[27] The proportion delivered via rail was negligible, and nearly all refineries served by Line 5 do not have any crude oil rail service. Moreover, the proportion delivered via pipeline has changed little over the years, underscoring that pipelines remain the most efficient, economical and safest means of transporting large volumes of liquid product.

All volumes of crude oil that are transported on Line 5 are received in Superior, Wisconsin; except there is a single intermediate receipt point on Line 5 at Lewiston, Michigan, where a relatively small volume of locally-produced Michigan crude oil (approximately 9,500 bpd) is collected and transported via Line 5 to U.S. and Canadian refineries. The table below provides a list of the 10 refineries that are supplied by Line 5 crude oil volumes. The table also shows the individual refinery capacities and their estimated crude oil throughputs. These refineries are key sources for refined product supply for Michigan, Ohio, western Pennsylvania, Ontario, and Quebec. The total crude oil demand in this region (based on refinery capacities) is estimated to be approximately 1,188,400 bpd. Accordingly, the crude oil transported by Line 5 (about 460,000 bpd) represents about 40 percent of their total crude oil throughput. Line 5 is responsible for about the same portion of their total refined product production in the region. From Line 5 volumes, these refineries produce primarily transportation fuels—gasoline, jet fuel, and diesel.

[27] *See* U.S. Energy Information Administration, Refinery Receipts of Crude Oil by Method of Transportation; https://www.eia.gov/dnav/pet/pet_pnp_caprec_dcu_nus_a.htm.

REGIONAL REFINERY CAPACITY

(Thousands of Barrels per Day, Unless Noted)

	Refinery Capacity
Detroit/Toledo Region	
BP-Husky Toledo	155.0
Marathon Detroit	140.0
PBF Toledo	172.8
Subtotal/Average	**467.8**
Pennsylvania	
United Warren	65.0
Ontario	
Imperial Nanticoke	113.0
Imperial Sarnia	119.0
Shell Sarnia	78.0
Suncor Sarnia	85.0
Subtotal/Average	**395.0**
Quebec	
Suncor Montréal	137.0
Valero Lévis	235.0
Subtotal/Average	**372.0**
Grand Total	**1,299.8**

The specific Line 5 crude oil delivery points are at Marysville, Michigan, and several sites in Sarnia, Ontario. From the Marysville delivery point, the Marathon Detroit refinery and two refineries in Toledo, Ohio (BP-Husky and PBF Toledo), receive Line 5 crude oil via third-party crude oil pipelines. In addition to supplying the three Canadian refineries located in the Sarnia area (Imperial, Shell, and Suncor), Line 5 is also connected to other Enbridge pipelines that transport crude oil to refineries in Nanticoke, Ontario (Imperial), western Pennsylvania (United), and Quebec (Suncor and Valero Lévis). Specifically, in addition to supplying three Canadian refineries located in Sarnia, Line 5 is also connected to Enbridge Line 7 and Line 9 at Sarnia. Enbridge Line 7 connects to the Imperial refinery in Nanticoke, Ontario, and a third-party pipeline that delivers crude oil to the United refinery in western Pennsylvania. Enbridge Line 9 transports crude oil from Sarnia to Montréal, Quebec.

II. <u>The Use of Existing Pipelines, Including in Combination with Other Modes, to Transport All of Line 5 Volumes is Not Feasible/Practicable</u>

The use of existing pipelines to transport all 540,000 bpd of petroleum products carried by Line 5 is not an available, practicable alternative. For purposes of responding to this request, Enbridge addresses NGL and crude oil transport separately below.

A. There Are No Existing Pipelines or Alternative Transportation Modes to Transport Line 5's 80,000 BPD of NGLS

There is no existing pipeline alternative to Line 5 for the supply of NGLs to the fractionators located in Superior, Rapid River, Sarnia. As noted above, Line 5 is the only existing pipeline on Enbridge's mainline system that can transport NGLs south of Superior; while other Enbridge pipelines connect to Superior (*e.g.*, Line 6A, Line 14, and Line 61), they are not capable of transporting NGLs. Nor are there any existing third-party pipelines, whether utilized in combination with rail/truck, that are connected to the Line 5 delivery points, or that have available capacity to deliver the type of NGLs that are transported by Line 5 to fractionators.

Superior NGL Volumes. As explained above, Line 5 enables the transport of NGLs on Enbridge's mainline system to Superior, a portion of which are delivered to the Superior fractionator. Enbridge's mainline system is currently the only existing pipeline that transports NGLs to Superior. Without Line 5, NGLs would not be transported on the Enbridge mainline system to Superior, and thus current deliveries to Plains' Superior fractionator would cease. There are also no other existing pipelines owned or operated by third-parties, including any that could be used in combination with truck/rail facilities, to transport NGLs to the Superior fractionator.[28] The lack of existing alternatives (in a scenario where Line does not enable the transport of NGLs to Superior) is further evidenced by the fact that Plains has disclosed that its Superior fractionator would cease operation if Line 5 did not continue to enable the transportation of NGLs to this facility via Enbridge's mainline system. Accordingly, without Line 5 enabling NGL deliveries to Superior, new NGL transportation facilities would be required, which would require significant investment, permitting, and take years to complete.

Rapid River Volumes. As noted above, Line 5 is the only pipeline on the Enbridge mainline system that connects to and is located south of Superior, Wisconsin that can transport NGLs. There are also no other existing Enbridge or third-party pipelines connecting to Rapid River. Accordingly, without Line 5 NGL deliveries to Rapid River, new NGL transportation facilities would be required, which would require significant investment, permitting, and take years to complete.

Sarnia Volumes. As noted above, Line 5 is the only pipeline on the Enbridge mainline system that connects to and is located south of Superior, Wisconsin that can transport NGLs. While Enbridge's Line 78 connects directly to Sarnia, it (and the lines that connect to it – Lines 6A, 14, 61) cannot transport NGLs. The only existing third-party-owned pipeline in the geographic area of Sarnia that could theoretically deliver Y-grade NGLs to Sarnia is the Utopia pipeline. It originates in the Marcellus/Utica Shale in Ohio and terminates at Windsor, Ontario. However, the Utopia pipeline is currently designed to deliver ethane to Sarnia petrochemical customers, and the Sarnia fractionator is designed to process a mixed propane/butanes NGL. Further, the Y-grade NGLs available in the Marcellus/Utica Shale for potential delivery on the Utopia pipeline (even assuming that the NGLs could somehow be diverted from the local fractionators in the area and that the Utopia pipeline had capacity to transport those NGLs), cannot be processed by the Sarnia fractionator. Plains, the operator of the Sarnia fractionator, would not undertake the cost and modifications necessary to process Y-grade NGLs, and, as noted

[28] For example, the Enterprise Mid-America Pipeline (MAPL) system, which originates in Conway, is a pipeline segment that supplies Wisconsin. However, the terminus of this pipeline segment is at Janesville, near the southern border of Wisconsin, and is 357 miles away from Superior. The propane deliveries from this MAPL pipeline segment are understood to be currently absorbed by the markets in southern Wisconsin and northern Illinois. Also, the MAPL segment connected to Wisconsin is already operating at capacity and is incapable of delivering additional propane. There are no other NGL pipelines in existence in proximity to the Superior market.

above, has indicated that it would shut down the fractionator without Line 5, evidencing a lack of existing alternatives to provide it with its necessary NGL feedstock. Accordingly, without Line 5 NGL deliveries to Sarnia, new NGL transportation facilities would be required, which would require significant investment, permitting, and take years to complete.

B. There Are No Existing Pipelines to Transport All Line 5's 460,000 BPD of Crude Oil

Pipelines are almost the exclusive means by which Midwestern refineries receive crude oil. There are not existing crude oil pipelines, whether used in combination with rail or trucking, that are capable of transporting all of the 460,000 bpd of crude oil that is transported by Line 5 from Superior to Sarnia and points in between to Midwestern refinery destinations.

There are only three crude oil pipelines that are currently in operation serving the Line 5 delivery area. These are Enbridge's Line 5, Line 78, and a pipeline owned by a third-party, the Maumee Pipeline. The Maumee Pipeline originates in Lima, Ohio and terminates at the Samaria Station, Michigan. It is fully utilized at its capacity of 159,700 bpd and thus has no capacity to transport any portion of Line 5 crude oil volumes.

There is the potential to transport a small portion of Line 5 volumes on Enbridge's Line 78. At Superior, as noted above, Enbridge operates three southbound pipelines that transport crude oil from Superior to three locations in Illinois, which connect to Enbridge's Line 78 pipeline: Line 6A, Line 14, and Line 61. Line 6A, Line 14, and Line 61 are all at or near capacity and they lack the necessary capacity to transport an additional 460,000 bpd of crude oil to Line 78 that is currently transported by Line 5.

Even assuming that Enbridge pipelines connecting from Superior (Lines 6A, 14, and 61) had available capacity to transport any portion of the 460,000 bpd of Line 5 crude oil volumes for further delivery on Line 78, Line 78's capacity is limited to 570,000 bpd and therefore cannot transport the full 460,000 bpd of Line 5 crude oil volumes. Line 78 originates at the Enbridge Flanagan terminal located in the Chicago area and terminates in Sarnia, with delivery points in Stockbridge,[29] Michigan, Marysville, and Sarnia. Assuming that Line 78 were utilized up to its capacity of 570,000 bpd to transport crude oil to Line 5 delivery points, this would still result in a shortfall of approximately 334,700 bpd. In other words, Line 78 capacity would only allow for the transport of approximately 125,000 bpd of the 460,000 bpd of crude oil transported to refineries currently served by Line 5. This shortfall could potentially be reduced to 226,700 bpd assuming that existing rail and tanker unloading facilities were reactivated to serve the Quebec refineries that receive Line 5 crude oil volumes. However, some of these facilities would require refurbishment before they could be utilized, and the time and cost to do so is unknown.

Accordingly, without Line 5 crude oil deliveries, new crude oil transportation facilities would be required, which would require significant investment, permitting, and take years to complete.

[29] From Stockbridge, the three refineries in the Detroit/Toledo area served by Line 5 can be accessed via a combination of Enbridge (Lines 17 and 79) and third-party pipelines.

***Data Request Question 13.c**. For the route alternatives you provided, explain how the evaluation and comparison of these alternatives supports the search for the least environmentally damaging practicable alternative required by the 404(b)(1) guidelines.*

Data Request Question 13.c. Response:

In evaluating Enbridge's application for the Relocation, USACE must evaluate alternatives that are practicable and reasonable. In accordance with the USACE 404(b)(1) guidelines at 40 C.F.R. § 230.10(a), a permit cannot be issued if a practicable alternative exists that would have less adverse impact on the aquatic ecosystem, and that the alternative does not have significant adverse environmental consequences to other natural ecosystem components.

In terms of USACE's 404(b)(1) analysis, "practicable" is defined as meaning the alternative is "*available* and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes." 40 C.F.R. § 230.3(l) (emphasis added). USACE has explained that an alternative needs to fail only one practicability factor to be eliminated during the Section 404(b)(1) screening process.

As explained in response to Question 13.b above, existing pipelines (whether used in combination with one another or with other transportation modes) are not available to transport all of the 540,000 bpd of petroleum products to Line 5 delivery points. No portion of Line 5 NGLs could be transported via existing pipelines because none exist, or those that may exist (*e.g.*, in the Sarnia area) do not transport the correct NGL product for fractionation. While a portion of Line 5 crude oil volumes (approximately 125,000 bpd) could theoretically be transported on Enbridge's Line 78 to Sarnia, this would still result in a shortfall of 334,700 bpd (or 226,700 bpd if rail/tanker facilities were reactivated to deliver crude oil to the Quebec refineries served by Line 5). Likewise, there are not adequate existing non-pipeline options (rail, truck, barge) that connect to existing pipelines in the Line 5 delivery area to transport all Line 5 volumes.

Due to the fact that existing pipelines (whether used in combination or with other modes) are not available to transport all Line 5 volumes, this is not a practicable alternative under USACE's 404(b)(1) guidelines. USACE has also explained that alternatives making it to Step 4 (identification of the least environmentally damaging alternative ("LEDPA")) are only those that are practicable. Because the use of existing pipelines (whether used in combination with one another or with other modes) is not practicable, this is not an alternative that should be carried forward for LEDPA analysis under Section 404(b)(1).

Aside from the fact that the use of existing pipelines (whether used in combination or with other modes) is not a "practicable" alternative, any alternative that contemplates the development of new pipelines and/or truck/rail facilities to transport all Line 5 NGL and crude oil volumes would result in other significant adverse environmental consequences resulting from their construction and/or operation.

Data Request Question 14: *We have received comments expressing concern that enforcement of state trespass laws will restrict tribal access to lands used for hunting, fishing, and gathering natural resources. Please describe how pipeline construction activities may impair access to areas where treaty rights are exercised, and how any potential impairment may be mitigated.*

Data Request Question 14 Response:

Enbridge will work with any tribal members to facilitate access to public lands during construction, and no long-term impairment to the exercise of tribal treaty rights will be caused by the relocation.

These actions will minimize any limitations during pipeline construction on the exercise of treaty rights by tribal members and access to hunting on public lands consistent with Wisconsin law and regulations. In Wisconsin, the rights to hunt and fish are established both by treaty as well as by the Wisconsin Constitution. Section 5 of the Treaty of 1837 reserves to members of the Ojibwa the right to hunt, fish, and gather upon the lands, the rivers and the lakes within the Ceded Territory, where the Project is located. These rights reserved by the Treaty of 1837 currently applies to public lands in the Ceded Territory. Likewise, Article I, Section 26 of the Wisconsin Constitution guarantees that all Wisconsin citizens have the right to hunt, fish, trap, and take game, subject only to reasonable restrictions prescribed by law. Such reasonable restrictions include, for example, exclusions from privately owned dwellings, buildings, or fenced farm areas not open to the general public for hunting, or actions constituting trespass under Wis. Stat. Ch. 943.143 or 943.15.

During active pipeline construction or maintenance, in areas where the relocated Line 5 will cross public land, access to Enbridge's ROW will be temporarily restricted, as required under federal regulations to ensure the safety of the contractors and general public during excavation and trenching. During those activities, Enbridge will make its best efforts to accommodate requests for access to public lands requiring a crossing of the ROW to exercise treaty rights and will identify a point of contact to facilitate safe access to public lands by tribal members seeking to exercise treaty rights. Access to these areas will continue to be open for all legal activities at all other times.

Post construction, no long-term impairment to the exercise of tribal treaty rights will occur. Wisconsin's trespass law applicable to energy providers are not currently restricting tribal access to lands used for hunting, fishing, and gathering natural resources, and the relocation project will not restrict access in the future. Wis. Stat. § 943.143 was adopted by the Wisconsin Legislature in 2015, and initially applied to all electrical and natural gas transmission right-of-way throughout the State of Wisconsin. Coverage under Section 943.143 was expanded to petroleum pipelines four years later. While significant portions of the Ceded Territory are crossed by electrical and natural gas transmission pipelines (as well as Line 5), in the seven years since the statute was adopted, Enbridge has not identified any case where a tribal member engaged in hunting, fishing, or gathering was prosecuted under this provision.

Finally, Enbridge has prepared an Environmental Justice Plan, which was included as Appendix O to the December 2021 DEIS prepared by the Wisconsin Department of Natural Resources. That Plan includes Enbridge's commitment to allow the exercise of treaty- and constitutionally protected rights along the pipeline right-of-way. That plan also notes that tribal members have asked for confirmation of Enbridge's consent to the lawful exercise of treaty rights in the right-of-way on public land.

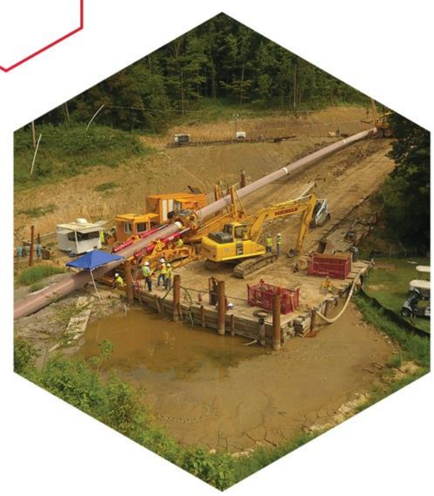
Enbridge

Line 5 – White River HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 4 – 30-INCH WHITE RIVER HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 4,485’
- Notable Obstacles: White River, surrounding valley, multiple wetlands and creeks
- Length of Wetlands: 508’ (directly north of the entry point), 570’ (south of White River), 755’ (directly south of the exit point)
- Waterbody Information: The White River is approximately 140’ wide, and 10’ deep at the crossing location
- Depth of HDD Under Applicable Creeks: Minimum of 114’
- Depth of HDD Under Waterbody: Minimum of 108’

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X

- Bara-Kade
- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

<u>Upland and Terrestrial Locations</u>

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

<u>Wetland and Waterbody Locations</u>

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch White River crossing is located near pipeline milepost 4, roughly 5 miles south of Ashland, Wisconsin. It involves passing beneath the White River, the surrounding valley, and multiple wetlands and creeks. The river has a width of approximately 140 feet from bank to bank at the crossing location and a typical depth of less than 10 feet. The proposed HDD alignment will be established in a new right-of-way that runs south to north while paralleling an overhead powerline corridor on the northern end of the crossing. For an overview of the area, refer to the White River plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

The river, environmentally sensitive area, and some of the wetlands are within the forested valley; beyond which the surface elevation sharply rises roughly 135 feet, plateauing on both sides into densely treed areas with wetlands prominent throughout. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the White River Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the White River would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the river is approximately 140 feet and the average depth is 10 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

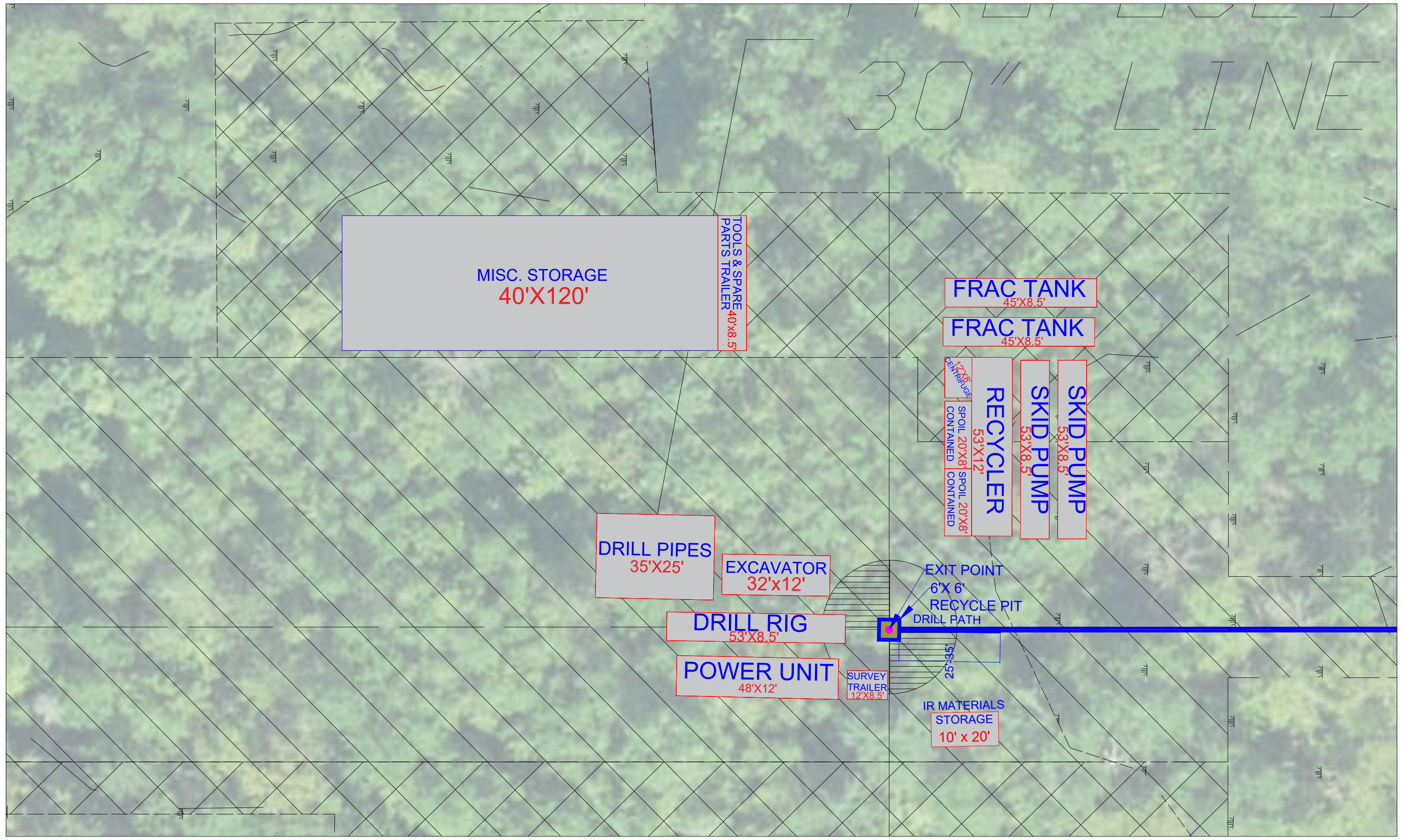
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT

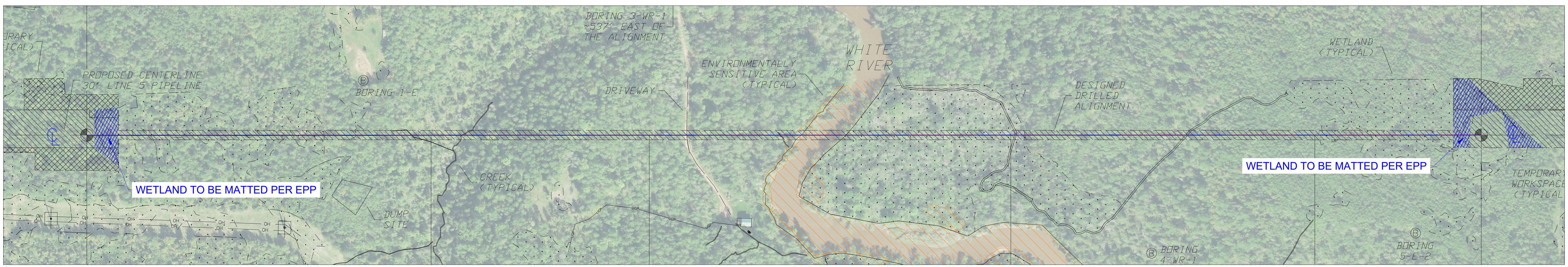


PLAN

SCALE: 1"=50'

PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 300'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR: ENBRIDGE	
PROJECT: LINE 5 PIPELINE PROJECT	
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING	
CROSSING REFERENCE: MP4 - WHITE RIVER HDD	
PRODUCT PIPES SIZE (INCHES): 30"	
LOCATION: ASHLAND COUNTY, WISCONSIN	
DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/18/22	

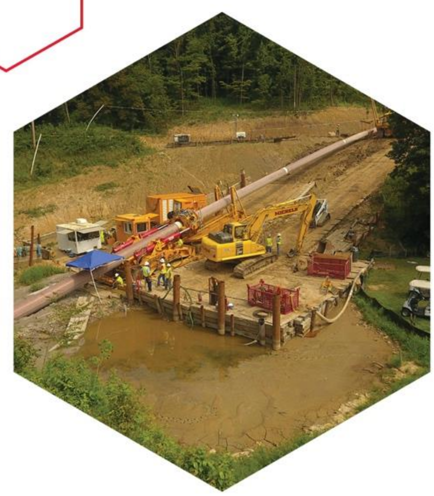
Enbridge

Line 5 – Deer Creek HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 6 – 30-INCH DEER CREEK HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 1,790'
- Notable Obstacles: Deer Creek, several forested wetlands, and a creek ravine
- Length of Wetlands: The HDD alignment crosses through wetlands in multiple locations in the first 520' north of the entry point
- Waterbody Information: Deer Creek is approximately 50' wide, and 10' deep at the crossing location
- Depth of HDD Under Applicable Wetlands: Minimum of 13'
- Depth of HDD Under Waterbody: Minimum of 40'

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X

- Bara-Kade
- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Deer Creek crossing is located near pipeline milepost 6, roughly 7.5 miles south of Ashland, Wisconsin. It involves passing beneath Deer Creek, several forested wetlands, and the creek ravine. While the creek itself is only about 50 feet wide with a depth no more than 10 feet, the steep walled creek ravine is a more substantial obstacle at over 500 feet across. The proposed HDD alignment will be established in a new right-of-way running mostly north to south. Just offset from Schwiesow Road, the entry point of the drill, as well as the creek, wetlands, and ravine are within a densely treed area on the southern half of the HDD alignment. The exit point resides in a cultivated field to the north. For an overview of the area, refer to the Deer Creek plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the "Prevention" section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Deer Creek Crossing will follow procedures outlined in the "Containment" section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary. Additional access points for containment and cleanup equipment may be required due to the steep terrain down into the base of the Deer Creek ravine.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within Deer Creek would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and creek bed features at the time and location of the release. As mentioned above, the average width of the creek is approximately 50 feet and the average depth is 10 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

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Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

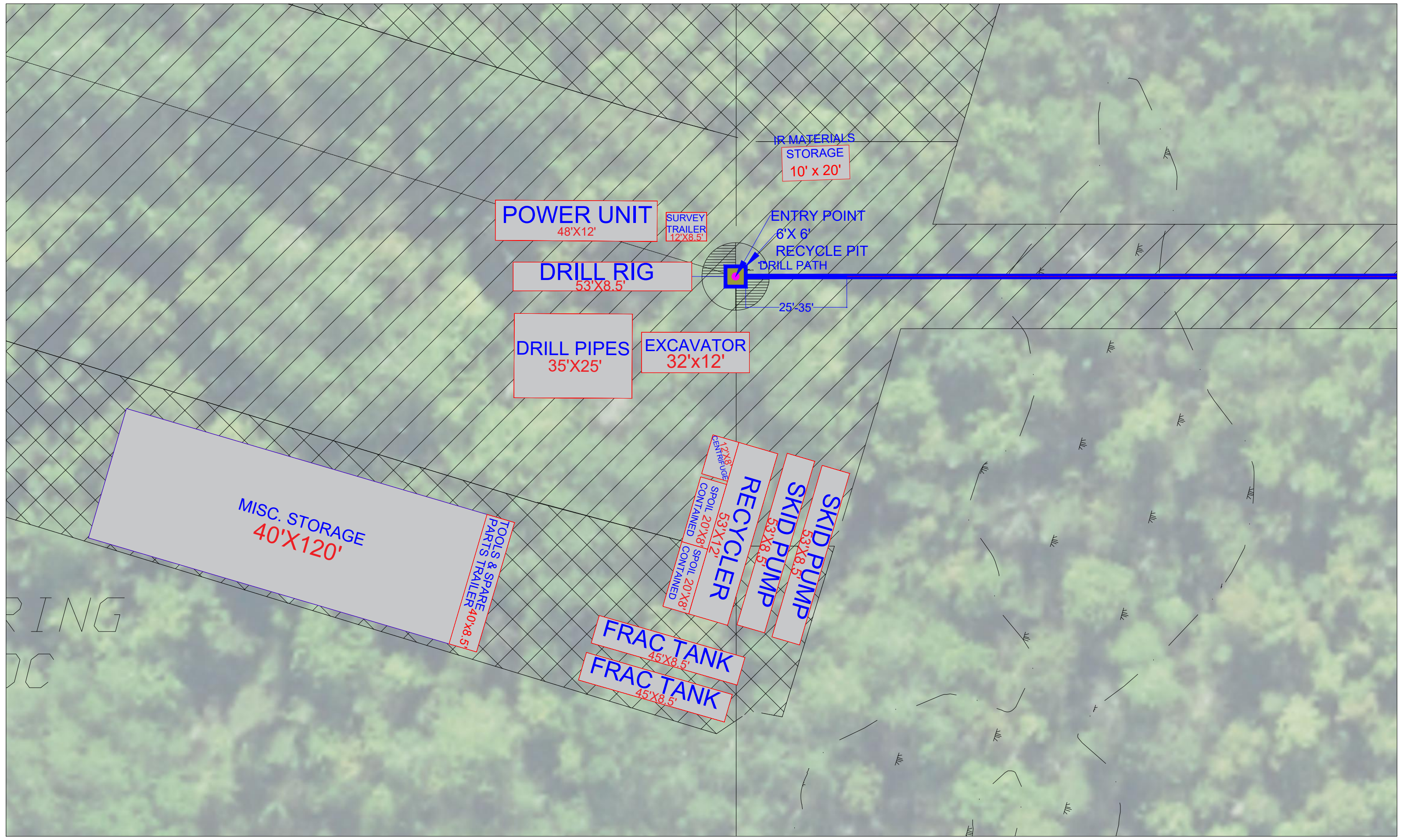
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

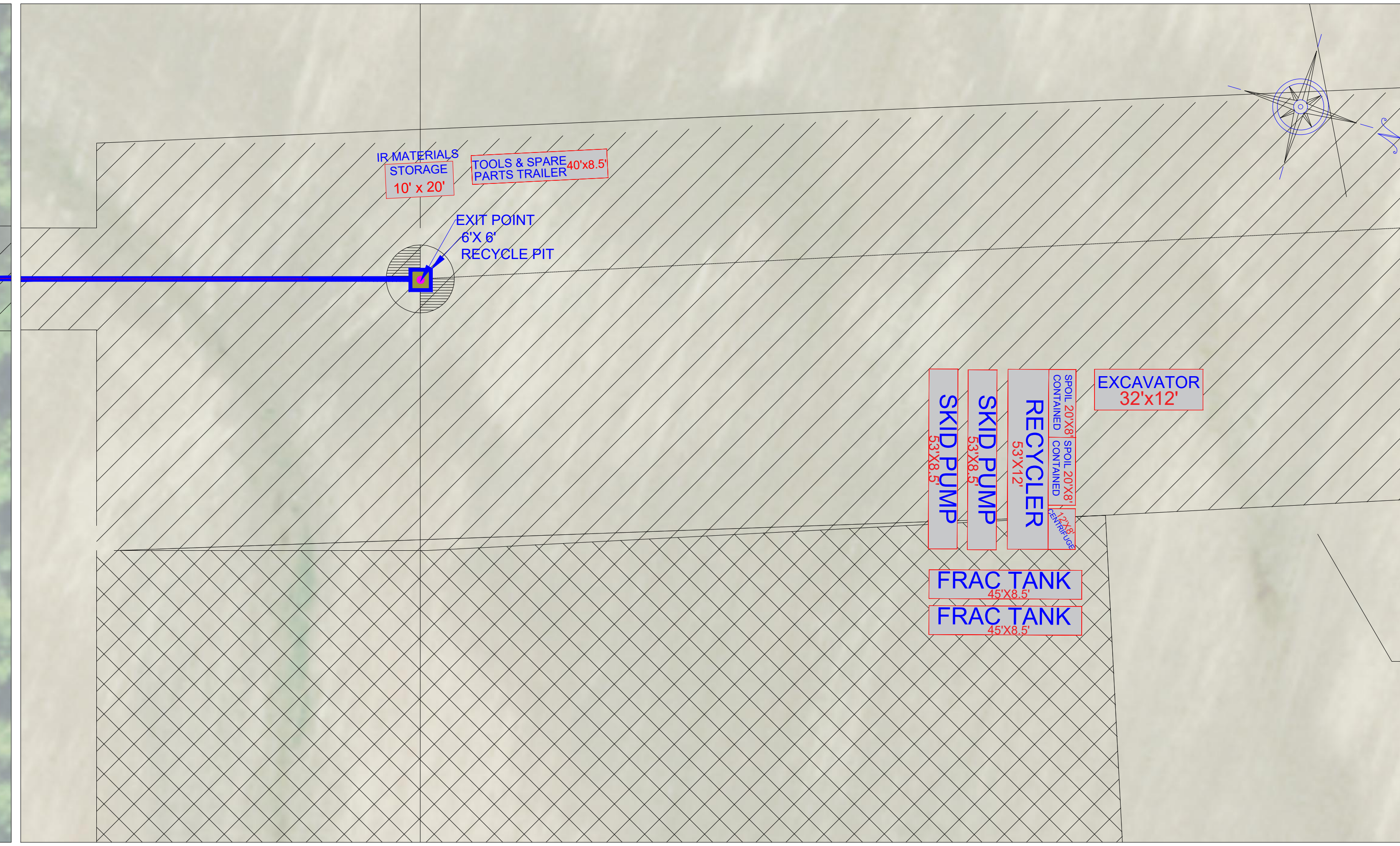
ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT



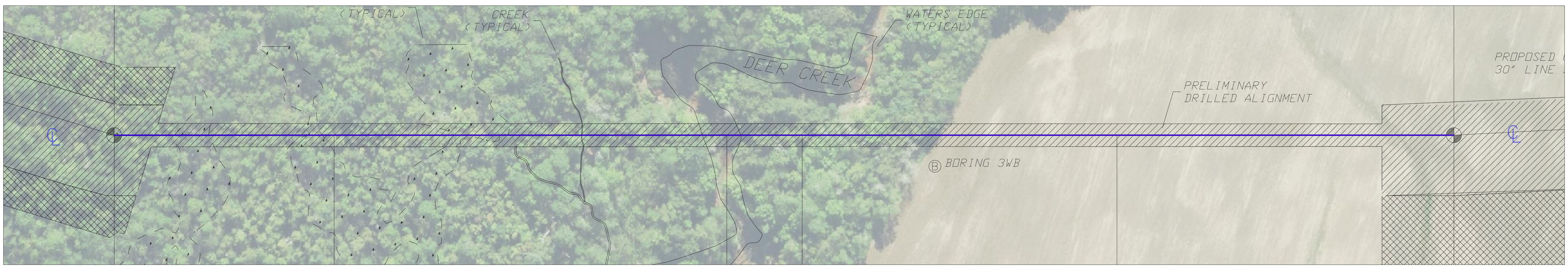
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 125'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICAITON IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR: ENBRIDGE	
PROJECT: LINE 5 PIPELINE PROJECT	
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING	
CROSSING REFERENCE: MP6 - DEER CREEK HDD	
PRODUCT PIPES SIZE (INCHES): 30"	
LOCATION: ASHLAND COUNTY, WISCONSIN	
DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/18/22	

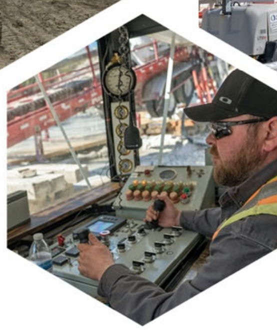
Enbridge

Line 5 – Marengo River Direct Pipe Crossing

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 11 – 30-INCH MARENGO RIVER DIRECT PIPE CROSSING

I. SITE SPECIFIC DIRECT PIPE INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- Direct Pipe Length: 2,013'
- Notable Obstacles: Marengo River, Marengo River Road, a forested wetland north of the road
- Length of Wetland: 364'
- Waterbody Information: The Marengo River is approximately 45' wide, and 10' deep at the crossing location
- Depth of DP Under Wetland: Minimum of 10' (directly south of exit workspace)
- Depth of DP Under Road: Minimum of 54'
- Depth of DP Under Waterbody: Minimum of 29'

II. DRILLING FLUID PLAN

Essential to any successful Direct Pipe installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out.

Bentonite serves many purposes in the Direct Pipe process. The bentonite drilling fluid is primarily used to clean cuttings from the tunnel face as the down hole cutter advances through the ground. The drilling fluid also serves to cool the down hole tools, stabilize the annulus, and reduce friction between the ground formation and the product pipe during installation.

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed work site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X
- Bara-Kade
- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire tunneling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank down to the tunnel face. Closed circuit circulation from the tunnel face back to the separation plant will continue for the duration of the installation. The pumping rate and the rate of drilling fluid return is constantly monitored while the tunnel head is progressing.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the tunneling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during tunneling operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the bore exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the bore can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, in a horizontal directional drill, that path is through the annulus of the tunnel and back into the drilling fluid recycling unit. In the case of a Direct Pipe installation, the majority of the drilling fluid flows back through the pipe. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of tunneling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI personnel are trained in the safe handling and use of drilling fluids and materials associated with direct pipe installations. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during Direct Pipe operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Vac Trucks/Dump Trucks: Possible leak or release at valve location or worn hose.	**Vac Truck Driver:** Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the driller, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the mud system. The drilling fluid pumping rate and the rate of drilling fluid return to the mud system is constantly monitored by the driller while the tunnel head is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease tunneling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the tunnel head in relation to the point of entry
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on

If circulation is reestablished, tunneling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before tunneling resumes. The direct pipe alignment will be continually monitored for surficial drilling fluid as tunneling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags
- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue tunneling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue tunneling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line
- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions operations may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation

- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-DP RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Superintendent-DP RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and Monitoring

The 30-inch Marengo River direct pipe crossing is located near pipeline milepost 11, about 11 miles directly south of Ashland, Wisconsin and roughly 1.5 miles west of Marengo, Wisconsin. The crossing involves passing beneath the Marengo River, Marengo River Road, and a forested wetland north of the gravel road. The river has a width of roughly 45 feet from bank to bank at the crossing location and a typical depth of less than 10 feet. The proposed alignment will be established in a new right-of-way that runs mostly north to south. While topography over the length of the crossing varies, likely as a result of historical river meander, elevation differential between the endpoints is only about 16 feet.

For an overview of the area, refer to the Marengo River plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted. Prior to commencing operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the path to support monitoring for, and response to, any potential inadvertent releases. Monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Marengo River crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the Marengo River would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the river is approximately 45 feet and the average depth is 10 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

MICHELS®
TRENCHLESS, INC.

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

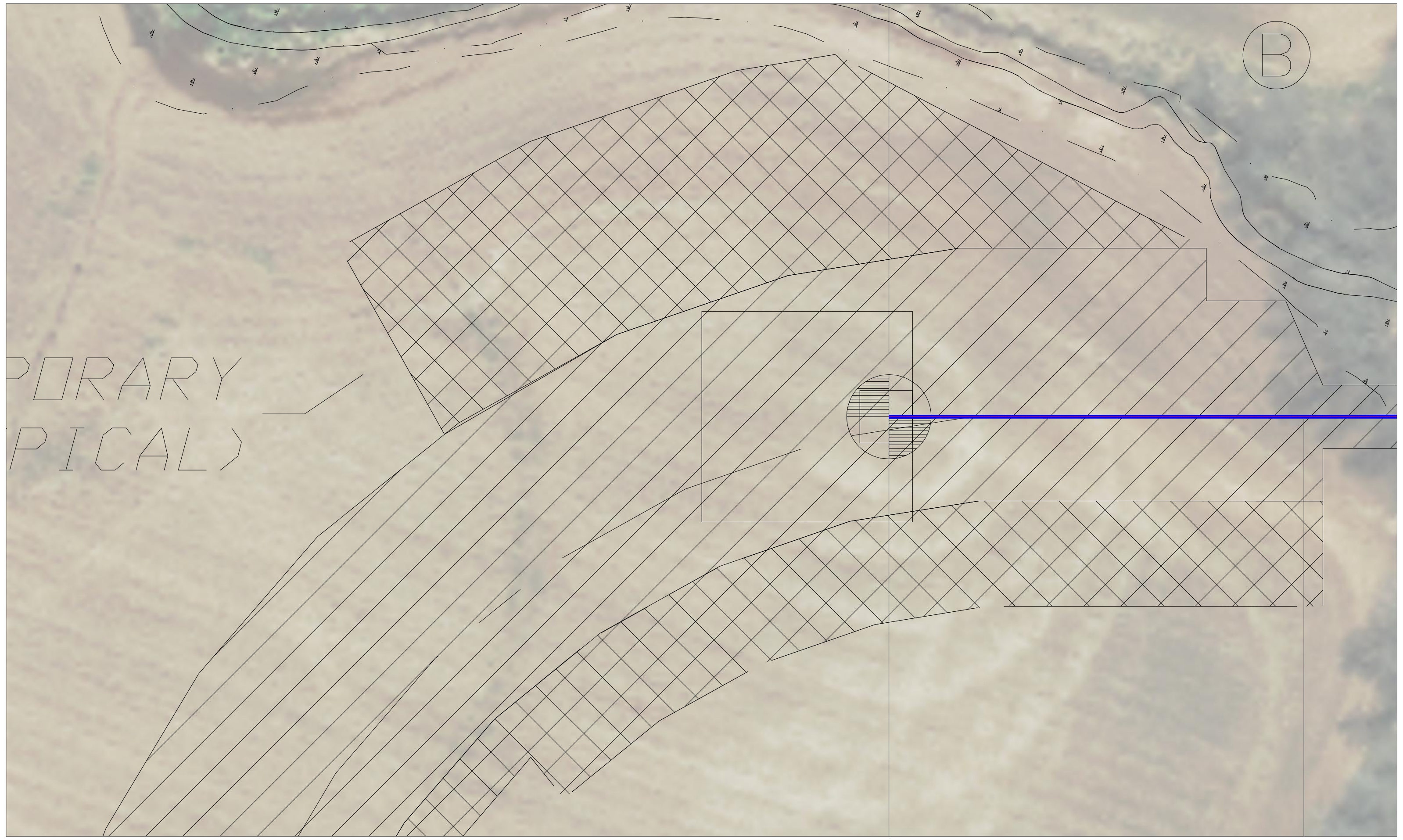
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

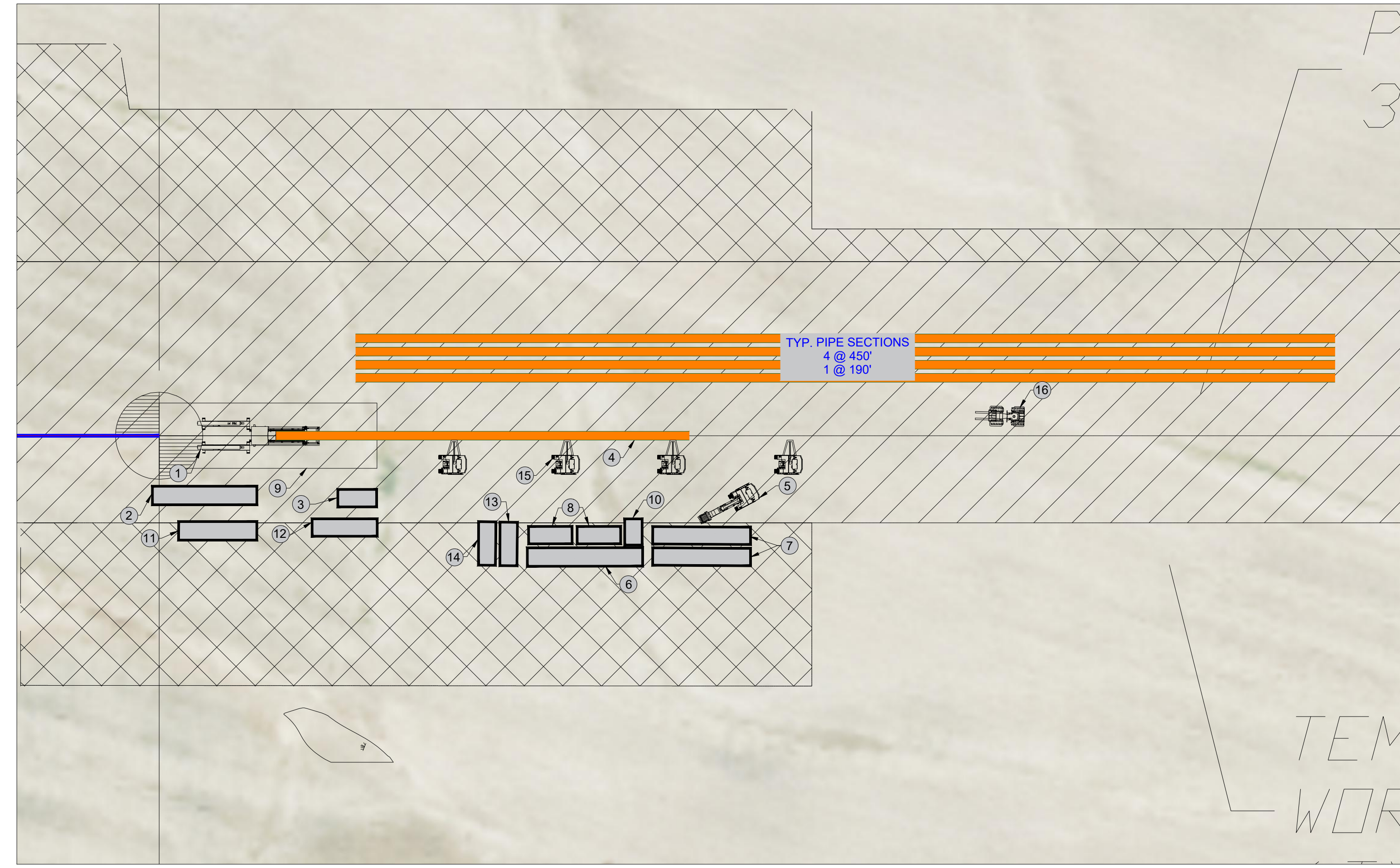
ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT



PLAN

SCALE: 1"=80'



PLAN

SCALE: 1"=80'

OVERALL PLAN VIEW

SCALE: 1" = 175'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICAITON IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

DPI EQUIPMENT LEGEND

1. PIPE THRUSTER (53' X 8.5')
2. POWER MODULE (48' X 8.5')
3. CONTROL CABIN (12' X 8.5')
4. TYPICAL PIPE SECTION
5. EXCAVATOR (32' X 12')
6. RECLAIMER (48' X 8.5')
7. FRAC TANK (45' X 8.5')
8. CUTTINGS BIN (20' X 8')
9. ENTRY (30' X 100')
10. CENTRIFUGE (12' X 8')
11. GENERATOR
12. POWER PACK
13. HIGH PRESSURE WATER JETTING
14. BENTONITE PUMP
15. SIDE BOOM CRANE
16. FORKLIFT

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

MICHELS®
TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECT STEERABLE PIPE THRUSTING INSTALLATION FOR:
ENBRIDGE
PROJECT:
LINE 5 PIPELINE PROJECT
DRAWING:
CONCEPTUAL WORKSPACE DESIGN DRAWING
CROSSING REFERENCE:
MP11 - MARENGO RIVER DSPT
PRODUCT PIPES SIZE (INCHES): 30"
LOCATION: ASHLAND COUNTY, WISCONSIN

DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/30/22	

Enbridge

Line 5 – Brunsweiler River HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL

MICHELS®
TRENCHLESS, INC.

MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 14 – 30-INCH BRUNSWEILER RIVER HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 2,809’
- Notable Obstacles: Brunsweiler River, surrounding river valley, multiple wetlands and creeks
- Length of Wetlands: 588’ (directly east of the river), 50’ (directly east of the exit workspace boundary)
- Waterbody Information: The Brunsweiler River is approximately 60’ wide, and less than 5’ deep at the crossing location
- Depth of HDD Under Waterbody: Minimum of 60’

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X

- Bara-Kade
- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Brunsweiler River crossing is located near pipeline milepost 14, roughly 13 miles south of Ashland, Wisconsin and less than 1 mile west of Minersville, Wisconsin. It involves passing beneath the Brunsweiler River, the surrounding river valley, and multiple wetlands and creeks. The river has a width of approximately 60 feet from bank to bank at the crossing location and a typical depth of less than 5 feet at the time of the survey. The proposed HDD alignment will be established in a new right-of-way that runs east to west. The river and most of the wetlands are within the forested valley, beyond which the surface elevation sharply rises around 60 feet, plateauing on both sides. The entry point is in a mostly clear field adjacent to a driveway to the south. The HDD exits into a cultivated field west of the valley, just beyond a grove of trees. For an overview of the area, refer to the Brunsweiler River plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

The roughly 135-foot elevation differential between the HDD endpoints and the horizontal tangent will result in relatively high annular pressures in the lower portion of the hole. Elevated drilling fluid pressures in softer overburden soils will increase the potential for circulation losses due to hydrofracture, although the occurrence of drilling fluid losses at depth may not result in inadvertent returns at the surface. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the "Prevention" section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Brunsweiler River Crossing will follow procedures outlined in the "Containment" section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the river would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the river is approximately 60 feet and the average depth is less than 5 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

MICHELS®
TRENCHLESS, INC.

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

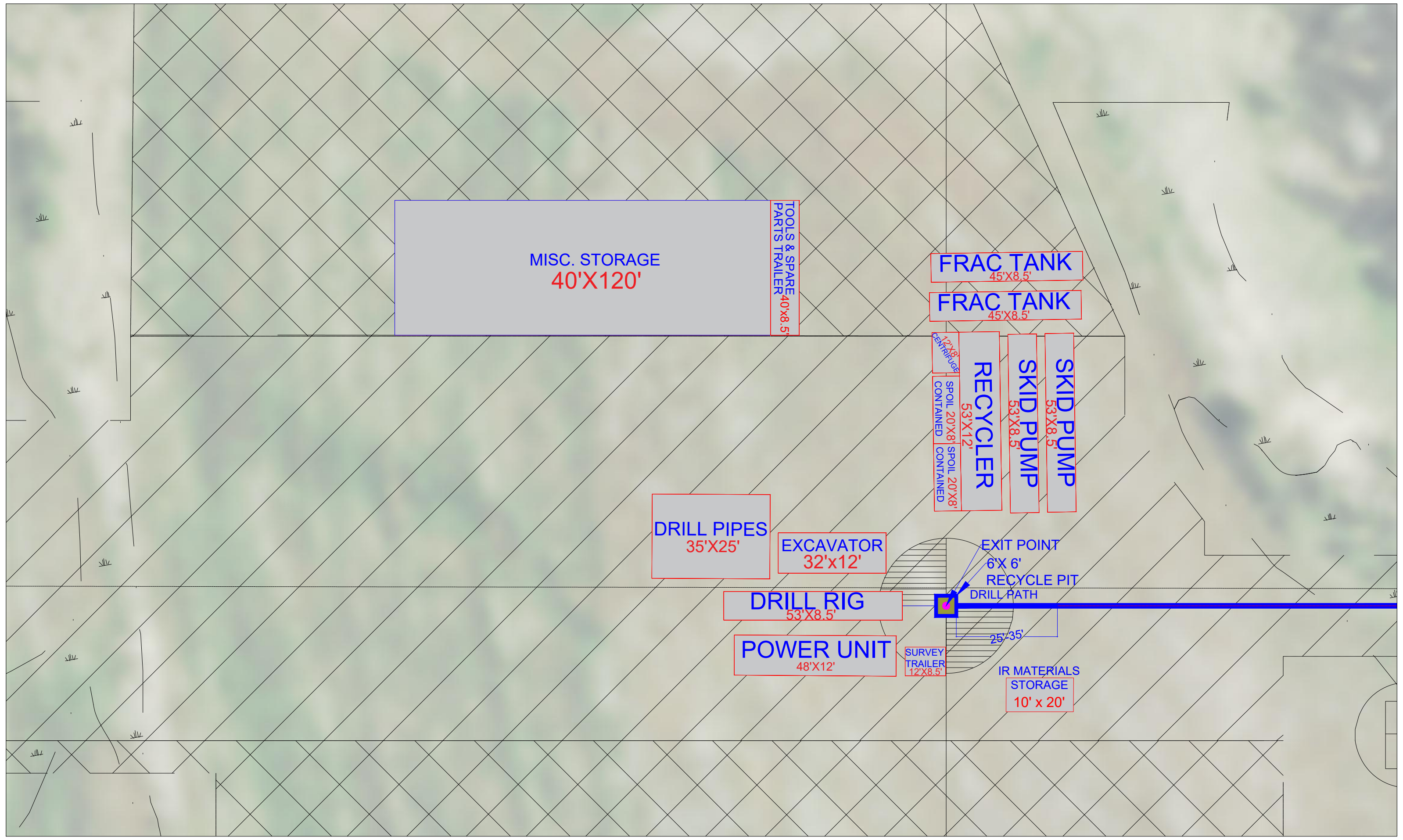
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

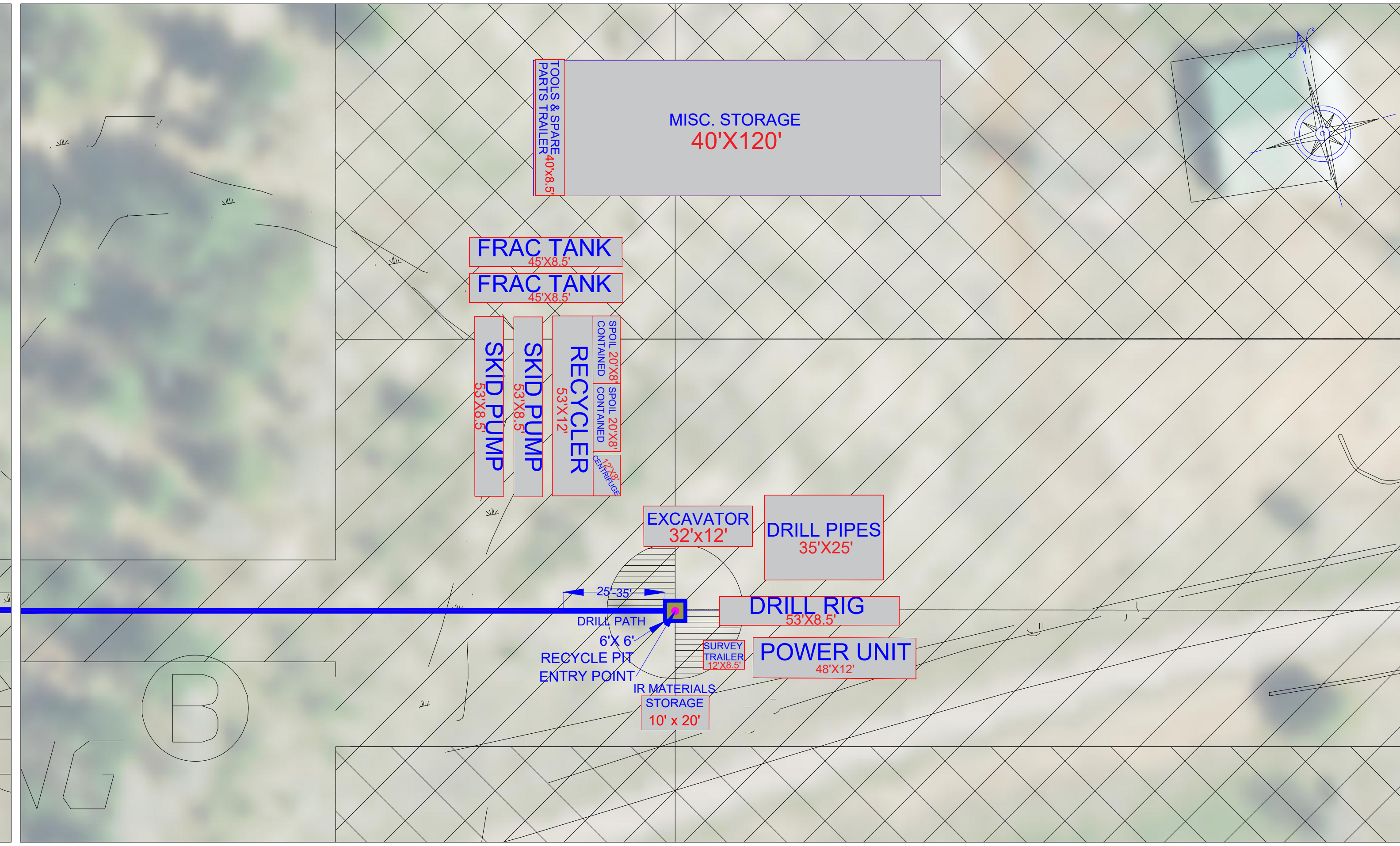
ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT



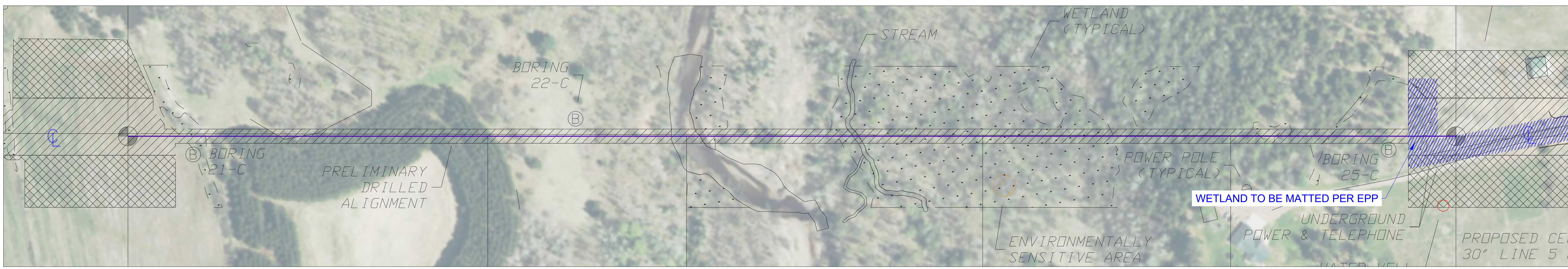
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 200'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

MICHELS®
TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR:
ENBRIDGE

PROJECT:
LINE 5 PIPELINE PROJECT

DRAWING:
CONCEPTUAL WORKSPACE DESIGN DRAWING

CROSSING REFERENCE:
MP14 - BRUNSWEILER RIVER HDD

PRODUCT PIPES SIZE (INCHES): 30"

LOCATION: ASHLAND COUNTY, WISCONSIN

DRAWN BY: C.L.G. | JOB NUMBER: XXXXXXX

DATE: 11/18/22

Enbridge

Line 5 – Highway 13 HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL

MICHELS®
TRENCHLESS, INC.

MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 15 – 30-INCH HIGHWAY 13 HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 2,007’
- Notable Obstacles: Highway 13, Wisconsin Central Railroad, a stream flanked by small wetlands within a surrounding shallow ravine, and Bass Lake Road
- Length of Wetlands: 90’ of wetland within the ravine on each side of the stream
- Depth of HDD Under Highway 13: 61’
- Depth of HDD Under Railroad: 75’
- Depth of HDD Under Stream Ravine: 50’

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X
- Bara-Kade

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- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller's discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
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In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Highway 13 crossing is located near pipeline milepost 15, roughly 14 miles south southeast of Ashland, Wisconsin and roughly halfway between Minersville and North York, Wisconsin. It involves passing beneath Highway 13, Wisconsin Central Railroad, a stream flanked by small wetlands within a surrounding shallow ravine, and Bass Lake Road. At the crossing location, the shallow ravine has a width of almost 400 feet from the railroad to the west, across to the eastern top of bank. The proposed HDD alignment will be established in a new right-of-way that runs directly west to east. End points on this crossing are set with the entry in a cultivated field to west and the exit in an open field east of Bass Lake Road. For an overview of the area, refer to the Highway 13 plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Highway 13 Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary. A vacuum truck could be deployed if required due to the volume of the release. If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately.

Response to an inadvertent release within the ravine could include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the stream, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

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6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

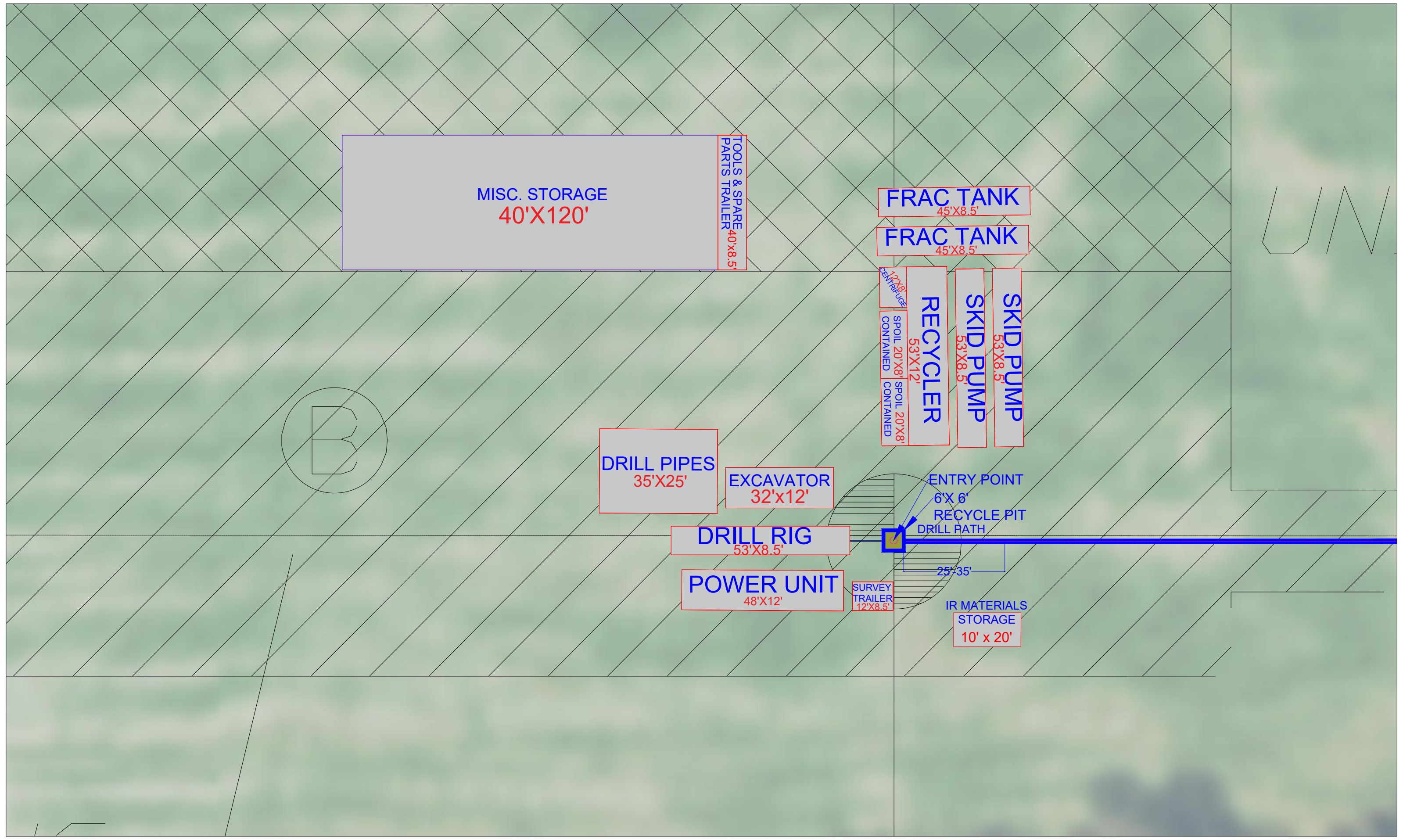
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

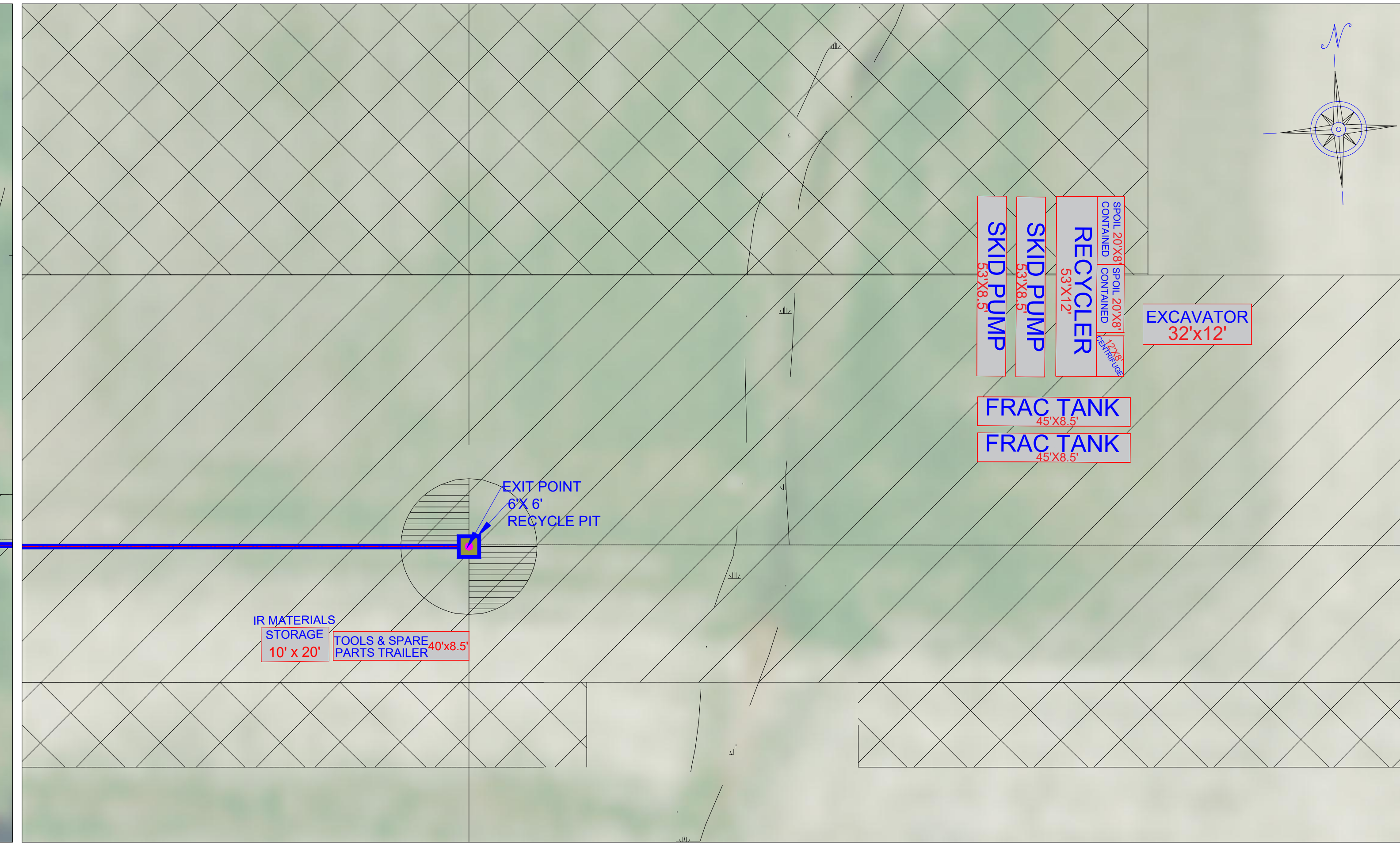
ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT



PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'

OVERALL PLAN VIEW

SCALE: 1" = 150'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR:
ENBRIDGE

PROJECT:
LINE 5 PIPELINE PROJECT

DRAWING:
CONCEPTUAL WORKSPACE DESIGN DRAWING

CROSSING REFERENCE:
MP15 - HIGHWAY 13 HDD

PRODUCT PIPES SIZE (INCHES): 30"

LOCATION: ASHLAND COUNTY, WISCONSIN

DRAWN BY: C.L.G. | JOB NUMBER: XXXXXXX

DATE: 11/18/22

Enbridge

Line 5 – Trout Brook HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL

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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 16 – 30-INCH TROUT BROOK HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 2,356'
- Notable Obstacles: Trout Brook and the surrounding shallow ravine, multiple wetlands, and a creek
- Length of Wetlands: 385' (directly east of the brook), 138' (directly west of the brook), multiple small wetlands crossed up to 683' west of the exit workspace
- Waterbody Information: Trout Brook is approximately 25' wide, and less than 10' deep at the crossing location
- Depth of HDD Under East Side Creek: 40'
- Depth of HDD Under Trout Brook: 71'

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X

- Bara-Kade
- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

<u>Upland and Terrestrial Locations</u>

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

<u>Wetland and Waterbody Locations</u>

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

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IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Trout Brook crossing is located near pipeline milepost 16, roughly 15 miles south southeast of Ashland, Wisconsin. It involves passing beneath Trout Brook and the surrounding shallow ravine, multiple wetlands, and a creek. The ravine containing Trout Brook has a width of approximately 750 feet at the crossing location, while the waterway is roughly 25 feet across and has a typical depth of less than 10 feet. The proposed HDD alignment will be established in a new right-of-way and runs primarily west to east. The designed entry point is within an open field while the exit point is located on the downward slope of a small rise. For an overview of the area, refer to the Trout Brook plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Trout Brook Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary. Temporary access could be supported by construction matting installed during clearing within the wetland areas, and a vacuum truck could be deployed if required due to the volume of the release.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the brook would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the brook, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the brook is approximately 25 feet and the average depth is less than 10 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

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ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT

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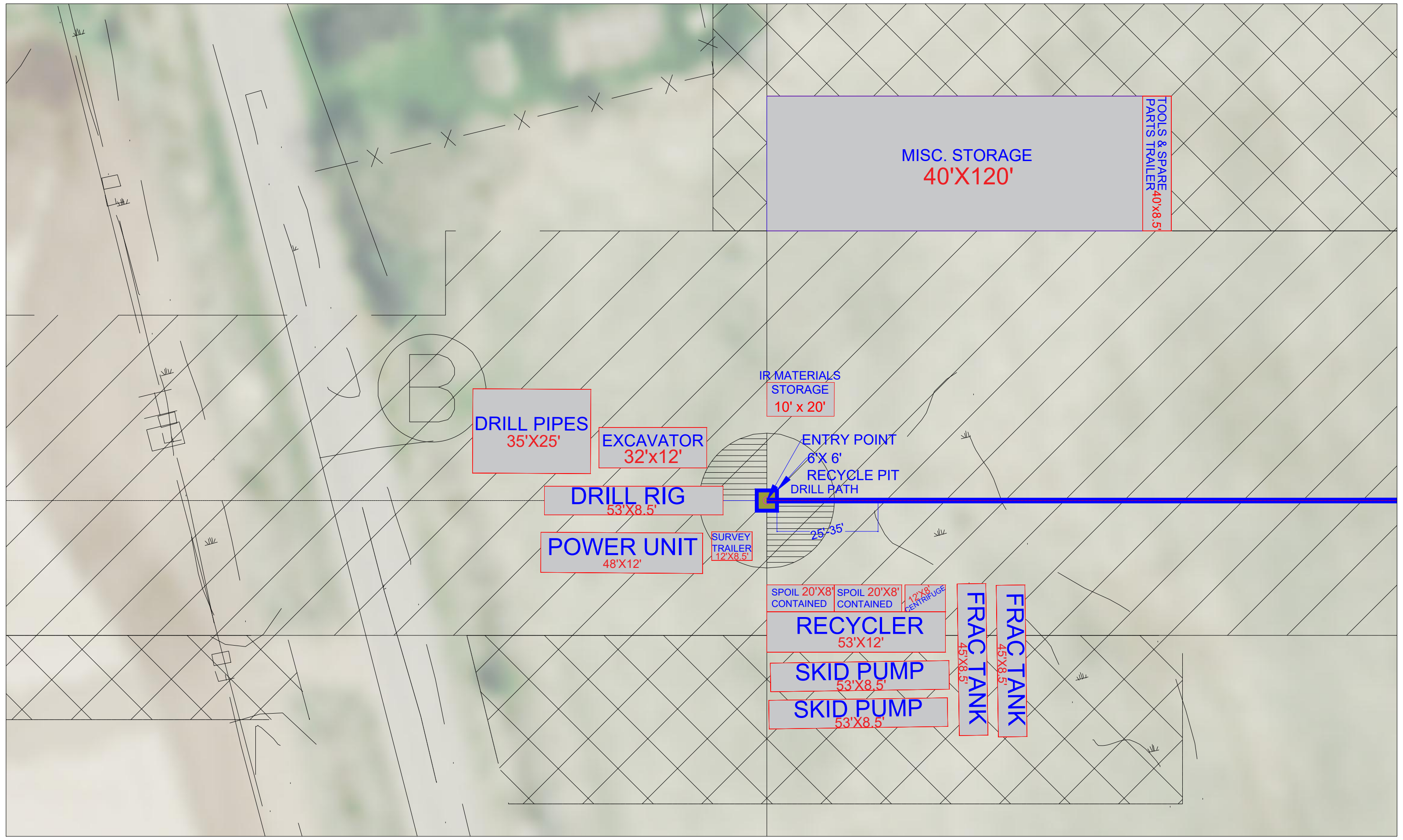
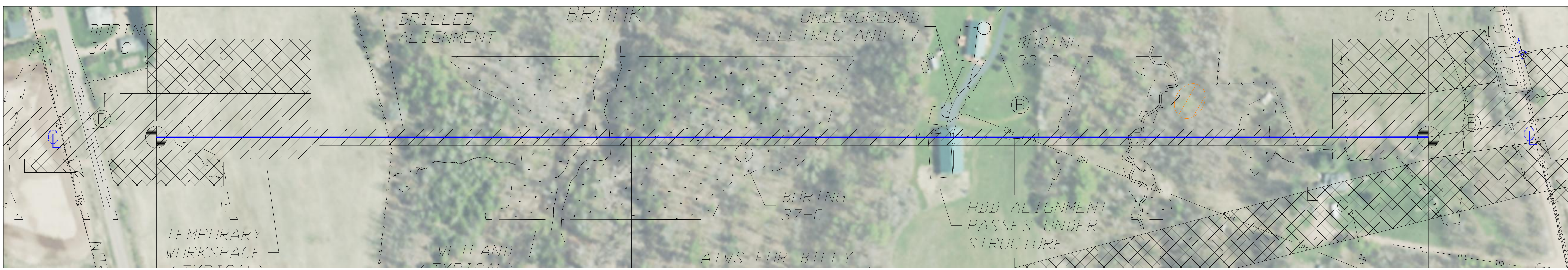


PLAN

SCALE: 1"=50'

PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 150'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

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PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4325

DIRECTIONAL BORE FOR: ENBRIDGE
PROJECT: LINE 5 PIPELINE PROJECT
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING
CROSSING REFERENCE: MP16 - TROUT BROOK HDD
PRODUCT PIPES SIZE (INCHES): 30"
LOCATION: ASHLAND COUNTY, WISCONSIN
DRAWN BY: C.L.G. | JOB NUMBER: XXXXXXX
DATE: 11/18/22

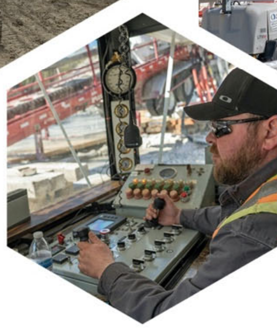
Enbridge

Line 5 – Billy Creek HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 17 – 30-INCH BILLY CREEK HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 1,788'
- Notable Obstacles: Billy Creek and the steep walls of the surrounding shallow ravine, and Poppe Road
- Waterbody Information: Billy Creek is approximately 10' wide, and less than 1' deep at the crossing location
- Depth of HDD Under Applicable Roads: Minimum of 40'
- Depth of HDD Under Waterbody: Minimum of 60'

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X
- Bara-Kade

- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller's discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Billy Creek crossing is located near pipeline milepost 17, roughly 15 miles south southeast of Ashland, Wisconsin. It involves passing beneath the Billy Creek and the steep walls of the surrounding shallow ravine. The creek has a width of approximately 10 feet at the crossing location and a typical depth of less than 1 foot at the time of the site visit. The proposed HDD alignment will be established in a new right-of-way that runs west to east, generally parallel to Highway 13. The creek and surrounding ravine are in a densely treed area, with Poppe Road to the east, and another field east of the road. Moving west from the creek is an open field, followed by a slight rise in topography before the grade drops down into a small depression that likely serves as intermittent drainage. For an overview of the area, refer to the Billy Creek plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Billy Creek Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within Billy Creek would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the creek is approximately 10 feet, and the average depth is less than a foot. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

MICHELS®
TRENCHLESS, INC.

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT

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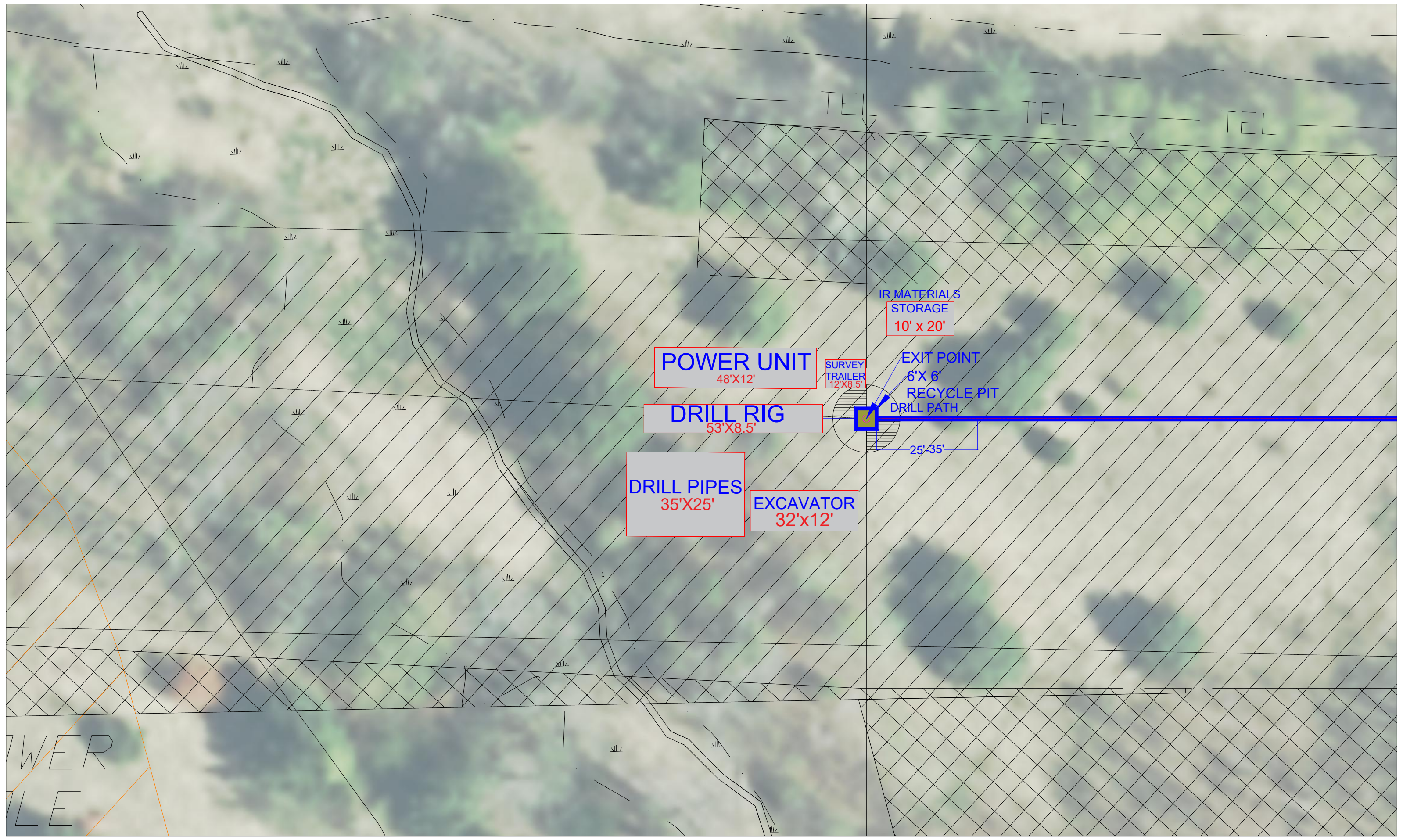
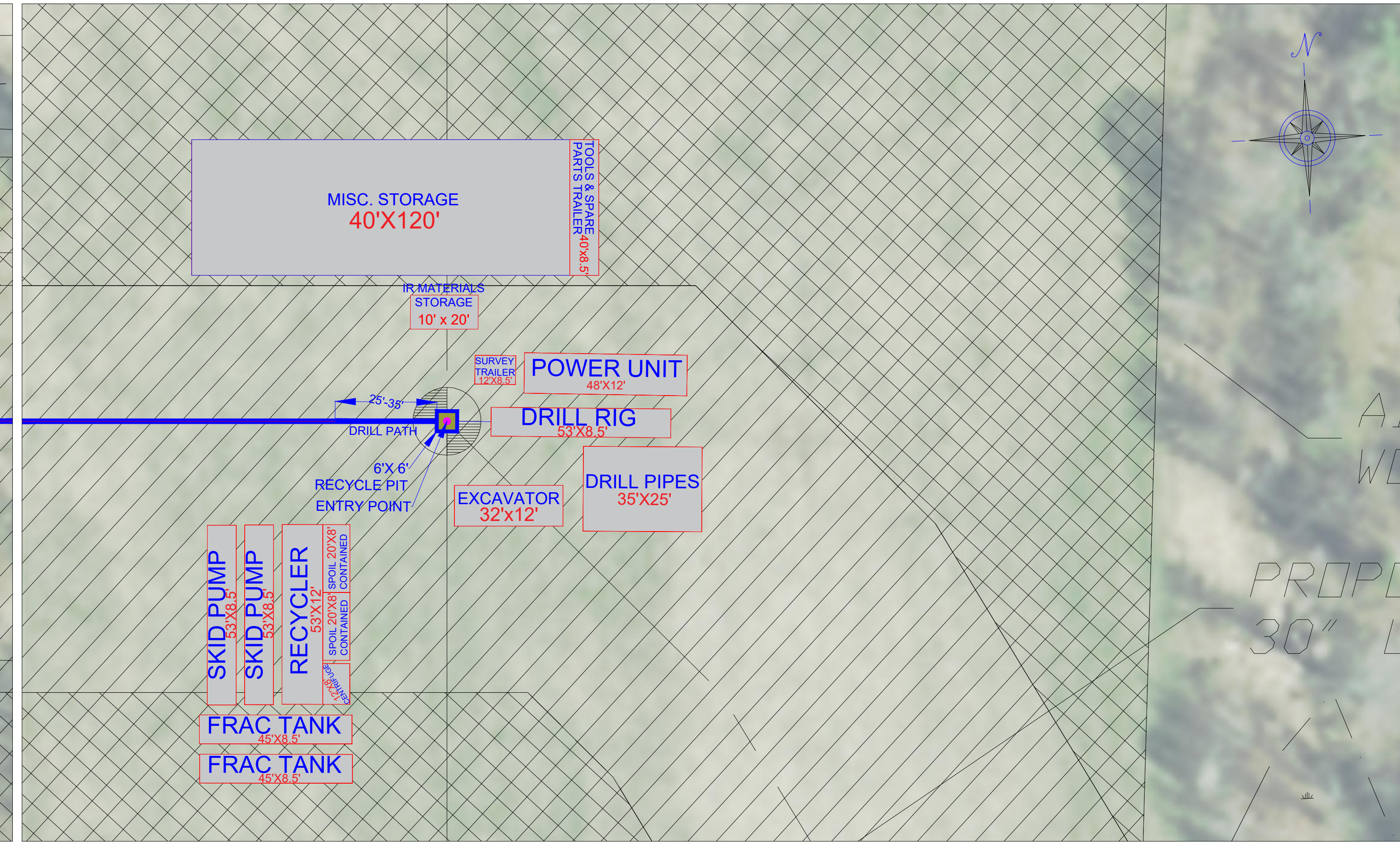
TRENCHLESS, INC.



PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'

OVERALL PLAN VIEW

SCALE: 1" = 125'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F	12/1/2022	ADDED EQUIPMENT TO EXIT SIDE	

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DIRECTIONAL BORE FOR: ENBRIDGE

PROJECT: LINE 5 PIPELINE PROJECT

DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING

CROSSING REFERENCE: MP17 - BILLY CREEK HDD

PRODUCT PIPES SIZE (INCHES): 30"

LOCATION: ASHLAND COUNTY, WISCONSIN

DRAWN BY: C.L.G. | JOB NUMBER: XXXXXXX

DATE: 11/18/22

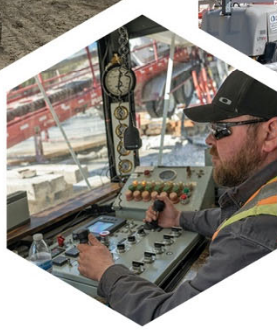
Enbridge

Line 5 - Silver Creek HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



MICHELS®
TRENCHLESS, INC.

MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 19 – 30-INCH SILVER CREEK HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 3,674’
- Notable Obstacles: Highway C, upland and creek valley wetlands, several meanders of Silver Creek, excavated gravel pit area
- Length of Wetlands: 795’ (upland area west of Silver Creek), 45’ (between two creek meanders), 130’ (east of Silver Creek in the valley)
- Waterbody Information: Three separate areas along the HDD alignment with a maximum 30’/5’ width/depth
- Depth of HDD Under Applicable Roads: Minimum of 42’
- Depth of HDD Under Waterbody: Minimum of 102’

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

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Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

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cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

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While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

<u>Containment</u>

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

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IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The Silver Creek crossing is located near pipeline milepost 19, roughly 16 miles south southeast of Ashland, Wisconsin. It involves passing beneath Highway C, a forested wetland, Silver Creek, and the surrounding creek valley. At each place the HDD alignment crosses the waterway, the creek has a width of approximately 30 feet from bank to bank and a typical depth of less than 5 feet. The proposed HDD alignment has been established in a new right-of-way running roughly west to east. For an overview of the area, refer to the Silver Creek plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted.

The creek and some of the wetlands are within the treed valley, beyond which the surface elevation quickly rises over 100 feet to the west and roughly 125 feet to the east. The topography plateaus to the west into densely forested wetland and to the east adjacent to an active gravel excavation pit. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetland along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Silver Creek Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within Silver Creek would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the HDD alignment crosses Silver Creek in multiple places with the average width of the creek at 30 feet and the average depth of 5 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT

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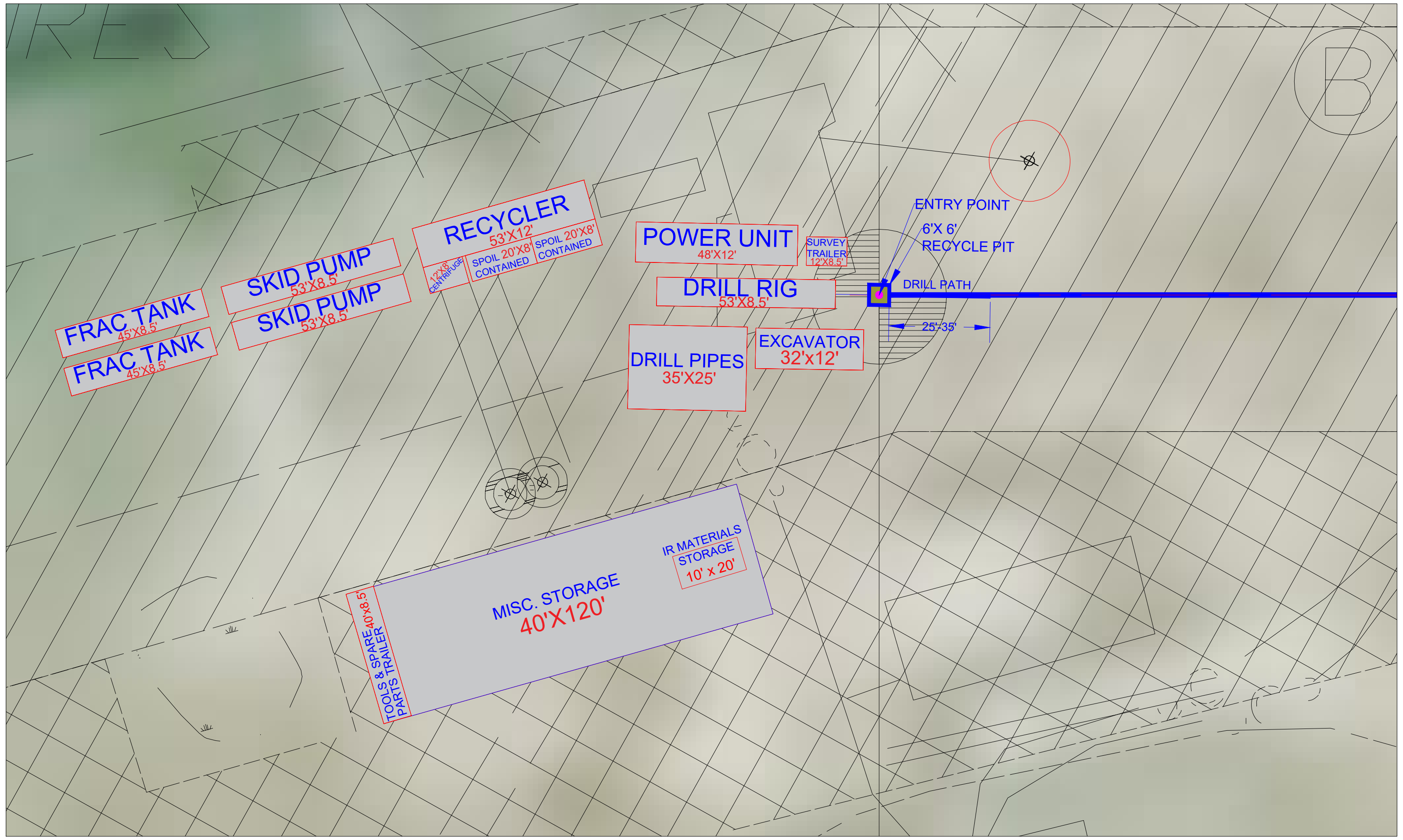
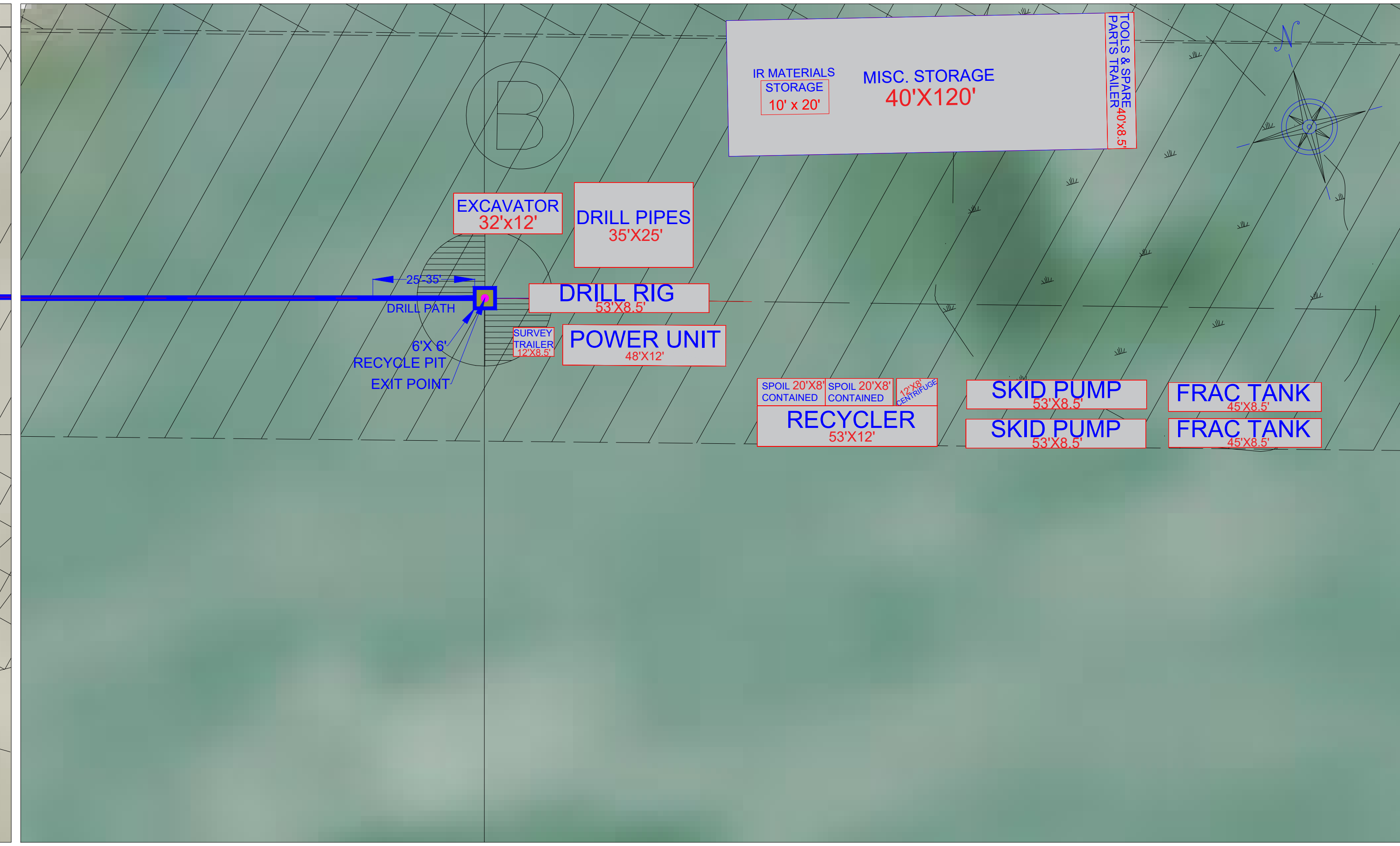


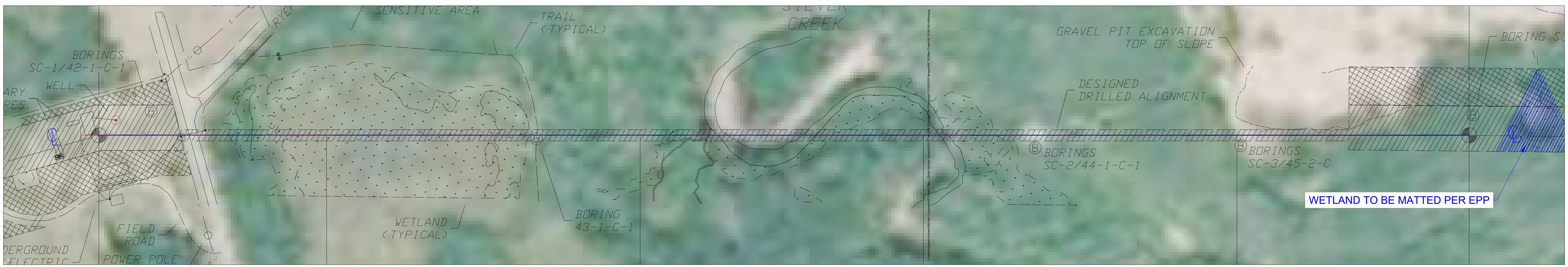
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 250'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OR DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

MICHELS®
TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR:
ENBRIDGE

PROJECT:
LINE 5 PIPELINE PROJECT

DRAWING:
CONCEPTUAL WORKSPACE DESIGN DRAWING

CROSSING REFERENCE:
MP19 - SILVER CREEK HDD

PRODUCT PIPES SIZE (INCHES): 30"

LOCATION: ASHLAND COUNTY, WISCONSIN

DRAWN BY: C.L.G. | JOB NUMBER: XXXXXXX

DATE: 11/16/22

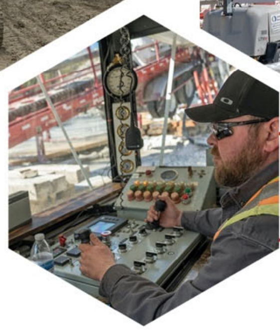
Enbridge

Line 5 - Krause Creek HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 22 – 30-INCH KRAUSE CREEK HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 2,092'
- Notable Obstacles: Krause Creek, multiple forested wetlands
- Length of Wetlands: 172' (directly southeast of entry workspace), 27' (north of Krause Creek within a small ravine)
- Waterbody Information: Krause Creek has a width of roughly 15' and depth typically less than 5 feet.
- Depth of HDD Under Waterbody: Minimum of 58'

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X
- Bara-Kade
- AMC Gel

- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

<u>Upland and Terrestrial Locations</u>

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

<u>Wetland and Waterbody Locations</u>

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

<u>**Communication**</u>

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
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In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

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IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Krause Creek crossing is located near pipeline milepost 22, roughly 19 miles south, southeast of Ashland, Wisconsin. It involves passing beneath Krause Creek and the surrounding ravine, which contains multiple wetlands throughout the wooded area. While the creek only has a width of roughly 15 feet from bank to bank at the crossing location and a typical depth of less than 5 feet, the ravine is a more substantial obstacle. Krause Creek and the wetlands are within the treed ravine, beyond which the surface elevation sharply rises roughly 40 feet to the east and more gently rises to the west.

The crossing area plateaus on the north side in an open field while the south end appears to be in a thickly wooded area. The proposed HDD alignment will be established in a new right-of-way that runs mostly north to south. For an overview of the area, refer to the Krause Creek plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetland along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the "Prevention" section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Krause Creek Crossing will follow procedures outlined in the "Containment" section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within Krause Creek would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the HDD alignment crosses Krause Creek where the width of the creek is roughly 15 feet and the depth less than 5 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

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Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT

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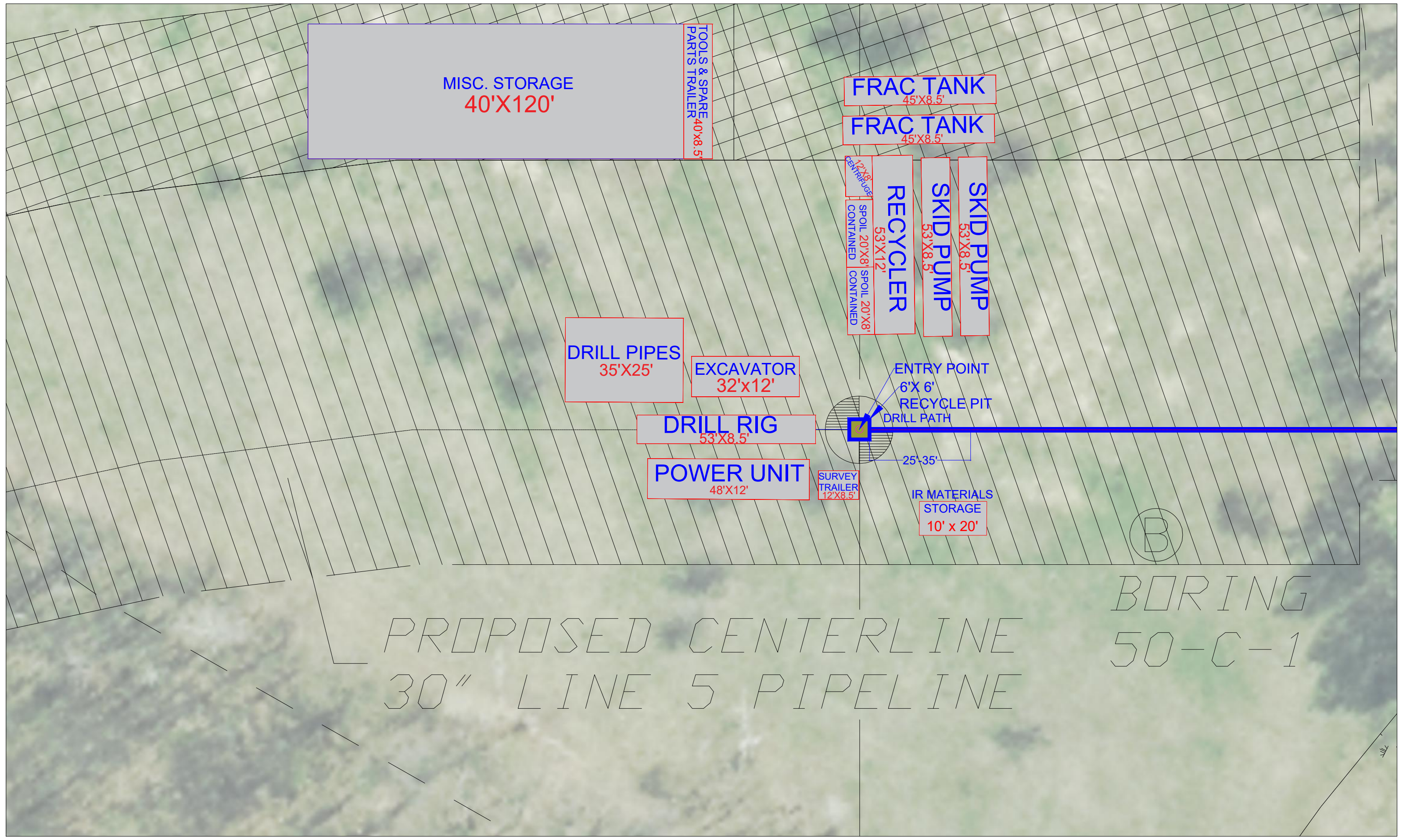

PLAN

SCALE: 1"=50'

PLAN

SCALE: 1"=50'

OVERALL PLAN VIEW

SCALE: 1" = 150'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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DIRECTIONAL BORE FOR: ENBRIDGE	
PROJECT: LINE 5 PIPELINE PROJECT	
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING	
CROSSING REFERENCE: MP22 - KRAUSE CREEK HDD	
PRODUCT PIPES SIZE (INCHES): 30"	
LOCATION: ASHLAND COUNTY, WISCONSIN	
DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/18/22	

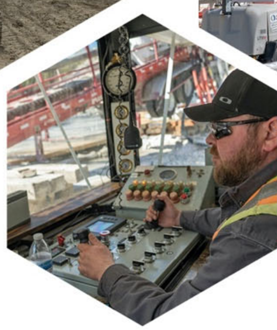
Enbridge

Line 5 – Bad River HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 24 – 30-INCH BAD RIVER HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 1,788'
- Notable Obstacles: CN Railroad tracks, Bad River, multiple wetlands, and Copper Falls Drive
- Length of Wetlands: 672' (east of the Bad River), 268' (east of Copper Falls Drive), 75' (surrounding the exit point)
- Waterbody Information: The Bad River is approximately 70' wide, and less than 5' deep at the crossing location
- Depth of HDD Under Applicable Wetlands: Minimum of 30'
- Depth of HDD Under Waterbody: Minimum of 47'

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel

- Super-Gel X
- Bara-Kade
- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac

		truck or other storage tank. Maintain exterior valves.
Vac Trucks/Dump Trucks: Possible leak or release at valve location or worn hose.	**Vac Truck Driver:** Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags
- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid

- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line
- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

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IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Bad River crossing is located near pipeline milepost 24, roughly 20 miles south southeast of Ashland, Wisconsin and on the northern edge of Mellen, Wisconsin. It involves passing beneath a set of CN Railroad tracks, the Bad River, multiple wetlands, and Copper Falls Drive. The river has a width of approximately 70 feet from bank to bank at the crossing location and a typical depth of less than 5 feet when the survey was performed. The proposed HDD alignment will be established in a new right-of-way running west to east. The river, environmentally sensitive area, and most of the wetlands are within what look to be the Bad River flood plain, beyond which the elevation rises steadily when moving out from each proposed end point.

West of the railroad is densely treed while cultivated fields lie east of the prominent wetlands. For additional details relative to site access locations, the project alignment sheets should be consulted. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Bad River Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the Bad River would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the river, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the river is approximately 70 feet and the average depth is less than 5 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

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6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
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Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

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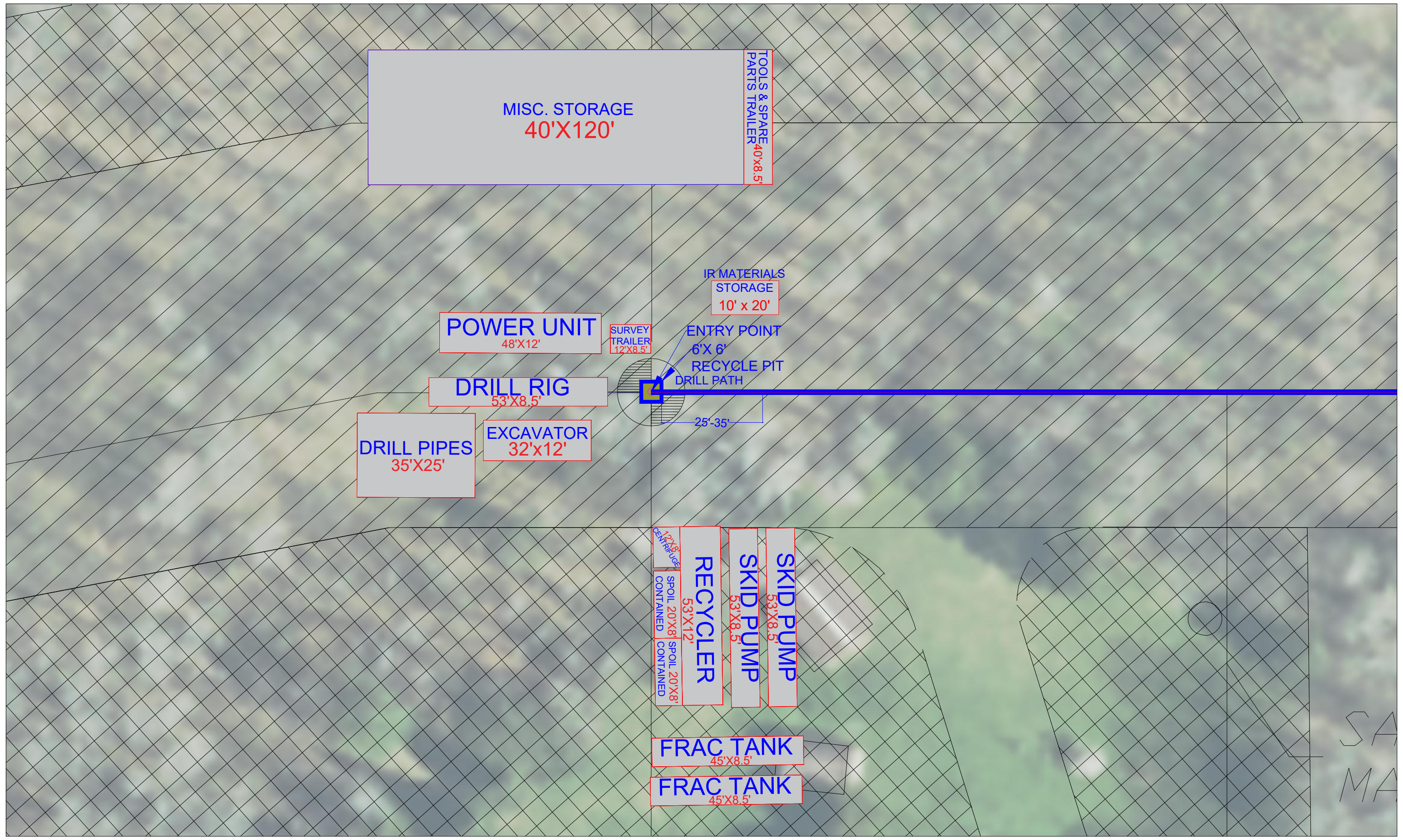
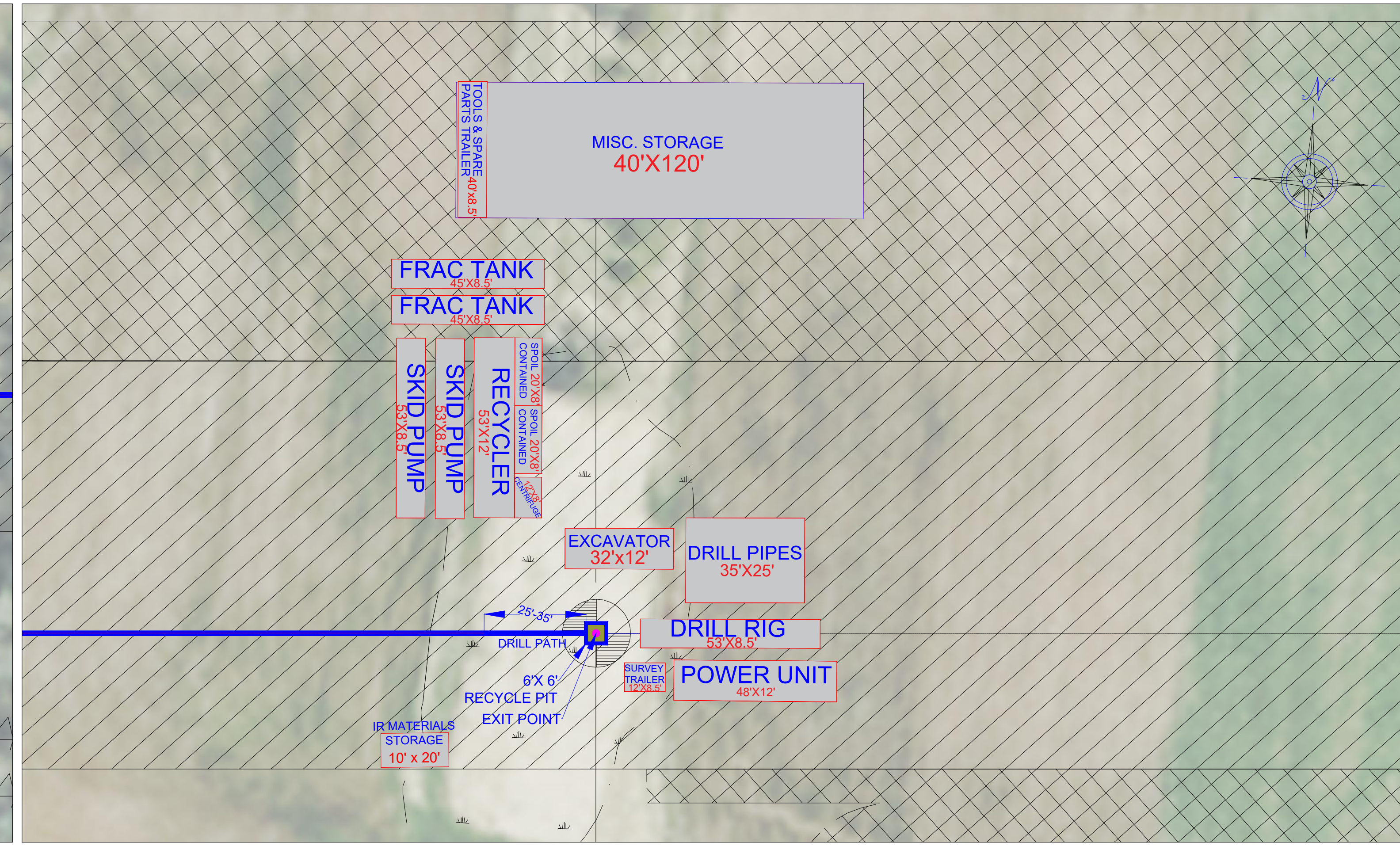


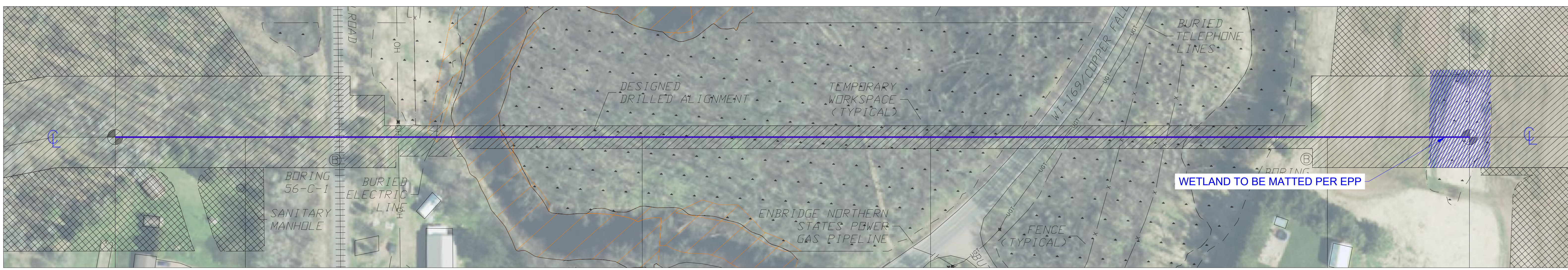
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 125'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4325

DIRECTIONAL BORE FOR: ENBRIDGE
PROJECT: LINE 5 PIPELINE PROJECT
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING
CROSSING REFERENCE: MP24 - BAD RIVER HDD
PRODUCT PIPES SIZE (INCHES): 30"
LOCATION: ASHLAND COUNTY, WISCONSIN
DRAWN BY: C.L.G. JOB NUMBER: XXXXXXX
DATE: 11/18/22

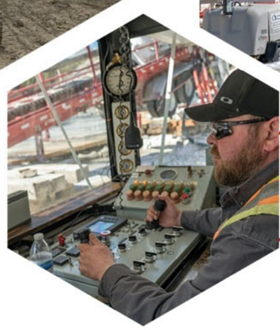
Enbridge

Line 5 – Tyler Forks HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 34 – 30-INCH TYLER FORKS HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 1,851’
- Notable Obstacles: Tyler Forks waterway and multiple wetlands
- Length of Wetlands: 211’ (directly southwest of the entry point), 43’ (547’ southwest of the entry point), 15’ (on either side of the Tyler Forks waterway)
- Waterbody Information: The Tyler Forks waterway is approximately 57’ wide, and less than 10’ deep at the crossing location
- Depth of HDD Under Waterbody: Minimum of 60’

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X
- Bara-Kade

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- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller's discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Tyler Forks crossing is located near pipeline milepost 34, roughly 21 miles southeast of Ashland, Wisconsin and 3.5 miles south of Gurney, Wisconsin. It involves passing beneath the Tyler Forks and multiple wetlands. The main waterway has a width of approximately 57 feet from bank to bank along the project alignment. At the crossing location, there were no survey points to determine the depth of the stream; however, around 150 feet downstream, depths of roughly 2 feet were noted. The proposed HDD alignment will be established in a new right-of-way running mostly south to north. Across the length of the crossing, the topography is generally flat with a small rise of around 12 feet just north of the Tyler Forks. For the most part, the entire area is densely wooded, even throughout the identified wetlands.

For an overview of the area, refer to the Tyler Forks plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Tyler Forks Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the Tyler Forks would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the waterway, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the waterway is approximately 50 feet and the average depth is 2 feet. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

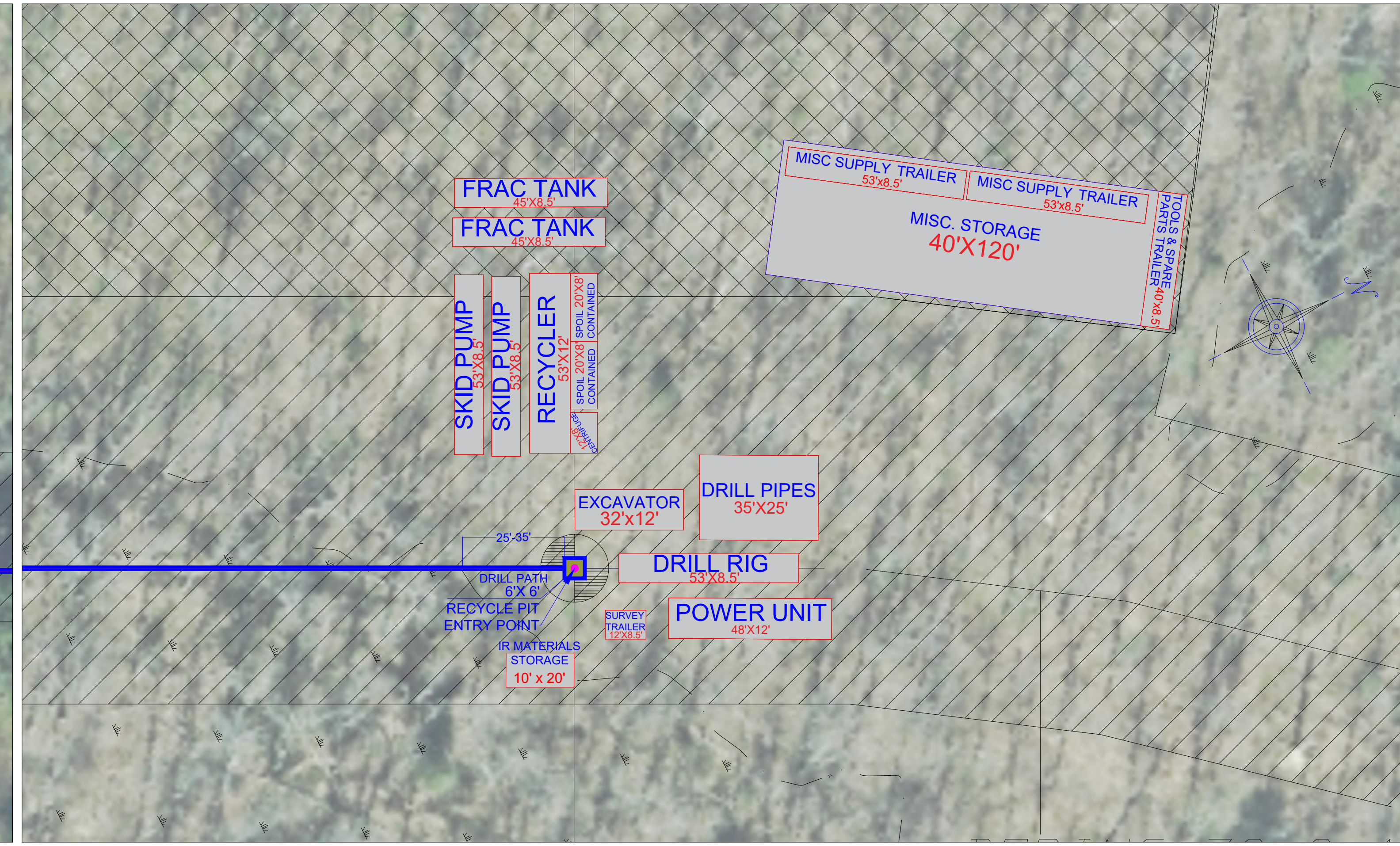
For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT

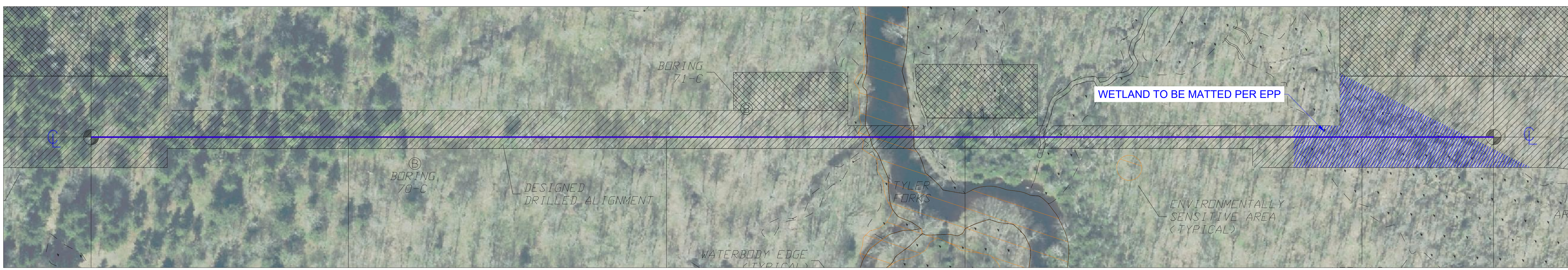
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 125'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

MICHELS®
TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR: ENBRIDGE	
PROJECT: LINE 5 PIPELINE PROJECT	
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING	
CROSSING REFERENCE: MP34 - TYLER FORKS HDD	
PRODUCT PIPES SIZE (INCHES): 30"	
LOCATION: ASHLAND COUNTY, WISCONSIN	
DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/18/22	

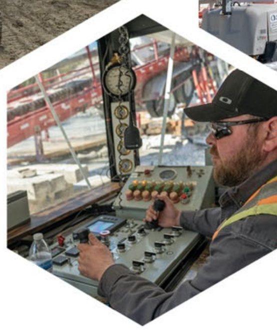
Enbridge

Line 5 – Potato River HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



MICHELS®
TRENCHLESS, INC.

MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 38 – 30-INCH POTATO RIVER HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 3,496'
- Notable Obstacles: Potato River, the surrounding flood plain, and multiple wetlands
- Length of Wetlands: The HDD alignment crosses beneath multiple 300' to 500' wide stretches of wetland over the length of the crossing
- Waterbody Information: The Potato River is approximately 35' wide, and less than 5' deep at the crossing location
- Depth of HDD Under Wetlands: Minimum of 20' directly north of the entry workspace
- Depth of HDD Under Waterbody: Minimum of 60'

II. DRILLING FLUID PLAN

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While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller's discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#2 (If Needed)		***Michels Trenchless Inc.***
Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Potato River crossing is located near pipeline milepost 38, roughly 21 miles east-southeast of Ashland and less than 2 miles directly east of Gurney, Wisconsin. It involves passing beneath the Potato River, the surrounding flood plain, and multiple wetlands. The river has a width of approximately 35 feet from bank to bank at the crossing location and a typical depth of less than 5 feet at the time of the survey. The proposed HDD alignment will be established in a new right-of-way running directly south to north. The river and some of the wetlands are within the wooded flood plain, adjacent to the river meander loops. To the south, just beyond the river, the surface elevation sharply rises roughly 65 feet, plateauing near the exit point.

Across the entire length of the crossing, the area is densely wooded. For an overview of the area, refer to the Potato River plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the “Prevention” section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Potato River Crossing will follow procedures outlined in the “Containment” section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within the Potato River would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the river, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the river is approximately 35 feet and the average depth is less than 5 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

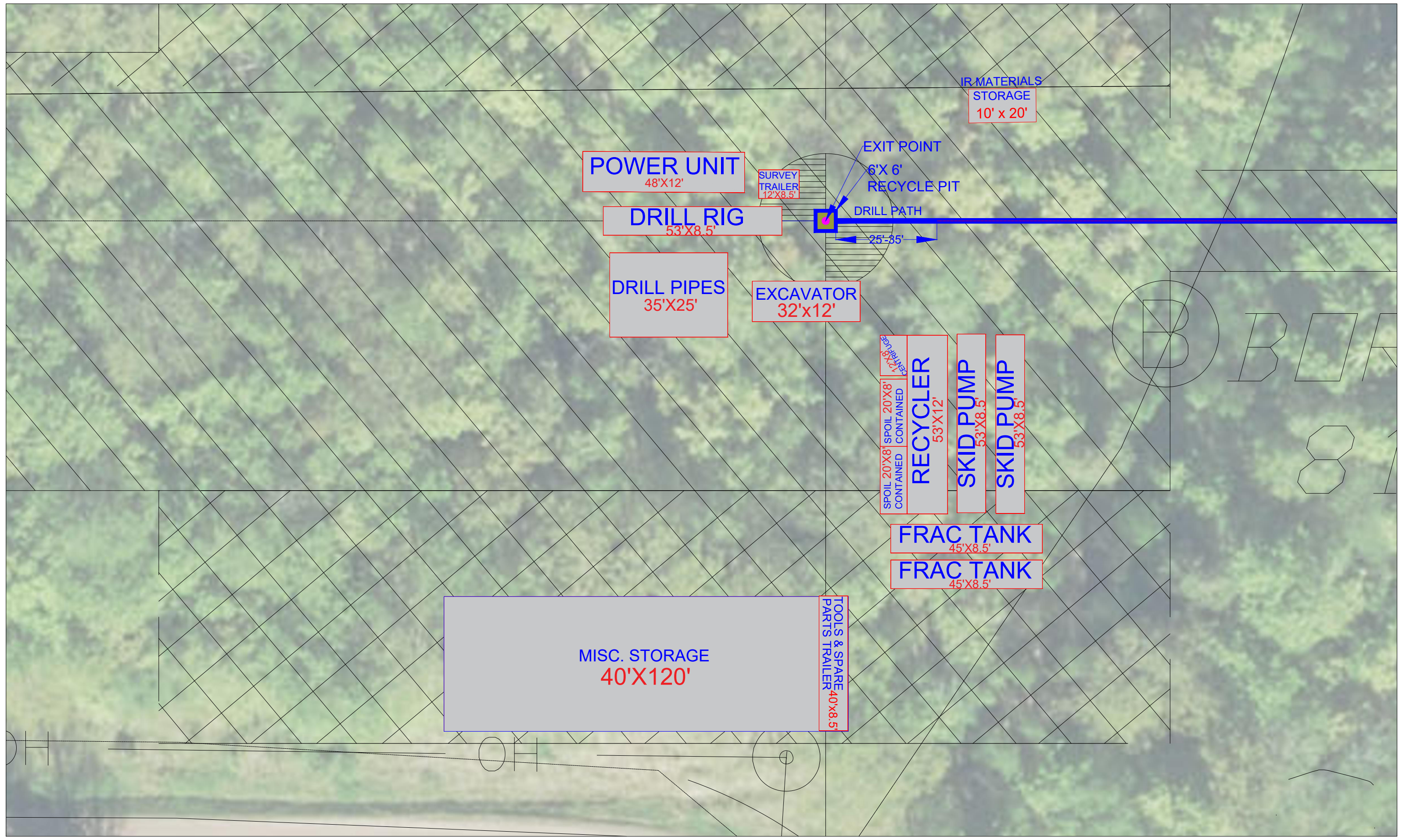
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

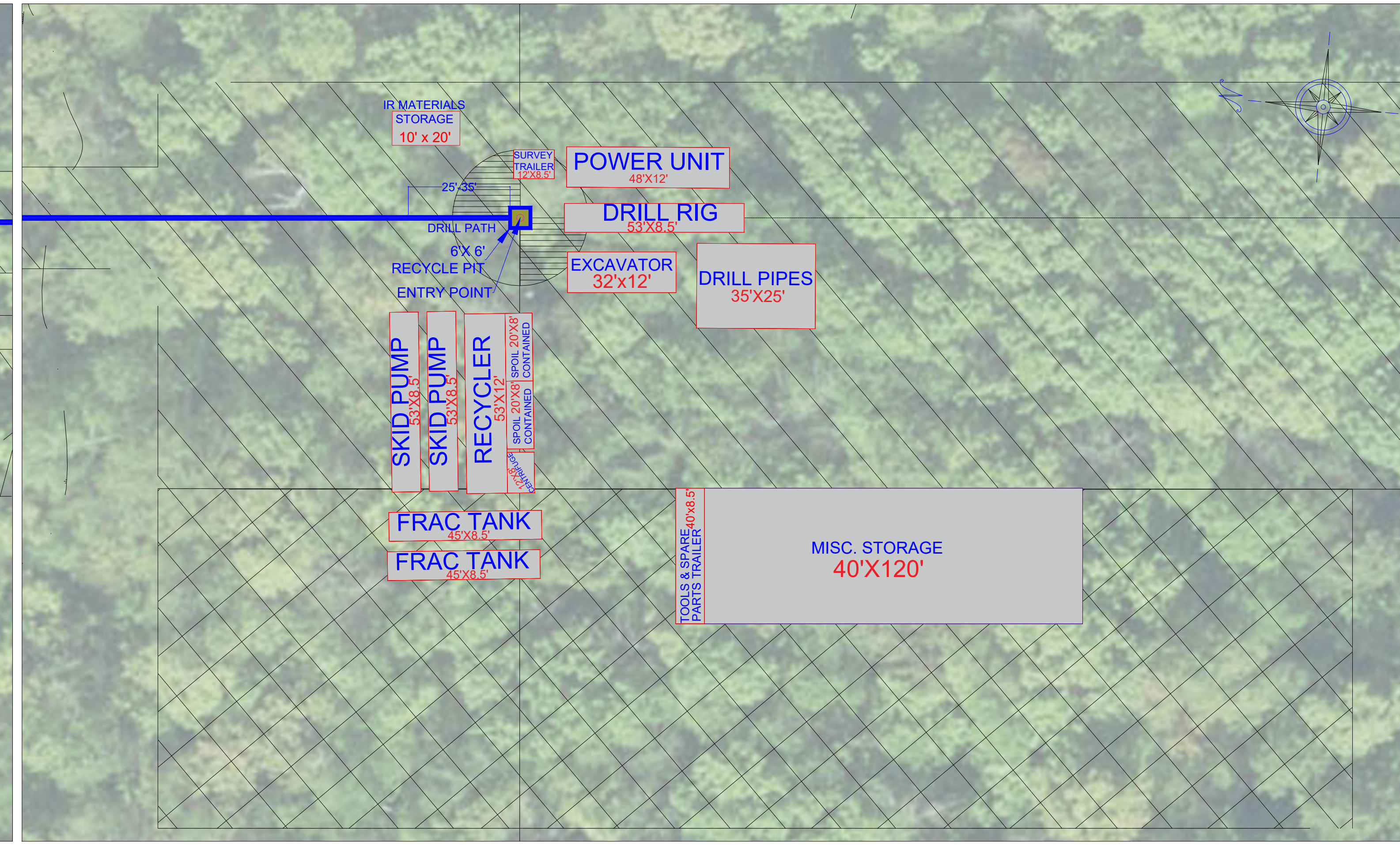
ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT



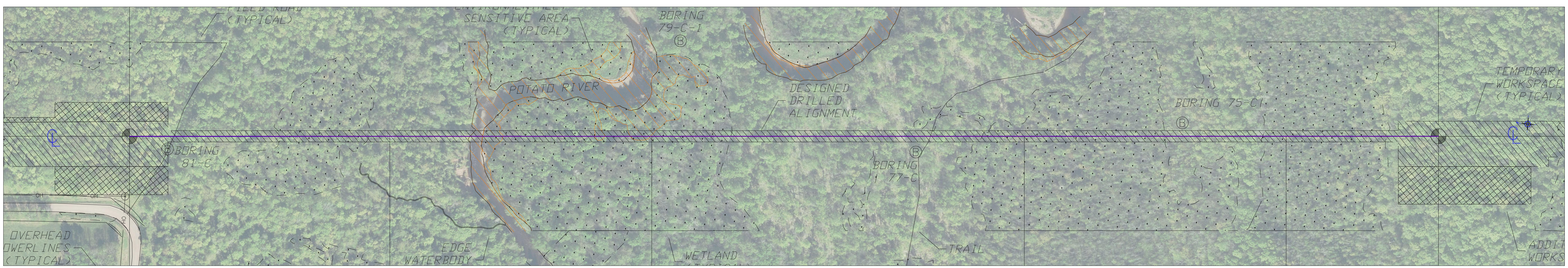
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 250'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICATION IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

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TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR: ENBRIDGE	
PROJECT: LINE 5 PIPELINE PROJECT	
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING	
CROSSING REFERENCE: MP38 - POTATO RIVER HDD	
PRODUCT PIPES SIZE (INCHES): 30"	
LOCATION: ASHLAND COUNTY, WISCONSIN	
DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/18/22	

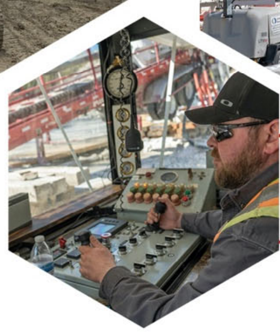
Enbridge

Line 5 – Vaughn Creek HDD Crossing

HDD INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

12/2/2022

PROPRIETARY & CONFIDENTIAL



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MICHELS TRENCHLESS INCORPORATED (MTI)

INADVERTENT RETURN MITIGATION AND CONTINGENCY PLAN

ENBRIDGE LINE 5 PROJECT

MP 39 – 30-INCH VAUGHN CREEK HDD CROSSING

I. SITE SPECIFIC HDD INFORMATION

In preparing the site-specific Inadvertent Return Mitigation and Contingency Plan for this crossing, the following information has been considered:

- HDD Length: 2,072'
- Notable Obstacles: Vaughn Creek, the surrounding ravine, and multiple wetlands
- Length of Wetlands: The HDD alignment crosses through 50' to 100' wide wetlands in multiple locations on the south (entry) side of the crossing and the creek ravine
- Waterbody Information: Vaughn Creek is approximately 25' wide, and less than 5' deep at the crossing location
- Depth of HDD Under Waterbody: Minimum of 60'

II. DRILLING FLUID PLAN

Essential to any successful HDD installation is the selection and proper utilization of drilling fluid, which consists primarily of water and dehydrated bentonite clay. Bentonite is a naturally occurring, non-toxic, inert substance that meets NSF/ANSI-60 Drinking Water Additive Standards and is frequently used for drilling potable water wells. The primary environmental impact of an inadvertent release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or settles out. Bentonite serves many purposes in the HDD process, including:

- Cleans the drilled cuttings from the bore hole
- Cools downhole drilling tools
- Transports cuttings to the surface
- Creates a wall cake within the annulus which aids in stabilizing the bore hole and prevents fluid loss into the formation
- Provides lubrication for the drill string and downhole assembly, reducing frictional forces
- Drives a downhole motor for rock drilling
- Provides hydrostatic fluid pressure in the bore hole to offset groundwater and formation pressures

The selected drilling fluid for this crossing consists of water (approximately 96%) and bentonite clay (approximately 4%). MTI has access to several different brands of bentonite. The selection of which brand to use is typically based on price, availability, and proximity to the proposed drill site. The following brands all have similar characteristics and provide the results described above:

- Max Gel
- Super-Gel X
- Bara-Kade

- AMC Gel
- SW-101

The bentonite will be mixed in a tank with a volume of up to 5,000 gallons, depending on mud rig size, in accordance with the manufacturer's recommendations. Approximately 15 to 20 pounds of powder bentonite will be mixed with 100 gallons of water and will be used throughout the entire drilling process to establish and maintain optimum drilling fluid properties. MTI maintains fluid performance through the daily sampling, testing, and recording of fluid properties during drilling operations. This provides the MTI Mud Technician the information needed to make educated recommendations regarding maintenance of efficient drilling fluid rheology consistent with hole stabilization and limiting of inadvertent surface returns.

Once the drilling fluid is thoroughly mixed to an acceptable consistency, it is pumped from the mud tank to the back end of the drilling rig. From there it is injected under high pressure through the drill stem at a rate of 300 to 800 gpm until it is expended through one or more nozzles in the drill bit. The spent drilling fluid, mixed with accumulated cuttings, flows back through the annular space between the drill stem and the formation wall. Drilling fluid eventually returns to the entry pit where it is pumped by a 6 hp submersible pump to the fluid recycling and processing system.

The first phase of the fluid processing system displaces solid returns at the shakers. Heavy solids are sifted out by a shaker with screens and transported from the site by dump truck to a disposal site. The scalped cuttings containing medium fines and reusable drilling fluid are pumped to the next phase of processing, which takes place at the desilter/mud cleaning unit. The heavier cuttings are again processed out for disposal while the recycled drilling fluid is pumped back and reused in the drilling process.

Additives may be deemed necessary based on evaluations and recommendations made by the Mud Technician during drilling and hole opening operations. If the need for drilling fluid additives does arise, it is anticipated that all additives used will be listed on the Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List.

III. PREVENTION – CONTAINMENT – COMMUNICATION

This section elaborates on measures to be implemented by MTI if an inadvertent release of drilling fluid occurs despite prevention efforts. Hydraulic fracture, also known as hydrofracture, is a phenomenon that occurs when drilling fluid pressure in the annular space of the drilled hole exceeds the strength of the surrounding soil, resulting in plastic deformation and fracturing. Uncontrolled expansion and fracture propagation in the soil surrounding the borehole can serve as a means by which drilling fluid can flow into the formation, resulting in lost circulation. In some cases, drilling fluid that is lost to the formation can flow up to the ground surface at locations other than the HDD end points, resulting in an inadvertent drilling fluid return.

Although hydrofracture may be one mechanism by which inadvertent drilling fluid returns occur, it is not the only one. In fact, it is thought that inadvertent returns due to true hydrofracture occur in only a small percentage of cases. Drilling fluid flows in the path of least resistance. Ideally, that path is through the annulus of the drilled hole and back to the drilling fluid containment pits at the HDD endpoints. However, the path of least resistance may also be through naturally occurring subsurface features such as fissures in the soil, shrinkage

cracks, or porous deposits of gravel. Drilling fluid may also flow to the surface along existing piers, piles, utility poles, or other structures.

Prior to the commencement of drilling operations, MTI will inform construction personnel of the responsible parties for release containment and response. MTI will ensure that the appropriate response personnel and containment equipment are on site.

Prevention

MTI drilling personnel are trained in the safe handling and use of drilling fluids and materials associated with directional drilling. Every project has a designated supervisory person responsible for implementation and execution of environmental policy, safety monitoring and reports, and implementation of mitigation plans. The Project Supervisor is well-versed in the written procedures and policies and is responsible for carrying them out.

Prevention of accidental spills of drilling fluid during HDD operations in the following areas is accomplished by the following actions. The responsible person follows proper protocol and established procedures for their job assignment.

Area of Potential Spill	Responsible Personnel	Preventative Action
Mud Containment Pits: Potential overflow located at excavated entry and exit areas.	**Driller:** Closely monitor fluid returns in the drill entry pit in view of the drill survey trailer to maintain appropriate levels.	**Response:** Contain Area. If fluid level becomes high, run pump continuously in pit until safe level is achieved. Add multiple pumps if required.
Hoses: Possible leaks at the connection between tanks and sump pumps.	**Mud Technician:** Inspect hose connections every day for leaks and wear while maintaining a full stock of replacement parts in the supply trailer.	**Response:** Contain Area. Repair leaks and replace worn-out hoses and parts.
Containment Tanks: Potential overflow or leak at soil separation, cuttings containment and solids control tanks.	**Mud Technician:** Continuously observe and control fluid levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.
Frac Tanks: Potential overflow or leak at temporary holding tank for drill cuttings and fluids. At exterior valve location.	**Mud Technician:** Continuously observe levels and flow from a birds-eye view located on the top deck of the mud mixing/soil separation rig.	**Response:** Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck or other storage tank. Maintain exterior valves.

Vac Trucks/Dump Trucks:	Vac Truck Driver:	Response:
Possible leak or release at valve location or worn hose.	Maintain equipment in proper working order and follow specific guidelines in operation of vacuum and valves.	Contain Area. If solid control tanks reach overflow point, pump down to manageable level. May have to pump excess fluid/cuttings to vac truck.

During construction, MTI personnel will be aware of the importance of timely detection and response actions with respect to any release of drilling fluid. MTI personnel will have appropriate operational communication equipment, with the ability to communicate directly with the drilling rig operator, available at all times. The absence of an open bore hole conduit or the presence of a major formation fracture can lead to partial, and potentially total, loss of drilling fluid circulation.

While it is impossible to determine the precise nature of this type of fluid loss, it is possible to accurately monitor for it by watching for a significant difference between the rates the fluid is being pumped down hole and the rate it returns to the surface. The drilling fluid pumping rate and the rate of drilling fluid return to the surface is constantly monitored by the driller while the drilling is progressing. The driller will know immediately if an unusually high volume of drilling fluid is being lost down hole, depending on the ground conditions encountered in the crossing and taking into account the volume used to fill the bore hole. If the rig operator identifies a sustained loss in drilling fluid pressure or a loss of circulation, the following steps will be taken:

- Temporarily cease drilling operations, including pump shut down
- Dispatch experienced observers to monitor the area in the vicinity of the crossing for inadvertent drilling fluid returns at the ground surface
- Identify the position of the drill head in relation to the point of entry
- Restart the pump and stroke the bore hole up and down in 30-foot stroke lengths up to 6 times, but no fewer than 2, in an effort to size the bore hole annulus and reopen the circulation pathway
- Drilling fluid properties may be modified to aid in reestablishing circulation
- Personnel will continuously monitor for inadvertent fluid returns as long as the pump remains on
- Based on the driller’s discretion, stroke length may be increased up to 90 feet or beyond the point at which circulation is believed to be lost

If circulation is reestablished, drilling will proceed as usual. If drilling fluid returns continue to diminish, or are lost completely, MTI will consult with the Owner before drilling resumes. The HDD alignment will be continually monitored for surficial drilling fluid as drilling proceeds.

Containment

Containment, response, and clean-up equipment will be available on both sides of the HDD crossing location prior to the commencement in order to assure a timely response in the event of an inadvertent drilling fluid release. Containment and response equipment includes but is not limited to:

- Straw bales and staking
- Pre-filled sandbags

- Turbidity curtain
- Check dams
- Silt fence
- Plastic sheeting and/or geotextile fabric
- Shovels, brooms, buckets, and other appropriate hand tools
- Pumps and sufficient hoses
- Fluid storage tanks
- Backhoe
- Vacuum truck
- Small boat (for larger rivers and open water wetlands as necessary)
- Light plant/generator

If an inadvertent drilling fluid release is observed, MTI will assess to determine the amount of fluid being released and the potential for the release to reach sensitive resource areas (e.g., wetlands, waterbodies). If an inadvertent return is discovered along the alignment and the amount of surficial drilling fluid is not great enough to allow practical collection, the affected area will be diluted with fresh water and allowed to dry and dissipate naturally. If the amount of surficial returns exceeds that which can be suitably contained with hand placed containment barriers, small collection sumps (less than 3.8 cubic meters) will be used to pump fluid back to the solids control system. Response measures will vary based on the location of the inadvertent release as discussed below.

Upland and Terrestrial Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an accessible upland location, the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Contain the location such that the drilling fluid cannot migrate across the ground surface
- Excavate a small sump at the location and provide a means for the fluid to be returned to either the drilling fluid system or a disposal site (i.e., pump through hose or into tanker)
- Continue drilling operations after Owner representative approval
- Maintain the integrity of the containment measures, and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled

Wetland and Waterbody Locations

When drilling fluid returns are observed to be continuously surfacing above ground at an inaccessible location (i.e., wetlands or waterbodies), the following procedure will be followed:

- Immediately cease pumping drilling fluid
- Notify on-site contractor supervisor and Owner representative as required by the communication plan
- Evaluate the release and implement appropriate containment measures
- Evaluate the recovery measures to determine the most effective collection method
- Ensure that all reasonable measures within the limitations of the technology have been taken to reestablish drilling fluid circulation
- Upon approval from Owner representative, continue drilling with the minimum amount of drilling fluid required to penetrate the formation and successfully install the product line

- Maintain the integrity of the containment measures and monitor the fluid returns as required to ensure that no additional surface migration occurs
- Carry out clean-up once inadvertent returns are contained/controlled
- Consult with Owner and regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions drilling may proceed

Clean-up

The following clean-up measures are to be considered as appropriate:

- Drilling fluid will be cleaned up by hand using shovels, buckets, and soft-bristled brooms as possible without causing extensive damage to existing vegetation
- Containment structures will be pumped out and the ground surface scraped to bare topsoil without causing undue loss of topsoil or damage to existing and adjacent vegetation
- Material will be collected in containers for temporary storage prior to removal from the site

Following clean-up activities, restoration of affected areas will be completed in accordance with all applicable local, state, and federal permits in addition to project environmental requirements.

Communication

Site Specific contacts are as follows:

Contacts	Phone No.	Affiliation
Drilling Contractor *On-Site Representative* TBD Project Manager		***Michels Trenchless Inc.***
Drilling Contractor *On-Site Representative* TBD Drill Superintendent-HDD RIG#1		***Michels Trenchless Inc.***
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Drilling Contractor *Off-Site Representative* TBD Assist. Operations Manager		***Michels Trenchless Inc.***

In case of emergency, MTI will notify the on-site inspector who will refer to the communication plan. The representative chain of communication is as follows:

Contacts	Phone No.	Affiliation
After Hours Contact		

The Owner's Field Representative will contact the following Organizations as needed:

Contacts	Phone No.	Affiliation

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IV. SITE SPECIFIC RESPONSE

Site Access and HDD Monitoring

The 30-inch Vaughn Creek crossing is located near pipeline milepost 39, roughly 20 miles east of Ashland, Wisconsin and 3.5 miles west of Saxon, Wisconsin. It involves passing beneath Vaughn Creek and the surrounding ravine, as well as multiple wetlands. The creek has a width of approximately 25 feet from bank to bank at the crossing location and a typical depth of less than 5 feet. The proposed HDD alignment will be established in a new right-of-way running south to north while mostly paralleling an overhead powerline corridor to the west. The creek and some of the wetlands are within the wooded ravine, beyond which the surface elevation sharply rises roughly 70 feet, plateauing on both sides into dense trees.

At the top of both banks, the topography gently slopes down through densely forested areas with wetlands scattered throughout on the south side of the ravine. For an overview of the area, refer to the Vaughn Creek plan and profile design drawing. For additional details relative to site access locations, the project alignment sheets should be consulted. Prior to commencing drilling operations vegetation will be cleared within proposed workspace, during which time construction matting could be placed in the wetlands along the drill path to support monitoring for, and response to, any potential inadvertent releases. Drill path monitoring will follow the measures described in the "Prevention" section of this plan.

Inadvertent Release Response and Clean-up

Initial response to an upland or wetland inadvertent release on the Vaughn Creek Crossing will follow procedures outlined in the "Containment" section of this plan. Low ground pressure equipment will conduct limited passes to assist personnel carrying containment materials to a release location if necessary.

If a release were to occur outside of the proposed workspace shown on the plan and profile drawing, MTI would mobilize lightweight containment materials (e.g. hay bales, silt fence, sand bags) on foot to the inadvertent return location to isolate the surficial drilling fluid immediately. Response to an inadvertent release within Vaughn Creek would include placement of a turbidity curtain to isolate and envelop the released drilling fluid against the nearest bank of the creek, as feasible. The turbidity curtain placement and drilling fluid recovery efforts are dependent on the water depth and bed features at the time and location of the release. As mentioned above, the average width of the creek is approximately 25 feet and the average depth is less than 5 feet, therefore, multiple sections of turbidity curtains may be required. Once drilling fluid has been contained, a determination will be made as to the necessity for additional equipment or alternate access locations. Should an inadvertent drilling fluid return occur, drilling operations will only resume after receiving approval from Enbridge.

ATTACHMENT

WISCONSIN DEPARTMENT OF NATURAL RESOURCES APPROVED HORIZONTAL DIRECTIONAL DRILLING PRODUCTS LIST

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Note: This list is intended to supplement the Approved Drilling and Filling Sealing Products List including Heat Exchange Drillhole Products List and the National Sanitation Foundation (NSF) Drinking Water Treatment Chemicals NSF/ANSI/CAN 60-Health Effects List . Products on both lists are approved for use in Horizontal Directional Drilling in addition to the products listed below.

Wisconsin Pre-Approved HDD Drilling Fluid Products:

Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Baroid Fluid Services/Haliburton	Polyselect Power Swell	Proprietary ingredients	Lost circulation material	
6/20/22	Bentonite Performance Materials/Halliburton	Polyselect Power Xan	Xanthan gum	Viscosifier	
6/20/22	Cetco	Drill-terge	Non-ionic surfactant	Drilling detergent/wetting agent	
6/20/22	Cetco	Rel-Pac Xtra-low	Polyanionic cellulose	Filtration control	
6/20/22	Cetco	Suspend-IT	Polysaccharid gum	Cutting transport	
6/20/22	DCS Fluid Solutions	Clay Breaker	Quaternary Ammonium Compound	Clay Stabilizer	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Polymud	Mineral Oil	Viscosofier	Requires project-specific pre-approval
6/20/22	DCS Fluid Solutions	Sandmaster	Xanthan gum	Viscosofier	
6/20/22	DCS Fluid Solutions	SealPac HV	Polysaccharide	Fluid Loss Reduction	
6/20/22	DCS Fluid Solutions	TorqBreaker	Quaternary Ammonium Alkyl dimethyl ammonium chloride Ethanolamine	Surfactant	Requires project-specific pre-approval
6/20/22	Halliburton Energy Services	Polyselect DMD Soda Ash	sodium carbonate	Buffer	
6/20/22	Lost Circulation Specialists, Inc.	Magna Fiber	Mineral fiber	Lost circulation material	
10/20/22	Northstar Fluid Solutions	Lubra-Star Plus	Proprietary, derived from oleo chemicals	Water soluble lubricant	Use product purchased after 10/15/22

Wisconsin Department of Natural Resources Approved Horizontal Directional Drilling Products List

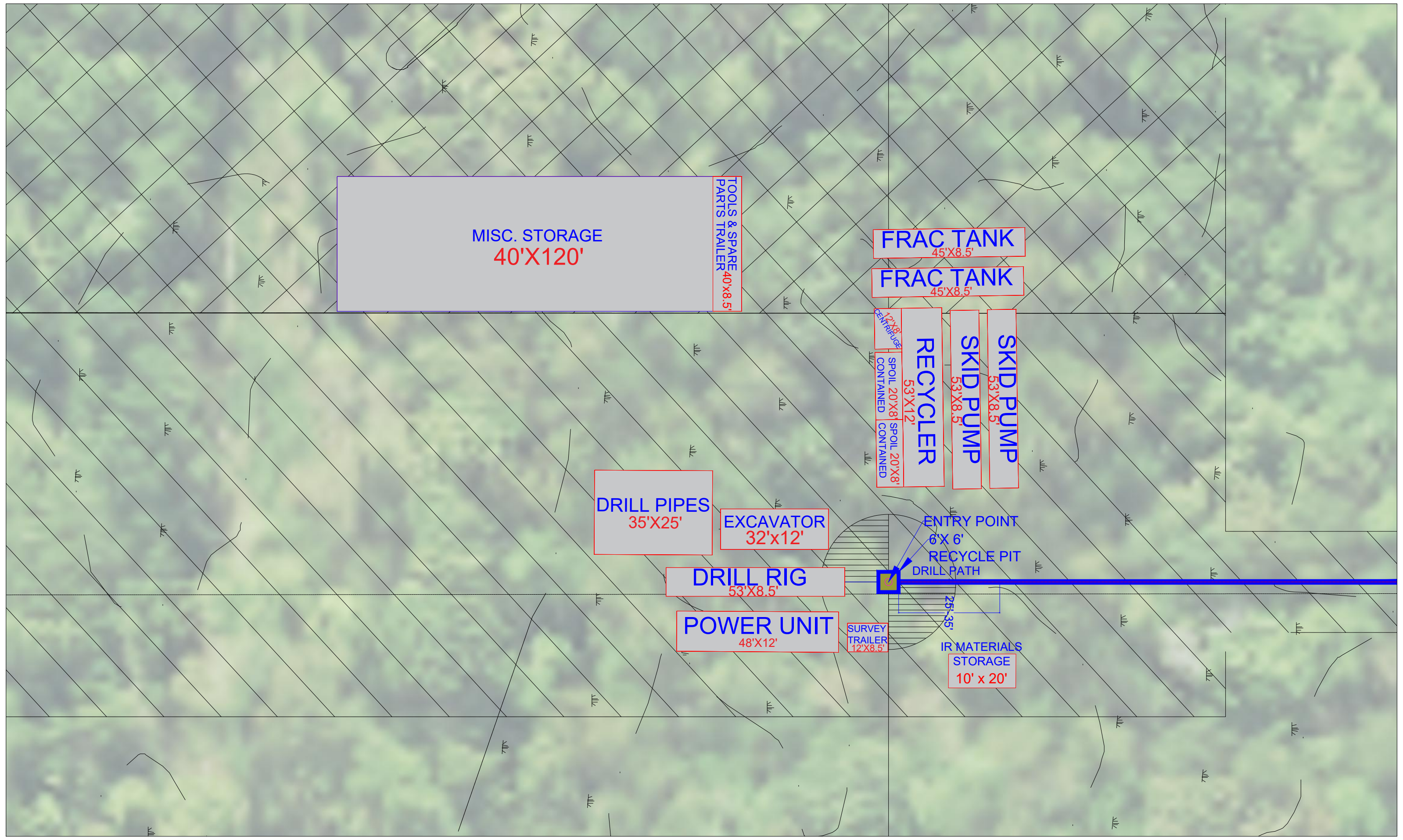
Approval Date	Manufacturer or Distributor	Product Name	Material(s)	Uses	Special Conditions
6/20/22	Northstar Fluid Solutions	Star-Plex	Poly Hydroxy Silicate, Proprietary Mg, Na, Al compounds	Viscosofier	

Last Update 10/20/2022

For review of products not on the pre-approved list, please submit the material safety data sheet and product sheets used for marketing to Samantha Whitens, Office of Energy Storm Water Engineer or Amy Minser, Statewide Storm Water Engineer. The safety data sheet or supplementary material must disclose the presence of any ingredients listed on Table 1 in s. NR 140.10, Wis. Adm. Code and Chemical List | Wisconsin Department of Health Services. Section NR 283.55, Wis. Adm. Code allows the department to handle trade secrets as confidential information. If information is considered a trade secret, confidential information should be provided in a separate document, clearly marked as confidential, and a request for confidentially should be provided as required in s. NR 2.19, Wis. Adm. Code. Disclosure of the information to the Wisconsin Department of Health Toxicologist may be required as part of the Department of Natural Resources review process.

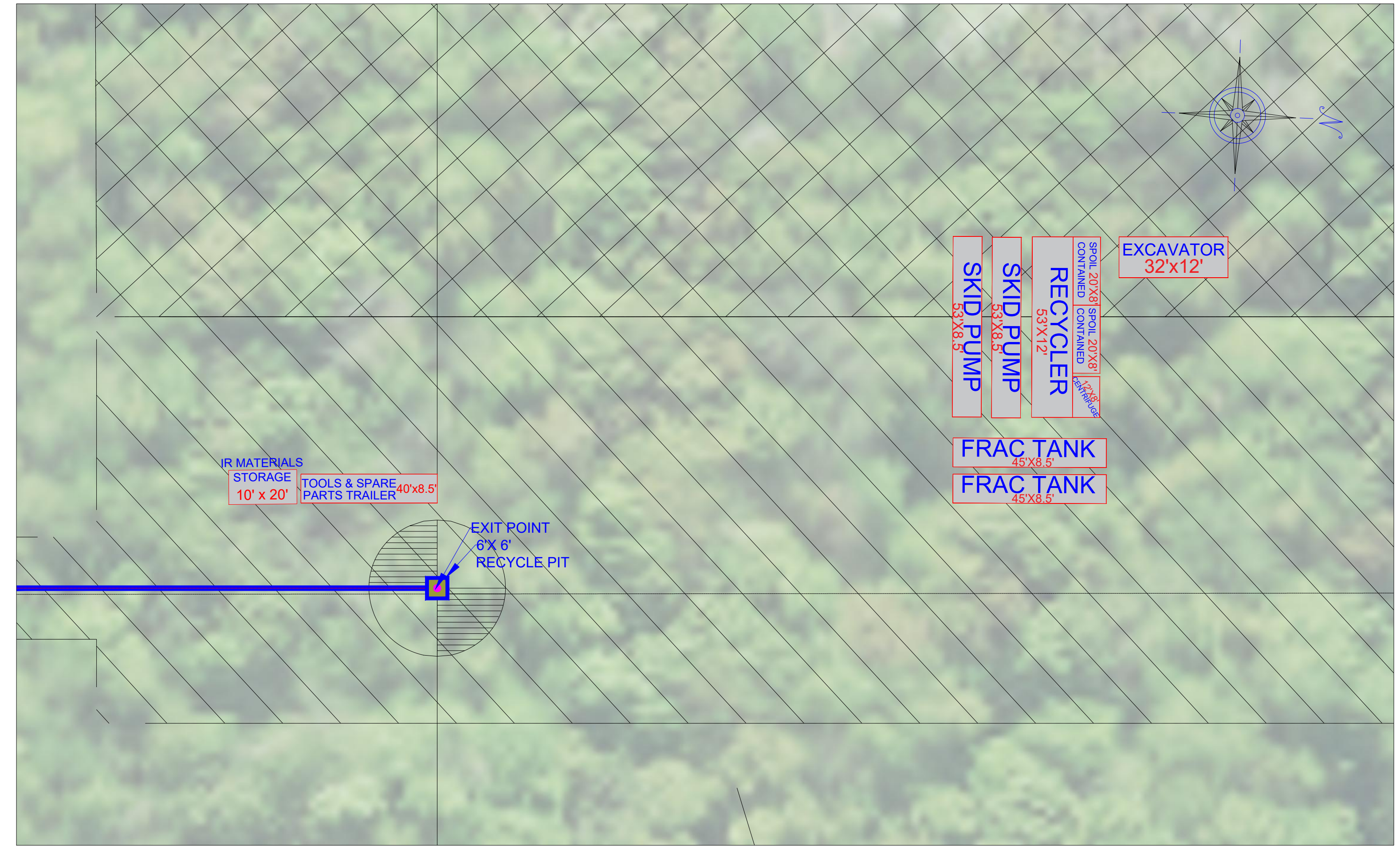
ATTACHMENT

EQUIPMENT AND CONTAINMENT SITE LAYOUT



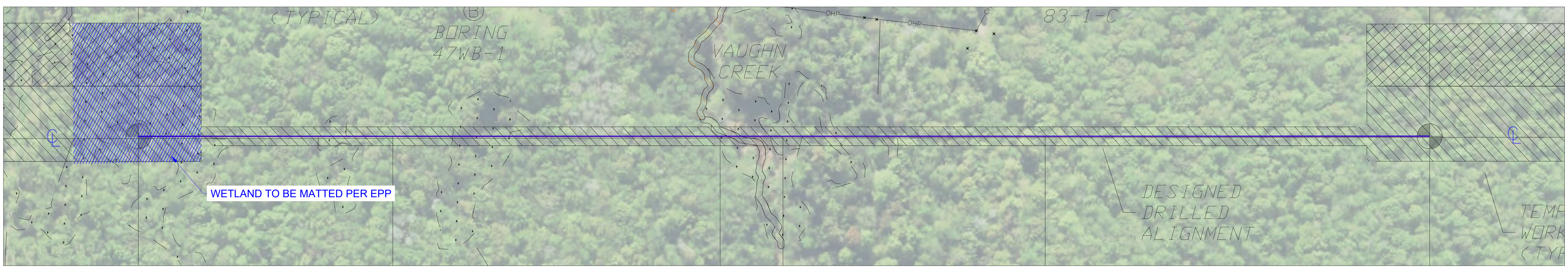
PLAN

SCALE: 1"=50'



PLAN

SCALE: 1"=50'



OVERALL PLAN VIEW

SCALE: 1" = 250'

CONSTRUCTION NOTES:

1. EROSION CONTROL MEASURES TO BE IMPLEMENTED IN ACCORDANCE WITH EPP.
2. IN THE EVENT OF INADVERTENT RETURNS, CONSTRUCTION EFFORTS SHALL CEASE UNTIL PERMITTED BY ENBRIDGE.

NOTES

1. PRELIMINARY DESIGNED DRAWING MAY BE MODIFIED IN FIELD BASED ON CONDITIONS ENCOUNTERED.
2. FIELD VERIFICATION OF STATIONS AND ELEVATIONS REQUIRED.
3. PLACEMENT OF DRILL RIG(S) IS NOT FIXED BY DESIGNATED ENTRY AND EXIT POINTS. MICHELS RESERVES THE RIGHT TO DETERMINE PLACEMENT OF DRILL RIG AND/OR NEED FOR DUAL RIGS (1-RIG AT ENTRY AND 1-RIG AT EXIT) FOR OVERALL SAFETY AND CONSTRUCTABILITY OF PROPOSED HDD CROSSING.
4. DRAWING IS PROPRIETARY TO MICHELS CORPORATION. ANY UNAUTHORIZED USE OF DUPLICAITON IS STRICTLY PROHIBITED. RECEIPT OF THIS DRAWING SIGNIFIES ACCEPTANCE OF SAID CONDITIONS.

PRELIMINARY DRAWING

REVISIONS

NO.	DATE	REVISION DESCRIPTION	SOURCE DRAWING
A			
B			
C			
D			
E			
F			

MICHELS®
TRENCHLESS, INC.
817 W. MAIN ST., P.O. BOX 128 BROWNSVILLE, WISCONSIN 53006
PHONE: 920-583-3132 FAX: 920-924-4323

DIRECTIONAL BORE FOR: ENBRIDGE	
PROJECT: LINE 5 PIPELINE PROJECT	
DRAWING: CONCEPTUAL WORKSPACE DESIGN DRAWING	
CROSSING REFERENCE: MP39 - VAUGHN CREEK HDD	
PRODUCT PIPES SIZE (INCHES): 30"	
LOCATION: ASHLAND COUNTY, WISCONSIN	
DRAWN BY: C.L.G.	JOB NUMBER: XXXXXXX
DATE: 11/18/22	

PART I TO COMMENTS OF ENBRIDGE ENERGY, LIMITED PARTNERSHIP ON DECEMBER 16, 2022, DRAFT ENVIRONMENTAL IMPACT STATEMENT LINE 5 REROUTE PROJECT

INTRODUCTION

The Draft Environmental Impact Statement (DEIS) for the Line 5 Wisconsin Segment Relocation Project (Project) published on December 16, 2021, provides extensive evaluation and discussion of the potential benefits, impacts, and mitigation measures for the Project and alternatives being considered by the Wisconsin Department of Natural Resources (WDNR). The DEIS was prepared in response to significant public interest in the Project and addresses the issues identified by the public scoping process conducted in July 2020. Accordingly, the Applicant, Enbridge Energy, Limited Partnership (Enbridge) has focused these comments on corrections, clarifications, and additions that the WDNR Office of Energy may want to consider in preparing the final EIS (FEIS) to best inform the public during the permitting processes.

Enbridge has organized these DEIS comments to first suggest general or overarching clarifications to the terminologies and methodologies used in the DEIS and then to provide specific comments on the content of each chapter.

OVERARCHING COMMENTS

The DEIS is being prepared by the WDNR under the Wisconsin Environmental Policy Act (WEPA) to address public interest in the Project and the associated waterway and wetland permits required under Wis. Stats. §§ 30.12, 30.18, 30.20, and 281.36. Under WDNR's WEPA regulations at Wis. Admin. Code § NR 150.20(2), these permits are "integrated actions" for which no separate environmental assessment or environmental impact statement is required. However, given the multiple department actions required for the Line 5 Reroute and the potential for public controversy, the WDNR exercised discretion to prepare a voluntary EIS pursuant to Wis. Admin. Code § NR 150.30(4).

The DEIS notes that it was prepared with input from multiple stakeholders, including state, federal, and tribal groups. This diversity of the stakeholders, coupled with the WDNR's decision to prepare a voluntary EIS addressing issues of potential public controversy, has yielded a broad review, addressing numerous topics including potential impacts, right-of-way clearing, and Wisconsin trespass law. Despite commentary on a substantial range of issues, the FEIS should be focused on more specific discussion of the probability of impacts and associated mitigation strategies while staying within the scope of WDNR's permitting regulations. A more fulsome response to individual sections of the DEIS is set forth below, but some areas for focus in the FEIS include detailed information about water quality impacts, potential releases, forest management, and access to public lands for lawful activity. The discussion of impacts to water quality from pipeline construction should include details about the pre- and post-construction monitoring required by the Department for a prior pipeline construction project proposed by a different operator utilizing the same construction techniques. The discussion of potential petroleum releases needs to include consideration of the low probability of release, as well as Enbridge's comprehensive monitoring of the pipeline and emergency response capabilities to respond and mitigate impacts.

The Project is proposed in portions of Ashland and Iron Counties, where there are areas with active ongoing forest management programs, including parcels enrolled in the WDNR's Managed Forest Land programs and subject to WDNR forestry reviews. Commentary on right-of-way clearing should incorporate the context of vibrant and ongoing forest management in the region.

In several places the DEIS discusses the Wisconsin Utility Trespass law, an existing statute that applies to all current utility rights-of-way. The FEIS should note that lawful activity will be treated as such by Enbridge and local law enforcement.

COMMENTS BY SECTION

1.0 PROJECT OVERVIEW AND REGULATORY PROCESS

1.3 Project Purpose and Need

Section 1.3 identifies the Project purpose and need in two ways. The first is that the Project will allow the continued transportation of crude oil and natural gas liquids (NGLs) through the Line 5 pipeline, serving refineries and depropanization plants that produce products on which residences and businesses rely for heating fuel and transportation, among many other products. Those customers include the Rapid River depropanization plant in the Upper Peninsula of Michigan and the Plains Midstream depropanization plant in Superior, Wisconsin, which would, according to Plains Midstream, close if Line 5 ceases operation, creating propane supply disruptions. In addition, the cessation of operation of Line 5 will remove 540,000 barrels per day of petroleum from the upper Midwest and eastern Canadian markets (80,000 barrels per day of NGLs and 460,000 barrels per day of crude oil), resulting in a material reduction in crude oil supply to those regions used for production of fuel and other petroleum-based products.

This reduction in supply will yield shortages of, and price increases, for fuel. Necessities like heating propane have inelastic demand, meaning that households and businesses will not reduce consumption by much, even if prices continue to increase. Shortages and increases in the price of propane will have a severe negative impact on low-income households that use propane for heating, and it will force them to decide whether to "heat or eat," – i.e., they will need to choose whether to heat their homes or spend less on groceries and other essentials.

The recent report prepared by Consumers Energy Alliance and previously submitted to this docket further outlines the significant impacts to households, businesses, and local and state governments of a shutdown of Line 5 on Michigan, Ohio, Indiana, and Illinois.

Shortages in crude oil and NGL supply due to lack of pipeline transportation will occur and cannot be remedied through use of alternative modes of transportation such as truck, tanker, or rail. Loading and unloading facilities for each of these modes do not currently exist in the locations where Line 5's products are delivered, and would require significant capital investments and time to develop, permit, and install. Further, these alternatives introduce significant risks of their own. Transporting Line 5 volumes via truck is not feasible given the volumes and distances involved. Further, it would require no less than 6,700 and possibly many more trucks and drivers, neither of which are available. Even if the trucks and drivers were available, putting this number of trucks on Wisconsin roads each day would strain road capacity and increase road maintenance costs. Tanker vessels or barges are similarly problematic for transporting Line 5 products across the Great Lakes. Crude oil is not currently transported across the Great Lakes, nor are NGLs. The specialized barges required to safely transport crude oil and/or NGLs across the Great Lakes do not currently exist. Finally, rail is not a viable alternative for transporting Line 5 products. An insufficient number of suitable tank cars is available, and it is unlikely that adequate rail line capacity exists to add transport of Line 5 products to the current rail line hauling activity on available tracks. None of these alleged alternatives are suitable to solve the transportation issues that would result from a closure of Line 5.

Beyond the inadequacy of alternative transportation for Line 5 volumes, closure of Line 5 would also result in annual state tax loss for Wisconsin and Michigan.

1.3.1 Lawsuit to Remove Line 5 from the Tribal Lands

A federal lawsuit was filed against Enbridge seeking the shutdown of Line 5 across the Bad River Reservation. Enbridge disagrees with the lawsuit in full, but in response to the relief requested by the Bad River Band in that lawsuit, Enbridge has voluntarily proposed the Project.

1.6 Authorities and Required Approvals

As discussed in further detail in Section 9.0, below, on January 28, 1977, the United States and Canada entered into a treaty titled *Agreement Between the United States of America and Canada Concerning Transit Pipelines* (Transit Treaty). That treaty notes that "pipelines can be an efficient, economical and safe means of transporting hydrocarbons from producing areas to consumers, in both the United States and Canada" and that "measures to ensure the uninterrupted transmission by pipelines through the territory of one Party of hydrocarbons not originating in the territory of that Party, for delivery to the territory of the other Party, are the proper subject of an agreement between the two Governments."

The FEIS should include the Transit Treaty in the description of authorities and required approvals.

2.0 DESCRIPTION OF THE PROPOSED PROJECT AND GENERAL PIPELINE PRACTICES

2.8 Operation and Maintenance Procedure

2.8.1.2

Sections 2.8 and 2.8.1.2 include discussion of the Integrity Management Program (IMP) information provided in the Environmental Impact Report (EIR) prepared for the Project and subsequent data request responses. However, these sections do not include integrity threat mitigation measures – Dig and Repair, set forth below.

Enbridge employs a broad range of mitigation measures or activities, including but not limited to integrity monitoring, operating a state-of-the-art control center with highly qualified and trained personnel to respond in the event of a trigger alerting them that there has been a change in volume or operations of a pipeline, reducing operating pressure, undertaking a dig and repair, or replacing segments of the pipeline.

The Project pipeline and ancillary facilities will be constructed to accommodate internal inspection instruments, such as in-line inspection devices also referred to as “smart pigs” to identify features that may be areas of internal corrosion, dents, cracks, or other features that could compromise pipeline integrity. Such inspections are required periodically under PHMSA’s regulations at 49 C.F.R. Part 195. Specifically, Part 195 requires that an operator continually assess a pipeline’s integrity at five-year intervals, not to exceed 68 months. Because there are multiple in-line inspection technologies used to detect distinct types of pipeline features, that often means that several types of tools are run more frequently over a five-year period to assess varying feature types. In addition, Enbridge assesses certain features via a risk-based approach that may require multiple inspection tool runs over a five-year period. Part 195 requires a baseline assessment prior to operation.

3.0 PROJECT ALTERNATIVES

Section 3.3 includes Subsections 3.3.1 (Continued Operation of Line 5 within the Bad River Reservation) and Subsection 3.3.2 (Decommissioning). Neither of these alternatives are contemplated by the Project, and neither would accomplish the objective of the Project – to relocate a segment of Line 5 off the Bad River Reservation. As such, neither meets the purpose nor need of the Project.

Section 3.4 notes that loss of the Line 5 NGL supply at Sarnia, given the absence of pipeline alternatives to transport those NGLs, would result in economic dislocations. Inclusion of additional information in the FEIS about the local and regional disruptions caused by this loss in Canada as well as in the United States is warranted. Such disruptions include:

- The NGL depropanization facilities operated by Plains Midstream in Superior, Wisconsin, Rapid River, Michigan, and Sarnia, Ontario are entirely reliant on Line 5. These facilities account for most of the propane supply in Michigan and virtually all of the propane consumed in Ontario. There are no existing NGL transportation alternatives to Line 5, and Plains has confirmed that the loss of the Line 5 NGL supply would result in the closure of its depropanization facilities.
- The closure of the Plains depropanization facilities would cause shortages in propane for a minimum of several years in the Upper Midwest and Ontario, with consumer prices elevated and volatile. Price increases in Michigan, Wisconsin, and Ontario for propane and butanes would be expected to amount to $128 million.
- Line 5 transports approximately 38% of crude oil demand for 10 refineries in Michigan, Ohio, Pennsylvania, Ontario, and Quebec, which are all key sources for refined products for the region. A Line 5 closure would cause these refineries to receive approximately 334,700 bpd less crude from Enbridge than their current demand, resulting in approximately a 14-million-US-gallons-per-day supply shortage of gas, diesel, and jet fuel.
- The loss of Line 5 crude oil volumes would be severe for refineries in western Pennsylvania and Ontario, causing them to struggle to maintain stable operations and resulting in the closure of one or more refineries. The loss of Line 5 crude oil volumes would be significant for refineries in Michigan, northern Ohio, and Quebec, causing shortages throughout the region. Refined product

shortages would be expected to result in price increases and panic buying, creating additional shortages and price increases.

- As a result, significant job losses will result, with adverse economic impacts most acute in Michigan, Ontario, and western Pennsylvania. The government of the province of Ontario, for example, has said the economic disruption resulting from a loss of Line 5 products would result in thousands of layoffs at facilities directly and indirectly served by Line 5 in Sarnia.

- Michigan would need to find an alternative supply for anywhere from 4.2 million to 7.77 million US gallons of refined products a day (gas, diesel, jet fuel and propane). This alternative supply would require delivery out of Superior, WI, by rail, truck, or ship, all of which, even if feasible, which they are not, as outlined above in response to Section 1.3, would generate massive additional rail and truck traffic through Wisconsin and neighboring states (15.4 trains per trip and 5,684 trucks per day) and increased mobile source emissions for such transport.

Sections 3.4.1 and 3.4.2 suggest that, in lieu of the Project, Enbridge could either transfer the 540,000 bpd of crude oil and NGLs onto another existing pipeline or it could construct a new pipeline route around Lake Superior and Lake Huron. First, there is no existing pipeline in the region that could transport NGLs between Superior, Wisconsin and Sarnia, Ontario. Line 5 is operationally unique as compared to other Enbridge pipelines because it transports both NGLs and crude oil. No other Enbridge pipeline serving points between Superior and Canada is capable of transporting NGLs. Accordingly, the 80,000 bpd of NGLs transported on Line 5 cannot be transported via any other existing Enbridge pipeline to facilities in Michigan or Sarnia.

Second, there is insufficient capacity available on Enbridge's pipeline system to transport all of the crude oil that is currently transported by Line 5. Some crude oil could be transported on Enbridge's Line 78, but the resultant shortfall in crude oil volumes delivered to Sarnia, Ontario via Line 78 would still be approximately 334,700 bpd. This conclusion is affirmed by the analysis of alternatives to the continued operation of Line 5 across the Straits of Mackinac prepared by Dynamic Risk Assessment Systems, Inc. on behalf of the State of Michigan. That analysis formally evaluated the utilization of existing alternative pipeline infrastructure that does not cross the open waters of the Great Lakes. Dynamic Risk concluded in 2017 that "there are very limited options to utilize available capacity on existing assets whether they are owned by Enbridge or other parties". Accordingly, the use of existing pipelines is not a viable alternative to Line 5.

Third, the construction of a new pipeline is not currently being proposed, and even if it were, it would result in more significant environmental impacts than the Project. Section 3.4.2 includes Figure 3.4.2-1 showing two potential alternate pipeline routes discussed in the Dynamic Risk report: a northern route around Lake Superior, and a southern route following existing pipelines through Wisconsin and Illinois, Indiana, and Michigan to reach Sarnia. While Section 3.4.2 identifies the potential "northern route" as 834 miles in length, that includes only the portion that would follow an existing TransCanada right-of-way: the total length of the proposed northern route is 1,264 miles, including a 266-mile segment through Precambrian shield from Duluth, MN to Thunder Bay, Ontario, and a 186-mile segment from Barrie to Toronto, Ontario. In addition, Figure 3.4.2-1 shows the proposed southern route that would parallel Enbridge's existing system across Wisconsin, Illinois, Indiana, and Michigan. The Dynamic Risk report did not evaluate the environmental impacts of these alternatives. The FEIS should reflect that that these alternatives have not been carried forward for detailed study because they are not feasible and would presumably result in much more extensive impacts as compared to the 41-mile Project.

SCOPE OF ANALYSIS

Areas of Potential Direct and Indirect Affects

Sections 4.2.1-4.2.6 seek to identify the areas of direct and indirect effect of the Project. To provide greater clarity, each of these sections should distinguish between impacts reviewed under WEPA and impacts reviewed for wetland and waterway permits and should also note that the descriptions of the broader areas of review for direct, indirect, and cumulative effects are the areas of *potential* effect for purposes of the WDNR analysis, as opposed to areas that will definitively be adversely affected by the Project. While sections 4.2.5 (Ecological Landscapes) and 4.2.6 (Climate Zones) qualify whether the indirect effects are possible or potential, sections 4.2.2 and 4.2.4 do not clarify that these are areas of potential, and not determined, indirect effects. This additional qualification should be added to these sections in the FEIS.

4866-2133-3259.22

4.0 CURRENT CONDITIONS

State Listed Endangered and Threatened Species

In compliance with Wisconsin's Endangered Species Law (Wis. Stat. § 29.604), which requires the protection of Wisconsin state-threatened and endangered species, Enbridge conducted an Endangered Resources Review (ER Review) and evaluated the Project's potential for impacts on rare species (*e.g.*, special concern, threatened, or endangered species). A renewed ER Review (Log #20-034), which has been approved by the WDNR, was completed on February 15, 2022. The renewed ER Review provides specifics on species habitat considerations, including potential habitat within the proposed Project work areas; potential impacts on species and/or their habitat; and WDNR required or recommended actions to avoid and/or minimize impacts on state-listed species. Although not protected under the state endangered species law, special concern species are also listed in the ER Review and addressed. Enbridge will continue to coordinate with the WDNR and update the ER Review as appropriate.

The final EIS should be revised to include the total number of endangered resources identified in the February 2022 ER Review. Table 1 (*see* Table 1 at the end of this document) includes a summary of the most recent (*i.e.*, February 2022) ER Review and the avoidance/minimization measures required or recommended by the WDNR. It should be noted that the WDNR required measures only pertain to one species on the table (the wood turtle). The text following the table describes the potential impacts of the Project and avoidance/minimization measures Enbridge will implement for the wood turtle and other species listed on the table.

Impact Avoidance and/or Minimization Measures to be Implemented by Enbridge:

<u>Birds</u>

Activities required for construction have the potential to affect the habitat of birds classified as species of special concern. Take of, or direct impacts to, the bird special concern species included in the ER Review and summarized in Table 1 or other migratory birds are not expected due to the timing of vegetation clearing activities. Vegetation clearing activities associated with construction of the Project are anticipated to be scheduled to occur outside the migratory and nesting seasons for most migratory birds in the region (*e.g.*, April 1 to July 15). Impacts from vegetation clearing on special concern bird species (and other migratory bird species) requiring contiguous forested patches may occur. Some bird species that use open or shrubland habitats could benefit from the habitat conditions created by the proposed Project in the maintained right-of-way. For additional information regarding forest fragmentation, including topics such as right-of-way configuration and analysis of landscape scale changes, see Enbridge's Fragmentation Comment Response. While Enbridge will comply with the MBTA, activities required for construction have the potential to affect migratory bird habitats. Additionally, Enbridge will implement, as practicable, other measures to avoid and minimize such impacts, such as clearing outside of the nesting season and implementing activity buffers around active bald eagle nests.

Construction and operation of the Project will result in the permanent loss of some forested nesting habitat, most notably deciduous and coniferous forests in the pipeline right-of-way areas. After construction is complete, Enbridge will restore the construction right-of-way as near as practicable to preconstruction condition. Cropland will be restored to active agricultural production, and other areas will be revegetated using methods and seed mixes appropriate to existing land uses and cover types. Forested areas outside of the maintained operational easement will be allowed to reforest by succession and natural recruitment. Enbridge anticipates that most of the temporary use areas will recover to pre-disturbance conditions over time.

Bald Eagle

To the greatest extent practicable, Enbridge will avoid clearing vegetation from April 1 to July 15. If a bald eagle nest is identified, the Project will comply with the Bald and Golden Eagle Protection Act and activities would be avoided within 660 feet of the Project workspaces from mid-January through July 30 (or when the nest was actively being used). If this timing restriction cannot be maintained for some reason, Enbridge will coordinate with the WDNR and USFWS as appropriate.

Invertebrates

Aquatic Insects

Potential impacts to the habitat of the five aquatic insect special concern species listed in Table 1 will be minimized or avoided in several ways. The Project has prepared and submitted to the WDNR a Project specific Storm Water Pollution Prevention Plan (SWPPP). As described in that plan, all temporary and permanent erosion and sediment control measures will be installed and maintained in accordance with Enbridge's Environmental Protection Plan (EPP), the WDNR Storm Water Construction Technical Standards, and applicable permit requirements. More details regarding erosion control Best Management Practices (BMPs) implemented by the Project can be found in the SWPPP. The Potato River, Lawrence Creek, and the White River are listed by the WDNR as potential habitat for state listed special concern insect species. The Potato River and White River will be crossed by HDD, avoiding direct impacts to these waterbodies. Lawrence Creek is not crossed by the Project.

Confusing Bumble Bee and Yellowbanded Bumble Bee

If habitat for confusing bumble bee or yellowbanded bumble bee is present in the Project area, it will be temporarily affected by removal of vegetation. Clearing of herbaceous and shrub communities in the open areas of the temporary right-of-way, both in upland and wetland areas, would cause a short-term impact on the bees' habitat, but the effect would be mitigated by Enbridge's anticipated construction schedule and revegetation plans.

As described above, vegetation clearing activities associated with construction of the Project are anticipated to be scheduled to occur outside the April 1 to July 15 timeframe when the confusing bumble bee and yellowbanded bumble bee are most active.

Enbridge will also utilize herbaceous seed mixes on disturbed areas following the completion of pipeline construction to restore cover, minimize the duration of vegetative disturbance, and stabilize the soil. Following seeding, Enbridge expects that pre-existing herbaceous and shrub habitats will quickly become re-established and that wildlife species that use these habitats will return soon after construction.

West Virginia White

Clearing of woody shrubs and trees will be the primary long-term impact on vegetation associated with the Project, including in areas of potential suitable habitat for West Virginia white. This species is primarily found in rich, deciduous northern forests, where it lays its eggs on the host plant, the toothwort (*Cardamine diphylla*). If a suitable habitat for this species and its host plant is present within the Project work areas, it may be affected.

Enbridge will allow woody shrubs and trees to recolonize the temporary construction right-of-way and extra work areas as described in the EPP. However, recolonization of disturbed areas by woody shrubs and trees will be slower than herbaceous species. As natural succession proceeds in these areas, the early successional or forested communities present before construction will eventually re-establish.

Clearing trees in the construction right-of-way could affect undisturbed forest vegetation growing along the edges of the cleared areas and incrementally reduce suitable habitat for the West Virginia white and its host plant. Due to the increased light levels penetrating the previously shaded interior, shade-intolerant species will be able to grow, and the species composition of the newly created forest edge may change slightly.

Amphibians/Reptiles

Wood Turtle

Enbridge conducted wood turtle habitat assessment surveys during the 2020 field season. The results of these surveys were provided to the WDNR and were included in Section 6.5.4.2 (State Threatened and Endangered Resources) of Enbridge's EIR. Enbridge will implement conservation measures as required in the WDNR's Broad Incidental Take Permit for wood turtles in areas of suitable habitat (White River; Brunsweiler River; Tributary to Silver Creek (suitable aquatic habitat only); Bad River; Krause Creek (suitable aquatic habitat only); Tyler Forks; Potato River, and Lawrence Creek; and Vaughn Creek), including (1) ground disturbance, heavy equipment operation or supply/equipment storage within nesting habitat (exposed sand or gravel areas within 200 feet of a suitable stream/river) during the nesting season (May 20 – September 18) is not allowed unless herp exclusion fencing is installed outside of these dates to prevent turtles from entering the area to nest, or habitat has been made unsuitable outside of these dates, (2) instream work (*e.g.*, streambank/rip rap installation, ford installation, open cut trenching, and dredging) and drawdowns during the maximum overwintering period (October 1 – April 30) is not allowed, and (3) when construction crews are working within 300 meters of suitable waterbodies, wood turtles could be in/around the above waterbodies. Crew members would need to move any turtles out of harm's way during construction operations. If Enbridge's construction schedule changes, Enbridge would coordinate with the WDNR to determine if an Individual Take permit is required.

<u>Plants</u>

Braun's Holly-fern

In 2020, surveys were conducted for Braun's holly-fern. The surveys were conducted on public lands in areas determined suitable through coordination with the WDNR and the WDNR ER Review process. Specifically, presence/absence surveys were conducted on suitable woodland habitat on public lands within 1.0 mile from a previously documented WDNR natural heritage inventory element occurrence for this species. Surveys were conducted within the Project's environmental survey corridor and associated Project access roads (buffered) on public lands. Survey efforts did not result in any Braun's holly-fern observations on public lands; therefore, the Project will have no impact on the Braun's holly-fern on public lands within the survey area. During wetland and waterbody surveys, an incidental observation of an individual Braun's holly-fern was documented on private land where it overlaps with the Project workspace; therefore, the individual will be impacted by construction activities. An additional incidental observation of one individual Braun's holly-fern was documented on public land; however the single observance location is outside of the proposed right-of-way and workspace. For this reason, to the extent that additional occurrences of Braun's holly-fern have been identified, the Project will not adversely impact those ferns. Enbridge will continue to coordinate with the WDNR regarding natural heritage concerns.

Yellow Specklebelly and Fringed Rosette Lichen

Clearing of woody shrubs and trees will be the primary long-term impact on vegetation associated with the Project, including in areas of potential suitable habitat for Yellow Specklebelly and Fringed Rosette Lichen. If a suitable habitat for these species is present within the Project work areas, it may be affected.

As described above for the West Virginia white, Enbridge will allow woody shrubs and trees to recolonize the temporary construction right-of-way and extra work areas as described in the EPP. However, recolonization of disturbed areas by woody shrubs and trees will be slower than herbaceous species. As natural succession proceeds in these areas, the early successional or forested communities present before construction will eventually re-establish.

Clearing trees in the construction right-of-way could affect undisturbed forest vegetation growing along the edges of the cleared areas and incrementally reduce suitable habitat for the two lichen species. By exposing some edge trees to elevated levels of sunlight and wind, evaporation rates and the probability of tree knockdown could increase. Due to the increased light levels penetrating the previously shaded interior, shade-intolerant species will be able to grow, and the species composition of the newly created forest edge will likely change. The proposed clearing could also temporarily reduce local competition for available soil moisture and light and may allow some early successional species to become established and persist on the edge of the undisturbed areas adjacent to the site. A portion of forestland will be maintained clear of trees for operational purposes, including facilitating aerial inspections, preserving pipeline integrity, and providing access for maintenance or emergency work in compliance with federal regulations.

5.0 EFFECTS OF PROPOSED PROJECT AND ROUTE ALTERNATIVES

Discussion of Surface water quality

Section 6 of the DEIS discusses potential impacts of the Project to various media, including groundwater and wetlands, but does not evaluate surface water quality during and after the Project. This section should incorporate key water quality criteria evaluated by the Department for surface waters proposed to be crossed using the construction techniques identified in the EPP that have been demonstrated to not impact water quality, as well as of a prior study conducted in Wisconsin that sampled pre- and post-construction water quality for 15 separate waterways that were crossed utilizing the same suite of crossing methods proposed for the Project, and the results of that study.

Downstream Surface Water Quality Considerations

With respect to pipeline construction, the primary concern to water quality is the increase in sediment and material loading to streams and other waterways. The water quality parameter of consideration is total suspended solids (TSS).

The Project will utilize BMPs, further identified in the EPP, to avoid any increased loading of suspended solids to the waterways that will be crossed that could affect downstream water quality standards. These measures include the use of HDD to cross under ERW waterways. For waters crossed using other methods, BMPs include installation of erosion and sediment control devices along the waterbody banks prior to ground disturbing activities, installation of sediment control BMPs on the temporary bridges, and prohibition of spoil storage within the streambed. For dry crossings, utilization of these procedures further reduces the potential release of TSS by isolating the crossing area prior to excavation. Enbridge will also install in-stream BMPs at open cut and modified dry crossings to minimize TSS. Further, the timeline associated with these activities would typically be between 10 to 48 hours for the size of waterbodies to be crossed by the Project, except where the push-pull method is used to cross waterbodies within wetland complexes. In those areas, crossing activities will range from 1.5 to 14 days.

These BMPs have been successfully implemented in previous pipeline projects in Wisconsin, including the 2010 Guardian Expansion Extension project. As a part of the 2010 Extension, Natural Resources Group (NRG) conducted pre- and post-project water quality monitoring for fifteen (15) streams crossed during the installation. The results of that sampling showed no significant or adverse increase in TSS loading to the streams crossed, especially in light of background fluctuations in TSS levels related to stormwater runoff from undisturbed lands. A copy of the 2010 report is included as Attachment A to these comments.

Blasting Residuals

Section 6.8.3.4 discusses the potential effects of blasting residuals but does not reference or discuss any of the measures Enbridge would implement to minimize potential effects of residuals on groundwater supplies. To minimize the potential release of nitrogen compounds associated with blasting materials, Enbridge and its contractors will adhere to strict management of nitrogen-based explosives during the storage, handling, transportation, bore-hole loading, and detonating phases of blasting. The Project will use only packaged explosives (no bulk explosives will be used) with proven resistance to water infiltration to prevent leaching of soluble materials from the explosives. The use of packaged explosives will reduce the potential for spills and minimize the exposure of explosive products to wet weather and groundwater conditions. The type of explosive product used, and the associated blasting pattern will be selected to maximize the effectiveness of the blasting process to accomplish the desired results while minimizing the mass of explosives required thereby minimizing the potential amount of residual (unconsumed) blasting material. The types of explosives that may be used will have the best available detonation properties, low residual waste profiles, and higher safety and reliability of detonation. The Project's blasting contractor will communicate with the drillers to obtain geological information for each shot and will adjust the mass of explosives accordingly. Explosives will not be primed until immediately before use and will not be allowed to lay overnight in drilled holes (unless completion of the detonation is delayed due to weather or other events). Project blasting will be done in accordance with all applicable federal, state and local laws and regulations applicable to obtaining, transporting, storing, handling, blast initiation, ground motion monitoring, and disposal of explosive materials and/or blasting agents. These include:

- Bureau of Alcohol, Tobacco and Firearms – 27 C.F.R. § 181 (Commerce in Explosives). Occupational Safety and Health Administration – 29 C.F.R. § 1926.90 (Safety and Health Regulations for Construction
- Blasting and Use of Explosives
- Pipeline Hazardous Material Safety Administration – 49 C.F.R. § 177 (Carriage by Public Highway)
- Explosives and Blasting Agents – OSHA, 29 C.F.R § 1910.109 (Safety in the Workplace When Using Explosives)
- Department of Energy– 18 C.F.R. § 2.69 (Guidelines to be Followed by Natural Gas Pipeline Companies in the Planning, Locating, Clearing and Maintenance of Right-of-Way and the Construction of Above Ground Facilities)

Additionally, Enbridge has committed to testing private wells within 150 feet of the pipeline centerline, with landowner approval. Pre- and post-testing will include sampling for nitrates. Given the limited blasting expected to be required for the project, the masses of blasting materials used will likely be substantially lower than those used in road construction projects where residual nitrate was identified after completion of construction activities.

Forestry and Habitat Impacts Associated with Right-of-Way

In several locations (Sections 6.11.4, 6.12.1, 6.14.4, 6.14.6, 6.14.7, and 6.14.9), the DEIS discusses potential effects of fragmentation on habitats, creation of edge, invasive species and temperature. The DEIS should also include discussion of the minimization and mitigation measures Enbridge has already implemented (*e.g.*, routing decisions) or has committed to in its EPP, EIR, and supplemental filings and data request responses to the WDNR, described below.

Fragmentation and Edge Effects

Fragmentation refers to the breaking up of contiguous areas of vegetation communities into smaller patches. Fragment size is thought to play a role in landscape function and many ecosystem interactions, including the distribution of plants and animals, fire regime, vegetation structure, and wildlife habitat. Reducing the size of contiguous patches of suitable habitat can indirectly reduce the effectiveness of that habitat for some species beyond the removal of habitat. Impacts of forest fragmentation on forest dwelling species include alteration and loss of interior forest habitat, reduction in forest patch size, and the addition of edge-type habitat.

Some species require large, un-fragmented blocks of habitat, and fragmentation can lead to reduced habitat quality for those species. Fragmentation has been shown to be one factor in the decline of neo-tropical migrant birds and can negatively impact habitat specialist species, while having a positive or neutral effect on habitat generalist species (Graham, 2002).

An important impact of fragmentation, aside from breaking up blocks of vegetation, is an increase in edge effects. Edge effects result when two different vegetation types are adjacent to each other. Edge effects can encompass a multitude of impacts including an alteration in nutrient flows/cycling; an increase in the rate of invasion by invasive species and pathogens, a lowering of the carrying capacity of a habitat patch, and disruptions in meta-population dynamics (Saunders et al., 1991). Invasive species may displace native wildlife by altering sheltering habitats and food sources such as plant communities and insect populations, respectively (Graham, 2002). While creation of edges can negatively impact bird/wildlife species that require interior habitat, there are some bird/wildlife species that benefit from creation of edge habitats. Valente and Betts (2019) for example found that patch size had little effect on total species richness, while decreasing patch size had a negative effect on interior species and a positive effect on edge species. However, reduction in patch size does not necessarily mean a reduction in species richness. Fahrig (2020) for example found that several small patches usually hold more species than a few large patches of the same total area. There is also evidence from recent studies that suggest small, relatively isolated habitat patches of high shape complexity in fragmented landscapes tend to be of higher conservation value according to a complementarity and representativeness criterion than a similar-sized habitat patch within contiguous tracts of intact vegetation of low shape complexity (Wintle, et al. 2019).

Edge effects tend to be more pronounced with increasing differences in the two adjacent habitat types (*e.g.*, mature forest adjacent to grassland). The creation of edges in forests influences microclimatic factors such as temperature, wind, humidity, and light, and could lead to a change in plant species composition within the adjacent uncut or un-manipulated habitat or increase the rate of invasion by invasive species and forest pathogens (Murcia, 1995). Compared to the interior of a forest, areas near edges receive more direct solar radiation during the day, lose more long-wave radiation at night, have lower humidity, and have less protection from wind. Increased sunlight and wind can desiccate vegetation by increasing evapotranspiration, can affect which plant species survive (typically favoring shade-intolerant species), and can dry out soil. Edge effects are typically more pronounced in forest and woodland vegetation communities than shrub-steppe or grassland communities due to the greater typical vegetation height and structural complexity in forested ecosystems.

Utility corridors can create a barrier to wildlife movement for some species and a travel corridor for other species (Graham, 2002). Corridor widths and vegetative characteristics can have varying effects on different species. Abrupt vegetation transitions may have the greatest effect, while a forest to shrub to grassland transition can have minimal to no effect on transiting species (Graham, 2002). Utility corridors can also create connections between habitats where invasive species can travel to gain access to other habitats more easily

(Askins, 1994). Common predators found using utility corridors in forested landscapes include avian predators, such as hawks and owls, as well as mammalian predators, such as opossums and raccoons.

Minimization and Mitigation Already Implemented or Proposed by Enbridge to Reduce Potential Effects

Pipeline Routing and Access

For linear projects of this nature and in this landscape, it is not feasible to avoid all wetlands, waterbodies and forested areas. Where feasible, Enbridge utilized routing as a tool to minimize fragmentation of large, forested areas to the extent practicable. Specifically, Enbridge designed the pipeline route in a manner that minimizes the environmental footprint while adhering to the purpose and need of the Project. The route review process consists of an assessment of technical and economic feasibility; constructability; impacts on environmental resources; and coordination with agencies and other stakeholders to identify and, where feasible, avoid sensitive habitats or resources.

The landscape that is crossed by the Project has already experienced some fragmentation in the form of existing roads, other utility rights-of-way, residential and commercial development, agriculture, and forestry practices. Where it was practical, Enbridge collocated the pipeline route with other existing corridors to minimize the creation of an entirely new right-of-way. Enbridge also planned to maximize the use of existing access roads. As currently designed, approximately 93 percent of the access roads proposed for use on the Project are existing access roads and/or previously disturbed areas which will largely avoid forest fragmentation associated with access. Enbridge also attempted to locate the Project in open versus wooded areas. This is evident primarily along the western portion of the proposed route, which crosses an already highly fragmented landscape with a few large patches of contiguous forest. In this area, the incremental increase in fragmentation associated with the proposed pipeline corridor will likely be small. Enbridge was unable to find connected existing corridors that it could follow along the eastern portion of the route. While several roads and other corridors are present in the area, none of them travel in the direction required by Enbridge. Along this stretch the pipeline will cross several small to large mostly contiguous tracts of forestland. However, Enbridge's timber evaluation did not identify any areas that the assessors would consider old growth forest. Moreover, no portion of the route crosses the old growth forest identified by Bates 2008. It should also be noted that much of the forestland crossed by the eastern portion of the route is managed for timber production and has likely been cut one or more times. The creation of a new corridor for the pipeline will reduce the amount of interior forest habitat on the right-of-way and for a distance adjacent to the right-of-way, which will become open and edge habitats. However, based on Enbridge's review and as discussed under the Analysis of Landscape Changes heading below, the Project will not diminish the amount of contiguous forest in the area such that they can no longer support forest interior species.

Right-of-Way Configuration

In addition to the routing and design decisions described above, Enbridge also planned its right-of-way configuration to minimize impacts. Enbridge proposes to use a 120-foot-wide construction right-of-way in most areas to construct the pipeline. Enbridge believes this is the minimum width needed to efficiently construct the pipeline and accommodate safe operation of the construction equipment. However, Enbridge proposes to reduce the construction right-of-way width in wetlands, including forested wetlands, to 95 feet. Forest fragmentation will also be reduced by Enbridge's plan to horizontally directional drill (HDD) many waterbodies and adjacent riparian areas. Where the HDD method is employed, Enbridge will follow WDNR's HDD Technical Guideline 1072. In addition, Enbridge proposes to reduce the width of the cleared area between the HDD drill entry and exit holes to 30 feet, with the exception of Tyler's Forks, where it will be reduced to 50 feet. Following construction Enbridge will only maintain vegetation on a 50-foot-wide corridor (30 foot wide between entry and exit holes of HDDs) to operate the pipeline. The remainder of the construction right-of-way including temporary extra workspaces will be allowed to revegetate naturally following initial restoration and seeding. As natural succession proceeds in these areas, the early successional or forested communities present before construction will eventually re-establish. The regrowth of this vegetation will soften the transition between the maintained right-of-way and bordering forestlands. Because of the linear nature of the Project, temporary impacts in these habitats will be minimized by the presence of undisturbed habitat communities adjacent to the right-of-way. In the temporary right-of-way, upland and wetland forested areas will be impacted to a greater extent than non-forested vegetation types due to the longer time required for forest to regrow and mature. However, the ample amount of adjacent forest habitat will allow birds/wildlife to disperse to nearby forest habitats. As such, the temporary effects of construction on these habitats should have little or no significant impact on local populations.

Invasive Species Management

After disturbances of the soil, vegetation communities may be susceptible to infestations of noxious or invasive species. These species are typically most prevalent in areas of prior surface disturbance, such as agricultural areas, roadsides, existing utility corridors, and wildlife concentration areas. Enbridge's EPP (updated and submitted to the WDNR on September 16, 2021) addresses the control and spread of noxious and invasive species. Enbridge filed a list of invasive species with the WDNR on November 5, 2021, that were identified during surveys conducted by Enbridge. Enbridge's current EPP is provided as Attachment B.

Specific measures Enbridge proposes for the Project include: Requiring the contractor to clean equipment prior to its arrival on site; washing and drying equipment that has been involved in in-water work prior to its use; purging and cleaning pumps before being moved to a new location if weeds or invasive species are known to be present, potentially treating invasive species or using other measures such as full topsoil stripping in uplands to minimize contact between equipment and weed seed in the topsoil; installing and maintaining effective erosion controls and stormwater management measures to stabilize soils; using seed mixes adapted to the area that are labeled with tags certifying they are "Noxious Weed Free"; using mulch that is free of noxious weeds; seeding promptly within the recommended seeding windows using seed mixes that include native species and that are adapted to the region; and utilizing temporary seeding as appropriate where permanent seeding cannot be completed soon after final grading or when there is a high risk of erosion. These measures will minimize the potential for the establishment of undesirable species.

Wetland Mitigation

The USACE (permanent fill only) and the WDNR require mitigation for unavoidable wetland impacts to preserve no net loss of wetland function. Although final approval of requirements (*e.g.*, banking credits, on-site mitigation, in-lieu fees, or permittee responsible mitigation) has not yet been determined for the Project, Enbridge would be required to complete compensatory mitigation through the section 404 process of the CWA with the USACE.

Enbridge has prepared and submitted to the USACE and WDNR a Project-specific wetland mitigation plan to maintain no net loss of wetlands, and to adequately replace lost wetland functions and functional values. The plan addresses and mitigates impacts related to temporary conversion, permanent conversion, and permanent loss of wetlands functional values. A copy of the April 2022 Wetland Compensatory Mitigation Plan is provided as Attachment C.

Trout Streams and Water Temperature

Section 6.14.9 contains contradictory statements pertaining to the effect of tree removal on water temperature. In one sentence, it states "the permanent removal of tree cover 25 feet on either side of the pipeline could result in a warming of the cold-water stream", and then in the same paragraph states that a 50-foot-wide break in tree cover is unlikely to cause a measurable difference in water temperatures.

Enbridge has described the effects of removal of vegetation and habitat at waterbody crossings including the potential to affect aquatic resources by reducing shade, cover, and nutrient input, and by affecting stream banks as described in the EIR and under the Right-of-Way Configuration heading above. Enbridge proposes to install the pipe using the direct pipe or horizontally directionally drill all but two of the proposed pipeline crossings of trout streams. Moreover, Enbridge proposes to reduce the width of the cleared construction right-of-way and the maintained permanent right-of-way at these HDD crossings to 30 feet, with the exception of Tyler's Forks, where it will be 50 feet. The maintained right-of-way width will also be reduced in other areas to 50 feet. Such a narrow break in the tree cover is unlikely to cause a measurable difference in water temperatures or the aquatic species inhabiting the rivers and streams crossed by the Project (*also see* Enbridge's comments to Section 6.14.9.1.1).

Analysis of Landscape Scale Changes

To evaluate how much of the route crosses intact forestland, and to better understand potential landscape level changes from the construction and operation of the Project, Enbridge assessed pre-construction forest conditions using Wiscland 2 land use land cover (LULC) raster data converted to GIS polygons and then grouped the LULC covers into Forest and Non-Forest classifications (*see* Table 3).

Table 3 LULC Forest and Non-Forest Classifications			
Level 1 Value	**Level 1 Class Description**	**Level 2 Class Description**	**Reclassified Value**
1000	Urban/Developed	Developed, High Intensity	Non-Forest
1000	Urban/Developed	Developed, Low Intensity	Non-Forest
2000	Agriculture	Crop Rotation	Non-Forest
2000	Agriculture	Cranberries	Non-Forest
3000	Grassland	Forage Grassland	Non-Forest
3000	Grassland	Idle Grassland	Non-Forest
4000	Forest	Coniferous Forest	Forested
4000	Forest	Broad-leaved Deciduous Forest	Forested
4000	Forest	Mixed Deciduous/Coniferous Forest	Forested
5000	Open Water	Open Water	Non-Forest
6000	Wetland	Floating Aquatic Herbaceous Vegetation	Non-Forest
6000	Wetland	Emergent/Wet Meadow	Non-Forest
6000	Wetland	Lowland Scrub/ Shrub	Non-Forest
6000	Wetland	Forested Wetland	Forested
7000	Barren	Barren	Non-Forest
8000	Shrubland	Shrubland	Non-Forest

Existing roads, railroads, and pipeline centerlines were overlaid on the Wiscland 2 LULC data and buffered by 25 feet on each side to identify existing rights-of-way. These corridors were classified as non-Forest. The remaining contiguous forested areas were then buffered by 300 feet from the outer edges and existing developed features (*e.g.*, roads, railroads, pipelines) to identify edge areas and forest cores. Forest core areas were classified into four classes based on acreage (*see* Table 4).

Table 4 Forest Core Classes based on Acreage	
Core Class	**Size**
Fragment	0 – 100 acres
Small	100 – 250 acres
Medium	250 – 500 acres
Large	> 500 acres

Enbridge then overlaid the proposed Enbridge construction right-of-way (permanent easement, temporary workspace, additional temporary workspace, valve sites and associated permanent roads), plus a 300-foot buffer to identify the areas of direct and indirect forest impacts. Areas directly impacted by construction clearing activities were classified as non-Forest. Areas within the 300-foot buffer were classified as Forest Edge.

Enbridge then calculated the amount of forested area that is affected by construction and operation of the Project within the respective watersheds (WDNR Watersheds) crossed by the Project. The results indicate that the Project would convert approximately 2.21 square miles of forest core to forest edge and increase grassland by approximately 0.63 square miles. Table 5 shows the change in core type. The locations of mapped natural forest habitat cores relative to the proposed pipeline route are shown on the attached Figure A.

Table 5 Core Forest Habitat Conversion		
	Pre-Construction (sq. mile)	Post-Construction (sq. mile)
Large	759.92	754.37
Medium	44.34	45.83
Small	29.32	30.28
Fragment	23.29	23.79
Total	856.87	854.27

As shown on the figure, the western portion of the proposed pipeline route is located in an already highly fragmented habitat and crosses small and medium natural forest habitat cores. In contrast, the eastern portion of the pipeline route is less fragmented and crosses a combination of small, medium, and large natural forest habitat cores. Enbridge's right-of-way clearing and conversion of forest to grassland will incrementally increase forest fragmentation and locally reduce the acreage of core forest habitat. However, it will not significantly diminish the amount of core interior forest habitat available within the watersheds crossed by the Project. Based on analysis of the data, the Project would result in a conversion of approximately 0.15 percent of all land within the watersheds crossed by the proposed route to forest edge and the conversion of approximately 0.26 percent of forest core to forest edge. Given the adjacent available forested habitat in the landscape surrounding the pipeline route, this minimal reduction in core forest habitat is not expected to have a measurable effect on birds or wildlife. At present, large-scale losses of these habitat types are not planned and the proposed route would not have significant cumulative impacts on habitat loss in the Superior Coastal Plain."

The DEIS discusses habitat conversion as an impact and focuses on the loss of forest. These statements should include a discussion of habitat conversion. Converted habitats can and do provide ecological value, and therefore the discussion of conversion as an impact should be revised to accurately state the acres that will be converted temporarily or permanently. The successional stages of regrowth in the temporary right-of-way (ROW) should be acknowledged.

Cultural Resources

The DEIS discusses the Tribal Cultural Resources Survey, related steps taken to comply with Section 106 of the National Historic Preservation Act, and comments provided by the USACE.

On March 25, 2022, the USACE issued a letter summarizing consultations between the Bad River and the USACE, including discussions related to conducting a new traditional cultural resources survey. The March 25th letter discusses the sufficiency of the investigations conducted to date and determined that additional surveys would be duplicative. The letter also set forth a proposal to conduct oral history interviews for the Area of Potential Effect. The letter requested a response by May 2, 2022. A copy of the letter is provided as Attachment D.

6.0 RISK AND POTENTIAL EFFECTS OF PIPELINE SPILLS

<u>Risk and Potential Effects of Pipeline Spills (Chapter 7)</u>

Section 7 of the DEIS includes commentary on the potential effects of pipeline spill. It is expected that this topic will be included in joint agency discussions on permitting for the Project. While Section 7 discusses potential results of an accidental release, it focuses almost exclusively on improbable "worst case" scenarios of a release during operation of the line, while providing little or no discussion of the actual probabilities of any such release, or of the comprehensive monitoring and maintenance programs Enbridge employs on a daily basis, or of the mitigation and remediation resources that will be put in place as a part of the Project. The FEIS should incorporate these topics. On the issue of probability, an approach used to better characterize the risks associated with a release and mitigation steps is a paired probability analysis and quantitative consequence assessment of potential releases, combined using a risk assessment framework. In such a framework, the term "risk" is defined as the product of the probability of an event occurring (*i.e.*, an oil release) and the resulting consequence (*i.e.*, trajectory, fate, and effects) of a release. Taking this approach, high probability events with relatively low consequence may have similar quantifiable risk as low probability events with relatively higher consequence. In general, and in the context of the risk associated with the proposed Line 5 reroute, a risk assessment quantifies the range of potential consequences of activities that will happen (*e.g.*, construction activities) as well as those that may not (*e.g.*, the range of potential accidental releases occurring during operation). A risk framework should therefore provide the necessary context around how likely specific consequences may be expected. In many cases, extremely low probability events that would result in very large potential for consequence (*e.g.*, accidental release from a full-bore rupture) are assessed, but are not the "expected" effects of the Project. A third critical factor in the risk evaluation is assessing anticipated emergency response activities and predicting how emergency response mitigation measures may decrease the potential for consequences.

These three factors (probability, consequence, and mitigation) are not quantitatively or comprehensively addressed in the existing DEIS. However, based on rigorous assessments already completed for other large pipeline projects in the region, a relative bound can be established for the potential risk by applying existing quantitative analyses and conservative extrapolations to the Line 5 reroute. Each factor of risk can be reasonably anticipated, particularly focusing on the greatest consequence (but very low probability) scenarios, such as large volume spills or full-bore pipeline ruptures.

In addition, there are certain sections within the DEIS, such as those addressing difficult-to-access areas and important downstream receptors, that can be better characterized with respect to risk, by applying a broad understanding of pipeline assessments that have been conducted on large volume mainlines, and addressing how those assessments quantitatively considered probability, risk, and mitigation. This additional context for the proposed Project would help reinforce the contents of the DEIS and put the likelihood and potential consequences of different outcomes discussed therein into context. The following comments are provided with this objective. With this additional information, the FEIS would be more effective to facilitate an informed decision.

Probability Assessment – Risk of Spills and Releases

The probability that a release could occur from a pipeline (*i.e.*, failure frequency) is a core metric driving risk and potential effects. Other important probabilities include whether any released oil would reach environmentally sensitive areas; if receptors will be present in the areas expected to be oiled; and if the exposure (concentration and duration) and state of oil weathering will be sufficient to elicit potential effects. The release volume associated with the failure frequency (further discussed in the next section) is also important and inversely linked to probability of occurrence. While any release is relatively unlikely, small volume releases are much more likely to occur than the extremely unlikely large or very large releases.

Section 7.4 of the DEIS describes several factors that can affect pipeline integrity and potentially result in spills, but the risk of each factor is not developed or quantified. For example, the DEIS states that "pipeline exposure is a common and dangerous scenario for pipeline operators" (WDNR 2021, p. 261). It is not clear what this statement is based on. To the extent that this statement is based on operation of other existing pipelines, it does not estimate the likelihood of a release occurring along a portion of pipeline nor address what volumes of release might commonly be associated with this failure type. Highly quantitative probability assessments are a typical approach used in such cases to assess all potential factors, across each pipeline section, combining them into an overall probability of occurrence and range of hypothetical release volumes. Such an approach would be extremely valuable here to accurately reflect the appropriate scale and weight in the context of both likelihood and the potential range of effects.

One key example of a quantitative probability assessment that has been conducted for a large volume pipeline (also on the mainline system) is the recent assessment of the Enbridge Line 3 Replacement Project (L3RP), which covered the installation of 337 miles of new pipeline. While the L3RP was significantly larger in scale than this Project, which proposes just 41 miles of new pipeline, the probability assessment information is useful here. The L3RP Final EIS included a chapter that analyzed the types of threats to pipelines (similar to the Line 5 DEIS), but also conducted a failure frequency analysis for each analyzed pipeline segment (MN DOC 2017). The failure frequency analysis compiled recent data from industry incidents (2010-2015), mechanistic reliability approaches, and evaluations of potential hydrotechnical and geotechnical hazards to determine the annual probability of large volume oil releases (*i.e.*, full-bore ruptures) for pipeline segments that intersected the full range of representative waterbodies that were to be crossed by the planned re-route (Stantec et al. 2017, pp. 4.89-4.90). Combining all considered threats, the likelihood of a large oil release on each segment was calculated to range from approximately 4.0×10^{-07} to 4.4×10^{-06}. The return period for these probability values is roughly equivalent to a one in several hundred thousand years chance to a one in several million years' chance of occurrence each year. In essence, these releases are extremely unlikely.

To capture the other end of the risk spectrum (higher probability, smaller volume releases that might not be rapidly detected by leak detection systems), an assessment of potential pinhole releases was also conducted for the L3RP (Stantec and Barr 2017). This assessment included analyzing historical pipeline incident data to determine anticipated frequencies. Although the data analyzed were of "older vintage pipelines, they can provide insight into what could potentially occur with respect to spill volume, incident cause, and incident frequency" (Stantec and Barr 2017, p. 13). Incident rates for the U.S., Region, and Minnesota (respectively) were estimated at 0.00081, 0.00068, and 0.00071 per Mile-Year (Stantec and Barr 2017, p. 17). The regional incident rate (applying to ND, MN, and WI) is applicable here to the 41-mile proposed Line 5 pipeline, and similarly would be an overestimate due to the rate's development from data on older pipelines. In addition, the assessment indicated that effects would be relatively localized to regions of tens to hundreds of meters, as opposed to the tens of kilometers of potential transport and effects for the large volume releases that entered waterways assessed above. Again, these values indicate the likelihood of even a pinhole release is quite low and the effects of pinhole releases are geographically constrained.

Similar probability assessments have been conducted on other new and replacement mainlines, such as the Supplemental EIS for the Keystone pipeline that calculated probabilities at site-specific water crossings on the order of once in more than 10,000 years (for any size release) to once in several million years (for worst-case discharges) (U.S. Department of State 2019, p 5-3 to 5-4). The risk of smaller volume releases, such as pinhole leaks, can also be quantified for a project by using methodologies that assess historical spills recorded along similar pipelines, as reported to PHMSA.

Inclusion of a discussion of these recent quantitative probability assessments completed by the State of Minnesota and the United States should be incorporated into the FEIS to help contextualize the types of consequences already discussed within the document to allow the reader to better understand the concept of risk. An understanding of consequence alone is insufficient, especially when the probability of such occurrences is so low. It is particularly important to consider release probability when evaluating the potential consequences of a large release volume or full-bore rupture. Many of the consequences described in Section 7.4 of the Line 5 DEIS are primarily associated with these larger release volumes, yet terms like "common" are used to describe pipeline threats without acknowledging the one-in-a-million, very low likelihoods of large volume releases actually occurring. The DEIS subsections on pipeline threats should include the probability of failure, as well as the range of spill types, release volumes, and variable environmental conditions might affect the probability and spatial extent of downstream transport, exposure, and potential for effects, that should be addressed later in the DEIS. Further, the FEIS should acknowledge that the relocated segment of Line 5 contemplated by the Project will meet or exceed PHMSA's minimum depth standards, thereby minimizing threat of exposure.

Consequence Assessment

Release Volume

Considering the frequency and magnitude of historical spill volumes is a crucial part of assessing probability of potential spill volumes. Sections 7.2 and 7.3 of the DEIS provide an overview of the types of releases that may result in specific volume releases. However, there is no consideration of release volume or the likelihood and range of potential effects (*i.e.*, consequence). In general, Sections 7.2 and 7.3 of the DEIS provide a broad overview of potential size spills possible from a pipeline failure, but a more robust general analysis of inland pipeline spills followed by a state-specific analysis is warranted.

As noted in Section 2.6 of the L3RP Addendum, an unmitigated hypothetical full-bore rupture is extremely unlikely. Enbridge and numerous contracted 24-7 on-call response operators (Oil Spill Response Organizations) have numerous caches of response equipment and trained and capable response personnel nearby such that, in the unlikely event of a release, they would respond rapidly (within minutes to hours). Enbridge emergency response plans note that they have the ability to contain and recover the released product within hours of a release, which in many cases, based upon inference of downstream travel times for the Line 3RR assessment, would be prior to oil reaching the Bad River Reservation or beyond (Stantec and RPS 2019). The Department previously discussed those plans in the FEIS prepared for Line 3R Segment 18 in 2016. Copies of the excerpt of that discussion, as well as of Enbridge's current response plans, are submitted as Attachments E and F. Enbridge has prepared a map of the spill response Control Points, shows the potential control points to be further reviewed in 2022 in the Project area. One can see that many initial control points have been identified to contain and recover a release and additional control points would be added during the emergency response effort if required to contain the release. A copy of this map is provided as Attachment G.

The FEIS should include additional context such as the following from the L3RP EIS:

> Analysis of the data for crude pipeline spills of all sizes that occurred since 2000 indicates there were 91 spill incidents, with one incident occurring in 2017. For the years 2000 through the present (end of June 2017), there were 91 incidents of which nearly 30 percent involved less than one bbl. The average spill volume was 201 bbl. The median (*i.e.*, 50th percentile) was 2.0 bbl. For the years 2010 through the present, there were 37 incidents of which over 81 percent involved less than one bbl. The average spill volume was 7.8 bbl. The median was 0.54 bbl. The spill volumes have been significantly smaller since 2010. (MN DOC 2017 p. 10-19).

The graphs provided on Page 257 (Section 7.3) of the DEIS provide the net loss of oil due to all significant spills from all operators and would be more effective in providing context and quantification of the range of potential spill volumes that went into those values. It would be useful if release volumes were provided along with the context including total number of Significant (>10,000 gallons or 238 bbl) or Substantive (> 2,100 gallons or 50 bbl) U.S. Inland Pipeline Spills that went into these net values (see Figure 10.1-1 of the Enbridge L3RP EIS) (MN DOC 2017 p. 10-12). These figures would also be more informative if they were broken down by oil type (*i.e.*, crude, refined heavy, refined light, refined gasoline), as they currently include all types (most of which are not transported on Line 5).

A figure or table probability distribution of spill volumes for inland pipelines would be extremely effective in providing quantification of historic spills (see Table 10.1-2 in the Enbridge L3RP EIS provided below) (MN DOC 2017 p. 10-13). The risk is effectively defined by including the associated probability of a release volume (risk = probability x consequence).

Difficult to access areas

Section 7.6.3 of the DEIS posits that it would take years for recovery and cleanup if a spill were to occur in a "Difficult-to-Access Area." There is no source identified for this speculation. The accuracy of this conjecture depends upon many factors including release volume of the spill, the oil type, the environmental conditions at the time of the release, whether there was snow or ice cover when the spill occurred, the natural weathering and degradation of the oil, emergency response mitigation measures, and the geographic and hydrologic specifics of the receiving environment. As noted previously, the hydrocarbons that this pipeline carries would be highly volatile, meaning that large fractions of oil would be anticipated to evaporate and degrade within the first hours of a spill.

The Copper Falls State Park contains two large gorges and waterfalls that water moves through rapidly. As such, the Copper Falls region could be considered a turbulent and self-flushing system. Thus, while recovery and cleanup efforts would not be undertaken in the rapids or difficult to reach areas, the oil would not be expected to remain in the system for very long. A large rain event, snowmelt, or spring freshet would likely flush any submerged oil out of the system rapidly. Therefore, it is unlikely that oil would remain in the system for years. Additionally, response measures would be undertaken to contain and collect as much of the oil as possible upstream of Copper Falls. As the oil was transported through and downstream of Copper Falls into quiescent waters, response and clean-up efforts would resume on both floating and sunken oil.

Furthermore, although the Copper Falls region could be difficult-to-access, Enbridge maintains a robust amount of emergency response equipment along each ROW (see Section 2.5 of the L3RP Addendum) (Stantec and RPS 2019). Major equipment available in Enbridge's Midwest Region includes:

- Command Post Trailers
- Response Boats
- Air Boats
- Amphibious Vehicles
- All-Terrain Vehicles
- Fixed-Wing Aircraft (Enbridge Enterprise-owned)
- Helicopters (Enbridge Enterprise-owned)
- Portable ATV Vacuum Units
- Heavy Construction Equipment
- Spill Response Trailers (includes winter equipment such as chainsaws, augers, plywood, etc.)
- Wildlife Response Trailers
- Containment Boom (Multiple sizes)
- Oil Skimmers (Multiple types and sizes)

- Temporary Storage Tanks
- WaterGateTM
- Vacuum Trucks

Any and all of the above equipment would be utilized to access difficult-to-access regions where response would make sense.

Table 10.1-2. Probability Distribution of Spill Volumes for U.S. Inland Pipelines (2006–2015)

Spill Volume	% Spill Incidents	Number Incidents
<1 bbl	33.51%	1,027
1-9 bbl	34.78%	1,066
10-99 bbl	18.76%	575
100-999 bbl	10.15%	311
1,000-9,999 bbl	2.58%	79
10,000-90,000 bbl	0.23%	7
100,000+ bbl	0.00%	0

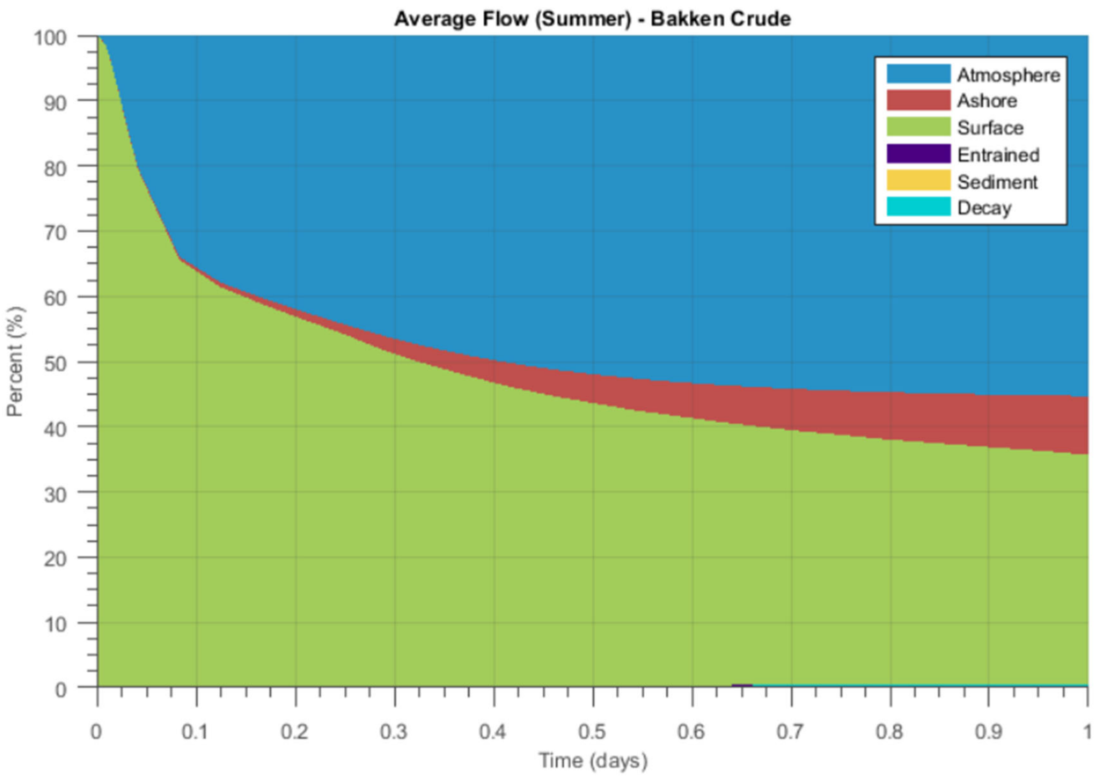
Effects of weathering

In Section 7.8, there is no consideration given for the variety of fate processes that affect released oil (*e.g.*, evaporation, natural degradation), and no quantitative assessment is provided to estimate the degree to which oil would weather upon release, depending on oil type and conditions. While all of these processes are possible, it is crucial to have an understanding of how much oil would be expected to disperse or sink. Typically, this is assessed through mass balance. Mass balance is an accounting of where oil may be found, with a fraction of the total release volume in the water column, on the water surface, on shorelines, in sediments, evaporated to the air column, or with another fate.

The Line 5 pipeline is used to transport unconventional light crude and NGLs, along with shale oil from the Bakken formation (WDNR 2021 p. 5). Such oils contain a significant fraction of volatile components (ranging from 50% to at least 80%) with 15-30% typically in the highly volatile range. When oil is on the water or land surface, the highly volatile fraction would evaporate rapidly within hours, while much of the remaining volatile fraction would evaporate over the next few days, depending on the level of entrainment by turbulence into water and other factors including most importantly what emergency response mitigation measures are undertaken (*i.e.*, source control, containment, and collection). For any spill that might occur from Line 5 into the tributaries and rivers described within the DEIS, evaporation is a major fate process to be considered.

The fractions that do not evaporate (primarily heavier residuals) will continue to naturally degrade (biodegradation and photodegradation) over time, meaning that oil remaining on shorelines or riverbeds after a significant period will typically become depleted of constituents of concern (such as PAHs). However, different fractions of oil can be more persistent in the environment and undergo slower degradation, so it is important to not only consider the trajectory and amount of oil that may be released from a spill, but what the ultimate fate will be as it relates to weathering, emulsion formation, tarballs, etc. and how specific compounds within these components will preferentially weather.

As such, the DEIS should appropriately consider the expected weathering of common oil types that are expected to be transported on Line 5 and how that weathering might differ under varying environmental conditions. The fate of released oil can be quantified using generalized weathering simulations, with consideration for unique circumstances (*e.g.*, ice cover or moving through rapids) that can affect oil fate. The characteristic parameters applied for different oils affect the weathering of the oil as it is released, as well as its ability to be retained on shorelines (Stantec et al. 2017, p. 5.166). An example weathering curve modeled from the L3RP project is provided below (Stantec et al. 2017, p. 6.282), depicting that approximately 55% of Bakken crude was predicted to evaporate within 24 hours, having a significant effect on the physical and chemical parameters of the oil and the resulting fate of the oil as it was transported downstream.



The discussion in the Line 5 DEIS of oil becoming "trapped in sediments and vegetation at the river bottom" does not take into account how volatility and potential spill responses would reduce the likelihood and conditions under which such effects could occur. Unless heavy crude (*i.e.*, a different product mix) were released, the oil would not be expected to sink on its own and would require specific conditions (*i.e.*, turbulence and presence of large mass of suspended sediments in the water column, followed by quiescent waters in which to settle) to collect as heavier oil formations on the river bottom. The presence of conditions conducive to oil particulate settling can be predicted by geography and are not equally present throughout the waterways.

A quantitative risk assessment of hypothetical releases at representative water crossings (targeting specific oil types being transported on Line 5) would be well suited to predict the potential movement, behavior, and potential effects of the range of releases that may be possible, particularly regarding how much oil may be found at specific locations and how weathered the oil would be. Conditions for greater adverse effects are also able to be identified. For example, the total hydrocarbon concentrations of Bakken crude on bed sediments following hypothetical completely unmitigated full bore rupture scenarios on the L3RP pipeline were generally predicted to be less than 0.01 g/m^2, with small areas as high as 0.5 g/m^2 based on the low potential for entrainment in specific project areas (Stantec et al. 2017, p. 7.758, 7.807).

Consequences to downstream receptors

The DEIS considers potential environmental impacts to several important downstream receptors, including Lake Superior (7.8.1), the Kakagon – Bad River Sloughs (7.8.1.2), and Wild Rice Beds (7.8.1.3). Each of these discussions can be better contextualized with an understanding of the pipeline crossing locations relative to the receptors of concern, as it relates to the potential timing and extent of hypothetical releases.

While the DEIS notes that "it is unlikely that a large volume of oil would reach [Lake Superior] …" (DEIS p. 272), additional context is helpful. The Bad River crossing for the proposed Line 5 pipeline route is approximately 49 miles upstream of Lake Superior. By comparison, hypothetical large volume releases from Line 3 were modeled at a location on Little Otter Creek in the Lake Superior watershed, as part of a technical addendum to the L3RP EIS (Stantec and RPS 2019). Across three seasonal simulations and flow conditions, full-bore rupture releases of Bakken crude were predicted to reach maximum downstream distances of 12.0 to 19.7 miles after 24 hours (based upon characteristics of that specific waterbody), and it was determined "unlikely that any substantial quantity of released oil would be transported…into Lake Superior once emergency response activities are taken into consideration." (Stantec and RPS 2019, p. 4.111, 5.166, 7.183). Similar considerations would apply to potential releases from the preferred Line 5 pipeline route. For example, oil released during winter months can become trapped within snow cover or on ice, which limits the potential for downstream movement or, in some cases, reaching the waterway at all (Stantec et al. 2017, p. 5.187-5.188). In most cases, substantial quantities of oil would be unlikely to reach Lake Superior (~49 miles downstream).

It is also important to note that Section 7.8 of the DEIS discusses possible release impacts despite very limited pathways for contact between the pipeline and the areas discussed. Section 7.8 discusses the Bad River and Kakagon slough complexes. As noted above, the Bad River crossing of the proposed Line 5 pipeline is approximately 49 miles upstream of the discharge of the Bad River into Lake Superior, and the Bad River Sloughs are located <0.25 miles upstream of the mouth of the river. The proposed route fully bypasses the Denomie Creek watershed, which drains directly into the Bad River slough complex and could therefore not be a possible pathway for oil under the proposed route. Also notable, the proposed route partially reroutes the Line 5 pipeline out of the watershed of Beartrap Creek, which drains into the Kakagon slough complex. The pipeline would now cross Beartrap Creek more than 6 miles upstream of the existing pipeline crossing and has a shorter segment passing through the watershed, which directly reduces the probabilities of accidental release in that area and potential impact to the slough complex.

The Project has the effect of moving the pipeline in all cases further away from impacting downstream areas (*e.g.*, wild rice). Review of documented wild rice areas indicates the only habitats downstream of the proposed reroute are located in the Beartrap Creek watershed (approximately 18 miles downstream of the proposed crossing) and in the Bad River watershed (approximately 45 miles downstream of the proposed crossing) (*see* WDNR 2021, p. 241 and Wild Rice Habitat Data). Although the DEIS appropriately acknowledges the value of wild rice to the local ecology, culture, and economy (WND 2021, p. 274), it does not quantify the much lower risk (probability and consequence) to wild rice posed by the proposed route. There is an extremely low probability of pipeline failure and resulting probability of oil reaching these downstream habitats. In addition, there is the reduced potential for impacts to wild rice, in that any hypothetical release would be required to travel greater distances (over which the oil would adhere to shorelines, evaporate, and further degrade – reducing the amount reaching the wild rice), resulting in a smaller magnitude and spatial extent of consequences for wild rice. Additionally, there is no discussion in the DEIS of how quickly and effectively emergency response mitigation would be implemented upstream of the habitats. Again, the proposed reroute places any hypothetical release (extremely unlikely) further from wild rice, allowing for even more time for emergency response efforts to contain and collect oil prior to reaching the wild rice habitats.

There is brief mention in the DEIS that the proposed Project terminates approximately two to four miles inland from Lake Superior (WNDR 2021, p. 274; [straight line distance]). However, these distances do not accurately reflect the distance required for the actual routes of potential transport for oil to reach wild rice areas or the form and concentration in which oil could arrive. The distances for oil to be transported downstream, potentially reaching wild rice, are much further than two to four miles, and only spills with very large release volumes (*e.g.*, FBR), limited mitigation opportunity, and conducive transport conditions would be able to reach wild rice areas with concentrations or thicknesses of oil that would be of a level to result in impacts. As noted above, the probabilities of spills on modern pipelines are typically very low (*i.e.*, unlikely).

Spill Prevention and Monitoring

Section 7.5 of the DEIS addresses pipeline safety standards and regulations but it does not fully characterize the Enbridge-specific measures that have been undertaken in the past 15 years to help prevent spills. In 2010 and 2014, Enbridge added a number of measures and procedures into its routine maintenance and operation activities, including the following:

- Augmented Control Center staff, including additional engineering and operator positions
- Provided additional training and technical support
- Re-organized the functional areas responsible for pipeline and facility integrity
- Increased the number of in-line inspection programs and integrity digs (excavation, examination, maintenance, and repair)
- Revised and improved many procedures within the IMP (Integrity Management Program)
- Implemented additional leak detection analysis procedures, including improvements to the leak detection escalation process, shift change transitions, alternate leak detection procedures, and analysis and communication procedures
- Formalized a quality management system to execute more effectively the critical work activities that meet pre-defined quality objectives
- Established a Pipeline Control Systems and Leak Detection Department, doubling the number of employees and contractors dedicated to leak detection and pipeline control
- Implemented a Leak Detection Instrumentation Improvement Program to add and upgrade instrumentation across its system based on the assessments
- Enhanced the Leak Detection Analyst Training Program

- Made changes to its pipeline remote monitoring and control systems

Section 7.5 also does not mention Enbridge's Public Awareness Program, which is a critical part of spill prevention planning, monitoring, and early detection.

> Since third-party damage is a leading cause of pipeline releases, Enbridge has a comprehensive Public Awareness Program in place. Enbridge maintains this Public Awareness Program to improve public awareness of the presence of its underground pipelines and related facilities. As a part of the program, Enbridge installs aboveground markers to identify the presence of pipelines and identifies ways to prevent damage to the pipelines from excavating equipment. The program includes communication with local, state, and national officials and agencies; emergency responders; local fire and law enforcement departments; state pipeline safety and emergency management agencies; landowners along their pipeline rights-of-way; excavators; and others. Enbridge also facilitates face-to-face communication, advertising, e-campaigns, sponsorships, events, mailings, publications in local newspapers, and grants (MN DOC 2017 p. 10-126).

These items should be incorporated into the FEIS.

Additionally, Section 7.5 does not include the following spill prevention measures:

- Pipeline Design
- Pipeline construction
- Prevention of Pipeline Exposure
- Valve placement
- Integrity Management
- Release Detection

<u>Pipeline Design</u>

Enbridge's focus on release prevention begins with sound pipeline design and construction. The Project has been designed by a team of professional engineers with experience in liquid pipeline design and construction.

Enbridge has established company standards that meet or exceed referenced regulatory (C.F.R., PHMSA, Canadian Standards Association (CSA) or industry (API or American Society of Mechanical Engineers (ASME)) standards. PHMSA regulations at 49 C.F.R. Part 195 prescribe safety standards and reporting requirements for pipeline facilities used in the transportation of hazardous liquids. PHMSA is the federal safety agency for the pipeline industry that interprets and enforces the pipeline standards. API is the national trade association that represents all aspects of America's oil and natural gas industry and has led the development of petroleum equipment and operating standards for more than 85 years. API maintains standards and recommended practices, many of which have been incorporated into applicable regulations. Enbridge, in the development of its own internal standards, references many of these state, federal, and industry standards.

To ensure proper manufacturing of pipe, Enbridge acquires pipe for all of the projects it, or one of its affiliates, is undertaking from reputable manufacturers with whom Enbridge has long-standing relationships.

The process for making large diameter pipes starts by establishing the specification for the high-tensile steel required for the type of pipe being produced. The pipe mill will then either produce this steel themselves or acquire it from a steel manufacturer who is able to meet the specification. Generally, steel is produced by utilizing electric arc furnaces to melt the right combination of recycled metals, new metals, and chemistry additives until it is ready to cast into large slabs. These slabs are then sent through a thinning process which converts the slab into a long coil of the precise wall thickness required. These coils are then formed into tubular shapes and welded. This exacting process ensures that the pipe can be relied upon to carry large volumes of oil at pressures required for pipeline operation. Producing the pipe requires meeting stringent requirements for quality and integrity.

In addition, a comprehensive inspection system at the mill helps Enbridge to achieve this quality and integrity by ensuring accuracy at every step of the process. Expert inspectors, employed by Enbridge, examine the formed pipe for possible defects at the manufacturer's facilities. Each length of pipe is visually inspected, every weld is examined with ultrasound or x-rays, and each pipe section is pressure-tested before a final fusion-bonded epoxy coating is applied to the surface under the close scrutiny of Enbridge's inspectors. The inspectors' specific duties include monitoring ultrasonic or x-ray tests that examine the integrity of each weld; using calipers and micrometers to assess each section for exact tolerances on diameter, roundness, and straightness; and ensuring proper coating application. The state-of-the-art fusion-bond epoxy coating enhances the integrity of the pipe over previous coatings by decreasing the chance of dis-bondment and assisting with cathodic protection.

In designing the Project, Enbridge used a design factor of 0.72 as required by 49 C.F.R. Subpart 195.106 to meet the minimum wall thickness requirement for the planned Maximum Operating Pressure (MOP). Additionally, Enbridge took into account external loads (crossings and burial depth), installation stresses, and pressure cycling effects when designing the Project. As a result, the wall thickness for the Project is 0.500 inches for the majority of the route, with wall thicknesses of 0.625 inches and 0.750 inches as needed where the Project utilizes and Horizontal Directional Drill or Direct Pipe Installation method.

Further in designing the pipe for the Project, Enbridge requires that the pipe is:

- Manufactured according to API Specification 5L PS2
- Grade X-70 steel with a minimum yield strength of 70,000 pounds per square inch ("psi")
- Submerged arc welded, a common manufacturing process in the pipeline industry

External corrosion control is also an important part of pipeline design. The coating of the pipe in the manufacturing facility and coating of the girth weld during construction are specified in Enbridge specifications, referencing C.F.R., NACE International, and other industry specifications.

Another part of the design criteria for the pipeline is the operating parameters. The design is optimized to maximize the efficiency of transporting the oil, with the MOP being set by the maximum rating of any component in an operating section, or based on the hydrostatic test pressure of the section. These criteria are set forth in 49 C.F.R. Subpart 195.304, as well as ASME B16.5 and other specifications.

Installation practices of the pipeline are also taken into consideration for the design. For example, when installing the pipeline via bore or directional drilling method, additional analysis of the pipe wall thickness is done to ensure the stresses (e.g., fatigue, circumferential, radial, longitudinal, and total effective) experienced during installation are within the acceptable limits of the applicable regulations and standards. Similarly, clearances between pipe and underground structures are set forth in 49 C.F.R. Subpart 195.250 and included in Enbridge's design standards. Finally, bending practices of the pipe, whether it is in the field or a manufacturing facility, are also noted in the C.F.R. and ASME B31.4, and these parameters are included in Enbridge's design standards.

<u>Pipeline Construction</u>

Pipeline construction techniques also help ensure safe operation. Enbridge utilizes rigorous construction standards, specifications, and procedures to ensure proper construction, integrity, and operational reliability.

The timing of construction activities is taken into consideration to prevent adverse weather conditions from affecting the integrity of the pipeline and workers' safety. Cold, snow, wind, rain, and other weather conditions are accounted for when scheduling the project construction so that appropriate measures can be utilized. Additionally, Enbridge consults with federal, state, and local environmental agencies to determine timing restrictions for potentially affected species and/or resources. This includes, but is not limited to, trout streams and migratory or nesting birds.

Enbridge has sought to obtain and has obtained ROW access that allows construction activities to commence without limitations to workers or pipeline safety. Generally, access to the ROW is from existing public roads and private access roads where permission has been acquired by Enbridge in advance.

During pipeline construction, clearing and grading activities are completed to allow for unencumbered ROW. Following clearing, the topsoil is stripped and separated, and the ROW is graded so that there are safe working conditions for construction activities.

Mechanical bending of the pipe is performed at certain locations to prevent geometric deformation during installation. Bends can either be done in the field or, for greater bend angles, completed in a manufacturing facility. As part of Enbridge's specifications, the bend procedure is prescribed such that the integrity of the pipe and coating is maintained throughout the process.

Enbridge has an inspection and quality assurance program that verifies, tracks, and documents the construction activities. During construction, every field weld is visually inspected by qualified Enbridge inspection staff. Enbridge also hires professional non-destructive inspection firms that perform x-ray or ultrasonic inspections on 100 percent of field welds, which is more stringent than federal regulatory requirements. Each weld is covered with an epoxy coating compatible with the rest of the pipeline, ensuring consistent quality and integrity.

During grading and trenching activities, the topsoil and subsoil are separated in order to protect the various layers of soil stratification. The pipeline installation ditch is excavated to the contour of the land and in concert with the bending activities so that the pipe copies the shape of the trench bottom and undue stress is not introduced on the pipe.

Federal regulations require various minimum depths of cover on a pipeline depending on the type of soil and land use the pipeline will traverse. In all cases the Project will meet or exceed these requirements.

All crossings of waterbodies, roads, railroads, and foreign utilities shall meet the requirements set forth in their respective crossing permits. These may contain depth of cover, minimum separation distances, and required crossing methods in order to minimize stresses and ensure integrity of all assets.

Cleanup activities on the ROW are completed in accordance with appropriate regulations and Project construction specifications, as well as in consultation, and pursuant to agreement, with landowners. Reclamation is performed to prevent soil erosion and ground degradation, thus preserving the stability of the ground around the pipeline and reducing the likelihood for pipe movement.

Once the pipe is lowered into the excavated ditch and backfilled with appropriate material, the new pipeline is hydrostatically tested with water to ensure integrity and to verify the segment has the ability to withstand internal pressures up to the MOP of the segment being tested. The hydrostatic testing will be conducted in accordance with both Enbridge standards and 49 C.F.R. Subpart 195.304, which require a test pressure of at least 125 percent of the MOP for at least four continuous hours. In the case of a pipeline that is not visually inspected for leakage during the test, the pipeline will be hydrostatically tested for a minimum of another four continuous hours at a test pressure of at least 110 percent of MOP.

Following the hydrostatic testing process, each tested section is inspected with an in-line inspection tool, which assesses whether any dents, buckles, or geometric non-conformities are present and also provides a baseline for future inspections. Once the pipeline has been backfilled and the ROW restored, additional surveys are done to test the quality of the coating. These surveys and tests may include: Alternate Current Voltage Gradient (ACVG) Survey or Direct Current Voltage Gradient (DCVG) Survey; close interval study; and coating conductance testing.

Prevention of Pipeline Exposure

All flowing water bodies have some component of erosion that occurs. Enbridge performs a Hydrotechnical analysis to establish an appropriate depth of cover in each waterway to account for such erosion. This analysis establishes the minimum depth of cover in each waterway that is then met by either installing the pipeline via a surface installation method such as a dam and pump dry crossing method or via a trenchless installation method such as a Horizontal Directional Drill (HDD) or Direct Pipe Installation (DPI) method. HDDs and DPIs can be used to significantly increase the depth of cover where the hydrotechnical analysis suggests it is needed. WDNR and the Wisconsin Standards Oversight Council have recently developed for adoption Technical Standard 1072 for Horizontal Directional Drilling (HDD), which identified best practices for pipeline installation to prevent pipeline exposure. The public comment period ended on March 28, 2022.

Valve Placement

Valves are designed and installed to isolate sections of the pipeline for maintenance purposes or in the event of a release. Valves are also required to be installed per federal pipeline safety regulations (49 C.F.R. Part 195). The valves are remotely controlled by the Control Center to limit the extent of a release. Enbridge conducted an Intelligent Valve Placement (IVP) analysis for the Preferred Route, which ensures that Enbridge complies with federal law and places valves in the optimal locations.

In accordance with federal law, valves must be placed:

1. On the suction end and the discharge end of a pump station in a manner that permits isolation of the pump station equipment in the event of an emergency.

2. On each line entering or leaving a breakout storage tank area in a manner that permits isolation of the tank area from other facilities.
3. On each mainline at locations along the pipeline system that will minimize damage or pollution from accidental hazardous liquid discharge, as appropriate for the terrain in open country, for offshore areas, or for populated areas.
4. On each lateral takeoff from a trunk line in a manner that permits shutting off the lateral without interrupting the flow in the trunk line.
5. On each side of a water crossing that is more than 100 feet (30 meters) wide from high-water mark to high-water mark unless the PHMSA Administrator finds in a particular case that valves are not justified.
6. On each side of a reservoir holding water for human consumption.

The IVP methodology, which is a key element of Enbridge's broader risk management program, combines rigorous consequence assessment, competent engineering judgment, and sound engineering practices to determine optimal valve locations. The objective of the IVP methodology, and our guiding principle, is to reduce the potential release volume in the unlikely event of a pipeline release.

Enbridge's IVP methodology is designed to ensure valves are placed at the right location to reduce potential release volumes along a pipeline corridor. Enbridge's IVP analysis takes a rigorous approach to valve placement that considers and protects water crossings, as well as other HCAs, from potential impacts.

The IV modeling identified the need for valves and proposed locations for the relocated segment of Line 5. Since that modeling was conducted, PHMSA finalized a rulemaking published in the *Federal Register* on April 8, 2022*, Valve Installation and Minimum Rupture Detection Standards, (*Docket No. PHMSA-2013-0255-0005). Enbridge is evaluating these final rules and the addition of valves in connection with the Project. Preliminary evaluations of potential sites for additional valves are all located in upland areas and would be sized consistent with other valves.

Integrity Management

Enbridge's integrity management program is a key component of Enbridge's release prevention efforts. Enbridge's integrity management program collects pipeline integrity data through the use of high resolution in-line inspection (ILI) tools. This data is analyzed to identify integrity risks to the pipeline such as corrosion or cracking. The analysis is then reviewed to develop a plan for safely maintaining the pipeline with the objective of restoring the pipeline to its historical operating capability.

The sections that follow address components of Enbridge's integrity management program. Enbridge is an industry leader in investing in ILI development and has been instrumental in the advancement of new ILI technologies.

Inspections

Pipeline inspections – internal and external, below- and above-ground – are a key method by which Enbridge assesses the integrity of its pipelines. Enbridge uses sophisticated internal inspection instruments, referred to as "smart pigs" or ILI tools, to identify areas of corrosion, cracks, and deformations (dents) that may develop in a pipeline. Any anomalies that are discovered by the tools that meet specific criteria are identified for further inspection and are excavated, inspected, and repaired, as necessary.

For example, in the detection of corrosion, there are two types of sensor technologies –magnetic flux leakage and ultrasonic transducers – which provide a highly detailed profile of corrosion on external and internal surfaces. The figure below shows a magnetic flux leakage ILI tool. The tool is commonly used throughout the industry with a great deal of success in identifying metal loss anomalies.

The figure below depicts an ultrasonic crack detection ILI tool: the General Electric Phased Array Tool. The tool provides the highest resolution detection and characterization to identify cracking in welds and the pipe body.

The next figure depicts an MFL tool combined with a caliper tool that is used to detect and characterize pipeline deformations.

ILI tools use calipers (to measure geometry), gyroscopes (to gauge pipe movement), GPS (for precise pipe position), and ultrasonic or magnetic flux (to measure associated gouge, corrosion, and cracking) to measure the size, frequency and location of minute changes on both the inside and the outside of pipe walls. The ILI tools

Enbridge uses to inspect its pipelines are extremely sensitive and provide a level of detail similar to that provided by an MRI, ultrasound, or x-ray screening in the medical industry.

Once gathered, the data from each ILI run is analyzed by internal Enbridge and external engineering and integrity experts to align current and prior ILI data such as anomaly density and severity with pipe characteristics, relative location of anomalies, environmental conditions, coating materials, and operating history.

Data analysis requires significant expertise by engineers and integrity specialists that review the millions of pieces of data collected through the tool runs. Once the data is collected and analyzed, Enbridge then reviews the analysis to develop an integrity management plan to address the anomalies that have been identified. This maintenance plan addresses the work required to be undertaken and predicts the amount and type of work required in the future.

PHMSA's regulations require Enbridge to assess the integrity of its pipelines at five-year intervals, not to exceed 68 months. While that is the minimum, inspections are typically more frequent due to the wide variety of ILI tools employed by Enbridge. Enbridge also assesses integrity threats via a risk-based approach, which may require additional tool runs. In accordance with federal regulations, Enbridge will perform a baseline assessment of the Project when it is placed into service.

During operation Enbridge uses appropriate techniques to monitor the system and assess operational data in order to verify pipeline integrity and confirm that prevention mechanisms are effective. The monitoring techniques include ILI, on-line sensors, pressure cycle monitoring, active slope monitoring (*i.e.*, geohazard), hydrostatic testing, Non-destructive Examination (NDE), direct assessment techniques and other proven and new innovative methods and technologies.

1. ILI: For all mainlines and certain facility piping, ILI tools are capable of performing crack detection and metal loss inspection.
2. Sensory Instruments: Instruments that read pressures/cycling, pipe movement, external and internal corrosion, and vibration are installed on each new pipeline. Flexible power options and communication options allow installation at remote locations, and the ruggedized design assures reliable operation in the harshest environments.
3. Hydrostatic testing: Hydrostatic testing is conducted during pipe manufacturing, prior to pipeline commissioning, and as an integrity verification tool. The test involves filling a pipeline segment with water until it is at a pressure that is higher than the pipeline will ever operate. This can validate the safe operating pressure of the pipeline and ensure that the line is structurally sound.
4. NDE: NDE does not permanently alter the article being inspected. It is a highly valuable technique that can save both money and time in product evaluation, troubleshooting, and research. Common NDE methods include ultrasonic, magnetic-particle, liquid penetrant, radiographic, and remote visual inspection; eddy-current testing; and low coherence interferometry.
5. Surveys: Various surveys are used to measure pipe depth, assess river crossing and geotechnical conditions, determine the effectiveness of corrosion control, and identify third-party activity near the ROW. Aerial patrols are one of the types of surveys conducted.

Corrosion Protection Monitoring

Enbridge's pipelines have cathodic protection systems to prevent external corrosion of the pipes. The cathodic protection system is subject to regular maintenance and inspection. It is also continuously monitored. Enbridge takes actual readings each calendar year (not to exceed a 15-month interval) by taking pipe/structure to soil readings where possible. Enbridge also inspects the rectifiers and anode ground beds used in the cathodic protection system, conducting repairs as necessary.

Enbridge evaluates the susceptibility of its pipelines to internal corrosion by integrating and evaluating data on pipeline characteristics, ILI results, operating conditions, pipeline cleanliness, crude sampling, and historical leak data.

Monitoring and Mitigation of Pipeline Exposure

Enbridge reviews the depth of cover over all pipelines on a periodic basis. Enbridge's ongoing integrity management program includes evaluation of pipelines that have become exposed over time. Enbridge maintains its existing assets in accordance with federal and state law, and all new pipelines are installed according to those requirements.

Enbridge's integrity management programs also include a Geohazard Management Program, which monitors extreme weather events and for potential line exposures at flowing water crossings. Enbridge has conducted a baseline review of all river crossings to determine the potential for exposed and shallow pipe, unstable banks, and steep slopes. Based on this review, Enbridge developed flood monitoring criteria for each crossing that describes events triggering inspection (*e.g.*, a 5-year rain event and a 25-year rain event) with the potential for several inspections based on water levels. When an inspection is triggered by an event, the regional engineering group is notified and it deploys a local pipeline maintenance crew to make visual inspection of the crossing. If the inspection finds damage, it is examined, and repair work is completed as needed on a site-by-site basis. In the unlikely event that a pipeline exposure does occur, the exposure itself does not necessarily increase the risk of release. Conditions around the exposed pipeline will be continuously monitored and assessed for potential risk of third-party strikes, pipeline movement, and planning for future repairs.

Prevention of Third-Party Damage

Third-party damage is a leading cause of pipeline releases. Enbridge strives to prevent any dents, scrapes, and other damage to its pipes and facilities during construction and operation or by third parties. Enbridge has a comprehensive public awareness program in place to engage landowners, community members, and first responders to ensure they are aware of our pipelines and related facilities. The program focuses on identifying the presence of the pipeline by installing markers above ground and how to prevent damage to the pipeline from excavating equipment. Enbridge supports and is a member of the State One-Call System.

Integrity Threat Mitigation

Threat prevention occurs over the complete lifecycle of a pipeline, and Enbridge assesses the "fitness" of the pipeline for the service it is intended to perform, considering hazards and risks. The need for remedial action or repair work is based on the goal of ensuring a long-life asset and preventing failures.

When Enbridge's ILI program identifies anomalies that require excavation and visual inspection, Enbridge obtains the required environmental and regulatory permits, notifies affected landowners, and identifies all existing utilities in the vicinity of the area to be excavated. Enbridge then excavates around the section of buried pipe so that it can be cleaned and examined and then repaired, as needed. This is referred to as a dig and repair program, and individual digs are referred to as "integrity digs." Repair methods include cleaning the pipe, addressing corrosion and/or crack features, and recoating the pipe with modern epoxy coating. Integrity features that cannot be sufficiently addressed in this manner may be encapsulated by another layer of pipe, called a sleeve, before being recoated with modern epoxy coating. In some rare cases, a section of pipe may be cut out to remove an anomaly and a new piece of pipe welded in its place. Upon completion of the examination and repair, subsoil and top soil are replaced, and the site is restored by grading, planting, and reseeding, as necessary. Integrity digs involve disturbance of the land, which may interfere with the landowner's use of the property. However, integrity digs are necessary to maintain the safety of the pipeline.

To ensure the safe operation of a pipeline, it may be necessary to reduce the pipeline pressure below its MOP. Temporary pressure restrictions may be imposed when an ILI reports a severe anomaly that necessitates a pressure reduction to ensure a factor of safety is maintained. The restriction may be removed after the anomaly is excavated, examined, and repaired. Temporary pressure restrictions may also be imposed if Enbridge is unable to verify the reliability of the ILI data. These restrictions may be removed after evaluating the pipe using additional inspection methods such as performing more ILI, completing more dig and repair programs, integrity digs, pressure testing, and/or completing an engineering assessment.

When it is determined that on-going maintenance activities will not feasibly restore the pipeline back to its MOP, a permanent pressure restriction may be imposed. The lowered MOP enables the continued operation of the pipeline, at a lower pressure, while maintaining a factor of safety on the condition of the pipeline. Pressure restrictions can cause significant operational challenges and typically limit capacity and operating flexibility.

Replacement is another mitigation measure that Enbridge employs. Enbridge has a formalized procedure for assessing pipeline replacement, which is continuously updated and refined based on increased knowledge and improved technologies. Enbridge's replacement analysis involves forecasting integrity digs required to address integrity threats, and also takes into account factors such as the impact to the environment and landowners, risk reduction, and operating reliability requirements, among others. Pipe replacement is neither an easy decision nor a last resort. Instead, it is a calculated decision that takes into consideration the costs and benefits given the circumstances of the specific pipeline.

Internal Corrosion Prevention

Internal pipeline cleanliness is important for preventing internal corrosion. Cleaning tools, liquid inhibitors, and biocides can be used throughout the life cycle of pipelines to prevent the development of internal corrosion.

Release Detection and Emergency Response

Release detection is accomplished through pipeline monitoring and inspections. As with all Enbridge pipelines, the relocated segment will be monitored 24 hours a day, seven days a week, and 365 days a year from the Control Center Operations (Control Center) facility located near Edmonton, Alberta.

The state-of-the-art Control Center was constructed in 2011 and was purposefully designed to enhance the safety and reliability of our pipeline operations by creating optimal working conditions while supporting our operations team as they conduct critical around-the-clock activities. The Enbridge Control Center facility allows for greater interaction and enhanced support, with design measures to address fatigue management in conjunction with maximizing human performance through such features as ergonomic consoles, improved circadian lighting, and noise reduction paneling equipment.

Controllers are supported by additional on shift 24/7 peer support, Senior Technical Advisor support, and Shift Supervisor support. In addition, Controllers have access to the Control Center Technical Services group, and Engineering and Management teams. The Control Center Engineering and Management teams are also available 24/7 through a rotational, on-call program.

The systems operated by the Control Center include approximately 15,380 miles of pipe segregated into 59 distinct pipeline assets, 26 of which are located in the United States. Enbridge also maintains a fully functional back-up Control Center in the Edmonton area that can assume full control of the Enbridge system in the unlikely event the primary Control Center is unable to function properly.

Monitoring Systems

The Control Center employs multiple redundant systems that have been designed and optimized to prevent the release of hydrocarbons and mitigate the magnitude of a release in the unlikely event of a pipeline failure. The following methods are used by the Control Center to monitor and assess whether a release may have occurred:

Computational Pipeline Monitoring (CPM)

The Project will be protected by a computer-based pipeline monitoring system that utilizes measurements and pipeline data to detect operational anomalies that indicate possible leaks. This system employs a sophisticated computer model that applies a sequential probability ratio test to the corrected flow balance system. This system continuously calculates the statistical probability of a release based on fluid flow and pressure measured at the inlets and outlets of a pipeline. The expected pressures and liquid flow rate in each section of the pipeline are compared to the actual measured pressures and flow rate. Discrepancies between the expected and actual values result in a leak alarm that precipitates shutdown.

Supervisory Control and Data Acquisition (SCADA)

In addition to keeping in close contact with field operators via telephone and computer, Controllers use the SCADA computer system to monitor what is occurring within our pipeline and terminal systems. Using the SCADA system, computers in the control room and at remote sites continually relay information back and forth, enabling our Controllers to constantly monitor pressures, flow rates and other conditions on our pipelines and terminals, allowing for a quick response when abnormal or emergency conditions are identified. The system is designed to remotely control the line, detect anomalies, issue controller alarms, and initiate a station shutdown or line stop when allowable operating limits are exceeded or logical arguments fail.

Examples of SCADA controller alarms include:

- Explosive vapor alarms
- Pump seal failure alarms
- Equipment vibration alarms
- Station fire alarms

Examples of SCADA initiated station shutdown or stop line commands include:

- High pressure limits
- Low pressure limits
- Unintentional valve closures

Line Balance Calculations

Controllers will employ line balance calculations that compare the volume of oil injected into the pipeline with the volume of oil delivered from the line to identify unexpected losses of oil that would indicate a leak. Line balance calculations are performed every two hours using both two hour and 24-hour balance intervals. Enbridge also maintains a rolling 24-hour calculation based on the calculations done at the prescribed set times. These calculations identify unexpected losses of pipeline inventory during pipeline operation. Negative line balances that exceed the detection thresholds may indicate a release and result in the line being shut down.

Controller Monitoring

The Project will be monitored 24/7 by specially trained and qualified Enbridge employees located in the Control Center. Controllers are trained to monitor the operating parameters of the line and react to operational anomalies, CPM alarms, discrepancies in line balance calculations, SCADA alarms, SCADA station shutdown commands, and SCADA stop line commands.

Controllers continuously monitor SCADA data to identify the pipeline leak triggers. Pipeline leak triggers from the upstream side of a suspected leak site include:

- Sudden drop in upstream discharge pressure
- Sudden change in upstream control valve throttling or pump speed
- Upstream unit(s) shut down (or lock out) in combination with a sudden drop in upstream discharge pressure and/or a sudden change in upstream control valve throttling (or a sudden change in percentage Variable Frequency Drive (VFD) control)
- Sudden increase in upstream flow rate

Pipeline leak triggers from the downstream side of a suspected leak site include:

- Sudden drop in downstream suction pressure
- Sudden change in downstream control valve throttling or pump speed
- Downstream unit(s) shut down (or lock out) in combination with a sudden drop in downstream suction pressure and/or a sudden change in downstream control valve throttling (or a sudden change in percentage VFD control)
- Sudden drop in holding pressure at a delivery location
- Sudden decrease in downstream flow rate

Controllers also consider alarms from the CPM system and line imbalances that exceed the line balance thresholds from the line balance calculations as independent leak triggers.

The Control Center actively monitors all pipeline and terminal systems, including systems that are operating and systems that are shut down. The Control Center monitors all fieldwork and maintenance activities taking place on Enbridge assets. It has processes in place to ensure that these activities are considered and that alternate monitoring strategies are developed when required. In addition to monitoring and controlling the pipeline systems, the Control Center monitors the incoming and outgoing terminal flows and individual tank levels. The Control Center also performs volume balance checks on the Project while also monitoring gas alarms and fire alarms.

Enbridge Inspections

Visual inspections are also very important. Enbridge patrols all pipeline ROW by air at least 26 times per year (not to exceed a three-week interval) to assess the ROW for potential damage or other release threats. Typically, aerial inspections are made on a weekly basis, weather and other factors permitting. These inspections review conditions on or adjacent to the ROW. Line walking inspections are used, as necessary, to supplement aerial inspections in congested areas. To facilitate these regular inspections, Enbridge is required to maintain a ROW clear of woody vegetation.

Enbridge also inspects its facilities, such as pump stations and terminals, through targeted tankage, equipment, and piping inspections. A team of subject-matter experts in Engineering, Operations, and Integrity implement a release detection program for all facilities throughout the liquids pipeline system.

In addition, Enbridge checks the operation of isolating valves at least twice per year and regularly reviews the equipment used to limit, regulate, control, or relieve pipeline pressure.

Third-Party Reports

Enbridge operates an emergency telephone line whereby members of the public and public officials can notify Enbridge of any issues related to its pipelines. The emergency phone number is communicated to emergency officials and the public as part of a continuing public awareness program. The number is also advertised on the www.enbridge.com website and on Enbridge ROW signage. The Control Center continuously monitors the Enbridge emergency telephone line for reports of oil on the ground or reports of odor provided by third parties.

Emergency Response

Enbridge's emergency response plan, referred to as the Integrated Contingency Plan (ICP), was approved by PHMSA in July 2013. Enbridge reviews the ICP at least annually, with the latest update in November 2021. Enbridge's current ICP serves as the emergency response plan for all Enbridge Liquids Pipelines.

The ICP was developed in consultation with PHMSA and was the first industry plan to undergo an extensive, multi-agency peer review process. Agencies that participated in the review of the Enbridge ICP included, but were not limited to, the United States Environmental Protection Agency (EPA), the United States Coast Guard (USCG), the Occupational Safety and Health Administration (OSHA), and PHMSA. The Enbridge ICP follows the format of a document prepared by the National Response Team (NRT), which provides technical assistance, resources and coordination on preparedness, planning, response and recovery activities for emergencies involving hazardous substances. That document, known as the ICP Guidance, was developed by the EPA, USCG, OSHA, PHMSA, and the Minerals Management Service in the Department of the Interior (DOI) to provide a sample contingency plan outline that addresses the requirements of various federal regulations. The ICP Guidance format is the federally-preferred method of response planning, and plans prepared in accordance with the ICP Guidance are viewed favorably by the NRT and reviewing federal agencies. Using the ICP Guidance document allowed Enbridge to create a single plan that serves as the primary emergency response tool.

The ICP consists of two parts. Part 1 is the Core Plan that serves as the overall plan and is consistent across all operating regions. Part 2 is an annex based on the geographical Response Zone (or Region), which provides detailed supporting information and regulatory compliance documentation for each of the Enbridge Response Regions. The Project will be within the Midwest Region.

The ICP utilizes the Incident Command System (ICS), which is a system used by both public and private sector emergency responders to coordinate objectives and actions when responding to an incident. ICS is a management system that uses a Unified Command structure to set objectives for a response to any type of incident. A Unified Command is established when representatives from Enbridge, federal agencies, state agencies, and local agencies form a single chain of command to issue instructions relating to the response. Each leader is responsible for a limited number of workers, which increases safety and makes response management easier. Resources from the company and response agencies are also coordinated for maximum efficiency and effectiveness. All activities are documented in an Incident Action Plan, which is a written document created for each phase of the response.

The ICP is used by Enbridge responders to manage an emergency anywhere within Enbridge's United States system. Those responders include the Regional Incident Management Teams (IMTs), which are groups of Enbridge employees located in each region with training in the ICS, and the Field Response Teams (FRT), which are groups of Enbridge employees in each region with specialized training in containment and recovery operations.

The ICP's primary purpose is to ensure an effective, safe, and comprehensive response to all types of incidents, regardless of where the incident occurs, or what type of resource may be impacted. Accordingly, Enbridge is prepared to respond to any incident, regardless of the type of oil, the location, or type of incident, such as fire or a security event. The two primary goals of any incident response are to prevent injury or damage to the public and Enbridge employees and mitigate any possible impact on the environment. The specific objectives of the ICP are to:

- Provide guidelines for handling an emergency response operation
- Develop alert and notification procedures to be followed when an emergency response incident occurs
- Document equipment, personnel, and other resources available to assist with an emergency response to an incident
- Describe response teams, assign individuals to fill the positions on the team, and define the roles and responsibilities of team members
- Define organizational lines of responsibility to be adhered to during an emergency response
- Outline specific response procedures and techniques to be used during an emergency response incident
- Comply with United States Homeland Security Presidential Directive 8 to take an "All Hazards" approach to emergency response, which means having a response plan to address not only a product release, but also a tank fire, power outage, or security incident

The ICP may undergo additional revisions in connection with a change in regulations or due to operational changes that require reporting per applicable regulations.

Field Emergency Response Plan

Each of the nine regional annexes to the ICP contains a Field Emergency Response Plan (FERP), which is a region-specific, condensed version of the ICP tailored to the unique features of the region. Each FERP is publicly available and specifically designed to be used by first responders and Enbridge personnel in the field. The current FERP for the Midwest Region, which will govern emergency response for the Project, is included as Attachment F. The FERPs are also available to the public at www.emergencyresponderinfo.com. Registration is required to obtain a copy of the FERP so that Enbridge can provide any updates to the FERP to those individuals that have requested the FERP in the past.

The FERPs include, but are not limited to:

1. HCA maps, which show areas of high population, other population, water, and environmentally sensitive areas;
2. Control point maps, which show downstream water access and collection points;
3. Facility Response Plans, which address pumping and terminal areas;
4. Line information, which includes valve locations;
5. Response maps; and
6. Equipment lists.

The FERP will be updated to include Project-specific information once the route is finalized and final construction design of the Project has been completed.

Enbridge's ICP and FERP meet or exceed all local, state, and federal requirements, including PHMSA's pipeline safety regulations specified in 49 C.F.R Parts 194 and 195, and applicable OSHA, USCG, API national technical standards, and API 1174 recommended practices for Liquid Pipelines Emergency Response.

Emergency Response Resources

Pipeline Maintenance (PLM) shops are equipped with emergency response equipment and pre-positioned and packed response trailers. These are the main repositories of Enbridge-owned emergency response equipment. Detailed lists of equipment maintained at each station are provided in the FERP for each region. Examples of maintained equipment at these locations include containment boom and related equipment, skimmers, pumps, trailers, boats, generators, specialized vehicles, and trucks.

Enbridge does not limit its response resources to only those located at staffed stations within the region where an incident occurs. Enbridge will mobilize any response asset that may be required, regardless of where the asset is located. Enbridge maintains its own Tier 1 response resources as defined in the USCG Oil Spill Removal Organization (OSRO) classification regulations. Enbridge will also mobilize resources from contracted OSRO companies and other OSRO companies as needed. Local suppliers are also used for equipment rentals and purchases of ATVs and boats. Additionally, Enbridge has an Enbridge Enterprise Emergency Response Team (E3RT), which is a cross-business unit response team that responds to large-scale events anywhere in North America that require more resources than a single region could provide.

In addition, in the event that the ICP Team determines additional resources are required to respond, Enbridge has developed a relationship with other contractors along the route who have been trained and have agreed to provide resources and participate in responding to any incident when called upon by Enbridge. For example, to assist with clean up, Enbridge could call on those companies that Enbridge contracts with on a regular basis, such as vacuum truck vendors and rental companies to provide additional equipment and personnel.

All of these resources described above have been identified and have agreed to participate or assist in the event Enbridge asks for their assistance. Any contractor involved in a response will first be trained and, at the incident, will be part of the ICS response. Enbridge enters into arrangements with hotels so that housing and conference space used during regular business operations is also available during emergency response.

Emergency Response Timing and Processes

Enbridge treats all incidents, regardless of type or location, in a uniform manner to ensure a consistent, effective response. An incident is any event that is outside of expected operating procedures and requires an emergency response. Enbridge has made the decision to immediately mobilize more resources than may be necessary to respond to an incident and then scale the response down rather than respond with minimal resources and then have to engage others as response occurs.

Initial Control Center Response

The Control Center is Enbridge's primary incident detection system. When one or two leak triggers are identified, the Controller has 10 minutes to analyze the information and conclusively rule out the possibility of a leak. If the possibility of a leak cannot be irrefutably ruled out within 10 minutes of the first leak trigger being identified, the Controller immediately initiates a shut-down of the affected line segment so that it is sectionalized and isolated. The Controller then notifies the appropriate personnel in Enbridge, who initiate the investigation process.

When three or more leak triggers occur, immediate steps are taken to sectionalize and isolate the pipeline using remote controlled valves. There is little to no time between detection of a release and execution of the line shutdown process.

The amount of time required to identify a leak is dependent on the nature of the release. Full-line ruptures will result in multiple leak triggers and alarms that will notify the Controller almost instantaneously. Small leaks are typically detected by the CPM system and the line balance calculation process (as described above), both of which are tuned to detect large and small leaks. Although the highest sensitivity leak threshold requires 24 hours to trigger an alarm, changes in operations and other monitoring techniques alert the Controller of changes in volume that will also be relied upon to shut the pipeline down and initiate an investigation in a shorter timeframe. Controllers are required to shut the line down in the event that they suspect that there is an issue with the pipeline operations.

Emergency Response Processes

Many activities are undertaken within a short period of time in response to an incident. Enbridge personnel are trained to respond to an incident in accordance with the FERP. The FERP provides specific response steps and tactics to be used within each region, considering the unique topography and features along a pipeline route within the region.

When notified of an incident, the Control Center will shut down the pumps and close the valves in the area of concern. On-call operations personnel and managers are notified internally by the Control Center. These include individuals that are part of the IMT and FRT. Notifications occur for both internal and external parties, including the National Response Center (NRC), the state, and local police.

Enbridge first responders work to confirm the nature and location of the incident as notifications occur. Trained Enbridge personnel will also be directed to the site of an incident after receiving notice of the incident.

External first responders will arrive on the scene within minutes of being alerted to an incident secure the scene, undertake evacuations when necessary, and deploy the FERP procedures, which are provided to Enbridge and external first responders. External first responders are public health or safety agents, such as fire or police departments, charged with responding to an incident during the emergency phase and alleviating any immediate danger to human life, health, safety, or property.

When notified, Enbridge follows the ICP and initiates a response using the ICS model. The goal is to prudently over respond. Initial indications of response needs are based on assessment of the level of emergency.

One of the first steps under the ICS is for a Qualified Individual, a person with specialized training in incident command, to take the role of Incident Commander. That Qualified Individual is charged with ensuring that *more* than the required resources are provided to respond to the incident. The Incident Commander will set incident objectives and Operations will identify tactical objectives for the response. The primary incident objective will always be ensuring the safety of the public and responders.

The IMT will use Enbridge's response plans and processes to create an Incident Action Plan (IAP) for each period of the incident response. An IAP is a work plan that guides response activities for the next work period, which can vary in duration from 12 hours to several days. The initial response periods are shorter and may increase in length if the objectives and tactics being used do not change. Command objectives and tactical objectives are used to create work plans, order resources, and communicate with those involved in the response.

Enbridge's emergency response plans include pre-determined steps to take in the event of an incident. Maps and tables have been developed by Enbridge that identify HCAs and ESAs along pipeline routes for each region. Response regions maintain control point map sets that identify product containment and recovery sites on high-risk water bodies that could be impacted by a pipeline release. The purpose of the control point maps is to identify in advance the best locations for deploying emergency response equipment, such as containment booms. This allows emergency responders to know exactly what equipment is required and what to do in the event of an incident.

The HCA, ESA, and control point maps and tables allow Enbridge to know where to locate response resources in advance of a release so that emergency responders can get to work immediately upon deployment. For example, Enbridge will have identified the location of sensitive resources, such as aquatic vegetation, sensitive shoreline areas, important habitats, and other features in advance and ensure that there is appropriate equipment in the vicinity, which is to be deployed at pre-determined locations. Emergency responders will use the HCA and control point maps and tables to begin placing booms and taking any other necessary response measures to protect resources and limit the impact of an incident.

These maps and tables are reviewed annually and updated in accordance with Enbridge policy along with the ICP. In addition to updating the maps and information to reflect updates from PHMSA, the management groups in each operating region are responsible for ensuring that a visual field reconnaissance of each control point is carried out at least once every three years.

From an emergency response perspective, if a pipeline can be built in an area, emergency responders can reach the pipeline. Enbridge has a wide variety of methods to access an emergency site in any terrain or location.

The ROW provides direct access to a pipeline. Enbridge can access the ROW from public roads, or from access roads built during construction. Federal law requires pipeline ROWs to be kept free of vegetation that would interfere with inspection, so emergency responders will be able to travel down the ROW.

If conditions are not conducive to regular vehicles traveling down the ROW, Enbridge has specialized vehicles that can travel through swamp and marsh areas to access an incident. These vehicles include airboats, Marsh Master utility vehicles (specialized amphibious work vehicles that can transport equipment and personnel through wetlands and other difficult to access areas), ATVs, and work boats. Tracked mini-vacuum systems and portable tanks are also available to respond to incidents. Enbridge has also stationed a helicopter dedicated to aerial inspection and emergency response in Bemidji, Minnesota.

While those vehicles can transport equipment and personnel to a response site quickly, Enbridge can also build temporary access roads or mat roads through difficult terrain along the ROW in short order to bring additional equipment and response personnel to an incident site.

Emergency Response Training

Enbridge's emergency response efforts include significant training and exercises for Enbridge employees, as well as emergency responders.

Employee Training

Personnel anticipated to be involved in responding to incidents receive training in ICS levels 100-400. ICS is the common system used by first responders, the military and civil authorities across North America for responding to incidents. ICS classes are categorized by the different levels of information provided. ICS 100-200 classes focus on basic ICS and are taken by all responders. ICS 300 and 400 are two-day courses for select personnel. The courses include training on staffing and response organization, reporting requirements, transfer of incident command, unified incident command structure for multi-jurisdictional or multi-agency incidents, documentation, resource management, and related topics. ICS role-specific training is also required for all IMT positions. Role specific training is a class focused on training for specific ICS positions. Also included in training is ICS 320, a three-day course that focuses on the proactive planning phase of a multi-day incident. ICS training is conducted on an on-going basis and ever-increasing numbers of Enbridge IMT team members will be trained and available to respond in the event of an incident.

The qualified individuals, who function as Incident Commanders within the ICS system in each region during an emergency response situation, receive additional training focused on their role in developing an ICP for a response, coordinating resources, and identifying the type and quantity of resource required for their respective regions in order to ensure more than the required resources are provided to respond to any incident.

Enbridge's preparedness and response exercise programs follow the National Preparedness for Response Exercise Program (NPREP) standards, which were developed by PHMSA, the USCG, the EPA and DOI to establish a preparedness exercise program for federally-regulated companies. The NPREP standards require a minimum number of different exercise types over a three-year period, including at least one spill IMT exercise and one FRT exercise annually. Also included is a Full-Scale Exercise (FSE) at a minimum of every three years. A FSE is an exercise that includes both equipment deployment and the IMT responding to the same scenario. Enbridge employees participate in regular emergency response drills and simulations to provide training, test, and improve upon Enbridge's preparedness procedures. Enbridge's exercise and drill program far exceeds federal standards.

Exercises are planned annually for employees and first responders to participate in hands-on training in their primary response area. Employees are trained through workshops, equipment deployment drills, and tabletop exercises where various scenarios are discussed. These training events occur regularly and frequently across all Enbridge Response Regions to ensure that personnel are trained to respond to an incident and able to address the unique features of their environment. Many of these exercises involve local emergency responders using emergency response equipment to practice recovery and cleanup in various terrains and/or on water.

First Responder Training

Enbridge's training is not limited to its employees. Enbridge currently bears the cost of training first responders and will continue to do so. Enbridge offers a free online Emergency Responder Education Program, which has been launched to more than 8,000 response agencies in North America, including those along the Preferred Route of the Project. The online program is for all public sector first responders. There is also a specific program for 911 dispatchers, which was created with the assistance of the National Emergency Number Association (NENA). The content for both programs is based on "Pipeline Emergencies," an industry-leading pipeline emergency response training program developed by the National Association of State Fire Marshals. The purpose of this training is to make sure that first responders know their role and are prepared to fulfill that role in the event of an incident. To that end, Enbridge works with first responders so that they know the following information:

- Names of companies operating pipelines in their community
- Emergency and non-emergency contact information for all operators
- The approximate location of the pipelines

- What materials or products are being transported in the pipelines
- The physical indications of an unintended release
- Potential impacts of an unintended release
- Steps that should be taken to protect the public

Some Enbridge employees are also trained as Emergency Response Ambassadors in each Response Region to provide additional face-to-face training and information to 911 operators and emergency responders at Enbridge's expense. Enbridge's primary focus is on those agencies and responders within a five-minute response time of an Enbridge pipeline because those are the agencies and individuals that will likely be first on scene for an incident. The goal of this additional training and information is to provide further, specific, practical information to be used by first responders when interacting with the public in response to an incident.

The level of training that incident response personnel receive, regardless of whether they work for a non-company agency or for Enbridge, is commensurate with the respective personnel's role in the incident response plan. First responders are therefore trained to be able to perform the following functions as part of an emergency response:

- Secure the scene
- Deploy or initiate the FERP procedures
- Respond to protect people, property, and the environment, including isolation of the area, rescue, and evacuation
- Call for assistance
- Work with Enbridge to remedy the situation

While non-company agency personnel fulfill important incident response roles, such as ensuring the safety of the public by controlling access to the area, implementing the procedures set forth in the FERP, providing medical support if necessary, and, if required, responding to fires or other immediate hazards to life or property, they are not expected to fulfill the role of halting or remediating a release. Enbridge employees and contractors with more specialized training will be used to perform those functions. As a result, Enbridge ensures that non-company agency personnel are trained to make sure they are, among other things, (i) aware of Enbridge and Enbridge assets in their areas, (ii) aware of and able to implement the FERP, and (iii) able to coordinate response efforts with Enbridge, using ICS and Unified Command, as effectively as possible during all phases of incident response, from first response through remediation. In this way, Enbridge ensures that everyone who is expected to respond to an incident is equipped with the information and resources necessary to fulfill their respective roles.

Enbridge sponsors annual emergency response information and training meetings that focus on pipeline response and response safety, such as annual meetings with the emergency response personnel along Enbridge's pipelines, to ensure they have the latest information on our operations. These emergency responders include Emergency Medical Services (EMS), fire chiefs, sheriffs, police chiefs, and state and county emergency managers. Enbridge offers training and, if requested, goes to the department's training night to give a presentation. Enbridge has also hosted pipeline emergency workshops and exercise drills for local first responders.

Emergency Response Funding

Enbridge's first priority and primary objective is to prevent incidents from occurring through its comprehensive operational risk management practices and processes. The safe operation of our pipelines is Enbridge's top priority; however, in the event of a release, Enbridge remains committed to returning affected areas to their pre-existing conditions. Enbridge has the financial capability to ensure that Enbridge responds to an incident and satisfies its commitments.

As the Project owner, Enbridge is responsible for emergency response. Enbridge has access to multiple sources of financial resources to fund the response to and remediation of a release. Enbridge is able to draw down cash from operations, issue debt, or acquire commercial paper as a result of its exceptionally strong credit rating. Enbridge is also well-capitalized to absorb unforeseen operational costs, maintains adequate insurance for operations, and has exceptional access to public debt markets to fund operational needs, including those stemming from pipeline releases or leaks. For example, Enbridge has spent more than $1 billion responding to the release at Kalamazoo, Michigan, demonstrating Enbridge's responsibility and ability to perform response and remediation operations.

In addition to Enbridge's ability to fully fund all response needs, during the Project operations, Enbridge will maintain a comprehensive insurance program that includes commercial general liability insurance consistent with coverage considered customary for its industry. Enbridge's general liability program provides insurance coverage under which Enbridge may submit claims to recover its incurred costs responding and cleaning up a release.

Notification of Spills

Section 7.6.2 of the DEIS very briefly discusses the required notification for pipeline spills. However, Enbridge has voluminous and detailed procedures to detect leaks, shut down pumps, close MLVs, and provide notifications to necessary personnel. These procedures are not referenced in the DEIS and should be noted in this section.

7.0 ENVIRONMENTAL JUSTICE AND MISSING AND MURDERED INDIGENOUS WOMEN (MMIW)

Appendix O to the DEIS includes the draft Environmental Justice Commitment Plan (EJCP) for the Project. That plan includes commitments for coordination and outreach, environmental controls, spill prevention and response, invasive species mitigation, tribal monitors, tribal economic participation and workforce development, and human trafficking prevention and awareness.

Section 5.9 of the EJCP addresses hunting, fishing, and gathering rights. Enbridge will not impede the lawful exercising of the right to hunt, fish, or gather on property open to the public. In areas where the rerouted Line 5 crosses public land, members of the Signatory Tribes and public can lawfully hunt, fish or gather; however, to ensure public safety, access to the right-of-way will be temporarily restricted during active pipeline construction or maintenance activity. During active construction or maintenance activity, Enbridge will make its best efforts to accommodate requests for access to the ROW for all such lawful activity, and will identify a point of contact to coordinate access locations and timing to ensure public safety.

In section 5.8 of the EJCP, Enbridge identifies that they have established a project-specific Human Trafficking Awareness and Prevention Program (HTAPP). The HTAPP began in October 2020 and is managed by Perodigm, a Bad River Native-owned media company. Perodigm has brought together an Advisory Group with unique knowledge, expertise, and skills to provide recommendations for training. The Advisory Group is diverse with both women and men, is led by a Native woman from Oneida Nation and includes two Enbridge employees, a sex trafficking investigator/trainer at Paramount Planning/ former TRUST Task Force Commander, a current sex trafficking investigator in Ashland, three employees of the New Day Advocacy Center in Ashland, citizens from Bad River, St. Croix Chippewa, and Stockbridge-Munsee Band of Mohicans, as well as a retired Ashland police officer. In addition to ongoing training for all employees and contractors working on the L5 Relocation Project throughout the term of construction, there will also be an outward facing public campaign to raise awareness in the greater region.

In Section 6.0 of the EJCP, Enbridge commits to continued engagement with all stakeholders. Enbridge provides a revised draft of the Environmental Justice Commitment Plan as Attachment H to this document.

8.0 EFFECTS OF NO ACTION AND SYSTEM ALTERNATIVES

While Section 1 discusses the "purpose and need" for the Project, that purpose and need are not addressed with respect to the alternatives discussed in Section 9. The defined Purpose and Need should be carried through Section 9. Likewise, the discussions of all non-pipeline alternatives fail to address the implications of the alternatives regarding compliance with the 1977 Pipeline Transit Treaty.

Sections 9.2.1, 9.3.1, 9.4.1, 9.5.1, and 9.6.1 address the so-called "no action alternative" and discusses the impacts to fuel supply and resulting impacts to residents and business in Wisconsin, Michigan, Illinois and Canada if WDNR does not authorize the permits required to complete the re-route. However, the discussion in these sections fails to address that the no action alternative does not meet the Purpose and Need of the Project. As noted in the comments on Section 1, the purpose and need for the Project are to re-route the transportation of petroleum products around the Bad River Reservation to allow the decommissioning of the existing segment falling within the lands of Bad River Band while allowing continued safe, economical, and efficient shipment of petroleum products on Line 5, and avoiding triggering a potential breach of the 1977 Pipeline Transit Treaty.

The discussion of greenhouse gas emissions, as well as the climate change impacts of the Project, is inconsistent. Section 9.5 states that Line 5 accounts for approximately 2.6% of all daily US consumption of petroleum products, and notes that not all of the product imported are combusted for heating or fuel. According to the U.S. EPA, emissions from combustion of petroleum represent 43.6% of U.S. total greenhouse gas emissions in 2020.[1] In 2021, the United States emitted an estimated 11% of global GHG emissions.[2] Conservatively assuming that all of the products carried on Line 5 are combusted for fuel, even if all emissions products carried on Line 5 were eliminated, those emissions would represent roughly one tenth of one percent of estimated GHG emissions. To the extent that Sections 9.4.2 and 9.5 discuss potential greenhouse gas emissions, an inclusion of the very limited magnitude of potential emissions that Line 5 contributes to global totals should be included to provide additional context with respect to discussion of climate change impacts.

9.0 OTHER ISSUES

State of Michigan Easement Termination

Two cases involving Line 5 are currently pending in the U.S. District Court for the Western District of Michigan involving the State of Michigan and Enbridge. In *Nessel v. Enbridge* (No. 1:21-cv-01057), the Attorney General of Michigan is seeking to force the closure of Line 5 at the Straits of Mackinac on the grounds that (1) the easement allowing the Line to be located in the Straits of Mackinac was void from its inception for failure to meet certain public trust requirements, (2) the operation of the Line is contrary to the State's public trust obligations, (3) the operation of the Line constitutes a public nuisance and (4) the operation of the Line violates the State's environmental laws. This case had been initiated in state court but has now been removed by Enbridge to federal court. The State has filed a motion to remand, which is pending.

The second case, *Enbridge vs. Whitmer* (No. 1:20-cv-1141), was initiated by Enbridge seeking a declaratory order and injunction to prohibit the Governor and Director of the Department of Natural Resources from taking steps to close Line 5 on the grounds that their efforts are preempted by the federal Pipeline Safety Act, by the federal government's exclusive control over foreign affairs and by the Interstate and Foreign Commerce Clause of the US Constitution. Enbridge has filed a motion for summary judgment in this case, which has now been fully briefed and is awaiting decision. . In addition, the Governor and Director have moved to dismiss the case on 11th Amendment/sovereign immunity grounds. That motion has also been fully briefed and is awaiting a decision.

A third case, *State of Michigan v. Enbridge* (No. 1:20-cv-1142), was voluntarily dismissed by the State in November 2021 following a ruling by Judge Neff that the case was properly removed to federal court by Enbridge. In that case, the State had sought to enforce its November 13, 2020 Notice purporting to require the closure of Line 5 by May 12, 2021. Enbridge has maintained that that order is unlawful and that it will not adhere to it.

1977 Pipeline Transit Treaty

Section 10 of the DEIS should include consideration of the 1977 Pipeline Transit Treaty (Transit Treaty). The Transit Treaty prohibits "public authorities" in either nation from implementing "measures" that would "have the effect of impeding, diverting, redirecting or interfering with in any way the transmission of hydrocarbons in transit." Hydrocarbons in transit are defined in the Transit Treaty as hydrocarbons moving via a so-called transit pipeline from one nation to the same nation through the other nation.

As is made clear in the U.S. Senate record considering the Transit Treaty, Line 5 is a transit pipeline covered by the Treaty because it transports crude oil and NGLs that originate in Western Canada to Central and Eastern Canada. Accordingly, any measure taken by any governmental authority in the United States that would impede the operation of Line 5 is contrary to the Transit Treaty. Enbridge has raised the Transit Treaty an affirmative defense in its answer to the Bad River Band's federal court complaint, in which the Band is seeking an injunction that would force the closure of Line 5. Enbridge asserts in its defense that the Band's lawsuit to force the closure of Line 5 and certain of the Band's other actions are measures barred by the Transit Treaty.

On October 4, 2021, Canada formally invoked dispute resolution under the Transit Treaty concerning pending efforts in Michigan to force a closure of Line 5. Under the Transit Treaty's dispute resolution provisions, the two

[1] *Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020*, at 2-14 (available at: https://www.epa.gov/system/files/documents/2022-02/us-ghg-inventory-2022-chapter-2-trends.pdf)
[2] BBC, *Report: China emissions exceed all developed nations combined* (May 7, 2021) (available at: https://www.bbc.com/news/world-asia-57018837)

nations will endeavor to negotiate a resolution, failing which the matter can then become the subject of an international arbitration.

Public Support

The Project has received significant local support. The Town of White River, the Town of Morse, and Iron County have each passed separate resolutions in approval and support of the Project. Each Resolution recognizes that Enbridge is a “dependable partner” and further notes that the Project “will respect native sovereignty and continue to protect the environment by moving product the safest way.” The Resolutions all emphasize the economic benefits to be gained by the State of Wisconsin and by individual localities. For example, each Resolution finds that the Project will “add $135 million to Wisconsin’s economic output, with Ashland, Bayfield and Iron counties seeing the bulk of those benefits” and that the Project “will result in an annual increase of $6.4 million in Wisconsin tax revenue.”

The Project has also received international support. The Government of Canada and the Governments of the Provinces of Alberta and Ontario have all submitted comments in support of Enbridge’s application for the Project, noting that Line 5 is vital infrastructure providing essential crude oil and NGL supplies for the residents and businesses of in the U.S. and Canada, and that closure of Line 5 would be devastating to those communities.

Memorandum on Finding of a Severe Energy Supply Interruption

On March 31, 2022, President Joseph R. Biden declared a national energy crisis. On that date, the White House issued a memorandum entitled *Memorandum on the Finding of a Severe Energy Supply Interruption.* That memorandum acknowledged that the war in Ukraine, disruptions to international trade, and sanctions had resulted in a national energy shortage that is likely to be of significant scope and duration, may cause significant adverse impact on national safety or the national economy; and is the result of an interruption in the supply of imported petroleum products. The Memorandum directed the Secretary of Energy to draft down and sell petroleum from the Strategic Petroleum Reserve (SPR). The White House announced an initial plan to draw one million barrels of crude oil per day for one hundred eighty days, for a total of 180 million barrels of crude oil. The White House determination that a national energy shortage exists follows the issuance by the President of an Executive Order on March 8, 2022, banning the importation into the United States of Russian oil and other energy products. Prior to the ban, the United States imported approximately 700,000 bpd of Russian oil.

For comparison, the daily average amount of crude oil carried on Line 5 is 460,000 bpd. Copies of the Memorandum and Executive Order are included as Attachments I and J.

10.0 CONCLUSION

Enbridge appreciates the extensive time and effort put into the DEIS by Department staff. The Line 5 Wisconsin Segment Relocation Project is an important project for ensuring the future safety, adequacy, and reliability of Wisconsin’s energy infrastructure, and of the nation’s energy supply. Enbridge respectfully requests that these comments be considered for inclusion in the FEIS so that the Department has the accurate and complete information available as it considers Enbridge’s applications for the wetland and waterway permits.

Invasive and Noxious Species Management Plan

Line 5 Wisconsin Segment Relocation Project

Version: 0
Version Date: 1/05/2023

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Acronyms and Abbreviations

Name	Description
BMPs	best management practices
CLL	construction line list
Enbridge	Enbridge Energy, Limited Partnership
EPP	Environmental Protection Plan
HDD	horizontal directional drill
INS	invasive and noxious species
L5R or Project	Line 5 Wisconsin Segment Relocation Project
PCMP	Post-Construction Wetland and Waterbody Monitoring Plan
Plan	Invasive and Noxious Species Management Plan
USDA	U.S. Department of Agriculture
WDNR	Wisconsin Department of Natural Resources

1. INTRODUCTION

Enbridge Energy, Limited Partnership ("Enbridge") is committed to minimizing the spread of invasive and noxious species ("INS") as defined by law or regulation, including invasive and noxious terrestrial plants, invasive aquatic species, and tree pests, along the construction right-of-way and associated access roads and haul routes where improvements are needed due to construction of the Line 5 Wisconsin Segment Relocation Project ("L5R" or "Project"). The L5R route extends approximately 41 miles through Ashland and Iron counties, Wisconsin.

1.1 Purpose of the Plan

The goal of this Invasive and Noxious Species Management Plan ("Plan") is to outline the INS management strategies that will be used to minimize the introduction and spread of INS identified within the Project construction workspace, access roads, and improved haul routes in compliance with applicable laws or regulations. Management strategies will be implemented where applicable and appropriate prior to construction, and during Project construction, restoration, and post-construction monitoring phases. Existing INS occurrences will be documented throughout the construction workspace, and access roads, through pre-construction surveys, publicly available datasets, or monitoring. This Plan is complimentary to Enbridge's Environmental Protection Plan ("EPP").

Enbridge would like to emphasize that the treatment method selected for an INS population will be dependent on a number of factors, including the time of year and species-specific biology, proximity to sensitive species, and construction activities and the timing of those activities as further explained in the following sections. Although this Plan describes a preference for herbicide pre-treatment, it will not be feasible in all locations; in those situations, a different methodology will be selected by Enbridge at the time of construction. Should treatment not be possible during construction, Enbridge will manage INS as appropriate during the restoration and/or post-construction monitoring phases. The Post-Construction Wetland and Waterbody Monitoring Plan ("Monitoring Plan") establishes performance standards for the management of the INS to ensure that these infestations are appropriately managed.

Management strategies for INS on the Project are outlined below by INS group: terrestrial plant species and aquatic species.

2. TERRESTRIAL PLANT INVASIVE AND NOXIOUS SPECIES

This Plan defines terrestrial plant INS as any species that is listed by the U.S. Department of Agriculture ("USDA") as Noxious or Wisconsin Department of Natural Resources ("WDNR") as Prohibited or Restricted Noxious Weeds.

2.1 Wisconsin Regulations

In Wisconsin, the management objectives for INS within the Project area are to minimize the spread of documented occurrences of terrestrial plant INS that are: 1) listed as Noxious by the USDA; or 2) listed as "Restricted" or "Prohibited" (see Table 1) under the Wisconsin Chapter NR40 Invasive Plant Species rule.

Table 1: Wisconsin Restricted or Prohibited Noxious Weeds

Species	Common Name	Species	Common Name
Abutilon theophrasti [b]	Velvetleaf	*Epipactis helleborine* [a]	Helleborine orchid
Aegopodium podagraria [a]	Bishop's goutweed	*Eriochloa villosa* [b]	Woolly cupgrass
Agropyron repens [b]	Quackgrass	*Euphorbia esula* [a b]	Leafy spurge
Alliaria petiolata [a]	Garlic mustard	*Frangula alnus* [a]	Glossy buckthorn
Amaranthus palmeri [b]	Palmer amaranth	*Galeopsis tetrahit* [a]	Hemp nettle
Amaranthus tuberculatus [b]	Waterhemp	*Linaria dalmatica*	Dalmatian toadflax
Ambrosia trifida [b]	Giant ragweed	*Linaria vulgaris*	Yellow toadflax
Artemisia absinthium	Absinth wormwood	*Lonicera* complex [a]	Non-native honeysuckles
Avena fatua [b]	Wild oat	*Lythrum salicaria* [a]	Purple loosestrife
Bassia scoparia	Kochia	*Myosotis scorpioides* [a]	Aquatic forget-me-not
Berberis thunbergii [a]	Japanese barberry	*Panicum miliaceum* [b]	Wild proso millet
Berteroa incana [b]	Hoary alyssum	*Pastinaca sativa* [a]	Wild parsnip
Campanula rapunculoides [a]	Creeping bellflower	*Plantago lanceolata* [b]	Buckhorn
Caragana arborescens [a]	Siberian peashrub	*Polygonum perfoliatum* [b]	Mile-a-minute weed
Carduus nutans	Musk thistle	*Pueraria montana* var. *lobata* [b]	Kudzu
Centaurea diffusa	Diffuse knapweed	*Raphanus raphanistrum* [b]	Wild radish
Centaurea jacea [a]	Brown knapweed	*Rhamnus cathartica* [a]	Common buckthorn
Centaurea maculosa / C. stoebe [a b]	Spotted knapweed	*Robinia pseudoacacia* [a]	Black locust
Centaurea repens / C. picris [b]	Russian knapweed	*Silene alba* [b]	White cockle
Cirsium arvense [a b]	Canada thistle	*Sinapis arvensis* [b]	Wild mustard
Cirsium palustre [a]	European marsh thistle	*Sonchus arvensis* [b]	Perennial sowthistle
Convolvulus arvensis [b]	Field bindweed	*Tamarisk* spp.	Saltcedar
Coronilla varia [a]	Crown vetch	*Tanacetum vulgare* [a]	Common tansy
Cuscuta spp. [b]	Dodder	*Typha* complex [a]	Hybrid cattail
Cynoglossum officinale	Houndstongue	*Valeriana officinalis* [a]	Garden heliotrope/Valerian

Source: WDNR, 2015; USDA, 2022.

a *Indicates species that have been documented in the Project area based on pre-construction surveys.*

b *This species is listed as noxious by the USDA in Wisconsin.*

2.2 Terrestrial Plant Invasive and Noxious Species Surveys

Enbridge conducted terrestrial INS plant surveys in 2021 along approximately 41 miles of a 170-foot-wide survey corridor for construction of the pipeline, approximately 28 miles of a 30-foot-wide corridor for access roads, seven valve sites, and four pipe yards. Table 1 notes invasive terrestrial species identified during surveys.

Enbridge survey crews identified 23 terrestrial plant INS (Attachment A). Three USDA Noxious Weeds were observed, including spotted knapweed (*Centaurea maculosa* or *C. stoebe*), leafy spurge (*Euphorbia* *esula*), and Canada thistle (*Cirsium arvense*). The most commonly observed INS were tansy (*Tanacetum vulgare*), Canada thistle (*Cirsium arvense*), and common buckthorn (*Rhamnus cathartica*).

2.3 Management Strategies for Terrestrial Plant Invasive and Noxious Species

Two primary strategies are developed to minimize the spread of INS within the Project Area. The first strategy is application of prevention measures to limit spread of INS through establishment of INS Best Management Practices ("BMPs"). The second strategy is active management to minimize the spread of documented occurrences of terrestrial INS. Active management practices will be selected based on the site-specific conditions, timing, and INS ecology.

2.3.1 Prevention Measures

Prevention measures will be employed to limit spread and introduction of INS through activities such as construction or site management. The following BMPs will be implemented during construction and site management activities.

2.3.1.1 Identification of INS Populations

Prior to clearing, Enbridge will flag the boundaries of known INS populations that overlap with the construction workspace. For INS populations larger than 10,000 square feet or at INS sites where flagging is not practical, the boundaries will be marked by a series of flagged wooden stakes.

2.3.1.2 Movement of Equipment

Equipment used during construction and restoration activities includes trucks, tractors, off-highway vehicles, heavy equipment, tools, personal gear, etc.

1. Before leaving an INS site, inspect the equipment and remove visible plants, seeds, mud, dirt clods, and animals.
2. Equipment will be cleaned prior to arriving to the Project.
    a. Construction mats will be new/unused, or cleaned, prior to arriving to the Project.
3. If pre-treatment of INS is not possible and mitigation measures such as topsoil segregation and construction mat or ice/frost road installation cannot practicably be employed, Enbridge will conduct additional cleaning of equipment (see cleaning stations section in Section 2.3.2.4 of the Plan), as prudent and feasible.

2.3.1.3 Movement of Material

Materials include organisms and organic and inorganic material including plants, mulch, soil, gravel, rock, etc.

1. Enbridge will not plant or knowingly introduce prohibited or regulated INS.
2. To reduce the likelihood of introducing or spreading INS, Enbridge will employ the following measures:
    a. Use only weed-free mulch and hay.
    b. Stored topsoil in heavily infested areas will be covered or sprayed with tackifier or mulch to reduce the viability of INS seeds and rootstock prior to the restoration phase and prevent transport by wind. Weed-infested stockpiles will be marked with clearly visible signage until the restoration phase. During restoration, Enbridge will return topsoil and vegetative material from

INS sites to the areas from which they were stripped and will not move soil and/or vegetative matter outside of the identified and marked weed infestation areas.

c. For revegetation, Enbridge will utilize seed mixes labelled "Noxious Weed Free" as required by regulations (Section 21.1 of the EPP).

3. Enbridge will not knowingly move soil, dredge material, or raw wood products that may harbor invasive or noxious species from INS sites except under contract specifications, permit, or compliance agreements.

   a. Enbridge will generally dispose of non-merchantable timber and slash by mowing, cutting, chipping, grinding, and mulching and broadcasting the mulch in upland areas (Section 7.1 of the EPP). Alternatively, it will be hauled off-site to an approved location or disposal facility. All merchantable timber will be managed in accordance with Enbridge contract specifications and applicable permits and licenses.

2.3.1.4 Standard Best Management Practices

Enbridge has also committed to several BMPs described in the EPP that will limit the amount of disturbance associated with construction activities and assist with managing terrestrial INS infestations. These BMPs include:

- Reducing the width of the construction workspace in wetlands and near waterbodies;
- Limiting grading and topsoil segregation to trench-line-only in wetlands and forested vegetation communities;
- Installing construction mats for travel lanes in wetlands and other specific locations;
- Utilizing weed-free mulch;
- Removing accumulated sediment from silt fence when depth reaches one-third of height;
- Stabilization of all exposed areas, including spoil piles, must be initiated immediately to limit soil erosion when construction activity has permanently or temporarily ceased on any portion of the site and will not resume for a period exceeding 14 calendar days. Stabilization must be completed no later than 14 calendar days after the construction activity has ceased;
- Utilizing Natural Resources Conservation Service guidelines for seed mixes and adapted restoration guidelines;
- Decompacting subsoil; and
- Construction activities in agricultural lands will proceed as described in the Agricultural Protection Plan.

Enbridge has also prepared a Monitoring Plan that includes monitoring and performance standards for INS within these features.

2.3.2 Active Management Strategies

Where existing INS occurrences have been documented, pre-treatment management will be implemented where possible. The pre-treatment objective will be to reduce the observable aboveground vegetative growth and seed production by INS at known locations. The intended effects of pre-treatment are to reduce potential spread of INS plants, seeds (observable on above-ground seed heads), and propagules by reducing INS populations prior to clearing and ground-disturbing activities. Prior to conducting pre-treatment, the herbicide contractor or vegetation management specialist will verify identification to species level. Following pre-treatment, a visual assessment will be conducted to evaluate whether herbicide treatment has had the intended effects; where this is not the case Enbridge will consider implementing additional BMPs.

Enbridge will implement active management strategies and BMPs during one or more of the following phases as appropriate:

- Prior to clearing: Where practicable and feasible, Enbridge will implement BMPs prior to initiating clearing of the construction workspace. However, the ability to implement BMPs is dependent upon the timing of the receipt of required permits and authorizations, landowner or land-managing agency permissions, seasonality, INS ecology (e.g., maturity of plant, aggressiveness), and the proposed treatment method, effectiveness, and frequency of application.
- During clearing or other construction activities: Should the implementation of certain BMPs not be feasible prior to clearing (e.g., herbicide treatment), alternative BMPs (e.g., cleaning stations) may be implemented during clearing or other construction activities to minimize the spread of INS.
- Restoration: Once construction activities are complete, and final grading and permanent seeding is complete as described in the EPP, Enbridge will continue to monitor and manage terrestrial INS until the revegetation performance standards have been met.
- Post-Construction Monitoring: Enbridge will perform post-construction monitoring at wetlands and waterbodies as described in Enbridge's Monitoring Plan. Enbridge will manage INS until the performance standards described in the PCMP have been met.

As described in the EPP, construction, restoration, and post-construction monitoring activities are restricted to the construction right-of-way, approved access roads, and additional temporary workspace. Once restoration and/or post-construction monitoring activities are complete, terrestrial INS will be managed by Enbridge Operations within the 50-foot-wide permanent right-of-way easement.

The following sections provide a general overview of the active management strategies that will be implemented on the Project to minimize the spread of documented occurrences of terrestrial plant INS.

2.3.2.1 Personnel Training

Enbridge will provide terrestrial plant INS awareness training that:

- Ensures that personnel conducting monitoring and terrestrial plant INS treatments are qualified to distinguish between INS and commonly mistaken native species. This may include, for example, documentation of personnel experience with control of the target INS and their INS control work in similar environments with sensitive resources.

2.3.2.2 Pre-Treatment

Pre-treatment will be prioritized for INS listed by the WDNR as Restricted Noxious Weeds that must be eradicated or controlled in Wisconsin (Table 1). Where possible, Enbridge will pre-treat known locations of terrestrial plant INS by flagging the populations, spot mowing, mechanical removal (e.g., hand-pulling, digging), spot herbicide application, prescribed burning, spot propane weed torching, or an integrated management approach that combines one or more of these techniques prior to clearing. Any of these methods or a combination thereof may also be used during construction, restoration, and/or post-construction monitoring as needed. The pre-treatment objective will be to reduce the observable aboveground vegetative growth and seed production by INS at known locations and reduce the likelihood that plants, seeds (observable on aboveground seed heads), and propagules are viable when clearing and ground-disturbing activities begin. Where possible, Enbridge will attempt to minimize the spread of INS by first managing the outlying populations, and then working toward the center of an infestation. The chosen method(s) will be species-specific and will consider the timing of implementation, quality of the surrounding vegetation, proximity to water resources, and other considerations as noted below. Pre-treatment will commence when all necessary permits and authorizations, and the necessary landowner or land-managing agency permissions are in place and will continue until the start of clearing or other construction activities.

A treatment method or combination of methods will be selected based on several considerations, including WDNR status (i.e., prohibited or restricted) and/or land-managing agency specifications, biological characteristics, and season, and will be based on consultation with the appropriate state and local agencies. Specific site factors such as topography, soil types and condition, water table level, open bodies of water, domestic water wells, and precipitation rates must also be taken into consideration when deciding the appropriate treatment option for a site. Additional important ecological and local land use factors that will be considered in designing and implementing treatment methods will include:

- Aquatic or wetland environments;
- Presence of federal or state-listed species or species of concern;
- Desirable existing vegetation community;
- Areas used for wildlife habitat or grazing;
- Recreation areas (e.g., campsite or picnic areas); and
- Residences.

2.3.2.3 Pesticide Use and Application

Enbridge will only utilize those pesticides (including herbicides) and methods of application approved by the WDNR and the U.S. Environmental Protection Agency in the state of Wisconsin. Selective foliage or basal application will be used when practicable. All pesticides will be applied in a safe and cautious manner so as not to damage adjacent properties including crops, orchards, tree farms, apiaries, gardens, or sensitive environmental resources. Enbridge's selected contractor(s) will obtain necessary permits and/or certifications for the use of the applicable herbicides, will be responsible to limit off-right-of-way overspray, and will comply with product labels and as specified by local, state, and federal regulations. Pesticide application will be completed by knowledgeable and licensed personnel. Records of herbicide applications will be kept in accordance with WDNR requirements.

Upon treatment, signage will be posted after pre-treatment with information on the species, when it was treated, and recommended timeframe to leave vegetation and soils undisturbed for herbicide uptake and plant activity (see Attachment B). This information will also be recorded in an electronic reporting system that will be used to monitor and communicate the management of INS populations between the Enbridge Environmental Compliance Team and the Enbridge Construction team.

Enbridge will contact the landowner or designee to obtain approval for the use of pesticide (including herbicides) at least 14 days prior to any application on their property. A minimum of 14 days prior to the proposed application of herbicide, the Enbridge right-of-way agent assigned to the affected tracts will provide a map of the proposed herbicide treatment location on the property in question and describe the type(s) of pesticides proposed for use and approximate application timeframe. The landowner may request that there be no application of herbicides on any part of the site within the landowner's property. A contact note showing that contact was made, whether the landowner has approved or denied herbicide application, and any application specifications or concerns that arose will be tracked in Enbridge's database system and will be identified in the construction line list ("CLL"). If a landowner does not respond within the required timeframe, it will be recorded as "herbicide application prohibited" on the CLL.

The following best management practices will be considered for herbicide use:

- Integrate biological controls instead of, or to complement, herbicide use, if available;
- Select spot treatments over broadcast applications when practicable to minimize potential impacts on pollinators and associated nectar or host plants;
- Products should be selected to be the most target-specific and applied on the smallest area practical to meet management objectives;
- The type of herbicide and treatment method will be selected to minimize impacts to wildlife (e.g., spot treatment, herbicides appropriate for application near aquatic resources); and
- Follow herbicide label instructions and industry standard practices to minimize non-target damage.

Cut stump or basal treatments may be used within the 75-foot vegetative buffer zone of aquatic resources. If herbicide treatment is necessary near rare species or rare natural communities or in or near aquatic resources, the herbicide must be designed for such use as designated by the manufacturer's specifications and federal and state regulations. Additional restrictions will be followed for INS control as required by federal, Tribal, and state permits or other environmental plans.

If herbicide treatment is limited due to landowner restrictions, or proximity to sensitive resources, an alternative treatment method may be selected.

2.3.2.4 Alternative Best Management Practices

In areas where INS occurrences have been documented and pre-treatment cannot be implemented prior to clearing or between clearing and construction, or pre-treatment has not had the intended effect, a combination of the following BMPs may be implemented, where appropriate and as determined to limit spread of INS.

Topsoil Segregation

Enbridge may implement topsoil segregation of the infested area to minimize the spread of INS and to allow equipment to work through the area after topsoil has been stripped, as long as equipment stays on the subsoil (clearing, grading, and restoration equipment will still be cleaned as described in the "Cleaning Stations" section or other BMPs will be implemented as appropriate).

Stored topsoil in heavily infested areas will be covered or sprayed with tackifier or mulch to reduce the viability of INS seeds and rootstock prior to the restoration phase and prevent transport by wind. Weed-infested stockpiles will be marked with clearly visible signage until the restoration phase. During restoration, Enbridge will return topsoil and vegetative material from infestation sites to the areas from which they were stripped and will not move soil and/or vegetative matter outside of the identified and marked noxious weed infestation areas.

Installation of Construction Mats

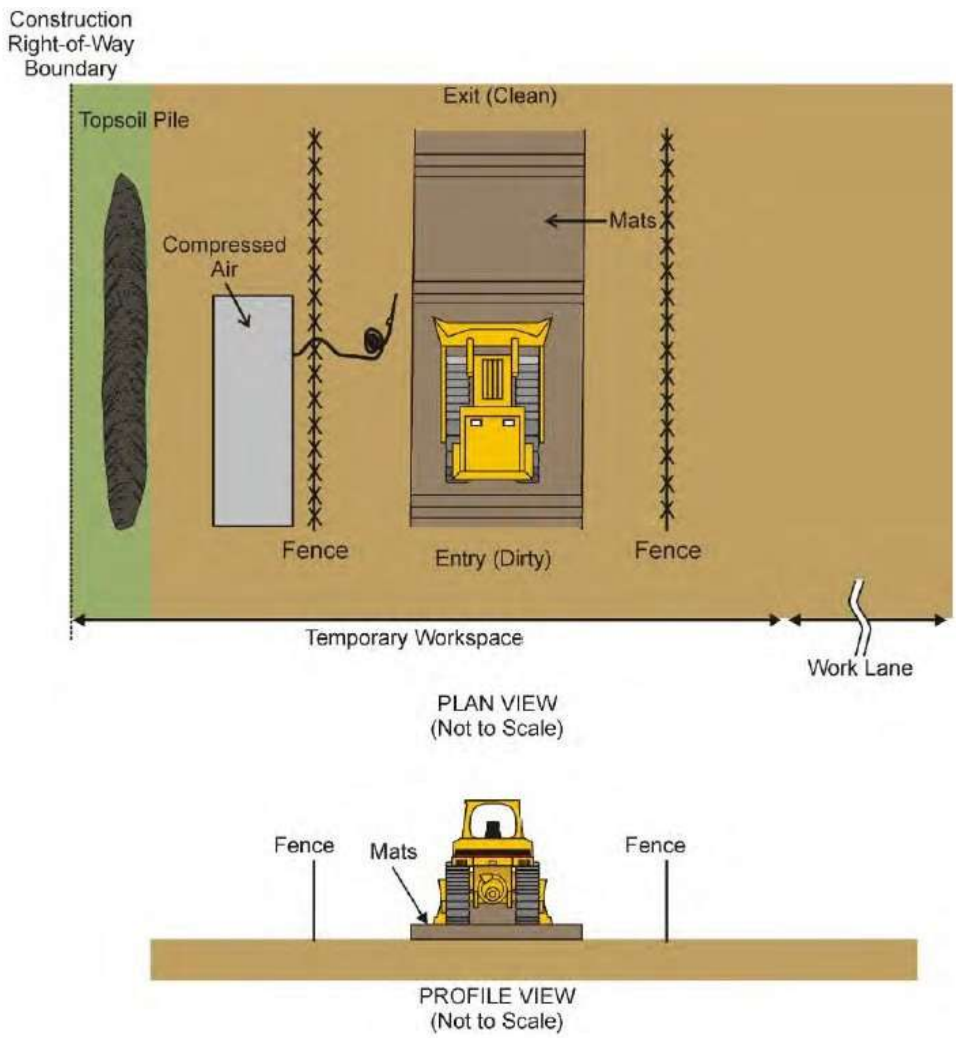
In areas of the construction workspace where pre-treatment of the INS population or topsoil segregation is not feasible, Enbridge will install and work off of construction mats or equivalent to cover the INS source. Construction mats will then be cleaned before use at another non-infested site as described in the "Cleaning Stations" section. Enbridge will also consider the use of construction mats in pre-treated areas with heavy infestations of INS.

Cleaning Stations

In areas where pre-treatment of terrestrial plant INS has not been implemented prior to clearing, Enbridge may establish cleaning stations to remove visible dirt and plant material from equipment and mats when exiting a known terrestrial INS infestation area along the construction workspace (Section 4.1 of the EPP). Cleaning stations may also be implemented at select sites during construction, restoration, or post-construction monitoring, as needed. Construction mats utilized in an INS site will either be cleaned at designated cleaning stations or will be transported to constructions yards for storage and/or cleaning prior to re-use. Construction mats will be covered and contained in plastic tarps or geotextile fabric when they are transported and stored to minimize the spread of INS seeds. See Figure 1 for a typical drawing of a cleaning station.

Mechanical means (initial scrape down followed by blow down with air or water) will be the primary method used to remove dirt and plant materials from vehicles, equipment, and construction mats at the cleaning stations or construction yards. Enbridge does not propose the exclusive use of high-pressure wash stations due to the need for additional water and space, and the challenges with containing and disposing of the cleaning water. Removal of dirt and plant material will be documented in a cleaning log (see Attachment C). Off-site cleaning stations will be placed in existing disturbed areas (e.g., construction yards that were previously used as construction yards, rail yards, sand/gravel mines) that are clearly designated as a cleaning station area, and where the appropriate erosion and sediment control BMPs have been implemented to prevent off-site surface run-off.

Figure 1: Typical Compressed Air Cleaning Station



Representation Only

2.3.2.5 Order of Active Management Protocols

The protocols discussed above will be prioritized in the following order:

1. Pre-treatment when possible based on construction schedule, access, and INS treatment timing. If clearing begins during winter months, there will be no pre-treatment until the following spring/early summer as appropriate. Pre-treatment would then occur as feasible and appropriate during the growing season.
2. Topsoil segregation of the infested site if pre-treatment cannot be completed. During winter/frozen conditions, topsoil segregation may be implemented along areas of the construction workspace or temporary access roads at INS locations where soil movement (e.g., grading or trench excavation) is proposed, where feasible.

3. Installation of construction mats may be used where pre-treatment of the INS population or topsoil segregation is not feasible (e.g., wetlands and access roads). Installation of mats may also be used at heavy INS occurrence locations that have been pre-treated, but where a post-treatment evaluation reveals that the herbicide application did not achieve the intended effect. During winter/frozen conditions, ice/frost road development or construction mat installation may be implemented as a BMP where feasible and appropriate for the portions of access roads that overlap with INS infestations where grading would otherwise be required to develop the road.
4. Cleaning stations may be used when other BMPs are deemed insufficient to minimize the spread of INS.
5. Finally, in some areas where pre-treatment is not feasible, implementation of INS treatments may be proposed during restoration and post-construction monitoring. In all cases, INS infestations along the construction workspace and temporary access roads will be managed until the performance standards established in Enbridge's PCMP have been met.

The decision on which treatment method will be implemented will be made collaboratively between Enbridge's Environmental Inspection Team, Enbridge's contractor(s), and the Construction Team in the field during construction.

Protocol for Unanticipated INS Populations

It is anticipated that Enbridge will encounter previously undocumented INS populations. When unanticipated populations of INS are found, they will be documented and reported to Enbridge. Enbridge Environmental Inspectors that encounter unanticipated INS populations will document occurrences through an electronic reporting system. Documentation will include species, approximate size, Global Positioning System location, and inspector name. This information will be communicated to the contractor conducting INS active management for species verification and incorporation into treatment plans. In addition, signage will be installed to notify the Construction Team of the INS occurrence and treatment status (Attachment B). As with prior to clearing, flagging will be used to delineate the INS population within the Project. For INS populations larger than 10,000 square feet or at INS sites where flagging is not practical, the boundaries will be marked by a series of flagged wooden stakes.

3. AQUATIC INVASIVE SPECIES

The WDNR regulates non-native and invasive aquatic plants and wild animals and tracks infested waters. Aquatic invasive species are typically spread via movement of equipment used in infested waters, such as boats, docks, and other equipment.

Based on publicly available data, only one of the waterbodies that the Project crosses has been documented to contain an aquatic invasive species. This waterbody is Tyler Forks, which has been documented as containing the Banded Mystery Snail (*Vivaparus georgianus*). Enbridge proposes to cross this waterbody using the HDD method and to install a clear span bridge; therefore, no equipment is expected to come into contact with the water as part of pipeline installation. Enbridge has proposed Tyler Forks as a source for hydrostatic test water appropriation. Water withdrawn from Tyler Forks will be discharged into an upland discharge structure near Tyler Forks and will not be discharged into other streams. Enbridge's EPP contains best management practices to minimize potential impacts to aquatic species associated with water withdrawal.

The Project crosses multiple waterbodies using a variety of technique including open cut (wet trench), dry crossings and trenchless methods. Most equipment and construction activities will be in the water (either for crossing or water appropriation) for 72 hours or less.

3.1 Management Strategies for Invasive Aquatic Species

To minimize the spread of invasive aquatic species in Wisconsin, Enbridge will implement the following procedures when working in waterbodies in compliance with Wisconsin Admin. Code NR 40, and Wisconsin Manual Code 9183.1.

Equipment will not be allowed to operate within waterbodies until verification by the Environmental Inspector or Site Inspector that the appropriate inspection and/or decontamination procedures described in Sections 3.1.1 through 3.1.3 have been implemented.

3.1.1 Procedures at Any Watercourse

- Equipment intended for use at the Project site will be free of invasive species prior to being transported to the worksite. Equipment (e.g., hoe stick and bucket, pumps, hoses) used in any watercourses, regardless of infestation status, will be inspected for invasive aquatic species prior to and following in-water work.
- Pumps, hoses, and other equipment with water intakes will be drained of water after use. Enbridge will remove plants, mud, debris, and organisms from the exterior of the equipment (e.g., hoe stick and bucket).
- If aquatic invasive species are identified during inspection of the equipment, Enbridge will implement one or more of the following decontamination procedures before use in another waterbody (WNDR, 2016):
  - dry for 5 consecutive days after cleaning with soap and/or high-pressure water prior to using at another waterbody;
  - wash equipment (e.g., pumps) with heated water (greater than 140 degrees Fahrenheit);
  - apply a 500 parts per million (ppm) Chlorine (sodium hypochlorite) solution for 10-minute contact time; or
  - apply a 2:100 solution of Virkon Aquatic for 20-minute contact time.
- For crossings of completely frozen waterbodies during winter, if no liquid water comes in contact with equipment, no decontamination will occur.
- Decontamination water will be allowed to infiltrate in an upland area at least 300 feet from any watercourse, or within 300 feet of the aquatic invasive species source water in accordance with applicable permits.
- If personnel enter any state watercourse, personnel will scrub clothes, waders, boots, and other personal gear with a stiff bristled brush to remove debris.
- Enbridge will notify the WDNR if any aquatic invasive species are identified in a watercourse not previously designated as an infested water.

3.1.2 Infested Waters

- If equipment has been used in an infested water, Enbridge will implement one or more of the decontamination procedures outlined in Section 3.1.1 before use in another waterbody.
- For crossings of completely frozen waterbodies during winter, if no liquid water comes in contact with equipment, no decontamination will occur.
- Decontamination water will be allowed to infiltrate in an upland area at least 300 feet from any watercourse, or within 300 feet of the aquatic invasive species source water in accordance with applicable permits.
- If personnel enter infested waterbodies, personnel will scrub clothes, waders, boots, and other personal gear with a stiff-bristled brush to remove debris.

3.1.3 Surface Water Appropriation Sites

- Enbridge will implement the procedures described in Section 3.1.2 at surface water appropriation sites for in-water construction activities and for the equipment used at HDD installations.
- Enbridge will discharge appropriated water for HDD and hydrostatic testing activities either back to the source or infiltrate in an upland area in accordance with applicable permits.

3.1.4 HDD Drilling Mud Preparation

During the execution of an HDD, equipment will not come into contact with the surface water of the waterbody being crossed, except where surface water is utilized to prepare the drilling mud that is utilized throughout the drilling process. To prevent the need for decontamination of equipment after an HDD, Enbridge may instead pre-treat the surface water utilized to prepare the HDD drilling mud by either:

- Using Enbridge's filtration system; or
- Heating the water to the temperature prescribed in Section 3.1.1 for the Soaking Decontamination and Pre-Treatment Activities.

4. REFERENCES

U.S. Department of Agriculture ("USDA"). 2022. State Noxious-Weed Seed Requirements Recognized in the Administration of the Federal Seed Act. Revised February 2022. Available online at: https://www.ams.usda.gov/sites/default/files/media/StateNoxiousWeedsSeedList.pdf. Accessed December 15, 2022.

Wisconsin Department of Natural Resources ("WDNR"). 2015. Invasive Species Rule—NR 40. Available at: https://dnr.wisconsin.gov/topic/invasives/classification.html. Accessed December 15, 2022.

WNDR. 2016. State of Wisconsin, Department of Natural Resources, Manual Code # 9183.1 Boat, Gear, and Equipment Decontamination and Disinfection Protocol. Available at: https://dnr.wisconsin.gov/sites/default/files/topic/Invasives/MC9183-1.pdf. Accessed December 30, 2022.

WDNR. 2022a. Aquatic Invasive Species. Available at: https://dnr.wi.gov/lakes/invasives/aisbywaterbody.aspx. Accessed December 30, 2022.

ATTACHMENT A DOCUMENTED INVASIVE SPECIES

Enbridge conducted surveys for state-listed invasive species, pursuant to the Wisconsin Chapter NR 40 Invasive Species Rule, within the Project's proposed workspaces including mainline workspaces, access roads, valve areas, and pipe yards. Surveys were specific to regulated plant species in the restricted category, which is a list of 63 species (Attachment A).

Surveys resulted in the documentation of 23 different invasive species at over 900 locations throughout the survey area (Table 1).

Table 1. Invasive Species Occurrences

Scientific Name	Common Name	Plant Type	Occurrences
Aegopodium podagraria	Bishop's goutweed	Herbaceous	1
Alliaria petiolata	Garlic mustard	Herbaceous	4
Berberis thunbergii	Japanese barberry	Woody/Shrub	2
Campanula rapunculoides	Creeping bellflower	Herbaceous	2
Caragana arborescens	Siberian peashrub	Woody/Shrub	1
Centaurea jacea	Brown knapweed	Herbaceous	19
Centaurea stoebe	Spotted knapweed	Herbaceous	102
Cirsium arvense	Canada thistle	Herbaceous	165
Cirsium palustre	European marsh thistle	Herbaceous	9
Coronilla varia	Crown vetch	Herbaceous	12
Epipactis helleborine	Helleborine orchid	Herbaceous	3
Euphorbia esula	Leafy spurge	Herbaceous	9
Frangula alnus	Glossy buckthorn	Woody/Shrub	36
Galeopsis tetrahit	Hemp nettle	Herbaceous	59
Lonicera complex	Non-native honeysuckles	Woody/Shrub	72
Lythrum salicaria	Purple loosestrife	Herbaceous	2
Myosotis scorpioides	Aquatic forget-me-not	Herbaceous	42
Pastinaca sativa	Wild parsnip	Herbaceous	15
Rhamnus cathartica	Common buckthorn	Woody/Shrub	160
Robinia pseudoacacia	Black locust	Woody/Shrub	4
Tanacetum vulgare	Tansy	Herbaceous	201
Typha complex	Hybrid cattail	Herbaceous	83
Valeriana officinalis	Garden heliotrope/Valerian	Herbaceous	18

The three most commonly observed invasive species were tansy (*Tanacetum vulgare*), Canada thistle (*Cirsium arvense*), and common buckthorn (*Rhamnus cathartica*). Nine of the mapped invasive species occurrences are considered major infestations (greater than 0.5 acre with interrupted (50-75%) or continuous (75-100%) cover), five of which primarily contain spotted knapweed (*Centaurea stoebe* L.).

The documented invasive species are generally located along roadsides, field edges, and other disturbed openings such as existing utility corridors, trails, and the proposed pipe yards. Invasive species were also more frequently documented near population centers, including the cities of Ashland and Mellen.

ATTACHMENT B PESTICIDE APPLICATION SIGNAGE

Invasive Species Alert

Species:

Treated Date:

Do Not Disturb Marked Area Until:

Enbridge

ATTACHMENT C CLEANING LOG

Equipment Cleaning Log

Form Completed By: ____

Date: ______________________ Time: ______________________

Location of Equipment (tract & milepost): ______________________________

Equipment Type: ____

Equipment ID (e.g., company, unique ID number): ______________________

Cleaning Method: (check all that apply)

☐ Scrape Down
☐ Steam Wash Blow Down (compressed air)
☐ Power/Pressure Wash (water)
☐ Other (Describe): ____

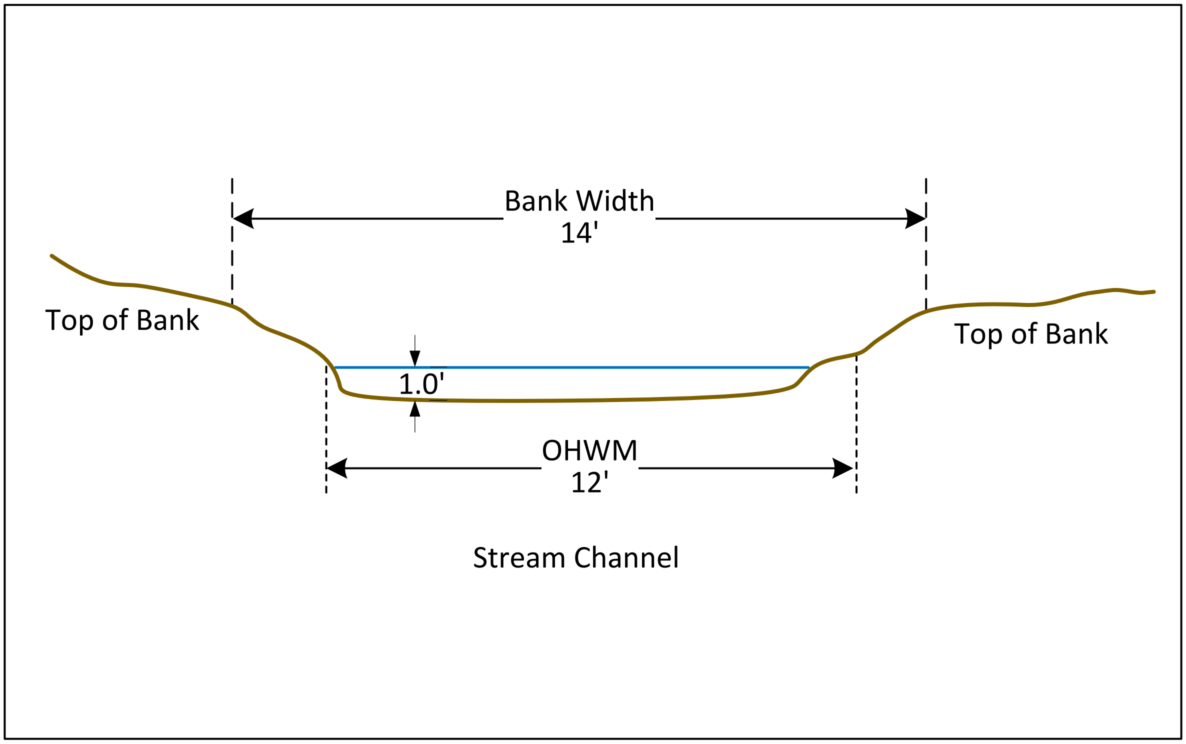
Comments: ____

____

____

____

____



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Erosion and Sediment Control Plan

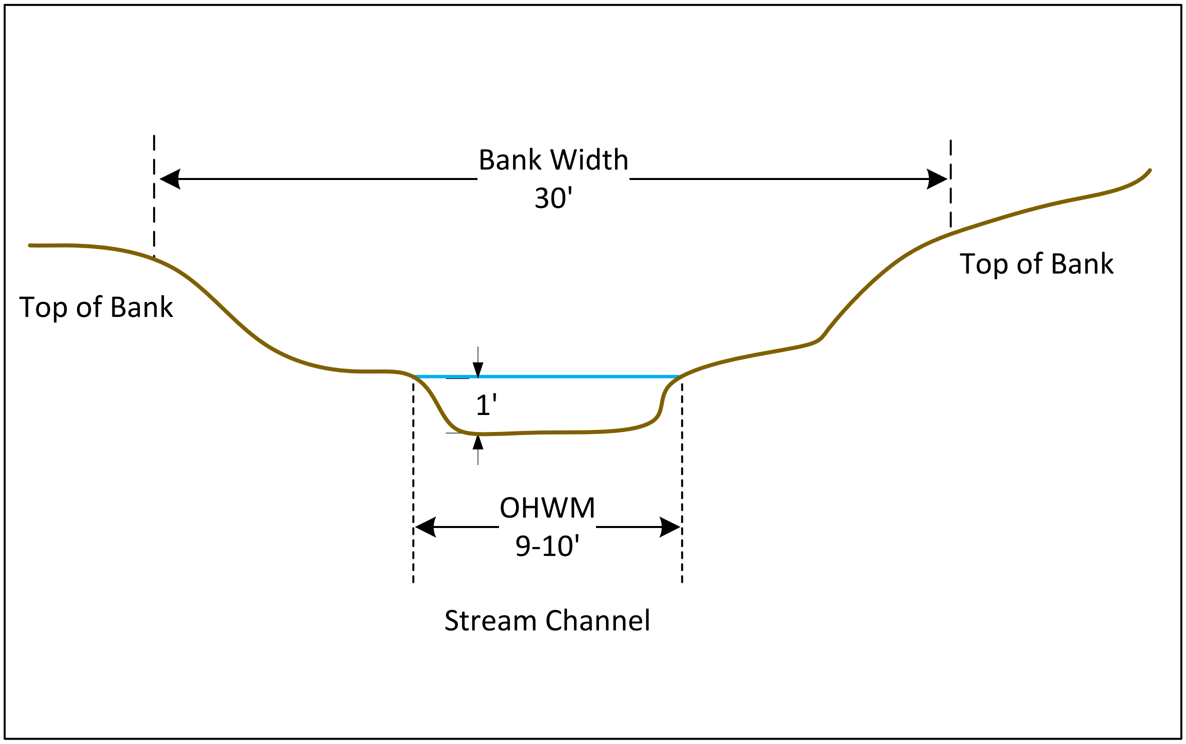
Stream Crossing Profile Drawing

Bay City Creek (sase006p)

MP 0.6

ERM

MPLS: M:\Clients\D-F\EEL\BadRiver_ArcGIS\2022\12\Waterbody_Xsections\	Perennial_XSection_Drawings.vsdx	Scale: NTS	Revised: 12/28/2022	Drawn By: GIS



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Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
Rock Creek (sasc041p)
MP 5.1

ERM

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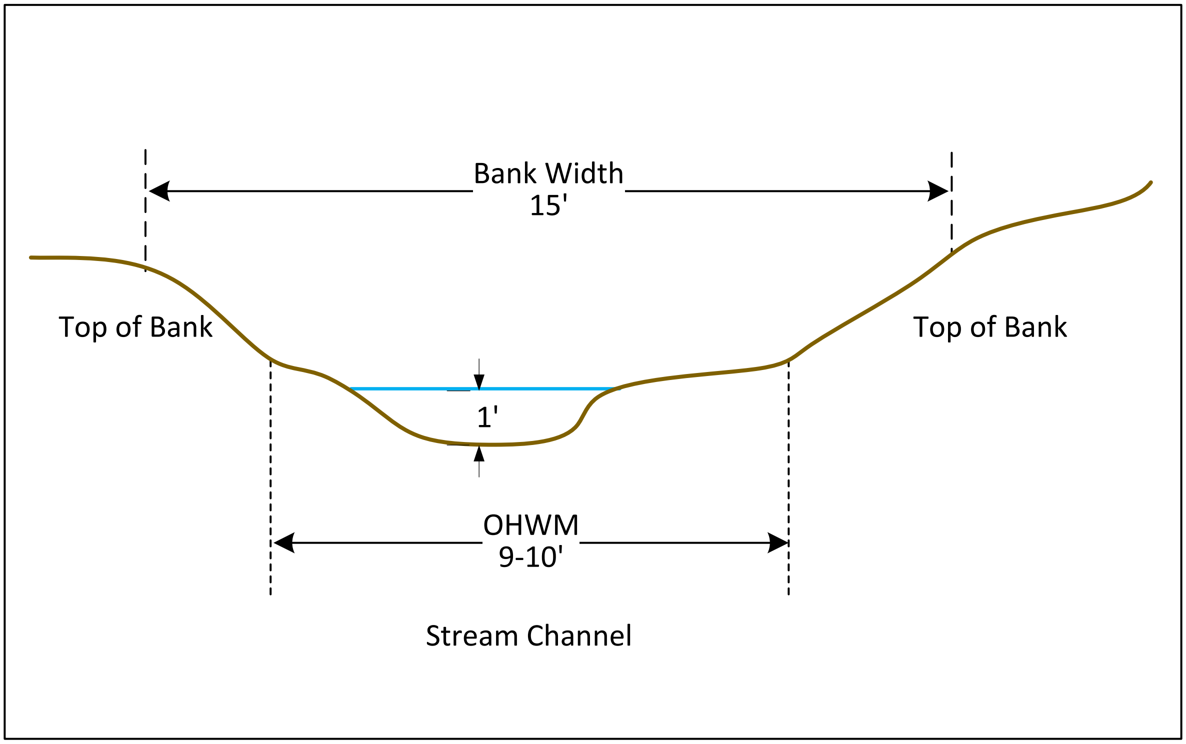

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Sheet 3 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Marengo River (sasd011p)
MP 8

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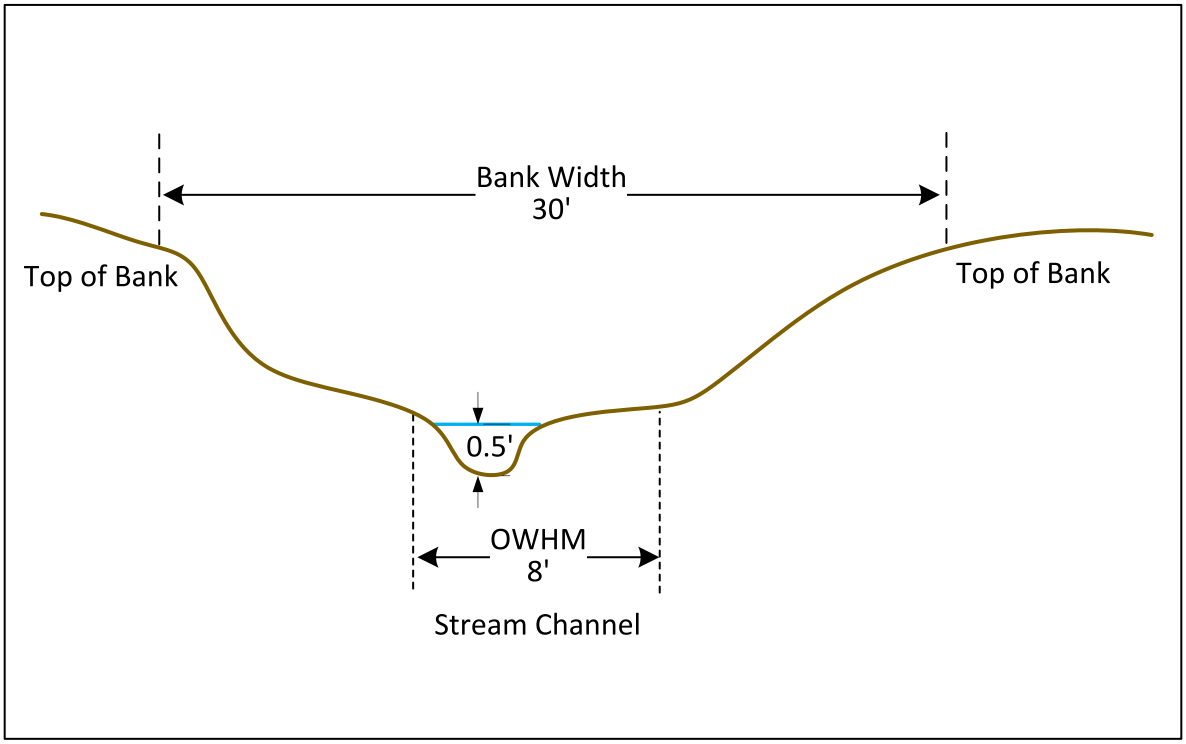

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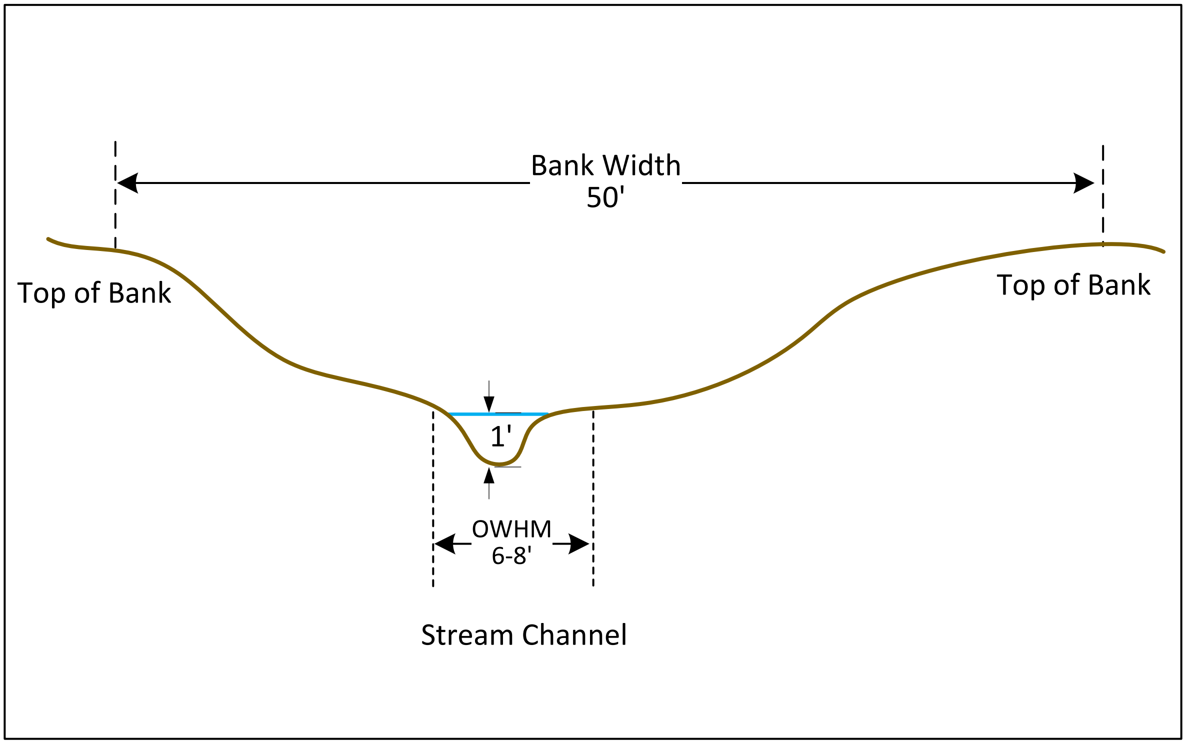
Sheet 4 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Brunsweiler River (sasc1006p)
MP 14.7

MPLS: M:\Clients\D-F\EEL\BadRiver_ArcGIS\2022\12\Waterbody_Xsections\	Perennial_XSection_Drawings.vsdx	Scale: NTS	Revised: 12/28/2022	Drawn By: GIS



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Sheet 5 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Trout Brook (sasc1003p_x1)
MP 15.9

ENBRIDGE

ERM

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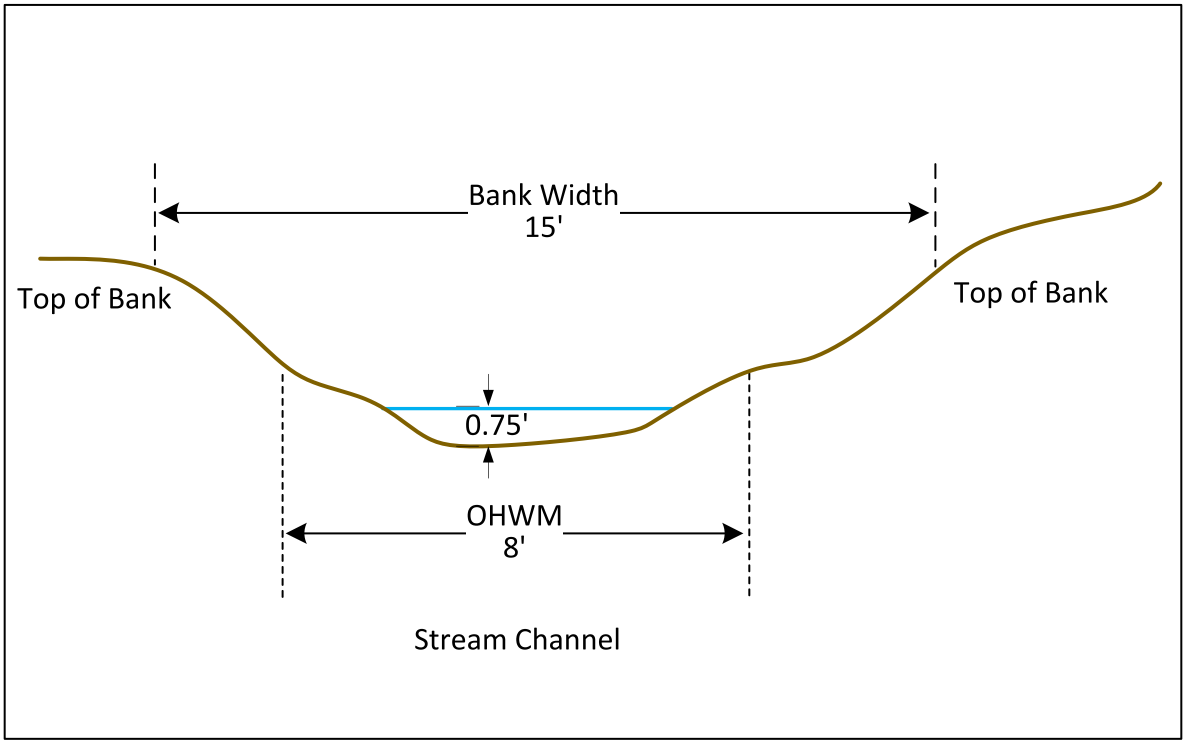

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Sheet 6 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Silver Creek (sasd1015p)
MP 19.8

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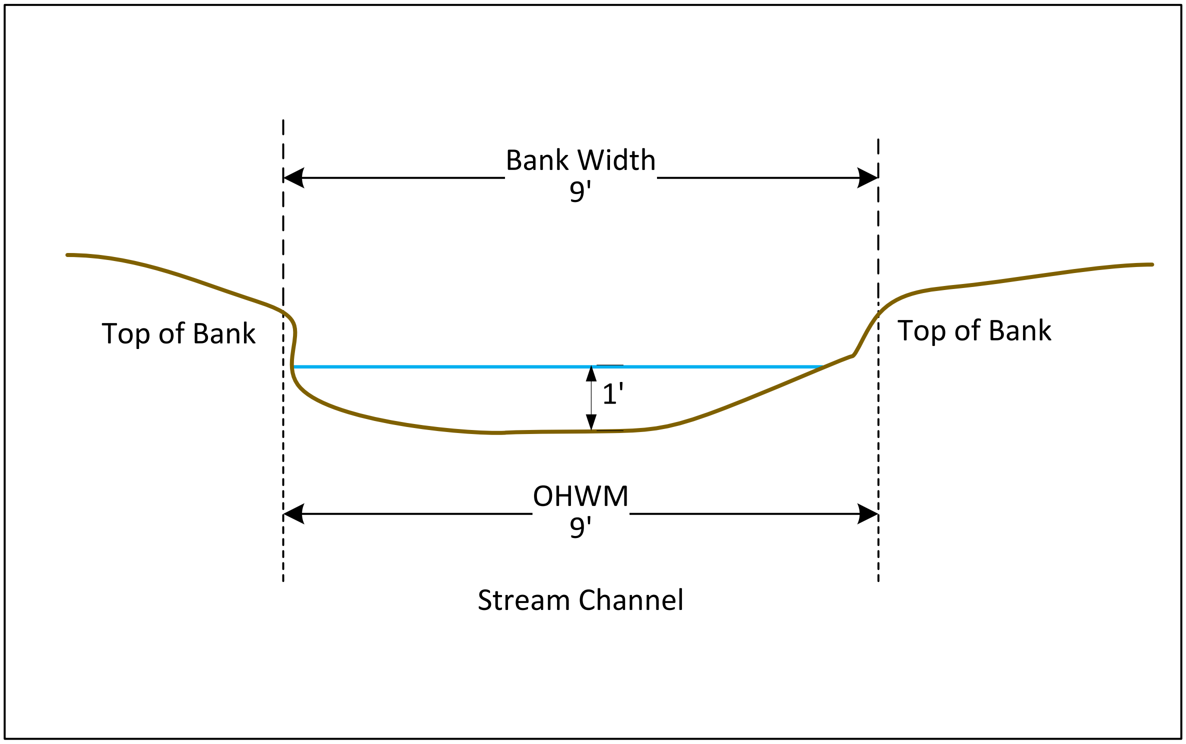

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Sheet 7 of 13

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Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Silver Creek (sase005p_x2)
MP 20.6

ERM

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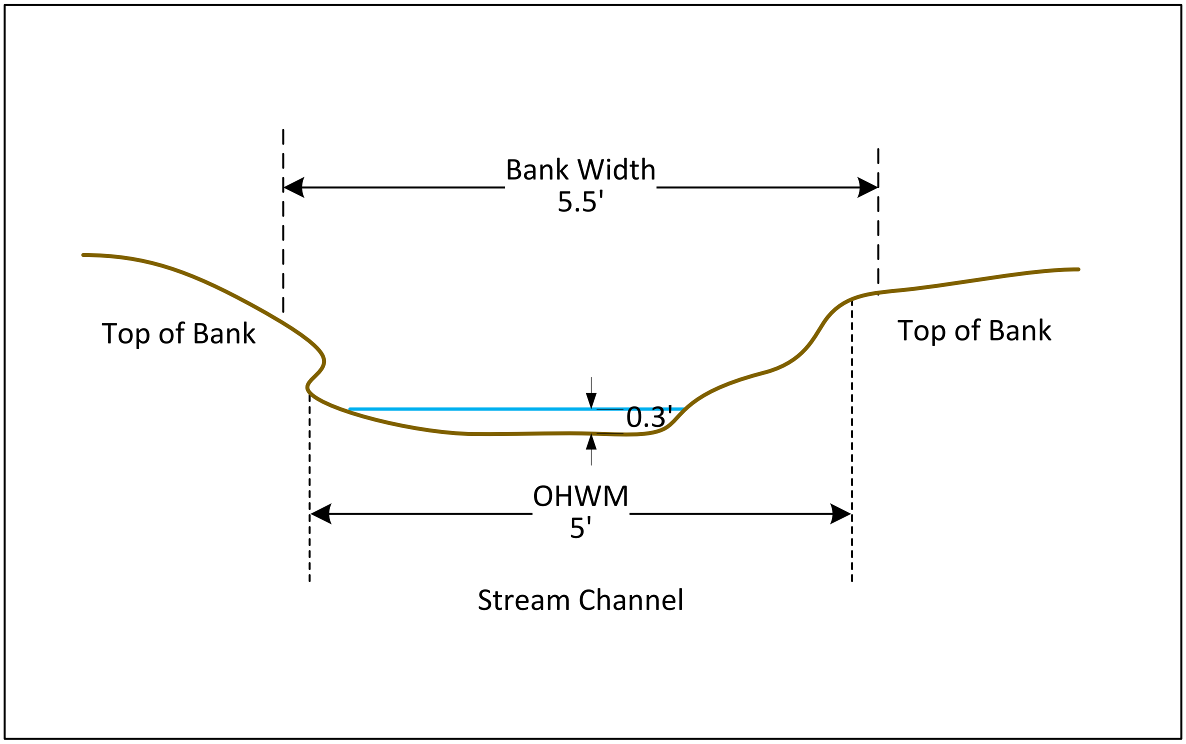

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Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Silver Creek (sasv004p)
MP 21.3

ERM

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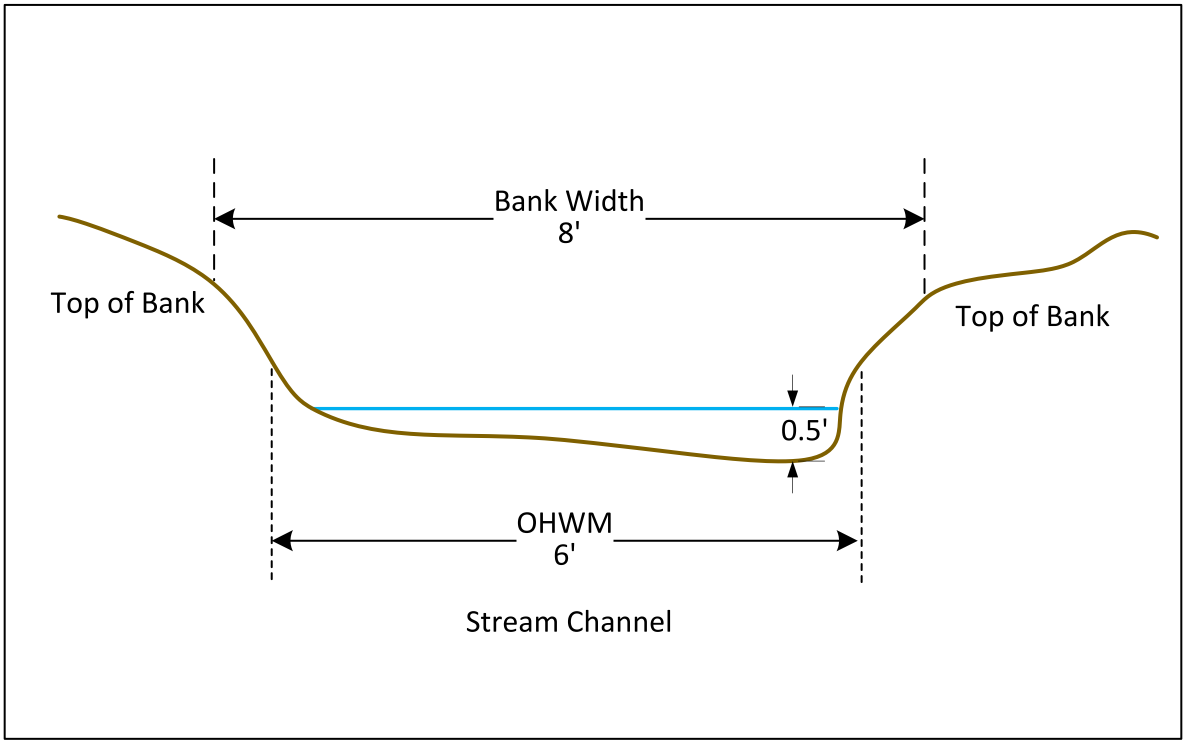

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Krause Creek (sasv020p)
MP 22

ENBRIDGE

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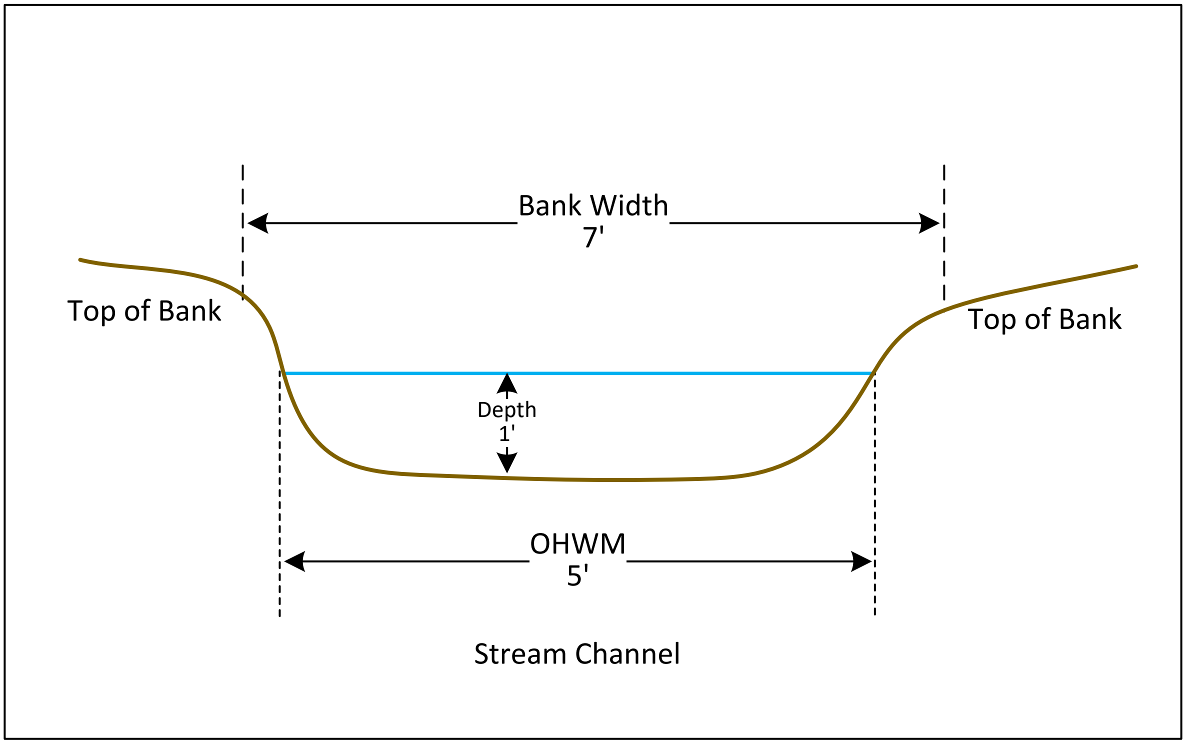

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Sheet 10 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Bad River (sasa008p)
MP 23.8

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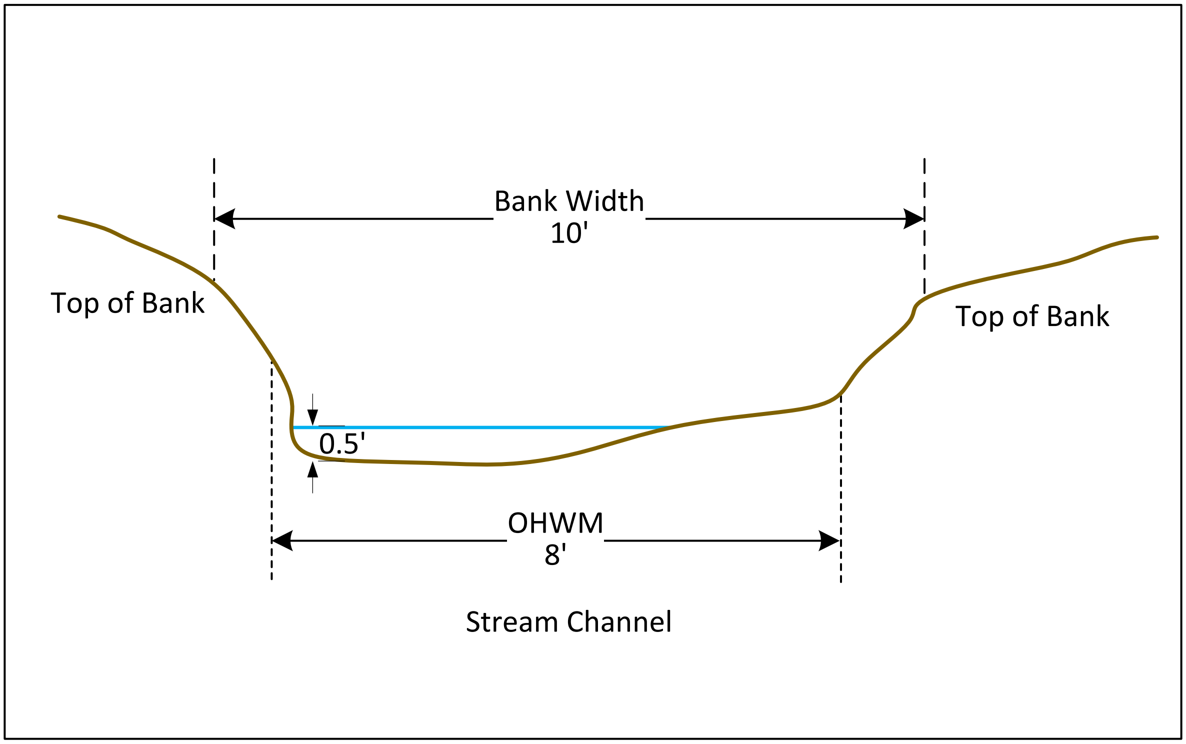

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Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Gehrman Creek (sasa004p)
MP 28.3

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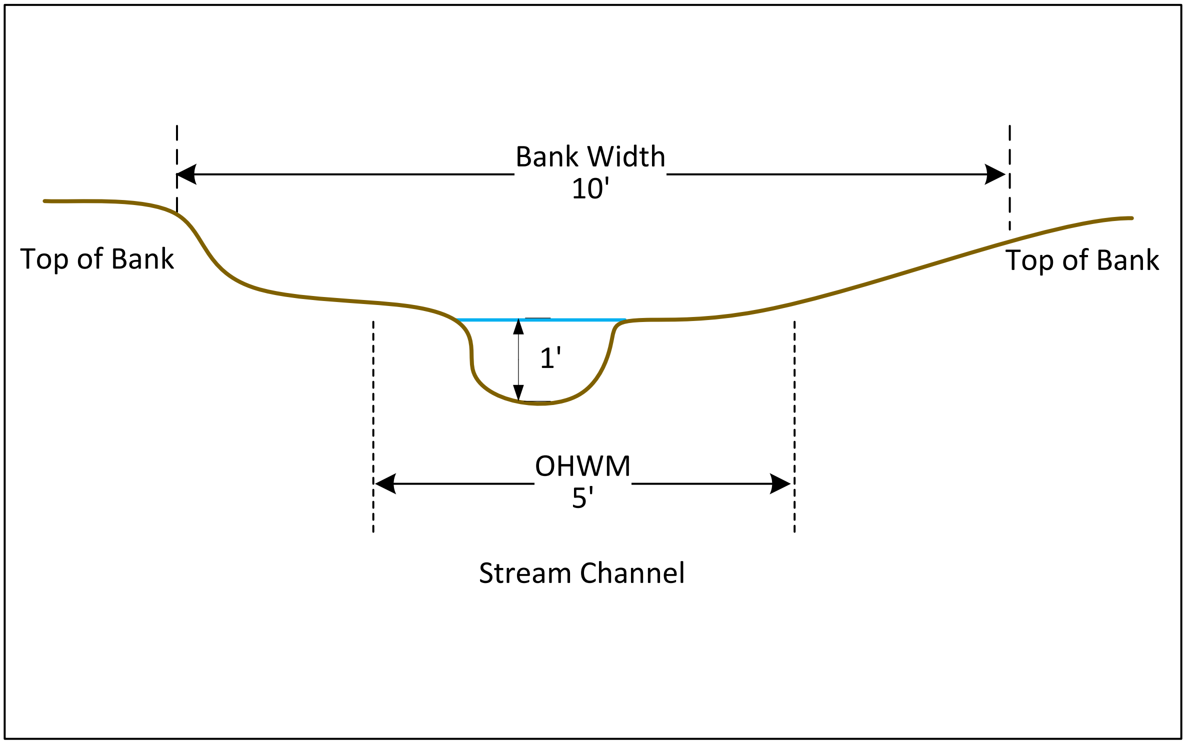

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Sheet 12 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Feldcher Creek (sirb010p)
MP 30.6

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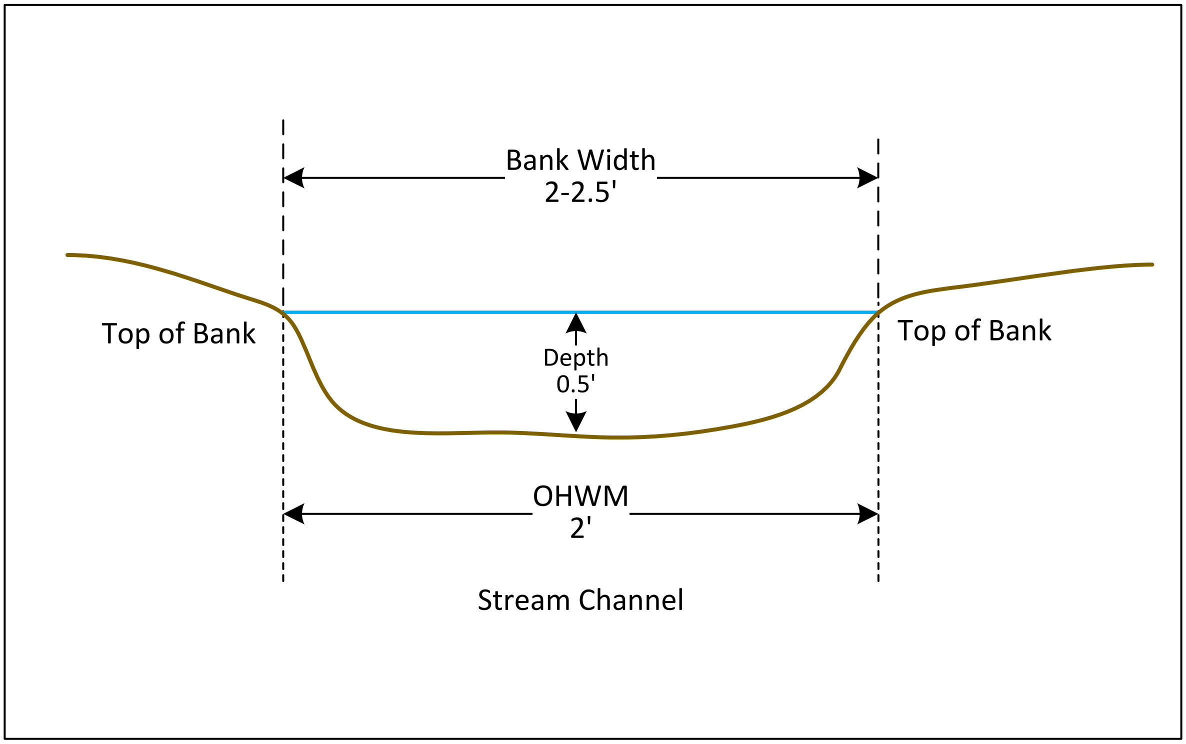

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Sheet 13 of 13

Erosion and Sediment Control Plan
Stream Crossing Profile Drawing
UNT of Vaughn Creek (sird009p)
MP 39.0

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MPLS: M:\Clients\D-F\EEL\BadRiver_ArcGIS\2022\12\Waterbody_Xsections\	Perennial_XSection_Drawings.vsdx	Scale: NTS	Revised: 12/28/2022	Drawn By: GIS

ENBRIDGE PIPELINES INC.
1409 HAMMOND AVENUE
SUPERIOR, WI 54880
USA
WWW.ENBRIDGE.COM

ENBRIDGE

LINE 5 WSRP
AFE# 20009293
SPECIFIC DRAWINGS FOR CHANNEL REMEDIATION
CWP XXX
ISSUED FOR BID

SPECIFIC DRAWINGS FOR CHANNEL REMEDIATION LIST					
PROJECT TITLE AND ACRONYM: LINE 5 SEGMENT RELOCATION PROJECT, L5WSRP					
AFE # AND PROJECT ID: AFE # 20009293					
STATION / TERMINAL: INO (WI) STATION TO SAXON (WI) STATION					
IN SERVICE DATE: 09/01/2021					
			Dwg Set Issue Issue Date	ISSUED FOR BID 2020-08-17	
Page No.	Discipline	CWP Number	DWG Number	Latest Revision	Description of Revision
1	ADMIN	-	D-5-0.0-SKG012-135	0.A	ISSUED FOR BID
2	PIPELINE	-	SASE006P-WXR	0.A	ISSUED FOR BID
3	PIPELINE	-	SASA047I-WXR	0.A	ISSUED FOR BID
4	PIPELINE	-	SASB007I-WXR	0.A	ISSUED FOR BID
5	PIPELINE	-	SASC039I-WXR	0.A	ISSUED FOR BID
6	PIPELINE	-	SASE1015I-WXR	0.A	ISSUED FOR BID
7	PIPELINE	-	SASC1006P-WXR	0.A	ISSUED FOR BID
8	PIPELINE	-	SASW011-WXR	0.A	ISSUED FOR BID

REV: 0.A	PROJECT TITLE: L5WSRP	SEQ #:
AFE: 20009293	PROJ NO: 2000105	
WP NO:		

REV	REVISION DESCRIPTION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-17 SRK	JMO LSC

LAKE SUPERIOR CONSULTING
A SHAWCOR COMPANY

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

ENBRIDGE LINE 5 WSRP
INDEX SHEET
ASHLAND COUNTY/IRON COUNTY, WI
WATERBODY REMEDIATION PLAN

BY: SRK	CHK: JMO	ENG.: NIN	ENB APPR: M. STATTERS
DATE: 2020-08-07		SCALE: NONE	STATUS: DESIGN
DWG NO.: D-5-0.0-SKG012-135			REV NO: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

NORTH BANK (DOWNSTREAM BANK LEFT)

STEP 1. RE-CONTOUR TOE OF SLOPE, LINE WITH GEOTEXTILE AND INSTALL RIP-RAP ALONG TOE, (TOE OF RIP-RAP IN AT LEAST 2 FT BELOW THE STREAMBED LEVEL)

STEP 2. INSTALL ROCK RIP-RAP UP TO 1 FT ABOVE CHANNEL BOTTOM

STEP 3. LAYER WILLOW BRANCES AS BRUSH LAYERS ON TOP OF RIP-RAP

STEP 4. INSTALL FIRST SUBSOIL LIFT WRAPPED WITH COIR MATTING (LAY COIR MATTING UNDER, BACKFILL BANK MATERIAL, INSTALL SEED MIX PER EPP, AND WRAP FRONT EDGE OF COIR MATTING AROUND AND OVER TOP). WRAP LAYER HEIGHTS SHOULD BE NO MORE THAN 1 FOOT HIGH AND GRADE BACK AT AN ANGLE SIMILAR TO THE ADJACENT NATURAL BANK SLOPES.

STEP 5. INSTALL ANOTHER LAYER OF WILLOW BRUSH BETWEEN SOIL LIFTS AND BEGIN THE NEXT SOIL WRAP WITH COIR MATTING. REPEAT STEPS UNTIL DESIRED BANK HEIGHT HAS BEEN REACHED. ENSURE THE TOP LAYER WITHIN THE SOIL WRAP CONTAINS SALVAGED TOPSOIL. CROWN THE TRENCH SLIGHTLY HIGHER TO ALLEVIATE SUBSIDENCE ISSUES.

STEP 6. ON THE TOP OF THE BANK, INSTALL RIPRARIAN SEED MIX PER EPP, COIR MATTING, AND WILLOW STAKES TO HOLD COIR MATTING IN PLACE. INSTALL WILLOW STAKES THROUGH THE FINAL SOIL WRAP AND APPROXIMATELY 10 FT BEYOND BANK EDGE AT APPROXIMATELY 1 PER 8 SF (STAGGARD FORMATION). STAKES SHOULD BE INSTALLED WITH 1/4 OF THE STAKES EXPOSED (3/4 IN THE GROUND), ANGLED TOWARD THE WATERCOURSE.

STEP 7. IF BANKS WERE GRADED FOR THE VEHICLE AND EQUIPMENT ACCESS CROSSING, CROWN BANK AREA AND STABILIZE SOILD WITH COIR MATTING, WILLOW STAKES, AND RIPRARIAN SEEDING PER EPP.

SOUTH BANK (DOWNSTREAM BANK RIGHT)

STEP 1. RE-CONTOUR TOE OF SLOPE, LINE WITH GEOTEXTILE AND INSTALL RIP-RAP ALONG TOE, (TOE OF RIP-RAP IN AT LEAST 2 FT BELOW THE STREAMBED LEVEL)

STEP 2. INSTALL ROCK RIP-RAP UP TO 1 FT ABOVE CHANNEL BOTTOM

STEP 3. LAYER WILLOW BRANCES AS BRUSH LAYERS ON TOP OF RIP-RAP

STEP 4. INSTALL FIRST SUBSOIL LIFT WRAPPED WITH COIR MATTING (LAY COIR MATTING UNDER, BACKFILL BANK MATERIAL, INSTALL SEED MIX PER EPP, AND WRAP FRONT EDGE OF COIR MATTING AROUND AND OVER TOP). WRAP LAYER HEIGHTS SHOULD BE NO MORE THAN 1 FOOT HIGH AND GRADE BACK AT AN ANGLE SIMILAR TO THE ADJACENT NATURAL BANK SLOPES.

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STEP 6. ON THE TOP OF THE BANK, INSTALL RIPRARIAN SEED MIX PER EPP, COIR MATTING, AND WILLOW STAKES TO HOLD COIR MATTING IN PLACE. INSTALL WILLOW STAKES THROUGH THE FINAL SOIL WRAP AND APPROXIMATELY 10 FT BEYOND BANK EDGE AT APPROXIMATELY 1 PER 8 SF (STAGGARD FORMATION). STAKES SHOULD BE INSTALLED WITH 1/4 OF THE STAKES EXPOSED (3/4 IN THE GROUND), ANGLED TOWARD THE WATERCOURSE.

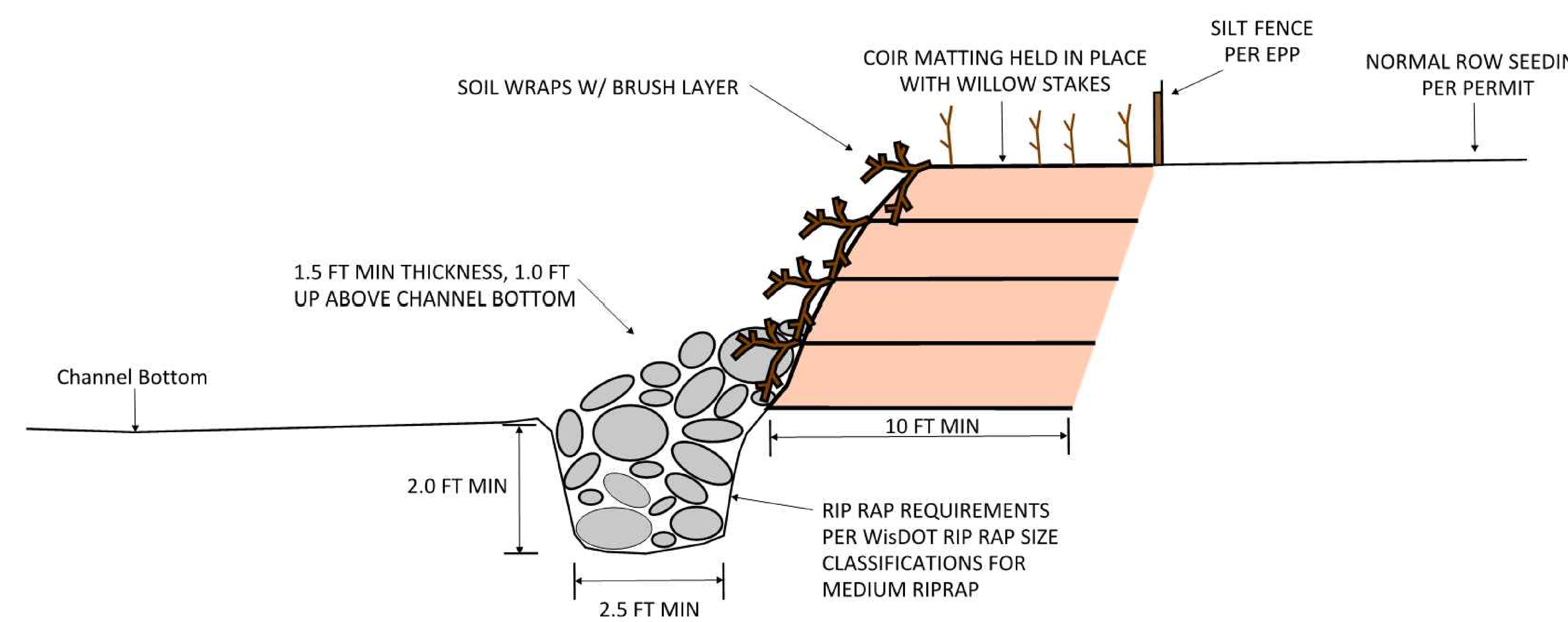
STEP 7. IF BANKS WERE GRADED FOR THE VEHICLE AND EQUIPMENT ACCESS CROSSING, CROWN BANK AREA AND STABILIZE SOILD WITH COIR MATTING, WILLOW STAKES, AND RIPRARIAN SEEDING PER EPP.

APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 250 WILLOW STAKES (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS COVERAGE X 10 FT WILLOW SETBACK WIDTH * 1 EA/8 SF WILLOW STAKE SPACING. CUT TO APPROXIMATELY 2-3 FEET LONG, BRANCHES REMOVED, AND COLLECT ALL BRUSH FROM FROM WILLOW STAKE TRIMMINGS (CUT BRANCHES)
- 800 BRANCHES (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 4 BRANCHES / LINEAL FOOT
- 9 ROLLS COIR MATTING (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 53 FT LENGTH OF COIR MATTING PER LINEAL FOOT OF BANK (ASSUMING 4 FT CHANNEL WITH 3.0 H: 1 V SLOPE)* 1 ROLL/1200 SF
- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 53 (CY) OF MEDIUM RIP-RAP - ASSUME 7.12 SF PER LINEAL FOOT * 100 FOOT WORKSPACE * 2 BANKS * 1 CY / 27 CF
- 144 (SY) OF GEOTEXTILE FABRIC TYPE HR - ASSUME 6.5 SF / 1 LF X 100 FT WORKSPACE X 2 BANKS X 1 SY / 9 SF
- 19 (CY) OF SELECT CRUSHED MATERIAL (REPLACEMENT OF DRIVEABLE PATH) - ASSUME 0.5 FT DEPTH X 10 FT WIDE X 100 FT LENGTH
- 2 ROLLS OF SILT FENCE (EA) - ASSUME 100FT WORKSPACE WIDTH X 1.2 BANK COVERAGE X 1 ROLL/100FT

* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

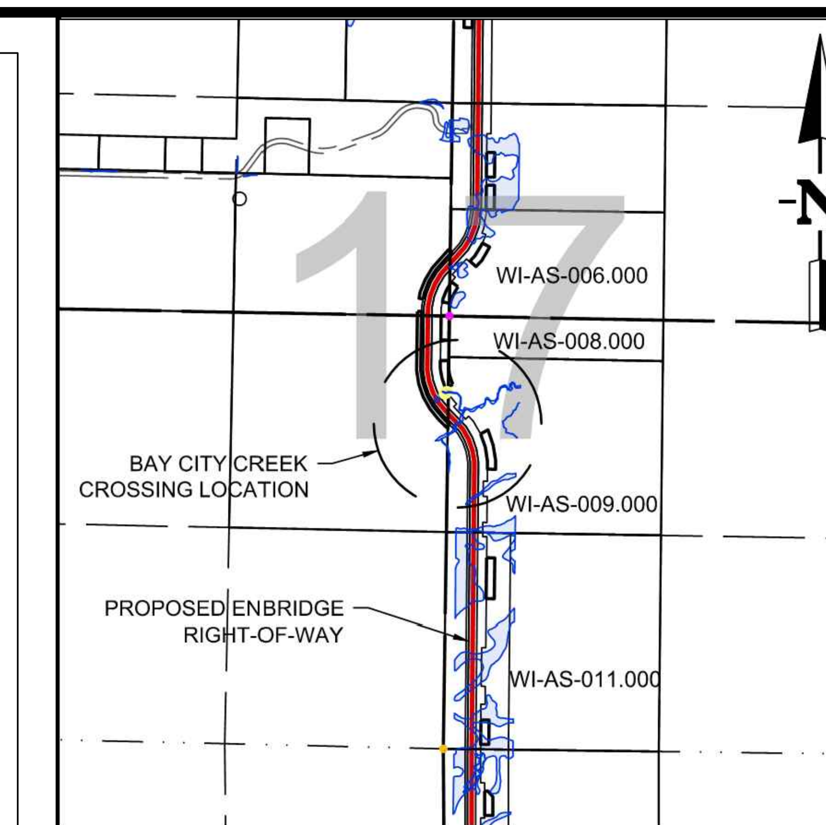
TYPICAL SIDE VIEW OF SOIL WRAPS W/ BRUSH LAYER & RIP RAP TOE



DOWNSTREAM RIGHT, EXISTING CHANNEL (NORTH BANK BACKGROUND, SOUTH BANK FOREGROUND)

DOWNSTREAM RIGHT, PROPOSED CONCEPT (NORTH BANK BACKGROUND, SOUTH BANK FOREGROUND)

LEGEND



LOCATION PLAN

CHANNEL DESCRIPTION

TYPE: INTERMITTENT STREAM
TROUT WATER: NO (THOUGH TROUT WERE FOUND DURING FIELD INVESTIGATION)
OUTSTANDING /EXCEPTIONAL WATER: NO
IMPAIRED WATER: YES
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 14 FT WIDE. BANKS SHOW SIGNS OF EROSION AND ARE APPROX. 2.75-3.00H:1V SLOPES. CHANNEL BED IS MOSTLY SAND W/ PEBBLES & SMALLER ROCKS

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

THIS DRAWING IS TO AID IN THE REMEDIATION OF THE CHANNEL BANKS. REMEDIATION OF THE CHANNEL TO CONFORM TO THE METHODS DICTATED IN THIS DRAWING, REQUIREMENTS OF THE EPP, AND AGENCY REQUIREMENTS. EXTENTS OF REMEDIATION, QUANTITIES, AND DIMENSIONS DEPENDENT ON THE EXTENT OF REMEDIATION REQUIRED

REV: 0.A	PROJECT TITLE: L5WSRP		SEQ #:
AFE: 20009293		PROJ NO: 2000105	
WP NO:			
REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE
SASE006P-WX	WATERBODY CROSSING DRAWING BAY CITY CREEK

THIS DRAWING REPRESENTS THE INITIAL ENGINEERING DESIGN AND SHALL BE USED ONLY FOR THE PURPOSE OF PREPARING A BID. THIS DRAWING DOES NOT PRESENT THE FINAL ENGINEERING DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION.

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 0.631 (STA 33+31)
LINE 5 CROSSING (ID SASE006P)
BAY CITY CREEK CREEK IN S17, T47N, R4W
WATERBODY REMEDIATION PLAN

BY: FJS	CHK: JMO	ENG. : NIN	ENB APPR: M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN
DWG NO.: SASE006P-WXR			REV NO: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

NORTH BANK (LEFT DOWNSTREAM BANK)

ROOTWAD

STEP 1. CLEAR AND GRUB THE WORK AREA AT THE DIRECTION OF THE SITE ENGINEER AND SALVAGE LARGE TREES AS DIRECTED.
STEP 2. RE-CONTOUR TOE OF SLOPE, SET FOOTER LOG BEHIND BANK AND BACKFILL WITH NATIVE BANK MATERIAL
STEP 3. RE-GRADE TO PRE-CONSTRUCTION CONDITIONS HALFWAY UP CHANNEL BANK, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.
STEP 4. SET SALVAGED ROOTWAD AS SHOWN IN ROOTWAD TYPICAL, CANTILEVERED OVER FOOTER LOGS.
STEP 5. CONTINUE TO RE-GRADE TO PRE-CONSTRUCTION CONDITION, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

RE-GRADING TO 3 H : 1 V

STEP 1. RE-CONTOUR TOE OF SLOPE
STEP 2. GRADE AT A 3 H : 1 V TO PRE-CONSTRUCTION CONDITIONS, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

SOUTH BANK (RIGHT DOWNSTREAM BANK)

ROOTWAD

STEP 1. CLEAR AND GRUB THE WORK AREA AT THE DIRECTION OF THE SITE ENGINEER AND SALVAGE LARGE TREES AS DIRECTED.
STEP 2. RE-CONTOUR TOE OF SLOPE, SET FOOTER LOG BEHIND BANK AND BACKFILL WITH NATIVE BANK MATERIAL
STEP 3. RE-GRADE TO PRE-CONSTRUCTION CONDITIONS HALFWAY UP CHANNEL BANK, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.
STEP 4. SET SALVAGED ROOTWAD AS SHOWN IN ROOTWAD TYPICAL, CANTILEVERED OVER FOOTER LOGS.
STEP 5. CONTINUE TO RE-GRADE TO PRE-CONSTRUCTION CONDITION, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

RE-GRADING TO 3 H : 1 V

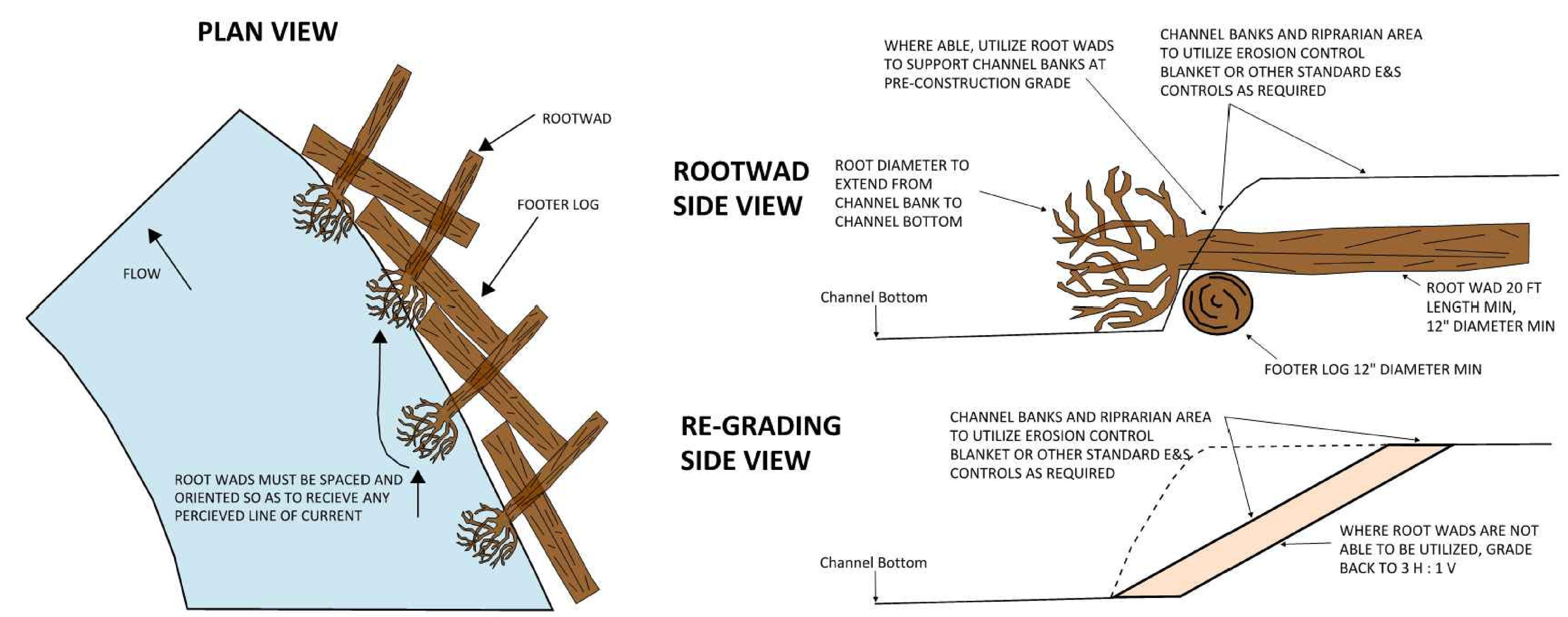
STEP 1. RE-CONTOUR TOE OF SLOPE
STEP 2. GRADE AT A 3 H : 1 V TO PRE-CONSTRUCTION CONDITIONS, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 2 ROLLS OF SILT FENCE (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 1 ROLL/100FT
- 10 ROOTWADS (EA) - ASSUME 100 FT WORKSPACE X 2 BANKS X 1 ROOTWAD / 20 FT
- 10 FOOTER LOG (EA) - ASSUME 1 FOOTER LOG / ROOTWAD

* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

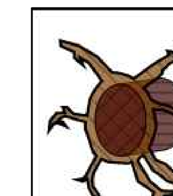
TYPICAL PLAN AND SIDE VIEW OF ROOTWADS AND RE-GRADING



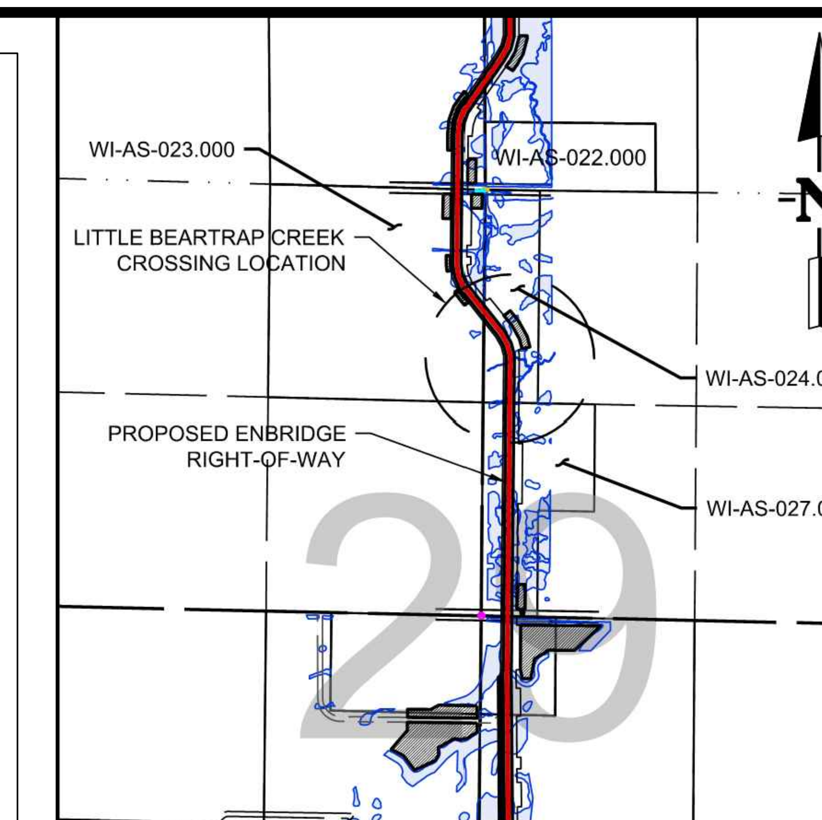
DOWNSTREAM LEFT, EXISTING CHANNEL (NORTH BANK FOREGROUND, SOUTH BANK BACKGROUND)

DOWNSTREAM LEFT, PROPOSED CONCEPT (NORTH BANK FOREGROUND, SOUTH BANK BACKGROUND)

LEGEND


ROOTWAD

BANKS TO BE RE-GRADED OR STABILIZED WITH ROOTWADS



LOCATION PLAN

CHANNEL DESCRIPTION

TYPE: INTERMITTENT STREAM
TROUT WATER: NO
OUTSTANDING /EXCEPTIONAL WATER: NO
IMPAIRED WATER: NO
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 7 FT WIDE. BANKS SHOW SIGNS OF EROSION AND ARE APPROX. <1H:1V SLOPES. CHANNEL BED IS MOSTLY FINES/CLAY MATERIAL.

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

THIS DRAWING IS TO AID IN THE REMEDIATION OF THE CHANNEL BANKS. REMEDIATION OF THE CHANNEL TO CONFORM TO THE METHODS DICTATED IN THIS DRAWING, REQUIREMENTS OF THE EPP, AND AGENCY REQUIREMENTS. EXTENTS OF REMEDIATION, QUANTITIES, AND DIMENSIONS DEPENDENT ON THE EXTENT OF REMEDIATION REQUIRED

REV: 0.A	PROJECT TITLE: L5WSRP		SEQ #:
AFE: 20009293		PROJ NO: 2000105	
WP NO:			
REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE
SASA0471-WX	WATERBODY CROSSING DRAWING LITTLE BEARTRAP CREEK

THIS DRAWING REPRESENTS THE INITIAL ENGINEERING DESIGN AND SHALL BE USED ONLY FOR THE PURPOSE OF PREPARING A BID. THIS DRAWING DOES NOT PRESENT THE FINAL ENGINEERING DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION.

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 2.239 (STA 118+21)
LINE 5 CROSSING (ID SASA0471)
LITTLE BEARTRAP CREEK IN S29, T47N, R4W
WATERBODY REMEDIATION PLAN

BY: FJS	CHK: JMO	ENG. :NIN	ENB APPR: M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN

DWG NO.: SASA047I-WXR
REV NO.: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

NORTH BANK (LEFT DOWNSTREAM BANK)

STEP 1. CLEAR AND GRUB THE WORK AREA AT THE DIRECTION OF THE SITE ENGINEER AND SALVAGE LARGE TREES AS DIRECTED.

STEP 2. RE-CONTOUR TOE OF SLOPE, LINE WITH GEOTEXTILE AND INSTALL RIP-RAP ALONG TOE, (TOE OF RIP-RAP IN AT LEAST 2 FT BELOW THE STREAMBED LEVEL)

STEP 3. INSTALL ROCK RIP-RAP UP TO THE 1 FT ABOVE CHANNEL BOTTOM

STEP 4. LAYER WILLOW BRANCES AS BRUSH LAYERS ON TOP OF RIP-RAP

STEP 5. INSTALL FIRST SUBSOIL LIFT WITH FOOTER LOGS WRAPPED WITH COIR MATTING ALLOWING FOR HALF CYLINDRICAL SHAPE FOR ROOTWAD IN SUBSOIL LIFT (LAY COIR MATTING UNDER, BACKFILL BANK MATERIAL, INSTALL SEED MIX PER EPP, AND WRAP FRONT EDGE OF COIR MATTING AROUND AND OVER TOP). WRAP LAYER HEIGHTS SHOULD BE NO MORE THAN 1 FOOT HIGH AND GRADE BACK AT AN ANGLE SIMILAR TO THE ADJACENT NATURAL BANK SLOPES.

STEP 6. INSTALL SALVAGED ROOTWADS AS SHOWN IN TYPICAL PLAN ON TOP OF COIR MATTING.

STEP 7. INSTALL ANOTHER LAYER OF WILLOW BRUSH BETWEEN SOIL LIFTS AND BEGIN THE NEXT SOIL LIFT ON TOP OF ROOTWADS AND WRAP WITH COIR MATTING. REPEAT SOIL LIFTS AND COIR WRAPPING UNTIL DESIRED BANK HEIGHT HAS BEEN REACHED. ENSURE THE TOP LAYER WITHIN THE SOIL WRAP CONTAINS SALVAGED TOPSOIL. CROWN THE TRENCH SLIGHTLY HIGHER TO ALLEVIATE SUBSIDENCE ISSUES.

STEP 8. ON THE TOP OF THE BANK, INSTALL RIPRARIAN SEED MIX PER EPP, COIR MATTING, AND WILLOW STAKES TO HOLD COIR MATTING IN PLACE. INSTALL WILLOW STAKES THROUGH THE FINAL SOIL WRAP AND APPROXIMATELY 10 FT BEYOND BANK EDGE AT APPROXIMATELY 1 PER 8 SF (STAGGARD FORMATION). STAKES SHOULD BE INSTALLED WITH 1/4 OF THE STAKES EXPOSED (3/4 IN THE GROUND), ANGLED TOWARD THE WATERCOURSE.

STEP 9. IF BANKS WERE GRADED FOR THE VEHICLE AND EQUIPMENT ACCESS CROSSING, CROWN BANK AREA AND STABILIZE SOIL WITH COIR MATTING, WILLOW STAKES, AND RIPRARIAN SEEDING PER EPP.

SOUTH BANK (RIGHT DOWNSTREAM BANK)

STEP 1. CLEAR AND GRUB THE WORK AREA AT THE DIRECTION OF THE SITE ENGINEER AND SALVAGE LARGE TREES AS DIRECTED.

STEP 2. RE-CONTOUR TOE OF SLOPE, LINE WITH GEOTEXTILE AND INSTALL RIP-RAP ALONG TOE, (TOE OF RIP-RAP IN AT LEAST 2 FT BELOW THE STREAMBED LEVEL)

STEP 3. INSTALL ROCK RIP-RAP UP TO THE 1 FT ABOVE CHANNEL BOTTOM

STEP 4. LAYER WILLOW BRANCES AS BRUSH LAYERS ON TOP OF RIP-RAP

STEP 5. INSTALL FIRST SUBSOIL LIFT WITH FOOTER LOGS WRAPPED WITH COIR MATTING ALLOWING FOR HALF CYLINDRICAL SHAPE FOR ROOTWAD IN SUBSOIL LIFT (LAY COIR MATTING UNDER, BACKFILL BANK MATERIAL, INSTALL SEED MIX PER EPP, AND WRAP FRONT EDGE OF COIR MATTING AROUND AND OVER TOP). WRAP LAYER HEIGHTS SHOULD BE NO MORE THAN 1 FOOT HIGH AND GRADE BACK AT AN ANGLE SIMILAR TO THE ADJACENT NATURAL BANK SLOPES.

STEP 6. INSTALL SALVAGED ROOTWADS AS SHOWN IN TYPICAL PLAN ON TOP OF COIR MATTING.

STEP 7. INSTALL ANOTHER LAYER OF WILLOW BRUSH BETWEEN SOIL LIFTS AND BEGIN THE NEXT SOIL LIFT ON TOP OF ROOTWADS AND WRAP WITH COIR MATTING. REPEAT SOIL LIFTS AND COIR WRAPPING UNTIL DESIRED BANK HEIGHT HAS BEEN REACHED. ENSURE THE TOP LAYER WITHIN THE SOIL WRAP CONTAINS SALVAGED TOPSOIL. CROWN THE TRENCH SLIGHTLY HIGHER TO ALLEVIATE SUBSIDENCE ISSUES.

STEP 8. ON THE TOP OF THE BANK, INSTALL RIPRARIAN SEED MIX PER EPP, COIR MATTING, AND WILLOW STAKES TO HOLD COIR MATTING IN PLACE. INSTALL WILLOW STAKES THROUGH THE FINAL SOIL WRAP AND APPROXIMATELY 10 FT BEYOND BANK EDGE AT APPROXIMATELY 1 PER 8 SF (STAGGARD FORMATION). STAKES SHOULD BE INSTALLED WITH 1/4 OF THE STAKES EXPOSED (3/4 IN THE GROUND), ANGLED TOWARD THE WATERCOURSE.

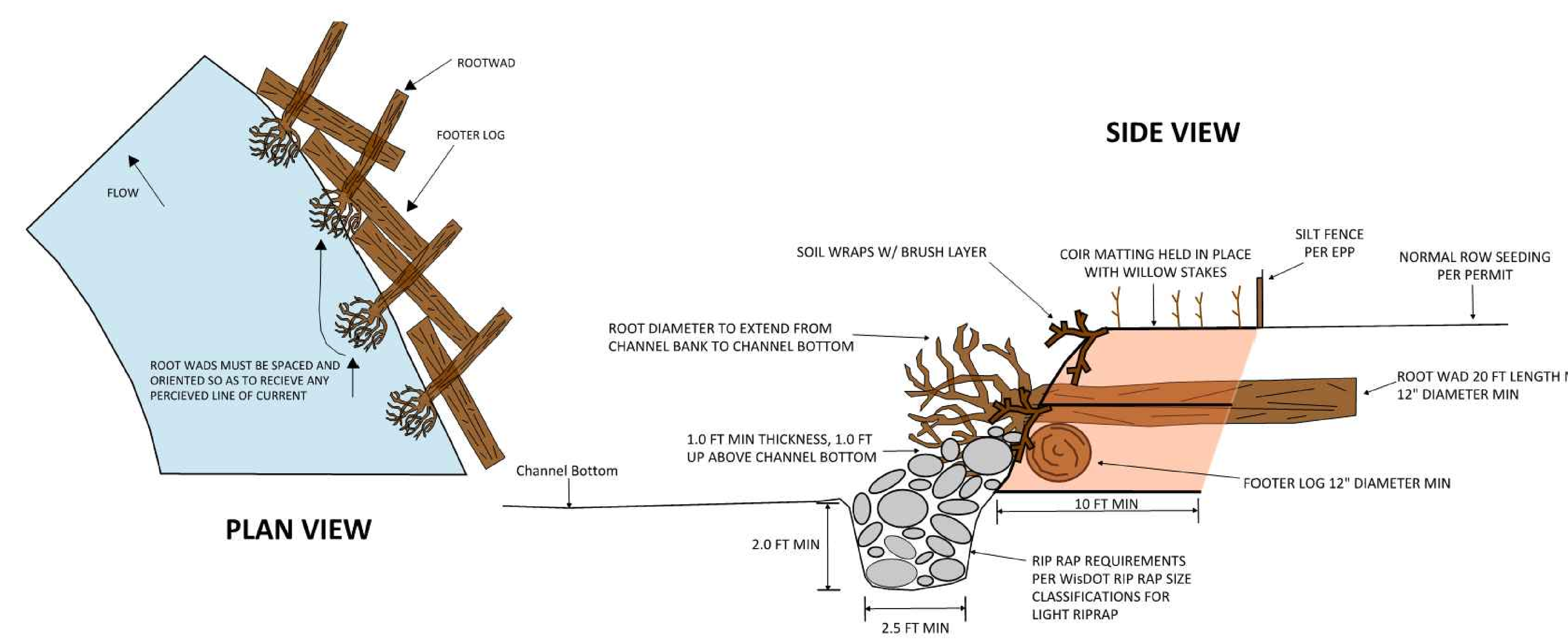
STEP 9. IF BANKS WERE GRADED FOR THE VEHICLE AND EQUIPMENT ACCESS CROSSING, CROWN BANK AREA AND STABILIZE SOIL WITH COIR MATTING, WILLOW STAKES, AND RIPRARIAN SEEDING PER EPP.

APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 275 WILLOW STAKES (EA) - ASSUME 110 FT WORKSPACE WIDTH X 2 BANKS X 10 FT WILLOW SETBACK WIDTH * 1 EA/8 SF WILLOW STAKE SPACING. CUT TO APPROXIMATELY 2-3 FEET LONG, BRANCHES REMOVED, AND COLLECT ALL BRUSH FROM FROM WILLOW STAKE TRIMMINGS (CUT BRANCHES)
- 440 BRANCHES (EA) - ASSUME 110 FT WORKSPACE WIDTH X 2 BANKS X 2 BRANCH / LINEAL FOOT
- 3 ROLLS COIR MATTING (EA) - ASSUME 110 FT WORKSPACE WIDTH X 2 BANKS X 18 FT LENGTH OF COIR MATTING PER LINEAL FOOT OF BANK (ASSUMING 2 FT CHANNEL WITH 1.5 H: 1 V SLOPE)* 1 ROLL/1200 SF
- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 52 CY OF LIGHT RIP-RAP - ASSUME 6.41 SF PER LINEAL FOOT * 110 FOOT WORKSPACE * 2 BANKS * 1 CY / 27 CF
- 159 SY OF GEOTEXTILE FABRIC TYPE R - ASSUME 6.5 SF / 1 LF OF BANK X 2 BANKS X 110 FT WORKSPACE X 1 SY / 9 SF
- 3 ROLLS OF SILT FENCE (EA) - ASSUME 110 FT WORKSPACE WIDTH X 2 BANKS X 1 ROLL/100FT
- 22 ROOTWADS (EA) - ASSUME 110 FT WORKSPACE X 2 BANKS X 1 ROOTWAD / 10 FT
- 22 FOOTER LOG (EA) - ASSUME 1 FOOTER LOG / ROOTWAD

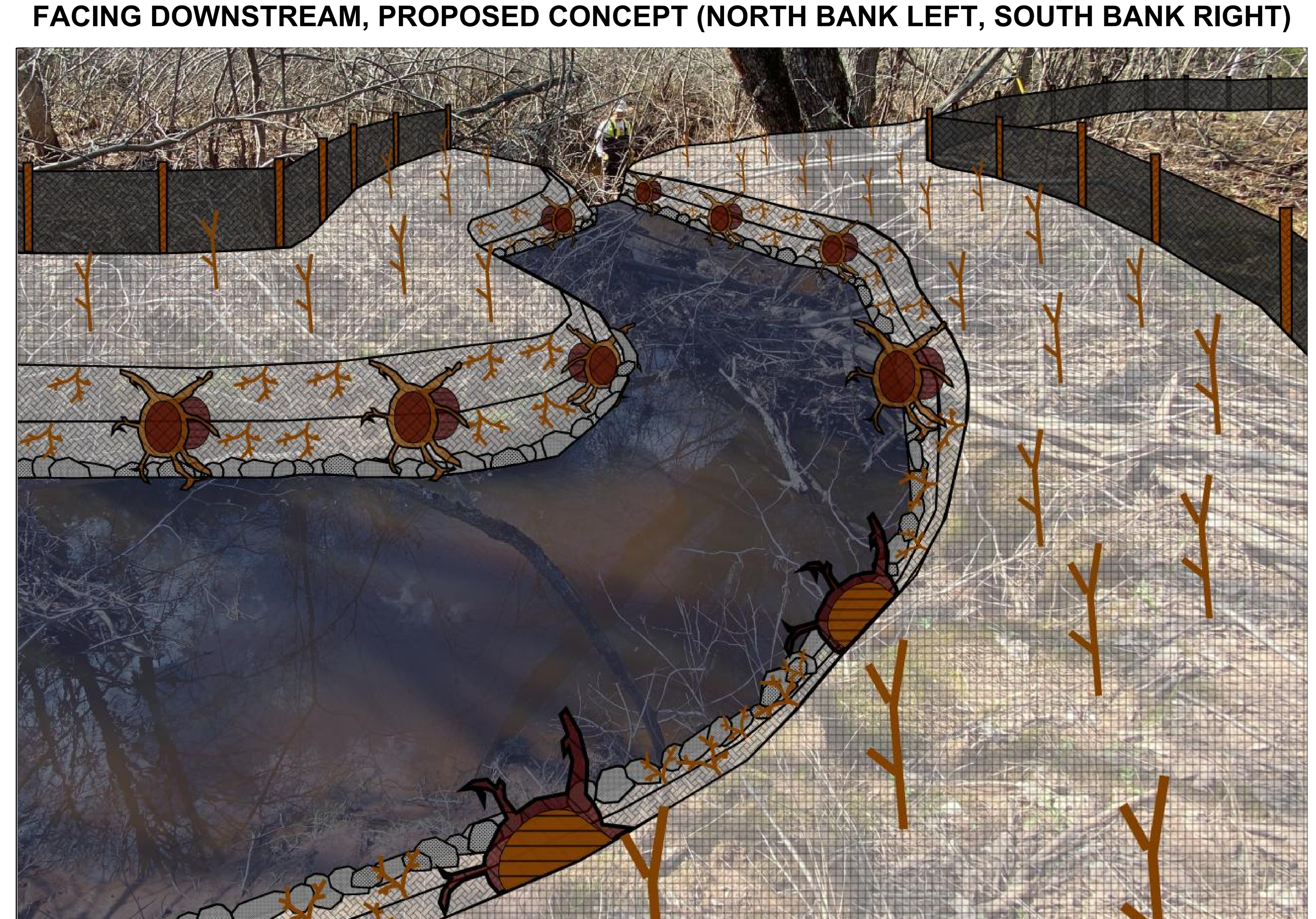
* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

TYPICAL PLAN AND SIDE VIEW OF ROOTWADS, SOIL WRAPS W/ BRUSH LAYER, AND STONE TOE

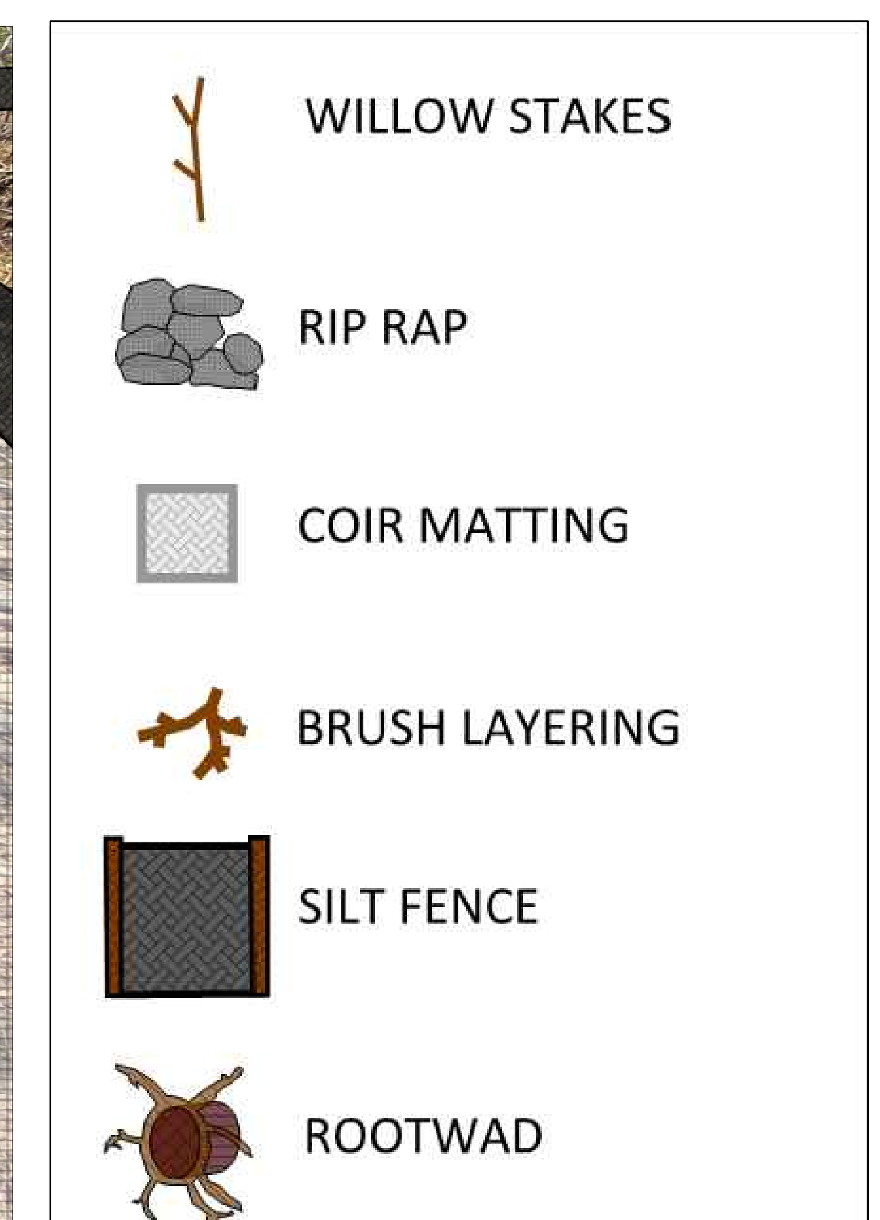


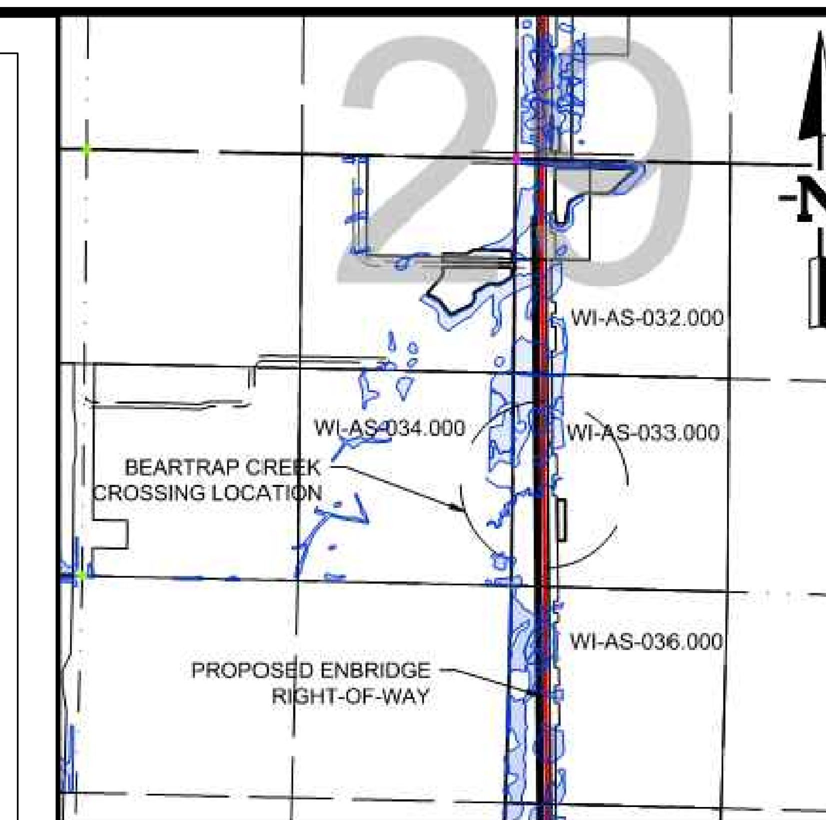
FACING DOWNSTREAM, EXISTING CHANNEL (NORTH BANK LEFT, SOUTH BANK RIGHT)

FACING DOWNSTREAM, PROPOSED CONCEPT (NORTH BANK LEFT, SOUTH BANK RIGHT)



LEGEND





LOCATION PLAN

CHANNEL DESCRIPTION

TYPE: INTERMITTENT STREAM
TROUT WATER: NO
OUTSTANDING /EXCEPTIONAL WATER: NO
IMPAIRED WATER: NO
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 15 FT WIDE. BANKS SHOW SIGNS OF EROSION AND ARE APPROX. 1.5-1.75H:1V SLOPES. CHANNEL BED IS MOSTLY FINES/CLAY MATERIAL

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

THIS DRAWING IS TO AID IN THE REMEDIATION OF THE CHANNEL BANKS. REMEDIATION OF THE CHANNEL TO CONFORM TO THE METHODS DICTATED IN THIS DRAWING, REQUIREMENTS OF THE EPP, AND AGENCY REQUIREMENTS. EXTENTS OF REMEDIATION, QUANTITIES, AND DIMENSIONS DEPENDENT ON THE EXTENT OF REMEDIATION REQUIRED

REV: 0.A	PROJECT TITLE: L5WSRP		SEQ #:
AFE: 20009293		PROJ NO: 2000105	
WP NO:			
REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE
SASB007I-WX	WATERBODY CROSSING DRAWING BEARTRAP CREEK

THIS DRAWING REPRESENTS THE INITIAL ENGINEERING DESIGN AND SHALL BE USED ONLY FOR THE PURPOSE OF PREPARING A BID. THIS DRAWING DOES NOT PRESENT THE FINAL ENGINEERING DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION.

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 2.912 (STA 153+75)
LINE 5 CROSSING (ID SASB007I)
BEARTRAP CREEK IN S29-T47N-R4W
WATERBODY REMEDIATION PLAN

BY: FJS	CHK: JMO	ENG. : NIN	ENB APPR: M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN
DWG NO.: SASB007I-WXR			REV NO: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

NORTH BANK (LEFT DOWNSTREAM BANK)

STEP 1. UTILIZE STANDARD E&S CONTROLS AS REQUIRED.

SOUTH BANK (RIGHT DOWNSTREAM BANK)

ROOTWAD

STEP 1. CLEAR AND GRUB THE WORK AREA AT THE DIRECTION OF THE SITE ENGINEER AND SALVAGE LARGE TREES AS DIRECTED.

STEP 2. RE-CONTOUR TOE OF SLOPE, SET FOOTER LOG BEHIND BANK AND BACKFILL WITH NATIVE BANK MATERIAL

STEP 3. RE-GRADE TO PRE-CONSTRUCTION CONDITIONS HALFWAY UP CHANNEL BANK, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

STEP 4. SET SALVAGED ROOTWAD AS SHOWN IN ROOTWAD TYPICAL, CANTILEVERED OVER FOOTER LOGS.

STEP 5. CONTINUE TO RE-GRADE TO PRE-CONSTRUCTION CONDITION, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

ARMOR CHANNEL BANK W/ RIP RAP

STEP 1. RE-CONTOUR TOE OF SLOPE, LINE WITH GEOTEXTILE AND INSTALL RIP-RAP ALONG TOE, (TOE OF RIP-RAP IN AT LEAST 2 FT BELOW THE STREAMBED LEVEL)

STEP 2. INSTALL ROCK RIP-RAP UP TO 10 FT ABOVE CHANNEL BOTTOM (OR UNTIL BREAK LINE OF TOP OF BANK) AND TO A DEPTH OF 1 FOOT AS REQUIRED BY WisDOT REQUIREMENTS FOR LIGHT RIP RAP

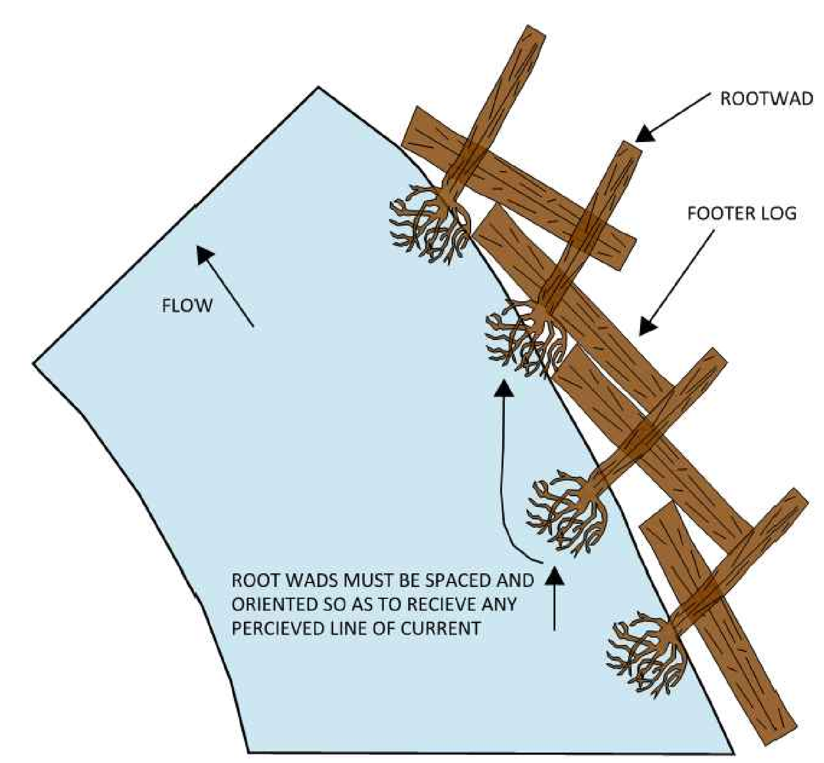
APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 2 ROLLS OF SILT FENCE (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 1 ROLL/100FT
- 3 ROOTWADS (EA) - ASSUME 30 FT OF REMEDIATION BY ROOTWAD REQUIRED X 1 BANK X 1 ROOTWAD / 10 FT
- 3 FOOTER LOG (EA) - ASSUME 1 FOOTER LOG / ROOTWAD
- 28 (CY) OF LIGHT RIP-RAP - ASSUME 15 CF / 1 LF * 50 LF OF REMEDIATION BY RIP RAP * 1 BANK * 1 CY / 27 CF
- 92 (SY) OF GEOTEXTILE FABRIC TYPE R - ASSUME 16.5 SF / 1 LF X 50 LF OF REMEDIATION BY RIP RAP X 1 BANK X 1 SY / 9 SF

* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

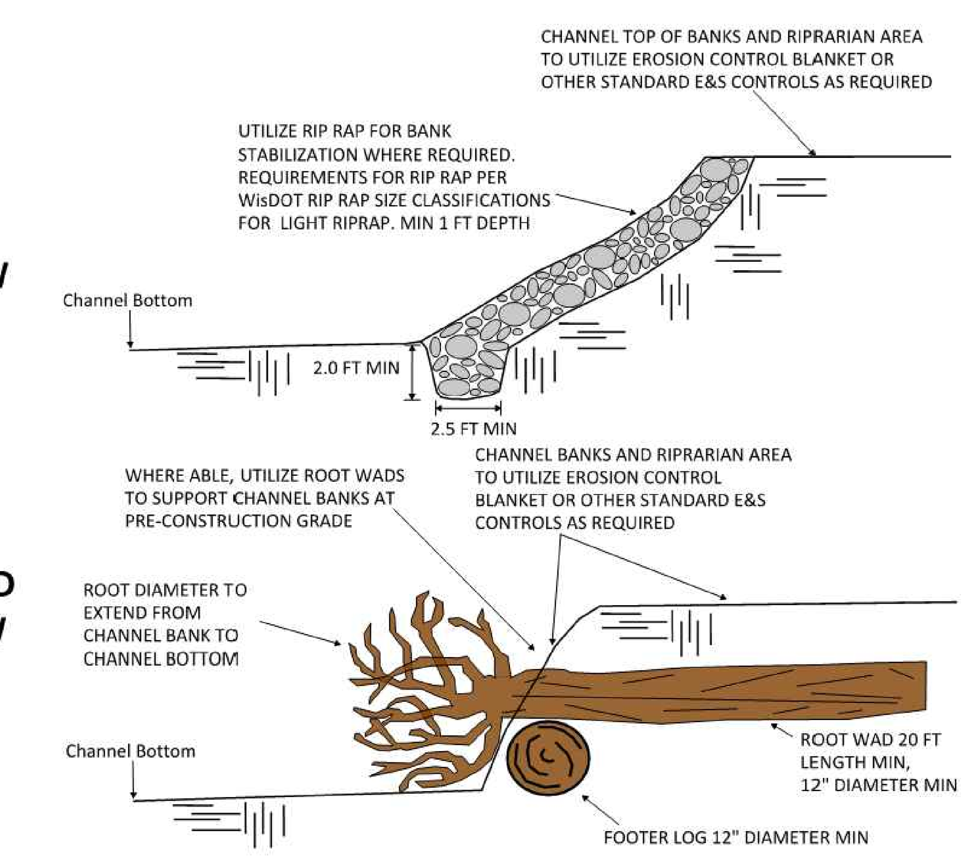
TYPICAL PLAN AND SIDE VIEW OF ROOTWADS AND RIP RAP

ROOTWAD PLAN VIEW



RIP RAP SIDE VIEW

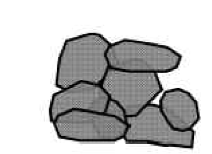
ROOTWAD SIDE VIEW

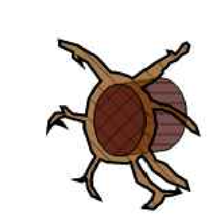


DOWNSTREAM RIGHT, EXISTING CHANNEL (NORTH BANK FOREGROUND, SOUTH BANK BACKGROUND)

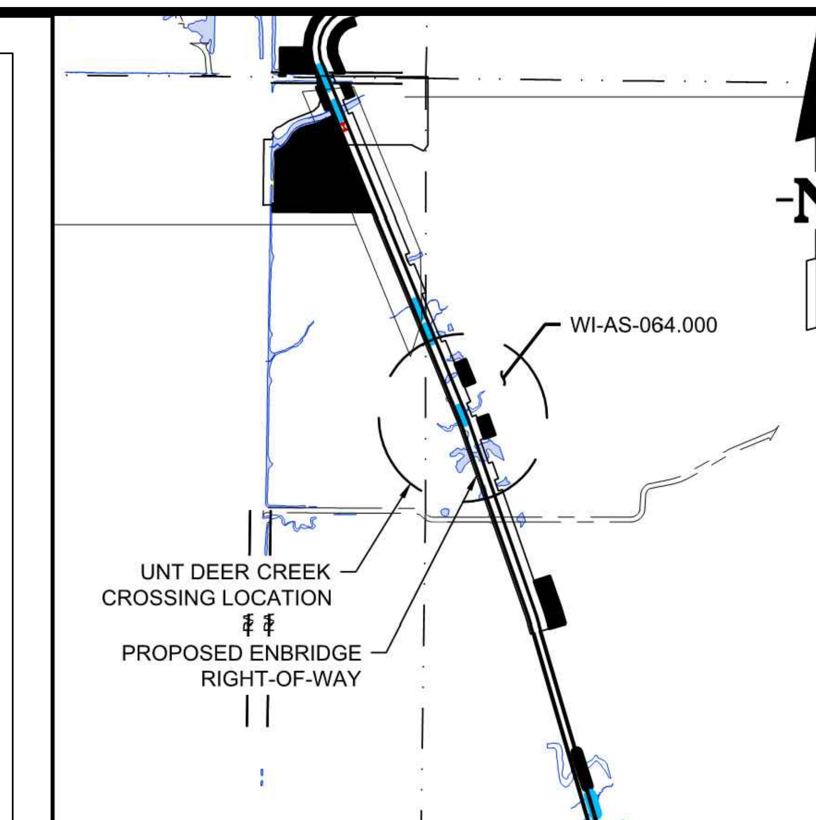
DOWNSTREAM RIGHT, PROPOSED CONCEPT (NORTH BANK FOREGROUND, SOUTH BANK BACKGROUND)

LEGEND


RIP RAP


ROOTWAD

BANKS TO BE STABILIZED WITH ROOTWADS



LOCATION PLAN

TYPE: INTERMITTENT STREAM
TROUT WATER: NO
OUTSTANDING /EXCEPTIONAL WATER: NO
IMPAIRED WATER: NO
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 5 FT WIDE. SOUTH BANK SHOWS SIGNS OF EROSION AND ARE <1H:1V IN PLACES. CHANNEL BED IS MOSTLY FINES W/ SOME PEBBLES.

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

THIS DRAWING IS TO AID IN THE REMEDIATION OF THE CHANNEL BANKS. REMEDIATION OF THE CHANNEL TO CONFORM TO THE METHODS DICTATED IN THIS DRAWING, REQUIREMENTS OF THE EPP, AND AGENCY REQUIREMENTS. EXTENTS OF REMEDIATION, QUANTITIES, AND DIMENSIONS DEPENDENT ON THE EXTENT OF REMEDIATION REQUIRED

REV: 0.A	PROJECT TITLE: L5WSRP		SEQ #:
AFE: 20009293		PROJ NO: 2000105	
WP NO:			
REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE

THIS DRAWING REPRESENTS THE INITIAL ENGINEERING DESIGN AND SHALL BE USED ONLY FOR THE PURPOSE OF PREPARING A BID. THIS DRAWING DOES NOT PRESENT THE FINAL ENGINEERING DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION.

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 5.928 (STA 312+98)
LINE 5 CROSSING (ID SASC039I)
UNT DEER CREEK IN S15, T45N, R3W
WATERBODY REMEDIATION PLAN

BY: FJS	CHK: JMO	ENG.: NIN	ENB APPR: M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN
DWG NO.: SASC039I-WXR			REV NO: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

EAST BANK (RIGHT DOWNSTREAM BANK)

STEP 1. RE-CONTOUR TOE OF SLOPE.

STEP 2. SET BIOLOG TO STABILIZE TOP OF BANK AT PRE-CONSTRUCTION CONDITIONS.

STEP 3. GRADE BACK AT PRE-CONSTRUCTION CONDITIONS UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

STEP 4. WHERE PRE-CONSTRUCTION CONDITIONS AT BANK CAN NOT BE MAINTAINED, GRADE BACK AT 3 H :1 V TO PRE- CONSTRUCTION CONDITIONS UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

WEST BANK (LEFT DOWNSTREAM BANK)

STEP 1. RE-CONTOUR TOE OF SLOPE.

STEP 2. SET BIOLOG TO STABILIZE TOP OF BANK AT PRE-CONSTRUCTION CONDITIONS.

STEP 3. GRADE BACK AT PRE-CONSTRUCTION CONDITIONS UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

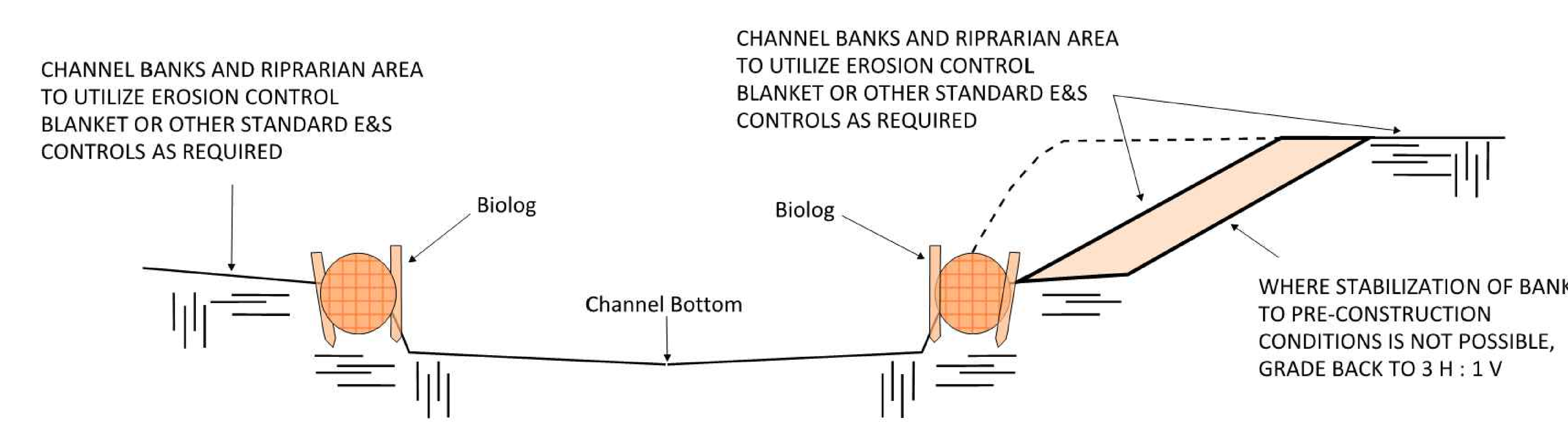
STEP 4. WHERE PRE-CONSTRUCTION CONDITIONS AT BANK CAN NOT BE MAINTAINED, GRADE BACK AT 3 H :1 V TO PRE- CONSTRUCTION CONDITIONS UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

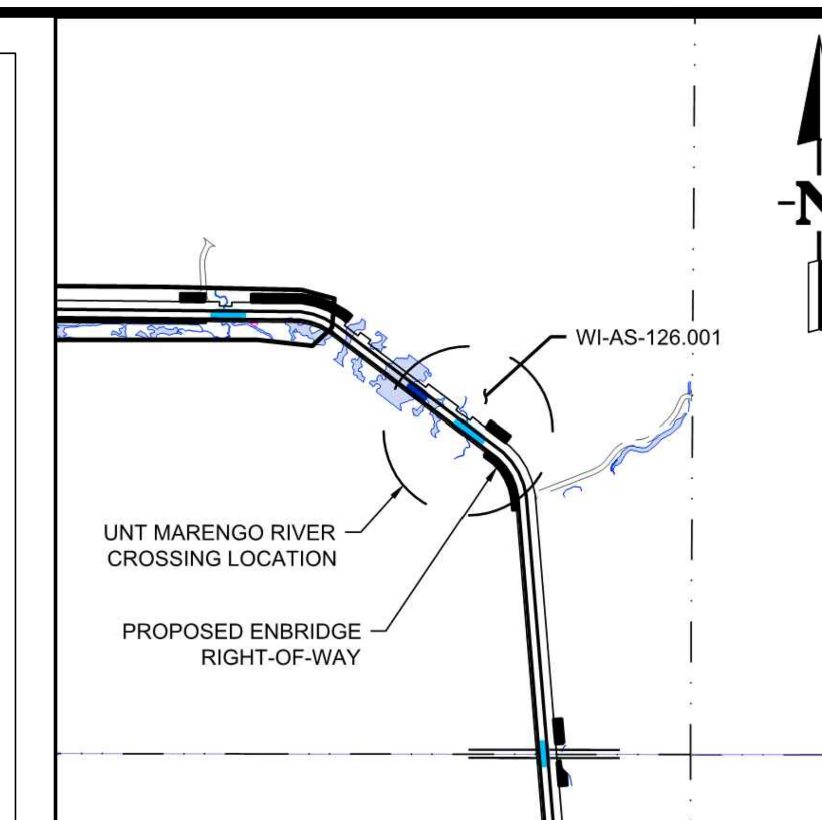
APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 2 ROLLS OF SILT FENCE (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 1 ROLL/100FT
- 8 ROLLS OF BIOLOG (EA) - ASSUME 100 FT WORKSPACE X 2 BANKS X 1 ROLL / 25 FT BIOLOG

* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

SIDE VIEW OF BIOLOG AND RE-GRADING





LOCATION PLAN

TYPE: INTERMITTENT STREAM
TROUT WATER: *
OUTSTANDING /EXCEPTIONAL WATER: *
IMPAIRED WATER: *
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 6 FT WIDE. BANKS ARE MOSTLY SHALLOW SLOPES WITH OCCASIANAL STEEPER SLOPES. CHANNEL BED IS MOSTLY FINES WITH SMALLER PEBBLES.
* NO DESCRIPTION FROM DNR SWDV

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

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REV:	PROJECT TITLE:		SEQ #:
0.A	L5WSRP		
AFE: 20009293		PROJ NO: 2000105	
WP NO:			
REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE

THIS DRAWING REPRESENTS THE INITIAL ENGINEERING DESIGN AND SHALL BE USED ONLY FOR THE PURPOSE OF PREPARING A BID. THIS DRAWING DOES NOT PRESENT THE FINAL ENGINEERING DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION.

FACING UPSTREAM, EXISTING CHANNEL (EAST BANK LEFT, WEST BANK RIGHT)

FACING UPSTREAM, PROPOSED CONCEPT (EAST BANK LEFT, WEST BANK RIGHT)

LEGEND

BANKS TO BE RE-GRADED AS NEEDED

BIOLOG

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 12.753 (STA 673+36)
LINE 5 CROSSING (ID SASE1015I)
UNT MARENGO RIVER IN S15, T45N, R3W
WATERBODY REMEDIATION PLAN

BY:FJS	CHK:JMO	ENG. :NIN	ENB APPR:M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN

DWG NO.: SASE1015I-WXR
REV NO: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

NORTHWEST BANK (LEFT DOWNSTREAM BANK)

STEP 1. RE-CONTOUR TOE OF SLOPE AND GRADE BANK SLOPE TO 3 H : 1 V. FIRST SOIL WRAP SHOULD BE SET 1/2 FOOT BELOW TOE.

STEP 2. INSTALL FIRST SUBSOIL LIFT WRAPPED WITH COIR MATTING (LAY COIR MATTING UNDER, BACKFILL BANK MATERIAL, INSTALL SEED MIX PER EPP, AND WRAP FRONT EDGE OF COIR MATTING AROUND AND OVER TOP). WRAP LAYER HEIGHTS SHOULD BE NO MORE THAN 1 FOOT HIGH AND GRADE BACK AT A 3 H : 1 V ANGLE TRANSITIONING TO ADJACENT NATURAL BANK SLOPES.

STEP 3. INSTALL A LAYER OF WILLOW BRUSH BETWEEN SOIL LIFTS AND BEGIN THE NEXT SOIL WRAP WITH COIR MATTING. REPEAT STEPS UNTIL DESIRED BANK HEIGHT HAS BEEN REACHED. ENSURE THE TOP LAYER WITHIN THE SOIL WRAP CONTAINS SALVAGED TOPSOIL. CROWN THE TRENCH SLIGHTLY HIGHER TO ALLEVIATE SUBSIDENCE ISSUES.

STEP 4. ON THE TOP OF THE BANK, INSTALL RIPRARIAN SEED MIX PER EPP, COIR MATTING, AND WILLOW STAKES TO HOLD COIR MATTING IN PLACE. INSTALL WILLOW STAKES THROUGH THE FINAL SOIL WRAP AND APPROXIMATELY 10 FT BEYOND BANK EDGE AT APPROXIMATELY 1 PER 8 SF (STAGGARD FORMATION). STAKES SHOULD BE INSTALLED WITH 1/4 OF THE STAKES EXPOSED (3/4 IN THE GROUND), ANGLED TOWARD THE WATERCOURSE.

STEP 5. IF BANKS WERE GRADED FOR THE VEHICLE AND EQUIPMENT ACCESS CROSSING, CROWN BANK AREA AND STABILIZE SOLID WITH COIR MATTING, WILLOW STAKES, AND RIPRARIAN SEEDING PER EPP.

SOUTHEAST BANK (RIGHT DOWNSTREAM BANK)

STEP 1. RE-CONTOUR TOE OF SLOPE AND GRADE BANK SLOPE TO 3 H : 1 V. FIRST SOIL WRAP SHOULD BE SET 1/2 FOOT BELOW TOE.

STEP 2. INSTALL FIRST SUBSOIL LIFT WRAPPED WITH COIR MATTING (LAY COIR MATTING UNDER, BACKFILL BANK MATERIAL, INSTALL SEED MIX PER EPP, AND WRAP FRONT EDGE OF COIR MATTING AROUND AND OVER TOP). WRAP LAYER HEIGHTS SHOULD BE NO MORE THAN 1 FOOT HIGH AND GRADE BACK AT A 3 H : 1 V ANGLE TRANSITIONING TO ADJACENT NATURAL BANK SLOPES.

STEP 3. INSTALL A LAYER OF WILLOW BRUSH BETWEEN SOIL LIFTS AND BEGIN THE NEXT SOIL WRAP WITH COIR MATTING. REPEAT STEPS UNTIL DESIRED BANK HEIGHT HAS BEEN REACHED. ENSURE THE TOP LAYER WITHIN THE SOIL WRAP CONTAINS SALVAGED TOPSOIL. CROWN THE TRENCH SLIGHTLY HIGHER TO ALLEVIATE SUBSIDENCE ISSUES.

STEP 4. ON THE TOP OF THE BANK, INSTALL RIPRARIAN SEED MIX PER EPP, COIR MATTING, AND WILLOW STAKES TO HOLD COIR MATTING IN PLACE. INSTALL WILLOW STAKES THROUGH THE FINAL SOIL WRAP AND APPROXIMATELY 10 FT BEYOND BANK EDGE AT APPROXIMATELY 1 PER 8 SF (STAGGARD FORMATION). STAKES SHOULD BE INSTALLED WITH 1/4 OF THE STAKES EXPOSED (3/4 IN THE GROUND), ANGLED TOWARD THE WATERCOURSE.

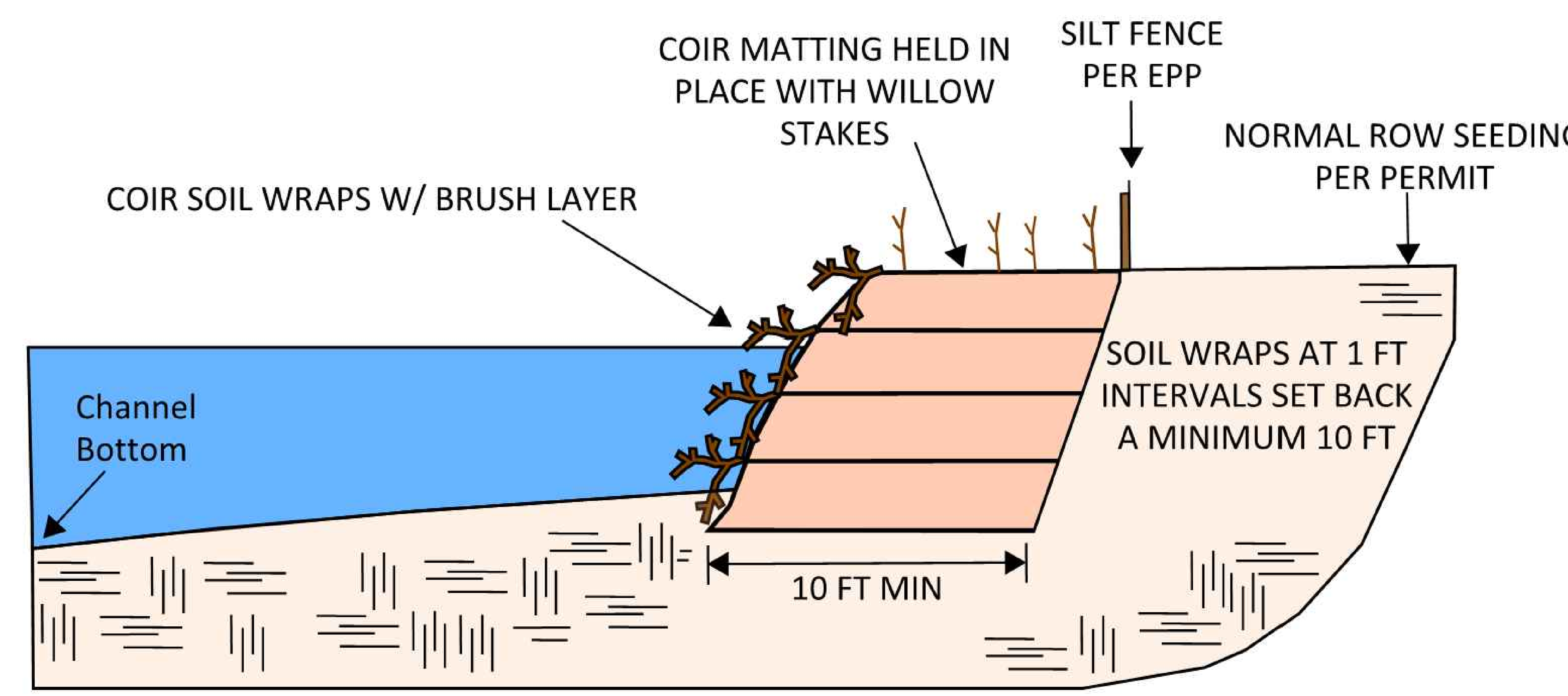
STEP 5. IF BANKS WERE GRADED FOR THE VEHICLE AND EQUIPMENT ACCESS CROSSING, CROWN BANK AREA AND STABILIZE SOLID WITH COIR MATTING, WILLOW STAKES, AND RIPRARIAN SEEDING PER EPP.

APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 250 WILLOW STAKES (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 10 FT WILLOW SETBACK WIDTH * 1 EA/8 SF WILLOW STAKE SPACING. CUT TO APPROXIMATELY 2-3 FEET LONG, BRANCHES REMOVED, AND COLLECT ALL BRUSH FROM FROM WILLOW STAKE TRIMMINGS (CUT BRANCHES)
- 1400 BRANCHES (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 7 BRANCH / LINEAL FOOT
- 19 ROLLS COIR MATTING (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 116 FT LENGTH OF COIR MATTING PER LINEAL FOOT OF BANK (ASSUMING 7 FT CHANNEL WITH 3 H: 1 V SLOPE) X 1 ROLL/1200 SF
- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 2 ROLLS OF SILT FENCE (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 1 ROLL/100FT

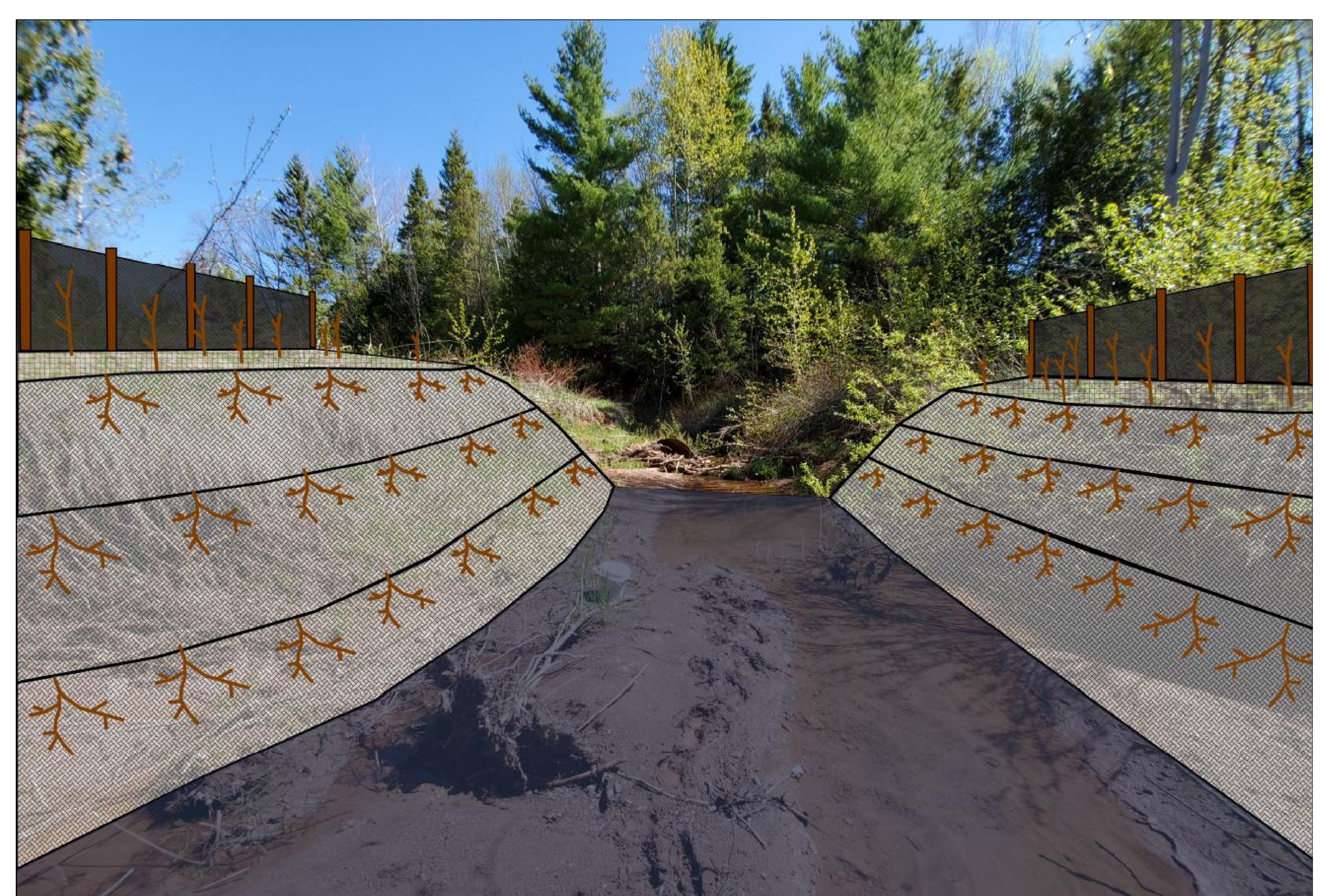
* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

TYPICAL SIDE VIEW OF SOIL WRAPS W/ BRUSH LAYER

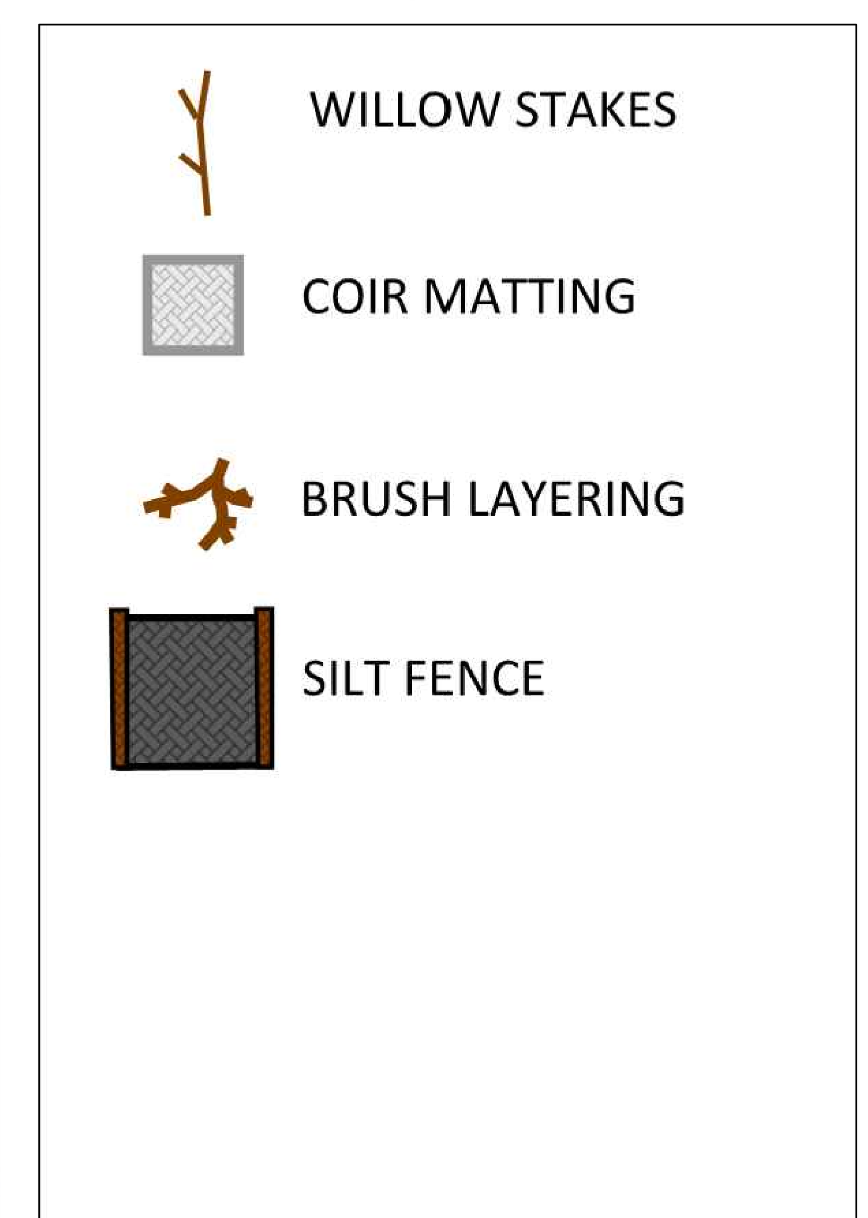


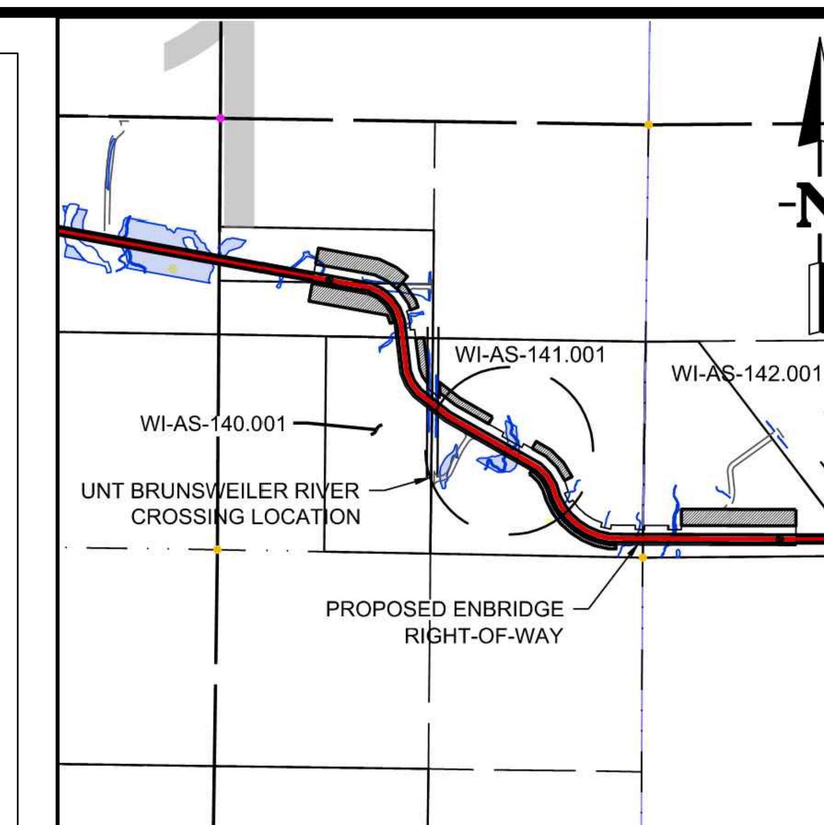
FACING DOWNSTREAM, EXISTING CHANNEL (NORTHWEST BANK LEFT, SOUTHEAST BANK RIGHT)

FACING DOWNSTREAM, PROPOSED CONCEPT (NORTHWEST BANK LEFT, SOUTHEAST BANK RIGHT)



LEGEND





LOCATION PLAN

CHANNEL DESCRIPTION

TYPE: INTERMITTENT STREAM
TROUT WATER: NO
OUTSTANDING /EXCEPTIONAL WATER: NO
IMPAIRED WATER: NO
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 15 FT WIDE. BANKS SHOW SIGNS OF EROSION AND ARE APPROX. 2H:1V SLOPES. CHANNEL BED IS MOSTLY SAND/ FINES WITH SPORADIC PEA SIZE PEBBLES.

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

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REV: 0.A	PROJECT TITLE: L5WSRP		SEQ #:
AFE: 20009293		PROJ NO: 2000105	
WP NO:			
REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE
SASC1006P-WX	WATERBODY CROSSING DRAWING UNT BRUNSWEILER RIVER

THIS DRAWING REPRESENTS THE INITIAL ENGINEERING DESIGN AND SHALL BE USED ONLY FOR THE PURPOSE OF PREPARING A BID. THIS DRAWING DOES NOT PRESENT THE FINAL ENGINEERING DESIGN AND SHALL NOT BE USED FOR CONSTRUCTION.

REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 14.726 (STA 777+54)
LINE 5 CROSSING (ID SASC1006P)
UNT BRUNSWEILER RIVER IN S1, T45N, R4W
WATERBODY REMEDIATION PLAN

BY: FJS	CHK: JMO	ENG.: NIN	ENB APPR: M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN
DWG NO.: SASC1006P-WXR			REV NO: 0.A

RESTORATION DETAILS

CREEK BED

STEP 1. SALVAGE AND RE-USE BED MATERIAL. BACKFILL AND RECONTOUR THE STREAMBED TO PRE-CONSTRUCTION PROFILE AND GRADIENT. IF GRANULAR MATERIAL WAS EXCAVATED, TOP STREAMBED TRENCH WITH CLEAN GRANULAR MIXTURE. ENSURE UPSTREAM AND DOWNSTREAM EDGES OF THE DITCH HAVE SMOOTH TRANSITION TO NATURAL STREAMBED.

EAST BANK (RIGHT DOWNSTREAM BANK)

STEP 1. RE-CONTOUR TOE OF SLOPE.

STEP 2. SET BIOLOG TO STABILIZE TOP OF BANK AT PRE-CONSTRUCTION CONDITIONS.

STEP 3. GRADE BACK AT PRE-CONSTRUCTION CONDITIONS UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

WEST BANK (LEFT DOWNSTREAM BANK)

STEP 1. RE-CONTOUR TOE OF SLOPE.

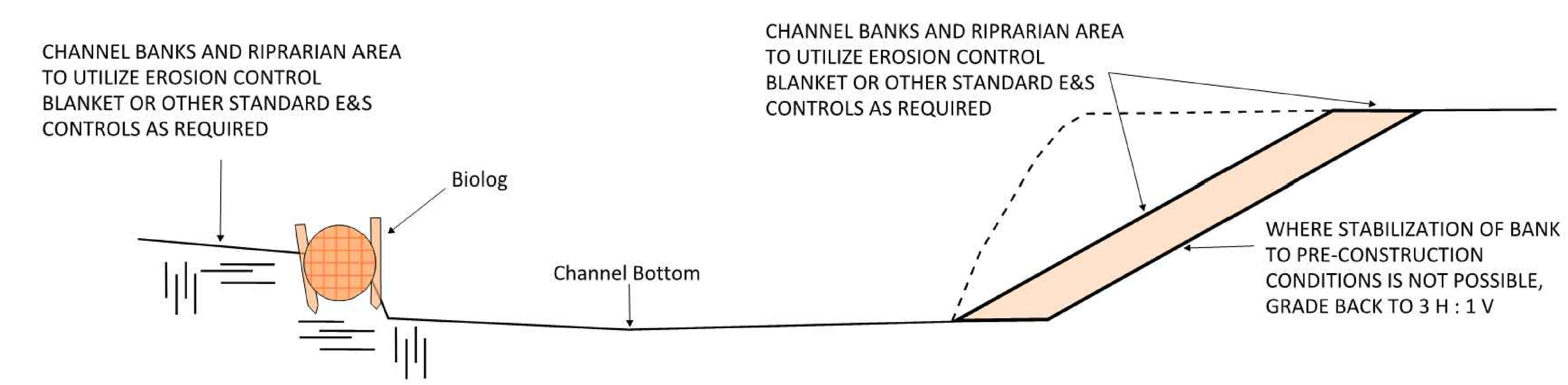
STEP 2. WHERE STABILIZATION OF BANK TO PRE-CONSTRUCTION GRADE IS NOT POSSIBLE, GRADE AT A 3 H : 1 V TO PRE-CONSTRUCTION CONDITIONS, UTILIZING STANDARD E&S CONTROLS AS REQUIRED.

APPROXIMATE QUANTITIES OF REMEDIATION MATERIALS REQUIRED*

- 1 BAG OF WATERBODY BAG SEED MIX (EA) - SEE TABLE 8-4 OF EPP
- 2 ROLLS OF SILT FENCE (EA) - ASSUME 100 FT WORKSPACE WIDTH X 2 BANKS X 1 ROLL/100FT
- 4 ROLLS OF BIOLOG (EA) - ASSUME 100 FT WORKSPACE X 1 BANKS X 1 ROLL / 25 FT BIOLOG

* NOTE THAT THE ABOVE QUANTITIES ARE BASED ON ESTIMATES ONLY FOR REMEDIATION MATERIALS BEYOND STANDARD E&S CONTROLS FOR CHANNEL REMEDIATION. PROPOSED WORKSPACE AND ESTIMATED DITCH DIMENSIONS WERE USED. ADDITIONAL MATERIALS MAY BE NEEDED OR MATERIALS MAY BE EXCESS.

TYPICAL SIDE VIEW OF BIOLOG AND RE-GRADING



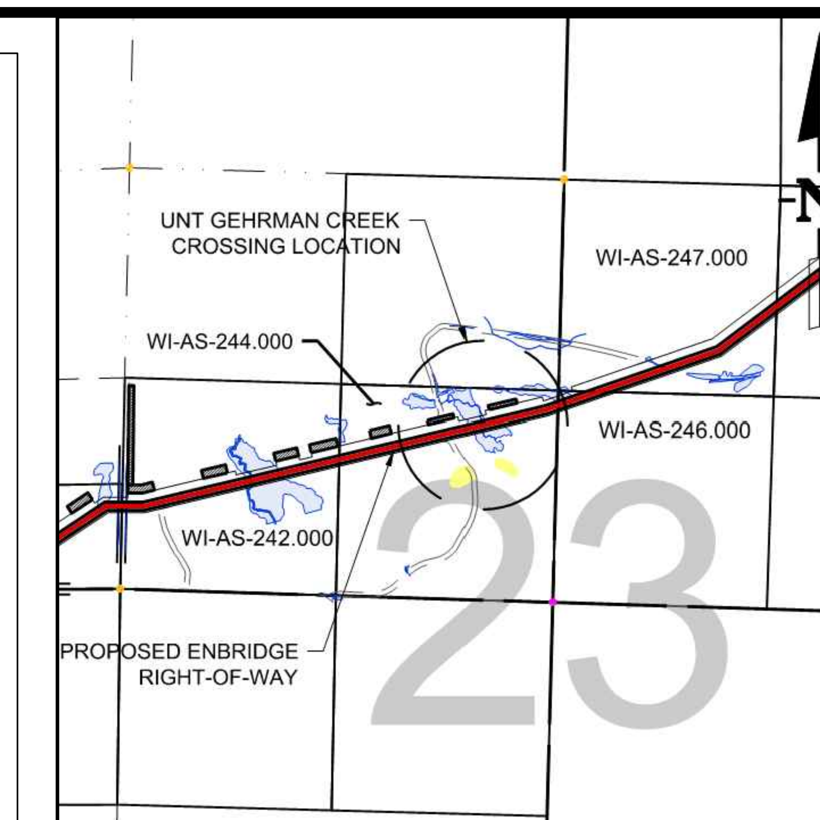
FACING UPSTREAM, EXISTING CHANNEL (EAST BANK LEFT, WEST BANK RIGHT)

FACING UPSTREAM, PROPOSED CONCEPT (EAST BANK LEFT, WEST BANK RIGHT)

LEGEND

BANKS TO BE RE-GRADED AS NEEDED

BIOLOG



LOCATION PLAN

CHANNEL DESCRIPTION

TYPE: INTERMITTENT STREAM
TROUT WATER: NO
OUTSTANDING /EXCEPTIONAL WATER: NO
IMPAIRED WATER: NO
DESCRIPTION: CHANNEL AT CROSSING IS APPROX 5 FT WIDE. WEST BANK IS STEEP AT APPROX. 1H:1V SLOPE. CHANNEL BED IS GOOD MIX OF SAND/PEBBLES/SMALLER ROCKS.

CONSTRUCTION DETAILS*

CONSTRUCTION TIMING: SUMMER
CONSTRUCTION METHODS:
PRIMARY - FLOW ISOLATION
SECONDARY - OPEN TRENCH (ONLY IF DRY OR FROZEN TO THE BOTTOM)
EQUIPMENT: CROSSING METHOD

*AS PER EPP AND CROSSING DRAWINGS

NOTES

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0.A	L5WSRP	
AFE: 20009293	PROJ NO: 2000105	
WP NO:		

REV	SUBSEQUENT REVISION	DATE BY	CHK APPR
0.A	ISSUED FOR BID	2020-08-10 FJS	JMO LSC

EPP FIGURE 19	TYPICAL DEWATERING MEASURES
EPP FIGURE 17	TYPICAL FINAL STREAM STABLIZATION
EPP FIGURES 14-16	TYPICAL WATERBODY CROSSING METHOD
EPP FIGURE 12	TYPICAL SPAN TYPE BRIDGE
SASW011-WX	WATERBODY CROSSING DRAWING UNT GEHRMAN CREEK

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REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

MP 28.669 (STA 1513+74)
LINE 5 CROSSING (ID SASW011)
UNT GEHRMAN CREEK IN S23, T45N, R2W
WATERBODY REMEDIATION PLAN

BY: FJS	CHK: JMO	ENG. : NIN	ENB APPR: M. STATTERS
DATE: 08/10/2020		SCALE: NTS	STATUS: DESIGN

DWG NO.: SASW011-WXR | REV NO: 0.A

Enbridge Line 5 Wisconsin Segment Relocation Project - Wetland Timed Meander Surveys Report

Prepared for:
ERM
222 S. 9th Street, Suite 2900
Minneapolis, MN 55402

December 2, 2022

Prepared by:
Midwest Natural Resources, Inc.
1032 West 7th Street, Suite 150
St. Paul, Minnesota 55102
www.mnrinc.us

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PROJECT BACKGROUND

In Wisconsin, the existing Line 5 pipeline owned by Enbridge Energy, Limited Partnership ("Enbridge") crosses Douglas, Bayfield, Ashland, and Iron Counties. Within Ashland County, the existing Line 5 pipeline crosses approximately 12 miles of the Bad River Reservation ("Reservation") of the Bad River Band of Lake Superior Chippewa Tribe. The Line 5 Wisconsin Segment Relocation Project ("Project") will replace approximately 20 miles of the existing Line 5 pipeline, including the approximate 12 miles of pipeline within the Reservation, with about 41.1 miles of a new, 30-inch outside diameter pipeline segment that will be located entirely outside the exterior boundaries of the Reservation (**Figure 1**).

As part of the environmental review process, wetland surveys were conducted during the 2019 and 2020 field seasons following the methodology described in the 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual[1] and Regional Supplement for the Northcentral and Northeast Region[2]. Wetland delineations involved collecting sample transects from upland to wetland and recording this information on standardized wetland determination data forms. Additionally, each collected wetland sample point was classified using the Cowardin system, a simple hierarchical national classification system. The community mapping of the wetland features was also based on the assigned Cowardin classification. A secondary classification was also assigned for each wetland sample point using the Eggers and Reed[3] classification system. The latter system is much more specific than the Cowardin system, focused on wetland plant communities of Minnesota and Wisconsin. However, the Eggers and Reed classification system is broad compared to other relevant classification systems, such as the native plant community classification system used in Wisconsin[4].

The wetland determination data forms specifically reference the area being sampled. However, this measure alone does not address the condition and functional value of that sample area or the entire feature. As such, field crews evaluated each wetland using the Wisconsin Wetland Rapid Assessment Methodology (RAM) [5], determining the functional value, floristic integrity, condition assessment of the wetland assessment area and buffer, and assessment of potential impacts. The floristic integrity assessment was focused on primary questions pertaining to invasive species cover, strata, Natural Heritage Information plant community ranking, and relative frequency of the plant community within the watershed. Excluded from this assessment was the optional documentation of vascular plant species and cover/abundance.

Vegetation surveys were conducted during the 2022 field season on a subset of wetlands within the current Project area to expand the assessment of floristic integrity. This subset of wetlands was restricted to those that ranged in quality from moderate to high based on the data collected during the initial wetland delineation field efforts (2019–2020). The 2022 vegetation surveys involved the implementation of timed-meander surveys, documenting observed species and species cover.

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1 Environmental Laboratory. (1987). "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

2 U.S. Army Corps of Engineers. 2011. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, C. V. Noble, and J. F. Berkowitz. ERDC/EL TR-12-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

3 Eggers S. D., Reed D. M., Reed D. M. 2015 Wetland Plants and Plant Communities of Minnesota and Wisconsin, Version 3.2. U.S. Army Corps of Engineers, St. Paul District.

4 Epstein, E.E. 2017. Natural communities, aquatic features, and selected habitats of Wisconsin. Chapter 7 in The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131H 2017, Madison

5 https://dnr.wisconsin.gov/topic/wetlands/methods.html#:~:text=The%20Wisconsin%20Wetland%20Rapid%20Assessment,wetland%20performs%20a%20given%20function. Accessed December 2022.

METHODS

Due to the nature of the proposed Project, meander efforts were restricted to specific project (corridor) limits. These limits are based on the anticipated project footprint for both the Project construction corridor (including the construction workspace) and the associated access roads. The evaluated survey corridor width for the proposed pipeline ranged from 130 to 320 feet, and the access road corridor width was 80 feet.

Two MNR field teams conducted surveys, and a field botanist led each team. Evaluation efforts involved timed-meander surveys but deviated from the traditional approach in two ways. Traditional timed-meander surveys evaluate entire features, in this case, wetlands. In being restricted to a corridor, survey efforts only reflect those spatial limits. The second deviation pertains to the time limits and approach, as there are a variety of ways to implement the time duration. In Wisconsin[6], species are recorded in 5-minute increments, noting which increment a species was first observed (e.g., 0-5 minutes, 5-10 minutes, etc.). It is suggested that surveys occur for a minimum of 30 minutes. This process can continue beyond 30 minutes under different scenarios, but the process is also flexible and allows the practitioner to stop before reaching a full 30 minutes. The approach implemented for this Project was to evaluate the entire defined assessment area and record every vascular plant species encountered. Another deviation specific to the Wisconsin method was that species abundance codes were not collected for this survey since they are non-numerical and cannot be used for analysis purposes.

Independent timed-meander surveys were conducted for those wetland features with multiple Eggers and Reed community types, each serving as a separate assessment area. In several cases, a community component of specific wetlands was reclassified and merged with the primary Eggers and Reed community. This was generally related to past forest management, where a portion of the forested community was now open, but the original delineations classified those as separate communities. It is anticipated that these areas will revert to having canopy cover and are considered one community.

The vegetative cover was recorded using areal cover and categorizing that cover using a modified Braun-Blanquet Scale as presented in Table 1. A point of clarification regarding the Braun-Blanquet Scale is the subject of a single occurrence of a species. There are instances, particularly with tree species, where the areal cover of that individual exceeds 5% cover and thus would be recorded as having a midpoint cover of 15%. This situation is rare, with most single individuals recorded as having less than 5% areal cover and a midpoint value of 1.

Table 1. Modified Braun-Blanquet Scale

Cover Class	Midpoint Cover
< 5% single individual	1
< 5% having two or more individual	2.5
5-25%	15
25-50%	37.5
50-75%	62.5
75-100%	87.5

The Wisconsin Department of Natural Resources (WDNR)[7] developed the Coefficient of Conservatism values used here, and the revised species nomenclature is based on the updates provided in the WDNR

[6] Timed-Meander Sampling Protocol for Wetland Floristic Quality Assessment, WDNR

[7] Bernthal, T. W. 2003. Development of a floristic quality assessment methodology for Wisconsin. Wisconsin Department of Natural Resources, Bureau of Integrated Science Services, Madison, Wis. PUB-SS-986 2003.

Floristic Quality Assessment (FQA) Calculator[8]. Meander surveys only represent the vegetation present or identifiable during the survey effort. As such, ephemeral species or species lacking recognizable diagnostic features were not documented during this survey.

Species encountered and associated cover values were collected electronically using field tablets. The data collected were then used to calculate two metrics, the Floristic Quality Index (FQI) and Mean C-value. Additionally, these two metrics were calculated considering native species only and then separately for all species observed, along with weighted calculation scores based on the cover.

Overall floristic quality can be determined in multiple ways, including the generalized wetland condition scale provided in the RAM approach or the regional and community-specific wetland condition scale provided in the Wisconsin FQA Calculator[9].

The more general RAM approach provides a single scale of four condition categories (low, medium, high, and exceptional) for the unweighted FQI and unweighted Mean C-value metrics (**Table 2**). The scale is general in that scores associated with the condition categories are uniform for the entire state, and plant communities are not considered.

Table 2. Wisconsin Wetland Rapid Assessment Methodology Floristic Integrity Scale

Metric	Low	Medium	High	Exceptional
FQI	<13	13-23	23-32	32
Mean C ($\overline{C}$)	<2.4	2.4-4.2	4.3-4.7	>4.7

This second wetland condition scale is based on five categories (Very Poor, Poor, Fair, Good, and Excellent). These condition category benchmarks pertain only to the Mean C-value, both non-weighted ($\overline{C}$) and weighted (w$\overline{C}$). Additionally, this scale is specific to a subset of native plant communities and is separated into four geographical regions[10]. The condition benchmarks presented in **Table 3** are for the weighted Mean C-values specific to the Northern Lakes and Forests Ecoregion (NLFE), with the Project occurring entirely within this ecoregion.

Table 3. Weighted Mean C (w$\overline{C}$) Condition Benchmarks for Northern Lakes and Forests Ecoregion

System	Natural Community	Condition Category				
		Least Disturbed			Most Disturbed	
		Excellent	Good	Fair	Poor	Very Poor
Emergent	Emergent Marsh	> 7.1	5.2 - 7.1	2.8 - 5.1	0.7 - 2.7	< 0.7
	Northern Sedge Meadow	> 7.1	5.2 - 7.1	3.5 - 5.1	< 3.5	
Shrub- Scrub	Shrub Carr	> 5.1			3.9 - 5.1	< 3.9
	Alder Thicket	> 5.3	4.5 - 5.3	4.2 - 4.4	3.8 - 4.1	< 3.8
	Open Bog	> 8.9	8.0 - 8.9	< 8.0		
	Muskeg	> 8.5	7.9 - 8.5	< 7.9		

8 https://dnr.wisconsin.gov/topic/wetlands/methods.html; Accessed December 2022.

9 https://dnr.wisconsin.gov/sites/default/files/topic/Wetlands/WDNR_FQA_CALCULATOR.xlsx; Accessed December 2022.

10 **Region 1**: Northern Lakes and Forest; **Region 2**: North Central Hardwood Forest/Western Corn Belt Plains; **Region 3**: Southeast WI Till Plains/Central Corn Belt Plains; and **Region 4**: Driftless Area.

Forested	Black Spruce/ Tamarack Swamp	> 7.9	7.4 - 7.9	6.8 - 7.3	5.7 - 6.7	< 5.7
	Cedar Swamp (NWMF)	> 7.4	6.9 - 7.4	< 6.9		
	Northern Hardwood Swamp	> 6.2	5.7 - 6.2	4.0 - 5.6	2.5 - 3.9	< 2.5

Source: Hlina, P., NP Danz, K. Beaster, D. Anderson S. Hagedorn. 2015. Northern Lakes and Forests Inland Wetland Surveys: Relationship between Floristic Quality Assessment and Anthropogenic Stressors. Technical Report 2015-2. Lake Superior Research Institute, University of Wisconsin-Superior, Superior, WI.

A crosswalk for the communities evaluated is provided in **Table 4**. This list of communities is specific to wetland features encountered during field efforts and subsequently classified using the Eggers and Reed classification system. This list of nine Eggers and Reed communities is cross-referenced with the equivalent community as classified by the state of Wisconsin[11] (Wisconsin Natural Communities) and for the NLFE.

As stated previously, the Eggers and Reed system is a broad classification system. In contrast, other systems, such as the Wisconsin Natural Communities classification system or Minnesota Native Plant Community classification system,[12] are more defined. For example, the Project area includes two black ash-dominated wet forest communities, the Northern Hardwood Swamp and Forested Seep, as classified using the Wisconsin Natural Communities system. However, these two communities are treated as a single community in the other two classification systems. Additionally, specific Eggers and Reed communities are either excluded or do not perfectly align with the NLFE communities. Those communities classified as Fresh (Wet) Meadow, Floodplain Forest, and Hardwood Swamp -Vernal Pool subtype (Vernal Pool) lack an equivalent community type in the list of NLFE communities.

Another separate wet forest community within the Project area is a mixed conifer and hardwood community of balsam fir (*Abies balsamea*), yellow birch (*Betula alleghaniensis*), black ash (*Fraxinus nigra*), northern white cedar (*Thuja occidentalis*), and hemlock (*Tsuga canadensis*). Northern white cedar or hemlock are important canopy species, but hardwood species, mainly black ash, are an important component of these features. This particular community is what NatureServe Explorer identifies as a *Tsuga canadensis - Betula alleghaniensis* Swamp Forest (CEGL005003)[13, 14]. The community falls under the concept of a Northern Wet-mesic Forest in the NatureServe Explorer crosswalk with the native plant communities of Wisconsin. It is important to note that the conceptual Northern Wet-mesic Forest[15], as described, is a northern white cedar-dominated community on peat soils. The community, as expressed here, would be considered a subtype of that community. Furthermore, this community would be correlated with the NLFE Cedar Swamp community, although these two "communities" are different in terms of species composition and richness.

Table 4. Community Crosswalk

Eggers and Reed[i]	Wisconsin Natural Communities	Northern Lakes and Forests Ecoregion
Alder Thicket	Alder Thicket	Alder Thicket
Coniferous Bog	Black Spruce Swamp	Muskeg
Coniferous Swamp	Northern Wet-mesic Forest	Cedar Swamp

11 Epstein, E.E. 2017. Natural communities, aquatic features, and selected habitats of Wisconsin. Chapter 7 in The ecological landscapes of Wisconsin: An assessment of ecological resources and a guide to planning sustainable management. Wisconsin Department of Natural Resources, PUB-SS-1131H 2017, Madison

12 https://www.dnr.state.mn.us/npc/classification.html; Accessed December 2022.

13 https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.690084/Tsuga_canadensis_-_Betula_alleghaniensis_Swamp_Forest;Nov. 2022

14 https://www1.usgs.gov/csas/nvcs/unitDetails/690084; Accessed December 2022.

15 https://dnr.wi.gov/topic/EndangeredResources/Communities.asp?mode=detail&Code=CPFOR036WI; Accessed December 2022.

Floodplain Forest	Floodplain Forest	NA
Fresh (Wet) Meadow	Fresh Wet Meadow	NA
Hardwood Swamp	• Northern Hardwood Swamp • Forested Seep	Northern Hardwood Swamp
Shrub-Carr	Shrub-Carr	Shrub-Carr
Open Bog	Open Bog	Open Bog
Hardwood Swamp (Vernal Pool Subtype)	Vernal Pool	NA

[i] **List only includes Eggers and Reed Communities evaluated here.**

RESULTS

Field surveys were conducted between August 22 – September 2, 2022. This involved the evaluation of 73 wetland features, with nine of these features having multiple community types. A complete list of all evaluated wetland features is provided in **Appendix A**. The accompanying map set showing meander routes is included under the **Maps** sections.

Nine different Eggers and Reed wetland community types were encountered during the timed meander survey efforts. The Forested Seep[16] community, as defined, is treated here as the tenth community. The Hardwood Swamp community was the most prevalent community surveyed, accounting for over half the features evaluated. The other encountered communities were relatively infrequent.

As previously mentioned, the RAM approach is more generalized, looking at unweighted FQI and Mean C metrics, with no consideration given to plant community or location. This is counter to the regional and community-specific wetland condition scale provided in the Wisconsin FQA Calculator. Both evaluation tools are presented here, each provides valuable information, but neither is fully comprehensive.

A list of unweighted FQI condition ratings using the broader RAM scale is provided in **Table 5**. This is organized to show the plant community, FQI rating, and the number of features with that rating. The condition rating for each feature is provided in **Appendix B**. Most independent community features were rated exceptional (54), with a significant number rated as high (24), and only eight features having a medium value.

Table 5. Unweighted Floristic Quality Index Score Ratings by Community

Community	FQI Rating	Number of Features
Alder Thicket	Exceptional	4
Coniferous Bog	Exceptional	1
Coniferous Swamp	Exceptional	7
Floodplain Forest	Exceptional	4
	High	2
	Medium	1
Fresh (Wet) Meadow	Exceptional	1
	High	6
	Medium	2

[16] https://dnr.wi.gov/topic/endangeredresources/communities.asp?mode=detail&Code=CPFOR025WI; Accessed December 2022.

Community	FQI Rating	Number of Features
Hardwood Swamp	Exceptional	29
	High	14
	Medium	2
Hardwood Swamp - Forested Seep	Exceptional	2
Open Bog	Exceptional	2
Shrub-Carr	Exceptional	2
	Medium	1
Vernal Pool	High	2
	Medium	2

Similarly, unweighted Mean C condition ratings by community type are provided in **Table 6.** The condition rating for each feature is provided in **Appendix B,** which also includes the unweighted FQI condition ratings. Most of the independent community features were rated exceptional (44) or high (24), with 15 features with medium value and one feature having a low value.

Table 6. Mean C Score Ratings by Community

Community	Mean C Rating	Number of Features
Alder Thicket	High	4
Coniferous Bog	Exceptional	1
Coniferous Swamp	Exceptional	7
Floodplain Forest	Exceptional	1
	High	2
	Medium	4
Fresh (Wet) Meadow	Exceptional	1
	High	3
	Medium	4
	Low	1
Hardwood Swamp	Exceptional	29
	High	11
	Medium	5
Hardwood Swamp - Forested Seep	Exceptional	2
Open Bog	Exceptional	2
Shrub-Carr	Exceptional	1
	High	1
	Medium	1
Vernal Pool	High	3
	Medium	1

The second system provides a much different assessment of quality. **Table 7** provides a range of weighted Mean C ($w\overline{C}$) and Condition Category for those Natural Communities that have been assigned a benchmark score. These individual scores are also presented in **Appendix C**.

Table 7. Community Features Evaluated

Eggers and Reed	Number of Evaluated Features	$\bar{C}$ low	$\bar{C}$ high	Condition Category Range
Alder Thicket	4	3.9	4.7	Poor to Good
Coniferous Bog	1	7.9	7.9	Good
Coniferous Swamp	7	5.2	6.6	Very Poor to Fair
Floodplain Forest	7	2.9	4.7	NA
Fresh (Wet) Meadow	9	2.9	4.8	NA
Hardwood Swamp	45	3.0	6.6	Poor to Excellent
Forested Seep	2	5.7	5.8	Good
Open Bog	2	6.9	8.2	"Very Poor - Fair"[ii] to Good
Shrub-Carr	3	3.0	5.0	Poor to Good
Vernal Pool	4	3.6	6.5	NA

[ii] Weighted Mean C scores for the Open Bog community of <7.0 are not differentiated from Fair, Poor, to Very Poor.

Overall, these Condition Categories for the NLFE provide a different picture of wetland quality for these wetland features. As indicated in **Table 7**, the two shrub communities evaluated, Alder Thicket and Shrub-Carr, ranged in quality from poor to good, where the rating was higher for those systems using the RAM scale. Only one Coniferous Bog community was evaluated, having a condition rating of good, where this community is considered excellent with the RAM scale. The other bog community, Open Bog, was encountered twice. The quality of these two features ranged from more disturbed (very poor – fair) to good, but both were ranked as exceptional using the RAM scale.

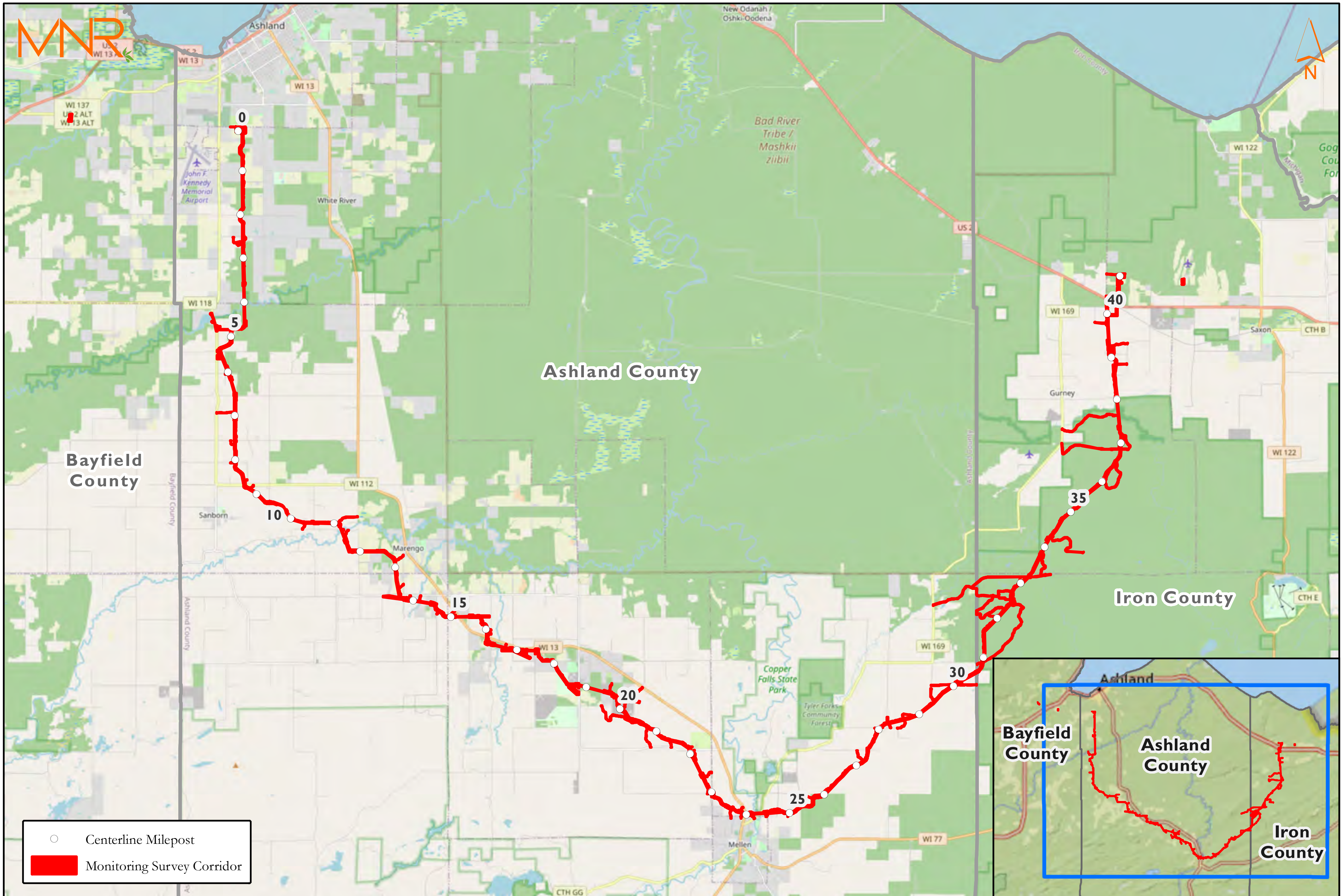
The Hardwood Swamp community had a considerable range of quality, from poor to excellent, with most evaluated features ranked fair to excellent. This is comparable to the condition values from the RAM scale. The two Forested Seep communities had a weighted Mean C score range of 5.7-5.8, putting that in the category of good, where these are considered exceptional using the RAM scale.

The Conifer Swamp communities ranged in quality from very poor to fair. However, the weighted Mean C scores ranged from 5.2 to 6.6, suggesting that these systems are of higher quality than the condition category rankings suggest. It is possible that lumping this community into the category of Cedar Swamp (NWMF) is miscategorized here, given that the observed systems are far poorer in terms of species richness and structure than the described Cedar Swamp community, but this appears to be the best match. All seven features were ranked as exceptional using the RAM scale.

Finally, the Fresh (Wet) Meadow, the Floodplain Forest, and Vernal Pools communities lacked a condition score with this regionalized system, so floristic quality determination is restricted to the RAM scale.
The full species lists for each wetland with individual species cover and Floristic Quality Metrics are provided in **Appendix D**. Associated representative wetland photos are provided in **Appendix E** and are arranged by milepost, with a brief description of each wetland feature evaluated is provided in **Appendix F**. Additionally, the resumes for the two lead botanists are included in **Appendix G**.

CONCLUSION

During recent field efforts, 73 wetland features were evaluated to determine floristic quality. This process considered various community classification systems and multiple quality scales, examining the overall floristic quality and species conservatism. Most of the features evaluated were high to exceptional under the statewide rating system, where the quality scores were lower using a regional scale.

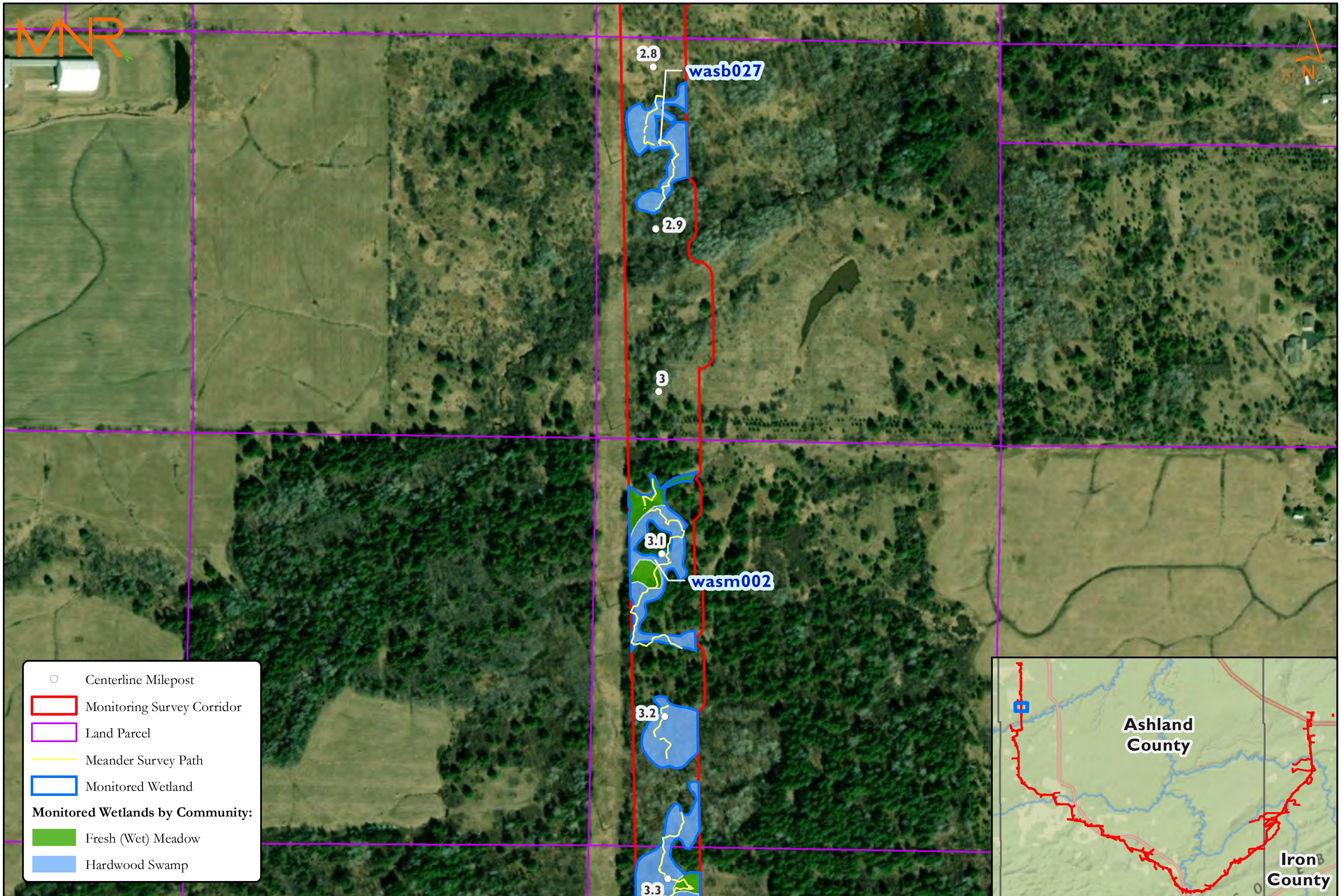


Source: Esri World Topographic Map, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 2 4 Miles

Survey Corridor Location
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Northern Wisconsin

Map 1

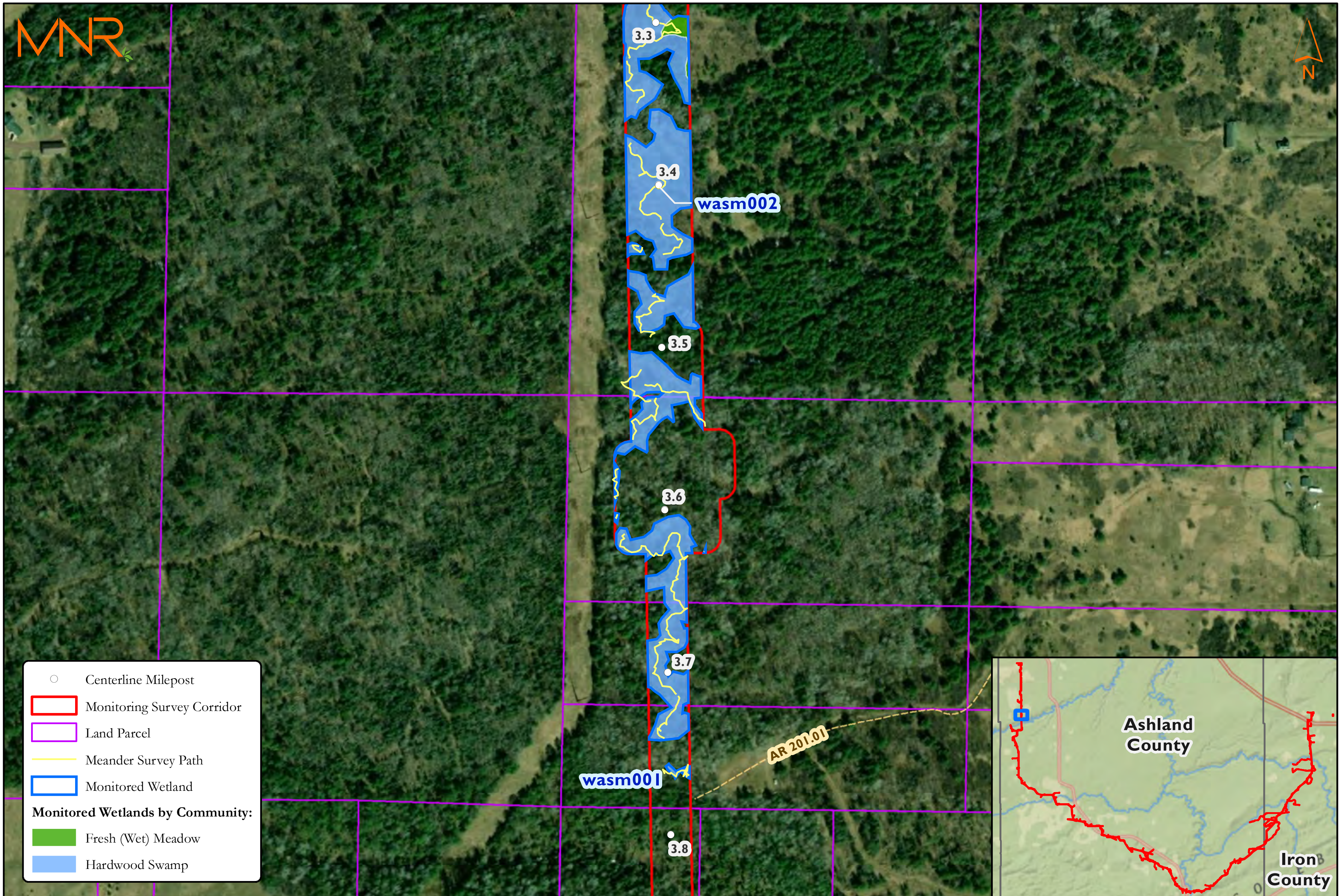


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 2



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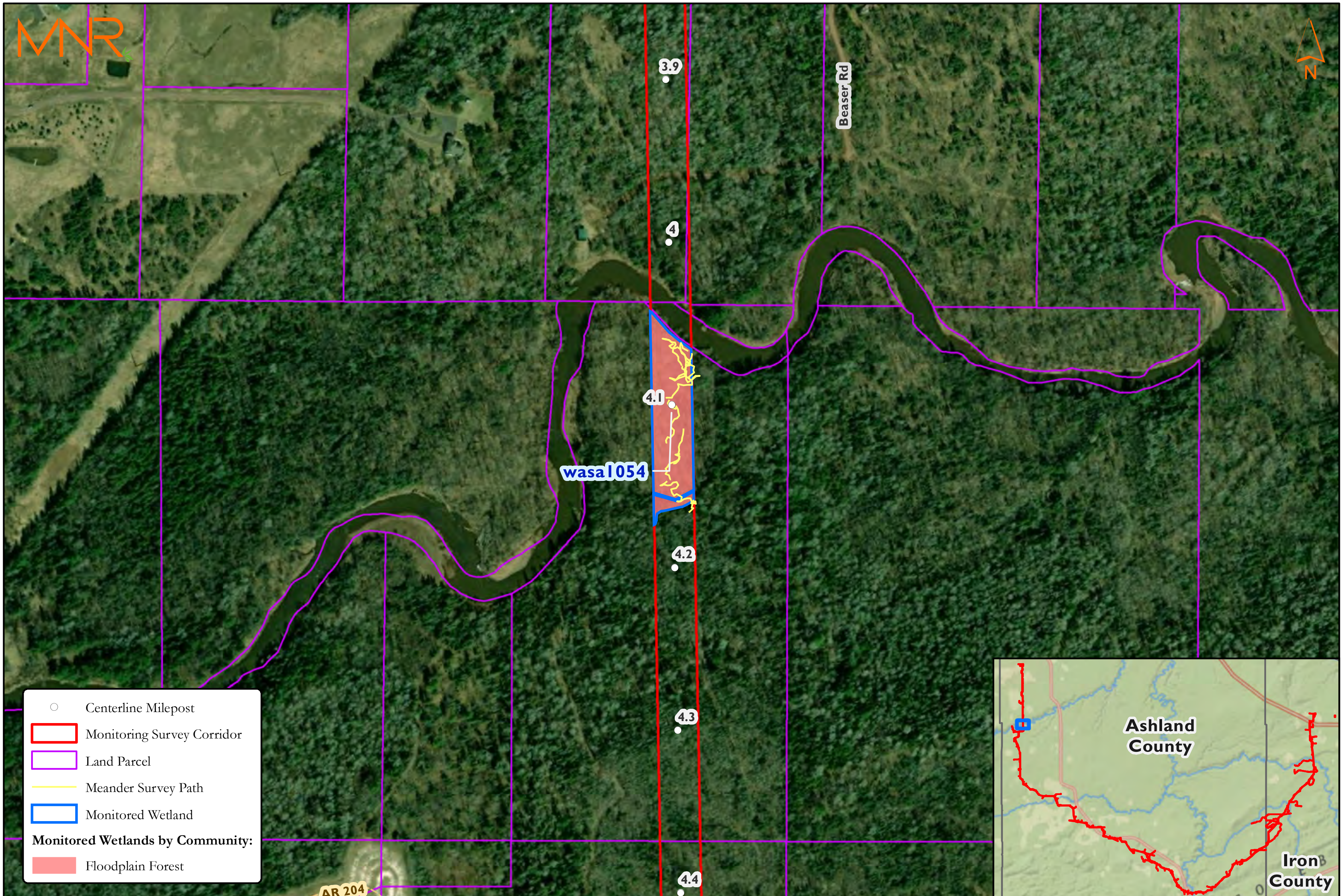
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 3



Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

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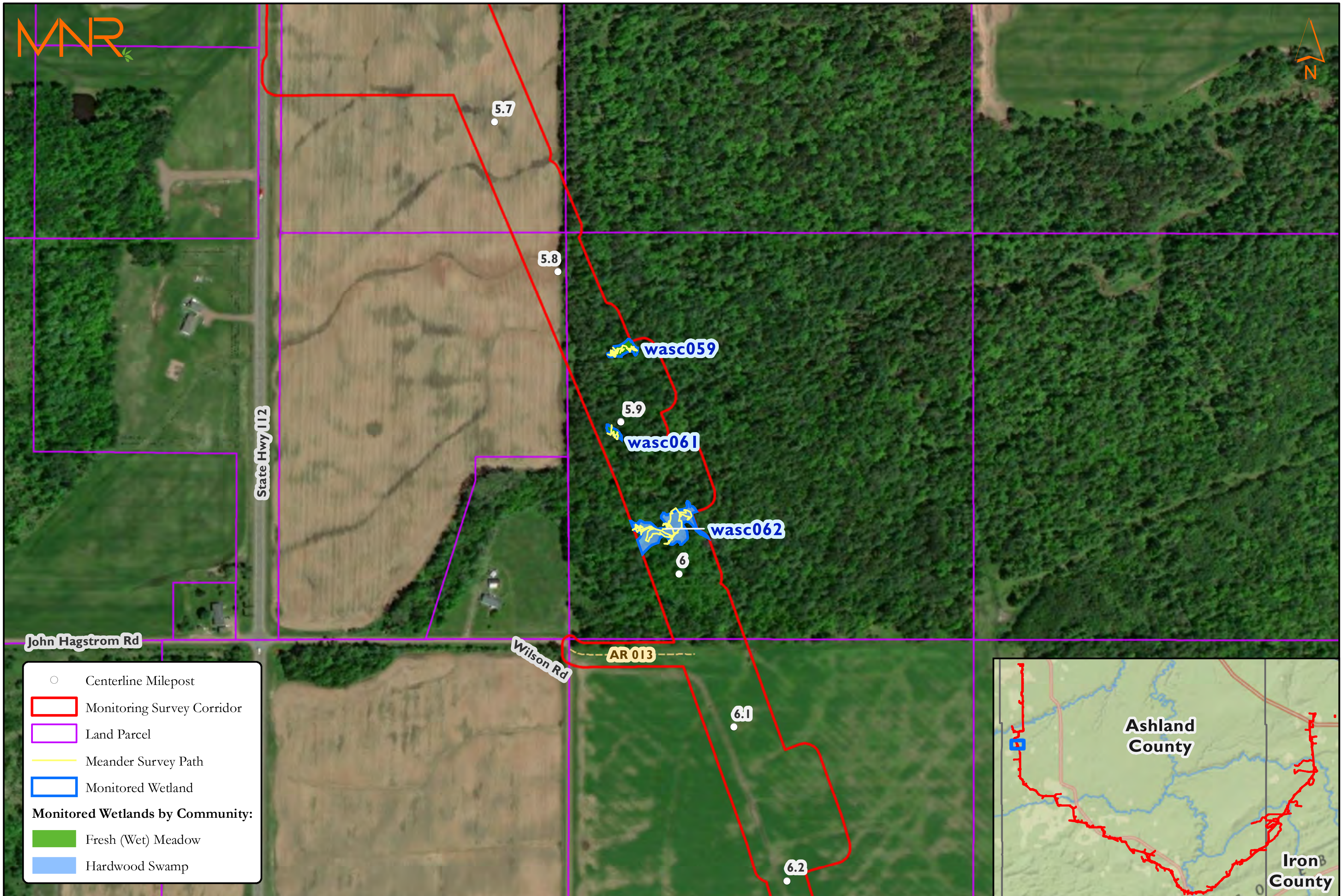
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 4



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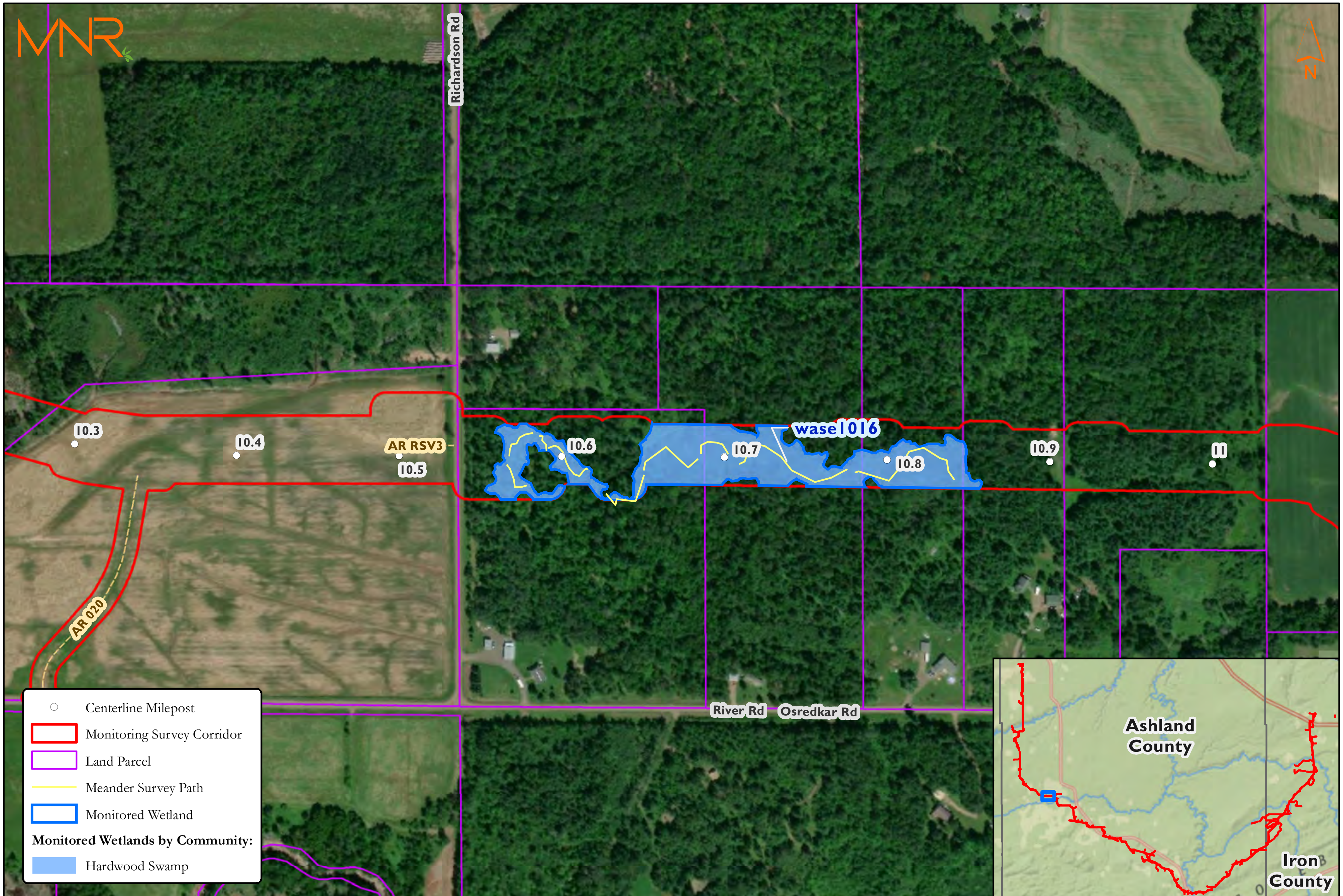
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 5



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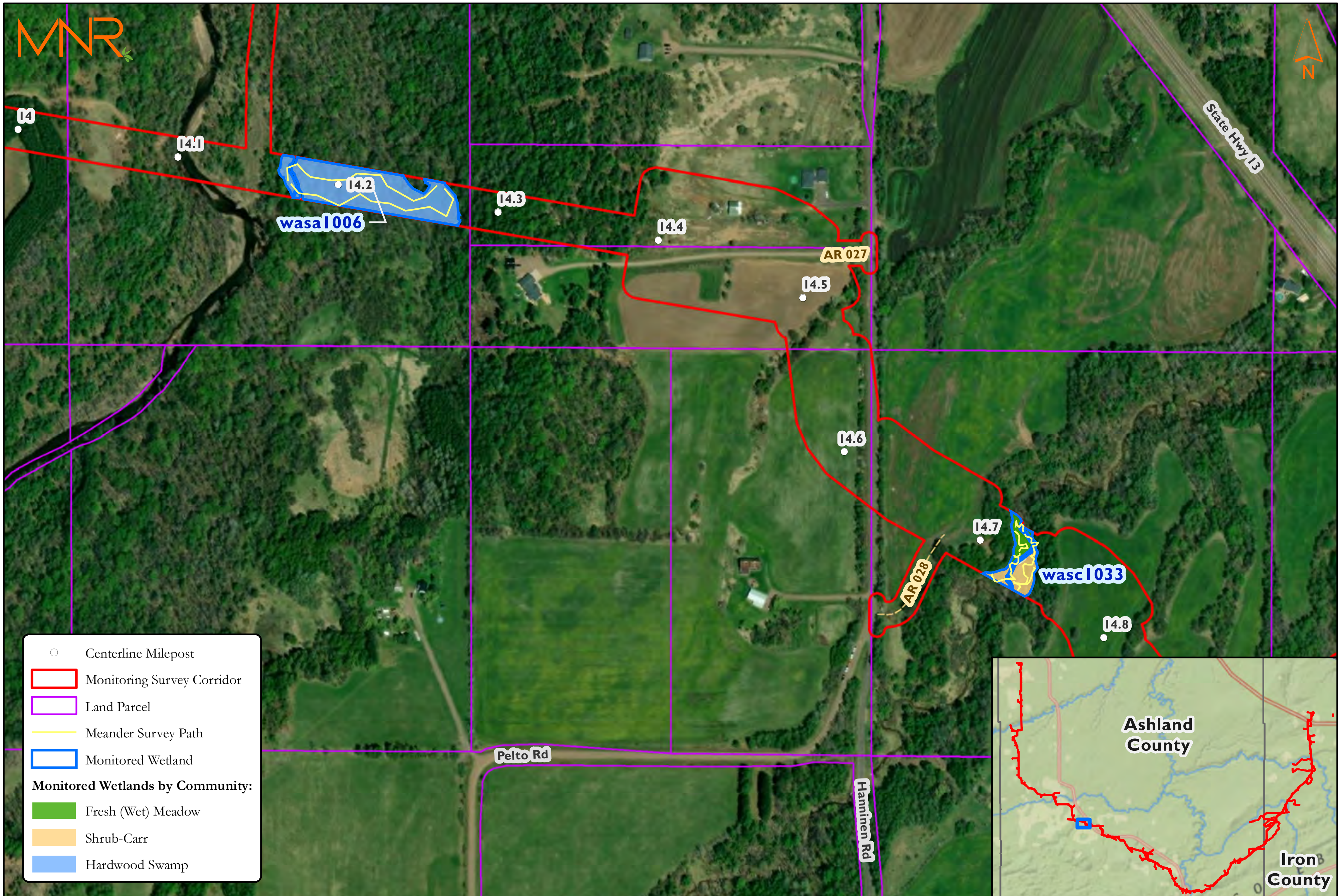
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 6



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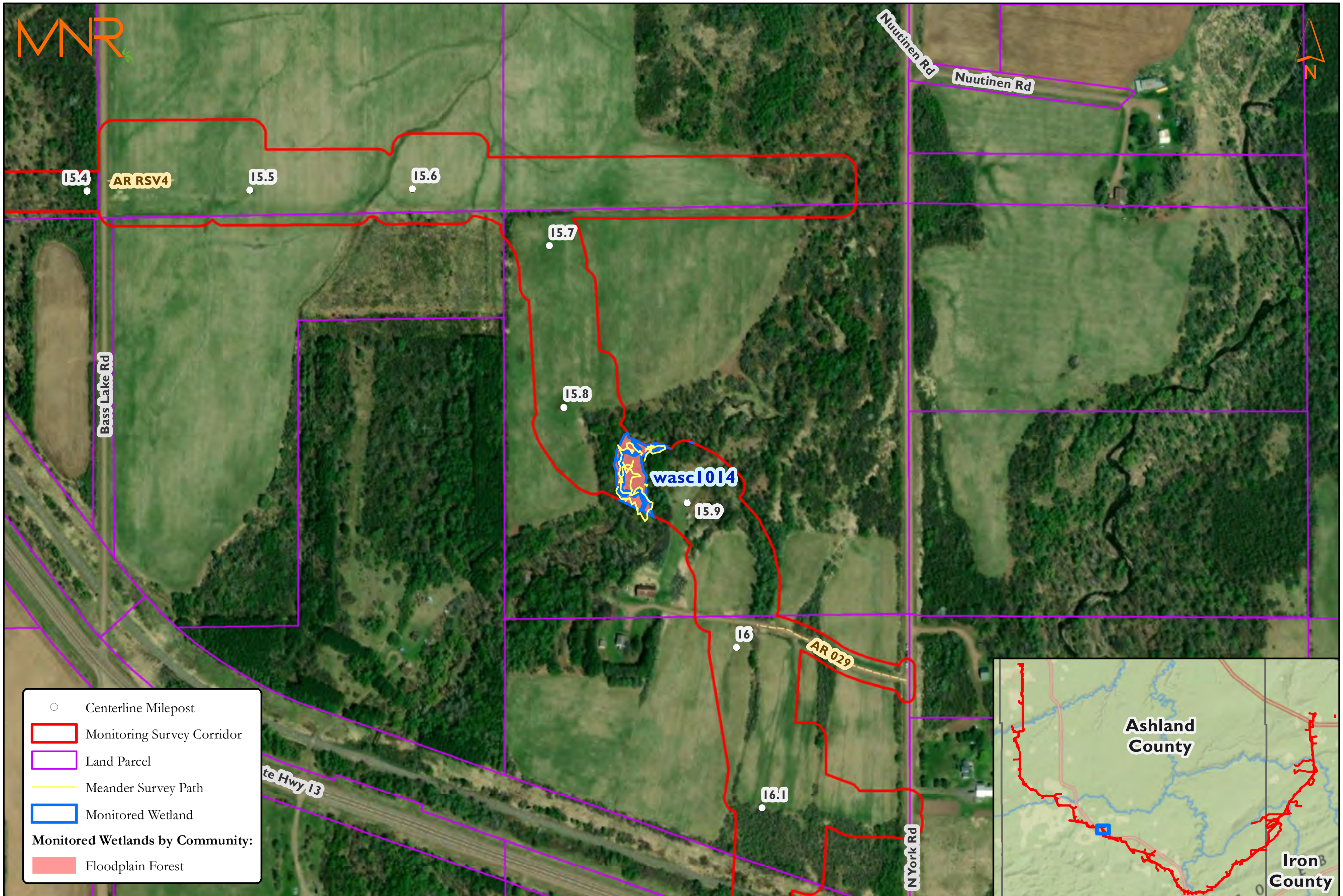
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 7



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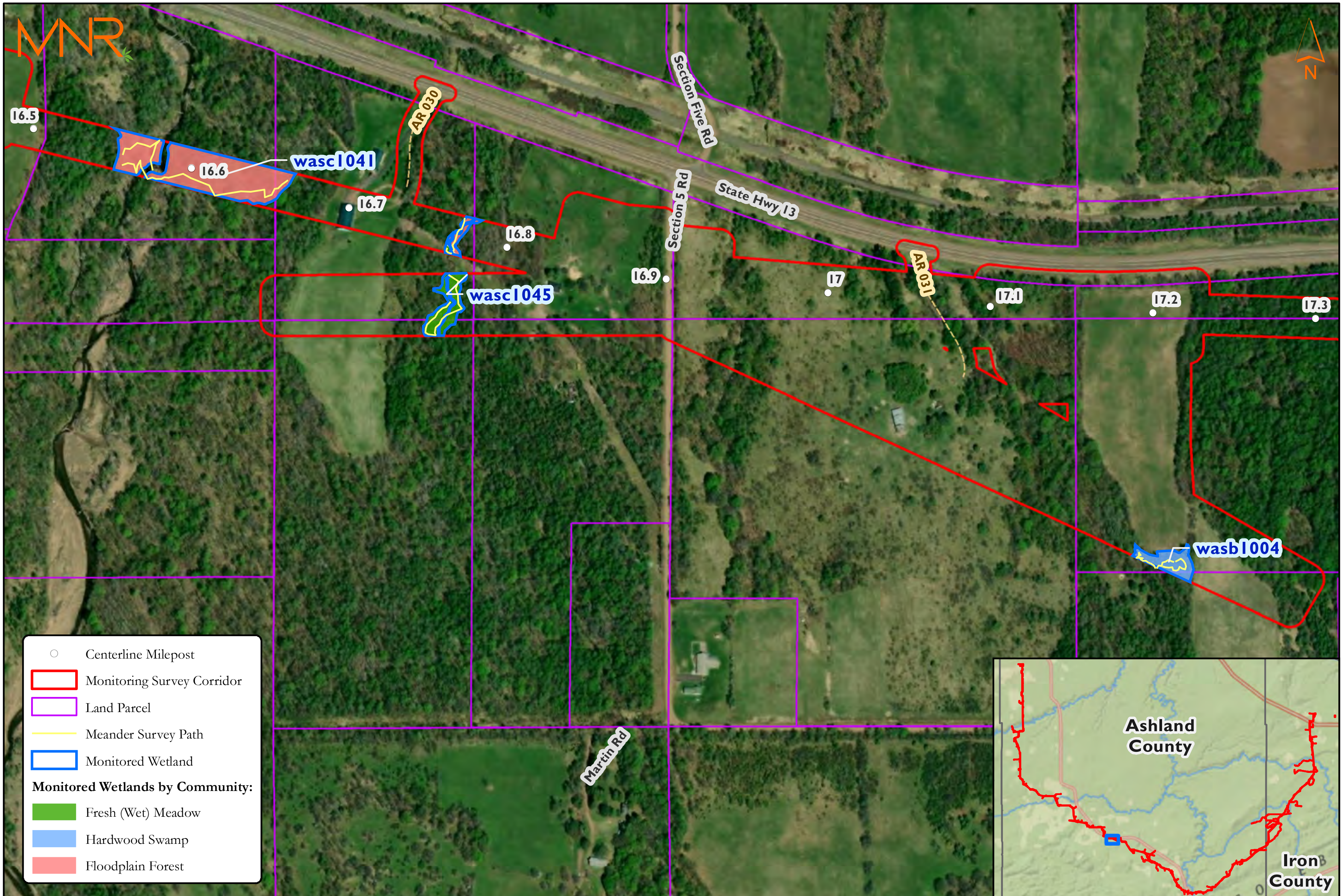
0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 8



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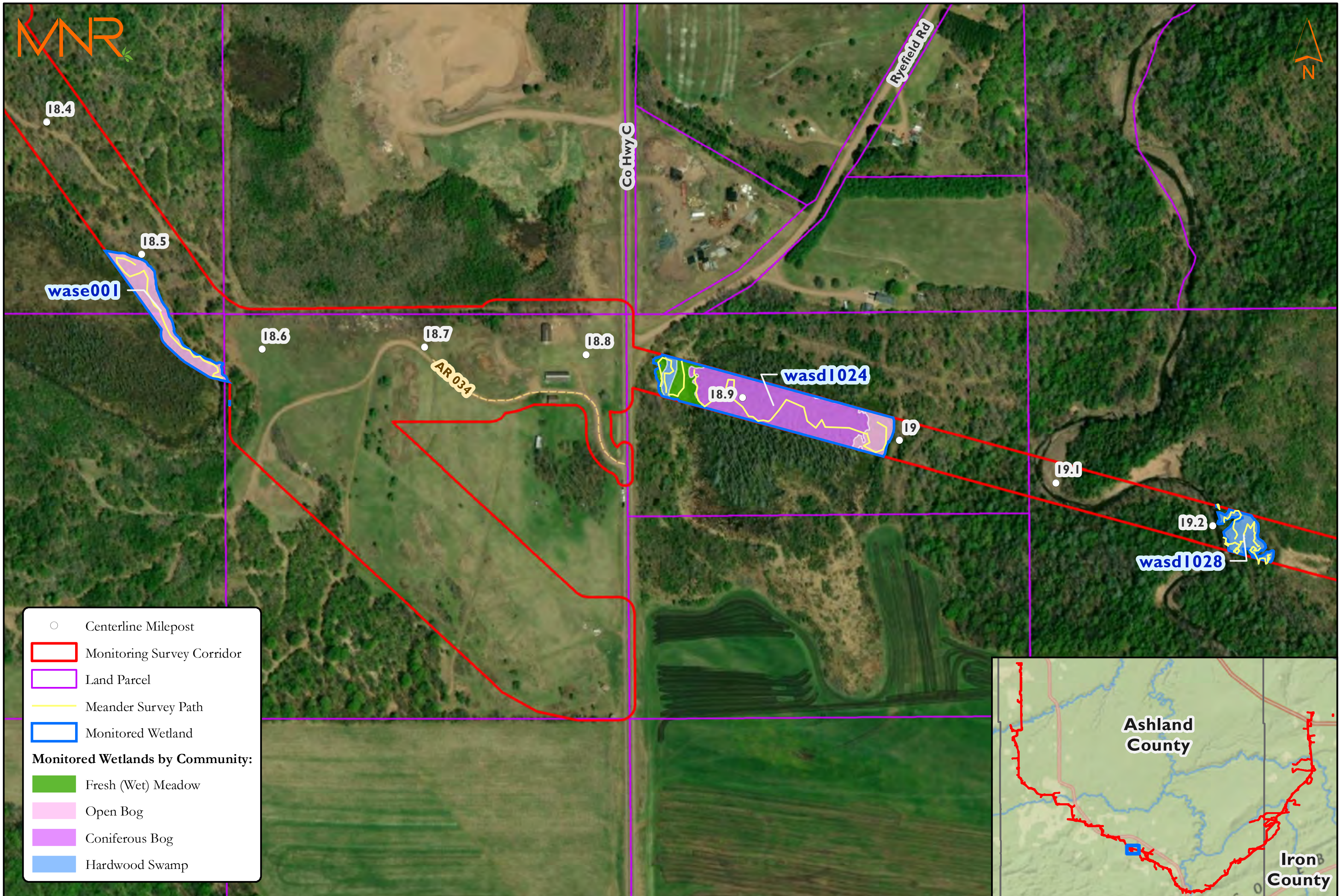
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 9



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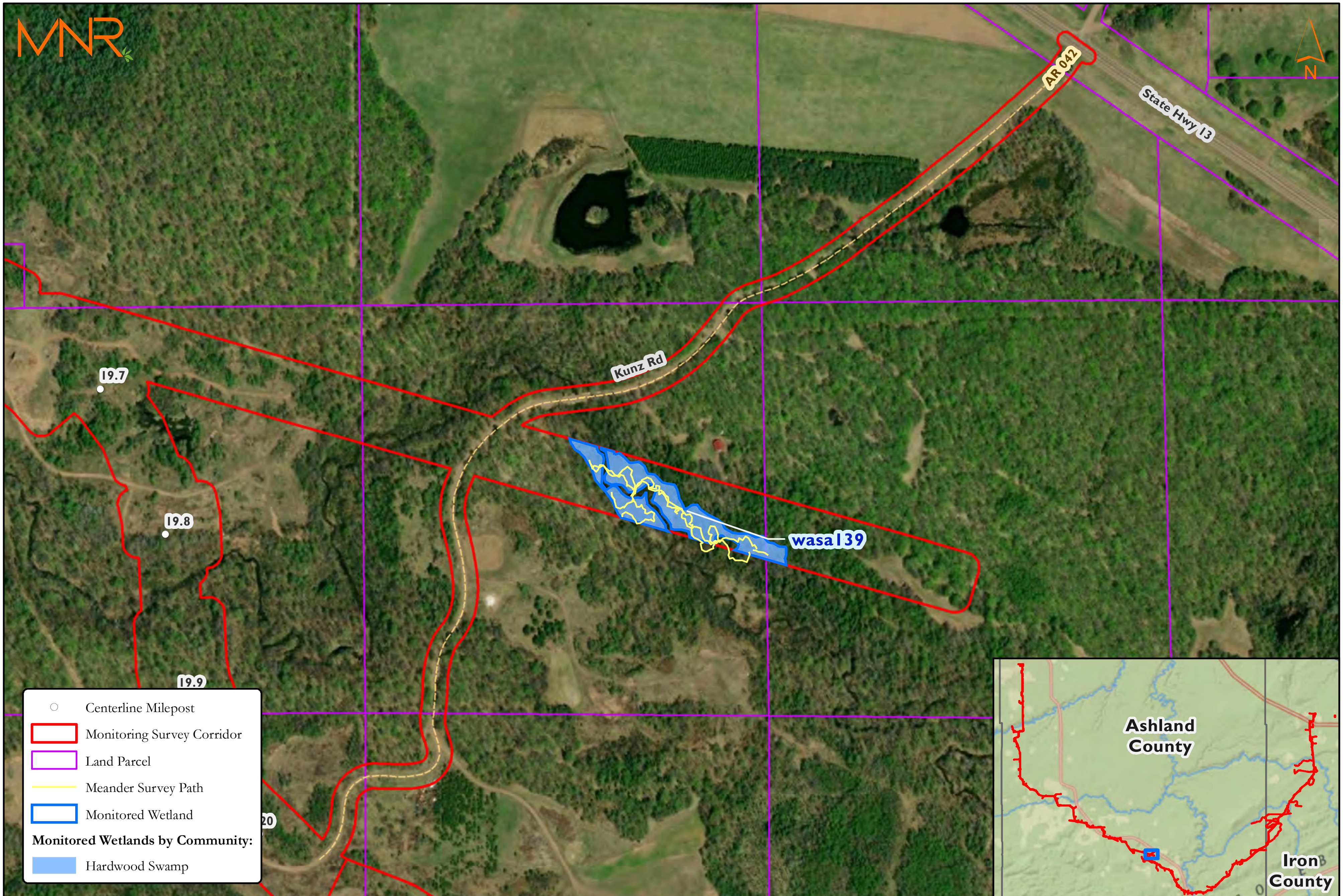
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 10



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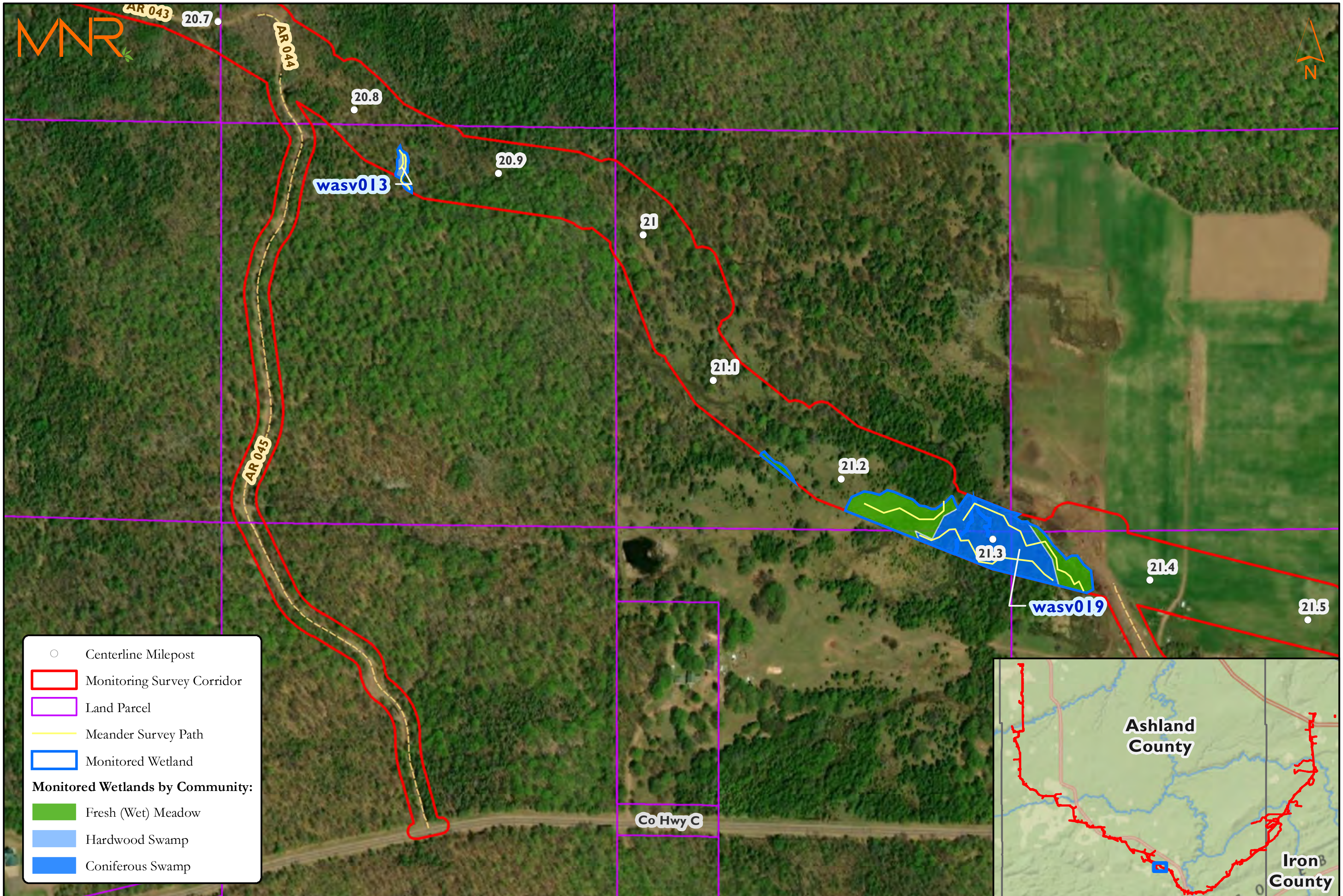
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 11



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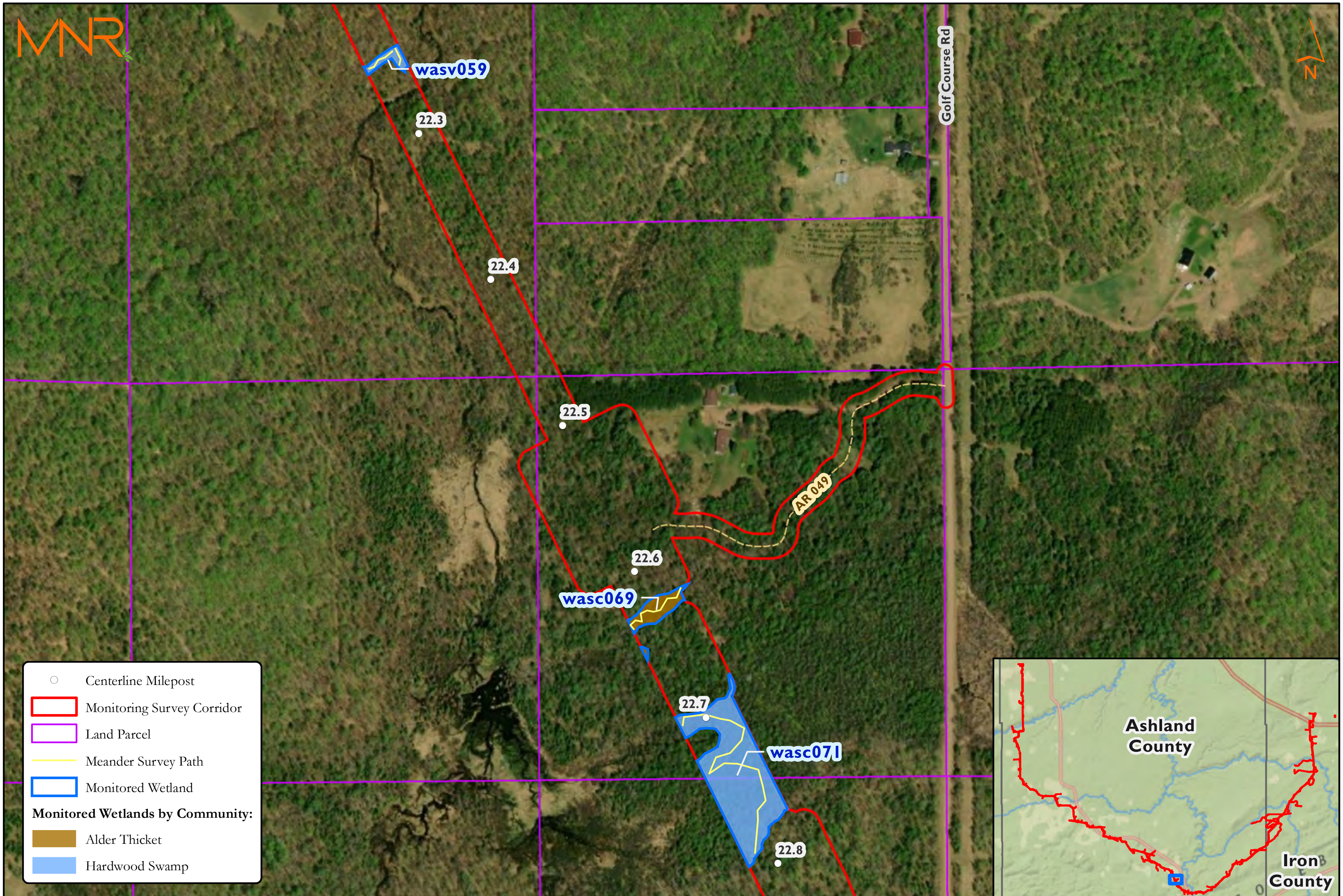
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 12



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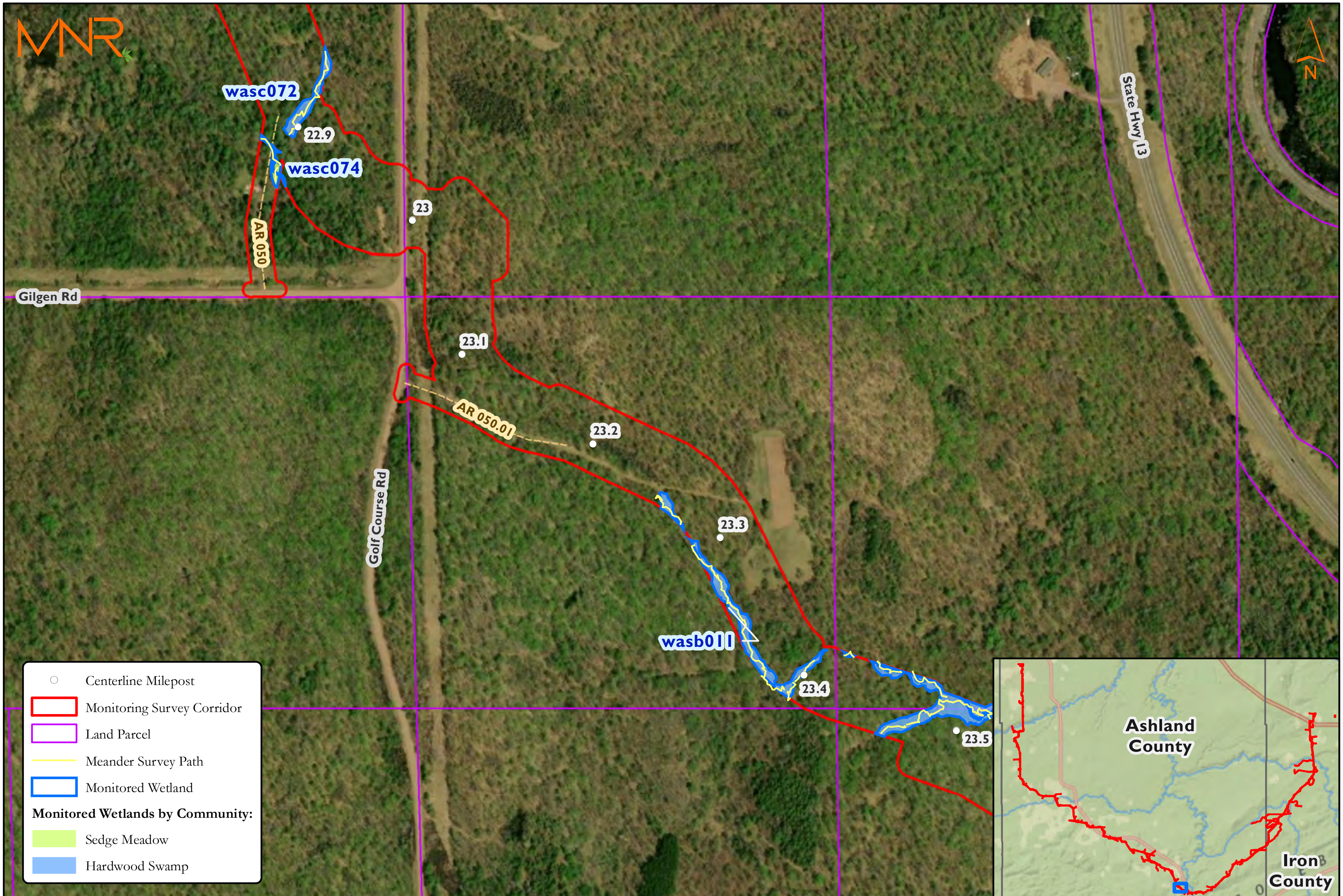
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 13



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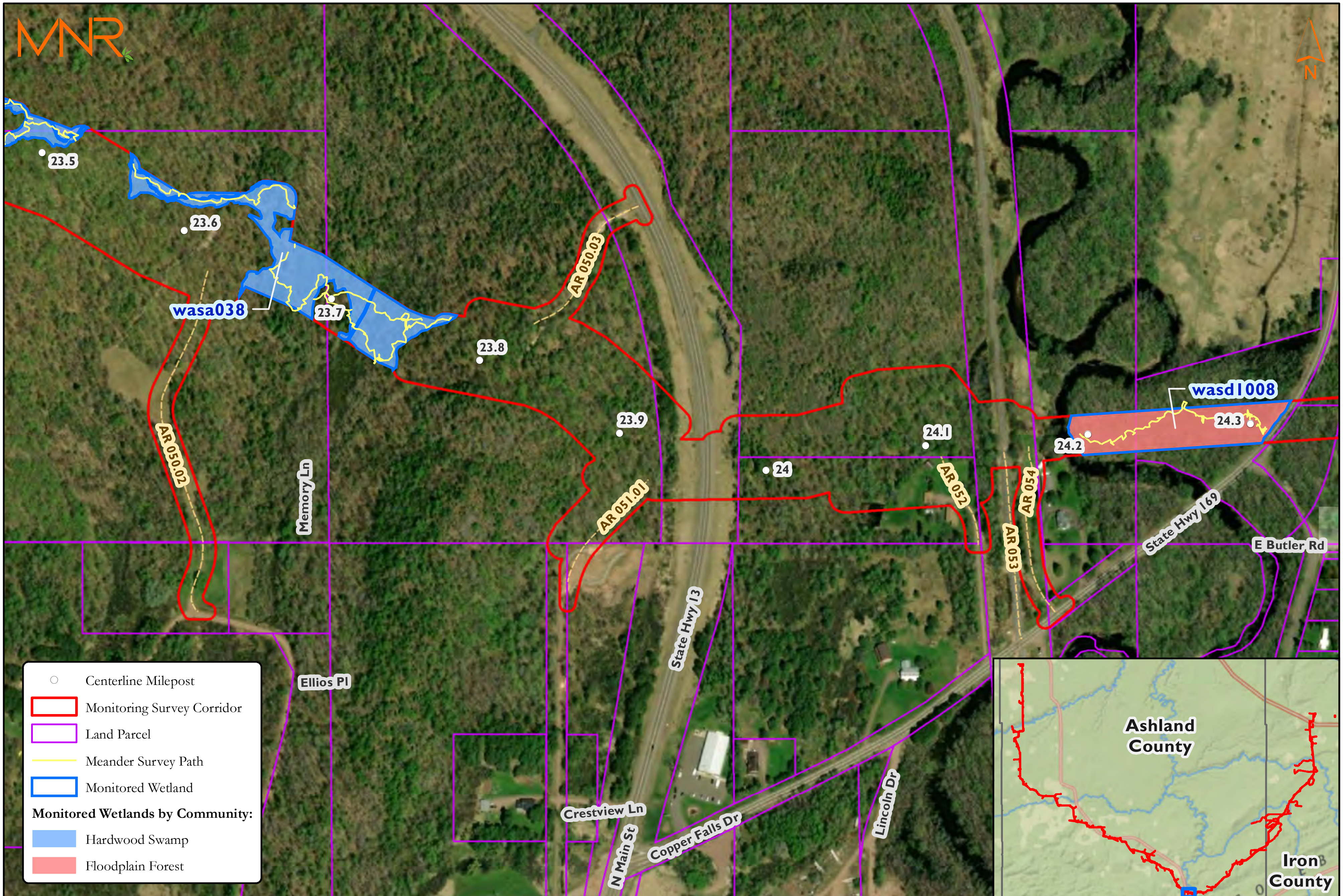
0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 14



Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

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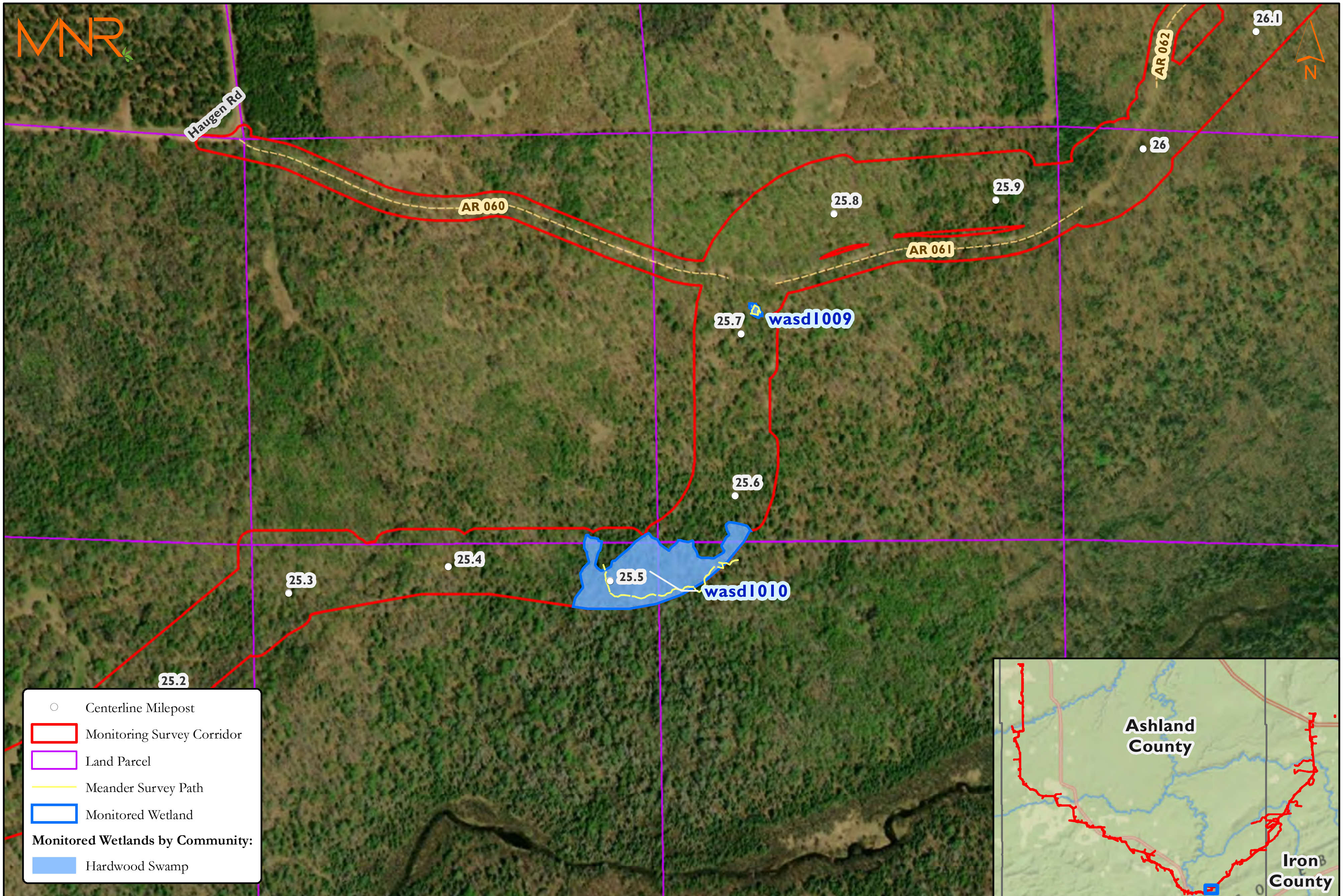
Map 15

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin



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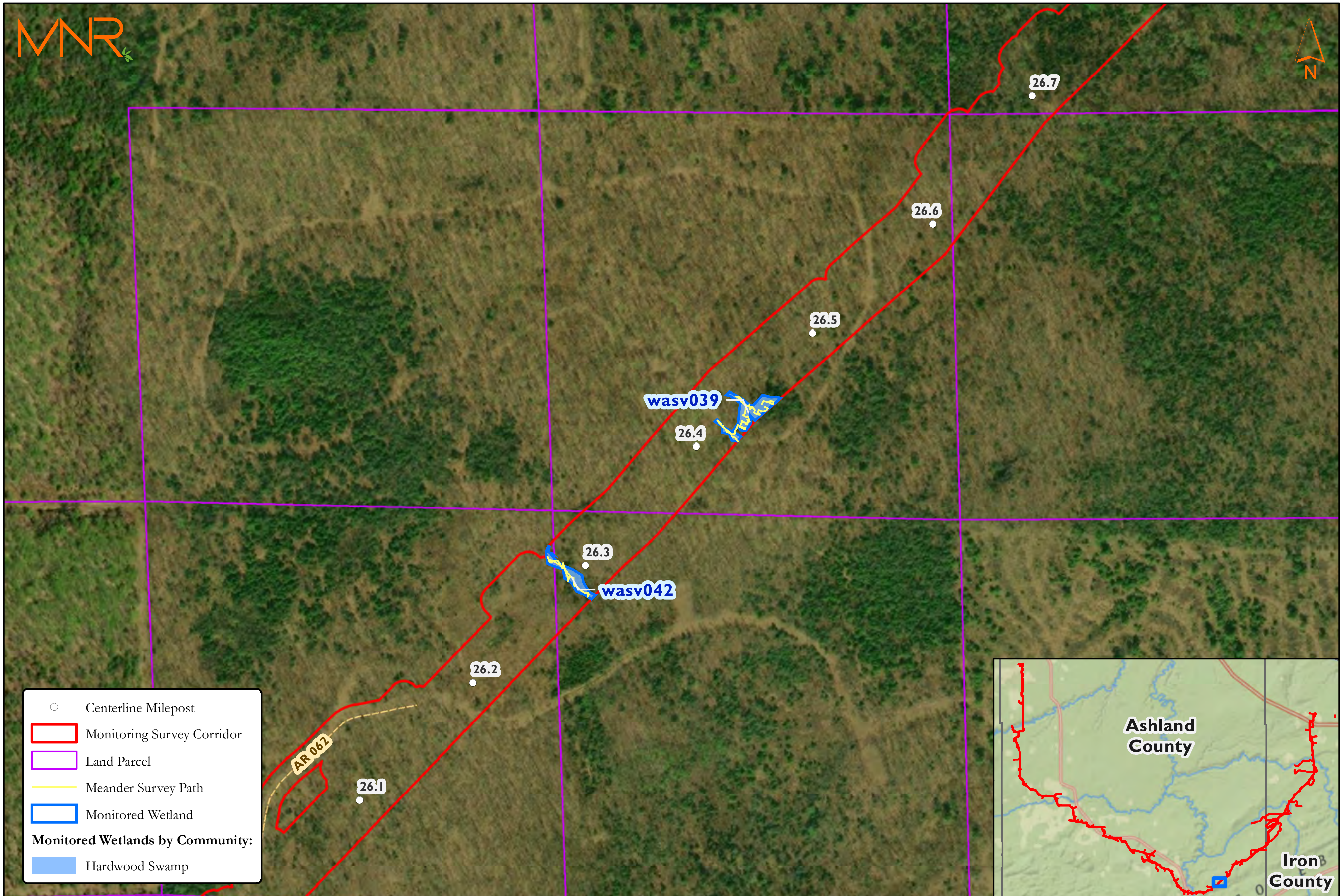
0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 16



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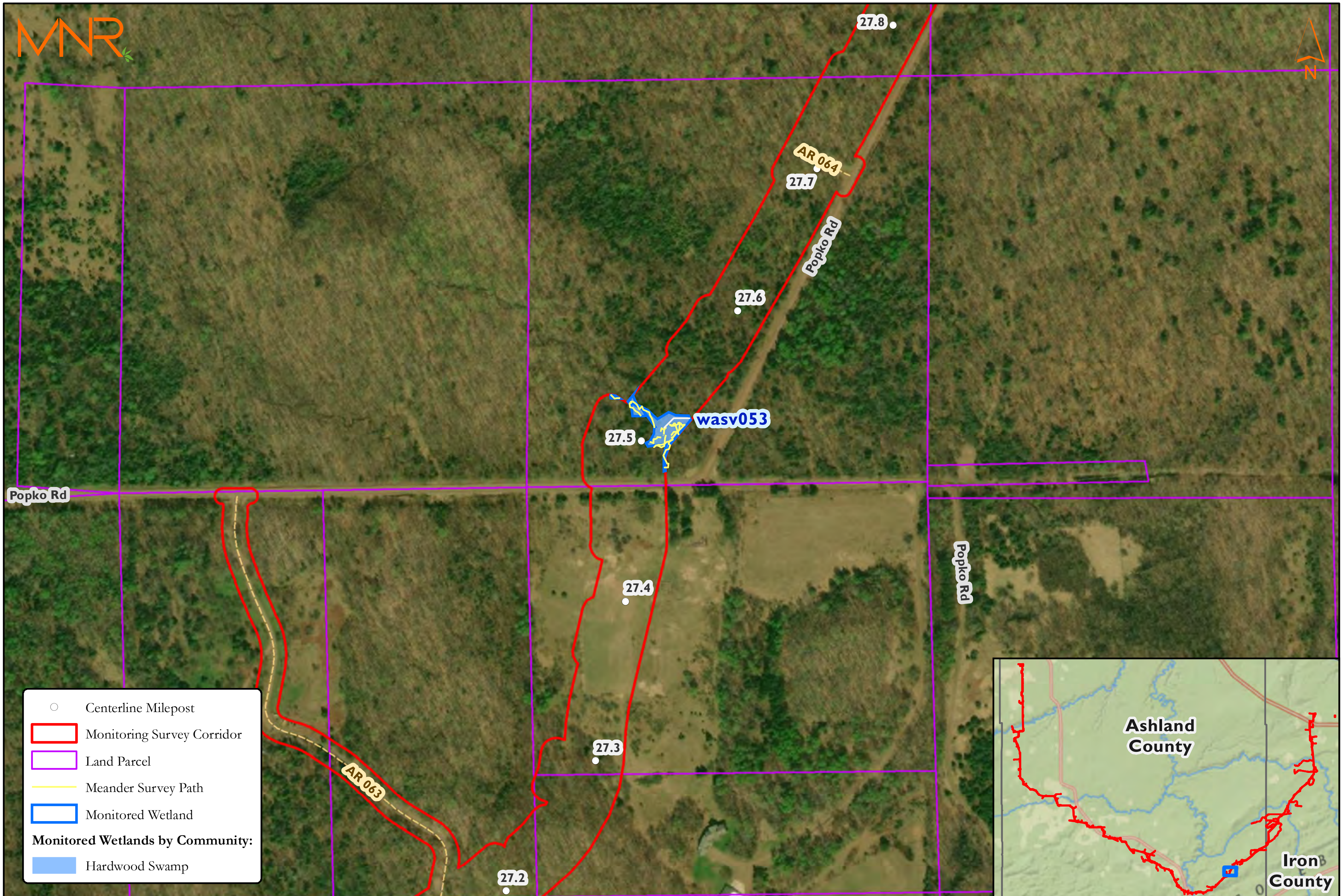
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 17



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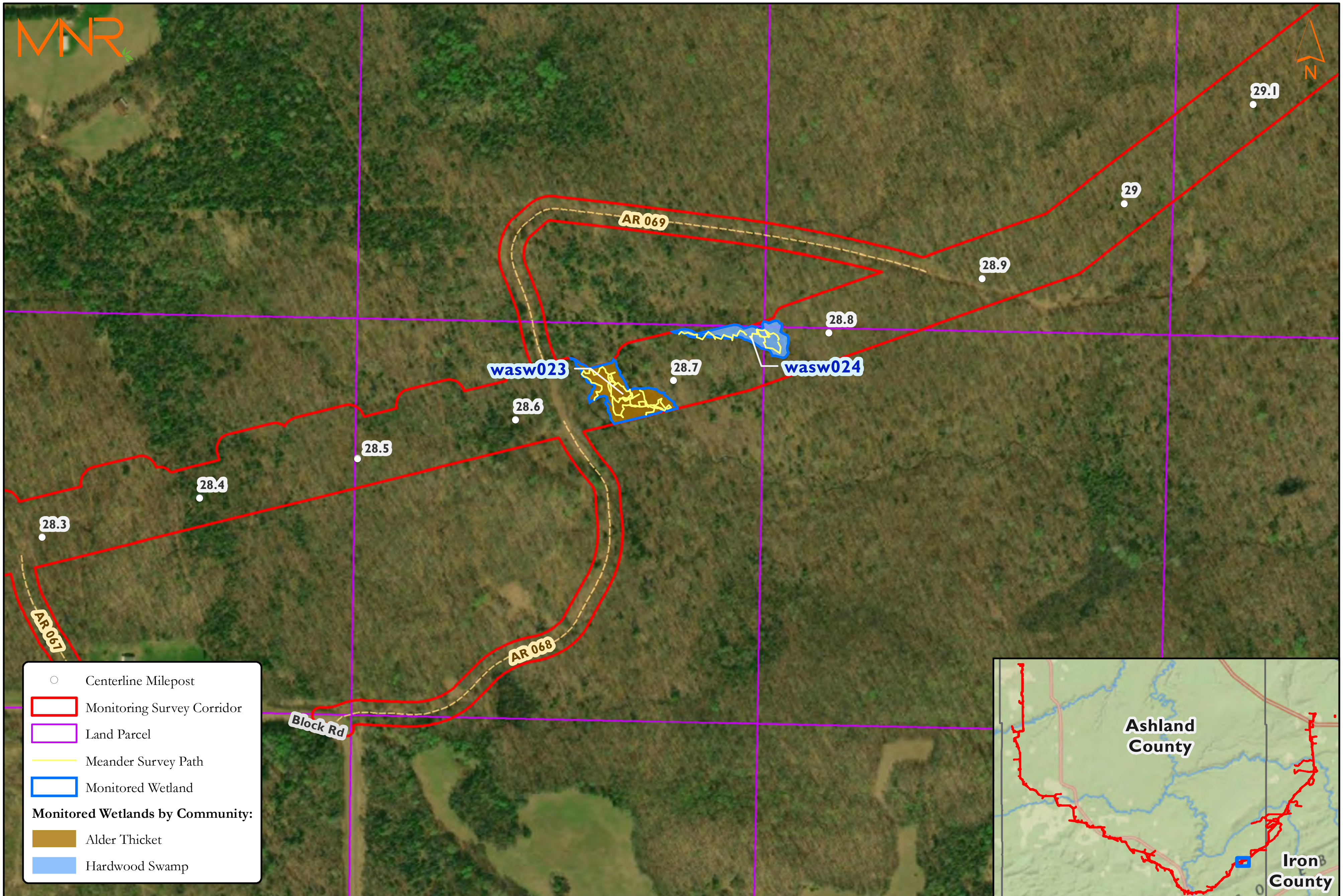
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 18



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Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
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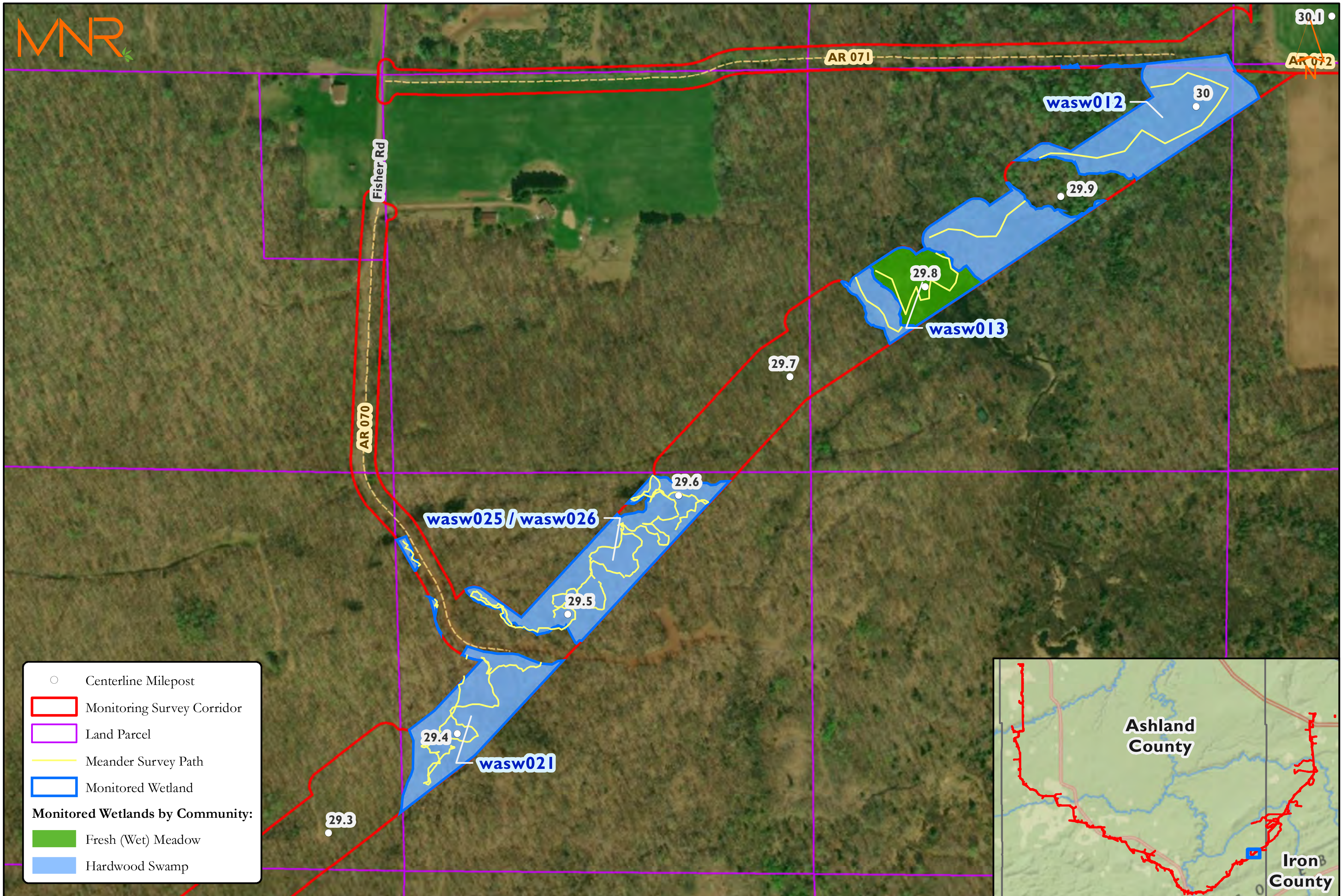
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 19

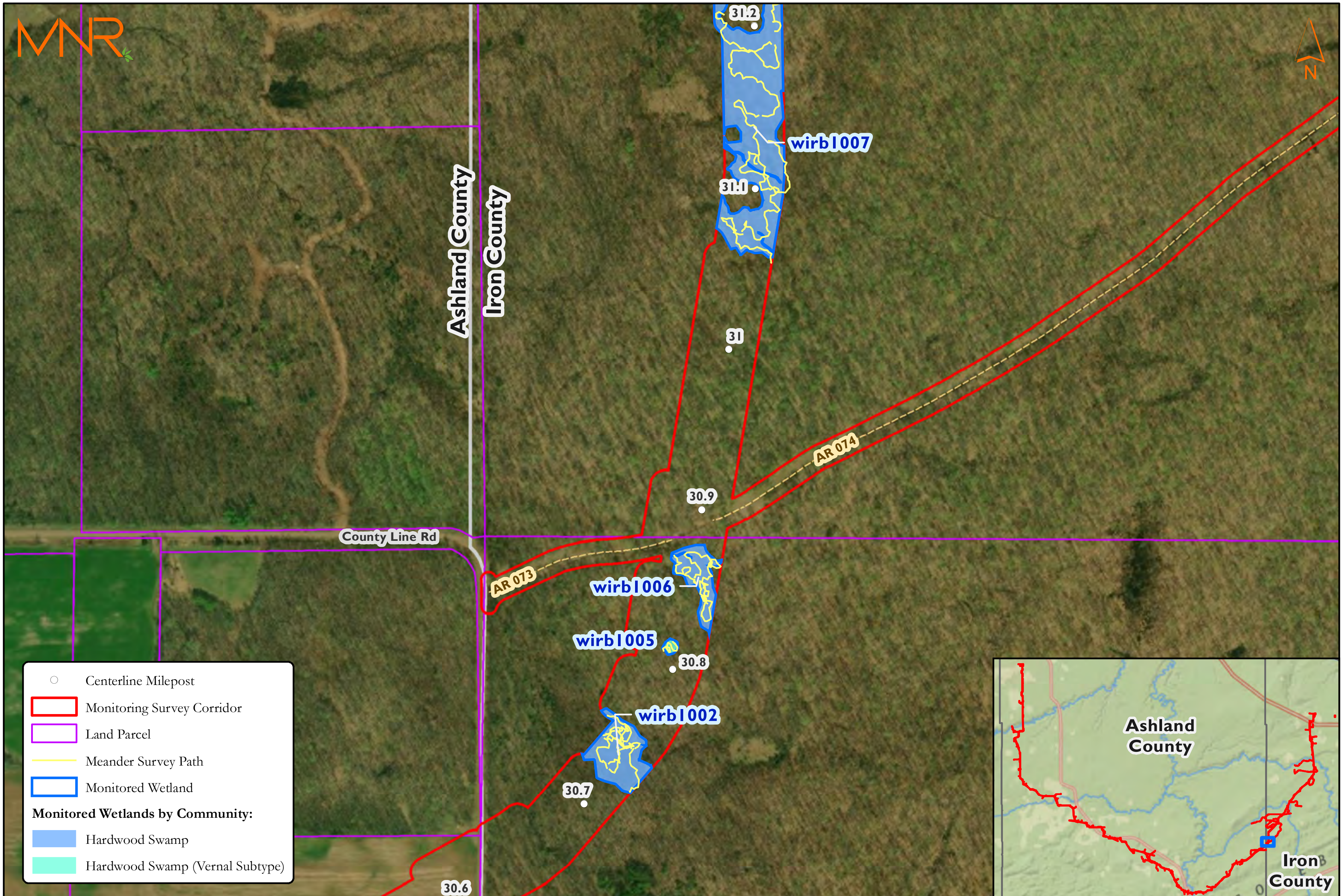


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland County, Wisconsin

Map 20

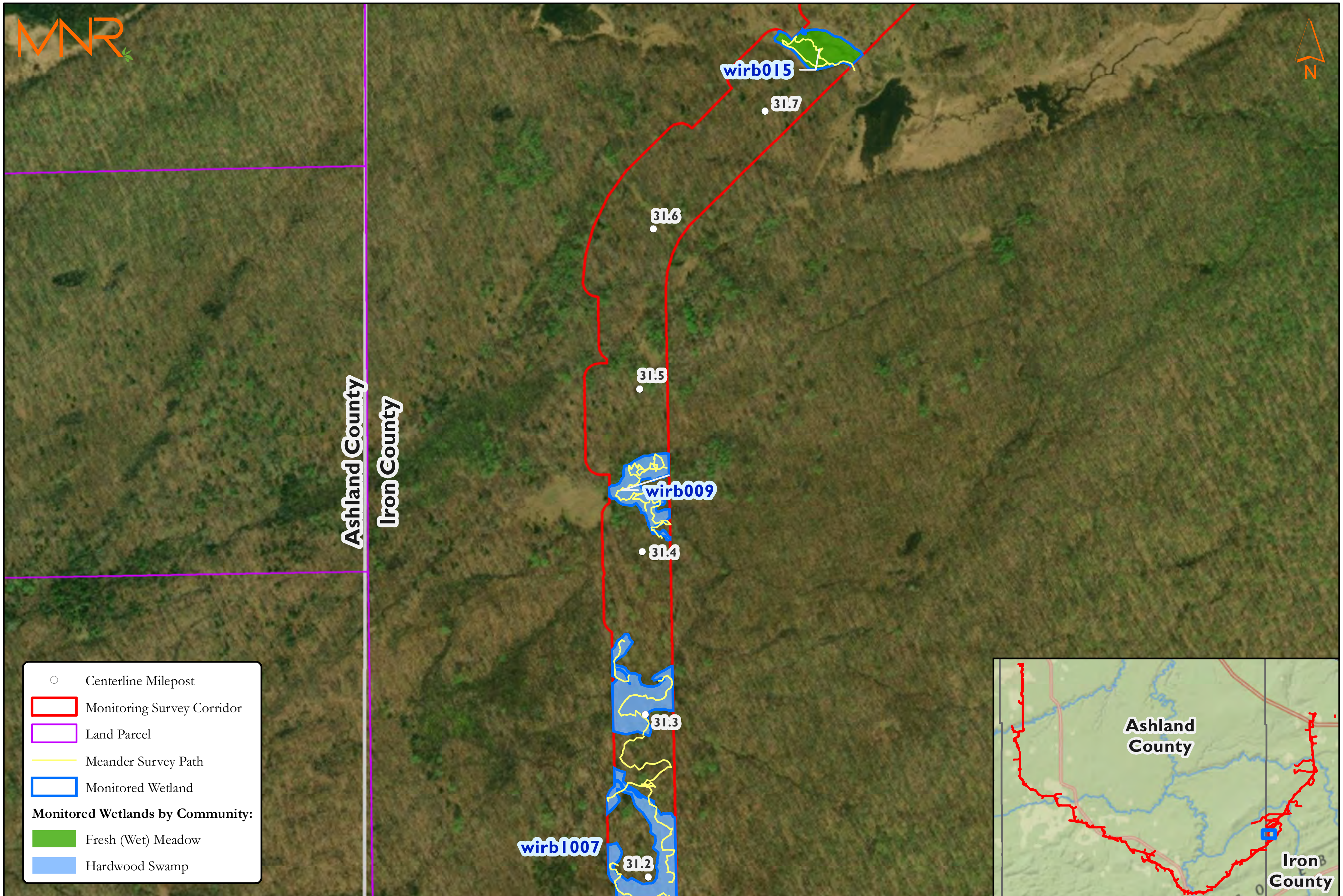


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland / Iron counties, Wisconsin

Map 21

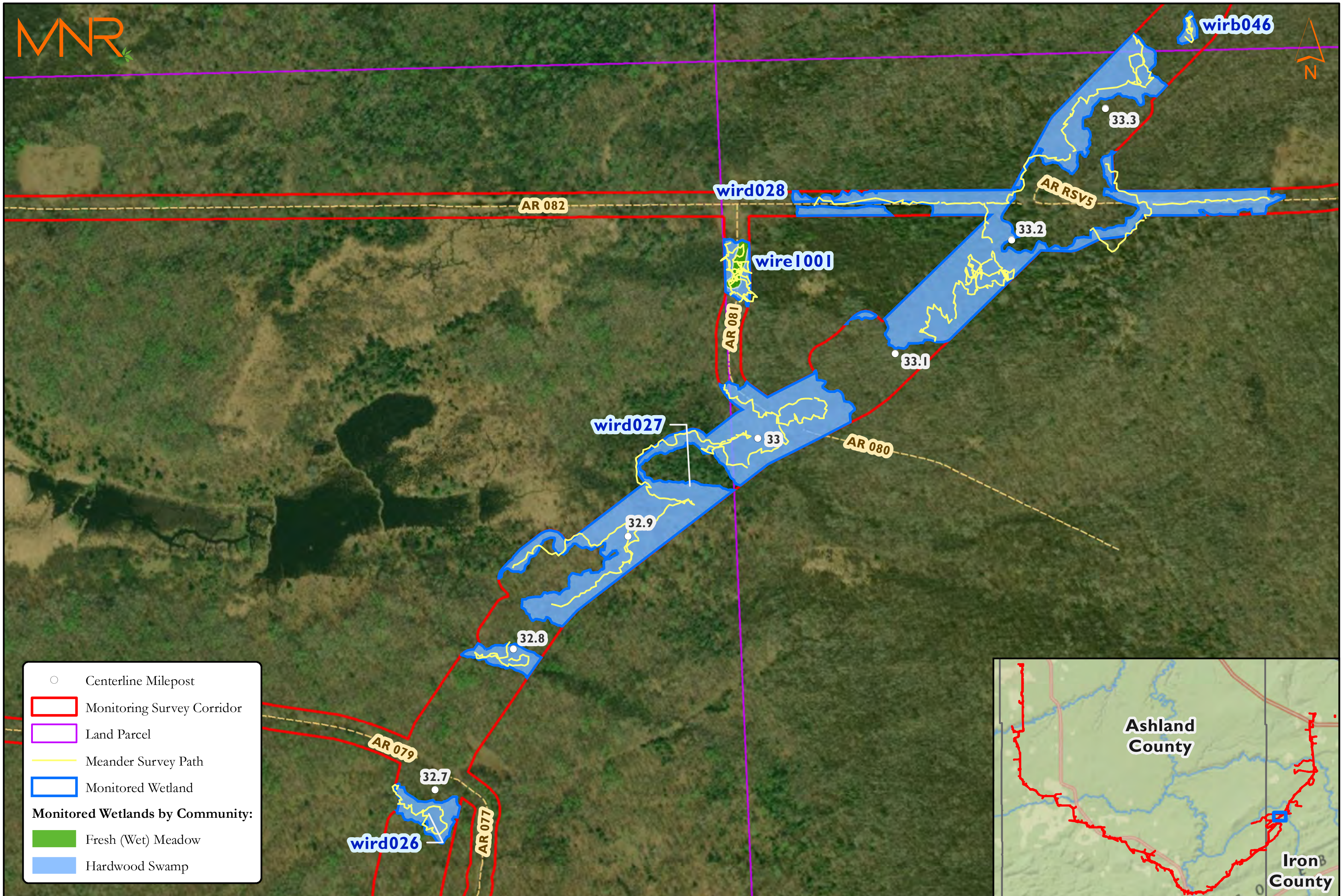


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Ashland / Iron counties, Wisconsin

Map 22

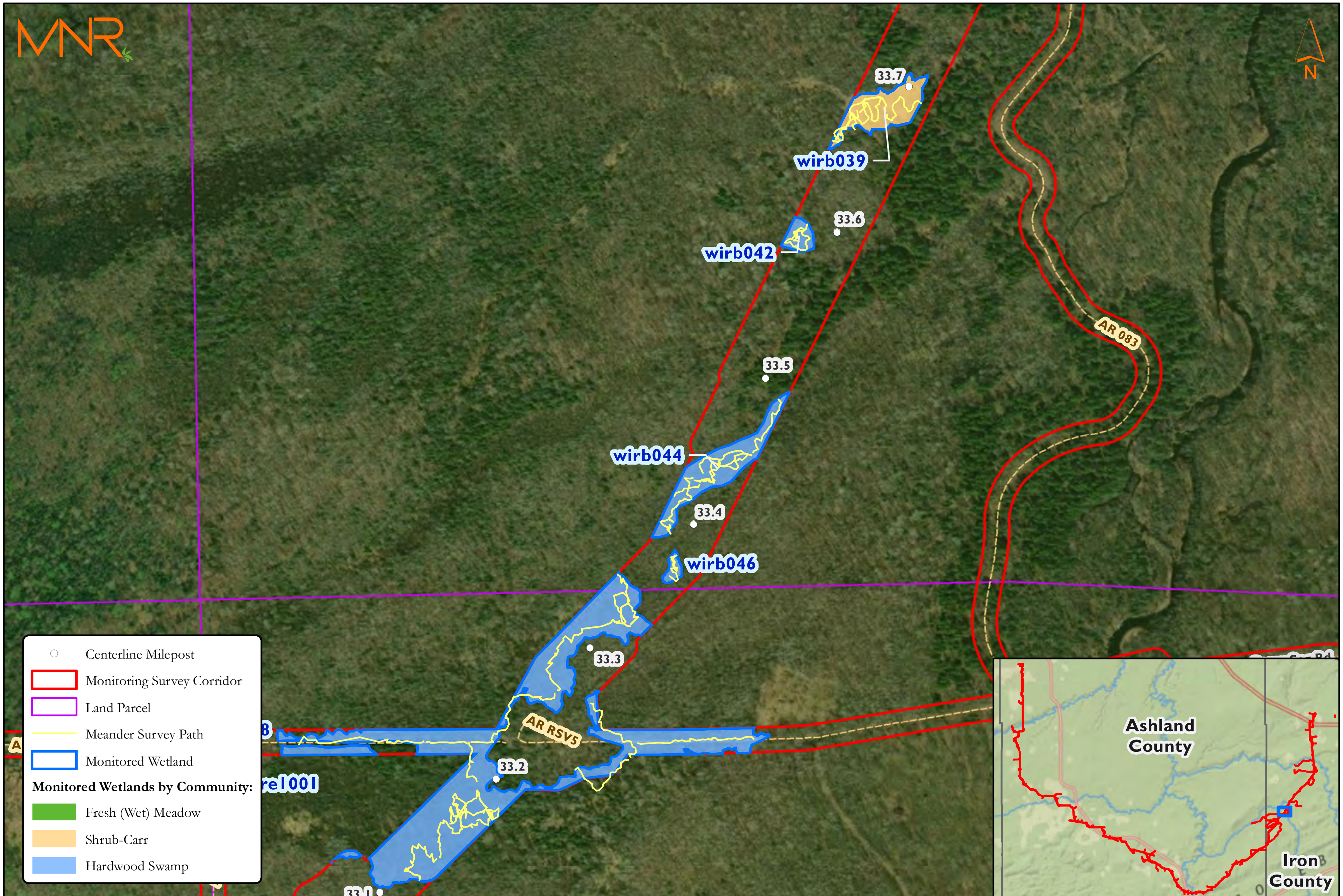


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 23

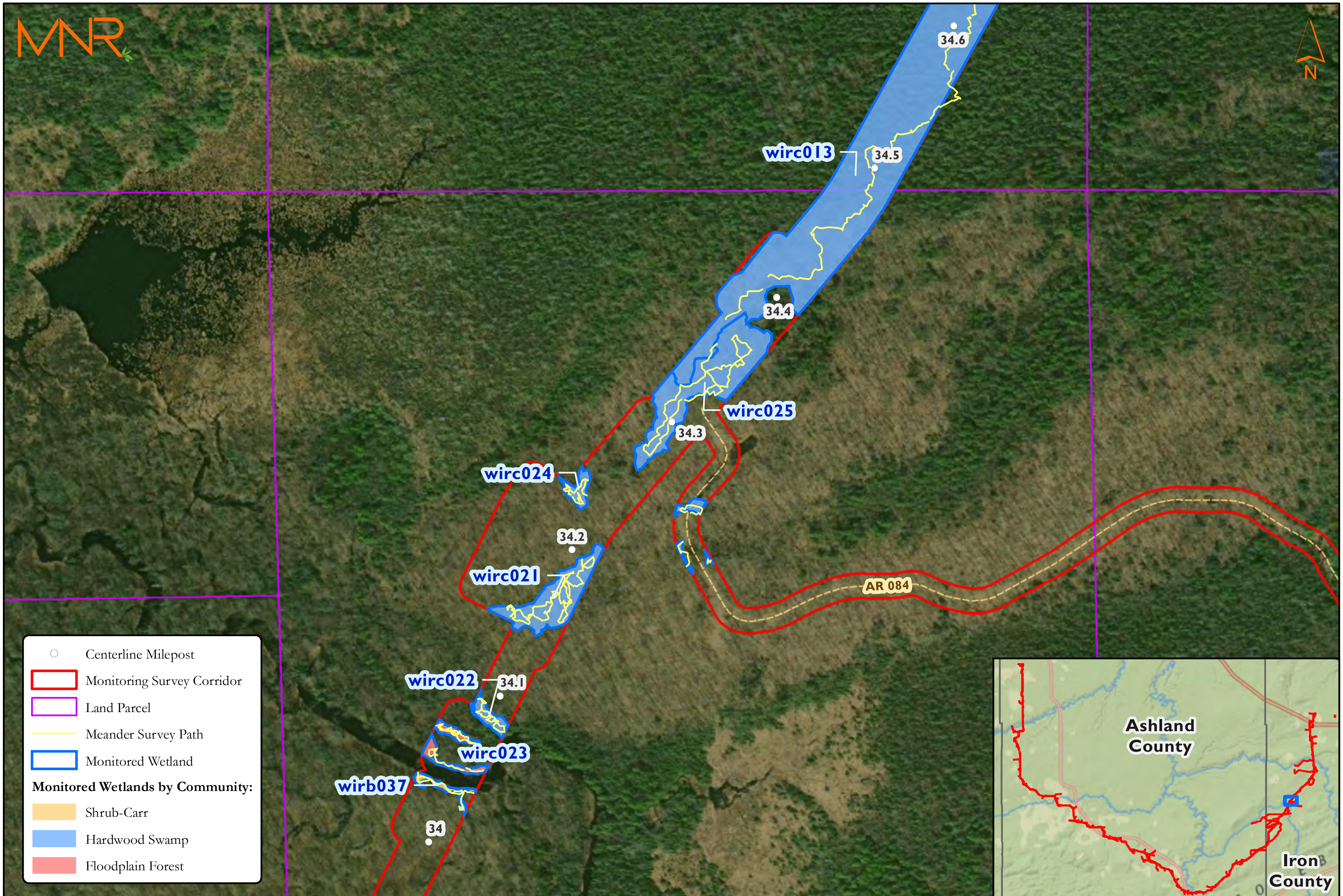


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

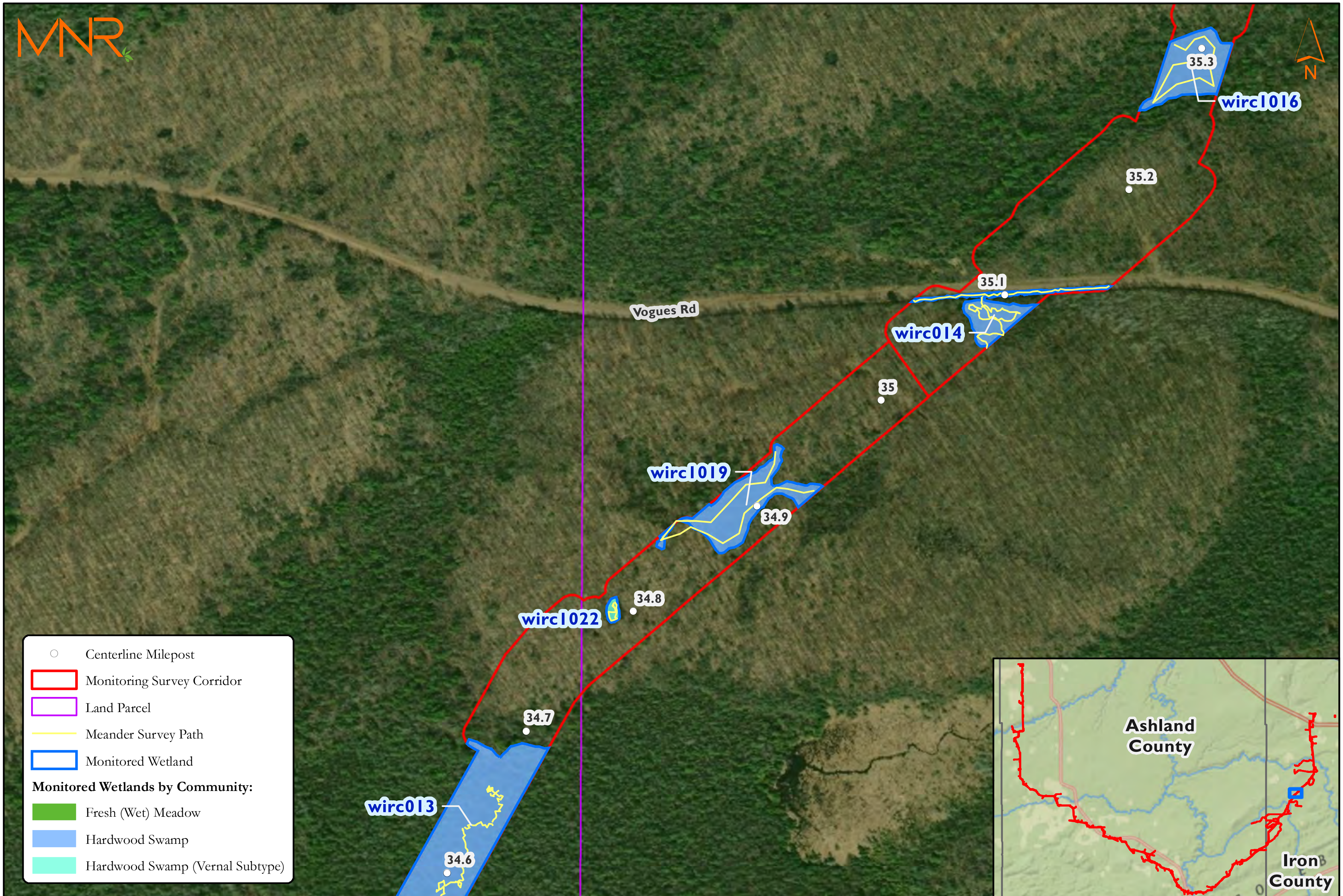
Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 24



Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 25

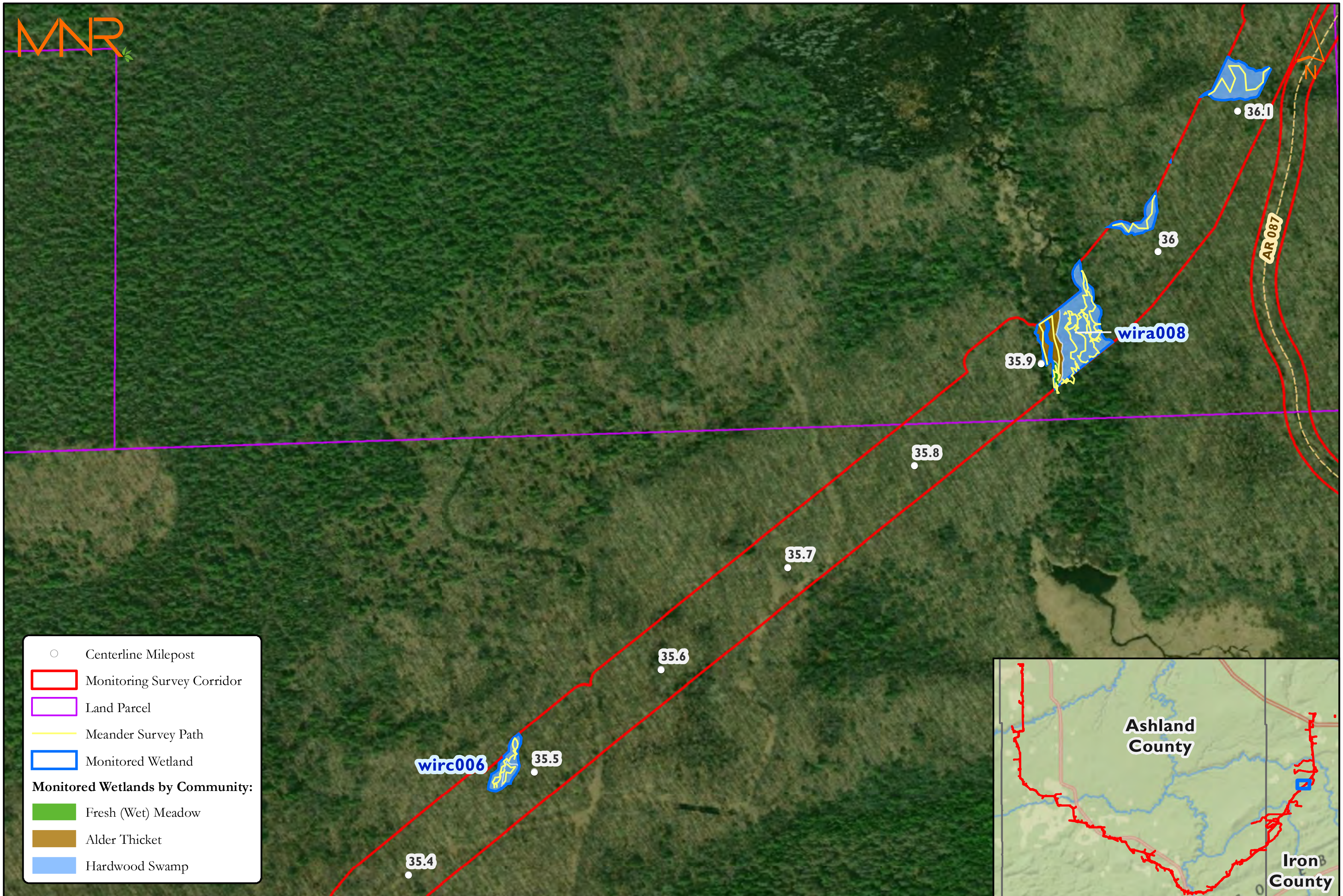


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 26

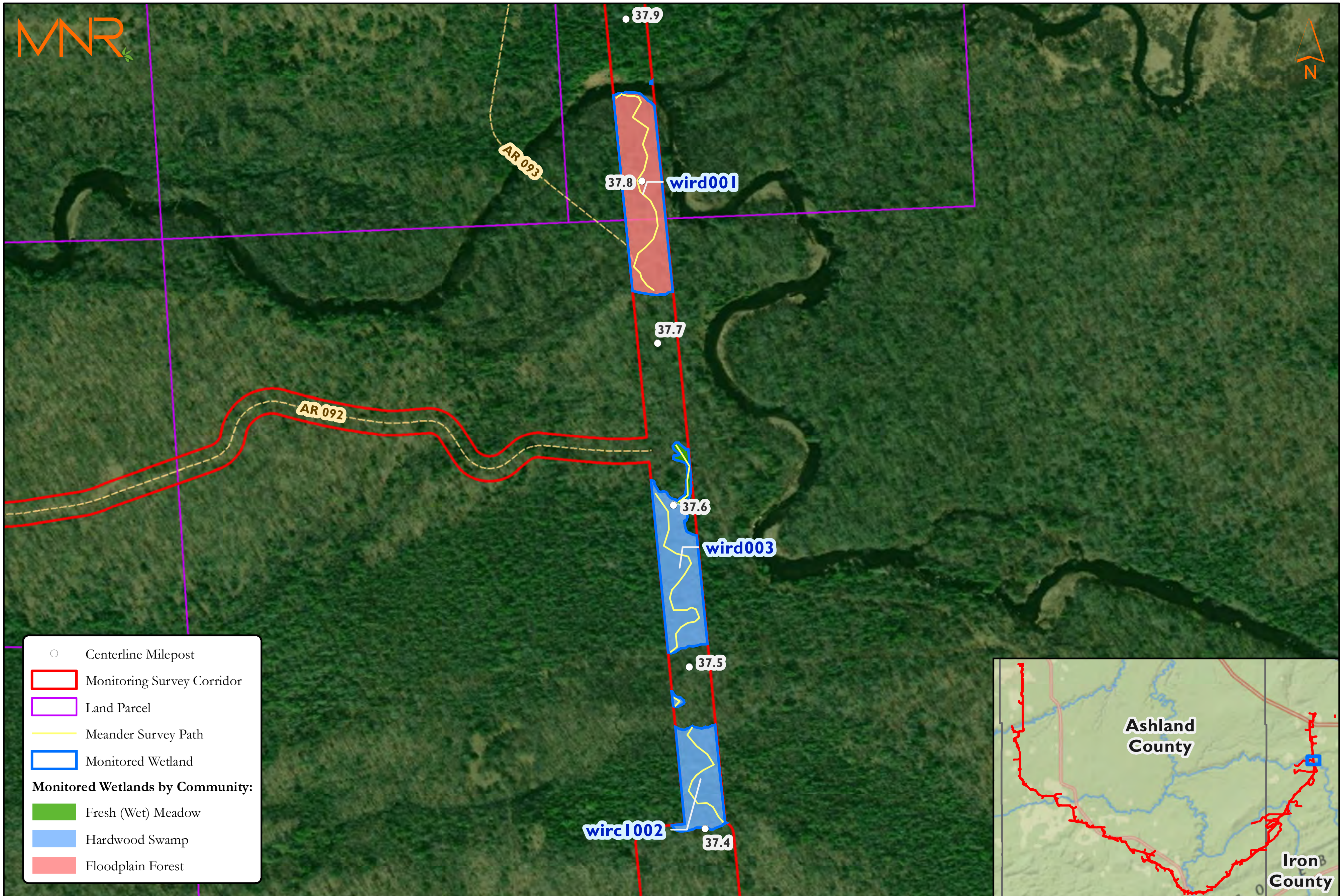


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 27

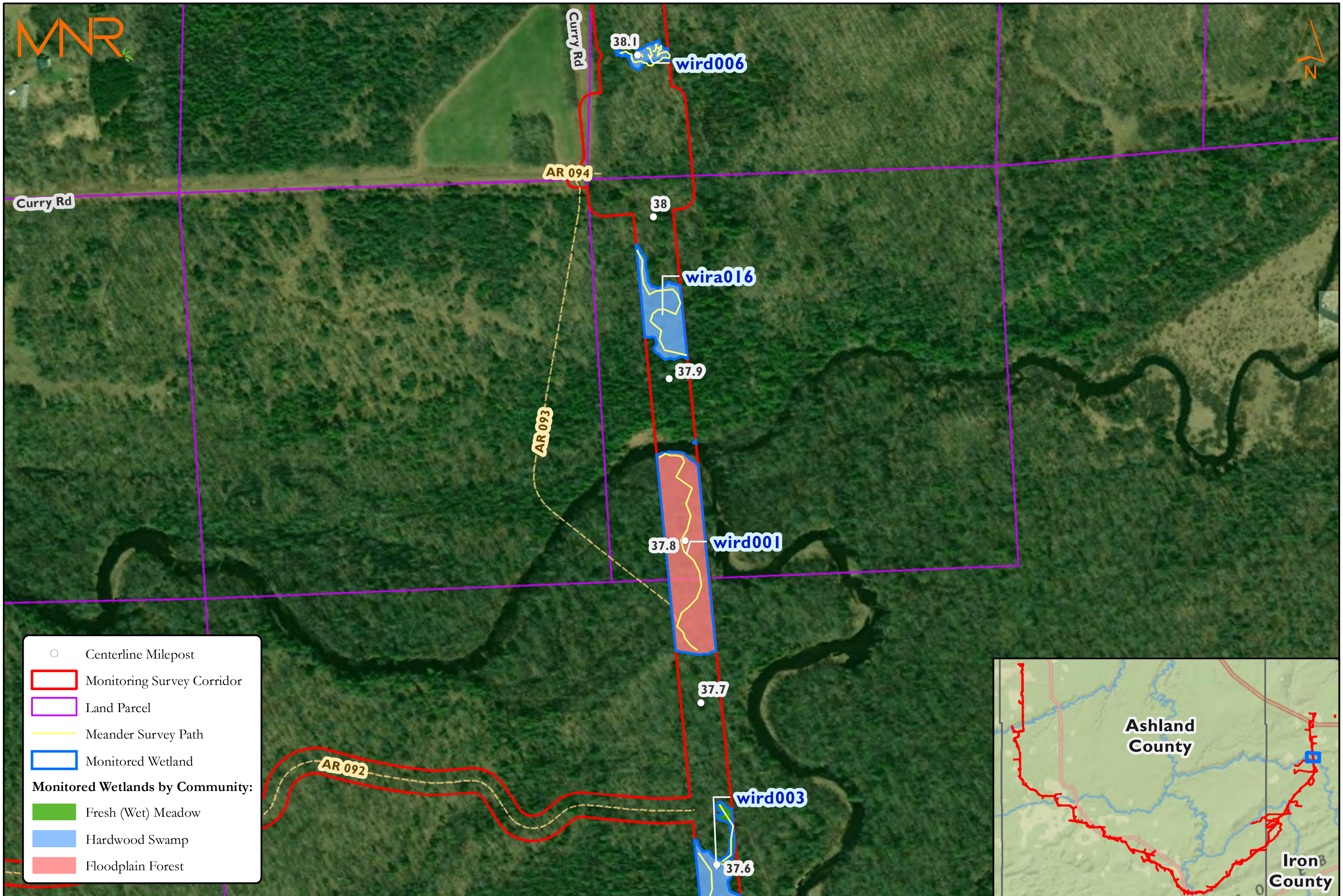


Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 28



Source: Esri World Imagery, National Geographic World Map, US Census Bureau, Date: 11/8/2022

0 400 800 Feet

Surveyed High-Quality Wetlands
High-Quality Wetlands Timed-Meander Survey Monitoring
Line 5 Wisconsin Segment Relocation Project
Enbridge Energy, L.P.
Iron County, Wisconsin

Map 29

Appendix A – Surveyed Wetland Features

Wetland Feature	County	Feature Acreage	Nearest Milepost
wasb027f	Ashland	0.85	2.9
wasm002e/f	Ashland	8.84	3.1
wasm001f	Ashland	0.04	3.8
wasa1054f	Ashland	1.70	4.1
wasc059e	Ashland	0.06	5.9
wasc061e	Ashland	0.02	5.9
wasc062f	Ashland	0.34	6.0
wase1016f	Ashland	4.65	10.6
wasa1006f	Ashland	1.60	14.2
wasc1033e/s	Ashland	0.40	14.7
wasc1014f	Ashland	0.41	15.9
wasc1041f	Ashland	1.53	16.6
wasc1045e/f	Ashland	0.40	16.8
wasb1004f	Ashland	0.25	17.2
wase001e	Ashland	0.70	18.5
wasd1024e/f1/f2/s	Ashland	2.34	18.9
wasd1028f	Ashland	0.34	19.2
wasa139f_x	Ashland	1.48	20.2
wasv013f	Ashland	0.08	20.8
wasv019e/f	Ashland	2.58	21.3
wasv059f1	Ashland	0.12	22.3
wasc069s	Ashland	0.26	22.6
wasc071f	Ashland	1.94	22.7
wasc072f	Ashland	0.19	22.9
wasc074e	Ashland	0.06	22.9
wasb011f	Ashland	0.49	23.4
wasa038f	Ashland	3.60	23.7
wasd1008f	Ashland	1.97	24.2
wasd1010f	Ashland	1.86	25.5
wasd1009f	Ashland	0.03	25.7
wasv042f	Ashland	0.13	26.3
wasv039f	Ashland	0.21	26.4
wasv053f	Ashland	0.29	27.5
wasw023ss	Ashland	0.68	28.7
wasw024f	Ashland	0.37	28.8
wasw021f	Ashland	2.45	29.4
wasw025f/wasw026f	Ashland	3.04	29.5
wasw013ss	Ashland	1.21	29.8
wasw012f	Ashland	5.29	30.0
wirb1002f	Iron	0.74	30.7
wirb1005f	Iron	0.04	30.8
wirb1006f	Iron	0.47	30.9
wirb1007f	Iron	4.91	31.3
wirb009f_x	Iron	0.58	31.4
wirb015e	Iron	0.50	31.8
wird026f	Iron	0.43	32.7

Wetland Feature	County	Feature Acreage	Nearest Milepost
wird027f	Iron	5.25	32.8
wire1001e/f	Iron	0.34	33.0
wird028f	Iron	5.95	33.2
wirb044f	Iron	0.93	33.4
wirb046f	Iron	0.09	33.4
wirb042f	Iron	0.18	33.6
wirb039s	Iron	0.70	33.7
wirb037s	Iron	0.09	34.0
wirc022f	Iron	0.14	34.1
wirc023f	Iron	0.20	34.1
wirc021f	Iron	0.89	34.2
wirc024f	Iron	0.14	34.2
wirc025f	Iron	1.48	34.3
wirc013f_x	Iron	7.62	34.5
wirc1022f	Iron	0.06	34.8
wirc1019f	Iron	1.11	34.9
wirc014e	Iron	0.12	35.1
wirc014f_x	Iron	0.44	35.1
wirc1016f	Iron	0.96	35.3
wirc006f	Iron	0.15	35.5
wira008f/s	Iron	0.78	35.9
wira008e/f_x	Iron	0.80	35.9
wirc1002f	Iron	1.00	37.4
wird003e/f	Iron	1.53	37.6
wird001f	Iron	1.93	37.8
wira016f	Iron	0.73	37.9
wird006f	Iron	0.16	38.1

Appendix B – General Condition Ratings

Sample Name	Natural Community	FQIa	FQIa Rating	Mean C	Mean C Rating	Nearest MP
wasb027f	Hardwood Swamp	34.1	Exceptional	4.10	Medium	2.9
wasm002e	Fresh (Wet) Meadow	28.7	High	4.66	High	3.1
wasm002f	Hardwood Swamp	41.8	Exceptional	4.64	High	3.1
wasm001f	Hardwood Swamp	24.6	High	4.50	High	3.8
wasa1054f	Floodplain Forest	28.7	High	3.41	Medium	4.1
wasc059e	Vernal Pool	25.6	High	4.38	High	5.9
wasc061e	Vernal Pool	17.4	Medium	3.48	Medium	5.9
wasc062f	Hardwood Swamp	27.0	High	4.43	High	6.0
wase1016f	Hardwood Swamp	45.8	Exceptional	4.41	High	10.6
wasa1006f	Hardwood Swamp	34.7	Exceptional	4.44	High	14.2
wasc1033e	Fresh (Wet) Meadow	14.6	Medium	2.33	Low	14.7
wasc1033s	Shrub-Carr	17.4	Medium	2.82	Medium	14.7
wasc1014f	Floodplain Forest	19.9	Medium	2.70	Medium	15.9
wasc1041f	Floodplain Forest	34.7	Exceptional	3.48	Medium	16.6
wasc1045e	Fresh (Wet) Meadow	28.1	High	3.94	Medium	16.8
wasc1045f	Floodplain Forest	34.4	Exceptional	5.02	Exceptional	16.8
wasb1004f	Hardwood Swamp	22.3	Medium	3.16	Medium	17.2
wase001e	Open Bog	33.6	Exceptional	5.45	Exceptional	18.5
wasd1024e	Fresh (Wet) Meadow	29.1	High	4.44	High	18.9
wasd1024f1	Hardwood Swamp	27.9	High	4.59	High	18.9
wasd1024f2	Coniferous Bog	41.1	Exceptional	6.76	Exceptional	18.9
wasd1024s	Open Bog	33.2	Exceptional	6.91	Exceptional	18.9
wasd1028f	Hardwood Swamp	36.3	Exceptional	5.35	Exceptional	19.2
wasa139f_x	Hardwood Swamp	35.8	Exceptional	4.79	Exceptional	20.2
wasv013f	Hardwood Swamp	34.2	Exceptional	4.78	Exceptional	20.8
wasv019e	Fresh (Wet) Meadow	24.7	High	3.11	Medium	21.3
wasv019f	Coniferous Swamp	37.1	Exceptional	4.96	Exceptional	21.3
wasv059f1	Hardwood Swamp	31.9	High	5.47	Exceptional	22.3
wasc069s	Alder Thicket	35.5	Exceptional	4.66	High	22.6
wasc071f	Hardwood Swamp	46.5	Exceptional	5.30	Exceptional	22.7
wasc072f	Hardwood Swamp	45.6	Exceptional	5.30	Exceptional	22.9
wasc074e	Hardwood Swamp	30.7	High	4.74	Exceptional	22.9
wasb011f	Hardwood Swamp	37.7	Exceptional	5.13	Exceptional	23.4
wasa038f	Hardwood Swamp	50.4	Exceptional	5.23	Exceptional	23.7
wasd1008f	Floodplain Forest	24.6	High	3.63	Medium	24.2
wasd1010f	Hardwood Swamp	27.1	High	3.50	Medium	25.5
wasd1009f	Hardwood Swamp	28.0	High	5.03	Exceptional	25.7
wasv042f	Hardwood Swamp	37.6	Exceptional	5.49	Exceptional	26.3
wasv039f	Hardwood Swamp	36.7	Exceptional	5.47	Exceptional	26.4
wasv053f	Hardwood Swamp	31.1	High	4.35	High	27.5
wasw023ss	Alder Thicket	36.8	Exceptional	4.68	High	28.7
wasw024f	Hardwood Swamp	37.2	Exceptional	5.22	Exceptional	28.8
wasw021f	Hardwood Swamp	35.0	Exceptional	5.00	Exceptional	29.4
wasw025f/wasw026f	Hardwood Swamp	41.4	Exceptional	4.94	Exceptional	29.5
wasw013ss	Alder Thicket	34.3	Exceptional	4.59	High	29.8
wasw012f	Hardwood Swamp	43.2	Exceptional	4.75	Exceptional	30.0

wirb1002f	Hardwood Swamp - Forested Seep	35.5	Exceptional	4.83	Exceptional	30.7
wirb1005f	Vernal Pool	15.5	Medium	4.31	High	30.8
wirb1006f	Hardwood Swamp	28.4	High	4.15	Medium	30.9
wirb1007f	Hardwood Swamp - Forested Seep	45.3	Exceptional	5.06	Exceptional	31.3
wirb009f_x	Hardwood Swamp	27.9	High	4.53	High	31.4
wirb015e	Fresh (Wet) Meadow	29.7	High	4.04	Medium	31.8
wird026f	Hardwood Swamp	38.2	Exceptional	4.89	Exceptional	32.7
wird027f	Hardwood Swamp	49.3	Exceptional	5.20	Exceptional	32.8
wire1001e	Fresh (Wet) Meadow	22.5	Medium	4.58	High	33.0
wire1001f	Hardwood Swamp	37.4	Exceptional	5.09	Exceptional	33.0
wird028f	Hardwood Swamp	47.6	Exceptional	5.04	Exceptional	33.2
wirb044f	Hardwood Swamp	38.2	Exceptional	5.02	Exceptional	33.4
wirb046f	Hardwood Swamp	28.5	High	4.97	Exceptional	33.4
wirb042f	Hardwood Swamp	37.1	Exceptional	5.59	Exceptional	33.6
wirb039s	Shrub-Carr	33.3	Exceptional	4.81	Exceptional	33.7
wirb037s	Shrub-Carr	33.8	Exceptional	4.47	High	34.0
wirc022f	Hardwood Swamp	30.4	High	4.48	High	34.1
wirc023f	Floodplain Forest	35.5	Exceptional	4.58	High	34.1
wirc021f	Hardwood Swamp	33.3	Exceptional	4.91	Exceptional	34.2
wirc024f	Hardwood Swamp	33.0	Exceptional	5.50	Exceptional	34.2
wirc025f	Hardwood Swamp	40.1	Exceptional	5.18	Exceptional	34.3
wirc013f_x	Coniferous Swamp	54.6	Exceptional	5.67	Exceptional	34.5
wirc1022f	Hardwood Swamp	19.2	Medium	4.19	Medium	34.8
wirc1019f	Hardwood Swamp	42.5	Exceptional	5.19	Exceptional	34.9
wirc014e	Fresh (Wet) Meadow	33.5	Exceptional	3.79	Medium	35.1
wirc014f_x	Hardwood Swamp	35.3	Exceptional	5.15	Exceptional	35.1
wirc1016f	Coniferous Swamp	41.6	Exceptional	5.47	Exceptional	35.3
wirc006f/wirc006f_x	Hardwood Swamp	28.9	High	4.45	High	35.5
wira008e_x	Fresh (Wet) Meadow	28.3	High	4.85	Exceptional	35.9
wira008f	Hardwood Swamp	36.1	Exceptional	4.74	Exceptional	35.9
wira008f_x	Coniferous Swamp	35.0	Exceptional	6.19	Exceptional	35.9
wira008s	Alder Thicket	32.2	Exceptional	4.46	High	35.9
wirc1002f	Coniferous Swamp	45.7	Exceptional	5.05	Exceptional	37.4
wird003e	Vernal Pool	31.8	High	4.64	High	37.6
wird003f	Coniferous Swamp	49.4	Exceptional	5.21	Exceptional	37.6
wird001f	Floodplain Forest	41.0	Exceptional	4.59	High	37.8
wira016f	Coniferous Swamp	38.6	Exceptional	5.46	Exceptional	37.9
wird006f	Hardwood Swamp	26.8	High	4.41	High	38.1

Appendix C – Condition Categories (NLFE)

Sample Name	Natural Community	Weighted Mean C	Condition Category - w(C)	Nearest MP
wasw013ss	Alder Thicket	3.9	Poor	29.8
wasc069s	Alder Thicket	4.4	Fair	22.6
wasw023ss	Alder Thicket	4.5	Good	28.7
wira008s	Alder Thicket	4.7	Good	35.9
wasd1024f2	Coniferous Bog	7.9	Good	18.9
wirc1002f	Coniferous Swamp	5.2	Fair to Very Poor	37.4
wirc1016f	Coniferous Swamp	5.4	Fair to Very Poor	35.3
wird003f	Coniferous Swamp	5.5	Fair to Very Poor	37.6
wira016f	Coniferous Swamp	5.6	Fair to Very Poor	37.9
wirc013f_x	Coniferous Swamp	5.9	Fair to Very Poor	34.5
wasv019f	Coniferous Swamp	6.1	Fair to Very Poor	21.3
wira008f_x	Coniferous Swamp	6.6	Fair to Very Poor	35.9
wasc1014f	Floodplain Forest[1]	2.9	[redacted]	15.9
wasd1008f	Floodplain Forest[1]	3.0	[redacted]	24.2
wasa1054f	Floodplain Forest[1]	3.8	[redacted]	4.1
wasc1041f	Floodplain Forest[1]	3.9	[redacted]	16.6
wirc023f	Floodplain Forest[1]	4.2	[redacted]	34.1
wasc1045f	Floodplain Forest[1]	4.4	[redacted]	16.8
wird001f	Floodplain Forest[1]	4.7	[redacted]	37.8
wasc1033e	Fresh Meadow (Disturbed)[1]	2.9	[redacted]	14.7
wasv019e	Fresh Meadow (Disturbed)[1]	3.2	[redacted]	21.3
wirc014e	Fresh Meadow (Disturbed)[1]	3.8	[redacted]	35.1
wasc1045e	Fresh Meadow (Disturbed)[1]	4.3	[redacted]	16.8
wire1001e	Fresh Meadow (Native Subtype)[1]	3.1	[redacted]	33.0
wirb015e	Fresh Meadow (Native Subtype)[1]	4.0	[redacted]	31.8
wasd1024e	Fresh Meadow (Native Subtype)[1]	4.2	[redacted]	18.9
wira008e_x	Fresh Meadow (Native Subtype)[1]	4.6	[redacted]	35.9
wasm002e	Fresh Meadow (Native Subtype)[1]	4.8	[redacted]	3.1
wasc074e	Hardwood Swamp	3.0	Poor	22.9
wasb1004f	Hardwood Swamp	3.1	Poor	17.2
wasb027f	Hardwood Swamp	3.6	Poor	2.9
wirb009f_x	Hardwood Swamp	3.6	Poor	31.4
wasd1010f	Hardwood Swamp	3.7	Poor	25.5
wasd1024f1	Hardwood Swamp	3.9	Poor	18.9
wasm001f	Hardwood Swamp	4.1	Fair	3.8
wasv013f	Hardwood Swamp	4.1	Fair	20.8
wirc006f/wirc006f_x	Hardwood Swamp	4.2	Fair	35.5
wird006f	Hardwood Swamp	4.2	Fair	38.1
wirb1006f	Hardwood Swamp	4.2	Fair	30.9
wasm002f	Hardwood Swamp	4.2	Fair	3.1
wasw021f	Hardwood Swamp	4.4	Fair	29.4
wirc022f	Hardwood Swamp	4.5	Fair	34.1
wird026f	Hardwood Swamp	4.5	Fair	32.7
wasw025f/wasw026f	Hardwood Swamp	4.7	Fair	29.5
wase1016f	Hardwood Swamp	4.8	Fair	10.6
wirb046f	Hardwood Swamp	4.9	Fair	33.4
wira008f	Hardwood Swamp	5.0	Fair	35.9
wasa1006f	Hardwood Swamp	5.2	Fair	14.2
wird027f	Hardwood Swamp	5.2	Fair	32.8
wasw012f	Hardwood Swamp	5.2	Fair	30.0
wirc1019f	Hardwood Swamp	5.3	Fair	34.9
wird028f	Hardwood Swamp	5.4	Fair	33.2
wasv053f	Hardwood Swamp	5.4	Fair	27.5
wasv059f1	Hardwood Swamp	5.5	Fair	22.3
wasa139f_x	Hardwood Swamp	5.5	Fair	20.2
wasc062f	Hardwood Swamp	5.5	Fair	6.0

wirc021f	Hardwood Swamp	5.7	Good	34.2
wirc025f	Hardwood Swamp	5.7	Good	34.3
wasc072f	Hardwood Swamp	5.7	Good	22.9
wirb044f	Hardwood Swamp	5.8	Good	33.4
wirc1022f	Hardwood Swamp	5.9	Good	34.8
wire1001f	Hardwood Swamp	5.9	Good	33.0
wasa038f	Hardwood Swamp	6.0	Good	23.7
wasv042f	Hardwood Swamp	6.0	Good	26.3
wasc071f	Hardwood Swamp	6.0	Good	22.7
wirc014f_x	Hardwood Swamp	6.1	Good	35.1
wasb011f	Hardwood Swamp	6.1	Good	23.4
wasd1009f	Hardwood Swamp	6.1	Good	25.7
wirb042f	Hardwood Swamp	6.2	Good	33.6
wasw024f	Hardwood Swamp	6.3	Excellent	28.8
wirc024f	Hardwood Swamp	6.4	Excellent	34.2
wasv039f	Hardwood Swamp	6.5	Excellent	26.4
wasd1028f	Hardwood Swamp	6.6	Excellent	19.2
wirb1007f	Hardwood Swamp - Forested Seep	5.7	Good	31.3
wirb1002f	Hardwood Swamp - Forested Seep	5.8	Good	30.7
wase001e	Open Bog	6.9	Fair to Very Poor	18.5
wasd1024s	Open Bog	8.2	Good	18.9
wasc1033s	Shrub-Carr	3.0	Very Poor	14.7
wirb037s	Shrub-Carr	4.7	Poor	34.0
wirb039s	Shrub-Carr	5.0	Poor	33.7
wasc061e	Vernal Pool[1]	3.6		5.9
wasc059e	Vernal Pool[1]	3.7		5.9
wird003e	Vernal Pool[1]	5.0		37.6
wirb1005f	Vernal Pool[1]	6.5		30.8

[1] - The community in this region has not been assigned a Condition Category

Appendix D – Wetland Species Lists/FQA Metrics

Sample Name	Crew	Date	Latitude	Longitude
wasb027f	SAM/IGL	2022-08-22	46.519349	-90.895202
Wetland Name		**Community Type**		
wasb027		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
281		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C (C̄n)**	**Weighted Mean C (wC̄n)**
36.535	31.818	4.717	4.108
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C (C̄a)**	**Weighted Mean C (wC̄a)**
34.069	29.871	4.101	3.596

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Populus tremuloides	quaking aspen	62.5	2	N
Alnus incana subsp. rugosa	speckled alder	15	4	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex lacustris	lake sedge	15	6	N
Rhamnus cathartica	common buckthorn	15	0	I
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis stolonifera	spreading bentgrass	2.5	0	I
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula papyrifera	canoe birch	2.5	3	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex interior	interior sedge	2.5	7	N
Carex intumescens	bladder sedge	2.5	5	N
Carex stipata	common fox sedge	2.5	2	N
Carex tenera	marsh straw sedge	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus racemosa	gray dogwood	2.5	2	N

Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Frangula alnus	glossy buckthorn	2.5	0	I
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Gaultheria procumbens	wintergreen	2.5	6	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Hieracium umbellatum	Canada hawkweed	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Phleum pratense subsp. pratense	timothy	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Potentilla simplex	oldfield cinquefoil	2.5	2	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Pteridium aquilinum	bracken	2.5	2	N
Ranunculus acris	tall buttercup	2.5	0	I
Ribes hirtellum	swamp gooseberry	2.5	6	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Salix bebbiana	Bebb's willow	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Solidago uliginosa	bog goldenrod	2.5	8	N
Spiraea alba var. alba	white meadowsweet	2.5	4	N
Stachys palustris	woundwort	2.5	5	N

Taraxacum officinale	common dandelion	2.5	0	I
Thelypteris palustris	northern marsh fern	2.5	7	N
Vaccinium myrtilloides	velvet-leaved blueberry	2.5	6	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum lentago	nannyberry	2.5	4	N
Viburnum rafinesquianum	downy arrowwood	2.5	7	N
Ulmus americana	American elm	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wasm002f	SAM/IGL	2022-08-23	46.515896	-90.895174
Wetland Name		**Community Type**		
wasm002		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
287		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
43.422	40.555	5.082	4.747
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
41.779	37.978	4.638	4.246

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	15	3	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Carex lacustris	lake sedge	15	6	N
Cornus racemosa	gray dogwood	15	2	N
Frangula alnus	glossy buckthorn	15	0	I
Populus tremuloides	quaking aspen	15	2	N
Abies balsamea	balsam fir	2.5	5	N
Agrostis gigantea	redtop	2.5	0	I
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex castanea	chestnut-colored sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex lupulina	hop umbrella sedge	2.5	6	N
Carex projecta	projecting sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Carex stipata	common fox sedge	2.5	2	N
Carex tenera	marsh straw sedge	2.5	4	N

Chelone glabra	white turtlehead	2.5	7	N
Cicuta maculata	common water-hemlock	2.5	6	N
Cirsium arvense	Canada thistle	2.5	0	I
Comarum palustre	marsh cinquefoil	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Hieracium umbellatum	Canada hawkweed	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Larix laricina	tamarack	2.5	8	N
Lysimachia thyrsiflora	tufted loosestrife	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mentha arvensis var. canadensis	common mint	2.5	3	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Penthorum sedoides	ditch stonecrop	2.5	3	N
Phleum pratense subsp. pratense	timothy	2.5	0	I
Pinus strobus	white pine	2.5	5	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Potentilla simplex	oldfield cinquefoil	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus macrocarpa var. macrocarpa	bur oak	2.5	5	N
Ranunculus acris	tall buttercup	2.5	0	I
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes hirtellum	swamp gooseberry	2.5	6	N

Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rumex britannica	great water dock	2.5	8	N
Salix petiolaris	slender willow	2.5	6	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria galericulata	marsh skullcap	2.5	5	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Sium suave	water parsnip	2.5	5	N
Maianthemum trifolium	false mayflower	2.5	10	N
Solidago gigantea	giant goldenrod	2.5	3	N
Spiraea alba var. alba	white meadowsweet	2.5	4	N
Toxicodendron rydbergii	western poison ivy	2.5	2	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Vaccinium myrtilloides	velvet-leaved blueberry	2.5	6	N
Veronica officinalis	common speedwell	2.5	0	I
Waldsteinia fragarioides	barren-strawberry	2.5	6	N
Fraxinus nigra	black ash	1	8	N
Prenanthes alba	white rattlesnakeroot	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wasm002e	SAM/IGL	2022-08-22	46.516123	-90.895057
Wetland Name		**Community Type**		
wasm002		Fresh Meadow (Native Subtype)		
Total % Cover		**Total % Non-Native Cover**		
238.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
29.918	2.016	5.057	0.341
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
28.713	29.478	4.658	4.782

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Calamagrostis canadensis	bluejoint	62.5	5	N
Carex lacustris	lake sedge	62.5	6	N
Phalaris arundinacea	reed canary grass	15	0	I
Scirpus cyperinus	wool-grass	15	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex projecta	projecting sedge	2.5	4	N
Cirsium arvense	Canada thistle	2.5	0	I
Comarum palustre	marsh cinquefoil	2.5	8	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Epilobium strictum	downy willow herb	2.5	10	N
Equisetum pratense	meadow horsetail	2.5	9	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Juncus effusus	common rush	2.5	4	N
Lycopus americanus	cut-leaved bugleweed	2.5	4	N

Lycopus uniflorus	northern bugleweed	2.5	4	N
Mentha arvensis var. canadensis	common mint	2.5	3	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes hirtellum	swamp gooseberry	2.5	6	N
Salix petiolaris	slender willow	2.5	6	N
Salix pyrifolia	balsam willow	2.5	7	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago gigantea	giant goldenrod	2.5	3	N
Spiraea alba var. alba	white meadowsweet	2.5	4	N
Triadenum fraseri	marsh St. John's wort	2.5	8	N
Verbena hastata	blue vervain	2.5	3	N
Rumex britannica	great water dock	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wasm001f	SAM/IGL	2022-08-23	46.505962	-90.89445
Wetland Name		**Community Type**		
wasm001		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
162		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
25.069	1.067	4.655	0.198
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
24.648	22.416	4.500	4.093

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Corylus cornuta	beaked hazelnut	37.5	5	N
Populus tremuloides	quaking aspen	37.5	2	N
Acer rubrum	red maple	15	3	N
Rubus pubescens	dwarf raspberry	15	7	N
Abies balsamea	balsam fir	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex lacustris	lake sedge	2.5	6	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus racemosa	gray dogwood	2.5	2	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus macrocarpa var. macrocarpa	bur oak	2.5	5	N
Ribes hirtellum	swamp gooseberry	2.5	6	N

Rosa acicularis	prickly rose	2.5	6	N
Toxicodendron rydbergii	western poison ivy	2.5	2	N
Veronica officinalis	common speedwell	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	1	6	N
Viburnum rafinesquianum	downy arrowwood	1	7	N
Athyrium filix-femina var. angustum	lady fern	0	5	N
Galium tinctorium	southern three-lobed bedstraw	0	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasa1054f	SAM/IGL	2022-08-31	46.500299	-90.894283
Wetland Name		**Community Type**		
wasa1054		Floodplain Forest		
Total % Cover		**Total % Non-Native Cover**		
331.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
31.242	2.757	4.033	0.356
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
28.720	32.065	3.408	3.805

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Fraxinus pennsylvanica	green ash	37.5	2	N
Matteuccia struthiopteris	American ostrich fern	37.5	5	N
Acer negundo	box elder	15	0	N
Carex bromoides	brome-like sedge	15	8	N
Laportea canadensis	woodnettle	15	4	N
Rhamnus cathartica	common buckthorn	15	0	I
Vitis riparia	wild grape	15	2	N
Acer saccharum	sugar maple	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Boehmeria cylindrica	false nettle	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex radiata	eastern star sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Cicuta maculata	common water-hemlock	2.5	6	N
Cirsium arvense	Canada thistle	2.5	0	I
Cirsium vulgare	bull thistle	2.5	0	I

Cornus stolonifera	red osier dogwood	2.5	3	N
Echinocystis lobata	wild cucumber	2.5	2	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Erigeron annuus	annual fleabane	2.5	0	N
Geum aleppicum	yellow avens	2.5	3	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Heracleum lanatum	cow parsnip	2.5	3	N
Humulus lupulus	common hops	2.5	3	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lapsana communis	nipplewort	2.5	0	I
Lemna minor	common duckweed	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Melilotus alba	white sweet clover	2.5	0	I
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Pilea fontana	black-fruited clearweed	2.5	7	N
Pinus strobus	white pine	2.5	5	N
Plantago major	common plantain	2.5	0	I
Potentilla norvegica	rough cinquefoil	2.5	0	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes americanum	wild black currant	2.5	4	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Stachys palustris	woundwort	2.5	5	N
Tanacetum vulgare	tansy	2.5	0	I
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Ulmus americana	American elm	2.5	3	N
Urtica dioica subsp. gracilis	stinging nettle	2.5	0	I
Verbena hastata	blue vervain	2.5	3	N
Viola sororia	door-yard violet	2.5	3	N
Achillea millefolium	common yarrow	1	1	N

Arctium minus	common burdock	1	0	I
Asclepias incarnata	swamp milkweed	1	5	N
Bromus ciliatus	fringed brome	1	7	N
Caulophyllum thalictroides	blue cohosh	1	8	N
Erechtites hieracifolia var. hieracifolia	American burn-weed	1	2	N
Oenothera biennis	bastard evening-primrose	1	1	N
Tilia americana	American basswood	1	5	N
Verbascum thapsus	common mullein	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasc059e	SAM/IGL	2022-08-23	46.481739	-90.902932
Wetland Name		**Community Type**		
wasc059		Hardwood Swamp (Vernal Pool Subtype)		
Total % Cover		**Total % Non-Native Cover**		
154.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
25.938	0.968	4.515	0.169
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
25.553	21.286	4.382	3.650

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	62.5	3	N
Fraxinus pennsylvanica	green ash	15	2	N
Abies balsamea	balsam fir	2.5	5	N
Anemone quinquefolia	wood anemone	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Cornus racemosa	gray dogwood	2.5	2	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Populus tremuloides	quaking aspen	2.5	2	N

Prunella vulgaris	heal-all	2.5	1	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ribes hirtellum	swamp gooseberry	2.5	6	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Rosa acicularis	prickly rose	1	6	N
Ulmus americana	American elm	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wasc061e	SAM/IGL	2022-08-23	46.481103	-90.903034
Wetland Name		**Community Type**		
wasc061		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
106.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
18.985	0.524	4.143	0.114
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
17.400	17.958	3.480	3.592

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Symphyotrichum lateriflorum	side-flowering aster	15	3	N
Carex gracillima	graceful sedge	15	5	N
Fraxinus pennsylvanica	green ash	15	2	N
Galium triflorum	fragrant bedstraw	15	5	N
Acer rubrum	red maple	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Cornus racemosa	gray dogwood	2.5	2	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Geum aleppicum	yellow avens	2.5	3	N
Ilex verticillata	common winterberry	2.5	7	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Rosa acicularis	prickly rose	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Veronica officinalis	common speedwell	2.5	0	I
Abies balsamea	balsam fir	1	5	N
Cerastium fontanum subsp. vulgare	mouse-ear chickweed	1	0	I
Epilobium coloratum	purple-leaved willow herb	1	3	N

Picea glauca	white spruce	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wasc062f	SAM/IGL	2022-08-23	46.480073	-90.9022

Wetland Name	Community Type
wasc062	Hardwood Swamp
Total % Cover	**Total % Non-Native Cover**
187	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C ($w\bar{C}n$)**
27.333	1.860	4.556	0.310
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C ($w\bar{C}a$)**
26.961	33.748	4.432	5.548

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Abies balsamea	balsam fir	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Populus tremuloides	quaking aspen	15	2	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Cornus racemosa	gray dogwood	2.5	2	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N

Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Lactuca biennis	biennial blue lettuce	1	3	N
Viburnum rafinesquianum	downy arrowwood	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wase1016f	EJO/MJF	2022-08-23	46.430542	-90.855162
Wetland Name		**Community Type**		
wase1016		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
390		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
47.840	5.581	4.808	0.561
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
45.803	50.030	4.407	4.814

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Acer rubrum	red maple	15	3	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex intumescens	bladder sedge	15	5	N
Corylus cornuta	beaked hazelnut	15	5	N
Pinus strobus	white pine	15	5	N
Rubus pubescens	dwarf raspberry	15	7	N
Viburnum lentago	nannyberry	15	4	N
Abies balsamea	balsam fir	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum firmum	shining aster	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula papyrifera	canoe birch	2.5	3	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N

Carex lacustris	lake sedge	2.5	6	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex projecta	projecting sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Carex stipata	common fox sedge	2.5	2	N
Carex tenera	marsh straw sedge	2.5	4	N
Carex tuckermanii	Tuckerman's sedge	2.5	8	N
Chelone glabra	white turtlehead	2.5	7	N
Cinna latifolia	drooping woodreed	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cirsium vulgare	bull thistle	2.5	0	I
Clematis virginiana	virgin's bower	2.5	4	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus racemosa	gray dogwood	2.5	2	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus americana	American hazelnut	2.5	5	N
Diervilla lonicera	bush honeysuckle	2.5	6	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Frangula alnus	glossy buckthorn	2.5	0	I
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N

Lobelia inflata	Indian tobacco	2.5	2	N
Lycopus americanus	cut-leaved bugleweed	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Persicaria hydropiper	marsh waterpepper	2.5	0	I
Phalaris arundinacea	reed canary grass	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Potentilla norvegica	rough cinquefoil	2.5	0	N
Potentilla simplex	oldfield cinquefoil	2.5	2	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes hirtellum	swamp gooseberry	2.5	6	N
Ribes triste	swamp red currant	2.5	8	N
Rosa blanda	smooth wild rose	2.5	4	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Salix petiolaris	slender willow	2.5	6	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago gigantea	giant goldenrod	2.5	3	N
Spiraea alba var. alba	white meadowsweet	2.5	4	N
Stellaria longifolia	long-leaved chickweed	2.5	5	N
Taraxacum officinale	common dandelion	2.5	0	I

Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Vaccinium myrtilloides	velvet-leaved blueberry	2.5	6	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum rafinesquianum	downy arrowwood	2.5	7	N
Waldsteinia fragarioides subsp. fragarioides	barren-strawberry	2.5	6	N
Picea glauca	white spruce	0	7	N

Sample Name	Crew	Date	Latitude	Longitude
wasa1006f	EJO/MJF	2022-08-23	46.404877	-90.81107
Wetland Name		**Community Type**		
wasa1006		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
237.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
36.214	2.756	4.839	0.368
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
34.698	40.531	4.443	5.189

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Acer saccharum	sugar maple	15	5	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Thuja occidentalis	white cedar	15	9	N
Ulmus americana	American elm	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Acer negundo	box elder	2.5	0	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula papyrifera	canoe birch	2.5	3	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex lacustris	lake sedge	2.5	6	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cornus stolonifera	red osier dogwood	2.5	3	N

Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum scirpoides	dwarf scouring rush	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glechoma hederacea	creeping charlie	2.5	0	I
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Poa palustris	fowl bluegrass	2.5	5	N
Populus balsamifera	balsam poplar	2.5	4	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes glandulosum	skunk currant	2.5	7	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Triosteum aurantiacum	orange-fruit horse gentian	2.5	5	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum lentago	nannyberry	2.5	4	N
Vitis riparia	wild grape	2.5	2	N

Sample Name	Crew	Date	Latitude	Longitude
wasc1033e	SAM/IGL	2022-08-31	46.401547	-90.801625
Wetland Name		**Community Type**		
wasc1033		Fresh Meadow (Disturbed Subtype)		
Total % Cover		**Total % Non-Native Cover**		
232		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
16.898	1.029	3.138	0.191
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
14.572	18.237	2.333	2.920

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Cornus stolonifera	red osier dogwood	15	3	N
Equisetum arvense	field horsetail	15	1	N
Glyceria grandis var. grandis	American manna grass	15	6	N
Leersia oryzoides	rice cut grass	15	3	N
Populus balsamifera	balsam poplar	15	4	N
Rubus idaeus var. strigosus	red raspberry	15	3	N
Salix interior	sandbar willow	15	2	N
Scirpus atrovirens	black bulrush	15	3	N
Scirpus microcarpus	panicled bulrush	15	6	N
Solidago gigantea	giant goldenrod	15	3	N
Vitis riparia	wild grape	15	2	N
Agrostis gigantea	redtop	2.5	0	I
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Asclepias syriaca	common milkweed	2.5	1	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Barbarea vulgaris	yellow rocket	2.5	0	I
Bidens frondosa	common beggar-ticks	2.5	1	N
Carex retrorsa	retrorse sedge	2.5	6	N
Carex stipata	common fox sedge	2.5	2	N
Carex vulpinoidea	fox sedge	2.5	2	N
Daucus carota	Queen Anne's lace	2.5	0	I
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Glyceria striata	fowl manna grass	2.5	4	N

Impatiens capensis	spotted touch-me-not	2.5	2	N
Juncus effusus	common rush	2.5	4	N
Lycopus americanus	cut-leaved bugleweed	2.5	4	N
Melilotus alba	white sweet clover	2.5	0	I
Melilotus officinalis	yellow sweet clover	2.5	0	I
Mentha arvensis var. canadensis	common mint	2.5	3	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Pteridium aquilinum	bracken	2.5	2	N
Rumex obtusifolius	bitter dock	2.5	0	I
Salix eriocephala	diamond willow	2.5	4	N
Sonchus arvensis	field sow thistle	2.5	0	I
Ulmus americana	American elm	2.5	3	N
Verbena hastata	blue vervain	2.5	3	N
Potentilla recta	rough-fruited cinquefoil	1	0	I
Ranunculus acris	tall buttercup	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasc1033s	SAM/IGL	2022-08-31	46.401375	-90.801943
Wetland Name		**Community Type**		
wasc1033		Shrub-Carr		
Total % Cover		**Total % Non-Native Cover**		
310.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
19.535	1.455	3.567	0.266
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
17.358	18.692	2.816	3.032

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Equisetum hyemale subsp. affine	common scouring rush	87.5	3	N
Salix interior	sandbar willow	62.5	2	N
Cornus stolonifera	red osier dogwood	15	3	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Populus balsamifera	balsam poplar	15	4	N
Rhus hirta	staghorn sumac	15	2	N
Thuja occidentalis	white cedar	15	9	N
Vitis riparia	wild grape	15	2	N
Achillea millefolium	common yarrow	2.5	1	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alisma triviale	common water plantain	2.5	4	N
Amphicarpaea bracteata	hog peanut	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum arvense	field horsetail	2.5	1	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Lapsana communis	nipplewort	2.5	0	I
Leersia oryzoides	rice cut grass	2.5	3	N
Leucanthemum vulgare	ox-eye daisy	2.5	0	I
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N

Persicaria maculosa	lady's thumb	2.5	0	I
Phalaris arundinacea	reed canary grass	2.5	0	I
Pinus strobus	white pine	2.5	5	N
Plantago major	common plantain	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Pteridium aquilinum	bracken	2.5	2	N
Scirpus atrovirens	black bulrush	2.5	3	N
Solidago gigantea	giant goldenrod	2.5	3	N
Sonchus arvensis	field sow thistle	2.5	0	I
Taraxacum officinale	common dandelion	2.5	0	I
Verbena hastata	blue vervain	2.5	3	N
Arisaema triphyllum	Jack-in-the-pulpit	1	5	N
Barbarea vulgaris	yellow rocket	1	0	I
Rudbeckia hirta var. pulcherrima	black-eyed susan	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wasc1014f	SAM/IGL	2022-08-31	46.397666	-90.781389

Wetland Name	Community Type
wasc1014	Floodplain Forest
Total % Cover	**Total % Non-Native Cover**
323	0

Floristic Quality Metrics: Native Species (n)			
FQIn	wFQIn	Mean C ($\bar{C}$n)	Weighted Mean C (w$\bar{C}$n)
22.528	1.728	3.476	0.267
Floristic Quality Metrics: All Species (a)			
FQIa	wFQIa	Mean C ($\bar{C}$a)	Weighted Mean C (w$\bar{C}$a)
19.868	21.499	2.704	2.926

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Populus balsamifera	balsam poplar	62.5	4	N
Equisetum arvense	field horsetail	37.5	1	N
Matteuccia struthiopteris	American ostrich fern	37.5	5	N
Fraxinus pennsylvanica	green ash	15	2	N
Impatiens capensis	spotted touch-me-not	15	2	N
Phalaris arundinacea	reed canary grass	15	0	I
Solidago gigantea	giant goldenrod	15	3	N
Viburnum lentago	nannyberry	15	4	N
Acalypha rhomboidea	three-seeded mercury	2.5	0	N
Actaea rubra	red baneberry	2.5	7	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis gigantea	redtop	2.5	0	I
Alisma triviale	common water plantain	2.5	4	N
Alliaria petiolata	garlic mustard	2.5	0	I
Amphicarpaea bracteata	hog peanut	2.5	5	N
Asclepias syriaca	common milkweed	2.5	1	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Calystegia sepium	hedge bindweed	2.5	2	N
Carex gracillima	graceful sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Clematis virginiana	virgin's bower	2.5	4	N
Cornus racemosa	gray dogwood	2.5	2	N

Cornus stolonifera	red osier dogwood	2.5	3	N
Daucus carota	Queen Anne's lace	2.5	0	I
Echinochloa crus-galli	cockspur barnyard grass	2.5	0	I
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Galium boreale	northern bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Laportea canadensis	woodnettle	2.5	4	N
Lapsana communis	nipplewort	2.5	0	I
Lycopus virginicus	Virginia bugleweed	2.5	8	N
Muhlenbergia mexicana	Mexican muhly grass	2.5	4	N
Myosotis scorpioides	true forget-me-not	2.5	0	I
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Persicaria maculosa	lady's thumb	2.5	0	I
Plantago major	common plantain	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Prunella vulgaris	heal-all	2.5	1	N
Ribes americanum	wild black currant	2.5	4	N
Rumex crispus	curly dock	2.5	0	I
Salix bebbiana	Bebb's willow	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Verbena hastata	blue vervain	2.5	3	N
Viola labradorica	alpine violet	2.5	4	N
Viola sororia	door-yard violet	2.5	3	N
Vitis riparia	wild grape	2.5	2	N
Geum canadense	white avens	1	2	N
Medicago lupulina	black medick	1	0	I
Ribes cynosbati	prickly gooseberry	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wasc1041f	EJO/MJF	2022-08-23	46.39041	-90.774793
Wetland Name		**Community Type**		
wasc1041		Floodplain Forest		
Total % Cover		**Total % Non-Native Cover**		
349.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
39.064	3.601	4.423	0.408
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
34.674	38.846	3.485	3.904

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	15	3	N
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Betula papyrifera	canoe birch	15	3	N
Fraxinus pennsylvanica	green ash	15	2	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Populus tremuloides	quaking aspen	15	2	N
Thuja occidentalis	white cedar	15	9	N
Tilia americana	American basswood	15	5	N
Achillea millefolium	common yarrow	2.5	1	N
Actaea rubra	red baneberry	2.5	7	N
Agrostis gigantea	redtop	2.5	0	I
Amphicarpaea bracteata	hog peanut	2.5	5	N
Arctium minus	common burdock	2.5	0	I
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N

Carex projecta	projecting sedge	2.5	4	N
Carex vulpinoidea	fox sedge	2.5	2	N
Cicuta bulbifera	bulb-bearing water hemlock	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cornus alternifolia	pagoda dogwood	2.5	7	N
Danthonia spicata	poverty grass	2.5	4	N
Daucus carota	Queen Anne's lace	2.5	0	I
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum scirpoides	dwarf scouring rush	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Erigeron philadelphicus var. philadelphicus	common fleabane	2.5	2	N
Eupatorium perfoliatum	boneset	2.5	6	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fraxinus nigra	black ash	2.5	8	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lapsana communis	nipplewort	2.5	0	I
Maianthemum canadense	Canada mayflower	2.5	5	N
Melilotus alba	white sweet clover	2.5	0	I
Melilotus officinalis	yellow sweet clover	2.5	0	I
Mitchella repens	partridgeberry	2.5	6	N
Muhlenbergia mexicana	Mexican muhly grass	2.5	4	N
Myosotis scorpioides	true forget-me-not	2.5	0	I
Myosoton aquaticum	giant chickweed	2.5	0	I
Oenothera biennis	bastard evening-primrose	2.5	1	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Ostrya virginiana	ironwood	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Picea glauca	white spruce	2.5	7	N
Plantago major	common plantain	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Fallopia cilinodis	black-fringe bindweed	2.5	1	N

Persicaria lapathifolia	curly-top knotweed	2.5	2	N
Persicaria pensylvanica	Pennsylvania knotweed	2.5	1	N
Populus balsamifera	balsam poplar	2.5	4	N
Prunella vulgaris	heal-all	2.5	1	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola asarifolia subsp. asarifolia	liver-leaf wintergreen	2.5	8	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes americanum	wild black currant	2.5	4	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rumex obtusifolius	bitter dock	2.5	0	I
Salix discolor	pussy willow	2.5	2	N
Scrophularia lanceolata	lance-leaved figwort	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Setaria pumila subsp. pumila	yellow foxtail	2.5	0	I
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Stachys palustris	woundwort	2.5	5	N
Tanacetum vulgare	tansy	2.5	0	I
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Thalictrum dioicum	early meadow-rue	2.5	7	N
Trifolium pratense	red clover	2.5	0	I
Ulmus americana	American elm	2.5	3	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Verbena hastata	blue vervain	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Vitis riparia	wild grape	2.5	2	N
Oxalis stricta	yellow wood-sorrel	1	0	N
Thelypteris palustris	northern marsh fern	1	7	N
Lotus corniculatus	bird's-foot trefoil	0	0	I
Saponaria officinalis	bouncing bet	0	0	I
Urtica dioica subsp. gracilis	stinging nettle	0	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasc1045e	EJO/MJF	2022-08-23	46.389226	-90.770492
Wetland Name		**Community Type**		
wasc1045		Fresh Meadow (Disturbed Subtype)		
Total % Cover		**Total % Non-Native Cover**		
200		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
30.652	1.695	4.674	0.258
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
28.146	30.887	3.941	4.325

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Matteuccia struthiopteris	American ostrich fern	37.5	5	N
Betula alleghaniensis	yellow birch	15	7	N
Betula papyrifera	canoe birch	15	3	N
Tilia americana	American basswood	15	5	N
Acer rubrum	red maple	2.5	3	N
Actaea rubra	red baneberry	2.5	7	N
Agrimonia striata	roadside agrimony	2.5	3	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex tenera	marsh straw sedge	2.5	4	N
Chelone glabra	white turtlehead	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium triflorum	fragrant bedstraw	2.5	5	N

Geum aleppicum	yellow avens	2.5	3	N
Geum laciniatum	rough avens	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lapsana communis	nipplewort	2.5	0	I
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Myosoton aquaticum	giant chickweed	2.5	0	I
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Polygonum hydropiper		2.5	0	
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Ranunculus acris	tall buttercup	2.5	0	I
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes americanum	wild black currant	2.5	4	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Thuja occidentalis	white cedar	2.5	9	N
Viburnum acerifolium	dockmackie	2.5	7	N

Sample Name	Crew	Date	Latitude	Longitude
wasc1045f	EJO/MJF	2022-08-23	46.389954	-90.770289

Wetland Name	Community Type
wasc1045	Floodplain Forest
Total % Cover	**Total % Non-Native Cover**
235	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
34.796	2.107	5.130	0.311
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
34.424	30.340	5.021	4.426

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	37.5	3	N
Acer saccharum	sugar maple	15	5	N
Carex bromoides	brome-like sedge	15	8	N
Fraxinus pennsylvanica	green ash	15	2	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Populus tremuloides	quaking aspen	15	2	N
Tilia americana	American basswood	15	5	N
Ulmus americana	American elm	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Actaea rubra	red baneberry	2.5	7	N
Amphicarpaea bracteata	hog peanut	2.5	5	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex interior	interior sedge	2.5	7	N
Carex tenera	marsh straw sedge	2.5	4	N
Equisetum pratense	meadow horsetail	2.5	9	N
Fraxinus nigra	black ash	2.5	8	N
Galium triflorum	fragrant bedstraw	2.5	5	N

Glyceria grandis var. grandis	American manna grass	2.5	6	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola asarifolia subsp. asarifolia	liver-leaf wintergreen	2.5	8	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes cynosbati	prickly gooseberry	2.5	3	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Trillium grandiflorum	large-flowered trillium	2.5	6	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Viburnum acerifolium	dockmackie	2.5	7	N
Carex pedunculata	long-stalked sedge	0	7	N
Monotropa uniflora	Ghost pipe	0	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasb1004f	SAM/IGL	2022-08-23	46.386864	-90.761109
Wetland Name		**Community Type**		
wasb1004		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
218		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
24.675	1.291	3.854	0.202
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
22.345	21.894	3.160	3.096

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus pennsylvanica	green ash	37.5	2	N
Acer rubrum	red maple	15	3	N
Carex gracillima	graceful sedge	15	5	N
Onoclea sensibilis	sensitive fern	15	5	N
Populus tremuloides	quaking aspen	15	2	N
Scirpus hattorianus	mosquito bulrush	15	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis gigantea	redtop	2.5	0	I
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Betula papyrifera	canoe birch	2.5	3	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex arctata	drooping wood sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex vulpinoidea	fox sedge	2.5	2	N
Cornus racemosa	gray dogwood	2.5	2	N
Dactylis glomerata	orchard grass	2.5	0	I
Daucus carota	Queen Anne's lace	2.5	0	I
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N

Geum aleppicum	yellow avens	2.5	3	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Hieracium umbellatum	Canada hawkweed	2.5	5	N
Juncus dudleyi	Dudley's rush	2.5	4	N
Leersia oryzoides	rice cut grass	2.5	3	N
Lotus corniculatus	bird's-foot trefoil	2.5	0	I
Lycopus americanus	cut-leaved bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Monotropa uniflora	Ghost pipe	2.5	5	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Plantago major	common plantain	2.5	0	I
Poa compressa	Canada bluegrass	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Solidago gigantea	giant goldenrod	2.5	3	N
Spiraea alba var. alba	white meadowsweet	2.5	4	N
Tilia americana	American basswood	2.5	5	N
Verbena hastata	blue vervain	2.5	3	N
Viburnum lentago	nannyberry	2.5	4	N
Vitis riparia	wild grape	2.5	2	N
Cornus obliqua	blue-fruited dogwood	1	4	N
Prunus virginiana var. virginiana	chokecherry	1	3	N
Ulmus americana	American elm	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wase001e	EJO/MJF	2022-08-24	46.377617	-90.741574
Wetland Name		**Community Type**		
wase001		Open Bog		
Total % Cover		**Total % Non-Native Cover**		
192.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
33.580	2.420	5.447	0.393
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
33.580	42.270	5.447	6.857

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Chamaedaphne calyculata var. angustifolia	leather-leaf	62.5	9	N
Carex oligosperma	bog wiregrass sedge	15	10	N
Carex utriculata	beaked sedge	15	7	N
Scirpus cyperinus	wool-grass	15	4	N
Acer rubrum	red maple	2.5	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Betula papyrifera	canoe birch	2.5	3	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex lasiocarpa subsp. americana	narrow-leaved woolly sedge	2.5	9	N
Epilobium leptophyllum	linear-leaved willow herb	2.5	8	N
Eriophorum virginicum	tawny cottongrass	2.5	10	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Ilex mucronata	cat-berry	2.5	8	N
Ilex verticillata	common winterberry	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N
Larix laricina	tamarack	2.5	8	N
Rhododendron groenlandicum	Labrador-tea	2.5	8	N
Lysimachia thyrsiflora	tufted loosestrife	2.5	7	N
Onoclea sensibilis	sensitive fern	2.5	5	N

Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Pteridium aquilinum	bracken	2.5	2	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Salix bebbiana	Bebb's willow	2.5	7	N
Salix discolor	pussy willow	2.5	2	N
Salix pedicellaris	bog willow	2.5	8	N
Salix petiolaris	slender willow	2.5	6	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thelypteris palustris	northern marsh fern	2.5	7	N
Triadenum fraseri	marsh St. John's wort	2.5	8	N
Typha latifolia	broad-leaved cattail	2.5	1	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1024e	EJO/MJF	2022-08-24	46.377567	-90.736004
Wetland Name		**Community Type**		
wasd1024		Fresh Meadow (Native Subtype)		
Total % Cover		**Total % Non-Native Cover**		
202.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C (C̄n)**	**Weighted Mean C (wC̄n)**
29.829	1.604	4.659	0.251
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C (C̄a)**	**Weighted Mean C (wC̄a)**
29.127	27.282	4.442	4.160

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Calamagrostis canadensis	bluejoint	37.5	5	N
Scirpus cyperinus	wool-grass	37.5	4	N
Rubus idaeus var. strigosus	red raspberry	15	3	N
Solidago canadensis	Canadian goldenrod	15	1	N
Acer rubrum	red maple	2.5	3	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex lacustris	lake sedge	2.5	6	N
Carex tenera	marsh straw sedge	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N
Epilobium angustifolium subsp. circumvagum	fireweed	2.5	3	N
Epilobium leptophyllum	linear-leaved willow herb	2.5	8	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fragaria vesca subsp. americana	hillside strawberry	2.5	3	N
Fragaria virginiana	common strawberry	2.5	1	N
Frangula alnus	glossy buckthorn	2.5	0	I
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N

Galium triflorum	fragrant bedstraw	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N
Lysimachia thyrsiflora	tufted loosestrife	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Parthenocissus vitacea	woodbine	2.5	4	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Pteridium aquilinum	bracken	2.5	2	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex britannica	great water dock	2.5	8	N
Salix bebbiana	Bebb's willow	2.5	7	N
Solidago gigantea	giant goldenrod	2.5	3	N
Tanacetum vulgare	tansy	2.5	0	I
Viburnum lentago	nannyberry	2.5	4	N
Vitis riparia	wild grape	2.5	2	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1024f1	EJO/MJF	2022-08-24	46.377779	-90.735898
Wetland Name		**Community Type**		
wasd1024		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
213.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
28.735	1.446	4.857	0.244
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
27.948	23.419	4.595	3.850

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Populus tremuloides	quaking aspen	62.5	2	N
Fraxinus nigra	black ash	15	8	N
Fraxinus pennsylvanica	green ash	15	2	N
Pteridium aquilinum	bracken	15	2	N
Rubus pubescens	dwarf raspberry	15	7	N
Viburnum lentago	nannyberry	15	4	N
Acer rubrum	red maple	2.5	3	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Gaultheria procumbens	wintergreen	2.5	6	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Ilex verticillata	common winterberry	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N

Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Prunus serotina	wild black cherry	2.5	3	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus rubra	northern red oak	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Solidago gigantea	giant goldenrod	2.5	3	N
Vaccinium myrtilloides	velvet-leaved blueberry	2.5	6	N
Veronica officinalis	common speedwell	2.5	0	I
Pinus resinosa	red pine	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1024f2	EJO/MJF	2022-08-24	46.37772	-90.735523
Wetland Name		**Community Type**		
wasd1024		Coniferous Bog		
Total % Cover		**Total % Non-Native Cover**		
225		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C ($w\bar{C}n$)**
41.100	3.225	6.757	0.530
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C ($w\bar{C}a$)**
41.100	48.189	6.757	7.922

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Chamaedaphne calyculata var. angustifolia	leather-leaf	62.5	9	N
Picea mariana	black spruce	37.5	8	N
Carex oligosperma	bog wiregrass sedge	15	10	N
Carex trisperma	three-seeded bog sedge	15	9	N
Rhododendron groenlandicum	Labrador-tea	15	8	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Andromeda glaucophylla	bog-rosemary	2.5	10	N
Betula papyrifera	canoe birch	2.5	3	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex magellanica	boreal bog sedge	2.5	10	N
Carex scoparia var. scoparia	lance-fruited oval sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Carex tenera	marsh straw sedge	2.5	4	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Eriophorum vaginatum subsp. spissum	tussock cotton-grass	2.5	10	N
Eriophorum virginicum	tawny cottongrass	2.5	10	N
Fraxinus nigra	black ash	2.5	8	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Gaultheria hispidula	creeping snowberry	2.5	8	N
Ilex mucronata	cat-berry	2.5	8	N
Iris versicolor	northern blue flag	2.5	5	N
Kalmia polifolia	bog laurel	2.5	10	N
Larix laricina	tamarack	2.5	8	N

Lycopus uniflorus	northern bugleweed	2.5	4	N
Lysimachia thyrsiflora	tufted loosestrife	2.5	7	N
Parthenocissus vitacea	woodbine	2.5	4	N
Picea glauca	white spruce	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Rumex britannica	great water dock	2.5	8	N
Salix petiolaris	slender willow	2.5	6	N
Salix pyrifolia	balsam willow	2.5	7	N
Sarracenia purpurea subsp. purpurea	purple pitcher-plant	2.5	10	N
Scirpus cyperinus	wool-grass	2.5	4	N
Maianthemum trifolium	false mayflower	2.5	10	N
Typha latifolia	broad-leaved cattail	2.5	1	N
Vaccinium myrtilloides	velvet-leaved blueberry	2.5	6	N
Vaccinium oxycoccos	small cranberry	2.5	9	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1024s	EJO/MJF	2022-08-24	46.377141	-90.733265
Wetland Name		**Community Type**		
wasd1024		Open Bog		
Total % Cover		**Total % Non-Native Cover**		
142.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
33.154	1.658	6.913	0.346
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
33.154	39.124	6.913	8.158

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Chamaedaphne calyculata var. angustifolia	leather-leaf	87.5	9	N
Acer rubrum	red maple	2.5	3	N
Andromeda glaucophylla	bog-rosemary	2.5	10	N
Betula papyrifera	canoe birch	2.5	3	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex magellanica	boreal bog sedge	2.5	10	N
Carex oligosperma	bog wiregrass sedge	2.5	10	N
Carex trisperma	three-seeded bog sedge	2.5	9	N
Eriophorum virginicum	tawny cottongrass	2.5	10	N
Ilex mucronata	cat-berry	2.5	8	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Kalmia polifolia	bog laurel	2.5	10	N
Larix laricina	tamarack	2.5	8	N
Rhododendron groenlandicum	Labrador-tea	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Picea glauca	white spruce	2.5	7	N
Populus tremuloides	quaking aspen	2.5	2	N
Rumex britannica	great water dock	2.5	8	N
Scirpus cyperinus	wool-grass	2.5	4	N
Maianthemum trifolium	false mayflower	2.5	10	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1028f	SAM/IGL	2022-08-29	46.376064	-90.728143
Wetland Name		**Community Type**		
wasd1028		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
201		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
37.086	2.629	5.591	0.396
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
36.271	44.895	5.348	6.619

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Thuja occidentalis	white cedar	37.5	9	N
Carex scabrata	eastern rough sedge	15	8	N
Onoclea sensibilis	sensitive fern	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Betula papyrifera	canoe birch	2.5	3	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Chelone glabra	white turtlehead	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cornus alternifolia	pagoda dogwood	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N

Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum scirpoides	dwarf scouring rush	2.5	7	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Populus tremuloides	quaking aspen	2.5	2	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Galium triflorum	fragrant bedstraw	1	5	N
Picea glauca	white spruce	1	7	N
Solanum dulcamara	bittersweet nightshade	1	0	I
Trillium cernuum	nodding trillium	1	8	N
Tsuga canadensis	eastern hemlock	1	8	N
Veronica officinalis	common speedwell	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasa139f_x	SAM/IGL	2022-09-02	46.372871	-90.712234
Wetland Name		**Community Type**		
wasa139_x		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
280.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
36.137	3.246	4.873	0.438
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
35.813	41.378	4.786	5.529

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Acer saccharum	sugar maple	37.5	5	N
Alnus incana subsp. rugosa	speckled alder	15	4	N
Carex bromoides	brome-like sedge	15	8	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Rubus idaeus var. strigosus	red raspberry	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Calystegia sepium	hedge bindweed	2.5	2	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cornus racemosa	gray dogwood	2.5	2	N

Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Galium asprellum	rough bedstraw	2.5	7	N
Geum canadense	white avens	2.5	2	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Laportea canadensis	woodnettle	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rumex obtusifolius	bitter dock	2.5	0	I
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Thuja occidentalis	white cedar	2.5	9	N
Tilia americana	American basswood	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Viburnum lentago	nannyberry	2.5	4	N
Prunus serotina	wild black cherry	1	3	N
Stachys palustris	woundwort	1	5	N
Trillium cernuum	nodding trillium	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wasv013f	EJO/MJF	2022-08-24	46.363381	-90.702992
Wetland Name		**Community Type**		
wasv013		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
212.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
35.218	1.813	5.083	0.262
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
34.167	29.574	4.784	4.141

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus pennsylvanica	green ash	62.5	2	N
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula papyrifera	canoe birch	2.5	3	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex rosea	starry sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex tenera	marsh straw sedge	2.5	4	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus racemosa	gray dogwood	2.5	2	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N

Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Gaultheria procumbens	wintergreen	2.5	6	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Ostrya virginiana	ironwood	2.5	5	N
Picea glauca	white spruce	2.5	7	N
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus rubra	northern red oak	2.5	5	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Veronica officinalis	common speedwell	2.5	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasv019e	EJO/MJF	2022-08-24	46.359626	-90.694212
Wetland Name		**Community Type**		
wasv019		Fresh Meadow (Disturbed Subtype)		
Total % Cover		**Total % Non-Native Cover**		
230		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
30.243	1.431	4.667	0.221
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
24.694	25.624	3.111	3.228

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Juncus effusus	common rush	37.5	4	N
Glyceria grandis var. grandis	American manna grass	15	6	N
Leersia oryzoides	rice cut grass	15	3	N
Ranunculus acris	tall buttercup	15	0	I
Achillea millefolium	common yarrow	2.5	1	N
Agrostis gigantea	redtop	2.5	0	I
Agrostis scabra		2.5	0	
Anthoxanthum odoratum		2.5	0	
Symphyotrichum firmum	shining aster	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex scoparia var. scoparia	lance-fruited oval sedge	2.5	4	N
Carex utriculata	beaked sedge	2.5	7	N
Chelone glabra	white turtlehead	2.5	7	N
Cirsium vulgare	bull thistle	2.5	0	I
Cornus canadensis	bunchberry	2.5	7	N
Daucus carota	Queen Anne's lace	2.5	0	I
Echinochloa muricata	rough barnyard grass	2.5	1	N
Eleocharis obtusa	blunt spike-rush	2.5	3	N
Epilobium leptophyllum	linear-leaved willow herb	2.5	8	N
Equisetum arvense	field horsetail	2.5	1	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N

Eupatorium perfoliatum	boneset	2.5	6	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Hieracium aurantiacum	orange hawkweed	2.5	0	I
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Impatiens capensis	spotted touch-me-not	2.5	2	N
Juncus brevicaudatus	narrow-panicled rush	2.5	6	N
Lotus corniculatus	bird's-foot trefoil	2.5	0	I
Lycopus uniflorus	northern bugleweed	2.5	4	N
Lythrum salicaria	purple loosestrife	2.5	0	I
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Myosoton aquaticum	giant chickweed	2.5	0	I
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Persicaria hydropiper	marsh waterpepper	2.5	0	I
Persicaria maculosa	lady's thumb	2.5	0	I
Phleum pratense subsp. pratense	timothy	2.5	0	I
Plantago major	common plantain	2.5	0	I
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Potentilla norvegica	rough cinquefoil	2.5	0	N
Potentilla simplex	oldfield cinquefoil	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Rumex crispus	curly dock	2.5	0	I
Salix discolor	pussy willow	2.5	2	N
Salix petiolaris	slender willow	2.5	6	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Setaria pumila subsp. pumila	yellow foxtail	2.5	0	I
Thelypteris palustris	northern marsh fern	2.5	7	N
Thuja occidentalis	white cedar	2.5	9	N
Trifolium pratense	red clover	2.5	0	I
Trifolium repens	white clover	2.5	0	I
Tsuga canadensis	eastern hemlock	2.5	8	N
Urtica dioica subsp. gracilis	stinging nettle	2.5	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasv019f	EJO/MJF	2022-08-24	46.359998	-90.694968
Wetland Name		**Community Type**		
wasv019		Coniferous Swamp		
Total % Cover		**Total % Non-Native Cover**		
234.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
38.552	3.091	5.346	0.429
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
37.149	46.001	4.964	6.147

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Thuja occidentalis	white cedar	62.5	9	N
Betula alleghaniensis	yellow birch	15	7	N
Fraxinus nigra	black ash	15	8	N
Impatiens capensis	spotted touch-me-not	15	2	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Echinochloa muricata	rough barnyard grass	2.5	1	N
Eleocharis obtusa	blunt spike-rush	2.5	3	N

Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Juncus effusus	common rush	2.5	4	N
Laportea canadensis	woodnettle	2.5	4	N
Leersia oryzoides	rice cut grass	2.5	3	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Monotropa uniflora	Ghost pipe	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Persicaria hydropiper	marsh waterpepper	2.5	0	I
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Ranunculus acris	tall buttercup	2.5	0	I
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Veronica officinalis	common speedwell	2.5	0	I
Danthonia spicata	poverty grass	1	4	N
Taraxacum officinale	common dandelion	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasv059f1	EJO/MJF	2022-08-24	46.3522	-90.68107
Wetland Name		**Community Type**		
wasv059		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
170		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
31.899	1.617	5.471	0.277
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
31.899	31.984	5.471	5.485

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Acer rubrum	red maple	15	3	N
Fraxinus pennsylvanica	green ash	15	2	N
Ostrya virginiana	ironwood	15	5	N
Tilia americana	American basswood	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Acer saccharum	sugar maple	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Clintonia borealis	bluebead lily	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Gaultheria procumbens	wintergreen	2.5	6	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N

Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus rubra	northern red oak	2.5	5	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N

Sample Name	Crew	Date	Latitude	Longitude
wasc069s	EJO/MJF	2022-08-25	46.347145	-90.677993
Wetland Name		**Community Type**		
wasc069		Alder Thicket		
Total % Cover		**Total % Non-Native Cover**		
274.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
36.407	2.680	4.909	0.361
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
35.453	33.709	4.655	4.426

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Alnus incana subsp. rugosa	speckled alder	62.5	4	N
Glyceria striata	fowl manna grass	37.5	4	N
Abies balsamea	balsam fir	15	5	N
Fraxinus pennsylvanica	green ash	15	2	N
Ilex verticillata	common winterberry	15	7	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gynandra	nodding sedge	2.5	6	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Chelone glabra	white turtlehead	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N

Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Impatiens capensis	spotted touch-me-not	2.5	2	N
Juncus effusus	common rush	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus balsamifera	balsam poplar	2.5	4	N
Populus tremuloides	quaking aspen	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago gigantea	giant goldenrod	2.5	3	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus pumila	Siberian elm	2.5	0	I
Acer saccharum	sugar maple	1	5	N
Quercus rubra	northern red oak	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasc071f	EJO/MJF	2022-08-25	46.345167	-90.676449

Wetland Name	Community Type
wasc071	Hardwood Swamp
Total % Cover	**Total % Non-Native Cover**
348	0

Floristic Quality Metrics: Native Species (n)			
FQIn	wFQIn	Mean C ($\bar{C}n$)	Weighted Mean C (w$\bar{C}$n)
46.496	5.462	5.299	0.622
Floristic Quality Metrics: All Species (a)			
FQIa	wFQIa	Mean C ($\bar{C}a$)	Weighted Mean C (w$\bar{C}$a)
46.496	52.776	5.299	6.014

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Acer rubrum	red maple	15	3	N
Betula alleghaniensis	yellow birch	15	7	N
Ilex verticillata	common winterberry	15	7	N
Onoclea sensibilis	sensitive fern	15	5	N
Rubus pubescens	dwarf raspberry	15	7	N
Thuja occidentalis	white cedar	15	9	N
Tsuga canadensis	eastern hemlock	15	8	N
Ulmus americana	American elm	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Acer saccharum	sugar maple	2.5	5	N
Acer spicatum	mountain maple	2.5	6	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex gracillima	graceful sedge	2.5	5	N

Carex gynandra	nodding sedge	2.5	6	N
Carex intumescens	bladder sedge	2.5	5	N
Carex lacustris	lake sedge	2.5	6	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Carex stricta	tussock sedge	2.5	7	N
Chelone glabra	white turtlehead	2.5	7	N
Clintonia borealis	bluebead lily	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N

Prunella vulgaris	heal-all	2.5	1	N
Pteridium aquilinum	bracken	2.5	2	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Aralia nudicaulis	wild sarsaparilla	1	6	N
Prunus serotina	wild black cherry	1	3	N
Scirpus cyperinus	wool-grass	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wasc072f	EJO/MJF	2022-08-25	46.343685	-90.675414
Wetland Name		**Community Type**		
wasc072		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
310		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
46.198	4.497	5.444	0.530
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
45.569	49.449	5.297	5.748

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex bromoides	brome-like sedge	37.5	8	N
Fraxinus nigra	black ash	37.5	8	N
Acer rubrum	red maple	15	3	N
Betula alleghaniensis	yellow birch	15	7	N
Fraxinus pennsylvanica	green ash	15	2	N
Osmunda cinnamomea	cinnamon fern	15	7	N
Ulmus americana	American elm	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Acer saccharum	sugar maple	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gynandra	nodding sedge	2.5	6	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N

Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Clintonia borealis	bluebead lily	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Ilex verticillata	common winterberry	2.5	7	N
Juncus effusus	common rush	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Milium effusum var. cisatlanticum	American millet grass	2.5	7	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus recurvatus	blisterwort	2.5	5	N

Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Tilia americana	American basswood	2.5	5	N
Trillium grandiflorum	large-flowered trillium	2.5	6	N
Equisetum fluviatile	water horsetail	1	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	1	4	N
Quercus rubra	northern red oak	1	5	N
Rumex obtusifolius	bitter dock	1	0	I
Uvularia sessilifolia	pale bellwort	1	6	N

Sample Name	Crew	Date	Latitude	Longitude
wasc074e	EJO/MJF	2022-08-25	46.343512	-90.675611

Wetland Name	Community Type
wasc074	Sedge Meadow

Total % Cover	Total % Non-Native Cover
185.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	wFQIn	Mean C ($\bar{C}$n)	Weighted Mean C (w$\bar{C}$n)
31.465	1.036	4.975	0.164
Floristic Quality Metrics: All Species (a)			
FQIa	wFQIa	Mean C ($\bar{C}$a)	Weighted Mean C (w$\bar{C}$a)
30.706	19.599	4.738	3.024

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex bromoides		62.5	0	
Acer rubrum	red maple	15	3	N
Alnus incana subsp. rugosa	speckled alder	15	4	N
Acer saccharum	sugar maple	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Chelone glabra	white turtlehead	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Impatiens capensis	spotted touch-me-not	2.5	2	N

Juncus effusus	common rush	2.5	4	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Solidago gigantea	giant goldenrod	2.5	3	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Abies balsamea	balsam fir	1	5	N
Caltha palustris	common marsh marigold	1	6	N
Stachys palustris	woundwort	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasb011f	SAM/IGL	2022-08-24	46.338698	-90.669062

Wetland Name	Community Type
wasb011	Hardwood Swamp
Total % Cover	**Total % Non-Native Cover**
207.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
38.413	2.702	5.327	0.375
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
37.695	44.622	5.130	6.072

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex bromoides	brome-like sedge	62.5	8	N
Equisetum sylvaticum	woodland horsetail	15	7	N
Acer saccharum	sugar maple	2.5	5	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Cardamine pensylvanica	Pensylvania bitter cress	2.5	3	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Chrysosplenium americanum	American golden saxifrage	2.5	9	N
Cinna latifolia	drooping woodreed	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N

Equisetum pratense	meadow horsetail	2.5	9	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Monotropa uniflora	Ghost pipe	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria punctata	dotted smartweed	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes glandulosum	skunk currant	2.5	7	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex obtusifolius	bitter dock	2.5	0	I
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Tilia americana	American basswood	2.5	5	N
Ulmus americana	American elm	2.5	3	N

Sample Name	Crew	Date	Latitude	Longitude
wasa038f	SAM/IGL	2022-08-24	46.336887	-90.662192
Wetland Name		**Community Type**		
wasa038		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
368.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
51.808	6.152	5.523	0.656
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
50.396	57.443	5.226	5.957

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Carex bromoides	brome-like sedge	37.5	8	N
Abies balsamea	balsam fir	15	5	N
Alnus incana subsp. rugosa	speckled alder	15	4	N
Carex crinita var. crinita	fringed sedge	15	6	N
Carex scabrata	eastern rough sedge	15	8	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Allium tricoccum	wild leek	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex radiata	eastern star sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Chrysosplenium americanum	American golden saxifrage	2.5	9	N

Cinna latifolia	drooping woodreed	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Clintonia borealis	bluebead lily	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Deparia acrostichoides	silver false spleenwort	2.5	10	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum fluviatile	water horsetail	2.5	7	N
Equisetum scirpoides	dwarf scouring rush	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fallopia convolvulus	black-bindweed	2.5	0	I
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Juncus effusus	common rush	2.5	4	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Laportea canadensis	woodnettle	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella diphylla	two-leaved miterwort	2.5	8	N
Monotropa uniflora	Ghost pipe	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Parthenocissus vitacea	woodbine	2.5	4	N

Phegopteris connectilis	Narrow beech fern	2.5	7	N
Phryma leptostachya	American lop-seed	2.5	5	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus sceleratus	cursed crowfoot	2.5	3	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex britannica	great water dock	2.5	8	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Solanum dulcamara	bittersweet nightshade	2.5	0	I
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Acer spicatum	mountain maple	1	6	N
Caulophyllum thalictroides	blue cohosh	1	8	N
Picea glauca	white spruce	1	7	N
Platanthera huronensis	Huron green orchid	1	7	N
Thuja occidentalis	white cedar	1	9	N
Trillium cernuum	nodding trillium	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1008f	SAM/IGL	2022-08-24	46.335996	-90.651985
Wetland Name		**Community Type**		
wasd1008		Floodplain Forest		
Total % Cover		**Total % Non-Native Cover**		
315.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
26.405	1.761	4.175	0.279
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
24.623	20.132	3.630	2.968

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer saccharinum	silver maple	87.5	2	N
Fraxinus pennsylvanica	green ash	37.5	2	N
Matteuccia struthiopteris	American ostrich fern	37.5	5	N
Carex radiata	eastern star sedge	15	4	N
Fallopia convolvulus	black-bindweed	15	0	I
Impatiens capensis	spotted touch-me-not	15	2	N
Laportea canadensis	woodnettle	15	4	N
Alliaria petiolata	garlic mustard	2.5	0	I
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Echinocystis lobata	wild cucumber	2.5	2	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Geum canadense	white avens	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N

Linaria vulgaris	butter-and-eggs	2.5	0	I
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Myosotis scorpioides	true forget-me-not	2.5	0	I
Onoclea sensibilis	sensitive fern	2.5	5	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Rhamnus cathartica	common buckthorn	2.5	0	I
Ribes americanum	wild black currant	2.5	4	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rudbeckia laciniata var. laciniata	cut-leaved coneflower	2.5	6	N
Sanguinaria canadensis	bloodroot	2.5	6	N
Smilax tamnoides	bristly greenbrier	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Ulmus americana	American elm	2.5	3	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Viola pubescens	yellow violet	2.5	5	N
Cornus alternifolia	pagoda dogwood	1	7	N
Festuca subverticillata	nodding fescue	1	4	N
Heracleum lanatum	cow parsnip	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wasd1010f	SAM/IGL	2022-08-25	46.338133	-90.627971
Wetland Name		**Community Type**		
wasd1010		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
304		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
28.846	2.370	3.962	0.325
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
27.111	28.398	3.500	3.666

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Scirpus cyperinus	wool-grass	62.5	4	N
Alnus incana subsp. rugosa	speckled alder	15	4	N
Symphyotrichum lateriflorum	side-flowering aster	15	3	N
Carex projecta	projecting sedge	15	4	N
Glyceria striata	fowl manna grass	15	4	N
Juncus effusus	common rush	15	4	N
Persicaria sagittata	arrow-leaved tear-thumb	15	6	N
Populus tremuloides	quaking aspen	15	2	N
Rubus idaeus var. strigosus	red raspberry	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex bebbii	Bebb's sedge	2.5	4	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Cirsium vulgare	bull thistle	2.5	0	I
Echinocystis lobata	wild cucumber	2.5	2	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N

Equisetum arvense	field horsetail	2.5	1	N
Erechtites hieracifolia var. hieracifolia	American burn-weed	2.5	2	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Geum aleppicum	yellow avens	2.5	3	N
Helianthus giganteus	giant sunflower	2.5	4	N
Heracleum lanatum	cow parsnip	2.5	3	N
Hieracium aurantiacum	orange hawkweed	2.5	0	I
Hieracium umbellatum	Canada hawkweed	2.5	5	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lamium amplexicaule	henbit	2.5	0	I
Lonicera hirsuta	hairy honeysuckle	2.5	7	N
Lycopus americanus	cut-leaved bugleweed	2.5	4	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Poa palustris	fowl bluegrass	2.5	5	N
Potentilla norvegica	rough cinquefoil	2.5	0	N
Potentilla simplex	oldfield cinquefoil	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Ranunculus hispidus var. nitidus	hispid buttercup	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex crispus	curly dock	2.5	0	I
Salix discolor	pussy willow	2.5	2	N
Solidago gigantea	giant goldenrod	2.5	3	N
Toxicodendron rydbergii	western poison ivy	2.5	2	N
Trifolium repens	white clover	2.5	0	I
Typha x glauca	hybrid cattail	2.5	0	I
Verbena hastata	blue vervain	2.5	3	N
Eupatorium perfoliatum	boneset	1	6	N
Salix petiolaris	slender willow	1	6	N
Triosteum aurantiacum	orange-fruit horse gentian	1	5	N
Verbascum thapsus	common mullein	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasd1009f	SAM/IGL	2022-08-24	46.340565	-90.625933
Wetland Name		**Community Type**		
wasd1009		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
221		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
28.482	2.207	5.200	0.403
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
28.018	34.137	5.032	6.131

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex bromoides	brome-like sedge	37.5	8	N
Fraxinus nigra	black ash	37.5	8	N
Doellingeria umbellata	flat-top aster	15	6	N
Betula alleghaniensis	yellow birch	15	7	N
Carex scabrata	eastern rough sedge	15	8	N
Impatiens capensis	spotted touch-me-not	15	2	N
Onoclea sensibilis	sensitive fern	15	5	N
Tilia americana	American basswood	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bromus ciliatus	fringed brome	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Fragaria virginiana	common strawberry	2.5	1	N
Glyceria striata	fowl manna grass	2.5	4	N
Juncus effusus	common rush	2.5	4	N
Lonicera hirsuta	hairy honeysuckle	2.5	7	N
Milium effusum var. cisatlanticum	American millet grass	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N

Populus tremuloides	quaking aspen	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Maianthemum racemosum	false Solomon's-seal	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasv042f	SAM/IGL	2022-08-25	46.344877	-90.616587
Wetland Name		**Community Type**		
wasv042		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
255		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
38.040	3.038	5.609	0.448
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
37.633	41.228	5.489	6.014

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Carex crinita var. crinita	fringed sedge	37.5	6	N
Abies balsamea	balsam fir	15	5	N
Acer rubrum	red maple	15	3	N
Betula alleghaniensis	yellow birch	15	7	N
Lycopus uniflorus	northern bugleweed	15	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex trisperma	three-seeded bog sedge	2.5	9	N
Cinna latifolia	drooping woodreed	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N

Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Oxalis montana	mountain wood-sorrel	2.5	9	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Thelypteris palustris	northern marsh fern	2.5	7	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Carex deweyana subsp. deweyana	Dewey's sedge	1	7	N
Carex pedunculata	long-stalked sedge	1	7	N
Dryopteris intermedia	glandular wood fern	1	7	N
Ranunculus acris	tall buttercup	1	0	I
Tilia americana	American basswood	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasv039f	SAM/IGL	2022-08-25	46.346216	-90.614636
Wetland Name		**Community Type**		
wasv039		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
219.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C ($w\bar{C}n$)**
37.086	2.756	5.591	0.415
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C ($w\bar{C}a$)**
36.672	43.473	5.467	6.481

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Abies balsamea	balsam fir	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Carex bromoides	brome-like sedge	15	8	N
Carex scabrata	eastern rough sedge	15	8	N
Acer rubrum	red maple	2.5	3	N
Acer saccharum	sugar maple	2.5	5	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Cinna latifolia	drooping woodreed	2.5	7	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N

Gymnocarpium dryopteris	common oak fern	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex obtusifolius	bitter dock	2.5	0	I
Scirpus cyperinus	wool-grass	2.5	4	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Acer spicatum	mountain maple	1	6	N
Thuja occidentalis	white cedar	1	9	N

Sample Name	Crew	Date	Latitude	Longitude
wasv053f	SAM/IGL	2022-08-25	46.356727	-90.599894
Wetland Name		**Community Type**		
wasv053		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
258		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
33.468	2.690	5.045	0.406
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
31.086	38.434	4.353	5.382

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Carex scabrata	eastern rough sedge	15	8	N
Fraxinus pennsylvanica	green ash	15	2	N
Scirpus atrocinctus	black-girdled wool-grass	15	7	N
Scirpus cyperinus	wool-grass	15	4	N
Solidago gigantea	giant goldenrod	15	3	N
Acer saccharum	sugar maple	2.5	5	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex plantaginea	plantain-leaved sedge	2.5	10	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Deparia acrostichoides	silver false spleenwort	2.5	10	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N

Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Mitchella repens	partridgeberry	2.5	6	N
Myosotis scorpioides	true forget-me-not	2.5	0	I
Ostrya virginiana	ironwood	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Pteridium aquilinum	bracken	2.5	2	N
Quercus rubra	northern red oak	2.5	5	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rumex obtusifolius	bitter dock	2.5	0	I
Taraxacum officinale	common dandelion	2.5	0	I
Tilia americana	American basswood	2.5	5	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Typha x glauca	hybrid cattail	2.5	0	I
Veronica officinalis	common speedwell	2.5	0	I
Acer rubrum	red maple	1	3	N
Agrimonia striata	roadside agrimony	1	3	N
Cirsium arvense	Canada thistle	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wasw023ss	SAM/IGL	2022-08-30	46.366544	-90.582923

Wetland Name	Community Type
wasw023	Alder Thicket
Total % Cover	**Total % Non-Native Cover**
214.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
38.079	2.167	5.000	0.285
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
36.830	35.075	4.677	4.455

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Alnus incana subsp. rugosa	speckled alder	15	4	N
Carex bromoides		15	0	
Persicaria sagittata	arrow-leaved tear-thumb	15	6	N
Rubus pubescens	dwarf raspberry	15	7	N
Solidago gigantea	giant goldenrod	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex scabrata	eastern rough sedge	2.5	8	N
Chrysosplenium americanum	American golden saxifrage	2.5	9	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N

Cirsium arvense	Canada thistle	2.5	0	I
Clematis virginiana	virgin's bower	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum fluviatile	water horsetail	2.5	7	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Hieracium scabrum	sticky hawkweed	2.5	6	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Populus tremuloides	quaking aspen	2.5	2	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rumex obtusifolius	bitter dock	2.5	0	I
Salix bebbiana	Bebb's willow	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Stachys palustris	woundwort	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Quercus rubra	northern red oak	1	5	N
Trillium cernuum	nodding trillium	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wasw024f	SAM/IGL	2022-08-30	46.367079	-90.581041
Wetland Name		**Community Type**		
wasw024		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
301		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
37.618	3.975	5.320	0.562
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
37.247	44.782	5.216	6.271

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex bromoides	brome-like sedge	62.5	8	N
Fraxinus nigra	black ash	62.5	8	N
Abies balsamea	balsam fir	15	5	N
Acer rubrum	red maple	15	3	N
Betula alleghaniensis	yellow birch	15	7	N
Equisetum sylvaticum	woodland horsetail	15	7	N
Fraxinus pennsylvanica	green ash	15	2	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bromus ciliatus	fringed brome	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex radiata	eastern star sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Chrysosplenium americanum	American golden saxifrage	2.5	9	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Deparia acrostichoides	silver false spleenwort	2.5	10	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Equisetum pratense	meadow horsetail	2.5	9	N

Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Hieracium aurantiacum	orange hawkweed	2.5	0	I
Impatiens capensis	spotted touch-me-not	2.5	2	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Actaea pachypoda	doll's-eyes	1	6	N
Cirsium muticum	swamp thistle	1	8	N
Ranunculus abortivus	little-leaf buttercup	1	1	N
Rubus idaeus var. strigosus	red raspberry	1	3	N
Salix discolor	pussy willow	1	2	N
Tilia americana	American basswood	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasw021f	SAM/IGL	2022-08-31	46.372293	-90.568487
Wetland Name		**Community Type**		
wasw021		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
241		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
35.737	2.055	5.213	0.300
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
35.000	30.861	5.000	4.409

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer saccharinum	silver maple	37.5	2	N
Ostrya virginiana	ironwood	37.5	5	N
Acer rubrum	red maple	15	3	N
Betula alleghaniensis	yellow birch	15	7	N
Fraxinus pennsylvanica	green ash	15	2	N
Quercus rubra	northern red oak	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Agrostis stolonifera	spreading bentgrass	2.5	0	I
Allium tricoccum	wild leek	2.5	6	N
Anemone quinquefolia	wood anemone	2.5	6	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex disperma	soft-leaved sedge	2.5	10	N
Carex intumescens	bladder sedge	2.5	5	N
Carex tuckermanii	Tuckerman's sedge	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N

Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Juncus effusus	common rush	2.5	4	N
Leersia oryzoides	rice cut grass	2.5	3	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oryzopsis asperifolia	mountain ricegrass	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Picea glauca	white spruce	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Solidago gigantea	giant goldenrod	2.5	3	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Veronica officinalis	common speedwell	2.5	0	I
Monotropa uniflora	Ghost pipe	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasw025f/wasw026f	SAM/IGL	2022-08-31	46.372746	-90.568137
Wetland Name		**Community Type**		
wasw025/wasw026		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
268.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
41.959	2.955	5.088	0.358
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
41.355	39.574	4.943	4.730

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer saccharum	sugar maple	37.5	5	N
Ostrya virginiana	ironwood	37.5	5	N
Acer rubrum	red maple	15	3	N
Fraxinus pennsylvanica	green ash	15	2	N
Abies balsamea	balsam fir	2.5	5	N
Adiantum pedatum	maidenhair fern	2.5	7	N
Allium tricoccum	wild leek	2.5	6	N
Anaphalis margaritacea	pearly everlasting	2.5	3	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex arctata	drooping wood sedge	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N

Carex radiata	eastern star sedge	2.5	4	N
Carex rosea	starry sedge	2.5	4	N
Carex tuckermanii	Tuckerman's sedge	2.5	8	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oryzopsis asperifolia	mountain ricegrass	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Picea glauca	white spruce	2.5	7	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria punctata	dotted smartweed	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus rubra	northern red oak	2.5	5	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N

Solidago gigantea	giant goldenrod	2.5	3	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Typha x glauca	hybrid cattail	2.5	0	I
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Pinus strobus	white pine	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wasw013ss	EJO/MJF	2022-08-25	46.375677	-90.563508

Wetland Name	Community Type
wasw013	Alder Thicket
Total % Cover	**Total % Non-Native Cover**
246	0

Floristic Quality Metrics: Native Species (n)			
FQIn	wFQIn	Mean C ($\bar{C}n$)	Weighted Mean C (w$\bar{C}n$)
35.639	2.034	4.942	0.282
Floristic Quality Metrics: All Species (a)			
FQIa	wFQIa	Mean C ($\bar{C}a$)	Weighted Mean C (w$\bar{C}a$)
34.343	29.386	4.589	3.927

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Alnus incana subsp. rugosa	speckled alder	37.5	4	N
Rubus idaeus var. strigosus	red raspberry	37.5	3	N
Calamagrostis canadensis	bluejoint	15	5	N
Impatiens capensis	spotted touch-me-not	15	2	N
Phalaris arundinacea	reed canary grass	15	0	I
Acer saccharum	sugar maple	2.5	5	N
Actaea rubra	red baneberry	2.5	7	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Barbarea vulgaris	yellow rocket	2.5	0	I
Betula alleghaniensis	yellow birch	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex gynandra	nodding sedge	2.5	6	N
Carex projecta	projecting sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex utriculata	beaked sedge	2.5	7	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Cirsium arvense	Canada thistle	2.5	0	I
Clematis virginiana	virgin's bower	2.5	4	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N

Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Eupatorium perfoliatum	boneset	2.5	6	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Galium aparine	cleavers	2.5	2	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Hypericum ascyron subsp. pyramidatum	giant St. John's-wort	2.5	6	N
Juncus effusus	common rush	2.5	4	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mentha arvensis var. canadensis	common mint	2.5	3	N
Muhlenbergia mexicana	Mexican muhly grass	2.5	4	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex britannica	great water dock	2.5	8	N
Scirpus cyperinus	wool-grass	2.5	4	N
Solidago canadensis	Canadian goldenrod	2.5	1	N
Solidago gigantea	giant goldenrod	2.5	3	N
Spiraea alba var. alba	white meadowsweet	2.5	4	N
Taraxacum officinale	common dandelion	2.5	0	I
Ulmus americana	American elm	2.5	3	N
Verbena hastata	blue vervain	2.5	3	N
Sanguinaria canadensis	bloodroot	1	6	N

Sample Name	Crew	Date	Latitude	Longitude
wasw012f	EJO/MJF	2022-08-25	46.377239	-90.560474
Wetland Name		**Community Type**		
wasw012		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
335		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
44.328	4.536	4.987	0.510
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
43.247	47.524	4.747	5.216

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Betula alleghaniensis	yellow birch	15	7	N
Carex bromoides	brome-like sedge	15	8	N
Carex gynandra	nodding sedge	15	6	N
Glyceria striata	fowl manna grass	15	4	N
Impatiens capensis	spotted touch-me-not	15	2	N
Onoclea sensibilis	sensitive fern	15	5	N
Osmunda claytoniana	interrupted fern	15	6	N
Ulmus americana	American elm	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Acer saccharum	sugar maple	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Allium tricoccum	wild leek	2.5	6	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula papyrifera	canoe birch	2.5	3	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N

Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Clinopodium vulgare	wild-basil	2.5	3	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Mitchella repens	partridgeberry	2.5	6	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Parthenocissus vitacea	woodbine	2.5	4	N
Picea glauca	white spruce	2.5	7	N
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus balsamifera	balsam poplar	2.5	4	N
Populus tremuloides	quaking aspen	2.5	2	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N

Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes americanum	wild black currant	2.5	4	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Solanum dulcamara	bittersweet nightshade	2.5	0	I
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Stachys palustris	woundwort	2.5	5	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum opulus	cranberry viburnum	2.5	6	N
Symphyotrichum ciliolatum	Lindley's aster	1	4	N
Oryzopsis asperifolia	mountain ricegrass	1	6	N
Quercus rubra	northern red oak	1	5	N
Maianthemum racemosum	false Solomon's-seal	1	5	N
Taraxacum officinale	common dandelion	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wirb1002f	SAM/IGL	2022-08-25	46.382737	-90.546915
Wetland Name		**Community Type**		
wirb1002		Hardwood Swamp – Forested Seep		
Total % Cover		**Total % Non-Native Cover**		
272.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
35.851	3.372	4.925	0.463
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
35.518	42.769	4.833	5.820

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Carex scabrata	eastern rough sedge	37.5	8	N
Acer saccharum	sugar maple	15	5	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Glyceria striata	fowl manna grass	15	4	N
Solidago gigantea	giant goldenrod	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Anemone quinquefolia	wood anemone	2.5	6	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N

Equisetum sylvaticum	woodland horsetail	2.5	7	N
Erechtites hieracifolia var. hieracifolia	American burn-weed	2.5	2	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Geum canadense	white avens	2.5	2	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Laportea canadensis	woodnettle	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Ostrya virginiana	ironwood	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Taraxacum officinale	common dandelion	2.5	0	I
Tilia americana	American basswood	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Viola labradorica	alpine violet	2.5	4	N
Caulophyllum thalictroides	blue cohosh	1	8	N
Clematis virginiana	virgin's bower	1	4	N
Picea glauca	white spruce	1	7	N
Quercus rubra	northern red oak	1	5	N
Salix discolor	pussy willow	1	2	N

Sample Name	Crew	Date	Latitude	Longitude
wirb1005f	SAM/IGL	2022-08-25	46.383981	-90.546398
Wetland Name		**Community Type**		
wirb1005		Hardwood Swamp (Vernal Pool Subtype)		
Total % Cover		**Total % Non-Native Cover**		
142.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
16.166	0.931	4.667	0.269
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
15.532	23.278	4.308	6.456

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	87.5	8	N
Acer saccharum	sugar maple	15	5	N
Ulmus americana	American elm	15	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Taraxacum officinale	common dandelion	2.5	0	I

Sample Name	Crew	Date	Latitude	Longitude
wirb1006f	SAM/IGL	2022-08-27	46.384815	-90.546337
Wetland Name		**Community Type**		
wirb1006		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
228.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
30.832	1.821	4.875	0.288
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
28.444	28.998	4.149	4.230

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer saccharum	sugar maple	62.5	5	N
Fraxinus pennsylvanica	green ash	37.5	2	N
Fraxinus nigra	black ash	15	8	N
Rubus idaeus var. strigosus	red raspberry	15	3	N
Allium tricoccum	wild leek	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Betula alleghaniensis	yellow birch	2.5	7	N
Calystegia sepium	hedge bindweed	2.5	2	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex scabrata	eastern rough sedge	2.5	8	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Cirsium arvense	Canada thistle	2.5	0	I
Deparia acrostichoides	silver false spleenwort	2.5	10	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Equisetum pratense	meadow horsetail	2.5	9	N
Fragaria virginiana	common strawberry	2.5	1	N
Glyceria striata	fowl manna grass	2.5	4	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lapsana communis	nipplewort	2.5	0	I
Leersia oryzoides	rice cut grass	2.5	3	N

Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Rumex obtusifolius	bitter dock	2.5	0	I
Scirpus cyperinus	wool-grass	2.5	4	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Taraxacum officinale	common dandelion	2.5	0	I
Tilia americana	American basswood	2.5	5	N
Uvularia grandiflora	large-flowered bellwort	2.5	7	N
Veronica officinalis	common speedwell	2.5	0	I
Viola labradorica	alpine violet	2.5	4	N
Cf Barbarea vulgaris		1	0	
Epilobium coloratum	purple-leaved willow herb	1	3	N
Euthamia graminifolia	grass-leaved goldenrod	1	4	N
Juncus effusus	common rush	1	4	N
Quercus rubra	northern red oak	1	5	N
Ulmus americana	American elm	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wirb1007f	SAM/IGL	2022-08-30	46.387577	-90.545171
Wetland Name		**Community Type**		
wirb1007		Hardwood Swamp – Forested Seep		
Total % Cover		**Total % Non-Native Cover**		
304		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
46.765	4.214	5.400	0.487
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
45.280	50.738	5.063	5.673

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Acer saccharum	sugar maple	15	5	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Carex scabrata	eastern rough sedge	15	8	N
Fraxinus pennsylvanica	green ash	15	2	N
Acer rubrum	red maple	2.5	3	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex radiata	eastern star sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N

Clinopodium vulgare	wild-basil	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Deparia acrostichoides	silver false spleenwort	2.5	10	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum scirpoides	dwarf scouring rush	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lapsana communis	nipplewort	2.5	0	I
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lonicera hirsuta	hairy honeysuckle	2.5	7	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Myosotis scorpioides	true forget-me-not	2.5	0	I
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Ostrya virginiana	ironwood	2.5	5	N
Packera aurea	golden ragwort	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Polystichum braunii	Braun's holly fern	2.5	10	N
Populus tremuloides	quaking aspen	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus rubra	northern red oak	2.5	5	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N

Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex obtusifolius	bitter dock	2.5	0	I
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Thuja occidentalis	white cedar	2.5	9	N
Tilia americana	American basswood	2.5	5	N
Trillium cernuum	nodding trillium	2.5	8	N
Ulmus americana	American elm	2.5	3	N
Uvularia grandiflora	large-flowered bellwort	2.5	7	N
Viola labradorica	alpine violet	2.5	4	N
Symphyotrichum ciliolatum	Lindley's aster	1	4	N
Epipactis helleborine	helleborine	1	0	I
Prenanthes alba	white rattlesnakeroot	1	5	N
Prunus serotina	wild black cherry	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wirb009f_x	SAM/IGL	2022-09-02	46.39271	-90.545204

Wetland Name	Community Type
wirb009_x	Hardwood Swamp
Total % Cover	**Total % Non-Native Cover**
224.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
28.277	1.398	4.649	0.230
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
27.902	22.365	4.526	3.628

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Populus tremuloides	quaking aspen	62.5	2	N
Fraxinus pennsylvanica	green ash	37.5	2	N
Acer saccharum	sugar maple	15	5	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Rubus pubescens	dwarf raspberry	15	7	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Bromus ciliatus	fringed brome	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Clematis virginiana	virgin's bower	2.5	4	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epipactis helleborine	helleborine	2.5	0	I
Equisetum arvense	field horsetail	2.5	1	N
Equisetum pratense	meadow horsetail	2.5	9	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N

Galium triflorum	fragrant bedstraw	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Ostrya virginiana	ironwood	2.5	5	N
Poa palustris	fowl bluegrass	2.5	5	N
Polygonatum pubescens	hairy Solomon's seal	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Solidago gigantea	giant goldenrod	2.5	3	N
Tilia americana	American basswood	2.5	5	N
Doellingeria umbellata	flat-top aster	1	6	N
Caltha palustris	common marsh marigold	1	6	N

Sample Name	Crew	Date	Latitude	Longitude
wirb015e	SAM/IGL	2022-08-30	46.396739	-90.542695
Wetland Name		**Community Type**		
wirb015		Fresh Meadow (Native Subtype)		
Total % Cover		**Total % Non-Native Cover**		
233.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
31.466	1.950	4.542	0.281
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
29.666	29.740	4.037	4.047

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Alisma triviale	common water plantain	15	4	N
Bidens cernua	nodding bur-marigold	15	4	N
Eupatorium perfoliatum	boneset	15	6	N
Impatiens capensis	spotted touch-me-not	15	2	N
Juncus effusus	common rush	15	4	N
Scirpus cyperinus	wool-grass	15	4	N
Sparganium androcladum	branching bur-reed	15	8	N
Typha x glauca	hybrid cattail	15	0	I
Agrostis gigantea	redtop	2.5	0	I
Agrostis scabra		2.5	0	
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Asclepias incarnata	swamp milkweed	2.5	5	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex comosa	bristly sedge	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex stipata	common fox sedge	2.5	2	N
Cirsium arvense	Canada thistle	2.5	0	I
Cirsium muticum	swamp thistle	2.5	8	N
Clematis virginiana	virgin's bower	2.5	4	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Eleocharis obtusa	blunt spike-rush	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N

Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium obtusum	blunt-leaf bedstraw	2.5	6	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Hypericum majus	large St. John's wort	2.5	5	N
Lycopus americanus	cut-leaved bugleweed	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Mentha arvensis var. canadensis	common mint	2.5	3	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Persicaria lapathifolia	curly-top knotweed	2.5	2	N
Persicaria punctata	dotted smartweed	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Potentilla norvegica	rough cinquefoil	2.5	0	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rumex britannica	great water dock	2.5	8	N
Sagittaria latifolia var. latifolia	broad-leaved arrowhead	2.5	3	N
Salix bebbiana	Bebb's willow	2.5	7	N
Salix discolor	pussy willow	2.5	2	N
Salix petiolaris	slender willow	2.5	6	N
Schoenoplectus tabernaemontani	great bulrush	2.5	4	N
Scirpus atrocinctus	black-girdled wool-grass	2.5	7	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scirpus microcarpus	panicled bulrush	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thelypteris palustris	northern marsh fern	2.5	7	N
Utricularia vulgaris	common bladderwort	2.5	7	N
Verbena hastata	blue vervain	2.5	3	N
Carex (ovales)		1	0	

Sample Name	Crew	Date	Latitude	Longitude
wird026f	SAM/IGL	2022-08-26	46.407611	-90.532699
Wetland Name		**Community Type**		
wird026		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
259.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
38.796	2.277	5.051	0.296
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
38.155	35.169	4.885	4.503

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Populus tremuloides	quaking aspen	62.5	2	N
Calamagrostis canadensis	bluejoint	15	5	N
Equisetum pratense	meadow horsetail	15	9	N
Fraxinus nigra	black ash	15	8	N
Solidago gigantea	giant goldenrod	15	3	N
Acer rubrum	red maple	2.5	3	N
Acer saccharum	sugar maple	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N

Corylus cornuta	beaked hazelnut	2.5	5	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Hieracium aurantiacum	orange hawkweed	2.5	0	I
Ilex verticillata	common winterberry	2.5	7	N
Juncus effusus	common rush	2.5	4	N
Lamium amplexicaule	henbit	2.5	0	I
Lonicera hirsuta	hairy honeysuckle	2.5	7	N
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Ostrya virginiana	ironwood	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Tilia americana	American basswood	2.5	5	N
Trillium cernuum	nodding trillium	2.5	8	N
Triosteum aurantiacum	orange-fruit horse gentian	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Viburnum rafinesquianum	downy arrowwood	2.5	7	N
Ranunculus abortivus	little-leaf buttercup	1	1	N
Smilax ecirrhata	erect carrion flower	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wird027f	SAM/IGL	2022-08-26	46.411139	-90.528307
Wetland Name		**Community Type**		
wird027		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
342		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
49.889	4.230	5.318	0.451
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
49.332	49.293	5.200	5.196

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Populus tremuloides	quaking aspen	37.5	2	N
Acer rubrum	red maple	15	3	N
Solidago gigantea	giant goldenrod	15	3	N
Abies balsamea	balsam fir	2.5	5	N
Acer saccharum	sugar maple	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Anemone americana	round-lobed hepatica	2.5	7	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N

Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Chelone glabra	white turtlehead	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus racemosa	gray dogwood	2.5	2	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Cypripedium parviflorum	yellow lady's-slipper	2.5	9	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Laportea canadensis	woodnettle	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lonicera hirsuta	hairy honeysuckle	2.5	7	N
Luzula acuminata var. acuminata	hairy wood rush	2.5	6	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oryzopsis asperifolia	mountain ricegrass	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Packera aurea	golden ragwort	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Picea glauca	white spruce	2.5	7	N

Persicaria punctata	dotted smartweed	2.5	5	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes glandulosum	skunk currant	2.5	7	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Salix discolor	pussy willow	2.5	2	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum trifolium	false mayflower	2.5	10	N
Smilax ecirrhata	erect carrion flower	2.5	5	N
Taraxacum officinale	common dandelion	2.5	0	I
Thuja occidentalis	white cedar	2.5	9	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum opulus	cranberry viburnum	2.5	6	N
Viola labradorica	alpine violet	2.5	4	N
Quercus rubra	northern red oak	1	5	N
Salix bebbiana	Bebb's willow	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wire1001f	SAM/IGL	2022-08-26	46.412531	-90.528483

Wetland Name	Community Type
wire1001	Hardwood Swamp

Total % Cover	Total % Non-Native Cover
250.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	wFQIn	Mean C ($\bar{C}$n)	Weighted Mean C (w$\bar{C}$n)
37.774	2.744	5.189	0.377
Floristic Quality Metrics: All Species (a)			
FQIa	wFQIa	Mean C ($\bar{C}$a)	Weighted Mean C (w$\bar{C}$a)
37.423	43.577	5.093	5.930

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	87.5	8	N
Glyceria striata	fowl manna grass	15	4	N
Onoclea sensibilis	sensitive fern	15	5	N
Solidago gigantea	giant goldenrod	15	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis stricta	slimstem reedgrass	2.5	7	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex projecta	projecting sedge	2.5	4	N
Carex radiata	eastern star sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N

Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eupatorium perfoliatum	boneset	2.5	6	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Laportea canadensis	woodnettle	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Muhlenbergia Mexicana		2.5	4	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Packera aurea	golden ragwort	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Petasites frigidus var. sagittatus	arrowhead sweet-colt's-foot	2.5	8	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Platanthera huronensis	Huron green orchid	2.5	7	N
Prunella vulgaris	heal-all	2.5	1	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Geum canadense	white avens	1	2	N
Lactuca biennis	biennial blue lettuce	1	3	N
Ribes triste	swamp red currant	1	8	N
Carex gracillima	graceful sedge	0	5	N

Sample Name	Crew	Date	Latitude	Longitude
wire1001e	SAM/IGL	2022-08-26	46.412258	-90.528376

Wetland Name	Community Type
wire1001	Fresh Meadow (Native Subtype)
Total % Cover	**Total % Non-Native Cover**
167.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
23.452	0.610	5.000	0.130
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
22.454	14.989	4.583	3.060

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Phalaris arundinacea	reed canary grass	62.5	0	I
Calamagrostis canadensis	bluejoint	37.5	5	N
Onoclea sensibilis	sensitive fern	15	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alisma triviale	common water plantain	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Alopecurus aequalis	short-awned foxtail	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Cardamine pensylvanica	Pensylvania bitter cress	2.5	3	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Eupatorium perfoliatum	boneset	2.5	6	N
Galium asprellum	rough bedstraw	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Petasites frigidus var. sagittatus	arrowhead sweet-colt's-foot	2.5	8	N
Rumex britannica	great water dock	2.5	8	N
Salix petiolaris	slender willow	2.5	6	N
Typha x glauca	hybrid cattail	2.5	0	I

Sample Name	Crew	Date	Latitude	Longitude
wird028f	SAM/IGL	2022-08-26	46.411663	-90.525798
Wetland Name		**Community Type**		
wird028		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
314.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
48.138	3.997	5.161	0.429
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
47.594	50.665	5.045	5.370

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Abies balsamea	balsam fir	15	5	N
Acer rubrum	red maple	15	3	N
Populus tremuloides	quaking aspen	15	2	N
Acer saccharum	sugar maple	2.5	5	N
Acer spicatum	mountain maple	2.5	6	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex radiata	eastern star sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Cinna latifolia	drooping woodreed	2.5	7	N

Clematis virginiana	virgin's bower	2.5	4	N
Clintonia borealis	bluebead lily	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Epilobium leptophyllum	linear-leaved willow herb	2.5	8	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Helianthus giganteus	giant sunflower	2.5	4	N
Hieracium umbellatum	Canada hawkweed	2.5	5	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Packera aurea	golden ragwort	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Poa palustris	fowl bluegrass	2.5	5	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N

Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex britannica	great water dock	2.5	8	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Triosteum aurantiacum	orange-fruit horse gentian	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum lentago	nannyberry	2.5	4	N
Viola labradorica	alpine violet	2.5	4	N
Monotropa uniflora	Ghost pipe	1	5	N
Thuja occidentalis	white cedar	1	9	N
Salix bebbiana	Bebb's willow	0	7	N

Sample Name	Crew	Date	Latitude	Longitude
wirb046f	SAM/IGL	2022-08-26	46.414342	-90.522614
Wetland Name		**Community Type**		
wirb046		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
235.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
28.991	1.907	5.125	0.337
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
28.549	28.162	4.970	4.902

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Populus tremuloides	quaking aspen	62.5	2	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Fraxinus pennsylvanica	green ash	15	2	N
Acer rubrum	red maple	2.5	3	N
Acer saccharum	sugar maple	2.5	5	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N

Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus acris	tall buttercup	2.5	0	I
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Tilia americana	American basswood	2.5	5	N
Abies balsamea	balsam fir	1	5	N
Agrimonia striata	roadside agrimony	1	3	N
Spiraea alba var. alba	white meadowsweet	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wirb044f	SAM/IGL	2022-08-27	46.415873	-90.521197
Wetland Name		**Community Type**		
wirb044		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
237		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
39.238	3.027	5.291	0.408
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
38.210	44.040	5.017	5.783

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Carex crinita var. crinita	fringed sedge	15	6	N
Populus tremuloides	quaking aspen	15	2	N
Rubus pubescens	dwarf raspberry	15	7	N
Abies balsamea	balsam fir	2.5	5	N
Abutilon theophrasti	velvet leaf	2.5	0	I
Acer rubrum	red maple	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Cornus canadensis	bunchberry	2.5	7	N

Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Poa palustris	fowl bluegrass	2.5	5	N
Polygonatum pubescens	hairy Solomon's seal	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes glandulosum	skunk currant	2.5	7	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Scirpus atrocinctus	black-girdled wool-grass	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Taraxacum officinale	common dandelion	1	0	I
Trillium cernuum	nodding trillium	1	8	N
Calamagrostis canadensis	bluejoint	0	5	N

Sample Name	Crew	Date	Latitude	Longitude
wirb042f	SAM/IGL	2022-08-27	46.41749	-90.52086
Wetland Name		**Community Type**		
wirb042		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
264		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
37.086	2.760	5.591	0.416
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
37.086	41.207	5.591	6.212

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	87.5	8	N
Abies balsamea	balsam fir	15	5	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Populus tremuloides	quaking aspen	15	2	N
Rubus pubescens	dwarf raspberry	15	7	N
Acer rubrum	red maple	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Chelone glabra	white turtlehead	2.5	7	N
Clintonia borealis	bluebead lily	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N

Ilex verticillata	common winterberry	2.5	7	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Packera aurea	golden ragwort	2.5	6	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Viburnum lentago	nannyberry	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	1	5	N
Picea glauca	white spruce	1	7	N
Ranunculus abortivus	little-leaf buttercup	1	1	N
Ribes glandulosum	skunk currant	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wirb039s	SAM/IGL	2022-08-27	46.41858	-90.519357
Wetland Name		**Community Type**		
wirb039		Shrub-Carr		
Total % Cover		**Total % Non-Native Cover**		
218.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
34.059	1.898	5.022	0.280
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
33.342	34.974	4.813	5.048

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Doellingeria umbellata	flat-top aster	15	6	N
Calamagrostis canadensis	bluejoint	15	5	N
Fraxinus nigra	black ash	15	8	N
Ilex verticillata	common winterberry	15	7	N
Onoclea sensibilis	sensitive fern	15	5	N
Populus tremuloides	quaking aspen	15	2	N
Salix petiolaris	slender willow	15	6	N
Scirpus cyperinus	wool-grass	15	4	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus inermis	smooth brome	2.5	0	I
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Chelone glabra	white turtlehead	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N

Corylus cornuta	beaked hazelnut	2.5	5	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Epilobium leptophyllum	linear-leaved willow herb	2.5	8	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium asprellum	rough bedstraw	2.5	7	N
Glyceria striata	fowl manna grass	2.5	4	N
Juncus effusus	common rush	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Picea glauca	white spruce	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Salix pyrifolia	balsam willow	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Solidago uliginosa	bog goldenrod	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wirb037s	SAM/IGL	2022-08-27	46.422891	-90.516265

Wetland Name	Community Type
wirb037	Shrub-Carr
Total % Cover	**Total % Non-Native Cover**
204.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
34.701	1.787	4.722	0.243
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
33.776	35.386	4.474	4.687

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Matteuccia struthiopteris	American ostrich fern	37.5	5	N
Alnus incana subsp. rugosa	speckled alder	15	4	N
Galium asprellum	rough bedstraw	15	7	N
Onoclea sensibilis	sensitive fern	15	5	N
Acer rubrum	red maple	2.5	3	N
Acer saccharum	sugar maple	2.5	5	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis gigantea	redtop	2.5	0	I
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Allium tricoccum	wild leek	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Cirsium muticum	swamp thistle	2.5	8	N
Clematis virginiana	virgin's bower	2.5	4	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N

Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Helianthus giganteus	giant sunflower	2.5	4	N
Humulus lupulus	common hops	2.5	3	N
Hypericum majus	large St. John's wort	2.5	5	N
Ilex verticillata	common winterberry	2.5	7	N
Lobelia siphilitica	great lobelia	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Plantago major	common plantain	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes glandulosum	skunk currant	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Smilax ecirrhata	erect carrion flower	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Ulmus americana	American elm	2.5	3	N
Viburnum lentago	nannyberry	2.5	4	N
Viburnum opulus	cranberry viburnum	2.5	6	N
Viola labradorica	alpine violet	2.5	4	N
Abies balsamea	balsam fir	1	5	N
Asclepias incarnata	swamp milkweed	1	5	N
Carex intumescens	bladder sedge	1	5	N
Carex lupulina	hop umbrella sedge	1	6	N
Platanthera huronensis	Huron green orchid	1	7	N
Prunus virginiana var. virginiana	chokecherry	1	3	N
Tilia americana	American basswood	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wirc023f	SAM/IGL	2022-08-29	46.423648	-90.516565
Wetland Name		**Community Type**		
wirc023		Floodplain Forest		
Total % Cover		**Total % Non-Native Cover**		
226.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
35.802	2.161	4.661	0.281
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
35.502	32.301	4.583	4.170

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus pennsylvanica	green ash	37.5	2	N
Abies balsamea	balsam fir	15	5	N
Acer saccharinum	silver maple	15	2	N
Acer saccharum	sugar maple	15	5	N
Carex lupulina	hop umbrella sedge	15	6	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alisma triviale	common water plantain	2.5	4	N
Allium tricoccum	wild leek	2.5	6	N
Asclepias incarnata	swamp milkweed	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex tuckermanii	Tuckerman's sedge	2.5	8	N
Chelone glabra	white turtlehead	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Clinopodium vulgare	wild-basil	2.5	3	N
Eleocharis obtusa	blunt spike-rush	2.5	3	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N

Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fraxinus nigra	black ash	2.5	8	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Helianthus giganteus	giant sunflower	2.5	4	N
Hypericum perforatum	common St. John's-wort	2.5	0	I
Laportea canadensis	woodnettle	2.5	4	N
Leersia oryzoides	rice cut grass	2.5	3	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Persicaria pensylvanica	Pennsylvania knotweed	2.5	1	N
Persicaria punctata	dotted smartweed	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Sagittaria latifolia var. latifolia	broad-leaved arrowhead	2.5	3	N
Scirpus cyperinus	wool-grass	2.5	4	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Ulmus americana	American elm	2.5	3	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Acer rubrum	red maple	1	3	N
Bromus ciliatus	fringed brome	1	7	N
Carex pedunculata	long-stalked sedge	1	7	N
Cicuta bulbifera	bulb-bearing water hemlock	1	7	N
Galium triflorum	fragrant bedstraw	1	5	N
Heracleum lanatum	cow parsnip	1	3	N
Mimulus ringens	Monkey-flower	1	6	N
Oxalis stricta	yellow wood-sorrel	1	0	N
Prunus virginiana var. virginiana	chokecherry	1	3	N
Ranunculus recurvatus	blisterwort	1	5	N
Smilax ecirrhata	erect carrion flower	1	5	N
Thuja occidentalis	white cedar	1	9	N
Verbena hastata	blue vervain	1	3	N
Viburnum lentago	nannyberry	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wirc022f	SAM/IGL	2022-08-29	46.42363	-90.515707
Wetland Name		**Community Type**		
wirc022		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
164.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
31.786	1.428	4.905	0.220
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
30.373	30.510	4.478	4.498

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer saccharum	sugar maple	37.5	5	N
Abies balsamea	balsam fir	15	5	N
Fraxinus pennsylvanica	green ash	15	2	N
Anemone canadensis	canada anemone	2.5	4	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum firmum	shining aster	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bromus ciliatus	fringed brome	2.5	7	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex intumescens	bladder sedge	2.5	5	N
Carex lupulina	hop umbrella sedge	2.5	6	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Chelone glabra	white turtlehead	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clinopodium vulgare	wild-basil	2.5	3	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Galium asprellum	rough bedstraw	2.5	7	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N

Impatiens capensis	spotted touch-me-not	2.5	2	N
Lapsana communis	nipplewort	2.5	0	I
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunella vulgaris	heal-all	2.5	1	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex obtusifolius	bitter dock	2.5	0	I
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Veronica officinalis	common speedwell	2.5	0	I
Agrimonia striata	roadside agrimony	1	3	N
Carex stipata	common fox sedge	1	2	N
Cicuta maculata	common water-hemlock	1	6	N
Galium triflorum	fragrant bedstraw	1	5	N
Ranunculus acris	tall buttercup	1	0	I
Ulmus americana	American elm	1	3	N
Viburnum opulus	cranberry viburnum	1	6	N

Sample Name	Crew	Date	Latitude	Longitude
wirc021f	SAM/IGL	2022-08-29	46.425058	-90.514682
Wetland Name		**Community Type**		
wirc021		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
247		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
33.690	2.807	5.022	0.418
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
33.322	38.580	4.913	5.688

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Acer saccharum	sugar maple	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Carex tuckermanii	Tuckerman's sedge	15	8	N
Fraxinus pennsylvanica	green ash	15	2	N
Ilex verticillata	common winterberry	15	7	N
Toxicodendron rydbergii	western poison ivy	15	2	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Calystegia sepium	hedge bindweed	2.5	2	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex projecta	projecting sedge	2.5	4	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Iris versicolor	northern blue flag	2.5	5	N

Juncus effusus	common rush	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda regalis var. spectabilis	royal fern	2.5	7	N
Ostrya virginiana	ironwood	2.5	5	N
Parthenocissus vitacea	woodbine	2.5	4	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Salix bebbiana	Bebb's willow	2.5	7	N
Salix petiolaris	slender willow	2.5	6	N
Scirpus atrocinctus	black-girdled wool-grass	2.5	7	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Taraxacum officinale	common dandelion	2.5	0	I
Ulmus americana	American elm	2.5	3	N
Arisaema triphyllum	Jack-in-the-pulpit	1	5	N
Tilia americana	American basswood	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wirc024f	SAM/IGL	2022-08-29	46.425678	-90.514702

Wetland Name	Community Type
wirc024	Hardwood Swamp
Total % Cover	**Total % Non-Native Cover**
204	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
33.468	2.288	5.657	0.387
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
33.000	38.191	5.500	6.365

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Acer saccharum	sugar maple	37.5	5	N
Betula alleghaniensis	yellow birch	15	7	N
Lonicera canadensis	fly honeysuckle	15	8	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Allium tricoccum	wild leek	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N

Osmunda cinnamomea	cinnamon fern	2.5	7	N
Ostrya virginiana	ironwood	2.5	5	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Ranunculus acris	tall buttercup	2.5	0	I
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Ulmus americana	American elm	2.5	3	N
Picea glauca	white spruce	1	7	N
Rubus idaeus var. strigosus	red raspberry	1	3	N
Trillium cernuum	nodding trillium	1	8	N
Tsuga canadensis	eastern hemlock	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wirc025f	SAM/IGL	2022-08-29	46.426584	-90.513138
Wetland Name		**Community Type**		
wirc025		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
233.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
40.489	3.053	5.271	0.397
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
40.150	44.270	5.183	5.715

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Acer saccharum	sugar maple	15	5	N
Fraxinus pennsylvanica	green ash	15	2	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Betula alleghaniensis	yellow birch	2.5	7	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex rosea	starry sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N

Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Leersia oryzoides	rice cut grass	2.5	3	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ranunculus recurvatus	hooked buttercup	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Picea glauca	white spruce	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wirc013f_x	SAM/IGL	2022-09-01	46.430338	-90.50956
Wetland Name		**Community Type**		
wirc013_x		Coniferous Swamp		
Total % Cover		**Total % Non-Native Cover**		
335.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
55.245	5.338	5.791	0.560
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
54.647	57.000	5.667	5.911

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Abies balsamea	balsam fir	37.5	5	N
Acer rubrum	red maple	15	3	N
Acer spicatum	mountain maple	2.5	6	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex bromoides		2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea		2.5	9	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex rosea	starry sedge	2.5	4	N
Carex stipata		2.5	2	N

Carex trisperma	three-seeded bog sedge	2.5	9	N
Chelone glabra	white turtlehead	2.5	7	N
Chrysosplenium americanum	American golden saxifrage	2.5	9	N
Cicuta bulbifera	bulb-bearing water hemlock	2.5	7	N
Cinna latifolia	drooping woodreed	2.5	7	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Clintonia borealis	bluebead lily	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Geum rivale	purple avens	2.5	8	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Laportea canadensis	woodnettle	2.5	4	N
Linnaea borealis subsp. americana	twinflower	2.5	9	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitella nuda	naked miterwort	2.5	9	N
Moneses uniflora subsp. uniflora	one-flowered pyrola	2.5	9	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Orthilia secunda	one-sided shin-leaf	2.5	7	N
Osmunda claytoniana	interrupted fern	2.5	6	N

Oxalis montana	mountain wood-sorrel	2.5	9	N
Packera aurea	golden ragwort	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Picea glauca	white spruce	2.5	7	N
Platanthera psycodes	lesser purple fringed orchid	2.5	7	N
Poa palustris	fowl bluegrass	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ribes americanum	wild black currant	2.5	4	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria galericulata	marsh skullcap	2.5	5	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum trifolium	false mayflower	2.5	10	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Taxus canadensis	Canada yew	2.5	10	N
Thuja occidentalis	white cedar	2.5	9	N
Toxicodendron rydbergii	western poison ivy	2.5	2	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum lentago	nannyberry	2.5	4	N
Viola macloskeyi subsp. pallens	small white violet	2.5	7	N
Acer saccharum	sugar maple	1	5	N
Coptis trifolia	three-leaved gold-thread	1	8	N
Pinus strobus	white pine	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wirc1022f	SAM/IGL	2022-08-27	46.432266	-90.507754
Wetland Name		**Community Type**		
wirc1022		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
161		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
19.203	1.288	4.190	0.281
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
19.203	26.869	4.190	5.863

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex tuckermanii	Tuckerman's sedge	87.5	8	N
Calystegia sepium	hedge bindweed	15	2	N
Fraxinus pennsylvanica	green ash	15	2	N
Acer rubrum	red maple	2.5	3	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Cardamine pensylvanica	Pensylvania bitter cress	2.5	3	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex tenera	marsh straw sedge	2.5	4	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Glyceria striata	fowl manna grass	2.5	4	N
Laportea canadensis	woodnettle	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Juncus effusus	common rush	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wirc1019f	EJO/MJF	2022-08-27	46.433434	-90.505773
Wetland Name		**Community Type**		
wirc1019		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
336		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
42.836	4.337	5.273	0.534
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
42.515	43.667	5.194	5.335

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	37.5	3	N
Fraxinus nigra	black ash	37.5	8	N
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex brunnescens	green bog sedge	15	7	N
Carex crinita var. crinita	fringed sedge	15	6	N
Fraxinus pennsylvanica	green ash	15	2	N
Lycopus uniflorus	northern bugleweed	15	4	N
Osmunda cinnamomea	cinnamon fern	15	7	N
Abies balsamea	balsam fir	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lanceolatum	eastern lined aster	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Carex canescens	silvery sedge	2.5	8	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N

Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Carex tenera	marsh straw sedge	2.5	4	N
Carex trisperma	three-seeded bog sedge	2.5	9	N
Cinna latifolia	drooping woodreed	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Clintonia borealis	bluebead lily	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Eupatorium perfoliatum	boneset	2.5	6	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Juncus effusus	common rush	2.5	4	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Lycopodium annotinum	bristly clubmoss	2.5	7	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oxalis montana	mountain wood-sorrel	2.5	9	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Prunus serotina	wild black cherry	2.5	3	N
Ribes glandulosum	skunk currant	2.5	7	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thuja occidentalis	white cedar	2.5	9	N

Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Verbena hastata	blue vervain	2.5	3	N
Galeopsis tetrahit	hemp nettle	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wirc014f_x	SAM/IGL	2022-09-01	46.434721	-90.502863

Wetland Name	Community Type
wirc014_x	Hardwood Swamp

Total % Cover	Total % Non-Native Cover
223.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	wFQIn	Mean C ($\bar{C}$n)	Weighted Mean C (w$\bar{C}$n)
35.299	2.617	5.149	0.382
Floristic Quality Metrics: All Species (a)			
FQIa	wFQIa	Mean C ($\bar{C}$a)	Weighted Mean C (w$\bar{C}$a)
35.299	41.502	5.149	6.054

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	62.5	8	N
Abies balsamea	balsam fir	15	5	N
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Carex crinita var. crinita	fringed sedge	15	6	N
Acer rubrum	red maple	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex disperma	soft-leaved sedge	2.5	10	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N

Dryopteris cristata	crested fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum canadense	white avens	2.5	2	N
Glyceria striata	fowl manna grass	2.5	4	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thuja occidentalis	white cedar	2.5	9	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Tsuga canadensis	eastern hemlock	1	8	N
Lactuca biennis	biennial blue lettuce	0	3	N

Sample Name	Crew	Date	Latitude	Longitude
wirc014e	EJO/MJF	2022-08-26	46.435035	-90.501469
Wetland Name		**Community Type**		
wirc014		Fresh Meadow (Disturbed Subtype)		
Total % Cover		**Total % Non-Native Cover**		
339.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C ($w\bar{C}n$)**
36.435	3.023	4.485	0.372
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C ($w\bar{C}a$)**
33.515	33.142	3.795	3.753

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Solidago canadensis	Canadian goldenrod	37.5	1	N
Doellingeria umbellata	flat-top aster	15	6	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Carex gynandra	nodding sedge	15	6	N
Clematis virginiana	virgin's bower	15	4	N
Eutrochium maculatum	spotted Joe-Pye-weed	15	4	N
Onoclea sensibilis	sensitive fern	15	5	N
Salix discolor	pussy willow	15	2	N
Solidago gigantea	giant goldenrod	15	3	N
Acer rubrum	red maple	2.5	3	N
Acer saccharum	sugar maple	2.5	5	N
Agrostis gigantea	redtop	2.5	0	I
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Apocynum androsaemifolium	spreading dogbane	2.5	2	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex scoparia var. scoparia	lance-fruited oval sedge	2.5	4	N
Carex vulpinoidea	fox sedge	2.5	2	N
Cicuta maculata	common water-hemlock	2.5	6	N

Cornus stolonifera	red osier dogwood	2.5	3	N
Dactylis glomerata	orchard grass	2.5	0	I
Diervilla lonicera	bush honeysuckle	2.5	6	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum variegatum subsp. variegatum	variegated horsetail	2.5	7	N
Erigeron annuus	annual fleabane	2.5	0	N
Eupatorium perfoliatum	boneset	2.5	6	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fragaria virginiana	common strawberry	2.5	1	N
Fraxinus nigra	black ash	2.5	8	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Helianthus giganteus	giant sunflower	2.5	4	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Hypericum perforatum	common St. John's-wort	2.5	0	I
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Leersia oryzoides	rice cut grass	2.5	3	N
Lotus corniculatus	bird's-foot trefoil	2.5	0	I
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Phleum pratense subsp. pratense	timothy	2.5	0	I
Plantago lanceolata	English plantain	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Poa pratensis subsp. pratensis	Kentucky bluegrass	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N

Ranunculus acris	tall buttercup	2.5	0	I
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rumex britannica	great water dock	2.5	8	N
Salix bebbiana	Bebb's willow	2.5	7	N
Salix petiolaris	slender willow	2.5	6	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Taraxacum officinale	common dandelion	2.5	0	I
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Thuja occidentalis	white cedar	2.5	9	N
Tilia americana	American basswood	2.5	5	N
Trifolium repens	white clover	2.5	0	I
Abies balsamea	balsam fir	1	5	N
Populus balsamifera	balsam poplar	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wirc1016f	EJO/MJF	2022-08-27	46.437251	-90.500259
Wetland Name		**Community Type**		
wirc1016		Coniferous Swamp		
Total % Cover		**Total % Non-Native Cover**		
299.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C ($w\bar{C}n$)**
41.988	3.625	5.561	0.480
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C ($w\bar{C}a$)**
41.624	40.990	5.466	5.382

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	62.5	3	N
Betula alleghaniensis	yellow birch	37.5	7	N
Abies balsamea	balsam fir	15	5	N
Carex intumescens	bladder sedge	15	5	N
Fraxinus nigra	black ash	15	8	N
Osmunda cinnamomea	cinnamon fern	15	7	N
Tsuga canadensis	eastern hemlock	15	8	N
Acer saccharum	sugar maple	2.5	5	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex bromoides	brome-like sedge	2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex gynandra	nodding sedge	2.5	6	N
Carex trisperma	three-seeded bog sedge	2.5	9	N
Cinna latifolia	drooping woodreed	2.5	7	N

Clintonia borealis	bluebead lily	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopodium annotinum	bristly clubmoss	2.5	7	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thuja occidentalis	white cedar	2.5	9	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Ulmus americana	American elm	2.5	3	N
Veronica officinalis	common speedwell	2.5	0	I
Chelone glabra	white turtlehead	1	7	N
Monotropa uniflora	Ghost pipe	1	5	N

Sample Name	Crew	Date	Latitude	Longitude
wirc006f/wirc006f_x	SAM/IGL	2022-09-02	46.439429	-90.497801
Wetland Name		**Community Type**		
wirc006_x		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
196.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
28.855	1.502	4.452	0.232
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
28.855	27.094	4.452	4.181

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Impatiens capensis	spotted touch-me-not	37.5	2	N
Acer saccharum	sugar maple	15	5	N
Carex projecta	projecting sedge	15	4	N
Fraxinus nigra	black ash	15	8	N
Glyceria striata	fowl manna grass	15	4	N
Scirpus cyperinus	wool-grass	15	4	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Calystegia sepium	hedge bindweed	2.5	2	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex cristatella	crested sedge	2.5	4	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex stipata	common fox sedge	2.5	2	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum arvense	field horsetail	2.5	1	N
Erechtites hieracifolia var. hieracifolia	American burn-weed	2.5	2	N

Fraxinus pennsylvanica	green ash	2.5	2	N
Geum canadense	white avens	2.5	2	N
Glyceria canadensis var. canadensis	rattlesnake grass	2.5	7	N
Juncus effusus	common rush	2.5	4	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus atrocinctus	black-girdled wool-grass	2.5	7	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Ulmus americana	American elm	2.5	3	N
Acer rubrum	red maple	1	3	N
Carex brunnescens	green bog sedge	1	7	N
Ranunculus abortivus	little-leaf buttercup	1	1	N
Tsuga canadensis	eastern hemlock	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wira008s	EJO/MJF	2022-08-27	46.442929	-90.490879
Wetland Name		**Community Type**		
wira008		Alder Thicket		
Total % Cover		**Total % Non-Native Cover**		
238.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
32.810	1.991	4.640	0.282
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
32.173	33.546	4.462	4.652

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Alnus incana subsp. rugosa	speckled alder	62.5	4	N
Carex bromoides	brome-like sedge	15	8	N
Carex crinita var. crinita	fringed sedge	15	6	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Onoclea sensibilis	sensitive fern	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Acer rubrum	red maple	2.5	3	N
Acer spicatum	mountain maple	2.5	6	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Carex tenera	marsh straw sedge	2.5	4	N
Cinna latifolia	drooping woodreed	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Eupatorium perfoliatum	boneset	2.5	6	N
Fragaria virginiana	common strawberry	2.5	1	N

Galium asprellum	rough bedstraw	2.5	7	N
Geum aleppicum	yellow avens	2.5	3	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Leersia oryzoides	rice cut grass	2.5	3	N
Ludwigia palustris	common water primrose	2.5	4	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Mimulus ringens	Monkey-flower	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Persicaria hydropiper	marsh waterpepper	2.5	0	I
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Ranunculus hispidus	hispid buttercup	2.5	6	N
Ranunculus pensylvanicus	bristly buttercup	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Sagittaria latifolia var. latifolia	broad-leaved arrowhead	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Tilia americana	American basswood	2.5	5	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Urtica dioica subsp. gracilis	stinging nettle	2.5	0	I
Verbena hastata	blue vervain	2.5	3	N
Viburnum lentago	nannyberry	2.5	4	N
Chelone glabra	white turtlehead	1	7	N

Sample Name	Crew	Date	Latitude	Longitude
wira008e_x	SAM/IGL	2022-09-02	46.442724	-90.490772
Wetland Name		**Community Type**		
wira008_x		Fresh Meadow (Native Subtype)		
Total % Cover		**Total % Non-Native Cover**		
118		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
29.168	0.864	5.156	0.153
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
28.297	26.758	4.853	4.589

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Impatiens capensis	spotted touch-me-not	15	2	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Onoclea sensibilis	sensitive fern	15	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Bidens cernua	nodding bur-marigold	2.5	4	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex scabrata	eastern rough sedge	2.5	8	N
Cicuta bulbifera	bulb-bearing water hemlock	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Eutrochium maculatum	spotted Joe-Pye-weed	2.5	4	N
Eupatorium perfoliatum	boneset	2.5	6	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium obtusum	blunt-leaf bedstraw	2.5	6	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Hydrocotyle americana	American water-pennywort	2.5	7	N
Mentha arvensis var. canadensis	common mint	2.5	3	N
Persicaria punctata	dotted smartweed	2.5	5	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Ranunculus hispidus	hispid buttercup	2.5	6	N

Rubus pubescens	dwarf raspberry	2.5	7	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Urtica dioica subsp. gracilis	stinging nettle	2.5	0	I
Verbena hastata	blue vervain	2.5	3	N
Chelone glabra	white turtlehead	1	7	N
Mimulus ringens	Monkey-flower	1	6	N
Ranunculus abortivus	little-leaf buttercup	1	1	N

Sample Name	Crew	Date	Latitude	Longitude
wira008f_x	SAM/IGL	2022-09-02	46.442876	-90.490566
Wetland Name		**Community Type**		
wira008_x		Coniferous Swamp		
Total % Cover		**Total % Non-Native Cover**		
128.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
35.002	1.350	6.188	0.239
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
35.002	37.221	6.188	6.580

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Thuja occidentalis	white cedar	15	9	N
Tsuga canadensis	eastern hemlock	15	8	N
Abies balsamea	balsam fir	2.5	5	N
Acer spicatum	mountain maple	2.5	6	N
Actaea rubra	red baneberry	2.5	7	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex stipata	common fox sedge	2.5	2	N
Circaea alpina subsp. alpina	alpine enchanter's-nightshade	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fraxinus nigra	black ash	2.5	8	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N

Oxalis montana	mountain wood-sorrel	2.5	9	N
Picea glauca	white spruce	2.5	7	N
Ribes triste	swamp red currant	2.5	8	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Taxus canadensis	Canada yew	2.5	10	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Carex bromoides	brome-like sedge	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wira008f	EJO/MJF	2022-08-27	46.445354	-90.488133
Wetland Name		**Community Type**		
wira008		Hardwood Swamp		
Total % Cover		**Total % Non-Native Cover**		
299.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}n$)**
36.425	2.866	4.825	0.380
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}a$)**
36.109	38.041	4.741	4.995

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Carex intumescens	bladder sedge	62.5	5	N
Acer rubrum	red maple	37.5	3	N
Betula alleghaniensis	yellow birch	15	7	N
Carex crinita var. crinita	fringed sedge	15	6	N
Corylus cornuta	beaked hazelnut	15	5	N
Dryopteris intermedia	glandular wood fern	15	7	N
Fraxinus nigra	black ash	15	8	N
Abies balsamea	balsam fir	2.5	5	N
Acer saccharum	sugar maple	2.5	5	N
Aralia nudicaulis	wild sarsaparilla	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex rosea	starry sedge	2.5	4	N
Carex scoparia var. scoparia	lance-fruited oval sedge	2.5	4	N
Cinna latifolia	drooping woodreed	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Dryopteris cristata	crested fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N

Eupatorium perfoliatum	boneset	2.5	6	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Fraxinus pennsylvanica	green ash	2.5	2	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Iris versicolor	northern blue flag	2.5	5	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Oxalis montana	mountain wood-sorrel	2.5	9	N
Parthenocissus vitacea	woodbine	2.5	4	N
Poa palustris	fowl bluegrass	2.5	5	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes glandulosum	skunk currant	2.5	7	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scirpus cyperinus	wool-grass	2.5	4	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Ulmus americana	American elm	2.5	3	N
Urtica dioica subsp. gracilis	stinging nettle	2.5	0	I
Uvularia sessilifolia	pale bellwort	2.5	6	N
Apocynum androsaemifolium	spreading dogbane	1	2	N
Spiraea alba var. alba	white meadowsweet	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wirc1002f	EJO/MJF	2022-08-26	46.462108	-90.481008

Wetland Name	Community Type
wirc1002	Coniferous Swamp
Total % Cover	**Total % Non-Native Cover**
370.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}$n)**	**Weighted Mean C (w$\bar{C}$n)**
46.000	5.078	5.111	0.564
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}$a)**	**Weighted Mean C (w$\bar{C}$a)**
45.719	47.220	5.049	5.215

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Ulmus americana	American elm	37.5	3	N
Acer rubrum	red maple	15	3	N
Acer saccharum	sugar maple	15	5	N
Calamagrostis canadensis	bluejoint	15	5	N
Carex bromoides	brome-like sedge	15	8	N
Fraxinus pennsylvanica	green ash	15	2	N
Solidago gigantea	giant goldenrod	15	3	N
Thuja occidentalis	white cedar	15	9	N
Tsuga canadensis	eastern hemlock	15	8	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Anemone quinquefolia	wood anemone	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula alleghaniensis	yellow birch	2.5	7	N
Caltha palustris	common marsh marigold	2.5	6	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex gynandra	nodding sedge	2.5	6	N
Carex intumescens	bladder sedge	2.5	5	N

Carex leptalea subsp. leptalea	slender sedge	2.5	9	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Chelone glabra	white turtlehead	2.5	7	N
Cinna latifolia	drooping woodreed	2.5	7	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium triflorum	fragrant bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Matteuccia struthiopteris	American ostrich fern	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Ostrya virginiana	ironwood	2.5	5	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Packera aurea	golden ragwort	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Picea glauca	white spruce	2.5	7	N
Poa palustris	fowl bluegrass	2.5	5	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N

Prenanthes alba	white rattlesnakeroot	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Ranunculus abortivus	little-leaf buttercup	2.5	1	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes americanum	wild black currant	2.5	4	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Veronica officinalis	common speedwell	2.5	0	I
Viburnum lentago	nannyberry	2.5	4	N
Vitis riparia	wild grape	2.5	2	N
Prunus serotina	wild black cherry	1	3	N
Sanguinaria canadensis	bloodroot	1	6	N
Trillium cernuum	nodding trillium	1	8	N

Sample Name	Crew	Date	Latitude	Longitude
wird003f	EJO/MJF	2022-08-26	46.463167	-90.481624
Wetland Name		**Community Type**		
wird003		Coniferous Swamp		
Total % Cover		**Total % Non-Native Cover**		
403.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
49.996	5.287	5.330	0.564
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
49.437	52.219	5.211	5.504

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Fraxinus nigra	black ash	37.5	8	N
Tsuga canadensis	eastern hemlock	37.5	8	N
Abies balsamea	balsam fir	15	5	N
Acer rubrum	red maple	15	3	N
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Betula papyrifera	canoe birch	15	3	N
Fraxinus pennsylvanica	green ash	15	2	N
Glyceria striata	fowl manna grass	15	4	N
Thuja occidentalis	white cedar	15	9	N
Ulmus americana	American elm	15	3	N
Agrimonia striata	roadside agrimony	2.5	3	N
Agrostis cf. perennans	autumn bent grass	2.5	4	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Symphyotrichum puniceum	bristly aster	2.5	5	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Bromus ciliatus	fringed brome	2.5	7	N

Carex bromoides	brome-like sedge	2.5	8	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita		2.5	0	
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex projecta	projecting sedge	2.5	4	N
Carex rosea	starry sedge	2.5	4	N
Carex stipata	common fox sedge	2.5	2	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Cinna latifolia	drooping woodreed	2.5	7	N
Clematis virginiana	virgin's bower	2.5	4	N
Clintonia borealis	bluebead lily	2.5	7	N
Coptis trifolia	three-leaved gold-thread	2.5	8	N
Cornus alternifolia	pagoda dogwood	2.5	7	N
Cornus canadensis	bunchberry	2.5	7	N
Cornus stolonifera	red osier dogwood	2.5	3	N
Corylus cornuta	beaked hazelnut	2.5	5	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Elymus hystrix	bottlebrush grass	2.5	6	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Equisetum pratense	meadow horsetail	2.5	9	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fragaria virginiana	common strawberry	2.5	1	N
Galium asprellum	rough bedstraw	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Ilex verticillata	common winterberry	2.5	7	N
Impatiens capensis	spotted touch-me-not	2.5	2	N
Lactuca biennis	biennial blue lettuce	2.5	3	N
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Mitella nuda	naked miterwort	2.5	9	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda cinnamomea	cinnamon fern	2.5	7	N

Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Picea glauca	white spruce	2.5	7	N
Poa palustris	fowl bluegrass	2.5	5	N
Prenanthes alba	white rattlesnakeroot	2.5	5	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus serotina	wild black cherry	2.5	3	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Pteridium aquilinum	bracken	2.5	2	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Quercus rubra	northern red oak	2.5	5	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes americanum	wild black currant	2.5	4	N
Ribes glandulosum	skunk currant	2.5	7	N
Ribes triste	swamp red currant	2.5	8	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Veronica officinalis	common speedwell	2.5	0	I
Oryzopsis asperifolia	mountain ricegrass	1	6	N
Osmunda claytoniana	interrupted fern	0	6	N

Sample Name	Crew	Date	Latitude	Longitude
wird003e	EJO/MJF	2022-08-26	46.465031	-90.481455
Wetland Name		**Community Type**		
wird003		Hardwood Swamp (Vernal Pool Subtype)		
Total % Cover		**Total % Non-Native Cover**		
199		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
32.498	1.692	4.844	0.252
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
31.799	34.244	4.638	4.995

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	15	3	N
Acer saccharum	sugar maple	15	5	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Carex crinita var. crinita	fringed sedge	15	6	N
Fraxinus nigra	black ash	15	8	N
Matteuccia struthiopteris	American ostrich fern	15	5	N
Onoclea sensibilis	sensitive fern	15	5	N
Allium tricoccum	wild leek	2.5	6	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Betula alleghaniensis	yellow birch	2.5	7	N
Betula papyrifera	canoe birch	2.5	3	N
Bidens frondosa	common beggar-ticks	2.5	1	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex projecta	projecting sedge	2.5	4	N
Carex tuckermanii	Tuckerman's sedge	2.5	8	N
Caulophyllum thalictroides	blue cohosh	2.5	8	N
Cinna latifolia	drooping woodreed	2.5	7	N
Cornus alternifolia	pagoda dogwood	2.5	7	N
Galium tinctorium	southern three-lobed bedstraw	2.5	5	N
Glyceria grandis var. grandis	American manna grass	2.5	6	N
Glyceria striata	fowl manna grass	2.5	4	N

Lonicera canadensis	fly honeysuckle	2.5	8	N
Mitchella repens	partridgeberry	2.5	6	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Parthenocissus vitacea	woodbine	2.5	4	N
Penthorum sedoides	ditch stonecrop	2.5	3	N
Poa palustris	fowl bluegrass	2.5	5	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Persicaria sagittata	arrow-leaved tear-thumb	2.5	6	N
Populus tremuloides	quaking aspen	2.5	2	N
Prunella vulgaris	heal-all	2.5	1	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Solidago gigantea	giant goldenrod	2.5	3	N
Thalictrum dasycarpum	tall meadow-rue	2.5	4	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Ulmus americana	American elm	2.5	3	N
Vitis riparia	wild grape	2.5	2	N
Carex radiata	eastern star sedge	1	4	N
Rumex obtusifolius	bitter dock	1	0	I
Maianthemum racemosum	false Solomon's-seal	1	5	N
Taraxacum officinale	common dandelion	1	0	I

Sample Name	Crew	Date	Latitude	Longitude
wird001f	EJO/MJF	2022-08-26	46.466819	-90.481827
Wetland Name		**Community Type**		
wird001		Floodplain Forest		
Total % Cover		**Total % Non-Native Cover**		
439.5		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C (C̄n)**	**Weighted Mean C (wC̄n)**
41.555	4.613	4.705	0.522
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C (C̄a)**	**Weighted Mean C (wC̄a)**
41.032	41.893	4.588	4.684

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Matteuccia struthiopteris	American ostrich fern	62.5	5	N
Acer saccharum	sugar maple	37.5	5	N
Fraxinus pennsylvanica	green ash	37.5	2	N
Acer rubrum	red maple	15	3	N
Acer saccharinum	silver maple	15	2	N
Betula alleghaniensis	yellow birch	15	7	N
Caulophyllum thalictroides	blue cohosh	15	8	N
Fraxinus nigra	black ash	15	8	N
Prunus serotina	wild black cherry	15	3	N
Thalictrum dasycarpum	tall meadow-rue	15	4	N
Thuja occidentalis	white cedar	15	9	N
Tilia americana	American basswood	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Adiantum pedatum	maidenhair fern	2.5	7	N
Allium tricoccum	wild leek	2.5	6	N
Alnus incana subsp. rugosa	speckled alder	2.5	4	N
Apocynum androsaemifolium	spreading dogbane	2.5	2	N
Aquilegia canadensis	columbine	2.5	5	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Bromus ciliatus	fringed brome	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex bromoides	brome-like sedge	2.5	8	N

Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex hystericina	porcupine sedge	2.5	3	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Carex radiata	eastern star sedge	2.5	4	N
Carex retrorsa	retrorse sedge	2.5	6	N
Circaea lutetiana	broad-leaf enchanter's-nightshade	2.5	2	N
Clematis virginiana	virgin's bower	2.5	4	N
Cornus alternifolia	pagoda dogwood	2.5	7	N
Dryopteris intermedia	glandular wood fern	2.5	7	N
Echinocystis lobata	wild cucumber	2.5	2	N
Elymus virginicus var. virginicus	common eastern wild-rye	2.5	6	N
Epilobium ciliatum	American willow-herb	2.5	3	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Equisetum hyemale subsp. affine	common scouring rush	2.5	3	N
Eupatorium perfoliatum	boneset	2.5	6	N
Geum aleppicum	yellow avens	2.5	3	N
Glyceria striata	fowl manna grass	2.5	4	N
Heracleum lanatum	cow parsnip	2.5	3	N
Laportea canadensis	woodnettle	2.5	4	N
Lycopus americanus	cut-leaved bugleweed	2.5	4	N
Lysimachia ciliata	fringed loosestrife	2.5	5	N
Melilotus alba	white sweet clover	2.5	0	I
Mimulus ringens	Monkey-flower	2.5	6	N
Muhlenbergia mexicana	Mexican muhly grass	2.5	4	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Oxalis stricta	yellow wood-sorrel	2.5	0	N
Parthenocissus vitacea	woodbine	2.5	4	N
Phalaris arundinacea	reed canary grass	2.5	0	I
Poa palustris	fowl bluegrass	2.5	5	N
Fallopia cilinodis	black-fringe bindweed	2.5	1	N
Persicaria lapathifolia	curly-top knotweed	2.5	2	N
Persicaria pensylvanica	Pennsylvania knotweed	2.5	1	N
Prunella vulgaris	heal-all	2.5	1	N
Prunus virginiana var. virginiana	chokecherry	2.5	3	N
Quercus rubra	northern red oak	2.5	5	N
Ranunculus recurvatus	blisterwort	2.5	5	N
Ribes cynosbati	prickly gooseberry	2.5	3	N
Ribes triste	swamp red currant	2.5	8	N

Rubus pubescens	dwarf raspberry	2.5	7	N
Rumex britannica	great water dock	2.5	8	N
Salix petiolaris	slender willow	2.5	6	N
Sanguinaria canadensis	bloodroot	2.5	6	N
Micranthes pensylvanica	eastern swamp saxifrage	2.5	7	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Maianthemum stellatum	starry false Solomon's-seal	2.5	5	N
Solidago flexicaulis	zigzag goldenrod	2.5	6	N
Solidago gigantea	giant goldenrod	2.5	3	N
Stachys palustris	woundwort	2.5	5	N
Trillium cernuum	nodding trillium	2.5	8	N
Uvularia sessilifolia	pale bellwort	2.5	6	N
Verbena hastata	blue vervain	2.5	3	N
Viburnum lentago	nannyberry	2.5	4	N
Lysimachia terrestris	yellow loosestrife	1	7	N
Scirpus cyperinus	wool-grass	1	4	N

Sample Name	Crew	Date	Latitude	Longitude
wira016f	EJO/MJF	2022-08-26	46.469466	-90.482007
Wetland Name		**Community Type**		
wira016		Coniferous Swamp		
Total % Cover		**Total % Non-Native Cover**		
232		0		

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C ($w\bar{C}n$)**
39.404	2.628	5.688	0.379
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C ($w\bar{C}a$)**
38.608	39.592	5.460	5.599

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Tsuga canadensis	eastern hemlock	37.5	8	N
Acer rubrum	red maple	15	3	N
Acer saccharum	sugar maple	15	5	N
Betula alleghaniensis	yellow birch	15	7	N
Fraxinus pennsylvanica	green ash	15	2	N
Osmunda claytoniana	interrupted fern	15	6	N
Quercus rubra	northern red oak	15	5	N
Abies balsamea	balsam fir	2.5	5	N
Allium tricoccum	wild leek	2.5	6	N
Anemone quinquefolia	wood anemone	2.5	6	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Eurybia macrophylla	big-leaved aster	2.5	4	N
Doellingeria umbellata	flat-top aster	2.5	6	N
Athyrium filix-femina var. angustum	lady fern	2.5	5	N
Betula papyrifera	canoe birch	2.5	3	N
Brachyelytrum aristosum	bearded shorthusk	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex brunnescens	green bog sedge	2.5	7	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Cinna latifolia	drooping woodreed	2.5	7	N
Clintonia borealis	bluebead lily	2.5	7	N
Cornus alternifolia	pagoda dogwood	2.5	7	N

Dryopteris intermedia	glandular wood fern	2.5	7	N
Equisetum sylvaticum	woodland horsetail	2.5	7	N
Fraxinus nigra	black ash	2.5	8	N
Glyceria striata	fowl manna grass	2.5	4	N
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Hieracium caespitosum	meadow hawkweed	2.5	0	I
Lonicera canadensis	fly honeysuckle	2.5	8	N
Lycopus uniflorus	northern bugleweed	2.5	4	N
Maianthemum canadense	Canada mayflower	2.5	5	N
Mitchella repens	partridgeberry	2.5	6	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Ostrya virginiana	ironwood	2.5	5	N
Phegopteris connectilis	Narrow beech fern	2.5	7	N
Picea glauca	white spruce	2.5	7	N
Pyrola elliptica	elliptic shinleaf	2.5	6	N
Rubus pubescens	dwarf raspberry	2.5	7	N
Scutellaria lateriflora	mad dog skullcap	2.5	5	N
Maianthemum racemosum	false Solomon's-seal	2.5	5	N
Thuja occidentalis	white cedar	2.5	9	N
Tilia americana	American basswood	2.5	5	N
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Trillium cernuum	nodding trillium	2.5	8	N
Veronica officinalis	common speedwell	2.5	0	I
Vitis riparia	wild grape	2.5	2	N
Aralia nudicaulis	wild sarsaparilla	1	6	N
Prunus serotina	wild black cherry	1	3	N

Sample Name	Crew	Date	Latitude	Longitude
wird006f	SAM/IGL	2022-08-30	46.472169	-90.482398

Wetland Name	Community Type
wird006	Hardwood Swamp
Total % Cover	**Total % Non-Native Cover**
189.5	0

Floristic Quality Metrics: Native Species (n)			
FQIn	**wFQIn**	**Mean C ($\bar{C}n$)**	**Weighted Mean C (w$\bar{C}$n)**
28.375	1.289	4.939	0.224
Floristic Quality Metrics: All Species (a)			
FQIa	**wFQIa**	**Mean C ($\bar{C}a$)**	**Weighted Mean C (w$\bar{C}$a)**
26.797	25.535	4.405	4.198

Scientific Name	Common Name	% Cover (Midpoint)	C-Value	WI Status
Acer rubrum	red maple	15	3	N
Acer saccharum	sugar maple	15	5	N
Athyrium filix-femina var. angustum	lady fern	15	5	N
Erechtites hieracifolia var. hieracifolia	American burn-weed	15	2	N
Fraxinus pennsylvanica	green ash	15	2	N
Juncus effusus	common rush	15	4	N
Phegopteris connectilis	Narrow beech fern	15	7	N
Scirpus cyperinus	wool-grass	15	4	N
Arisaema triphyllum	Jack-in-the-pulpit	2.5	5	N
Symphyotrichum lateriflorum	side-flowering aster	2.5	3	N
Betula alleghaniensis	yellow birch	2.5	7	N
Calamagrostis canadensis	bluejoint	2.5	5	N
Carex crinita var. crinita	fringed sedge	2.5	6	N
Carex gracillima	graceful sedge	2.5	5	N
Carex intumescens	bladder sedge	2.5	5	N
Carex pedunculata	long-stalked sedge	2.5	7	N
Dryopteris carthusiana	spinulose shield fern	2.5	7	N
Epilobium coloratum	purple-leaved willow herb	2.5	3	N
Euthamia graminifolia	grass-leaved goldenrod	2.5	4	N
Galeopsis tetrahit	hemp nettle	2.5	0	I
Gymnocarpium dryopteris	common oak fern	2.5	7	N
Hieracium aurantiacum	orange hawkweed	2.5	0	I
Lobelia inflata	Indian tobacco	2.5	2	N

Maianthemum canadense	Canada mayflower	2.5	5	N
Onoclea sensibilis	sensitive fern	2.5	5	N
Osmunda claytoniana	interrupted fern	2.5	6	N
Ostrya virginiana	ironwood	2.5	5	N
Quercus rubra	northern red oak	2.5	5	N
Rubus idaeus var. strigosus	red raspberry	2.5	3	N
Scirpus atrocinctus	black-girdled wool-grass	2.5	7	N
Scirpus hattorianus	mosquito bulrush	2.5	3	N
Solidago gigantea	giant goldenrod	2.5	3	N
Taraxacum officinale	common dandelion	2.5	0	I
Trientalis borealis subsp. borealis	American starflower	2.5	7	N
Tsuga canadensis	eastern hemlock	2.5	8	N
Cirsium vulgare	bull thistle	1	0	I
Lonicera canadensis	fly honeysuckle	1	8	N

Appendix E – Wetland Photos

wasb027f facing south - milepost 2.9

wasm002f facing southwest - milepost 3.1

wasm002e facing southwest - milepost 3.3

wasm001f facing northeast - milepost 3.8

wasa1054f facing northwest - milepost 4.1

wasa1054f facing west - milepost 4.1

wasc059e facing southeast - milepost 5.9

wasc061e facing southeast - milepost 5.9

wasc062f facing northeast - milepost 6

wase1016f facing northeast - milepost 10.6

wasa1006f facing northeast - milepost 14.2

wasc1033e facing east - milepost 14.7

wasc1033s facing southwest - milepost 14.7

wasc1014f facing south - milepost 15.9

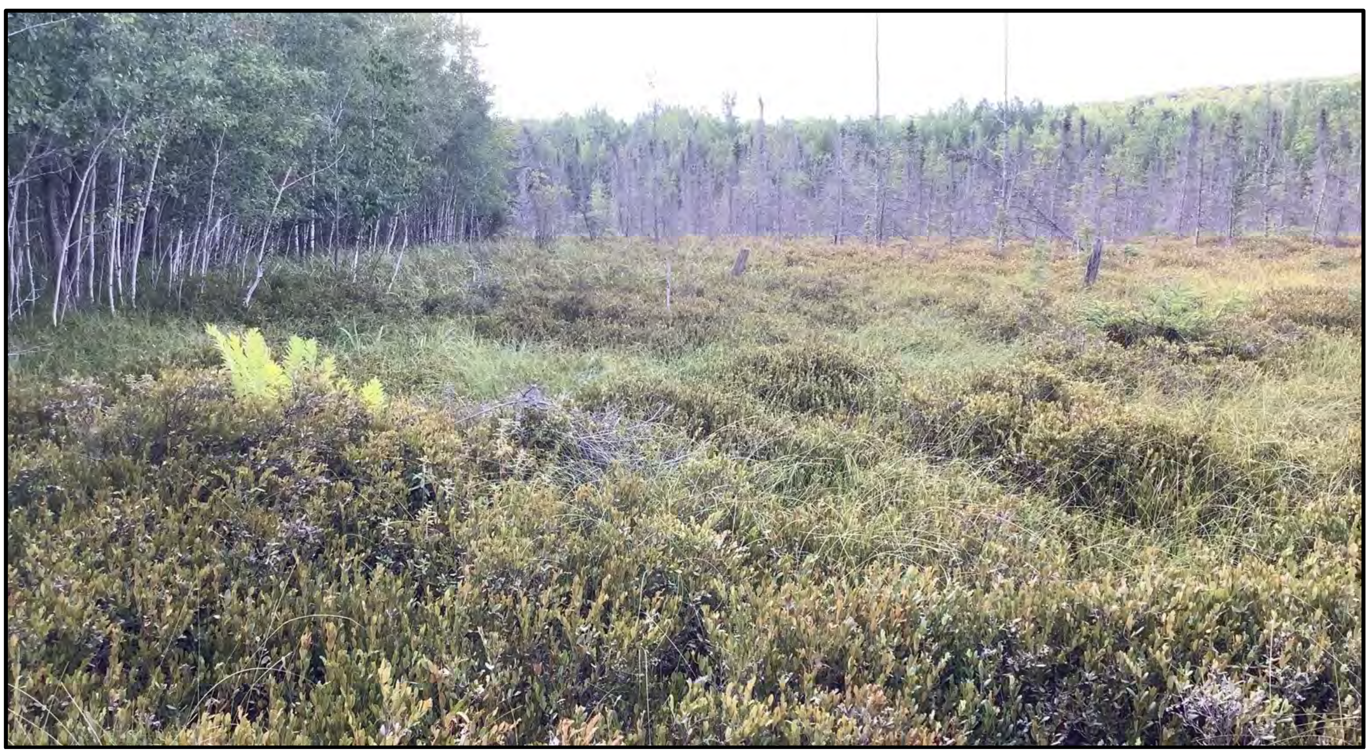
wasc1014f facing west - milepost 15.9

wasc1041f facing north - milepost 16.6

wasc1045e facing southwest - milepost 16.8

wasc1045f facing southwest - milepost 16.8

wasb1004f facing west - milepost 17.2



wase001e facing southeast - milepost 18.5

wasd1024e facing north - milepost 18.9

wasd1024f1 facing north - milepost 18.9

wasd1024f2 facing northeast - milepost 18.9

wasd1024s facing southwest - milepost 19


wasd1028f facing northeast - milepost 19.2


wasd1028f facing southwest - milepost 19.2

wasa139f_x facing north - milepost 20.2

wasa139f_x facing west - milepost 20.2

wasv013f facing north - milepost 20.8

wasv019e facing north - milepost 21.2

wasv019f facing east - milepost 21.3

wasv059f1 facing northeast - milepost 22.3

wasc069s facing southwest - milepost 22.6

wasc071f facing west - milepost 22.7

wasc072f facing southwest - milepost 22.9

wasc074e facing south - milepost 22.9

wasb011f facing west - milepost 23.4

wasa038f facing west - milepost 23.7


wasd1008f facing west - milepost 24.2


wasd1010f facing east - milepost 25.5

wasd1009f facing south - milepost 25.7

wasv042f facing northeast - milepost 26.3

wasv039f facing northwest - milepost 26.3

wasv053f facing east - milepost 27.5

wasv053f facing northwest - milepost 27.5

wasw023ss facing northeast - milepost 28.7

wasw023ss facing west - milepost 28.7

wasw024f facing west - milepost 28.8

wasw021f facing southwest - milepost 29.4

wasw026f facing north - milepost 29.5

wasw026f facing west - milepost 29.5

wasw026f facing northwest - milepost 29.6

wasw013ss facing northwest - milepost 29.8

wasw012f facing east - milepost 30

wirb1002f facing northwest - milepost 30.7

wirb1002f facing south - milepost 30.7

wirb1005f facing northeast - milepost 30.8

wirb1006f facing north - milepost 30.9

wirb1006f facing southeast - milepost 30.9

wirb1007f facing northwest - milepost 31.3

wirb1007f facing southeast - milepost 31.3

wirb009f facing east - milepost 31.4

wirb009f facing northwest - milepost 31.4

wirb015e facing east - milepost 31.8

wirb015e facing northwest - milepost 31.8

wird026f facing east - milepost 32.7

wird027f facing southeast - milepost 32.8

wire1001f facing south - milepost 33

wire1001e facing north - milepost 33

wird028f facing northeast - milepost 33.2

wird028f facing west - milepost 33.2

wirb046f facing north - milepost 33.4

wirb044f facing southwest - milepost 33.4

wirb042f facing west - milepost 33.6

wirb039s facing west - milepost 33.7

wirb037s facing east - milepost 34

wirb037s facing south - milepost 34

wirc023f facing east - milepost 34.1

wirc023f facing southeast - milepost 34.1

wirc021f facing south - milepost 34.2

wirc022f facing southeast - milepost 34.1

wirc024f facing west - milepost 34.2

wirc025f facing southwest - milepost 34.3

wirc013f facing north - milepost 34.5

wirc013f facing west - milepost 34.5

wirc1022f facing southwest - milepost 34.8

wirc1019f facing southwest - milepost 34.9

wirc014f facing north - milepost 35.1

wirc014e facing east - milepost 35.1

wirc1016f facing southeast - milepost 35.3

wirc006f facing southwest - milepost 35.5

wirc006f facing northeast - milepost 35.5

wira008s facing southwest - milepost 35.9

wira008e facing north - milepost 35.9

wira008f facing west - milepost 35.9

wira008f facing northwest - milepost 36.1

wirc1002f facing north - milepost 37.4

wird003f facing southwest - milepost 37.6

wird003e facing south - milepost 37.6

wird001f facing southeast - milepost 37.8

wira016f facing north - milepost 37.9

wird006f facing south - milepost 38.1

wird006f facing west - milepost 38.1

Appendix F – Wetland Descriptions

Wetland Feature	County	Community Description	Nearest Milepost
wasb027f	Ashland	Wet-mesic forest of Populus tremuloides with Alnus incana, Calamagrostis canadensis, and Carex lacustris.	2.9
wasm002e/f	Ashland	Mosaic wetland community wet-mesic forest with Acer rubrum and Populus tremuloides and various small openings/canopy gaps.Non-forested portions graminoid-dominated community, primarily Carex lacustris and Scirpus cyperinus, along with Phalaris arundinacea in the largest open portion.	3.1
wasm001f	Ashland	Canopy of Populus tremuloides with Acer rubrum and Alnus incana. Small depressional pocket that is likely inundated briefly in the spring.	3.8
wasa1054f	Ashland	Originally classified as a floodplain forest. Abrupt wetland boundary on the sound end, starting as the base of a slope, dominated by Fraxinus nigra with strong discharge hydrology. This area is more like a wet forest, but floodplain forest just north of there and for most of the feature. Ground layer includes dominant species Matteuccia struthiopteris and Carex bromoides. Seepage/discharge subsides north of southernmost waterbody feature. Varying topography throughout. Mix of black and Fraxinus pennsylvanica in the overall canopy. Buckthorn is present but rare on sound end of feature more common in the central portion of the feature. Nipplewort quite common on south end.	4.1
wasc059e	Ashland	Small depression with a canopy of Acer rubrum on fringe. Ground layer is rare to patchy, mostly devoid of vegetation where inundated during the first part of the growing season. Fraxinus pennsylvanica and Ulmus americana are just sapling size, with no mature individuals nearby. Carex intumescens and Symphyotrichum lateriflorum are very common.	5.9
wasc061e	Ashland	Small depressional basin surrounded by mesic hardwoods. Likely saturated for a brief period of time in the spring. Fraxinus pennsylvanica saplings are prevalent but no mature individuals. Dominant species include Carex gracillima, Symphyotrichum lateriflorus, and Fraxinus pennsylvanica.	5.9
wasc062f	Ashland	Wet forest of Fraxinus nigra, typically along the perimeter of the feature. Depressional feature with varying graminoid cover. Common species in the ground layer include Carex crinita, Carex intumescens, and Symphyotrichum lateriflorum. Extremely dry.	6.0
wase1016f	Ashland	Wetland is a hardwood swamp; the canopy is interrupted with Fraxinus nigra, Acer rubrum, and white pine among the dominant species. Community is variable with Fraxinus nigra dominated forest more in the eastern half of wetland and mixed canopy forest more in the western half.	10.6
wasa1006f	Ashland	Wetland is a hardwood swamp with mixed canopy of Fraxinus nigra, Thuja occidentalis, Acer saccharum, Acer rubrum, Fraxinus pennsylvanica, and Ulmus americana. Ground layer with abundant sedges and ferns; appears to be wormed with many areas of bare soil.	14.2
wasc1033e/s	Ashland	Disturbed floodplain wetland dominated by shrub cover. Not representative of a native plane community. Dominated by a mix of cover of Salix interior and shrub-sized Populus balsamifera. Interrupted ground cover of Equisetum hyemale. Open portion with Severe erosion and dominated by disturbance-tolerant species. Many ruderal species present. Extends into the overall flood zone (raised western end), which could be pulled out. Daucus carota confirmed.	14.7
wasc1014f	Ashland	Floodplain system, not representative of a native plant community, highly disturbed. Includes one spot in the south along the creek bend with a few garlic mustard. Nipplewort quite common. Canopy mostly Populus balsamifera with Fraxinus pennsylvanica. Galium boreale also present.	15.9
wasc1041f	Ashland	Wetland is a rich mesic to wet forest east of river, with mixed canopy (interrupted to continuous) of Acer saccharum, Fraxinus nigra, Thuja occidentalis, and Acer rubrum, and more of a disturbed floodplain with patchy canopy west of river. The non-native species were observed along the riverbank and outwash areas.	16.6

Wetland Feature	County	Community Description	Nearest Milepost
wasc1045e/f	Ashland	Wetland is a wet meadow with sparse canopy of species present in adjacent forest. The northern portion is located at edge of power line corridor and southern portion runs through an otherwise forested area. The southern portion is dominated by Matteuccia struthiopteris. Forest portion with an interrupted canopy of Acer rubrum, Acer saccharum, Tilia americana, and Fraxinus pennsylvanica. The ground layer has intermittent cover and is dominated by ferns and sedges.	16.8
wasb1004f	Ashland	Wetland is a narrow-forested drainage way with a canopy of Fraxinus pennsylvanica with Populus tremuloides, and Acer rubrum. Ground layer consisting of Carex gracillima along with Carex arctata, Scirpus hattorianus, and Onoclea sensibilis. With a hayfield to the north. Conditions very dry at the time of this survey.	17.2
wase001e	Ashland	Feature is an open bog dominated by leatherleaf. Along the ecotone between the bog and woodland, Populus tremuloides, Betula papyrifera, Acer rubrum, Carex utriculata, and Scirpus cyperinus are abundant.	18.5
wasd1024e/f1/f2/s	Ashland	A wetland complex that include wet meadow, wet forest, acid peatland and open bog. The wet meadow is dominated by Calamagrostis canadensis, with Scirpus cyperinus and scattered trees are present along the edges of the feature. The wet forest is dominated by Populus tremuloides. Several rises are present in feature, where more upland-associated species are present. Common ground layer species include bunchberry, Athyrium filix-femina, Equisetum sylvaticum, Rubus pubescens, and Pteridium aquilinum. The acid peatland includes a patchy canopy of black spruce. The ground layer is underlain by sphagnum and dominant vascular species include Chamaedaphne calyculata, Carex trisperma, and Carex oligosperma. The more minerotrophic species, such as paper birch, alder, and broad-leaved sedges, were observed to occur in the ecotonal zone closer to the wet meadow. and the open bog is dominated by Chamaedaphne calyculata. The more minerotrophic species present, such as Betula papyrifera, Calamagrostis canadensis, Scirpus cyperinus, and Acer rubrum, are restricted to the ecotone between the bog and adjacent woodland.	18.9
wasd1028f	Ashland	Forested wetland on a slope with active discharge hydrology. Canopy a mix of Thuja occidentalis, Fraxinus nigra, Acer rubrum, Fraxinus pennsylvanica, with Populus tremuloides, Abies balsamea, Betula alleghaniensis and paper birch. Carex scabrata dominant in sloped areas with strong discharge. Both Equisetum hyemale and Equisetum scirpoides are very common. Directly associated with a waterbody. Young pagoda dogwoods present in the seepage. Heavily wormed.	19.2
wasa139f_x	Ashland	Forest wetland. Open pools in spots, otherwise vegetated by Carex bromoides, Matteuccia struthiopteris, and Glyceria striata with Fraxinus nigra and Acer saccharum canopy. Acer saccharum on elevated mounds. Drier portions consisting of Thalictrum dasycarpum, Carex gracillima, Maianthemum canadense, and Calystegia sepium. Not great quality. Probably functions more like a floodplain forest.	20.2
wasv013f	Ashland	Feature is a hardwood swamp on a gradual slope within a mesic forest. The canopy is largely dominated by Fraxinus pennsylvanica, with occasional Betula alleghaniensis, Acer saccharum and Tilia americana. The feature has variable microtopography with more upland-associated species found on rises/boulders within the wetland.	20.8
wasv019e/f	Ashland	The wet meadow component is degraded and dominated by Juncus effusus. The feature is grazed with cattle prints present and is likely resulting in the presence of many of the observed ruderal species. Few areas of Sphagnum are present, with occasional groves of young Thuja occidentalis. The coniferous swamp component includes a continuous canopy dominated by Thuja occidentalis, with Betula alleghaniensis and Fraxinus nigra also common. The feature is grazed, with cattle prints and dung present. In canopy openings, Impatiens capensis dominant in the ground layer.	21.3

Wetland Feature	County	Community Description	Nearest Milepost
wasv059f1	Ashland	Feature is a wet forest located on a gradual slope that appears to function as a drainage; it is partially underlain with boulders, resulting in variable microtopography. The canopy is mostly continuous, dominated by Fraxinus nigra, Acer rubrum, Betula alleghaniensis, and Tilia americana. The ground layer cover is patchy.	22.3
wasc069s	Ashland	Feature is dominated by tall (generally >2 m) Alnus incana, with scattered trees, namely Abies balsamea, and Fraxinus pennsylvanica. The ground layer is largely dominated by graminoids, with Glyceria striata generally being the most abundant.	22.6
wasc071f	Ashland	Feature is a hardwood swamp; the canopy is interrupted to continuous with Fraxinus nigra the dominant tree and variable cover of Thuja occidentalis, Tsuga canadensis, Betula alleghaniensis, Acer rubrum, and Ulmus americana. The ground layer is variable with small pockets of sparse vegetation and other areas with interrupted vegetation. Ferns and fern allies, along with graminoids, generally are dominant in this layer.	22.7
wasc072f	Ashland	Feature is a hardwood swamp with an interrupted to continuous canopy of Fraxinus nigra, Acer rubrum, and Betula alleghaniensis, with occasional Ulmus americana and Fraxinus pennsylvanica. The ground layer is largely dominated by graminoids, namely Carex bromoides. A few small areas in the southwest portion of the feature were sparsely vegetated at the time of the survey and may function as vernal pools.	22.9
wasc074e	Ashland	Feature is a sedge meadow dominated by Carex bromoides, occurring along a gradual drainage within a mesic forest. Trees present within the feature are primarily rooted along the edge of the wetland.	22.9
wasb011f	Ashland	Southern leg of forested wetland logged (winter logging). Canopy dominated by Fraxinus nigra and ground layer dominated by Carex bromoides. Linear basin feature.	23.4
wasa038f	Ashland	A Black ash swamp that meanders in and out of the evaluated corridor. Canopy of Fraxinus nigra, occasional Betula alleghaniensis. Alder in shrub layer with Carex bromoides, along with Carex crinita, Carex gracillima, Carex scabrata, Thalictrum dasycarpum, and Symphyotrichum lateriflorum in the ground layer. There is Abies balsamea throughout. This is the narrative for the western component which is the main component: includes small portions of upland, with species excluded from the plant list for the most part. Groundwater discharge likely on the western side, which is sloped towards the southeast. Carex bromoides and Fraxinus nigra prevalent on the slope. This area is a sloped wetland. Includes drainage ways with wetland fringes of various size going upslope for the separate segments.	23.7
wasd1008f	Ashland	Floodplain forest of Acer saccharinum with Fraxinus pennsylvanica. The ground layer is dominated by Matteuccia struthiopteris with Laportea canadensis and Fallopia cilinodis. Several key invasives are present: Alliaria petiolata present but rare and localized on east end, then present but very uncommon elsewhere. Fallopia cilinodis throughout (5-25%); reed canary grass on the east end (rare), but along the river. Buckthorn is present but rare. Low species diversity.	24.2
wasd1010f	Ashland	The feature is logged. A portion of the feature consists of two drainage ways on the western and eastern end of the mapped feature, on slope topography. There is Carex cf. bebbii present. Typha is present but rare and restricted to one location. Hieracium aurantiacum in one location, in less than a two-foot area. Cirsium vulgare in two spots but less than 6 individuals collectively. Dominated by hydrophytic vegetation but origin likely due to logging associated with existing drainage ways. No longer forested, but had been when originally delineated.	25.5
wasd1009f	Ashland	A small depressional forested pocket within a mesic hardwood forest. Blowdown nearby. Basin with tree cover along the perimeter.	25.7
wasv042f	Ashland	Linear wet forest community of Fraxinus nigra (interrupted canopy). Prominent species in the ground layer include Carex crinita, Lycopus uniflorus, Bidens frondosa, and Iris versicolor. Elevated mound associated with Fraxinus nigra. Intact system surrounded by mesic hardwoods. Ran out of area to cover.	26.3

Wetland Feature	County	Community Description	Nearest Milepost
wasv039f	Ashland	Wet forest community that includes a forest trail (this portion not actually wetland). Main portion with an interrupted canopy of Fraxinus nigra. Portions inundated in the spring are devoid of vegetation, where vegetated areas in the ground layer include Carex bromoides along with cinnamon fern.	26.4
wasv053f	Ashland	Forested drainage way which includes a number of upland species. Mixed open canopy of Fraxinus nigra, Betula alleghaniensis, Fraxinus pennsylvanica along with Tilia americana and Acer saccharum east of area mapped as PEM (seems to be a mosaic of upland and wetland). PEM portion really should be forested. Obvious forested wetland west of the mapped PEM, much higher in terms of quality than those area affected by logging. This is on a slope with groundwater discharge, canopy of Fraxinus nigra and ground layer with near continuous cover of Carex scabrata.	27.5
wasw023ss	Ashland	Originally classified by the delineator as an alder-thicket. Part of an overall wetland complex that includes a forested component excluded here. Open portions dominated by Calamagrostis canadensis, Eutrochium maculatum, Solidago gigantea, Galium asprellum, Clematis virginiana, and Persicaria sagittata. Symphyotrichum lanceolatum is present. Alder thicket associated with darker signature in the south portion of the feature. Includes waterbody flowing through with alder in the shrub layer and ground layer consisting of mostly Carex bromoides, along with Carex scabrata, Equisetum fluviatile, Rubus pubescens, and Equisetum sylvaticum. Only two cattail individuals, assuming T. x glauca but no flowers/fruits. Several Cirsium arvense individuals were observed. Two separate locations with the open portion, each with two individuals. On a slope with discharge as the primary source of hydrology. Southeast corner transitions from wet forest to mesic hardwood forest.	28.7
wasw024f	Ashland	Sloped forested Fraxinus nigra community with discharge hydrology. Includes upland species like Pteridium aquilinum and Eurybia macrophylla. Ground layer dominated by Carex bromoides where open (shrub layer that is). Good condition. A few individuals of Hieracium aurantiacum found on the east end with Eurybia macrophylla. Strong area of seepage in the southeast portion of the feature. Seepage area consists of Scutellaria lateriflora, Galium asprellum, Impatiens capensis, and Chryosplenium americanum.	28.8
wasw021f	Ashland	Mostly mesic hardwood species. Ground layer dominants include Carex pedunculata, Mitchella repens pool, Acer saccharum saplings, Maianthemum canadense, and Pteridium aquilinum. Also includes Quercus rubra. Carex disperma observed in one location.	29.4
wasw025f/wasw026f	Ashland	Mosaic of upland and wetland on the south end. Canopy of Acer saccharum with Fraxinus pennsylvanica, Ostrya virginiana, and Acer rubrum. Canopy is patchy to interrupted; low-lying areas in the open include Scirpus cyperinus, Calamagrostis canadensis, and Persicaria sagittata. Upland areas with thinned Acer saccharum and ironwood in the understory and a ground layer of Lonicera canadensis, Carex pedunculata, and Fraxinus pennsylvanica saplings. The second photo of a small open depression is dominated by Calamagrostis canadensisand Scirpus cyperinus, with Carex crinita, Solidago gigantea and Onoclea sensibilis.	29.5
wasw013ss	Ashland	The feature is a beaver complex with pockets of wet meadow, alder thicket, and hardwood swamp. Overall, shrub cover in the mapped wetland is around 50%, but sizeable areas without shrubs (e.g., wet meadow) are present. The hardwood swamp to the southwest also grades into the wetland, hence the presence of more forest-associated species. The ground layer is variable overall, but red raspberry is abundant in the open and shrub-dominated portions. There is a beaver dam present on the northeast side of the feature.	29.8

Wetland Feature	County	Community Description	Nearest Milepost
wasw012f	Ashland	Feature is a hardwood swamp, with a canopy dominated by Fraxinus nigra. Much of the canopy (at least in the northeast section), appears to have dieback, leading to patchy cover in some areas. Here, where more sunlight reaches the ground layer, orange jewelweed, bittersweet nightshade, and Doellingeria umbellata are abundant. In areas where the canopy is more interrupted, the ground layer is variable, often with abundant sedges, such as Carex bromoides and nodding sedge.	30.0
wirb1002f	Iron	The feature is a wet forest community dominated by Fraxinus nigra with Acer saccharum, Tilia americana and Betula alleghaniensis. Sloped topography with groundwater discharge. Mixed ground layer of Carex scabrata, Glyceria striata, Athyrium filix-femina, and Solidago gigantea.	30.7
wirb1005f	Iron	Vernal pool with Fraxinus nigra along the perimeter. Pool devoid of vegetation with the exception of Fraxinus nigra seedlings. Most herbaceous cover is restricted to the perimeter of the feature. Species poor and excessively wormed.	30.8
wirb1006f	Iron	Degraded forested drainage features, sloping north, with shallow bedrock. Primarily Acer saccharum mixed with Fraxinus pennsylvanica, very little ground layer, heavily wormed with little to no leaf duff. Hydrology is questionable at this time of year. A number of uprooted trees with wetland. Reed canary grass and Cirsium arvensis in one location near start of tributary. Nipplewort coming in from the trail.	30.9
wirb1007f	Iron	Large wet forest complex; earthworms an issue. Forested seepage pockets dominated by Carex scabrata with Equisetum scirpoides, Athyrium filix-femina, Fraxinus nigra, and Betula alleghaniensis. One individual Epipactis helleborine is present.	31.3
wirb009f_x	Iron	Depressional forested Wetland, anthropogenic in origin (a former mining area) with undulating topography. Wetter locations are dominated by Carex crinita with Fraxinus pennsylvanica in the shrub layer and Populus tremuloides in the canopy. Species depauperate. Prunella vulgaris quite common.	31.4
wirb015e	Iron	Beaver meadow which includes a dam. West of the dam is drier and dominated by Rumex obtusifolius, Scirpus cyperinus, Juncus effusus, Onoclea sensibilis, and Scirpus microcarpus. Minimal shrub cover in the beaver meadow portion. The open water portion east of the dam is inundated and bordered by Sparganium androcladum with Potamogeton cf. natans in the water. Cirsium and Phalaris present but isolated and uncommon.	31.8
wird026f	Iron	Feature is a linear depression with a mix of Populus tremuloides and Fraxinus nigra in the canopy. Ground layer consisting of Calamagrostis canadensis, Equisetum pratense, Onoclea sensibilis, Carex scabrata, and Solidago gigantea. Includes shallow pools/depressions, now dry.	32.7
wird027f	Iron	Feature is a Fraxinus nigra dominated wet forest with dry pools throughout and Fraxinus nigra elevated on mounds with Populus tremuloides mixed in throughout. Ground layer commonly includes Glyceria striata, Carex gracillima, Rubus pubescens, and Onoclea sensibilis. Includes small upland mounds throughout which include upland species like bracken fern. Shallow bedrock.	32.8
wire1001e/f	Iron	A complex of emergent and forested wetland. The emergent portion is within the forested portion and is dominated by Phalaris arundinacea, but includes Petasites frigidus var. sagittatus. The forested portion is dominated by Fraxinus nigra with ground layer with interrupted cover of both forbs and graminoids. Commonly observed species include Carex bromoides, Glyceria striata, Onoclea sensibilis, Doellingeria umbellata, Packera aurea, and Solidago gigantea. Phalaris arundinacea present but not common, two locations within feature.	33.0

Wetland Feature	County	Community Description	Nearest Milepost
wird028f	Iron	A wet forest dominated by Fraxinus nigra (main part). Includes lower quality areas associated with existing logging/two-track roads. Intact areas with a canopy of Fraxinus nigra along with Carex crinita, Glyceria striata, and Micranthes pennsylvanica present. Other characteristic species include Packera aurea, Mitella nuda, and Symphyotrichum lateriflorum. It is a seepage-influenced feature. The western portion of the access road has compacted soils. Access road add one: Juncus effusus, Scirpus hattorianus, and Persicaria sagittata. The northern segment is drier and sloped southward on shallow bedrock. The vegetation on the access road was not included in the survey.	33.2
wirb044f	Iron	A Fraxinus nigra dominated wet forest with open non-inundated pools. The ground layer consists of Carex crinita along with Symphyotrichum lateriflorum, Dryopteris carthusiana, and Rubus pubescens; fairly uniformed throughout.	33.4
wirb046f	Iron	Small forest depression on shallow bedrock. Mix of Populus tremuloides with Fraxinus nigra. The ground layer includes Carex crinita, Mitchella repens (elevated), and Rubus pubescens. Shallow dry pools.	33.4
wirb042f	Iron	The portion to the south is an intact Black ash swamp with a continuous canopy cover of Fraxinus nigra and a ground layer of Calamagrostis canadensis, Carex crinita, and Doellingeria umbellata. Rubus pubescens is present but restricted to elevated mounds.	33.6
wirb039s	Iron	Depression over shallow bedrock with small, elevated rises within. Really a wet meadow but has enough shrub cover to be a PSS thus shrub-carr. Not representative of a natural wetland community. Likely affected by logging in the past. Includes a linear finger of Fraxinus nigra.	33.7
wirb037s	Iron	Riverine fringe floodplain wetland, that includes a linear vernal pool. Not a truly definable wetland plant community, but rather a floodplain feature.	34.0
wirc022f	Iron	Several waterbody features within a linear forested depression dominated by Fraxinus nigra, Abies balsamea, and Acer saccharum. Includes a mix of upland and wetland species. Not a typical wet forest system (more of a floodplain) on west end but with Fraxinus nigra and Carex bromoides on east end (more typical of a wet forest). Abuts a major river east of the survey corridor. Beaver activity present and nipplewort present on the west end.	34.1
wirc023f	Iron	Floodplain forest where the surrounding upland is clearly more elevated. Includes both Acer saccharum and Acer saccharinum. Ground layer with patchy cover, mostly bare. Likely inundated for a portion of the growing season. Includes species on the lower shelf of the river. Hypericum perfoliatum is localized along the shore. One wood turtle was observed.	34.1
wirc021f	Iron	Fraxinus nigra dominated wet forest with interrupted graminoid cover that includes Carex tuckermanii, Carex crinita, Glyceria striata, Carex gracillima, and Carex projecta. Western poison ivy common in the south of the wetland. Includes portions along an access road. Plants occurring on the access road include Scirpus atrocintus Scirpus atrocinctus, Salix bebbiana, Salix petiolaris, Eutrochium graminifolia, and Equisetum sylvaticum.	34.2
wirc024f	Iron	Feature a small depressional wet forest pocket with a canopy of Fraxinus nigra. Includes several upland species.	34.2
wirc025f	Iron	A Fraxinus nigra dominated wet forest community over shallow bedrock, poorly formed soils. Elevated mounding throughout. Slopes southwest, relying on both recharge and discharge hydrology. Drier on north end and includes more upland mounding.	34.3

Wetland Feature	County	Community Description	Nearest Milepost
wirc013f_x	Iron	A wet forest with strong discharge. Canopy mostly Fraxinus nigra with Abies balsamea in the understory. Seepage pools with Glyceria striata, Toxicodendron rydbergii, Carex bromoides and Scutellaria galericulata present. Mounded areas associated with seepage areas are populated with Coptis trifolia, Mitella nuda and Rubus pubescens. Acer spicatum is common throughout. Thuja occidentalis is prevalent with Fraxinus nigra in wetter locations with inundated pools at the beginning of September. The wetland is drier on the south end, with Acer rubrum and Acer saccharum common. This area is more of a mosaic of wetland and upland.	34.5
wirc1022f	Iron	Feature is a fully vegetated vernal pool dominated by Carex tuckermanii. The surrounding area was selectively logged. Calystegia sepium and Scutellaria lateriflora are common throughout.	34.8
wirc1019f	Iron	Feature has an interrupted canopy dominated by Fraxinus nigra, with Acer rubrum. The understory is fairly open with an interrupted to continuous ground layer dominated by graminoids and ferns.	34.9
wirc014e	Iron	Feature is a wet meadow located within a roadside ditch. Dominant species include Solidago canadensis, Carex crinita, Calamagrostis canadensis, Eutrochium maculatum, and Onoclea sensibilis. Tree species present in feature are generally seedlings or saplings.	35.1
wirc014f_x	Iron	A wet forest community dominated by Fraxinus nigra with Betula alleghaniensis. Acer saccharum is also present, but is much less common than Betula alleghaniensis. The topography is undulating, with Thuja occidentalis common in sapling size and one single large individual. The ground layer is dominated by Carex crinita, Glyceria striata and Calamagrostis canadensis.	35.1
wirc1016f	Iron	Feature has an interrupted to continuous canopy, largely dominated by Acer rubrum, with Betula alleghaniensis, Tsuga canadensis, and Fraxinus nigra also common. Tsuga canadensis and Abies balsamea are common in the subcanopy. The ground layer has variable microtopography with mossy hummocks and hollows and is dominated by ferns and graminoids.	35.3
wirc006f	Iron	Depressional wetland, previously logged, surrounded by mesic hardwoods. Feature dominated by Impatiens capensis. Other prevalent species include Scirpus cyperinus, Glyceria canadensis, Glyceria striata and Carex projecta. Dryopteris intermedia is also common in the ground layer.	35.5
wira008f/s	Iron	A wetland complex that includes wet forest and alder thicket. The forested portion appears to have been thinned at some point and has patchy cover of canopy trees, with Acer rubrum dominant. The shrub layer is patchy, common species including Corylus cornuta and Betula alleghaniensis and Acer rubrum saplings. The ground layer is continuous and dominated by Carex intumescens, with ferns also common.The shrub component has interrupted cover of Alnus incana. The ground layer is generally interrupted to continuous. Largely dominated by ferns and graminoids, but becomes sparse in the deep shade of the alders adjacent to the small stream that intersects the feature.	35.9
wira008e/f_x	Iron	A multi-community feature of wet forest with a small emergent component. The forest portion has a varying microtopography throughout. The canopy consists of Betula alleghaniensis, Tsuga canadensis, and Thuja occidentalis. Not the wettest feature, but still wetland. The ground layer is depauperate. The emergent portion is a a small fringe associated with a waterbody feature.	35.9
wirc1002f	Iron	The feature is a wet forest. In the southern portion, the canopy is interrupted with Fraxinus nigra, Tsuga canadensis, Thuja occidentalis, and Betula alleghaniensis. In the northern portion, Fraxinus nigra becomes dominant in the canopy and is patchy to interrupted, with American elm, Fraxinus pennsylvanica, and Acer saccharum common in the subcanopy. The ground layer is variable; Carex bromoides, Rubus pubescens, Calamagrostis canadensis, Glyceria striata, and ferns are common throughout the feature.	37.4

Wetland Feature	County	Community Description	Nearest Milepost
wird003e/f	Iron	A wetland complex that includes forested wetland and emergent wetland. Approximately the southern 2/3rds of the emergent feature appears to function as a vernal pool, as vegetation is relatively sparse-patchy. In the northern third, a forest trail intersects the feature, and vegetation north of that is more continuous. Canopy species include Acer saccharum, Fraxinus nigra, Acer rubrum, and American elm. Ferns and sedges are common in the ground layer. The true forested wetland component has a variable canopy, with areas dominated by Fraxinus nigra, and others mixed with Tsuga canadensis, Thuja occidentalis, Betula alleghaniensis, and Acer saccharum. Ulmus americana is common in the subcanopy. The ground layer is typically sparser in areas with abundant conifers than areas dominated by Fraxinus nigra. Common ground layer species include Glyceria striata, Rubus pubescens, Carex crinita, and ferns.	37.6
wird001f	Iron	Feature has a mostly continuous canopy of Fraxinus pennsylvanica, Acer saccharum, Acer rubrum, Tilia americana, Betula alleghaniensis, and Thuja occidentalis. The ground layer is often continuous and dominated by Matteuccia struthiopteris. Certain species, such as Acer saccharinum, are mostly limited to areas more adjacent to the river, as are certain species occurring on the sandbar adjacent to the river (e.g., Mimulus ringens, Apocynum androsaemifolium, Carex hystericina, etc.).	37.8
wira016f	Iron	The canopy is largely continuous, with Tsuga canadensis, Acer rubrum, and Acer saccharum among the dominant species. The ground layer has variable microtopography and generally sparse cover, with interrupted fern, Athyrium filix-femina, and Onoclea sensibilis among the most common species.	37.9
wird006f	Iron	Feature was noted as a hardwood swamp. Almost the entire wetland within this survey area was logged recently, removing/logging an entire stretch running north/south. The wetland is obviously disturbed as a result. The portion that is not logged is in good shape and is sloped down to the east with dry pools. This portion consists mostly of Carex crinita in the ground layer with Acer rubrum above. The portion that was logged drains into this portion. The western logged portion was likely mapped with the idea that this drains east where all the Carex crinita is located. A number of species, including Hieracium aurantiacum, Lobelia inflata, Galeopsis tetrahit and Erechtites hieraciifolius were present in the portions that were logged.	38.1

Appendix G – Botanical Field Lead Resumes

Scott A. Milburn, MS, PWS, CMWP

Principal Botanist/Ecologist/CFO

MIDWEST NATURAL RESOURCES

EXPERTISE

- Rare Plant Surveys
- Plant Identification
- Vegetation Monitoring
- Wetland Delineations
- Native Plant Community Classification/Mapping
- Habitat Assessments
- Aerial Photo Interpretation

EDUCATION

MS Biological Sciences
University of Mississippi
Thesis: *Chemical and Microbial Properties of Wintertime Flooded Agricultural Soils from the Mississippi Delta.*

BS Botany
Iowa State University

CERTIFICATIONS/PERMITS

- Professional Wetland Scientist (1609)
- Certified MN Wetland Professional (1214)
- MN DNR Qualified Surveyor for:
  All General State-listed Vascular Plants and specialized species:
  - *Botrychium/Sceptridium*
  - *Erythronium propullans*
  - *Lespedeza leptostachya*
  - *Platanthera praeclara*
- MN DNR Special Permit (32815) to collect and voucher rare plants
- Wisconsin Rare Plant Surveyor

TECHNICAL DOCUMENTS

- Floristic Quality Assessment for Prairie Parkland and Tallgrass Aspen Parklands Provinces (2019) – Project Leader
- Floristic Quality Assessment for Minnesota Wetlands (2007) – Primary Author

Scott Milburn is the founder of Midwest Natural Resources (MNR), a natural resources consulting firm focused on field services and data reporting pertaining to flora, wetlands, and wildlife. He is an academically trained botanist with further graduate studies in wetland biogeochemistry. He has been working professionally for over 20 years, running the St. Paul, Minnesota-based MNR since 2005. Scott has managed, as well as conducted, intensive field surveys for a wide range of projects focused on long-term vegetation monitoring, rare plant and botanical surveys, large-scale wetland delineation efforts, and native plant community mapping and analysis projects. He was additionally the lead developer for the Floristic Quality Assessment for Minnesota Wetlands (2007) and has since led the development of regionalized Coefficients of Conservatism based on ecological province in Minnesota.

SELECTED NATIVE PLANT COMMUNITY MAPPING/ CLASSIFICATION PROJECT EXPERIENCE

Sprague's Creek Peatland SNA (2020-2021)
Project Manager and field lead for the ecological evaluation of Sprague's Creek Peatland SNA, located in northern Minnesota. Responsibilities included the establishment of permanent relevé plots and point-intercept sampling transects, mapping of native plant communities, and rare plant surveys.

Iron Range OHV Project (2019)
Project Manager overseeing field efforts for the mapping of native plant communities for a project encompassing over 2,700 acres in northern Minnesota. Responsibilities included the aerial delineation of community boundaries and refinement of those boundaries using data collected by field staff.

Seavey Peatland – Natural Resources Inventory Project (2017)
Project Manager and field lead for efforts involving native plant community mapping, wetland delineations, and rare plant surveys for a proposed peat mine encompassing over 2,800 acres in northern Minnesota. Developed field protocols, implemented field efforts, conducted data review, mapped plant communities, and summarized data for the client. The project additionally involved the use of proprietary data applications pertaining to the documentation of wetlands as well as rare plant survey efforts.

Norman / Polk Counties – Calcareous Fen Inventory (2012)
Project Manager and field botanist responsible for identifying previously undocumented calcareous fens in NW Minnesota. This involved the collection of vegetation (relevé) plot data, documentation of rare plant populations, and mapping of newly documented calcareous fen locations. This effort was the result of compensatory mitigation requirements put forth by the Minnesota Department of Natural Resources due to construction impacts to rare plant populations. Data were summarized in a report prepared for the Minnesota Department of Natural Resources.

Trail / Gully – Calcareous Fen Inventory (2010-2011)
Project Manager and field botanist responsible for identifying previously undocumented calcareous fens in NW Minnesota. This involved the collection of vegetation (relevé) plot data, documentation of rare plant populations, and mapping of newly documented calcareous fen locations. This effort was the result of compensatory mitigation requirements put forth by the Minnesota Department of Natural Resources due to construction impacts to rare plant populations. Data were summarized in a report prepared for the Minnesota Department of Natural Resources.

SELECTED RARE PLANT SURVEY PROJECTS

Projects listed below are selected from numerous rare plant survey projects Scott has completed. In addition to the larger-scale projects listed below, Otto has led over one hundred small-scale rare plant surveys for development projects through the metro area. Standard methods for rare plant surveys always entail collecting a comprehensive plant species list, collecting voucher specimens where appropriate and submitting specimens to the Bell Museum of Natural History (MIN), as well as submitting spatial data for any rare plant detections to the DNR for inclusion in the NHIS database.

TMM – Rare Plant Surveys (2020-2021) Lake County, Minnesota
Botanical field lead responsible for conducting surveys for state-listed plant and lichen species for potential mine site in northeastern Minnesota.

Superior National Forest – Rare Plant Surveys (2006–2012, 2014–2015, 2020) Lake, Cook, St. Louis counties, Minnesota
Botanical field lead responsible for conducting surveys for state-listed plant species throughout the Superior National Forest.

MN DNR Cuyuna Country State Recreation Area – Rare Plant Surveys (2018, 2020, 2022) Crow Wing County, Minnesota
Responsible for conducting surveys for Minnesota state-listed plant species for a proposed recreation trail project. Surveys focused on moonworts (*Botrychium*).

Sandpiper/Line 3 Replacement – Rare Plant Surveys (2013-2020) Minnesota, Wisconsin
Lead field botanist responsible for conducting surveys for state-listed plant species along the project route in Minnesota and Wisconsin.

Chippewa National Forest – Rare Plant Surveys (2007-2016, 2019) Beltrami, Itasca, and Cass counties, Minnesota
Botanical field lead responsible for conducting surveys for state-listed plant species throughout the Chippewa National Forest for 10 consecutive field seasons. Field efforts included stand evaluations and invasive species documentation within the surveyed stands.

SELECTED VEGETATION MONITORING PROJECT EXPERIENCE

Line 3 Replacement Project – Post-construction Ecological Monitoring (2020-Current)
Principal Ecologist responsible for the monitoring design of required post-construction long-term vegetation monitoring efforts associated with the Line 3 Replacement Project (Minnesota). Worked in collaboration with the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and the client to develop monitoring protocols for peatland complexes, calcareous fens, and other sensitive wetland systems.

Prairie Monitoring – Long-term Vegetation Monitoring (2008-2022)
Principal Project Manager overseeing MNR's implementation of vegetation monitoring of high-quality remnant prairie sites throughout the Prairie Parklands and Tallgrass Prairie Parklands ecological provinces in Minnesota. This has been through contract with the Minnesota Department of Natural Resources in association with the Grassland Monitoring Team, a multi-agency group of grassland managers and scientists.

Gully 30 - Calcareous Fen Monitoring (2011-2020)
Principal Project Manager responsible for the collecting of detailed vegetation plot data at the state-designated Gully 30 Calcareous Fen located in NW Minnesota. Sampling has occurred over a period of ten years, involving the documentation of bryophytes and vascular plants, as well as hydrologic monitoring efforts. This project was the result of regulatory requirements requested by the Minnesota Department of Natural Resources as part of compensatory mitigation for construction impacts (Alberta Clipper Project).

Chester 24 - Calcareous Fen Monitoring (2011-2015)
Principal Project Manager responsible for the collecting of detailed vegetation transect data at the state-designated Chester 24 Calcareous Fen located in NW Minnesota. Sampling occurred over a period of five years and involved the documentation of vascular

plants as well as hydrologic monitoring. This project was the result of regulatory requirements requested by the Minnesota Department of Natural Resources as part of compensatory mitigation for construction impacts.

Alberta Clipper – Post-construction Wetland and Waterbody Monitoring (2011-2015)
Principal Project Manager responsible for overseeing and implementing field efforts and data analysis related to wetland/waterbody monitoring for the Alberta Clipper Project. This was a part of the federal permit requirement requested by the US Corps of Engineers. The project involved the monitoring of 666 wetlands and 187 waterbodies in Minnesota and Wisconsin.

Kasota 7 - Calcareous Fen Monitoring (2014-2020)
Principal Project Manager responsible for overseeing the collection of vegetation monitoring data at the state-designated Kasota 7 Calcareous Fen located in southern Minnesota. This project was the result of regulatory requirements requested by the Minnesota Department of Natural Resources as part of compensatory mitigation for permanent impacts to the recharge zone associated with the Kasota 7 Calcareous Fen.

SELECTED ASSESSMENT TOOL DEVELOPMENT EXPERIENCE

Floristic Quality Assessment for Laurentian Mixed Forest and Eastern Broadleaf Forest Provinces (2021-2022)
Project co-lead overseeing the development of regionalized Coefficients of Conservatism (C values) for native plant species present in the Laurentian Mixed Forest and Eastern Broadleaf Forest Provinces. The project is currently underway.

Floristic Quality Assessment for Prairie Parkland and Tallgrass Aspen Parklands Provinces (2018-2019)
Project lead overseeing the development of regionalized Coefficients of Conservatism (C-values) for native plant species present in the Prairie Parkland and Tallgrass Aspen Parklands Provinces. Established and managed a panel of experts, contributed to the assignment of C-values and prepared the final project document. This effort was done in partnership with the Minnesota Department of Natural Resources.

Floristic Quality Assessment for Minnesota Wetlands (2005-2007)
Project Manager overseeing the development of Coefficients of Conservatism (C-values) for wetland flora in Minnesota. Established and managed a panel of experts, contributed to the assignment of C-values and prepared the final project document. This effort was done in partnership with the Minnesota Department of Natural Resources through funding provided by the federal government and administered by the MN Pollution Control Agency.

Eric Ogdahl

Field Ecologist

EXPERTISE

- Plant Identification
- Vegetation Monitoring
- Wetland Delineations
- Native Plant Community Classification/Mapping
- Restoration Ecology

EDUCATION

MS Natural Resources Science and Management
University of Minnesota – Twin Cities

Thesis: Assessing the use of shrub-willows for living snow fences in Minnesota, USA

BS Ecology, Evolution, and Behavior
University of Minnesota – Twin Cities

PUBLICATIONS

Ogdahl, E.J., D.S. Zamora, G. Johnson, G. Wyatt. 2018. Comparison of woody species for use in living snow fences in the Midwestern United States. Journal of Soil and Water Conservation.

Ogdahl, E.J., D.S. Zamora, G. Johnson, G. Wyatt, D. Current, and D. Gullickson. 2016. Establishment and potential snow storage capacity of willow (Salix spp.) living snow fences in south-central Minnesota, USA. Agroforestry Systems.

Ogdahl, E.J. 2015. Financial assistance for living snow fences in Minnesota: programs to save lives, money, and time. Inside Agroforestry, USDA National Agroforestry Center: Volume 24, Issue 1.

Borer, E.T., E.M. Lind, **E.J. Ogdahl**, E.W. Seabloom, D. Tilman, R.A. Montgomery, and L.L. Kinkel. 2015. Food-web composition and plant diversity control foliar nutrient content and stoichiometry. Journal of Ecology 103:1432-1441.

Eric has been a field ecologist at MNR since the spring of 2020, where he began as a field assistant. During the 2021 field season, he proved his abilities and ecological knowledge and now serves as a field lead for vegetation assessment and monitoring projects, habitat management plans, native plant community mapping, and wetland delineations. Eric's background in ecological restoration and management has been utilized to develop several habitat management plans for sites across Minnesota and Wisconsin.

HABITAT MANAGEMENT PLANS

All habitat management plan projects include conducting a comprehensive and site assessment to document current conditions, classify and map native plant communities, conduct a vegetation inventory, and identify and map management issues and concerns.

Minnesota Land Trust – Grand Marais (2021) Cook County, Minnesota
Served as field lead assessing 40 acre site

Minnesota Land Trust – Sand Creek (2021) Pine County, Minnesota
Served as field lead assessing 420 acre site

Minnesota Land Trust – Roosevelt Lake (2021) Cass County, Minnesota
Served as field lead assessing 20 acre site

Minnesota Land Trust – Twin Lake (2020) Ottertail County, Minnesota
Served as field lead assessing 60 acre site.

Minnesota Land Trust – Knife River (2020) Lake County, Minnesota
Co-led field surveys to assess 300 acre site.

Alberta Clipper Wetland Restoration and Invasive Species Management Plan (2021)
Served as technical reviewer for wetland restoration and invasive species management plan for pipeline corridor in Douglas County, Wisconsin. Additionally developed site-specific seed specifications for wetland restoration.

VEGETATION MONITORING AND ASSESSMENT PROJECTS

MN DNR Prairie Monitoring (2020-2022) Western MN
Served as botanist responsible for the implementation of vegetation monitoring of high-quality remnant prairie sites throughout the Prairie Parklands and Tallgrass Aspen Parkland ecological provinces in Minnesota. Vegetation sampling is conducted along permanent 50-m transects in which plant inventories and abundance (visual estimation of cover using Braun/Blanquet scale) data are collected within plots along each transect. Additionally, he assists with sampling permanent relevé plots in remnant prairie. In both sampling methods, all plant species are identified, and data is collected using the Survey123 app.

Line 3 Peatland Monitoring (2021-2022) Northern Minnesota
Botanical field lead conducting sampling in relevé plots within select peatland areas along the Line 3 pipeline throughout northern Minnesota. Relevé plots were sampled at randomly assigned locations that were outside of the active pipeline construction area, and were placed at varying distances from the pipeline construction area. Plots are intended to be resampled in future years to study potential impacts on the quality of the peatland sites in relation to their proximity to the pipeline construction area.

BWSR Wetland Sampling (2020-2021) throughout Minnesota
Lead field botanist conducting vegetation monitoring within 53 compensatory mitigation wetland sites across Minnesota, including 13 in the prairie region with restored wet prairie and wet meadow communities. Surveys were conducted throughout the growing season and included timed-meander surveys following BWSR's modified FQA protocol, community mapping, and specimen collection. Data was collected using Field Maps. Voucher specimens were collected, pressed, and submitted to BWSR staff for confirmation of identification. All unknown plants encountered during surveys were identified in the field using dichotomous keys or were collected and later identified.

MN DNR Klondike Relevés (2021) Kittson and Roseau counties, Minnesota
Served as botanist co-leading project contracted by the DNR to resample four relevé plots, originally surveyed over 25 years ago, as well as two new plots, in State Wildlife Management Areas within the Aspen Parklands ecological subsection. Relevé plots were sampled following methods described in *the Handbook for Collection Vegetation Plot Data in Minnesota: the Relevé Method, 2nd Edition*. These data were then used to rank the condition of the native plant communities in which the relevés were sampled to inform the management of these communities.

Two Creeks Solar Project Vegetation Assessment and Management Recommendations (2021) Manitowac County, Wisconsin
Co-led vegetation assessments on recently established plantings of native vegetation, including pollinator plantings, on 780 acres across 6 solar project sites. Collected comprehensive species lists for each site, and mapped noxious weeds and areas requiring vegetation maintenance. These data were then used to develop recommendations for vegetation management across the solar sites.

NATIVE PLANT COMMUNITY MAPPING/CLASSIFICATION PROJECTS

Leech Lake Band of Ojibwe Native Plant Community Mapping (2021-2022) Cass and Itasca Counties, Minnesota
Co-led effort to classify native plant communities on over 10,000 acres within the Tribal lands of the LLBO to guide forest management. Following the *Field Guide to Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*, mapped 20 different NPCs, spanning eight NPC systems, and recorded one incidental detection of the state-listed *Botrychium lanceolatum*.

USFS Superior National Forest (2020) Northern Minnesota
Ecologist assisting with mapping native plant communities on over 4,000 acres of federal land for the US Forest Service Superior National Forest.

RARE PLANT SURVEY PROJECTS

Standard methods for rare plant surveys always entail collecting a comprehensive plant species list, collecting voucher specimens where appropriate and submitting specimens to the Bell Museum of Natural History (MIN), as well as submitting spatial data for any rare plant detections to the DNR for inclusion in the NHIS database.

USFS Superior National Forest Rare Plant Surveys (2020)
Field botanist responsible for conducting surveys for state-listed plant species throughout the Superior National Forest.

USFS Chippewa National Forest Rare Plant Surveys (2020)
Field botanist responsible for conducting surveys for state-listed plant species throughout the Chippewa National Forest. Field efforts included stand evaluations and invasive species documentation within the surveyed stands.

MN DNR Lake Vermilion State Park Rare Plant Surveys (2020) St. Louis County, Minnesota
Assisted with rare plant survey across 410 acres at Lake Vermilion-Soudan Underground Mine State Park for proposed recreational development. Surveys resulted in the documentation of 289 species of vascular plants, but no rare species were observed.

WETLAND DELINEATION PROJECTS

Wetland delineation surveys always follow standard delineation methods as defined by the 1987 U.S. Army Corps of Engineers (USACE) Manual and subsequent Regional Supplement. MNR had developed an internal wetland delineation data collection application which is used by MNR staff for all wetland delineation projects.

Midwest Carbon Exchange (2021-2022) North Dakota, South Dakota, and Nebraska
Field lead for surveys to delineate wetlands according to Army Corps of Engineers' guidelines for this proposed linear carbon capture project covering multiple routes in three states. Waterbodies were also mapped and documented in conjunction with the wetland delineations. Additional data collected included land use cover and potential habitat for threatened and endangered species across the proposed routes.

December 9, 2022 USACE Data Request

Data Request Response #12

Excerpted Pages from DNR's Invasive Species List
Restricted Category

PROHIBITED/RESTRICTED CATEGORY:

1. *Anthriscus sylvestris* (Wild chervil)[A] restricted in Adams, Barron, Chippewa, Crawford, Columbia, Dane, Dodge, Dunn, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Juneau, Kenosha, Lacrosse, Lafayette, Marquette, Milwaukee, Monroe, Ozaukee, Polk , Racine, Richland, Rock, Sauk, Sheboygan, Taylor, Vernon, Walworth, Waukesha, and Washington counties; prohibited elsewhere – Updated county list in 2015
2. *Bunias orientalis* (Hill mustard)[A] restricted in Dane, Grant, Green, Iowa, Lafayette, and Rock counties; prohibited elsewhere – Updated county list in 2015
3. *Cirsium palustre* (European marsh thistle)[A] restricted in Ashland, Bayfield, Chippewa, Clark, Door, Florence, Forest, Iron, Langlade, Lincoln, Marathon, Marinette, Menominee, Oconto, Oneida, Price, Rusk, Sawyer, Shawano, Taylor and Vilas counties; prohibited elsewhere – Updated county list in 2015
4. *Conium maculatum* (Poison hemlock)[A] restricted in Buffalo, Crawford, Dane, Grant, Green, Iowa, Jefferson, Kenosha, La Crosse, Lafayette, Milwaukee, Monroe, Ozaukee, Racine, Richland, Rock, Sauk, Sheboygan, Trempealeau, Vernon, Walworth, and Waukesha counties; prohibited elsewhere – Updated county list in 2015
5. *Epilobium hirsutum* (Hairy willow herb)[A] restricted in Brown, Calumet, Door, Kenosha, Kewaunee, and Manitowoc counties; prohibited elsewhere – Updated county list in 2015
6. *Glyceria maxima* (Tall or reed mannagrass)[A] restricted in Brown, Calumet, Columbia, Dane, Dodge, Door, Fond du Lac, Green, Jefferson, Kenosha, Kewaunee, Manitowoc, Milwaukee, Outagamie, Ozaukee, Racine, Rock, Sheboygan, Walworth, Washington, Waukesha and Winnebago counties; prohibited elsewhere – Updated county list in 2015
7. *Humulus japonicus* (Japanese hops)[A] restricted in Buffalo, Crawford, Dane, Grant, Green, Iowa, Jackson, La Crosse, Lafayette, Monroe, Pepin, Richland, Sauk, Trempealeau, and Vernon counties; prohibited elsewhere – Updated county list in 2015
8. *Leymus arenarius* or *Elymus arenarius* (Lyme grass or sand ryegrass)[A] restricted in Door, Kenosha, Kewaunee, Manitowoc, Milwaukee, Ozaukee, Racine, and Sheboygan counties; prohibited elsewhere – Updated county list in 2015
9. *Linaria dalmatica* (Dalmatian toadflax)[C] restricted in Juneau and Bayfield counties; prohibited elsewhere
10. *Lonicera maackii* (Amur honeysuckle)[A] restricted in Adams, Brown, Buffalo, Calumet, Columbia, Crawford, Dane, Dodge, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Juneau, Kenosha, Kewaunee, La Crosse, Lafayette, Manitowoc, Marquette, Milwaukee, Monroe, Outagamie, Ozaukee, Racine, Richland, Rock, Sauk, Sheboygan, Vernon, Walworth, Washington, Waukesha, Waupaca, Waushara and Winnebago counties; prohibited elsewhere – Updated county list in 2015
11. *Phragmites australis* non-native ecotype (Phragmites or Common reed non-native ecotype)[A] restricted in Brown, Calumet, Columbia, Dane, Dodge, Door, Florence, Fond du Lac, Forest, Green Lake, Jefferson, Kenosha, Kewaunee, Langlade, Manitowoc, Marathon, Marinette, Marquette, Menominee, Milwaukee, Oconto, Outagamie, Ozaukee, Portage, Racine, Rock, Shawano, Sheboygan, Walworth, Washington, Waukesha, Waupaca, Waushara, and Winnebago counties; prohibited elsewhere - Moved to Prohibited/Restricted from Restricted in 2015
12. *Solidago sempervirens* (Seaside goldenrod)[C] restricted in Kenosha, Milwaukee and Racine counties; prohibited elsewhere
13. *Torilis japonica* (Japanese hedgeparsley or erect hedgeparsley)[A] restricted in Adams, Brown, Calumet, Columbia, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Green Lake, Iowa, Jefferson, Juneau, Kenosha, Kewaunee, La Crosse, Lafayette, Langlade, Manitowoc, Marathon, Marinette, Marquette, Menominee, Milwaukee, Monroe, Oconto, Outagamie, Ozaukee, Portage, Racine, Richland, Rock, Sauk, Shawano, Sheboygan, Vernon, Walworth, Washington, Waukesha, Waupaca, Waushara, and Winnebago counties; prohibited elsewhere – Updated county list in 2015
14. *Vincetoxicum nigrum* or *Cynanchum louiseae* (Black or Louise's swallow–wort)[A] restricted in Columbia, Crawford, Dane, Grant, Green, Iowa, Jefferson, Juneau, Kenosha, La Crosse, Lafayette, Milwaukee, Monroe, Racine, Richland, Rock, Sauk, Vernon, Walworth and Waukesha counties; prohibited elsewhere

RESTRICTED CATEGORY:

1. *Acer tataricum* subsp. *ginnala* (Amur maple)[C] *except all cultivars
2. *Aegopodium podagraria* (Bishop's goutweed)[C]
3. *Ailanthus altissima* (Tree of heaven)[A]
4. *Alliaria petiolata* (Garlic mustard)[A]
5. *Alnus glutinosa* (Black alder)[C] *except all cultivars and hybrids
6. *Artemisia absinthium* (Wormwood)[C]
7. *Berberis thunbergii* (Japanese barberry)[C] *This restriction only applies to the parent type, the variety atropurpurea, the hybrid of B. thunbergii x B. Koreana, and the following cultivars. Berberis thunbergii cultivars: Sparkle, 'Anderson' Lustre Green™, Erecta, 'Bailgreen' Jade Carousel®, Angel Wings, Painter's Palette, Inermis ('Thornless'), Pow Wow, Golden Ring, Kelleriis, Kobold, 'JN Variegated' Stardust™ and Antares. Variety atropurpurea cultivars: Marshall Upright ('Erecta'), Crimson Velvet, 'Bailtwo' Burgundy Carousel®, Red Rocket, 'Monomb' Cherry Bomb™, 'Bailone' Ruby Carousel®, JN Redleaf, Rose Glow and Silver Mile. Hybrid of B. thunbergii x B. koreana cultivars: Tara and 'Bailsel' Golden Carousel®
8. *Butomus umbellatus* (Flowering rush)[A]
9. *Campanula rapunculoides* (Creeping bellflower)[A]
10. *Caragana arborescens* (Siberian peashrub)[C] *except the cultivars Lorbergii, Pendula, and Walkerii
11. *Carduus acanthoides* (Plumeless thistle)[A]
12. *Carduus nutans* (Musk thistle or Nodding thistle)[A]
13. *Celastrus orbiculatus* (Oriental bittersweet)[A]
14. *Centaurea biebersteinii*, *Centaurea maculosa* or *Centaurea stoebe* (Spotted knapweed)[A]

15. *Centaurea jacea* (Brown knapweed)[C]
16. *Centaurea nigra* (Black knapweed)[C]
17. *Centaurea nigrescens* (Tyrol knapweed)[C]
18. *Chelidonium majus* (Celandine)[A] - Moved to Restricted from Prohibited/Restricted in 2015
19. *Cirsium arvense* (Canada thistle)[A]
20. *Coronilla varia* (Crown vetch)[C]
21. *Cynoglossum officinale* (Hound's tongue)[A]
22. *Dipsacus laciniatus* (Cut–leaved teasel)[A]
23. *Dipsacus sylvestris* or *Dipsacus fullonum* (Common teasel)[A]
24. *Elaeagnus angustifolia* (Russian olive)[A]
25. *Elaeagnus umbellata* (Autumn olive)[A]
26. *Epipactis helleborine* (Helleborine orchid)[A]
27. *Euonymus alatus* (Burning bush)[C] *including the cultivar 'Nordine' and excluding all other cultivars
28. *Euphorbia cyparissias* (Cypress spurge)[A]
29. *Euphorbia esula* (Leafy spurge)[A]
30. *Fallopia japonica* or *Polygonum cuspidatum* (Japanese knotweed)[A]
31. *Filipendula ulmaria* (Queen of the meadow)[C]
32. *Galeopsis tetrahit* (Hemp nettle, brittlestem hemp nettle)[A]
33. *Galium mollugo* (White bedstraw)[C]
34. *Hesperis matronalis* (Dame's rocket)[A]
35. *Impatiens balfourii* (Balfour's touch-me-not)[C]
36. *Iris pseudacorus* (Yellow iris)[C]
37. *Knautia arvensis* (Field scabiosa)[C]
38. *Lonicera morrowii* (Morrow's honeysuckle)[A]
39. *Lonicera tatarica* (Tartarian honeysuckle)[A]
40. *Lonicera* x *bella* (Bell's or showy bush honeysuckle)[A]
41. *Lysimachia nummularia* or *L. nummelaria* (Moneywort)[A] *except the cultivar Aurea and yellow and gold leaf forms
42. *Lysimachia vulgaris* (Garden yellow loosestrife)[C]
43. *Lythrum salicaria* (Purple loosestrife)[A]
44. *Morus alba* (White mulberry)[C] *except male cultivars
45. *Myosotis scorpioides* (Aquatic forget-me-not)[C]
46. *Myosotis sylvatica* or *M. sylvaticum* (Woodland forget-me-not)[C]
47. *Myriophyllum spicatum* (Eurasian watermilfoil)[A]
48. *Najas marina* (Spiny naiad)[C]
49. *Pastinaca sativa* (Wild parsnip)[A] *except for the garden vegetable form
50. *Phalaris arundinacea* var. *picta* (ribbon grass or gardener's garters and other ornamental variegated varieties and cultivars)[C] *this restriction does not include the parent type - reed canary grass.
51. *Pimpinella saxifraga* (Scarlet pimpernel or Burnet saxifrage)[C]
52. *Populus alba* (White poplar)[C]
53. *Potamogeton crispus* (Curly–leaf pondweed)[A]
54. *Rhamnus cathartica* (Common buckthorn)[A]
55. *Rhamnus frangula* or *Frangula alnus* (Glossy buckthorn)[A] *including the Columnaris (tall hedge) cultivar but excluding the cultivars Asplenifolia and Fineline (Ron Williams)
56. *Robinia hispida* (Rose acacia or Bristly locust)[C]
57. *Robinia pseudoacacia* (Black locust)[C] *except all cultivars
58. *Rosa multiflora* (Multiflora rose)[A]
59. *Tanacetum vulgare* (Tansy)[A] *except the cultivars Aureum and Crispum
60. *Typha angustifolia* (Narrow-leaf cattail)[A]
61. *Typha* x *glauca* (Hybrid cattail)[A]
62. *Ulmus pumila* (Siberian elm)[C] *except hybrids and individuals used as rootstock
63. *Valeriana officinalis* (Garden heliotrope or Valerian)[C]

Phase-out: Restricted only plants located in Wisconsin prior to their effective listing date may be transported, transferred, and introduced without a permit for a period not to exceed 3 years for herbaceous plants and woody vines, or 5 years for trees and shrubs, from their effective listing date.

FISH AND CRAYFISH

PROHIBITED CATEGORY:

1. Channidae (Snakehead family)[A] including *Channa argus* (Northern snakehead) , *Channa bleheri* (Rainbow snakehead), *Channa gachua* (Dwarf snakehead), *Channa maculata* (Blotched snakehead), *Channa marulius* (Bullseye snakehead), *Channa punctata* (Spotted snakehead), and *Channa striata* (Chevron snakehead)
2. *Ctenopharyngodon idella* (Grass carp)[A]
3. *Cyprinella lutrensis* (Red shiner)[A]
4. *Hypophthalmichthys molitrix* (Silver carp)[A]
5. *Hypophthalmichthys nobilis* (Bighead carp)[A]
6. *Mylopharyngodon piceus* (Black carp)[A]
7. *Sander lucioperca* (Zander)[A]
8. *Scardinius erythrophthalmus* (Rudd)[A]
9. *Tinca tinca* (Tench)[A]
10. All other nonnative fish and nonnative crayfish except:
    a. Established nonnative fish species and established nonnative crayfish species
    b. Nonnative viable fish species in the aquarium trade
    c. Nonnative fish species in the aquaculture industry
    d. Nonviable fish species
    e. Genetically modified fish species

RESTRICTED CATEGORY:

1. Established nonnative fish species and established nonnative crayfish species
    a. *Alosa pseudoharengus* (Alewive)[A]
    b. *Cyprinus carpio* (Common carp)[A]
    c. *Gambusia affinis* (Western mosquitofish)[A] - Moved to Restricted from Prohibited in 2015
    d. *Gambusia holbrooki* (Eastern mosquitofish)[A] - Moved to Restricted from Prohibited in 2015
    e. *Gasterosteus aculeatus* (Three-spine stickleback)[A]
    f. *Gymnocephalus cernuus* (Ruffe)[A]
    g. *Morone americana* (White perch)[A]
    h. *Neogobius melanostomus* (Round goby)[A]
    i. *Orconectes rusticus* (Rusty crayfish)[A]
    j. *Osmerus mordax* (Rainbow smelt)[A]

Line 5 Wisconsin Segment Relocation Project

Wetland and Waterbody Post-Construction Monitoring Plan

DRAFT

January 2023
Rev 1

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List of Tables

1 PROJECT INTRODUCTION

Enbridge Energy, Limited Partnership ("Enbridge") owns the U.S. portion of the world's longest liquid petroleum pipeline system. Combined with the Canadian portion, the operationally integrated pipeline system spans approximately 3,200 miles across North America and has been in operation since 1950.

Enbridge's existing Line 5 pipeline is a 645-mile interstate pipeline that originates in Superior, Wisconsin, traverses northern Wisconsin and the Upper and Lower Peninsulas of Michigan, and terminates near Sarnia, Ontario, Canada. The Wisconsin portion of the existing Line 5 pipeline crosses Douglas, Bayfield, Ashland, and Iron Counties. Within Ashland County, the existing Line 5 crosses through approximately 12 miles of the Bad River Reservation ("Reservation") of the Bad River Band of Lake Superior Chippewa Tribe ("Bad River Band").

Enbridge and the Bad River Band have been in discussions for several years regarding renewal of pipeline easements on 15 parcels of land through the Reservation. In January of 2017, the Bad River Tribal Council announced their decision to deny renewal of Enbridge's easements. Enbridge entered into mediation with the Bad River Band and in July 2019, the Bad River Band terminated mediation discussions and filed suit against Enbridge seeking removal of the pipeline from the Reservation. In response to the discussions with the Bad River Band and litigation filed in July 2019, Enbridge developed the Line 5 Wisconsin Segment Relocation Project ("Project").

The Project will relocate the existing Line 5 pipeline around the Reservation and replaces approximately 20 miles of the existing Line 5 pipeline, including the segment of the existing Line 5 pipeline that traverses through the Reservation, with approximately 41 miles of new, 30-inch outside diameter pipeline segment located entirely outside the Reservation.

Enbridge has prepared this Wetland and Waterbody Restoration and Post-Construction Monitoring Plan ("Monitoring Plan") to evaluate and determine the success of wetland and waterbody restoration within the affected workspace following construction of the Project.

Restoration activities that will occur immediately after construction to stabilize and seed the disturbed construction workspace are described in Enbridge's Environmental Protection Plan ("EPP"). Post-construction monitoring will begin during the first growing season after the restoration work is complete. Monitoring will not be considered complete until the performance standards described in this Plan have been met and reviewed, and approved by the applicable agencies. If the performance standards have not been met by the end of the planned monitoring period (e.g., five years for wetlands), Enbridge, as directed by the applicable agencies, will either extend monitoring at those sites, develop a site-specific restoration plans, or provide additional mitigation.

1.1 MONITORING PLAN OBJECTIVES

The purpose of this Monitoring Plan is to establish the monitoring procedures and performance standards that will be used to:

- determine the status of wetlands and waterbodies restoration relative to pre-construction baseline conditions;
- document where successful wetland and waterbody restoration has been achieved; and
- identify additional mitigation that may be warranted if successful restoration in specific wetlands and waterbodies has not been achieved.

This Monitoring Plan is based on pre-construction data already collected to document aquatic resources; including previous data, analyses, and procedures submitted in support of Enbridge's USACE and DNR applications, and will incorporate future data that will be collected prior to construction to help establish baseline conditions. It also: describes the monitoring methodology to be followed during specified time periods following completion of the Project; identifies performance criteria to evaluate the success of wetland and waterbody restoration; and describes the contents of required monitoring reports, including, but not limited to conclusions regarding monitoring results and recommendations for appropriate next steps such as additional monitoring, adaptive management, and/or additional mitigation, to respond to any areas that are not successfully restored during the planned monitoring period.

2 QUALIFICATIONS

Post-construction monitoring of restored wetlands and waterbodies will be performed using personnel under contract with Enbridge who meet the following requirements:

- Personnel leading the monitoring activities for a given monitoring team will hold a bachelor's degree or higher in biological and or geological science, field research experience including project design sampling and analysis, experience/knowledge in wetland plant community ecology, and vegetation sampling/identification. Alternatively, personnel will have 10 years of field research, project design, and analytical experience; and experience/knowledge in wetland plant community ecology and vegetation sampling/identification.
- Personnel collecting the data shall demonstrate knowledge of local flora prior to fieldwork, including the identification of the range of native and non-native plant species expected to be encountered onsite. Personnel should be qualified to identify unknown plant species with a regional dichotomous key and/or herbarium work. Personnel must also demonstrate familiarity with soils and hydrology.

3 PRECONSTRUCTION BASELINE DATA

Enbridge completed wetland surveys along the Project route in 2019 and 2020 and submitted a 2019 Wetland and Waterbody Survey Report and an addendum report that included the information collected during the 2020 field season to both the U.S. Army Corps of Engineers ("USACE") and the Wisconsin Department of Natural Resources ("DNR"). As described in more detail in sections 3 and 4, Enbridge collected and compiled in its reports the following pre-construction baseline data for wetlands and waterbody within the proposed workspace of the Project:

- Field-delineated wetland community types according to Cowardin (1979), Circular 39 (U.S. Fish and Wildlife Service ["USFWS"], 1956), and Eggers and Reed (2014) classification systems;
- Publicly available data, such as aerial imagery U.S. Geological Survey topographic maps and U.S. Geological Survey gage data ;
- Field-delineated dominant plant species by stratum;
- Field characterization of hydric soil types and wetland hydrology (e.g., inundated, saturated soils);
- Field determined wetland functional assessments;
- Representative photos of wetlands and associated plant communities;
- Field-delineated waterbody locations;
- Waterbody characterizations, including top of bank width water depth, ordinary high water mark, substrate type, flow regime, and dominant riparian vegetation;

- Bank vegetation community type (i.e., Eggers and Reed, 2014);
- Representative photos of waterbody at the time of survey;
- Light Detection and Ranging ("LIDAR") of the Project route; and
- Ground elevation civil survey data collected at regular intervals along the centerline; and
- Quantified and qualitative assessments of wetland and waterbody impacts.

Enbridge will augment the existing baseline data, with the following additional information that will be collected prior to construction:

- civil survey elevation information along the proposed centerline of each non-HDD/Direct Pipe stream crossing starting and extending approximately 50 feet back from the top of each stream bank (where stream depth and velocity allows for safe access);
- additional photographs documenting upstream, downstream and of each bank crossing at the proposed centerline;
- visual assessments of streambed characteristics (observed streambed materials and characteristics such as gravel, cobble, riffles, pools);
- visual assessments of fish habitat such as undercut banks, instream structures (e.g., logs), potential spawning gravel; and
- visual evidence of bank erosion at or near the proposed centerline crossing.

4 WETLAND IDENTIFICATION, FUNCTIONAL ASSESSMENT, AND DISTURBANCE

4.1 WETLAND IDENTIFICATION

Table 4.1-1 summarizes the Cowardin wetland classification types and the corresponding Eggers & Reeds classifications of wetlands affected by the Project. Additional information regarding the specific wetland types identified during the field surveys is provided below. Enbridge also developed a Compensatory Wetland Mitigation Plan that addresses temporal wetland impacts, wetland conversion (e.g., conversion of forested wetland to emergent wetland), and permanent wetland fill. The Compensatory Wetland Mitigation Plan has been submitted to and reviewed by the respective agencies. Refer to the Wetland Mitigation Plan for further wetland definitions.

Table 4.1-1: Wetland Classification Types

Cowardin Classification	Eggers & Reed Classification
PEM	Bog; Deep Marsh; Farmed Wetland; Fresh Meadow; Open Bog; Seasonally Flooded Basin; Sedge Meadow; Shallow Marsh; Shallow Open Water; Wet Meadow
PSS	Alder Thicket; Bog; Coniferous Swamp; Shrub-Carr
PFO	Bog; Coniferous Swamp; Floodplain Forest; Hardwood Swamp

PEM = palustrine emergent; PFO = palustrine forested; PSS = palustrine scrub-shrub

As noted in the Wetland and Waterbody Survey Report, some of the wetlands included multiple Cowardin and/or Eggers and Reed classifications within the same wetland system. Where this occurred each community type within the wetland was recorded as a separate polygon.

4.2 WETLAND FUNCTIONAL ASSESSMENT

During preconstruction field delineations, each wetland was assessed based on the DNR Wetland Rapid Assessment Method ("WRAM") wetland functions, including: Floristic Integrity; Human Use Values; Wildlife Habitat; and Fish and Aquatic Life Habitat. The WRAM data sheets for these assessments were included in Enbridge's Wetland Delineation Report. Enbridge then used the WRAM data sheets to assign an overall functional value rating of: Low, Low-invasive, Medium, or High to each wetland. The assignment process was conservative and the highest potential overall general functional value was assigned to each wetland.

The wetland determination data forms specifically referenced the area being sampled. Because, this measure alone does not address the condition and functional value of the sample area or the entire feature, field crews also evaluated each wetland using the Wisconsin Wetland Rapid Assessment Methodology (RAM).[1] RAM was applied to determine the functional value, floristic integrity, and condition of each wetland assessment area and buffer, and assess potential impacts. The floristic integrity assessment was focused on primary questions pertaining to invasive species cover, strata, Natural Heritage Information plant community ranking, and relative frequency of the plant community within the watershed. Excluded from this assessment was the optional documentation of vascular plant species and cover/abundance.

Additional vegetation surveys were conducted during the 2022 field season on a subset of wetlands within the Project area to expand the assessment of floristic integrity. These additional surveys were restricted to wetland that were determined to be of moderate to high quality based on the data collected during the initial wetland delineation field efforts (2019-2020).

The 2022 evaluations used a modified timed-meander survey method that deviated from the traditional approach in three ways.

1. Traditional timed-meander surveys evaluate entire features, in this case, entire wetlands. The modified survey was restricted to a corridor, thus the survey effort only reflects the portion of the wetland area within the corridor.
2. Under the traditional method in Wisconsin[2], species are recorded in 5-minute increments, noting which increment a species was first observed (e.g., 0-5 minutes, 5-10 minutes, etc.). It is suggested that surveys occur for a minimum of 30 minutes. This process can continue beyond 30 minutes under different scenarios, but the process is also flexible and allows the practitioner to stop before reaching a full 30 minutes. The approach implemented for this Project was to evaluate the entire defined assessment area and record every vascular plant species encountered.
3. Another deviation specific to the Wisconsin method was that species abundance codes were not collected for this survey since they are non-numerical and cannot be used for analysis purposes.

In general, separate and independent timed-meander surveys were conducted for each wetland community type. As such, multiple surveys were often conducted within wetlands with multiple Eggers and Reed community types. However, in some cases, a community component of a specific wetland was reclassified and merged with the primary Eggers and Reed community. This was generally done where past forest management had resulted in a portion of the forested community being open. The original delineations

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[1] https://dnr.wisconsin.gov/topic/wetlands/methods.html#:~:text=The%20Wisconsin%20Wetland%20Rapid%20Assessment,wetland%20performs%20a%20given%20function. Accessed December 2022.

[2] Timed-Meander Sampling Protocol for Wetland Floristic Quality Assessment, WDNR

classified these open areas as separate communities within the forest, but because it is anticipated that these open areas will revert to having canopy cover, the 2022 evaluations treated these areas as one community.

4.3 CONSTRUCTION IMPACTS

The primary impact of pipeline construction and right-of-way maintenance activities on wetlands is the temporary removal of wetland vegetation during active construction and the conversion of forested and shrub-scrub wetland vegetation to emergent wetland vegetation within the permanent right-of-way. Construction also temporarily diminishes the recreational and aesthetic value of the wetlands crossed; and temporarily removes or alters wetland wildlife habitat. There is also a potential for impacts on groundwater surface water hydrology particularly in the vicinity of blasting, or as a result of changes in topography. These effects would be greatest during and immediately following construction and most, with the exception of vegetation and habitat impacts, will cease after the trench is backfilled, contours are restored, and erosion controls are installed. In PEM wetlands, the impact of construction vegetation and habitat is relatively brief, since herbaceous vegetation will typically regenerate within one or two growing seasons. In PFO and PSS wetlands, the vegetation and habitat impacts lasts longer due to the longer recovery period of these vegetation types.

Project construction activities will result in approximately 101.1 acres of temporary wetland disturbance associated with clearing, pipeline installation activities, and establishment of temporary access roads. As indicated in Table 3-2, PEM wetlands and more than half of the affected PFO and PSS wetlands (totaling together approximately 67.1 acres of wetlands) will be allowed to revert to its original cover type after construction. The remaining approximately 33.9 acres of PFO and PSS wetland will be converted to PEM wetland within the permanent right-of-way as a result of vegetation maintenance during operation of the pipeline. A total of approximately 0.02 acre of PEM and PSS wetland will be filled for construction of aboveground facilities permanent access roads.

Table 4.3-1: Summary of Line 5 Wetland Impacts

Wetland Type [a]	Impact Areas - Allowed to Revert to Pre-construction Wetland Cover Type (Acres) [b]	Impact Areas - Converted From One to Another Wetland Type (Acres) [c]	Permanent Impact (Acres) [d]
Palustrine Emergent (PEM)	28.1	0	0.02
Palustrine Forested (PFO)	32.8	30.0	0
Palustrine Scrub/Shrub (PSS)	6.3	3.9	<0.01
TOTAL	**67.1**	**33.9**	**0.02**

[a] The numbers in this table have been rounded for presentation purposes. As a result, the totals may not reflect the sum of the addends.
[b] Wetland type based on Cowardin, 1979.
[c] Based on temporary workspace disturbance due to construction activities.
[d] Based on permanent right-of-way ("ROW") with conversion from PSS and PFO to PEM.
[e] Based on permanent wetland impacts (fill).

4.4 WETLAND RESTORATION

To the maximum extent practicable, Enbridge will restore affected wetlands to preconstruction conditions, which is considered in-place compensation, but not in-kind and not in-advance compensation. Enbridge will also provide compensatory wetland mitigation for unavoidable Project-related impacts including temporary loss of wetland cover, permanent conversion of wetland type, and permanent wetland fill.

Non-standing water wetlands will be seeded using the mix provided in Appendix A to provide temporary cover and allow natural revegetation via the seeds and rhizomes in the topsoil spread back over the right-of-way (ROW) after pipe installation. No fertilizer, lime, or mulch will be applied in wetlands.

Enbridge does not intend to seed standing water wetlands because the reestablishment of vegetation in these types of wetlands occurs best through natural process without supplemental seeding. Enbridge plans to allow natural reforestation of the temporary workspace area within PFO wetlands via stump sprouting, root sprouting, and natural recruitment.

4.5 WETLAND MONITORING OBJECTIVES

The goal of the post-construction wetland monitoring program will be to assess quantitatively and/or qualitatively the success of post-construction wetland restoration through documentation of wetland elevations, hydrology and flow patterns, plant cover, plant distribution, and species composition of plant communities in the wetlands impacted by pipeline construction and operation. The following protocol was developed to establish a standardized monitoring procedure that will be used to evaluate the effectiveness of wetland restoration efforts, to document overall revegetation success, and to identify areas that may require additional remediation.

4.6 WETLAND MONITORING METHODOLOGY

Based on the functional value rating methods described in Section 4.2 above, it was determined that the Project will impact approximately:

- 26.1 acres of wetlands with a WRAM High assessed functional value
- 57.0 acres of wetlands with a WRAM Medium assessed functional value
- 18.1 acres of wetlands with a WRAM Low or Low-invasive assessed functional value.

Based on these functional value categories, Enbridge will implement two levels of monitoring. High functional value and medium value high floristic value wetlands, as well as select wetland adjacent to ASNRI waterbodies, will be assessed using one monitoring protocol and the other Medium, and Low or Low-invasive wetlands will be assessed using a second monitoring protocol, as described below. Additional data will also be collected for seeps and groundwater discharge wetlands where blasting was conducted.

Data will be collected to determine the success of revegetation within all wetlands, however high functional value and medium value high floristic value wetlands, as well as select wetland adjacent to ASNRI waterbodies and seeps and ground water discharge wetlands where blasting was conducted will be monitored more intensively than other medium, and low or low-invasive functional value wetlands, as described below.

Enbridge will generally maintain a 50-foot-wide operational corridor along the pipeline in an herbaceous state to facilitate aerial monitoring and pipeline access. As a result, portions of PFO and PSS wetlands will be permanently converted to PEM wetlands by routine clearing within the permanent easement. The status of revegetation in these permanently converted PFO/PSS areas will be described, inventoried and assessed similar to naturally occurring PEM wetlands during post-construction monitoring.

4.6.1 All Wetlands

Table 4.6-1 below describes the monitoring activities that will take place in wetlands within the Project workspace. Annual monitoring will begin the first growing season after construction and will be conducted for up to five growing seasons or until success criteria have been met[3].

Table 4.6-1: Summary of Proposed Monitoring Methods for Line 5

Monitoring Activities	Other Medium, and Low and Low Invasive Functional Value Wetlands	High Functional, Medium Functional High Floristic Quality Value Wetlands and Select wetlands Adjacent to ASNRI Waterbodies
Monitored first growing season post construction	X	X
Photos taken in each direction	X	X
Observations of Hydrologic Indicators	X	X
Status of erosion controls	X	X
Observations of off-road vehicle activity	X	X
Observations of elevation changes	X	X
Observations of third-party disturbances	X	X
Incidental wildlife observations	X	X
Dominant species list	X	X
Weed presence comparison against preconstruction condition	X	X
Plot sampling	**50 percent**	X
Timed-meander survey		X

4.6.2 Wetland Monitoring First Year Post Construction

Enbridge will visit each wetland affected by the Project during the first growing season after construction. This first year of monitoring will evaluate the topography and stabilization of wetland crossings. Any crowning left for anticipated settling will be evaluated to determine whether soils are returning to the native elevation within the expected timeframe. Areas where subsidence has occurred over the trench will also be noted for potential restoration. Enbridge will also utilize the baseline conditions documented during the pre-construction wetland surveys to identify any other potential deviations in site hydrology.

Enbridge will record general conditions in each wetland including: presence and distribution of hydrophytes and estimated cover; presence/absence of invasive species and estimated cover; natural indicators such as wildlife observations (incidental); visual evidence of rutting, compaction, or erosion; status of erosion controls; off-road vehicle activity; and other third-party disturbances[4]. Enbridge will take a representative photograph in each wetland to document first year post-construction conditions.

In addition to the collection of the base information described above, Enbridge will establish 1meter by 1-meter random plot locations (1-meter quadrat locations to be selected by field personnel during the first monitoring season) in 50 percent of the low and medium functional value wetlands, and in all of the high functional value wetlands. The exception would be in wetlands located between the HDD entry and exit points where Enbridge reduced the construction right-of-way to 30 feet and activities were restricted to only

[3] Monitoring will cease in a given wetland when revegetation is considered successful in that wetland.
[4] Other third-party disturbances could include excavations, filling, tree clearing, and livestock grazing.

vegetation clearing, which will be maintained as part of the permanent easement, Enbridge will conduct only a post construction walk-over inspection. No plots would be established in these wetlands.

The location of each plot will be recorded by global positioning system (GPS) and marked on aerial photographs in order to maintain consistent plot locations for the duration of the monitoring program. The same plots will be assessed each year, generally around the same time of year. At a minimum, one plot will be established for approximately every half-acre of affected wetland in the ROW. For example, a wetland that is between 0 and 1.0 acre in size will have at least two plots; a wetland that is at least 1.0 acre but less than 1.5 acres in size will have at least three plots; and a wetland that is at least 1.5 acres but less than 2.0 acres on the ROW will have at least four plots.

The species within each plot will be identified and recorded and the dominant species will be noted. Hydrologic indicators will be identified and the presence/absence of invasive species within the plot will be documented. Where forested wetlands are allowed to regenerate naturally, tree regrowth or natural recruitment will be documented on data sheets. The percent cover for each species, as well as the total percent cover by native hydrophytes, total percent cover for the entire plot, and relative percent of native hydrophytes will be estimated.

High Functional Value and Medium Functional Value with High Floristic Quality Wetlands, and Select Wetlands Adjacent to ASNRI Waterbodies

In addition to the data collection discussed above, timed-meander surveys will be conducted in high functional value and medium functional value with high floristic quality wetlands, as well as select wetlands adjacent to ASNRI waterbodies. The field surveyors will select an assessment area within each wetland that is representative of the wetland overall. Within this area, the surveyors will conduct the timed-meander survey. This will involve identifying within a specified amount of time the plant species within each assessment area and categorizing each species relative abundance (e.g., abundant, common, occasional, uncommon, rare) and percent areal cover within the assessment area.

Data will be recorded on data forms that will be used along with photographs to document the progress of restoration and compare previous seasons of monitoring. Sample data forms are provided in Appendix B.

Seeps and Groundwater Discharge Wetlands Where Blasting Occurred

Agencies have expressed concern that blasting could alter the hydrology of seeps and groundwater discharge wetlands. Prior to the start of construction, Enbridge will work with the respective agencies to identify select wetlands to install monitoring wells upslope and downslope of these types of wetlands where blasting is anticipated.

Monitoring wells will be installed in nests to allow for the determination of groundwater flow direction and to assess if there are changes in groundwater conditions upgradient and downgradient of the pipeline. Each nest will consists of at least 3 monitoring wells installed in a triangular pattern with at least one of the monitoring wells located on the opposite side of the pipeline. It is anticipated that the monitoring wells will be constructed of 2-inch, 10-slot, screened polyvinyl chloride (“PVC”) or stainless-steel pipe with a point (for direct push of the well into the soil) equipped with a 2-inch solid riser. Either the riser pipe or the expandable plug is vented to allow atmospheric equilibrium to develop in the well.

Wells will be monitored using non-vented, pressure-based loggers (e.g. In-SiteTM, HOBO®, or similar), installed in the wells and programmed to record absolute pressure at 1-hour intervals. Barometric pressure data will be collected using pressure-based loggers programmed to record absolute pressure at 1-hour intervals installed in an above-ground vented well riser. One barometric pressure logger will be installed. Water levels will be measured manually by a water level meter (e.g., Solinst®) at least bi-annually during installation and retrieval of the water level loggers from the monitoring wells. The wells will be resurveyed on an annual basis.

Data loggers will be installed following spring thaw and retrieved after the end of each growing season. Enbridge will continue to collect data on an annual basis during the frost-free period or until the performance standards have been met and reviewed by the applicable Agencies. Where performance standards at specific sites have not been met by year 5 of monitoring, Enbridge, in consultation with the Agencies, may extend monitoring at those sites.

4.6.3 Wetland Monitoring Years 2 through 5

Enbridge will continue to monitor the revegetation of affected wetlands annually for up to 5 years to assess wetland restoration as described in the Year 1 Post Construction Monitoring effort. Wetland monitoring during years 3 and 5 will also focus on both landscape level and on-the-ground assessments of whether hydrology on and the off-right-of-way are similar and consistent with the baseline conditions identified during pre-construction field surveys. Enbridge will also revisit any areas of crowning or subsidence, or other sites identified during years 1 and 3 monitoring where restoration did not meet the performance standards established in Section 3.8. If possible the subsequent monitoring will be performed during the same season/time of year as the Year 1 monitoring.

4.7 WETLAND SUCCESS CRITERIA

Wetland restoration shall be considered successful if all of the following criteria are satisfied:

- vegetation in the monitored wetland is at least 70 percent of either the baseline cover documented in the wetland prior to construction, or at least 70 percent of the cover in adjacent unaffected wetland areas;
- there is no evidence of adverse changes to baseline hydrology and drainage;
- wetland topography is restored to baseline conditions and similar to the topography of adjacent undisturbed wetland areas;
- the percent cover of invasive species within the construction workspace is similar to or less than the percent cover in adjacent undisturbed areas outside of the construction workspace and within the same community type.
- if natural rather than active revegetation was used, the plant species composition and distribution is consistent with early successional wetland plant communities in the affected ecoregion; and
- the presence, density, and distribution of invasive vegetation species is less than or similar to pre-construction baseline conditions.

5 WATERBODY IDENTIFICATION, ASSESSMENT, AND DISTURBANCE

5.1 WATERBODY IDENTIFICATION

Table 5.1-1 summarizes the number and types of waterbodies that are crossed by the pipeline centerline.

Table 5.1-1 Summary of Pipeline Centerline Waterbody Crossings

Waterbody Regime	Number
Delineated Waterbodies	
Perennial	29
Intermittent	40
Ephemeral	33
PROJECT TOTAL	102

Notes: Notes: Delineated waterbodies are based on 2019 and 2020 field surveys. Includes rivers, streams, swales, and ditches. Includes one WDNR 24K Hydrography Data waterway (WDH-18) where survey was not permitted in a highway median and 17 WDH waterbodies where a navigability determination by WDNR is requested.

As indicated on the table, the proposed pipeline centerline (including HDD crossings) will cross 102 delineated waterbodies. These include 29 perennial waterbodies, 40 intermittent waterbodies, and 33 ephemeral waterbodies.

5.2 WATERBODY IMPACTS AND MITIGATION

Enbridge will cross the majority of waterbodies using open cut construction methods, which will require trenching and backfilling of the bed and banks to install the pipeline. Enbridge will cross the remaining waterbodies using a trenchless method, which will avoid direct impacts on the water, bed and banks of these watercourses.

Potential waterbody impacts associated with pipeline construction include the clearing of bank vegetation and the disturbance of bed and banks; impacts on flow impacts and water quality including the suspension and downstream transport of sediments; and direct and indirect loss of aquatic organisms and habitat. These effects are typically minor and short-term; generally limited to the construction and near downstream area and the periods of active construction; and quickly dissipate once the bed and banks are restored, stabilized, and revegetated

Enbridge will mitigate waterbody impacts through use of its EPP. Enbridge will cross larger waterbody using a trenchless method. Enbridge will use a dry crossing method (either dam and pump or flume) at all other waterbodies if flowing water is present. Enbridge's use of a dry crossing method will maintain flows and use temporary dams upstream and downstream of the pipeline crossing to isolate the waterflow from the work area. Enbridge will only use the open cut (wet trench) method, which does not isolate the work area from the stream water, to cross waterbodies with no apparent flow. Enbridge has also reduced the width of the construction right-of-way at most waterbody crossings to 95 feet. The actual instream disturbance associated with excavation will typically be only 15-25 feet, depending on the cohesive nature of the substrate. For dry crossings, the isolated segment of the stream will be determined based on site-specific conditions, but typically is less than 50 feet wide. Enbridge's selective or application of these methods and narrower right-of-way width will avoid or minimize instream work and the potential for sedimentation and other waterbody impacts.

5.3 WATERBODY RESTORATION

Waterbody restoration will be performed at open cut crossings. Following installation of the pipeline where open cut methods are used, Enbridge will backfill the pipeline using the native materials excavated from the trench. Enbridge will restore the bed and banks of each stream. The bed elevations will be matched to avoid impediments to normal water flow. The streambanks will be restored as near as practicable to preconstruction conditions, unless the original slope is determined to be unstable. If there is a potential for significant bank erosion, the Contractor may stabilize disturbed stream banks with rock riprap or other bank protection, with WDNR and USACE approval. Where dry crossing methods are used, the temporary dams, flumes/hoses and pumps will be removed after the bed and banks are restored.

Temporary slope breakers will be installed on all sloped approaches to streams in accordance with the spacing requirements outlined in the EPP. Trench breakers will also be installed at the stream banks, as necessary, where slopes are adjacent to the waterbodies to prevent subsurface water flow and erosion along the trench line. Trench breakers typically consist of burlap sandbags filled with rock-free subsoil or sand and placed from the bottom of the trench to near the top surrounding the pipe. Permanent stabilization will be initiated within 24 hours unless site and weather conditions delay permanent installation.

Once the banks are reshaped, the banks will be seeded and stabilized with erosion control BMPs as specified in the EPP. Stream bank vegetation will be reestablished using the seed mix in Appendix B of the EPP, unless applicable agencies specify otherwise. Where a waterbody is within a wetland, the banks will be reseeded with the applicable wetland seed mix.

The travel lane portion of the construction right-of-way and the temporary bridge will remain in place until pipeline construction activities (including final cleanup) are complete. Permanent slope breakers will be installed across the full width of the right-of-way during final cleanup. The Contractor will remove temporary bridges during the final cleanup and restoration phase of construction after installation of the new pipeline and right-of-way access is no longer required. Enbridge will remove temporary sediment control devices across the construction right-of-way only after achieving vegetative cover, in accordance with permit conditions.

No routine post-construction maintenance or work is anticipated to be conducted in waterbodies, however, Enbridge will generally maintain a 50-foot-wide operational corridor along the pipeline in an herbaceous state to facilitate aerial monitoring and pipeline access.

5.4 WATERBODY MONITORING OBJECTIVES

The goal of the post-construction waterbody monitoring program will be to assess quantitatively and/or qualitatively the success of post-construction waterbody restoration through documentation of physical waterbody parameters including bed and bank elevations and contours, bank and bed composition and stabilization, and water quality, depth, and flow. The following protocol was developed to establish a standardized monitoring procedure that will be used to evaluate the effectiveness of waterbody restoration efforts, to document overall success, and to identify areas that may require additional remediation.

5.5 WATERBODY MONITORING METHODOLOGY

Enbridge proposes to visually monitor each waterbody crossing during the first, second and fifth growing seasons following construction to confirm the successful stabilization of streambanks during high and low flow regimes, and restoration of waterbody flow relative to the pre-construction baseline data. If possible the subsequent monitoring will be performed during the same season/time of year as the Year 1 monitoring. During each visit Enbridge will document:

- bank and near bank (within 50 feet of bank) stabilization and revegetation;
- any observed soil slumping or erosion
- bank height and width;
- waterbody depth, and flow;

  streambed characteristics and composition of the substrate; and presence of fish habitat such as undercut banks, instream structures (e.g., logs), potential spawning gravel.

Each of these physical parameters will be documented at the crossing location and recorded on a USACE wetland determination data along with the date, time, and location of the observation, the waterbody name, and additional notes on the condition of the surrounding right-of-way, any evidence of third-party activity (off-road-vehicles, grazing, recent construction, etc.), any evidence of erosion, flooding, or notable changes in bank or channel morphology.

In addition to recording physical attributes, during the first year of monitoring, Enbridge will collect grab samples approximately 50 to 100 meters upstream and downstream of the pipeline crossing locations of flowing streams. Samples will be analyzed for dissolved oxygen ("DO"), pH, conductivity, temperature, chemical oxygen demand ("COD"), turbidity (field measurement) and total suspended solids ("TSS"). For the three 303(d) impaired waterbodies (Bay City Creek, Trout Brook, Marengo River), the sampling will also include fecal coliform and total phosphorous. These last two and the COD and TSS analysis will be completed by a certified laboratory using standard analytical methodologies. DO, pH, conductivity, and temperature measurements will be collected in the field using standard analytical methodologies. Additional sampling will be conducted in subsequent monitoring years for any stream that exhibits substantial differences between the upstream and downstream samples for any of the measured attributes.

5.6 WATERBODY SUCCESS CRITERIA

Waterbody restoration shall be considered successful if all of the following criteria are satisfied:

- the waterbody bank is stable and successfully revegetated (based on the appropriate wetland/upland success criteria);
- the height and width of the stream bank approximate preconstruction baseline conditions and/or adjacent undisturbed bank areas;
- the depth and flow characteristics (i.e., free flow without construction related impediment) of the waterbody approximates the preconstruction baseline conditions and/or adjacent undisturbed areas;
- the composition of the bed substrate approximates the preconstruction baseline conditions and/or adjacent undisturbed beds areas; and
- the collected water quality parameters up and downstream of the crossing are similar.

6 WETLAND AND WATERBODY POST-CONSTRUCTION RESTORATION AND CORRECTIVE ACTIONS

Enbridge will work closely with the DNR and the USACE to determine success or additional steps if performance standards are not reached after the planned monitoring is completed. Post-construction restoration activities will be adaptive, based on the results of monitoring, changing site conditions (e.g., land use) and geared toward the final goal of restoring pre-construction characteristics of the resource (i.e., vegetation and hydrology). In determining whether corrective action is needed, Enbridge will evaluate the potential resource impacts from conducting the additional restoration compared to taking no action with continued monitoring.

Not every potential corrective action can be determined at this time but possible corrective measures that may need to be implemented include:

- Installation of additional erosion controls or sediment barriers to stabilize soils and capture or redirect runoff;
- Regrading or recontouring to address topography or hydrology issues;
- Implementation of integrated approaches to invasive or noxious weed infestations as outlined in Enbridge’s Invasive and Noxious Species Management Plan and in accordance with Section 4.0 of Enbridge's EPP;
- Reseeding and/or the addition of soil amendments, or supplementing the original seed mix to meet success criteria;
- Supplemental plantings of tree and/or shrubs in selected areas to enhance stabilization or vegetation diversity.

Enbridge will address site stabilization issues that are identified during monitoring. Erosion and erosion and sediment control BMP deficiencies that have the potential to allow silt-laden water to enter wetlands or waterbodies will be prioritized and promptly addressed to prevent resource impacts. If the selected erosion and sediment control BMP is not effective at a particular location (e.g., continued failure), other solutions will be evaluated, such as re-contouring an area to alleviate a drainage flow pattern that is causing erosion or adding additional erosion and sediment control BMPs to divert drainage to a well-vegetated area.

Examples of topography or hydrology-related issues that may require additional restoration include: unexpected ponding, unexpected drainage, and/or disruptions to flow patterns causing changes in pre-construction wetland hydrology. Corrective actions, such as regrading or recontouring, will be implemented if crowning, subsidence, or the restored grade is determined to be interfering with the goal of re-establishing vegetative communities according to the local ecotype, or pre-construction wetland hydrology. Where such issues have been identified, Enbridge will reference pre-construction baseline data including available pre-construction ground elevation data.

Corrective actions for unexpected alterations to groundwater flow related to changes in topography may include regrading or recontouring Actions that may require additional temporary impacts on a wetland or waterbody will be conducted according to pertinent permit requirements and in consultation with applicable Agencies.

If the cover of invasive species within a particular community type is too high within the construction workspace compared to the percent cover of the same species in adjacent undisturbed areas outside of the construction workspace, Enbridge will manage the issue in accordance with its Invasive Species Management Plan.

Monitoring may determine that some areas have not successfully revegetate after the first growing season. Causes for seeding failure include poor germination or insufficient seeding take as a result of weather conditions, soil conditions, disturbance from cattle or wildlife, competition from invasive species, or erosion. Enbridge will reseed areas that are not adequately revegetated during the monitoring period. Changes in hydrology can also prevent successful restoration. If impacts on hydrology are identified, Enbridge will take actions to restore the hydrology. Other actions may also be taken, such as regrading areas to correct topography, fertilizing low nutrient soils, decompacting soils, setting up exclusion areas to stop grazing or foraging, implementing Enbridge's Invasive Species Management Plan, and/or supplementing seed mixes.

7 REPORTING

The results of the wetland and waterbody monitoring efforts will be submitted to the DNR following each survey year, no later than December 31. The report will include data forms, photographs, location maps, comparisons of upstream and downstream water quality parameters, an analysis of the results and any notable issues, and a recommendation for any additional restoration activities.

If any of the applicable success criteria discussed in Sections 4.8 for wetlands and 5.6 for waterbodies are not met by the end of five years of monitoring, a remedial revegetation plan will be developed and submitted to the USACE and DNR.

8 REFERENCES

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* Washington, DC: U.S. Fish and Wildlife Service Pub., FWS/OBS-79/31. December.

Eggers, Steve D., and Reed, Donald M. 2014. *Wetland Plants and Plant Communities of Minnesota and Wisconsin.* Accessed May 2021. Available online at https://www.mvp.usace.army.mil/Portals/57/docs/regulatory/WetlandBook/Part%201%20-%20Introduction,%20Key%20to%20Plant%20Communities,%20Shallow%20Open%20Water%20Communities.pdf

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APPENDIX A

SEED MIXES FROM EPP

WISCONSIN SEED MIXES

Based on precipitation and general soil types the following seed mixes will be used in Wisconsin:

Table B-1
WI Seed Mix 1 – Standard Upland Seed Mix

Use: Wisconsin state-wide in upland areas
Seeding Rate: 15.0 pounds/acre PLS drilled or 30.0 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve* substitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
Perennial Ryegrass	2	17.0
Canada Wild-rye	4	33.0
Switchgrass: unimproved native variety	4	33.0
Timothy	2	17.0
Subtotal	12	100.0[1]
Associated Companion Crop Mix		
Oats for summer seeding; or Winter Wheat for seeding in late fall (dormant) or spring	16	80.0
Annual Ryegrass or Slender Wheat Grass	4	20.0
Companion/Cover Crop Subtotal	20	100.0
GRAND TOTAL (pounds)	**32**	**100.0[1]**

[1] May not equal 100 percent due to rounding

Table B-2
WI Seed Mix 2 – Native Sedge/Wet Meadow Mixture

Use: Wisconsin state-wide in unsaturated Wet Meadow wetland areas
Seeding Rate: See below summary.
Notes: *Enbridge Environment must approve* substitutions *in advance*

Common Name	Botanical Name	Indicator Status	Seeds/oz.	Seeds/ft^2	% of Mix
Brome, fringed	*Bromus ciliata*	*FACW*	10,000	1.5	8.1
Blue-joint grass	*Calamagrostis canadensis*	*OBL*	280,000	8.2	1.6
Wild-rye, Virginia	*Elymus virginicus*	*FACW-*	4,200	3.2	42.3
Manna grass, reed	*Glyceria grandis*	*OBL*	80,000	4.7	3.2
Manna grass, fowl	*Glyceria striata*	*OBL*	160,000	4.7	1.6
Bluegrass, fowl	*Poa palustris*	*FACW+*	118,000	16.7	7.1
Sedge, bottlebrush	*Carex comosa*	*OBL*	30,000	2.2	4.3
Sedge, pointed- broom	*Carex scoparia*	*FACW*	84,000	1.5	1.0
Sedge, tussock	*Carex stricta*	*OBL*	53,000	0.8	0.8
Sedge, Common fox	*Carex stipata*	*OBL*	34,000	2.0	3.2
Sedge, fox	*Carex vulpinoidea*	*OBL*	100,000	5.9	3.2
Rush, slender	*Juncus tenuis*	*FAC*	1,000,000	11.0	0.2
Torry's Rush	*Juncus toryi*	*OBL*	1,600,000	5.9	0.6
Bulrush, green	*Scirpus atrovirens*	*OBL*	460,000	16.9	2.0
Wool grass	*Scirpus cyperinus*	*OBL*	1,700,000	6.2	0.2
Milkweed, marsh	*Asclepias incarnata*	*OBL*	4,800	0.4	5.0
Aster, swamp	*Aster puniceus*	*OBL*	80,000	5.9	4.0
Aster, flat-topped	*Aster umbellatus*	*FACW*	67,000	1.5	1.2
Joe-pye weed	*Eupatorium maculatum*	*OBL*	95,000	0.7	0.4
Boneset	*Eupatorium perfoliatum*	*FACW+*	160,000	1.2	0.4
Goldenrod, grass- leaved	*Euthamia graminifolia*	*FACW-*	350,000	1.0	0.2
Sneezeweed	*Helenium autumnale*	*FACW+*	130,000	0.8	0.3
Sunflower, serrated	*Helianthus grosseserratus*	*FACW-*	15,000	0.2	0.6
Lobelia, great-blue	*Lobelia siphilitica*	*FACW+*	500,000	2.9	0.3
Monkey flower	*Mimulus ringens*	*OBL*	2,300,000	6.8	0.2
Mint, mountain	*Pycnanthemum virginianum*	*FACW+*	220,000	1.3	0.3
Meadow-rue, purple	*Thalicturm dasycarpum*	*FACW*	11,000	0.1	0.4
Vervain, blue	*Verbena hastata*	*FACW+*	93,000	2.2	1.3
Alexanders, Golden	*Zizea aurea*	*FACW*	11,000	1.0	5.0

Recommended Rate: 5.0 (PLS lbs/acre)

SUMMARY

Mix Seeds Per Square Foot	Mix Seeds Per Square Yard	Mix Seeds Per Acre
121	1,093	5,290,320
% by wt. Grasses	**% by wt. Graminoids**	**% by wt. Forbs**
64.0	15.0	21.0
% by Seed Count Grasses	**% by Seed Count Graminoids**	**% by Seed Count Forbs**
32.1	43.2	24.7

Table B-3
WI Seed Mix 3 – Native Wet Prairie Mixture

Use: Wisconsin state-wide in unsaturated Wet Prairie wetland areas
Seeding Rate: See below summary.
Notes: *Enbridge Environment must approve* substitutions *in advance*

Common Name	Botanical Name	Indicator Status	Seeds/oz.	Seeds/ft^2	% of Mix
Bluestem, big	*Andropogon gerardi*	*FAC-*	10,000	3.7	15.3
Brome, fringed	*Bromus ciliata*	*FACW*	10,000	1.8	7.7
Blue-joint grass	*Calamagrostis canadensis*	*OBL*	280,000	6.2	0.9
Wild-rye, Virginia	*Elymus virginicus*	*FACW-*	4,200	2.0	19.9
Manna grass, reed	*Glyceria grandis*	*OBL*	80,000	2.9	1.5
Manna grass, fowl	*Glyceria striata*	*OBL*	160,000	3.5	0.9
Switchgrass	*Panicum virgatum*	*FAC+*	14,000	3.1	9.2
Bluegrass, fowl	*Poa palustris*	*FACW+*	118,000	9.6	3.0
Indian grass	*Sorghastrum nutans*	*FACU+*	12,000	2.0	6.7
Cord grass, prairie	*Spartina pecinata*	*FACW+*	6,600	1.1	6.9
Sedge, tussock	*Carex stricta*	*OBL*	53,000	0.7	0.5
Sedge, fox	*Carex vulpinoidea*	*OBL*	100,000	3.7	1.5
Bulrush, green	*Scirpus atrovirens*	*OBL*	460,000	7.7	0.7
Wool grass	*Scirpus cyperinus*	*OBL*	1,700,000	18.7	0.5
Anemone, Canada	*Anemone canadensis*	*FACW*	8,000	0.09	0.5
Milkweed, marsh	*Asclepias incarnata*	*OBL*	4,800	0.1	1.4
Aster, swamp	*Aster puniceus*	*OBL*	80,000	2.4	1.2
Aster, flat-topped	*Aster umbellatus*	*FACW*	67,000	1.5	0.9
Tic-trefoil, showy	*Desmodium canadense*	*FAC-*	5,500	0.8	6.1
Joe-pye weed	*Eupatorium maculatum*	*OBL*	95,000	1.7	0.8
Boneset	*Eupatorium perfoliatum*	*FACW+*	160,000	2.4	0.6
Goldenrod, grass- leaved	*Euthamia graminifolia*	*FACW-*	350,000	2.0	0.3
Sneezeweed	*Helenium autumnale*	*FACW+*	130,000	2.39	0.8
Sunflower, serrated	*Helianthus grosseserratus*	*FACW-*	15,000	0.3	0.7
Blazingstar, tall	*Liatris pycnostachya*	*FAC-*	11,000	0.1	0.5
Lobelia, great-blue	*Lobelia siphilitica*	*FACW+*	500,000	1.4	0.1
Monkey flower	*Mimulus ringens*	*OBL*	2,300,000	6.4	0.1
Mint, mountain	*Pycnanthemum virginianum*	*FACW+*	220,000	1.2	0.3
Vervain, blue	*Verbena hastate*	*FACW+*	93,000	1.0	0.5
Ironweed	*Veronia fasciculate*	*FACW*	24,000	0.1	0.3
Culver's root	*Veronicastrum virginicum*	*FAC*	800,000	8.8	0.5
Alexander's, golden	*Zizea aurea*	*FAC+*	11,000	2.4	9.2

Recommended Rate: 5.0 (PLS lbs/acre)

SUMMARY

Mix Seeds Per Square Foot	Mix Seeds Per Square Yard	Mix Seeds Per Acre
102	884	4,436,283
% by wt. Grasses	**% by wt. Graminoids**	**% by wt. Forbs**
72.0	3.0	24.0
% by Seed Count Grasses	**% by Seed Count Graminoids**	**% by Seed Count Forbs**
35.0	30.0	35.0

Table B-4
WI Seed Mix 4 - Waterbody Banks Seed Mix

Use: Wisconsin state-wide on waterbody banks
Seeding Rate: 8.255 pounds/acre PLS drilled or 16.510 pounds/acre PLS broadcast without the companion crop
Double the rate of the companion crop when broadcast seeding
Notes: *Enbridge Environment must approve s*ubstitutions *in advance*

Species: Preferred Varieties (if available)	Pounds/Acre PLS	Percent of Mix
American slough grass: Common	1.500	18.2
Blue-joint grass: Common	0.100	1.2
Reed manna grass: Common	0.200	2.4
Fowl manna grass: Common	0.100	1.2
Fowl bluegrass: Common	1.800	21.8
Rice cut-grass: Common	0.250	3.0
Annual ryegrass: Common	0.900	10.9
Tussock sedge: Common	0.100	1.2
Fox sedge: Common	0.300	3.6
Green bulrush: Common	0.100	1.2
Wool grass: Common	0.005	0.1
River bulrush: Common	0.250	3.0
Soft-stem bulrush: Common	0.100	1.2
March milkweed: Common	0.100	1.2
Flat-topped aster: Common	0.300	3.6
Joe-pye weed: Common	0.300	3.6
Boneset: Common	0.250	3.0
Sneezeweed: Common	0.250	3.0
Spotted touch-me-not: Common	0.100	1.2
Great blue lobelia: Common	0.100	1.2
Monkey flower: Common	0.100	1.2
Mountain mint: Common	0.100	1.2
Giant goldenrod: Common	0.250	3.0
Blue vervain: Common	0.350	4.2
Ironweed: Common	0.350	4.2
Total	**8.255**	**100.0**[1]
Companion Crop		
Slender wheatgrass: Adanac, Pryor, Revenue, Primar, First Strike	3.000	100.0
Total Seed	**11.255**	**100.0**[1]

[1] May not equal 100 percent due to rounding

APPENDIX B

SAMPLE MONITORING DATA FORMS

PLOT SAMPLING DATA FORM – EMERGENT WETLANDS Surveyors: __________________

Line 5 Project Post-Construction Wetland Monitoring

Plot ID: ___________________________________ Date:______________________ Monitoring Year: ___________

Species	Wetland Status	Native Species (Y/N)	Percent Cover
		Total Percent of Native Hydrophytes (FAC or wetter):	
		Total Percent Cover:	
		Relative Percent of Native Hydrophytes:	

Notes:

Photo Number(s):

MEANDER SURVEY DATA FORM Page _____ of _____

Line 5 Project Post-Construction Wetland Monitoring Surveyors: _______________

Wetland ID: ________________________________ Date:_____________________ Monitoring Year: ___________

Species	Abundance Code:

Symbol	Abundance Code	Description
A	Abundant	The dominant plants throughout the site
C	Common	Locally abundant or frequently encountered
O	Occasional	Occasionally encountered, or locally common but absent or infrequent across much of the site
U	Uncommon	Infrequently encountered
R	Rare	Very few plants seen

Primary Hydrology Indicators (circle all that apply):				**Secondary Hydrology Indicators**	
[A1] Surface Water	[B3] Drift Deposits	[B9] Stained Leaves	[C4] Reduced Fe+	[B6] Soil Cracks	[D1] Stunt/Stress
[A2] Water Table	[B4] Algal Mat/Crust	[B13] Aquatic Fauna	[C6] Fe+ Tilled Soil	[B10] Drainage Patterns	[D2] Geomorphic Position
[A3] Saturation	[B5] Iron Deposits	[B14] True Aquatic Plants	[C7] Thin Muck	[C2] Dry Season H_2O Table	[D5] FAC-Neutral
[B1] Water Marks	[B7] Aerial Inundation	[C1] H_2S Odor	[D9] Gauge/Well	[C8] Crayfish Burrows	
[B2] Sediment Deposits	[B8] Bare Concave Surface	[C3] Rhizospheres	Other:	[C9] Aerial Saturation	

Original Wetland Delineation Indicators:

Notes:
Photo Number(s):