



# Environmental Protection Plan

Enbridge Energy, Limited Partnership • Line 3 Replacement Project

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## **ACRONYMS AND ABBREVIATIONS**

ATWS	additional temporary workspace
BMP	best management practices
BWSR	Minnesota Board of Water & Soil Resources
CLL	Construction Line List
CRP	Conservation Reserve Program
DOT	Department of Transportation
ECD	erosion and sediment control device
EI	environmental inspector
EMCP	Environmental Monitor Control Plan
Enbridge	Enbridge Energy, Limited Partnership
EPP	Environmental Protection Plan
FdL	Fond du Lac Band of Lake Superior Chippewa
HDD	horizontal directional drilling
IEM	independent environmental monitors
L3R or Project	Line 3 Replacement Project
MDNR	Minnesota Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
OHWL	ordinary high water level
OHWM	ordinary high water mark
PHMSA	Pipeline and Hazardous Materials Safety Administration
pig	pipeline inspection gauge
PLS	Pure Live Seed
PWI	Public Water Inventory
ROW	right-of-way
SPCC	Spill Prevention, Containment, and Control
SWPPP	Stormwater Pollution Prevention Plan
TWS	temporary workspace
WQC	Section 401 Water Quality Certification

## INTRODUCTION

### CONTROLLING REQUIREMENTS FOR CONSTRUCTION AND OPERATION

This Environmental Protection Plan (“EPP”) prepared by Enbridge Energy, Limited Partnership (“Enbridge”) includes statements, policies, procedures, and protection measures regarding the construction of the proposed Line 3 Replacement Project (“Project” or “L3R”) in the states of Minnesota, North Dakota, and Wisconsin. This EPP was developed based on Enbridge’s experience implementing Best Management Practices (“BMPs”) during construction as well as the Federal Energy Regulatory Commission’s Upland Erosion Control, Revegetation, and Maintenance Plan (May 2013 Version) and Wetland and Waterbody Construction and Mitigation Procedures (May 2013 Version). The federal government, Tribal Nations, State of Minnesota, State of North Dakota, State of Wisconsin, and local governments will issue multiple regulatory permits and Clean Water Act Section 401 water quality certifications (“WQCs”) to Enbridge for construction and operation of the proposed Project. The EPP is a component of the Construction Environmental Control Plan developed to comply with the conditions of right-of-way (“ROW”) preparation, construction, cleanup, and restoration and to meet or exceed federal, Tribal, state, and local environmental protection and erosion control requirements, specifications, and practices. The EPP and the regulatory permits and WQCs must be read together; they do not exist separate from one another. There may be discrepancies between the content of the EPP and the requirements of the regulatory permits and WQCs. For any discrepancy, particularly regarding construction conditions, protection measures, and required notifications, the regulatory permits and WQCs are controlling and supersede EPP content.

If there are discrepancies between contract specifications and Project-specific permit conditions and/or landowner agreements, the more stringent condition will apply. Any doubt as to which condition is more stringent will be resolved by Enbridge.

This document includes the following sections:

- Section 1.0 describes general mitigation measures, including soil erosion and sedimentation control BMPs to be implemented during construction and restoration;
- Section 2.0 describes practices for stream and river construction, crossings, and restoration;
- Section 3.0 describes practices for wetland construction, crossings, and restoration;
- Section 4.0 describes highway, road, and rail crossings;
- Section 5.0 describes construction and hydrostatic testing dewatering;
- Section 6.0 outlines water appropriation practices;
- Section 7.0 addresses revegetation measures;
- Section 8.0 addresses winter construction issues;
- Section 9.0 addresses waste management issues;



- Section 10.0 addresses construction equipment-related spill prevention, containment, and controls; and
- Section 11.0 addresses containment, response, and notification procedures for inadvertent releases of drilling fluid.

Alternative construction procedures implemented in lieu of this EPP will provide an equal or greater level of protection to the environment and will be approved in writing by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing the activity.

Enbridge and its Contractors (collectively referred to as “Enbridge” unless otherwise noted) are responsible for implementing the requirements of this EPP.

Enbridge has developed an Environmental Monitor Control Plan (“EMCP”) to ensure that appropriate systems are in place to achieve compliance with the various permits and plans that have been developed for the Project during the construction phase. The EMCP includes:

- definitions of the roles and responsibilities of the personnel involved with implementing the various environmental requirements;
- the reporting structure and electronic system that will be employed to document compliance during construction; and
- a series of training events to communicate the environmental requirements to the construction personnel.

Enbridge will provide appropriate construction oversight to confirm and document compliance with the measures of this EPP and requirements of applicable federal, Tribal, state, and local permits. Enbridge’s Environmental Inspectors (“EIs”) will assist in interpreting and implementing the requirements of the EPP and verify compliance with these procedures for Enbridge. The roles and responsibilities of the EIs are described in more detail in Section 2.4 of the EMCP.

Enbridge has also committed to applicable agencies to fund a comprehensive third-party monitoring program to be deployed during Project construction. The roles and responsibilities of the independent environmental monitors (“IEMs”), including Tribal Monitors, are described in more detail in Section 3.0 of the EMCP.

## **1.0 GENERAL MITIGATION MEASURES**

### **1.1 IDENTIFICATION OF AVOIDANCE AREAS**

Prior to the commencement of clearing activities, civil survey crews will flag the boundaries of the construction workspace. In addition, Enbridge will post signs for the following environmental features so they can be easily identified by Project personnel and managed as described in applicable permit applications:

- wetland boundaries and waterbody crossing locations;
- drainages/drain tiles as identified by counties and landowners;
- hiking and hunter walking trails, snowmobile and all-terrain vehicle trails, winter access roads, canoe routes and water access sites, or other recreational areas as required by permit conditions;
- buffer zones for environmentally sensitive features, including archaeological and historic sites, bald eagle nests, rare plant or ecological communities, and other sensitive wildlife species and/or habitat per agency consultations (note that the signs will not disclose the specific location and/or species or feature type where federal, Tribal, or state laws require data protection);
- areas where typical construction sequence may be delayed due to permit restriction, such as timing restrictions or clearing restrictions (e.g., hydrotest water infiltration areas); and
- invasive and noxious species locations, including infested waters.<sup>1</sup>

Enbridge's Rare and Sensitive Environmental Resources Plan will include additional mitigation and conservation measures to be implemented near sensitive biological resources. Federally or state-listed species observations within the construction workspace will be reported to the appropriate agency(ies).

### **1.2 ALIGNMENT SHEETS, CONSTRUCTION LINE LIST AND PERMITS**

Enbridge will prepare detailed alignment sheets of the L3R construction ROW that will include specifications for ROW preparation, construction, cleanup, and restoration. The alignment sheets will depict the plan and profile of the construction ROW, tract (property) boundaries, and environmental features such as wetlands, waterbodies, and buffer zones for sensitive features as listed in Section 1.1. Notations will be included in the alignment sheets to direct the personnel to the appropriate environmental plans/or permit conditions that stipulate the activities, restrictions, and/or BMPs to be employed at each environmental feature.

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<sup>1</sup> Infested waters means waters of the state listed by the commissioner under Minnesota Statutes Sections [84D.03](#), [subdivision 1](#), and [84D.12](#).

In addition, Enbridge will prepare detailed Environmental Plan Sheets that accompany the Stormwater Pollution Prevention Plan (“SWPPP”) required under the Minnesota Pollution Control Agency (“MPCA”) National Pollutant Discharge Elimination System/State Disposal System Construction Stormwater General Permit (MNR100001). The Environmental Plan Sheets will identify the temporary and permanent erosion and sediment control and stabilization measures for the Project. Refer to the Soil Erosion and Sediment Control Plan (which incorporates SWPPP by reference) for additional information.

Enbridge will also maintain a Construction Line List (“CLL”) for each tract (property) that describes special requirements (e.g., clearing, timber salvage, topsoil segregation, restoration measures, herbicide use, fencing requirements) as agreed upon with landowners, provided the special requirements conform to Project permits.

The CLL identifies requirements and comments provided by landowners; however, it is not a comprehensive list of construction requirements. The CLL will be considered in conjunction with other Project documents and permits.

### **1.3 WET WEATHER SHUTDOWN**

During construction, certain activities may be suspended in wet soil conditions, based on consideration of the following factors:

- extent of surface ponding;
- potential for rutting and mixing of soil horizons;
- extent and location of potential rutting and compaction (i.e., can traffic be rerouted around wet area); and
- type of equipment and nature of the construction operations proposed for that day.

Enbridge will cease work in the applicable area until Enbridge determines that site conditions are such that work may continue. Enbridge Construction Management, in collaboration with Enbridge Environment, will ultimately decide if wet weather shutdown is necessary in a given location in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Refer to Section 1.18 for a discussion of the measures to alleviate soil compaction.

Enbridge will monitor upcoming weather forecasts to determine if significant rainfall is anticipated during construction. Enbridge will be responsible for appropriately planning work, considering the potential for wet conditions, and being prepared to implement mitigation measures in the event of wet weather conditions and/or excessive waterflow. Enbridge will be responsible for implementing any and all such corrective measures deemed necessary should conditions subsequently worsen where the above described criteria cannot be met.

### **1.4 RIGHT-OF-WAY ACCESS**

Enbridge will utilize the following three main types of travel corridors to obtain access to the construction workspace:



- Haul Routes: Existing public roads will typically be used as haul routes, which are used to deliver equipment and materials to the workspace during construction.
- Access Roads: Access roads to the construction workspace may be private or public roads along existing roads or trails, or they may be new greenfield roads on private or public land that are constructed for the purpose of the Project.
- Shoo-flies: In some cases, Enbridge proposes to construct a “shoo-fly,” which is a short detour off the main access road or construction workspace used to avoid impacts to sensitive features, such as wetlands.

Enbridge will maintain existing roads, improve existing trails or roads, or build new roads as needed and as approved through applicable permits and leases, and as described in the Summary of Construction Methods and Procedures (Appendix A). Gravel will only be added to maintain existing roads that have an existing gravel road base, or to develop permanent access roads, if needed. If gravel is installed on a road that is not permanently maintained for the Project, it will be removed and the area will be restored to pre-construction conditions following construction.

Enbridge is responsible for posting signs or other methods to identify approved haul routes and access roads in the field and to ensure that access is confined to only the approved roads. Vehicle tracking of soil from construction sites will be minimized by implementation of BMPs such as installing rock access pads or construction mats, reducing equipment/vehicle access to the construction workspace where practicable (off-ROW parking), or equivalent. Installation of rock or construction mat access pads will be in accordance with applicable permits and federal, Tribal, and/or state specifications. Construction mat tracking pads or rock on top of geotextile fabric will be utilized in wetlands and will be removed after construction. Typical drawings for rock and construction mat approaches are provided in Figures 1 and 2. If such BMPs are not adequately preventing sediment from being tracked onto paved public roads, self-contained street sweeping, or other equivalent means of collecting sediment, will be used. If soil is tracked onto a paved roadway, Enbridge will remove accumulated material from the road and return it to the construction workspace within an upland area as soon as possible, but in no circumstances more than 24 hours after discovery. In addition, soil on paved roadways cannot be broomed, washed, and/or graded into the road ditch or onto the shoulder.

After construction, Enbridge will return improved roads to their pre-construction condition unless the road authority, landowner, or land-managing agency requests that the improvements be left in place. No temporary infrastructure in wetlands or waterbodies (e.g., bridges, construction mats) will be permanently left in place without the appropriate regulatory permits, authorizations, and certifications. Enbridge will maintain permanent access roads to aboveground facilities (e.g., pump stations, mainline valves) throughout Project operation.

#### **1.4.1 Bridges and Culverts**

Generally, the bridges and culverts associated with existing roads will be sufficient to allow the passage of construction equipment and vehicles. However, in some cases, improvements to existing infrastructure may be required, or new bridges or culverts may be installed as described in Section 2.4.2 of the Summary of Construction Methods and Procedures (Appendix A). Figures 3 and 4 provide typical drawings of the bridge types that may be implemented on the Project; Figure 1 illustrates a rock flume/culvert that may be used at road approaches. Ice

bridges are described in Enbridge's Winter Construction Plan. Enbridge will obtain the appropriate permits for new and improved infrastructure, as required, and will comply with the conditions associated with those permits, including in-stream timing restrictions for any work proposed within the ordinary high water mark ("OHWM") (refer to Section 2.1). Refer to Section 2.4.2 for additional discussion on bridge and culvert design and maintenance.

## **1.5 RIGHT-OF-WAY REQUIREMENTS**

All construction equipment and vehicles will be confined to the approved construction workspace and additional temporary workspace ("ATWS"), except where landowners or land managing agencies have given permission for construction dewatering activities outside of the construction workspace (see Section 5.0).

The width of the construction workspace for the Project will vary and is co-located with Enbridge's existing corridor, third-party (foreign) utilities, roads, railroads, or highways along the majority of the route. The construction workspace is inclusive of the permanent ROW, permitted temporary workspace ("TWS"), and site-specific extra workspaces (referred to as ATWS) as defined below and shown in Figure 5. The construction workspace width will be reduced (i.e., necked down) in selected locations (e.g., wetlands, waterbodies, in/near sensitive features), as indicated on the Project construction alignment sheets and in the field by the use of staking. The typical TWS and permanent ROW dimensions are described in Section 2.3 of the Summary of Construction Methods and Procedures (Appendix A).

### **(a) ROW (Permanent)**

The new permanent ROW will be located entirely within the construction workspace and is co-located with Enbridge's existing corridor along portions of the route. The permanent ROW is the legally acquired land that is used to install, maintain, operate, and access the pipeline system. The permanent ROW is maintained to facilitate access and aerial inspection of the pipeline system in accordance with U.S. Department of Transportation ("DOT") regulations.

### **(b) TWS**

Construction will require TWS to install the pipeline, which will be located adjacent to and contiguous with the permanent ROW.

### **(c) ATWS**

Site-specific ATWS locations (construction work areas beyond the permanent ROW and TWS previously described) will be required at select locations such as steep slopes; road, waterbody, railroad, and some wetland crossings; and, where it is necessary to cross under existing pipelines or foreign utilities. ATWS will typically be located in uplands adjacent to the construction workspace and set back at least 50 feet from sensitive resource boundaries where site-specific field conditions allow. However, to complete work safely, Enbridge may need to locate ATWS within a wetland or within the 50-foot setback from a wetland or waterbody based on site-specific conditions. ATWS adjacent to waterbodies and/or wetlands is addressed further in Sections 2.0 and 3.0, respectively.

## **1.6 MANAGEMENT OF UNDESIRABLE SPECIES**

It is Enbridge's intent to minimize the potential for introduction and/or spread of undesirable species (i.e., invasive or noxious species) along the construction workspace due to pipeline construction activities. However, it is not practicable for Enbridge to eradicate undesirable species that are adjacent to the construction workspace as Enbridge is restricted by its permits and authorizations to the limits of the construction workspace, as described in Section 1.5. Enbridge will minimize the potential for the establishment of undesirable species by minimizing the time duration between final grading and permanent seeding (refer to Section 3.9.1). The measures that Enbridge will implement to avoid the introduction and control the spread of terrestrial and aquatic invasive and noxious species are described in more detail in Enbridge's Invasive and Noxious Species Management Plan provided in Appendix B.

## **1.7 POTHOLING/HYDROVAC SLURRY**

Appropriate safety measures will be implemented before excavation begins, including notification through the One-Call system to ensure third-party utilities and adjacent pipelines are properly marked. Four-way sweeps<sup>2</sup> will also be conducted to positively locate any existing underground utilities.

Potholing is the act of using pressurized water to excavate the soil over pipelines and utilities identified through the One-Call and four-way sweep process. Hydrovac slurry is made up of clean water and subsoil excavated from the area over the utility to positively identify the utility lines and prevent line strike during construction. Enbridge will construct an unlined but bermed containment area or identify comparable containment (e.g., open-top tank) to hold the hydrovac slurry in an Enbridge- and landowner-approved upland area within the construction workspace or dispose of the material at an approved off-site location. The containment area/structure will be sized appropriately to contain the amount of hydrovac slurry material to be generated at that site. Once the slurry is drained and dry, it may be incorporated with the subsoil in an Enbridge- and landowner-approved upland area within the construction workspace in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Discharging hydrovac slurry onto topsoil is not permitted as the material will degrade the quality of the topsoil and potentially affect revegetation. Once construction activities are complete, the potholes will be backfilled, graded, and restored as described in Sections 1.15, 1.16, and 7.0.

## **1.8 UPLAND CLEARING**

The initial stage of construction involves the clearing of brush, trees, and tall herbaceous vegetation from the construction workspace. Clearing may be accomplished with chain saws, mowers, and hydraulic tree-cutting equipment. Clearing over HDD paths will be limited to the 30-foot-wide construction workspace.

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<sup>2</sup> A four-way sweep is a method of locating underground utilities that involves scanning the ground with electromagnetic induction or ground-penetrating radar equipment to detect the presence of buried features; it does not involve digging or other ground-disturbing activities. The term "four-way sweep" comes from the fact that an area typically is scanned (or swept) in at least four directions.



### **1.8.1 Disposal of Non-Merchantable Timber**

Unless otherwise directed by Enbridge, non-merchantable timber and slash will be disposed of by mowing, chipping, grinding, and/or hauling off-site to an approved location or used in stabilizing erodible slopes or construction entrances. In non-agricultural, non-wetland areas, chips, mulch, or mechanically cut woody debris (slash or brush less than 1.5-inch diameter and/or 12 inches in length) may be uniformly broadcast across the construction workspace (less than 1-inch thickness) where the material will ultimately be incorporated into the topsoil layer during grading activities, with landowner approval (coordinated through Enbridge Lands agents). Chips, mulch, or mechanically cut woody debris shall not be stockpiled in a wetland (except in peatlands as described in Section 7.7.3). Non-merchantable timber shall not be disposed of by placing it off the construction workspace.

Burning of non-merchantable wood may be allowed only where the applicable permits and approvals (e.g., agency, Tribal, and landowner) have been acquired and in accordance with all Tribal, state, and local regulations. Burning is not allowed in wetlands. Burning within 100 feet of a wetland or waterbody is prohibited without site-specific approval in advance from an EI and in accordance with applicable permits and/or approvals.

### **1.8.2 Disposal of Merchantable Timber**

All merchantable timber will be managed in accordance with Enbridge contract specifications and applicable permits and licenses.

### **1.8.3 Upland Grading and Stump Removal**

Stumps in the ditch line will be completely removed, ground, and/or hauled off-site to an approved location. Tree stumps outside the ditch line will be ground below normal ground surface to facilitate a safe work area and to allow topsoil removal, if necessary. In some circumstances, tree stumps outside the ditch line may be completely removed to allow for a safe work area and hauled off-site to an approved location. No grading or stump removal will occur along HDD paths except at limited locations where free-span engineered bridges will be installed. Bridge headers will be set back 10 feet from the top of bank and some limited grading may be required to allow for the safe installation of the bridge.

## **1.9 TEMPORARY EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES**

Temporary Best Management Practices ("BMPs") to minimize erosion and control sediment, also referred to erosion control devices ("ECDs"), include but are not limited to sediment barriers (silt fence, certified weed-free straw or hay bales,<sup>3</sup> bio-logs, etc.), filter socks (refer to Figures 6 through 9), mulch (Section 1.9.2), slope breakers (Section 1.9.4), and revegetation subsequent to seeding of exposed soils (Section 7.0).

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<sup>3</sup> Minnesota Department of Transportation 3882 Type 3 specifications: <http://www.dot.state.mn.us/pre-letting/spec/2018/2018-spec-book-final.pdf>.

Enbridge will maintain erosion and sediment control BMPs as required in the Project construction documents and as required by all applicable permits, including SWPPPs. Enbridge requires inspections of temporary ECDs at least once every 7 calendar days and within 24 hours after a rainfall event of 0.5 inch or greater. A “rainfall event” is the total amount of rainfall recorded in any continuous 24-hour period. Non-functional ECDs will be repaired, replaced, or supplemented with functional materials within 24 hours after discovery, or as otherwise specified in project permits. ECDs will be installed after initial clearing but before grading activities, and as site and seasonal conditions warrant the installation of additional erosion and sediment control BMPs during construction activities. Installation of permanent erosion and sediment control BMPs is discussed in Section 1.17.

Temporary ECDs will be installed prior to ground disturbing activities at the base of sloped approaches to streams, wetlands, water conveyances (e.g., ditches, swales) and roads. Temporary ECDs will also be installed at the edge of the construction workspace as needed, and/or in other areas determined by the EI to slow water leaving the site and prevent siltation of waterbodies and wetlands down slope or outside of the construction workspace (e.g., swales and side slopes). Temporary ECDs will be placed across the entire construction workspace at the base of slopes greater than 3 percent and at site-specific locations identified in the SWPPP until the area is revegetated and there is no potential scouring of, or sediment transport to surface waters. Adequate room will be available between the base of the slope and the sediment barrier to accommodate ponding of water and sediment deposition.

If silt fence is used, when the depth of sediment reaches about one-third of the height, the sediment will be removed. Non-functional ECDs will be repaired, replaced, or supplemented with functional structures within 24 hours after discovery, or as otherwise specified in Project permits.

Temporary ECDs installed across the travel lane may be removed during active daytime construction; however, ECDs will be properly reinstalled after equipment passage, or activities in the area are completed for the day. These ECDs will also be repaired and/or replaced prior to inclement weather when forecasted. Enbridge is responsible for monitoring weather conditions and adjusting resources as needed to address pending and/or existing weather conditions.

Additional erosion and sediment control BMPs may be installed as exclusionary fencing to protect other sensitive features, such as state-listed flora species or archaeological, cultural, or historic sites. These measures will be described in the applicable permit conditions and resource protection plans, such as the Rare and Sensitive Environmental Resource Plan.

### **1.9.1 Temporary Stabilization**

Stabilization<sup>4</sup> of all exposed areas, including spoil piles, must be initiated immediately<sup>5</sup> to limit soil erosion when construction activity has permanently or temporarily ceased on any portion of

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<sup>4</sup> Stabilization means that the exposed ground surface has been covered by appropriate materials such as mulch, staked sod, riprap, erosion control blanket, mats or other material that prevents erosion from occurring. Grass seeding, agricultural crop seeding or other seeding alone is not stabilization. Mulch materials must achieve approximately 90 percent ground coverage (Minnesota Rules 7090).

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.

In areas within 1 mile of, and draining to, a special or impaired water (refer to Section 2.2.2), stabilization measures will be initiated immediately and completed within 7 calendar days whenever construction activity has permanently or temporarily ceased on any portion of the site. Areas of the Project where this timing restriction applies will be clearly defined on the Environmental Plan Sheets accompanying the SWPPP.

On portions of the Project where work will be occurring during applicable “work in water restrictions” for Public Waters (refer to Section 2.1), all exposed soil areas within 200 feet of the water’s edge, and that drain to that water, will be stabilized within 24 hours during the restriction period. These areas will be identified on the Environmental Plan Sheets accompanying the SWPPP.

Enbridge may require that temporary stabilization materials be installed sooner based on site conditions, or as required in Project permits.

### **1.9.2 Mulch**

Mulch (certified weed-free hay or straw,<sup>5</sup> wood fiber hydromulch, or a functional equivalent) will be applied to disturbed areas (except for actively cultivated land and most wetlands) if requested by the landowner or land managing agency, if specified by the applicable permits or licenses, or as required by Enbridge. Mulch will specifically be required on:

- slopes greater than 5 percent; and
- dry, sandy areas that can blow or wash away (field decision).

Only certified weed-free mulch will be utilized on this Project. Sources will be approved by Enbridge prior to purchase.

Mulch will be applied to cover at least 90 percent of the ground surface unless otherwise stipulated by permit conditions. Mulch will be uniformly distributed by a mechanical mulch blower, or by hand in areas not accessible to the mulch blower. Strands of mulch shall be sized to allow proper anchoring. Mulch will be anchored/crimped using a mulch-anchoring tool or disc set in the straight position to minimize loss by wind and water, as site conditions allow and as approved by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. In areas not accessible to a mulch-anchoring tool or too steep for safe operation, the mulch may be anchored by liquid tackifiers with advance written approval from Enbridge. The manufacturer’s recommended method and rate of application will be followed.

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<sup>5</sup> Initiated immediately means taking an action to commence soil stabilization as soon as practicable, but no later than the end of the work day, following the day when the land-disturbing activities temporarily or permanently cease (Minnesota Rules 7090).

<sup>6</sup> Minnesota Department of Transportation 3882 Type 3 specifications: <http://www.dot.state.mn.us/pre-letting/spec/2018/2018-spec-book-final.pdf>.

Hydro-mulch and liquid tackifier can be used in place of certified weed-free straw or hay mulch with prior approval from Enbridge. All hydromulch and liquid tackifier products used will be on the applicable state DOT product list. Hydro-mulch and liquid tackifier products containing plastic/polypropylene fiber additives and Malachite Green (colorant) will not be utilized on this Project. Application rates will be at the manufacturer's recommended rate.

### 1.9.3 Cat Tracking

Cat tracking, also known as horizontal slope grading, may be implemented based on site conditions (sandy or silt soils) to reduce erosion potential. Cat tracking is achieved by driving a bulldozer vertically up and down the slope which results in the tracks being oriented horizontally; creating small speed bumps for water (refer to Figure 10).

### 1.9.4 Temporary Slope Breakers

Temporary slope breakers will be installed to minimize concentrated or sheet flow runoff in disturbed areas in accordance with the following maximum allowable spacing unless otherwise specified in permit conditions.

<u>Slope (%)</u>	<u>Approximate Spacing (ft)</u>
3-5	250
5-15	200
15-25	150
>25	<100

If the length of the slope is less than the distance of the required spacing, slope breakers are not required unless a sensitive resource area (e.g., wetland or public roadway) is located immediately down slope, or as determined to be needed by the EI. Temporary slope breakers may be constructed using earthen subsoil material, silt fence, certified weed-free straw or hay bales, or in non-agricultural land, rocked trenches may be used. On highly erodible slopes, slope breakers in the form of earthen berms will be used whenever possible.

Temporary slope breakers will be constructed according to the following specifications (refer to Figure 11):

- certified weed-free straw or hay bales used as slope breakers will be trenched in and staked so as to not allow spacing between bales or allow flow underneath the bales;
- the outfall of temporary slope breakers will be directed off the construction workspace into a stable well-vegetated upland area or into an appropriate energy-dissipating sediment control device (e.g., filter sock, silt fence, straw bales, rock aprons, sumps) to prevent the discharge of sediments (refer to Figure 11);
- proper slope breaker outfalls will be established where topsoil segregation and/or grading has created a barrier at the edge of the construction workspace; and
- gaps will be created through spoil piles where necessary to allow proper out-letting of temporary berms.

## **1.10 TOPSOIL SEGREGATION AND STORAGE**

Areas where topsoil will be stripped includes cropland, hay fields, pasture, residential areas, and other areas as requested by the landowner or as specified in the Project plans, commitments, and/or permits.

### **1.10.1 Topsoil Segregation Methods**

The following topsoil segregation methods may be employed during construction:

- Full Construction Workspace (refer to Figures 12 and 13)
- Trench-Line-Only (refer to Figures 14 and 15)
- Modified Ditch-Plus-Spoil Side (refer to Figures 16 and 17)

The Full Construction Workspace topsoil segregation technique will typically be used in agricultural areas, including active cropland, pasture, and hayfields, and will consist of stripping topsoil from the spoil storage area, ditch line, and the primary travel lane.

The Trench-Line-Only topsoil segregation method will be used in wetlands, forested vegetation communities, and where requested by the landowner or land-managing agencies. Topsoil is not typically segregated in standing water wetlands unless specifically requested by the landowner or managing land agency in accordance with applicable permit conditions.

Alternative topsoil segregation methods may be used on a site-specific basis or as requested by the landowner or land-managing agency.

### **1.10.2 Topsoil Storage**

Gaps will be left and erosion and sediment control BMPs installed where stockpiled topsoil and spoil piles intersect with water conveyances (i.e., ditches, swales, and waterways) to maintain natural drainage. A minimum 1 foot of separation will be maintained between the topsoil and subsoil/spoil piles to prevent mixing. Where the 1-foot separation cannot be maintained, the EI may approve the use of a physical barrier on a site-specific basis, such as a thick layer of mulch or silt fence, between the spoil and topsoil piles to prevent mixing.

### **1.10.3 Depth of Upland Topsoil Stripping**

In deep soils (more than 12 inches of topsoil), topsoil will be stripped to a minimum depth of 12 inches, unless otherwise specified/requested by other plans, permit conditions, or the landowner. If less than 12 inches of topsoil are present, Enbridge will attempt to segregate to the depth that is present. In the Red River Valley, Enbridge will strip topsoil in accordance with the Agricultural Protection Plan.

## **1.11 UPLAND TRENCHING**

Trenching in uplands is typically accomplished with a backhoe excavator or a rotary wheel ditching machine. The trench will be excavated to a depth that complies with the minimum depth of cover requirements described in the Summary of Construction Methods and Procedures (Appendix A) (Figure 18). Enbridge may implement additional depth of cover in upland areas adjacent to waterbodies where requested by the Minnesota Department of Natural Resources

("MDNR"); the extent of these areas will be depicted on the Alignment Sheets. Following installation of the pipeline, Enbridge will confirm that the pipe depth meets federal and state requirements through civil survey.

Excavated material will be side cast (stockpiled) within the approved construction workspace separate from topsoil and stored such that the area subject to erosion is minimized. Enbridge will coordinate with landowners to minimize disruption of access caused by the trench during construction. Where deemed appropriate, Enbridge will leave plugs of subsoil in the ditch or will construct temporary access bridges across the trench for the landowner to move livestock or equipment; temporary bridges may also be utilized by wildlife. Where trenches are left open overnight, trenches will also be sloped (less than 45 degrees) where started and ended to allow wildlife egress. Spacing of plugs and ramps will be determined in the field. Enbridge will inspect the trench and construction area for presence of animals every day before initiating construction activities and prior to backfilling the trench. If an animal is located, it will be relocated outside of the active construction workspace. If the animal is a federally or state-listed species, the appropriate agency(ies) will be notified. In the event that a large mammal such as a deer, moose, or bear becomes entrapped in the trench, Enbridge will contact the IEM to coordinate with the appropriate agencies.

In areas with shallow bedrock, blasting may be required to excavate the trench. Enbridge will follow the procedures outlined in its Blasting Plan wherever blasting may be required.

### **1.11.1 Timing**

The length of time a trench is left open will be minimized to ensure that installation of the pipe and restoration of the construction workspace occurs in a timely fashion. Generally, Enbridge will minimize the length of trench and amount of time that the trench is left open in wetter conditions to minimize water-management issues (e.g., construction dewatering) associated with high groundwater tables or precipitation events. Therefore, unless otherwise specified by regulatory permits or WQCs issued for this Project's construction, Enbridge will limit the amount of excavated open trench to a maximum of 3 days or 3 miles of anticipated welding production per spread. This timeframe or length may be decreased at the discretion of Enbridge based on field conditions including topography, soils, weather conditions, hydrology, presence of sensitive resources, and the construction technique being utilized.

## **1.12 TRENCH PILLOW INSTALLATION**

Pillows are placed under and around the pipe where needed to take stress off the pipe as a result of incidental variabilities in trench depth, or to protect the pipe coating in rocky conditions. For this same reason, the trench pillows are left in the trench. Enbridge will install pillows composed of closed cell polyurethane foam within the external boundaries of the Fond du Lac Band of Lake Superior Chippewa ("FdL") Reservation in Minnesota. Outside of the FdL Reservation, Enbridge will utilize sand bags. Foam pillows are rectangular blocks measuring approximately 3 feet by 2 feet. The foam components are mixed either at an off-site location or on-site on a protective sheet of plastic in an upland area to create the foam pillows. Cured foam pillows are then transported to the construction site for installation within the trench or the foam is applied directly into the trench line. Sand bags will be filled with clean rock-free subsoil or sand; topsoil will not be used to construct trench pillows.

### **1.13 TRENCH BREAKERS**

Trench breakers are installed in sloped areas after the pipe has been lowered into the trench to protect against subsurface water flow along the pipe after the trench is backfilled. Enbridge will install trench breakers composed of closed cell polyurethane foam within the external boundaries of the FdL Reservation in Minnesota. Outside of the FdL Reservation, Enbridge will utilize sand bags. Sand bag trench breakers will be constructed with bags filled with clean rock-free subsoil or sand. Topsoil will not be used to construct sand bag trench breakers. The foam trench breakers will only be used under dry conditions where no groundwater is present, or where the trench has been effectively dewatered. Enbridge will not backfill the trench until foam is completely cured (i.e., finished foam).

Trench breakers will be placed from the bottom of the trench to near the top of the trench, completely surrounding the pipe and will be properly keyed into the undisturbed trench walls (refer to Figure 19). The location of trench breakers will be selected based on field conditions at the time of construction and will consider the degree and length of slope, presence of down-slope sensitive resource areas such as wetland and waterbodies, and proximity to other features such as roads and/or railroads. The following conditions apply to the placement and installation of trench breakers unless otherwise directed by Enbridge:

- Trench breakers will be installed on slopes greater than 5 percent adjacent to streams, wetlands, or other waterbodies.
- Where the pipeline exits a wetland towards areas of lower relief, trench breakers will be installed (within the upland) where there is a potential for underground drainage along the pipe in order to prevent wetland or waterbody drainage.
- At all waterbody crossings, as necessary, to prevent diversion of water into upland portions of the pipeline trench and to keep accumulated trench water out of the waterbody.

The general location of trench breakers will be identified on construction alignment sheets with a note to "Field Verify," the precise location through coordination between Enbridge's EIs, Enbridge's Craft Inspectors, and the Contractor's Foreman. The trench breaker may be moved short distances in either direction from the location identified on the construction alignment sheets to more stable soils, or to avoid other site-specific conditions. Additional trench breakers may also be added depending on site-specific conditions. Enbridge will require Contractors to have additional materials on hand to install additional trench breakers as needed. The pipe will then be marked with paint near the location that the trench breaker is needed to alert the trench operators to key the banks for breaker placement.

### **1.14 DRAIN TILE INLET PROTECTION AND TILE REPAIRS**

Enbridge will attempt to locate existing drain tile inlets that are located near the construction work area prior to construction. Drain tile inlets will be marked using flags. Enbridge will protect located drain tile inlets with the potential to receive stormwater from construction of the Project using the appropriate erosion and sediment control BMPs until sources with the potential to discharge have been stabilized. The determination of the specific erosion and sediment control BMP will be made based on the location of an inlet with respect to the Project area, drainage area from the construction workspace to the inlet, topography, vegetation, soils, and

accessibility to the inlet. Where drain tile inlets are located off of Enbridge's construction workspace, Enbridge may not have authorization to install erosion and sediment control BMPs at the inlet site. In these cases, sediment control measures (typically silt fence) will be installed along the edge of the construction workspace that drains to the inlet structure to minimize sedimentation.

If underground drain tile is damaged by pipeline construction, it will be repaired in a manner that assures proper tile line operation at the point of repair in accordance with the Agricultural Protection Plan.

## **1.15 UPLAND BACKFILLING**

Backfilling follows pipe installation and consists of replacing the material excavated from the trench. Prior to backfilling, the trench will be dewatered in accordance with the methods discussed in Section 5.0 if water obscures the trench bottom, except during implementation of the push-pull technique (Section 3.7.1) or other site-specific conditions.

## **1.16 CLEANUP AND ROUGH/FINAL GRADING**

All waste materials, including litter generated by construction crews, will be disposed of daily. Initial cleanup and rough grading activities may take place simultaneously. Cleanup involves removing construction debris (including litter generated by construction crews and excess rock) and large woody debris (greater than 1.5-inch-diameter and/or 12 inches in length) and repairing/replacing fences or other infrastructure removed or damaged during construction as agreed upon with the landowner or land-managing agency.

Rough grading includes restoring disturbed subsoil to as near as practicable to pre-construction conditions and decompacting subsoil (where applicable) (Section 1.18). Final grading includes returning the topsoil where topsoil has been stripped and final contouring to near as practicable to pre-construction conditions. Enbridge will backfill the trench to an elevation similar to the adjacent area outside the ditch line and will add a slight crown of approximately 3 to 6 inches (depending on soil type) over the backfilled trench to allow for subsidence. Generally, excess subsoil displaced by the pipe installation will be spread across the portion of the construction workspace where topsoil removal has occurred (see Section 1.10). Any remaining excess subsoil will be removed and disposed of at an approved off-site location as needed to ensure contours are restored to as near as practicable to pre-construction conditions. Periodic breaks in the crown will be implemented to allow for normal hydrologic flow across the backfilled trench. Crowning will not extend beyond the previously excavated trench limits. As the backfill material settles, there is potential that the original crown may not completely recede to pre-construction contours. Additional (final) grading may occur when conditions allow to ensure the disturbed area has been returned to pre-construction conditions. Enbridge will then prepare the seedbed (Section 7.1.1) and install or repair erosion control measures (Sections 1.9 and 1.17).

### **1.16.1 Timing**

Enbridge will begin cleanup and rough grading (including installation of temporary erosion and sediment control BMPs) as soon as practicable, but not later than the end of the following workday after backfilling the trench (refer to Section 1.9.1 for temporary stabilization timing requirements). Enbridge will attempt to complete this rough cleanup within 1 week. Enbridge will initiate final grading, topsoil replacement, seeding, and installation of permanent erosion and



sediment control BMPs as described in Section 7.0. If seasonal or other weather conditions prevent compliance with these timeframes, temporary erosion and sediment control BMPs will be maintained until conditions allow completion of cleanup.

## 1.17 PERMANENT EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES

During final grading, slopes in areas other than cropland will be stabilized with erosion and sediment control BMPs (i.e., ECDs). With exception for actively cultivated areas, permanent berms (diversion dikes or slope breakers) will be installed on all slopes, according to the following maximum spacing requirements unless otherwise specified in permit conditions (Figure 20):

<u>Slope (%)</u>	<u>Approximate Spacing (ft)</u>
5	250
>5-15	200
15-25	150
>25	<100

Permanent berms will be constructed according to the following specifications:

- Permanent berms will be installed with a 2 to 4 percent out slope.
- Permanent berms will be constructed of compacted earth, stone, or functional equivalent as approved in advance by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity.
- The outfall of berms will divert surface water flow to a stable area, or in the absence of a stable area, to appropriate energy-dissipating devices. Berms will be extended slightly beyond the edge of the construction workspace if possible.
- Permanent berms will be inspected and repaired as deemed necessary by Enbridge to maintain function and prevent erosion.

### 1.17.1 Erosion Control Blanket

The appropriate class of erosion control blanket will be installed in accordance with manufacture recommendations and/or state DOT specifications on slopes greater than 33 percent that drain to surface waters (refer to Figure 21), and at other locations based on site-specific conditions. Installation of erosion control blankets and additional erosion and sediment control BMPs may occur after first snowfall depending on construction progress, seasonal weather, and site conditions. Erosion control blankets will be installed running parallel (up and down) with the direction of the slope (not perpendicular).

## 1.18 SOIL COMPACTION TREATMENT

Decompaction efforts typically occur in agricultural lands. To alleviate soil compaction, Enbridge will decompact the area prior to topsoil replacement with a deep tillage device or chisel plow if agreed to by the landowner or land-managing agency. Soil conditions must be dry enough to

shatter the compacted soil between the points of a subsoiler or chisel plow to lower the bulk density of soil and reduce compaction. Soil at the compacted depth must not be wet and plastic at the time of tilling, otherwise it will not reduce compaction. If subsequent construction and cleanup activities result in further compaction, the measures described above will be completed a second time to alleviate the soil compaction. Additional details on soil decompaction in agricultural areas is described in Enbridge's Agricultural Protection Plan.

### **1.19 STONE REMOVAL**

After soil decompaction, a diligent effort will be made to remove excess stones equal to or larger than 4 inches in diameter and other debris brought to the surface from decompaction efforts or as specified in permit conditions, contract documents, or landowner agreements. After the topsoil is replaced, stone removal efforts will cease when the size and density of stones on the construction workspace are similar to undisturbed areas adjacent to the construction workspace as determined by the EI. Excess rock will be piled in upland areas where landowner permission has been obtained or will be hauled off-site to an Enbridge approved disposal location.

### **1.20 REPAIR OF DAMAGED CONSERVATION PRACTICES**

Enbridge will restore all soil conservation practices (such as terraces, grassed waterways, etc.) that are damaged by the pipeline construction to pre-construction conditions to the extent practicable.

### **1.21 LAND LEVELING FOLLOWING CONSTRUCTION**

Following the completion of the pipeline, the construction workspace will be restored to its pre-construction conditions as practical. Should uneven settling or documented surface drainage problems occur following the completion of pipeline construction and restoration, Enbridge will take appropriate steps to remedy the issue.

Additional monitoring and corrective measures for wetlands and waterbodies are described in Enbridge's Post-Construction Monitoring Plan.

### **1.22 OFF-ROAD VEHICLES**

To reduce the potential for members of the public to access public lands with off-road vehicles or other recreational equipment along the cleared permanent ROW, Enbridge will incorporate barriers to restrict access within the operational ROW as practicable where requested and approved by the land-managing agency, and where these barriers will not restrict or impede access for maintenance and emergency response activities. The type of barrier will be selected in consultation with the landowner and/or land-managing agency.

## 2.0 STREAM AND RIVER CROSSING GENERAL REQUIREMENTS

The procedures in this section apply to streams, rivers, and other waterbodies such as jurisdictional ditches, ponds, basins, and lakes. These procedures require that judgment be applied in the field and will be implemented under the supervision of Enbridge.

Stream crossing requirements, including construction methods, timing, erosion and sediment control BMP usage, and restoration are described in this section and in the stream crossing permits, licenses, and certifications issued by state and federal agencies and by Tribal authorities (as applicable). Requests to change the proposed crossing method will follow the process outlined in Section 6.0 of the EMCP. Written approval from Enbridge must be obtained prior to implementing an alternative crossing method.

Enbridge will monitor upcoming weather forecasts to determine if significant rainfall is anticipated during construction.

### 2.1 TIME WINDOW FOR CONSTRUCTION

All in-stream work activities (installation of dams, sheet piling, etc.) will be minimized to the extent practicable on an area and time duration basis. In-stream trenching will be conducted during periods permitted by the appropriate regulatory agencies and applicable permits and certifications.

Enbridge will adhere to the following work-exclusion dates for Minnesota Public Water Inventory ("PWI") cool- and warm-water fisheries that require in-channel work<sup>7</sup>, or will seek a waiver with the MDNR:

- Region 1 (Northwest) Non-Trout Streams: March 15 – June 30;
- Region 1 Lakes: March 15 – June 30; and
- Region 2 (Northeast) Non-Trout Stream and Lakes: March 15 – June 30.

In addition, Enbridge will adhere to the following work-exclusion dates in designated Minnesota trout streams and their designated tributaries that require in-channel work<sup>7</sup> to allow for spawning and migration, or will seek a waiver with the MDNR:

- Region 1 (Northwest): September 1 – June 30;
- Region 2 (Northeast): September 15 – June 30; and
- Region 2 within the Lake Superior watershed: September 15 – June 30.

Special waters (including trout waters), impaired waters, and PWIs will be identified on the Environmental Plan Sheets accompanying the SWPPP. Unless otherwise specified in applicable permits or certifications and with exception to blasting and other rock breaking measures and horizontal directional drilling ("HDD"), in-stream construction activities (specifically trenching, pipeline installation, backfill, and restoration of the streambed contours) for open cut (non-isolated) crossing methods will occur within the following timeframes:

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<sup>7</sup> In-channel work that results in the alteration of the course, current, or cross-section of the public water; this restriction does not apply to water appropriation activities (see Section 6.0).

- Minor Waterbodies (all waterbodies less than or equal to 10 feet wide at the water's edge at the time of crossing): 24 hours
- Intermediate Waterbodies (all waterbodies greater than 10 feet wide but less than 100 feet wide at the water's edge at the time of crossing): 48 hours
- Major Waterbodies (all waterbodies greater than 100 feet wide at the time of crossing): As specified by Enbridge or in the applicable permits.

These timeframes apply regardless of the presence or absence of flow. These timeframes also apply to dry (isolated) crossing methods as a guideline and can be extended based on site-specific conditions with approval from Enbridge Environment, Construction Management, and the EI in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Enbridge will contact the MDNR if a crossing of a PWI waterbody crossing will take longer than 24 hours to complete.

Stream crossings have been designed to be as close to perpendicular to the axis of the stream channel as engineering and routing constraints allow, creating the shortest crossing length.

## **2.2 CLEARING AND GRADING**

For trenched crossings of waterbodies, the construction workspace width will consist of a 25-foot-wide neck down beginning 20 feet from the OHWM on the working side of the construction workspace (refer to Figures 22 through 24). Enbridge will properly install and maintain redundant sediment control measures immediately after clearing and prior to initial ground disturbance at surface waters<sup>8</sup> located within 50 feet of the Project and where stormwater flows to the surface water (refer to the Environmental Plan Sheets in the SWPPP). Enbridge will install perimeter sediment controls at least 5 feet apart unless limited by lack of available space. Redundant controls will not be installed adjacent to road ditches, judicial ditches, county ditches, stormwater conveyance channels, storm drain inlets, and sediment basins. Sheet piling is a redundant perimeter control if installed in a manner that retains all stormwater. Clearing, topsoil segregation, and trenching of an upland approach to the surface water will occur as described in Sections 1.8.3, 1.10, and 1.11. If it is a wetland approach to the surface water, clearing, topsoil segregation, and trenching will occur as described in Sections 3.2 and 3.6. Refer to Section 2.2.2 for a discussion of erosion and sediment control BMP installation at special and impaired waterbodies.

Enbridge will clear a 30-foot-wide corridor over the HDD path to allow vehicle and equipment to access the waterbody for appropriations and/or to monitor for inadvertent releases (refer to Section 11.0). No grading or stump removal will occur over the HDD path except at limited locations where free-span engineered bridges will be installed. Bridge headers will be set back 10 feet from the top of bank and some limited grading may be required to allow for the safe installation of the bridge.

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<sup>8</sup> "Surface water" or "waters" means all streams, lakes, ponds, marshes, wetlands, reservoirs, springs, rivers, drainage systems, waterways, watercourses, and irrigation systems whether natural or artificial, public or private, except that surface waters do not include stormwater treatment systems constructed from upland (Minn. R. Ch. 7090).

### **2.2.1 Beaver Dam Removal and Prevention of Dam Rebuilding**

Enbridge will obtain the appropriate permits from the applicable agencies for beaver dam removal and/or beaver trapping or implementation of other deterrents as needed.

### **2.2.2 Special, Impaired, and Infested Waters**

Enbridge will comply with the construction and mitigation measures identified in the applicable permits for special waters, such as trout streams, canoe waters, and other waters designated by state rules and statutes. Additional applicable erosion control and stabilization measures are described in the Project SWPPP. Enbridge will properly install and maintain redundant sediment control measures immediately after clearing and prior to initial ground disturbance at special waters located within 100 feet of the Project and where stormwater flows to the surface water (will be reflected in the Environmental Plan Sheets in the SWPPP).

Where discharges of stormwater may occur to waters designated under Section 303(d) of the Clean Water Act as Impaired Waters for phosphorus (nutrient eutrophication biological indicators), turbidity, total suspended solids, dissolved oxygen, or aquatic biota (fish bioassessment, aquatic plant bioassessment and aquatic macroinvertebrate assessment), additional erosion and sediment control BMPs will be implemented as specified in the Project SWPPP and other applicable Project permits. Enbridge will properly install and maintain redundant sediment control measures immediately after clearing and prior to initial ground disturbance at all relevant impaired waters located within 50 feet of the Project and where stormwater flows to the surface water (will be reflected in the Environmental Plan Sheets in the SWPPP).

During Project construction and restoration, Enbridge plans to appropriate water from local sources, such as lakes, streams, and private wells for construction activities such as dust control, make-up of HDD drilling mud, and hydrostatic testing. The Project will follow applicable permit and lease conditions for appropriation and discharge and the BMPs described in the Invasive and Noxious Species Management Plan (Appendix B) to prevent the spread of aquatic invasive species.

## **2.3 ADDITIONAL TEMPORARY WORKSPACE**

ATWS includes work areas outside the boundary of the typical construction workspace. These spaces are typically used to assemble pipe segments and for temporary spoil storage. Clearing of forested and brushy areas for ATWS will be avoided as much as possible. Woody vegetation in wetlands and riparian areas will typically not be cleared for the purpose of ATWS unless approved by appropriate regulatory agencies as stipulated in permits issued for the Project. ATWS will be constructed as follows:

- ATWS will be located at least 50 feet away from the OHWM/ordinary high water level ("OHWL") if topographic or other physical conditions such as stream channel meanders allow, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land (refer to Figures 22 through 24).
- If safe work practices or site conditions do not allow for a 50-foot setback, ATWS should be located no closer than 20 feet from the OHWM/OHWL, subject to site-specific

approval by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity.

- ATWS will be limited to the minimum size needed to construct the stream crossing.

## **2.4 BRIDGES**

Temporary equipment bridges will be used on most waterways (upon approval by the appropriate agency), including small waterways such as ditches and intermittent streams, where there is a potential for stormwater runoff or rain events to transport sediment downstream from equipment crossing the waterway. Some bridges may be used on waterbodies crossed using the HDD method, where approved by regulatory agencies. Bridges will be constructed as described below during clearing and will be removed as soon as possible during final restoration once the bridge is no longer required to complete and monitor restoration activities.

Fording of waterways is prohibited (i.e., civil survey, potholing, or other equipment are not permitted to ford waterways prior to bridge placement) unless the waterbody meets the following conditions:<sup>9</sup>

- is capable of supporting the crossing without special preparation;
- is dry or frozen at the time of crossing;
- the stream bank does not exceed 4 feet in height;
- the crossing is constructed of gravel, natural rock, concrete, steel matting, or other durable inorganic material not exceeding one foot in thickness;
- the approach is graded to a finished slope not steeper than 5:1 horizontal:vertical, and all graded banks are seeded or mulched to prevent erosion and sedimentation; and
- the crossing is not placed on a public water, designated trout stream, or designated state water trail.

### **2.4.1 Types of Bridges**

Bridge crossing methods associated with the travel lane of the construction workspace are described in detail in Section 2.4.2 of the Summary of Construction Methods and Procedures (Appendix A). Ice bridges are described in Enbridge's Winter Construction Plan. Equipment bridges will be constructed using one of the following techniques (Figures 1, 3, and 4):

- Clear span bridge;
- Non-clear span bridge (in-stream support); or
- Culvert/flume.

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<sup>9</sup> Minnesota Rules 6115.0230 Subp. 4B.

## **2.4.2 Bridge and Culvert Maintenance**

Equipment bridges and culverts will be maintained in accordance with the applicable permits. Debris or vegetation that becomes lodged on the bridge support will be removed and disposed of in an upland area. Bridges will be maintained to prevent soil from entering the waterbody (refer to Figure 3 and 4). Soil that accumulates on the bridge decking will be removed daily, or as deemed necessary by the EI.

## **2.5 STREAM AND RIVER CROSSING CONSTRUCTION METHODS**

Section 4.0 of the Summary of Construction Methods and Procedures (Appendix A) describes the different waterbody crossing techniques that Enbridge intends to utilize during construction, the site-specific conditions required for the method to be feasible, and the advantages and disadvantages associated with each technique. Procedures for frozen conditions are discussed in Enbridge's Winter Construction Plan. The following sections describe the stream and river crossing methods that are typically used, subject to further restrictions by Enbridge and applicable permits and subject to modifications as approved by appropriate regulatory agencies and Tribal resource specialists (as applicable) during construction. Generally, depth of cover under waterbody crossings is a minimum of 48 inches unless otherwise specified in applicable permits or authorizations. Following installation of the pipeline, Enbridge will confirm that the pipe depth meets federal and state requirements through civil survey.

### **2.5.1 Open Cut (Non-Isolated) Trench Method**

Crossing of waterbodies when they are dry or frozen to the bottom and not flowing may proceed using the open cut (non-isolated) trench crossing technique described below, provided that the EI verifies that water is unlikely to flow between initial disturbance and final stabilization of the feature. This also applies to features that have been permitted as waterbodies, but field delineations determined were wetlands based on conditions at the time of survey. If unanticipated flow conditions develop during construction of a given waterbody, Enbridge's EIs will be notified immediately to determine the extent of the flow and Enbridge will install additional erosion and sediment control BMPs, as necessary. If flows are significant, and sedimentation is likely to occur, work will be stopped, or Enbridge will switch to a dry (isolated) crossing technique (see Sections 2.5.2 and 2.5.3), with Enbridge and agency approval.

There are also a limited number of locations where due to surrounding saturated wetlands, it is not feasible to isolate the flow and the open cut trench method, such as the push-pull technique (see Section 3.7.1), may be used.

### **Installation**

The following procedures will be used during open cut trench crossings (Figure 22):

- Sediment control measures will be installed before initial ground disturbance at the waterbody. Spoil containment structures will be installed back from the stream bank so that spoil does not migrate into the stream.
- Grading will be directed away from the waterbody to minimize the potential for sediment to enter the stream. Grading of stream banks will be restricted to the trench line and areas necessary for safe bridge installation.

- After grading, backhoes or draglines will be used to excavate the trench. Where possible, excavating equipment will operate from one or both banks, without entering the stream. If equipment must encroach into the stream, it will operate on clean construction mats. The upper streambed material (e.g., up to 12 inches of streambed material such as gravel, sand, cobble) will be segregated and stored separately from the remaining trench spoil within the construction work area limits. Storage of streambed spoil within the stream is prohibited unless expressly approved in the applicable permits.
- Earthen trench plugs (hard plugs) between the stream and the upland trench will be left undisturbed during excavation of the in-stream trench to prevent diversion of the stream flow into the open trench and to prevent water that may have accumulated in the adjacent upland trench from entering the waterbody. Trench plugs will be removed immediately prior to pipe placement, and then replaced when the pipe is in place. Trench water accumulated upslope of trench plugs will be dewatered appropriately prior to trench plug removal.
- Water within the trench will be managed in accordance with Section 5.0.
- Backfilling will begin after the pipe is positioned in the trench at the desired depth. Backfill material will consist of the spoil material excavated from the trench and parent streambed unless otherwise specified in state, Tribal, or federal permits. The in-stream trench will be backfilled so that the stream bottom is as near as practicable to its pre-construction condition, with no impediments to normal water flow.

### **In-Stream Best Management Practices**

To minimize downstream sedimentation, Enbridge will install in-stream BMPs (e.g., silt curtains [Figure 25], bladder dams, or water gates) downstream of open cut crossing locations where there is water prior to the initiation of crossing, and where site-specific conditions allow access for BMP installation. The type of in-stream BMP utilized will depend on waterbody conditions (flow velocity, water depth, and the width of the waterbody) and will be selected depending upon the site-specific conditions at the time of crossing.

### **Temporary Stabilization**

Enbridge will restore the stream banks as near as practicable to pre-construction conditions unless that slope is determined to be unstable. If the slope is considered unstable, Enbridge will reshape the banks to prevent slumping. Once the banks have been reshaped, Enbridge will commence soil stabilization activities within 24 hours (refer to Section 1.9.1 for temporary stabilization timing requirements). Temporary slope breakers will be installed on all sloped approaches to streams in accordance with the spacing requirements identified in Section 1.9.3.

Seed mix (refer to Section 7.0) and mulch and/or erosion control blankets will be installed within the required natural buffer on either side of the stream, with exception to actively cultivated land. Redundant controls will be re-installed as needed until stabilization is achieved (refer to Section 2.6 for permanent restoration requirements). Silt fence, or functional equivalent as approved in advance by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity, will be installed upslope of the temporary seeding area.



## 2.5.2 Isolated Trench: Dam and Pump Method

### Installation

The dam and pump method is an isolated dry crossing technique that is suitable for low flow streams and is generally preferred for crossing meandering channels. The dam and pump method involves damming of the stream upstream and downstream to isolate the trench before excavation (refer to Figure 23) and pumping water around the construction area. Procedures for conducting dry crossing techniques in frozen conditions are described in Enbridge's Winter Construction Plan. The following procedures will be used for dam and pump crossings:

- Dams may be constructed of sandbags, inflatable dams, aqua-dams, sheet piling, and/or steel plates. The dams will prevent the stream from flowing into the construction area. The dams will be continuously monitored for a proper seal. Additional sandbags, plastic sheeting, steel plating, or similar materials will be used where necessary to minimize the amount of water seeping around the dams and into the construction work area. The dam will not be removed until after the pipeline has been installed, the trench has been backfilled, and the banks have been stabilized.
- Pumping of the stream across the construction workspace will commence simultaneously with dam construction to prevent interruption of downstream flow. Stream flow will be pumped across the construction area through a hose and will be discharged to an energy-dissipation device, such as plywood boards, filter bags, large rock or bricks, or any other material that reduces the concentrated flow of a water pump such that stream bed or banks scouring will not occur. These devices are placed within the channel or on the banks of waterbodies to ensure that stream water being pumped around a crossing will not cause erosion or scouring and that the water will not be inadvertently discharged outside of the feature.
- The pumps and fuel containers will be located on the upstream side of the crossing and will be placed in impermeable, sided structures that will act as containment units (refer to Section 10.0). The pumps used for this crossing method will not be placed directly in the stream or on the streambed. Pumps will have a capacity greater than the anticipated stream flow. The pumping operation will be staffed 24 hours a day and pumping will be monitored and adjusted as necessary to maintain an even flow of water across the work area and near-normal water levels upstream and downstream from the crossing. Backup pumps are required on site for each crossing.
- The pump intake will be installed in a manner to prevent sediment from being sucked from the bottom of the stream and will be equipped with a screen, or equivalent device, to prevent fish uptake.
- Where possible, excavating equipment will operate from one or both banks, without entering the stream. If equipment must encroach into the stream, it will operate on clean construction mats (free of soil and plant material prior to being transported onto the construction workspace). Streambed material will be segregated as stated in the open cut (non-isolated) trench method and will be placed within the construction workspace. Storage of streambed spoil within the stream will only be allowed if expressly approved in the applicable permits.

- Earthen trench plugs (hard plugs) between the stream and the upland trench will be left undisturbed during excavation of the in-stream trench to prevent diversion of the stream flow into the open trench and to prevent water that may have accumulated in the adjacent upland trench from entering the waterbody. Trench plugs will be removed immediately prior to pipe placement, and then replaced when the pipe is in place. Trench water accumulated upslope of trench plugs will be dewatered appropriately prior to trench plug removal.
- Standing water that is isolated in the construction area by the dams will be managed in accordance with Section 5.0.
- Backfilling will begin after the pipe is positioned in the trench to the desired depth. Backfill material will consist of the spoil material and parent streambed excavated from the trench unless otherwise specified in state, Tribal, or federal permits. The in-stream trench will be backfilled so that the stream bottom is similar to its pre-construction condition, with no impediments to normal water flow.

### **2.5.2.1 Isolated Trench: Modified Dam and Pump Method**

In situations where the stream banks are stable, but conditions are too saturated to effectively dewater from the construction workspace, Enbridge will conduct a modified dam and pump crossing. The only difference from standard dam and pump method and this modified technique is that Enbridge will not dewater the trench and will utilize buoyancy control methods (refer to Section 3.7.3) as appropriate to sink the pipe to the bottom of the trench. Enbridge will install in-stream BMPs downstream of these crossing locations prior to initiating the crossing to mitigate the potential for elevated sedimentation (refer to the discussion in In-Stream BMPs under Section 2.5.1). The exact location of in-stream BMPs will be determined on-site prior to initiating the crossing by Enbridge's EIs in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity.

### **Temporary Stabilization**

Initial stabilization, restoration of the stream banks, and the installation of temporary erosion and sediment control BMPs will be similar to that described for the open cut (non-isolated) trench method above but will occur immediately following installation of the pipeline (refer to Section 2.6 for permanent restoration requirements). Once the stream banks have been stabilized, the dams and pump will be removed.

### **2.5.3 Isolated Trench: Flume Method**

#### **Installation**

The flume method is an isolated dry crossing technique that is suitable for crossing relatively narrow streams that have straight channels and are relatively free of large rocks and bedrock at the point of crossing (refer to Figure 24). This method involves placement of flume pipe(s) in the stream bed to convey stream flow across the construction area without introducing sediment to the water. Procedures for conducting dry crossing techniques in frozen conditions are described in Enbridge's Winter Construction Plan. The procedures for using the flume method are described below.

- The flume(s) will be of sufficient diameter to transport the maximum flows anticipated to be generated from the watershed. The flume(s), typically 40 to 60 feet in length, will be installed before trenching and will be aligned so as not to impound water upstream of the flume(s) or cause downstream bank erosion. EIs will evaluate flume discharges; if excessive flows are observed and may cause scouring, then energy dissipation devices (plywood, steel plate, etc.) can be placed within the waterbody to deflect/absorb heavy water flows. The flumes will not be removed until after the pipeline has been installed, trench has been backfilled, and the stream banks have been stabilized.
- The upstream and downstream ends of the flume(s) will be incorporated into dams made of sand bags and plastic sheeting or steel plates (or equivalent). The upstream dam will be constructed first and will funnel stream flow into the flume(s). The downstream dam will prevent backwash of water into the trench and construction work area. The dams will be continuously monitored for a proper seal. Adjustments to the dams will be made where necessary to prevent large volumes of water from seeping around the dams and into the trench and construction work area.
- Where possible, excavating equipment will operate from one or both banks, without entering the stream. If equipment must encroach into the stream, it will operate on clean construction mats. Streambed material will be segregated and placed within the construction workspace. Storage of streambed spoil within the stream will only be allowed if expressly approved in the applicable permits.
- Earthen trench plugs (hard plugs) between the stream and the upland trench will be left undisturbed during excavation of the in-stream trench to prevent diversion of the stream flow into the open trench and to prevent water that may have accumulated in the adjacent upland trench from entering the waterbody. Trench plugs will be removed immediately prior to pipe placement, and then replaced when the pipe is in place. Trench water accumulated upslope of trench plugs will be dewatered appropriately prior to trench plug removal.
- If additional trench dewatering is necessary to complete the installation of the pipe, the discharge will be managed in accordance with Section 5.0.
- Backfilling will begin after the pipe is positioned in the trench to the desired depth. Backfill material will consist of the spoil material excavated from the trench and parent streambed unless otherwise specified in state, Tribal, or federal permits. The in-stream trench will be backfilled so that the stream bottom is similar to its pre-construction condition, with no impediments to normal water flow.

### **Temporary Stabilization**

Initial stabilization, restoration of the construction workspace, and the installation of temporary erosion and sediment control BMPs will be similar to that described for the open cut (non-isolated) trench method above but will occur immediately following installation of the pipeline (refer to Section 2.6 for permanent restoration requirements). After the stream banks have been stabilized, the dams and flume will be removed from the stream bed allowing water to resume its flow in the channel.

#### **2.5.4 Trenchless Methods: Horizontal Directional Drill Method (Pressurized)**

Refer to Section 3.6 of the Summary of Construction Methods and Procedures (Appendix A) for a more detailed description of the HDD method.

##### **Installation**

HDD is a trenchless crossing method that involves no direct excavation of the features being crossed; for this reason, it is often used for large waterbodies that cannot be crossed by other methods or to cross sensitive resources such as waterbodies (refer to Figure 26). An HDD occurs in multiple phases. In the first phase, a small-diameter pilot hole will be drilled under the feature along a prescribed profile. After the pilot hole has been completed, barrel reams will be used to enlarge the pilot hole to accommodate the desired pipeline diameter. Drilling mud will be necessary to remove cuttings and maintain the integrity of the hole. Water from an agency-approved source will be used to prepare the slurry of drilling mud and will be appropriated according to applicable permits. In the final phase, the pipe section will be pulled through the hole by the drilling rig (called “pullback”) and welded to the adjoining sections of pipe on each side of the feature. During the pilot hole drilling, reaming, and swabbing, pressure is applied to the borehole as drilling fluids are pumped in. A surveying system is utilized to guide the drill path from entry to exit point.

##### **Drilling Mud**

Drilling mud (potentially mixed with additives) is used to provide hydrostatic pressure to prevent fluids from entering the bore hole, to lubricate and cool the drill bit, and return cuttings from the bore hole to the surface to clear the hole and maintain drilling operations. Maintaining drilling fluid circulation to the extent possible is the key to reducing the risk of inadvertent drilling fluid returns (also referred to as an “inadvertent release”). Drilling mud additives help control sand content and flow, water hardness, keep the bore hole open and stable, prevent groundwater inundation, and allow the bentonite to yield properly. Only Enbridge and agency-approved drilling mud additives will be used on this Project.

During drilling operations, drilling mud and slurry will be stored back from the waterbody in an earthen berm sediment control structure, mud pit, in tanks, or by other methods so that it does not flow into the waterbody, adjacent wetlands or off the workspace (refer to Section 11.0 for additional details).

After the pipe is in place, excess drilling mud will be hauled off-site to an Enbridge-approved location (see Section 11.5).

##### **Temporary Stabilization**

Enbridge will clear a 30-foot-wide construction workspace along the HDD path for placement of guidewires, and to facilitate response to a potential inadvertent release and pipeline monitoring during operations. However, no grading or stump removal will occur along the HDD path except at limited locations where free-span engineered bridges will be installed. Bridge headers will be set back 10 feet from the top of bank and some limited grading may be required to allow for the safe installation of the bridge. This reduces the potential for erosion and sedimentation at the stream crossing. Consequently, temporary erosion and sediment control BMP measures will be installed as needed.

## **2.6 PERMANENT RESTORATION**

Stream/channel banks disturbed during installation of the pipeline will be stabilized with erosion and sediment control BMP materials such as an erosion control blanket and seeded in accordance with Section 7.0 (refer to Section 7.8 for discussion of riparian vegetation seed mixes). Permanent stabilization will be initiated within 24 hours after installation of the crossing using the open cut trench method and prior to restoring flow using the dam and pump or flume method, unless site and permit conditions delay permanent installation.

Where the banks have been disturbed, Enbridge will restore the slopes as near as practicable to pre-construction conditions unless that slope is determined by Enbridge to be unstable. Where the slope of the banks is determined to be unstable or has the potential to erode or fail, the banks will be reshaped to transition the disturbed areas into the natural stream bank with the intent to stabilize the bank and create a blended, natural appearance.

Berms or other sediment filter devices will be installed at the base of sloped approaches to streams greater than 5 percent and the outlet of the berm will be directed away from the stream into a well vegetated area; berms will not be installed in wetlands or floodplains. Temporary sediment control devices will remain in place until the area has stabilized and adequate revegetation has established.

### **2.6.1 Vegetative Bank Restoration**

Waterbody banks will be restored as near as practicable to pre-construction conditions after backfilling is complete and will be seeded with an appropriate seed mix as specified in Section 7.8 and covered with an erosion control blanket. Erosion and sediment control BMPs (e.g., straw bales, filter socks [Figure 27], silt fences) will be installed as necessary based on site-specific conditions. Wherever practicable at waterbody crossings, Enbridge will utilize wildlife-friendly erosion and sediment control BMPs that contain biodegradable netting (natural fiber, biodegradable polyesters, etc.) and will avoid the use of plastic mesh.

### **2.6.2 Supplemental Bank Stabilization**

Unstable soils and/or site-specific factors such as stream velocity and flow direction may require additional restoration efforts, such as installation of woody vegetation, geotextile fabric, or tree, log, rootwad, or boulder revetments to stabilize disturbed stream banks (see Figure 29). Enbridge does not plan to install rock rip-rap on this Project. Enbridge will prepare site-specific plans in coordination with the applicable agencies to identify riparian areas that may require specialized seed mixes, plantings of woody vegetation, or other specialized restoration techniques. Where specialized restoration measures are required, these locations will be noted on the construction alignment sheets and supplemental restoration plans.

### **2.6.3 Bridge Removal**

Equipment bridges will be removed during final cleanup or, if access is needed, after final cleanup and permanent seeding. Bridge decking will be removed to ensure sediment and debris are collected by geotextile fabric secured below decking during bridge construction. Subsequently, geotextile fabric will be removed to prevent debris from entering the watercourse.

Once the bridge is removed, Enbridge will conduct additional grading to restore the banks to as near as practicable to pre-construction conditions as needed. Additional seeding and/or installation of erosion and sediment control measures will also be implemented as required.

### **3.0 WETLAND CROSSING GENERAL REQUIREMENTS**

The various crossing techniques employed in different wetland types are described in more detail in Section 3.0 of the Summary of Construction Methods and Procedures (Appendix A). Note that the proposed crossing technique may change depending on seasonality and site-specific conditions at the time of crossing (e.g., saturation level). Procedures for wetland crossings during frozen conditions are discussed in Enbridge's Winter Construction Plan.

The procedures in this section apply to all wetlands that will be affected by the Project. These procedures require that judgment be applied in the field and will be implemented under the supervision of Enbridge and the EI. The intent of these procedures is to minimize construction-related disturbance and sedimentation of wetlands and to restore wetlands as nearly as possible to pre-construction conditions.

In wetlands that are being actively cultivated or hayed at the time of construction, Enbridge will construct the pipeline using standard upland methods. Most seasonally saturated farmed wetlands are used for crop production and topsoil will be segregated in the same manner as topsoil in upland agricultural lands. Pipe stringing and fabrication may occur within the farmed wetland adjacent to the trench, or adjacent to the farmed wetland in a designated ATWS.

Wetland crossing requirements, including construction methods, timing, erosion control, and restoration, are described in this section and in the wetland crossing permits issued by state, federal, and/or Tribal agencies as applicable.

#### **3.1 WETLAND ACCESS**

Enbridge will use the construction workspace and only approved roads to access wetland areas. Construction mats will be placed along the travel lane within delineated wetlands within the construction workspace and along access roads (refer to Section 1.4). Section 3.2 of the Summary of Construction Methods and Procedures (Appendix A) provides a description of the various construction mats that may be utilized on the Project. Mat travel lanes are typically a single layer (Figures 30 and 31); however, there may be cases in saturated areas where more than one layer of mats must be placed to provide a stable working surface (Figures 32 and 33). Enbridge will remove the mats during final cleanup activities. If there are multiple layers of mats, Enbridge will probe the soil after mats have been removed to verify that no additional mats remain.

#### **3.2 CLEARING**

Clearing the construction workspace in wetlands will be similar to clearing in uplands. For construction to proceed, obstructions (e.g., trees, brush, and logs) need to be removed. Vegetation and trees within wetlands will be cut off at ground level, leaving existing root systems intact; clearing debris will generally be removed from the wetland for disposal. Hydro-axe debris, or similar (less than 1.5-inch diameter and/or 12 inches in length) can be left in the wetland if spread evenly in the construction workspace to a depth that will allow for normal revegetation, as determined by the EI. Clearing over HDD paths will be limited to the 30-foot-wide construction workspace.

### **3.3 ADDITIONAL TEMPORARY WORKSPACE IN WETLANDS**

In general, Enbridge attempts to locate ATWS outside of wetlands wherever practicable; however, ATWS may be sited in select wetlands where the wetland is adjacent to a waterbody, road, railroads, foreign utility crossings, pipeline cross-overs, and/or where required based on site-specific conditions with prior approval from the applicable regulatory agencies. Clearing of forested wetlands for ATWS will be avoided as much as possible.

- Staging areas, additional spoil storage areas, and other ATWS will be located in upland areas at least 50 feet away from wetland boundaries (refer to Figure 34), where safe work practices or site conditions permit, except where the adjacent upland consists of cultivated or rotated cropland or other disturbed land. If site conditions do not permit a 50-foot setback, then these areas will be located as far away from the wetland as is practicable. Vegetation will not be cleared between these areas and the wetland in any event. No construction activities including vegetation clearing or earthwork will occur between the ATWS and the wetland.
- The size of the ATWS areas will be limited to the minimum needed to construct the wetland crossing.

### **3.4 GRADING IN A WETLAND**

Grading activities will be confined to the area of the trench and will be minimized to the extent practicable. Grading outside the trench will only be allowed where required to ensure safety and restore the construction workspace after backfilling the trench with prior approval from Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity.

Temporary erosion and sediment control BMPs will be installed:

1. across the entire construction workspace upslope of the wetland boundary, where necessary, to prevent sediment flow into the wetland;
2. along the edge of the construction workspace as necessary to prevent sediment flow into off-ROW wetlands;
3. along the edge of the construction workspace as necessary to contain spoil and sediment within the construction workspace through wetlands; and
4. at locations specified in any applicable permits.

Enbridge will identify the potential locations of these erosion and sediment control BMPs at wetland approaches and within wetlands on the Environmental Plan Sheets included with Enbridge's SWPPP. The SWPPP will also describe the procedures the Enbridge Environment will utilize to evaluate the potential location, extent, and type of erosion and sediment control BMPs to be implemented based on site-specific conditions.

Enbridge will properly install and maintain redundant sediment control measures immediately after clearing and prior to initial ground disturbance at wetlands located within 50 feet of the Project and where stormwater flows to the wetland (will be reflected in the Environmental Plan



Sheets in the SWPPP). Enbridge will install perimeter sediment controls at least 5 feet apart unless limited by lack of available space. Redundant controls will not be installed adjacent to road ditches, judicial ditches, county ditches, stormwater conveyance channels, storm drain inlets, sediment basins, and agriculturally-farmed wetlands. Sheet piling is a redundant perimeter control if installed in a manner that retains all stormwater. Clearing, topsoil segregation, and trenching of the upland approaches to wetlands will proceed as described in Sections 1.8.3, 1.10, and 1.11. Erosion and sediment control BMPs will be maintained in proper working order to prevent the flow of sediment into wetlands from spoil piles or sloped approaches that are adjacent to the wetlands.

### **3.5 RIGHT-OF-WAY STABILIZATION**

Tree stumps, brush riprap, imported soil, and rock fill will not be brought in to stabilize the construction workspace in wetlands. Where low ground pressure equipment is not used, construction equipment will operate from construction mats or equivalent means with prior approval from Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Timber riprap (also known as corduroy road) will not be used on this Project. Corduroy roads in wetlands will be removed if discovered during construction within the construction workspace, unless otherwise requested by the landowner or land-managing agency.

Subsoil from the pipeline trench within the immediate wetland may be placed on top of equipment mats for additional stabilization. Construction mats may be placed over the ditch line or on the working side to facilitate trench excavation. All construction mats, construction debris, and larger woody vegetative debris (greater than 1.5-inch diameter and/or 12 inches in length) will be removed during cleanup of wetlands.

### **3.6 TRENCHING**

Excavation of the pipeline trench in wetlands will typically be accomplished using backhoe excavators. Enbridge will take reasonable steps to ensure that the duration of open trench in wetlands, including tie-ins, is minimized to the fullest extent possible. As described in Section 1.11, where deemed appropriate, Enbridge will leave plugs of subsoil in the ditch or will construct temporary access bridges across the trench for the landowner to move livestock or equipment; temporary bridges may also be utilized by wildlife. Where trenches are left open overnight, trenches will also be sloped (less than 45 degrees) where started and ended to allow wildlife egress. Spacing of plugs and ramps will be determined in the field. Enbridge will inspect the trench and construction area for presence of animals every day before initiating construction activities and prior to backfilling the trench. If an animal is located, it will be relocated outside of the active construction workspace. If the animal is a federally or state-listed species, the appropriate agency(ies) will be notified.

#### **3.6.1 Topsoil Segregation**

When constructing in wetland areas without standing water, up to 1 foot of topsoil (organic layer) will be stripped from the trench line and stockpiled separate from trench spoil to preserve the native seed stock. In standing water wetlands, organic soil segregation is not typically practical; however, Enbridge will attempt to segregate as much of the organic layer as possible based on site/saturation conditions. If normally unsaturated wetlands are saturated at the time

of construction, topsoil segregation will be attempted as illustrated in Figures 32 and 33 and based on recommendations from the EI and appropriate regulatory agencies.

### **3.6.2 Trench Breakers**

Trench breakers will be installed as outlined in Section 1.13. Where the EI determines that the pipeline trench has the potential to drain or partially drain a wetland, trench breakers will be installed as necessary to maintain the original wetland hydrology.

## **3.7 PIPELINE INSTALLATION**

The following procedures are intended to minimize siltation and disturbance to wetlands during installation. Generally, depth of cover under wetland crossings is a minimum of 48 inches unless otherwise specified in applicable permits or authorizations. Following installation of the pipeline, Enbridge will confirm that the pipe depth meets federal and state requirements through civil survey.

### **3.7.1 Push-Pull Method**

Large wetlands with standing water can generally not be crossed with typical crossing methods. In these areas, the pipeline will be pre-assembled and positioned in the trench using the "push-pull" and/or "float" techniques (Figures 35 and 36).

Usually this fabrication requires use of ATWS adjacent to the construction workspace. A backhoe (or equivalent) supported on construction mats or equivalent low ground pressure equipment will be used to dig the trench. The prefabricated section of pipeline will then be pushed-pulled into position or floated across the wetland. When the pipeline is in position, floats, if used, will be removed and the pipeline will sink into position. The trench will then be backfilled and a backhoe or similar equipment working from construction mats or by low ground pressure equipment will be used restore the wetland.

### **3.7.2 Temporary Erosion and Sediment Controls**

Erosion and sediment control BMPs at approaches to wetlands will be installed as previously described and in accordance with Section 3.4.

### **3.7.3 Buoyancy Control**

Enbridge will install buoyancy control in saturated environments. Enbridge calculates the amount of buoyancy control required based on an empty pipe. Buoyancy control can be achieved by utilizing one or more of the following methods:

- Concrete coating (refer to Figure 37);
- Bag weights (also referred to as saddlebag weights) (refer to Figure 38); and/or
- Sand bags.

Enbridge will select the appropriate method(s) depending on site-specific conditions at the time of crossing. Weights will be strung along the construction workspace, where necessary, until they are placed over the pipe within the excavated ditch.

Concrete for the concrete-coated pipe or bag weights will generally be mixed off-site and transported to the construction workspace on trucks. Limited mixing and coating activities may occur on the construction workspace for coating pipe joints, and mainline valve and pump station foundations, etc. Washing equipment used for mixing, pouring, casting, or coating will not occur within 100 feet of any wetland. Enbridge will collect and retain all the concrete washout water and solids in a leak proof containment. Wash water disposal will be limited to a defined area of the site or to an area designated for concrete washout within construction yards. The area(s) will be sufficient to contain the wash water and residual cement and will include equipment capable of reclaiming wash water during wash out (Figure 39). No concrete washing stations are allowed on MDNR-Administered Lands.

### **3.8 BACKFILLING**

Subsequent to pipe installation, backfilling of wetland trenches will take place immediately, or as approved by EI in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Enbridge will restore wetlands as near as practicable to pre-construction conditions. In areas where topsoil has been segregated, the subsoil will be replaced first. Subsoil that exceeds the elevation of the ground adjacent to the trench will be removed from the wetland and disposed of in an upland area or an Enbridge-approved location in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. After the trench has been backfilled with subsoil, previously segregated topsoil will be spread uniformly over the trench area from which it was removed.

### **3.9 CLEANUP, ROUGH/FINAL GRADING, AND TEMPORARY RESTORATION**

Cleanup activities will occur as described in Section 1.16. Rough and final grading includes restoring original conditions within the disturbed areas (i.e., ditch line, spoil storage areas, and equipment travel lane). Enbridge will backfill the trench to an elevation similar to the adjacent areas outside the ditch line and will add a slight crown of approximately 3 to 6 inches (depending on soil type) over the backfilled trench to allow for subsidence. Generally, excess subsoil displaced by the pipe installation will be spread across the portion of the construction workspace where topsoil removal has occurred (see Section 1.10). Any remaining excess subsoil will be removed and disposed of at an approved off-site location as needed to ensure contours are restored to as near as practicable to pre-construction conditions. Periodic breaks in the crown will be implemented to allow for normal hydrologic flow across the backfilled trench. Crowning will not extend beyond the previously excavated trench limits. As the backfill material settles, there is potential that the original crown may not completely recede to pre-construction contours. Additional (final) grading may occur when conditions allow to ensure the disturbed area has been returned to pre-construction conditions. Enbridge will also prepare the seedbed (Section 7.1.1) and install or repair erosion and sediment control BMPs (Sections 1.9 and 1.17). Temporary slope breakers will be installed near the boundary between the wetland and adjacent sloped approaches, to prevent sediment flow into the wetland as described in Section 1.9.3.

### **3.9.1 Timing**

Cleanup, rough, and final grading (including installation of temporary erosion and sediment control BMP measures) will proceed as soon as the trench has been backfilled in wetlands. If seasonal or other weather conditions prevent compliance with these timeframes, temporary erosion and sediment control BMPs will be maintained until conditions allow completion of cleanup.

### **3.9.2 Temporary Stabilization**

Where necessary, disturbed wetland areas will be seeded with a temporary seed mix as described in Section 7.1.2. No fertilizer, lime, or mulch will be applied in wetlands, except for peatlands as described in Section 7.7.3. Stabilization will be completed no later than 14 calendar days after the construction activity has ceased. Permanent seeding of wetland areas is described in Section 7.7.

## **4.0 HIGHWAY, ROAD, AND RAIL CROSSINGS**

### **4.1 BORES (NON-PRESSURIZED)**

Conventional bore methods are typically used to cross highway, road, and rail crossing features. Because watercourses, such as ditches, often occur parallel to these features, bores may be extended to bore under multiple features. Bore methods involve construction of a bore pit on each side of the feature (e.g., highway, road, railroad, watercourse) and thumping or boring a carrier pipe underneath the feature(s) without use of pressurized drilling fluid. The specific equipment utilized to execute the bore is dictated by the length of the bore and soil conditions. Water and bentonite clay can be introduced if soil conditions dictate in order to lubricate the drill head and carrier pipe and allow it to move through the ground more freely. With this construction practice at no time is pressurized water or drill mud being used to hold the hole open as it will during an HDD, and therefore there is no risk for an inadvertent release at these locations. If drilling mud is needed at these locations, any release will travel back along the path of the pipe and into the bore pit. Typically, the length of these crossings is limited, and the bore holes must be set up relatively close to the edge of the feature, and the depth maintained just below the depth of scour for watercourses. Figures 40 and 41 provide typical examples of a horizontal bore crossing of transportation corridors.

### **4.2 ADDITIONAL WORKSPACE**

Additional workspaces for bored road and railroad crossings and open-cut road crossings will be determined on a site-specific basis. These workspaces will be adjacent to the road or railroad and limited to the size needed to contain spoil, stage equipment, and store supplies for the crossing.

### **4.3 MAINTENANCE**

Roadway crossings will be maintained in a condition that will prevent tracking of mud onto the roadway.

Rock/gravel or construction mat tracking pads, as required by the applicable permits, will be installed adjacent to paved public roads to prevent or minimize the tracking of soil onto the roadway. If the roadside ditch is part of a jurisdictional waterway, a permit will be obtained prior to installing the tracking pad or culvert. Construction mat tracking pads or rock/gravel tracking pads on top of geotextile fabric will be utilized in wetlands and will be removed after construction.

### **4.4 TEMPORARY EROSION AND SEDIMENT CONTROLS**

Temporary erosion and sediment control BMPs (e.g., silt fence and/or double-staked straw bales) will be installed on sloped approaches to road crossings where vegetation has been disturbed as described in Section 1.9.4.

## 5.0 CONSTRUCTION DEWATERING

### 5.1 TRENCH AND PIT DEWATERING

For pipeline trench and pump station pit construction dewatering, Enbridge will typically utilize portable pumps. Enbridge will vary the number and size of pumps employed in a dewatering event based on the volume of water to be removed from the trench. In addition to portable pump dewatering along the trench, Enbridge may need to employ a well point system for dewatering at some road bores, utility crossings, mainline valve excavations, and as required by site-specific conditions. A well point system will be utilized when traditional dewatering techniques cannot keep up with the rate of groundwater recharge into the excavation. This system will consist of a series of small diameter wells installed via hydro-jetting that are connected by a header pipe to a well point pump (Figure 42). The well point system will be installed within the construction workspace following topsoil segregation. Adequate temporary erosion and sediment control BMPs will be installed to prevent the migration of subsoil slurry produced during the well point installation process.

Prior to initiating dewatering activities, the EI will approve the water discharge plan to ensure that erosion and sediment control BMPs are applied in such a way as to minimize the potential for water containing sediment from reaching a wetland or waterbody. Furthermore, landowner approval is required in advance of placement of dewatering structures outside of the approved construction workspace. On lands administered by the MDNR, these discharges will be subject to the terms and conditions of a lease. The EI will consult pre-construction environmental resource survey data for lands adjacent to and outside of the construction workspace when siting the dewatering structure. Dewatering structures will be sited to avoid environmental resources that may be affected by the discharge, such as federally or state-listed species. If pre-construction environmental survey data is not available, Enbridge will consult Natural Heritage Information System data or other relevant resource data to determine if protected resources may be present in the area and/or conduct additional environmental resource surveys before initiating activities.

Enbridge will utilize the Environmental Plan Sheets accompanying the MPCA SWPPP in addition to site-specific conditions at the time of dewatering to assess each water discharge situation, including:

1. Water Discharge Setting – This includes:
  - a. Soil Type – The soil type the discharged water will flow over. The management of discharged water traveling over sandy soil is more likely to soak into the ground as compared to clay soils.
  - b. Ground Surface – The topography in the area that will influence the surface flow of the discharged water.
  - c. Adjustable Discharge rate – The flow rate of the discharged water (which may need to vary) can be managed based on the site conditions to minimize instances of water from reaching a sensitive resource area such as a wetland or waterbody.

- d. Discharge Outfall – The amount of hose and number/size of pumps needed to attempt to discharge water at a location which drains away from waterbodies or wetlands.
2. **Pump Intake** – Use floating suction hose or other similar measures to prevent sediment from being sucked from bottom of trench.
3. **Filtering Mechanism** – All dewatering discharges will be directed through a filtering device as indicated below. Additional information on the different types of dewatering structures that may be used depending on site-specific conditions and discharge volume are described in the Enbridge's SWPPP. The SWPPP also describes the procedures that Enbridge Environment will utilize to identify the appropriate dewatering structure.
  - a. Well-Vegetated Upland Area – Water can be directed to a well-vegetated upland area through a geotextile filter bag (Figure 43). Geotextile bags need to be sized appropriately for the discharge flow and suspended sediment particle size.
  - b. Straw/Hay Bale Dewatering Structure – Where the dewatering discharge point cannot be located in an upland area due to site conditions and/or distance, the discharge will be directed into a straw or hay bale<sup>10</sup> dewatering structure. The size of the straw or hay bale dewatering structure is dependent on the maximum water discharge rate (refer to Figure 44). A straw or hay bale dewatering structure will be used in conjunction with a geotextile filter bag to provide additional filtration near sensitive resource areas. Alternative filtration methods (e.g., sand filter) will be readily available and used as needed.
  - c. Stormwater Pond – When dewatering from pump station pits, Enbridge will discharge to a stormwater pond wherever feasible and as approved by the appropriate permits.
  - d. Supplemental/alternative dewatering methods – If Enbridge observes that the filtration system fails to adequately treat the discharge, Enbridge will stop the discharge and will implement alternative or supplemental filtration. Alternative/supplemental methods (e.g., sand filters) will be selected based on the volume and site-specific conditions to comply with regulatory authorizations and certifications and all applicable federal, state and local regulations governing this activity and as described in Enbridge's SWPPP.

Once dewatering activities are complete in a given area, Enbridge will clean up the discharge area by removing bags and structures for disposal to an approved off-site location. Enbridge will restore any areas disturbed by the discharge event as near as practicable to pre-construction conditions.

### 5.1.1 Flow Measurement and Water Sampling

Enbridge will maintain logs of daily use totals at each water source and will provide logs for periodic reporting as required by the applicable agency. The volume may be determined using a

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<sup>10</sup> Minnesota Department of Transportation 3882 Type 3 specifications: <http://www.dot.state.mn.us/pre-letting/spec/2018/2018-spec-book-final.pdf>.

timing device, flow meter, or equivalent method, as approved by Enbridge or specified by applicable permit conditions.

Enbridge will monitor dewatering throughout the duration of the dewatering activities. Samples of the water discharged will be sampled as required by Tribal permits and/or state-issued discharge permits. Enbridge will take immediate corrective actions to prevent dewatering activities from violating applicable permits and certifications.

### **5.1.2 Regulatory Notification and Reporting**

Enbridge will notify and submit reports to appropriate Tribal, state, and federal agencies as required by all permits/authorizations.

## **5.2 HYDROSTATIC TEST DISCHARGES**

Hydrostatic testing will be done to verify that there are no flaws in the pipe or welds. Hydrostatic testing involves filling the new pipeline segments with water acquired in accordance with applicable permits (refer to Section 6.0), raising the internal pressure level, and holding that pressure for a specific period of time per U.S. DOT Pipeline and Hazardous Materials Safety Administration ("PHMSA") specifications. The number of mainline spread segments are governed by PHMSA specifications as well as internal Enbridge specifications (e.g., elevation differences between segments require that test sections be broken up in certain areas).

Hydrostatic pre-tests will be performed on pre-built HDD sections prior to installation. HDD segments will be tested again post-installation and tie-in as part of the mainline hydrostatic test section.

Hydrostatic testing will be conducted in accordance with applicable appropriation and discharge permits and leases obtained by Enbridge. Hydrostatic test waters will not be transferred from one waterbody to another. After the hydrostatic test is complete, Enbridge Construction Management, in collaboration with Enbridge Environment will determine if discharge activities can proceed in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Then the line will be depressurized and the water discharged according to applicable permits.

Procedures for winter hydrostatic testing are described in Enbridge's Winter Construction Plan.

### **5.2.1 Refueling**

The operation and refueling of hydrostatic test equipment will be in accordance with the conditions outlined in Section 10.0.

### **5.2.2 Siting of Test Manifolds**

Hydrostatic test manifolds will be installed where necessary to ensure proper test pressures and incorporate changes due to topography. Where feasible, Enbridge will incorporate minor adjustments to the test manifold locations to avoid placement in wetlands and riparian areas. However, completely avoiding the placement of a test manifold in a wetland may not always be possible. Enbridge will install appropriate erosion and sediment control BMP measures where the EI determines they are necessary.



### **5.2.3 Water Sampling**

Water discharged from hydrostatic tests will be sampled as required by federal-, Tribal- and state-issued appropriation or discharge permits. Sampling parameters and methodology are described in the applicable permits. Enbridge will be responsible for recording water volumes and flow rates.

### **5.2.4 Hydrostatic Testing Procedures**

#### **5.2.4.1 Mainline Hydrostatic Testing**

Prior to hydrostatic testing the pipeline, Enbridge will prepare the pipe by removing accumulated construction debris, mill scale, dirt, and dust using a cleaning pig<sup>11</sup> that is moved by compressed air. Cleaning water and debris removed from the pipe will be disposed of off-site in accordance with applicable permits. Once the pipe has been cleaned, hydrostatic test manifolds are welded to each end of the pipeline test section. The pipeline is then filled with test water from an approved water source (see Section 6.0). Once the pipeline test section is filled, the pipeline is pressurized to a specific pressure and maintained for a minimum of 8 hours.

Once the testing procedure is complete, the hydrostatic test section will be depressurized and the water is drained from the pipeline through a pipe/hose connected to the test header to water containment tanks known as frac tanks, which allow for the settling of residual fines that may still be present in the test water. The water will then be run through a filtration system and discharged back to the source water or discharged to a well-vegetated, upland area with an appropriate dewatering structure such as a geotextile filter bag and/or a hay bale structure that will be lined with geotextile fabric to allow for infiltration. Enbridge has screened the soil conditions, topography, and other factors to identify areas suitable for infiltration. Direct discharges to surface waters, if allowed by permit, will be directed into an energy dissipation device such as a splash pup (see Figures 45 and 46).

After dewatering the pipe, Enbridge will conduct drying runs using foam or solid cup type pigs to remove all the free (residual) water from the pipeline as practical. The incidental volume of water collected from the drying runs will be allowed to infiltrate into the trench.

At no time will the discharge rate exceed the applicable discharge rates specified in federal-, Tribal- or state-issued or other discharge permits or leases. In the event no maximum discharge rate is identified, discharges will be monitored and adjusted as necessary to avoid scouring, erosion, or sediment transport from the discharge location. Visual observations will be performed for all hydrostatic test discharge events.

To minimize the potential for introduction and/or spread of invasive and noxious species due to hydrostatic testing activities, Enbridge will follow the procedures outlined in the Invasive and Noxious Species Management Plan (Appendix B). If water is reused to test multiple test sections, it will be relayed back to the source water through the pipeline for final discharge or

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<sup>11</sup> A pipeline “pig” is the acronym for pipeline inspection gauge. Pipeline inspection gauges have a variety of applications including, but not limited to, cleaning the pipeline, dewatering and drying post hydrostatic testing to prepare the pipeline to accept product, and working as an in-line inspection tool to identify pipeline anomalies prior to and during in-service use.

discharged to an upland area for infiltration in accordance with applicable permits. Test water will not be discharged to a waterbody other than the appropriation source, unless coordinated and permitted through the applicable agencies.

#### **5.2.4.2 HDD Hydrostatic Testing**

HDD test sections are hydrostatically tested in much the same manner as detailed above. The primary differences between the procedures are that HDD test sections are hydrostatically tested for a minimum of 4 hours prior to the installation or pullback of the pipe and then tested again with the mainline once they are tied-in.

Frac tanks may or may not be used for HDD discharges depending on water volumes and whether or not discharge rates need to be reduced. Infiltration areas used for HDD pre-test discharges will be constructed and operated in accordance with applicable permits and licenses.

#### **5.2.5 Flow Measurement**

The total volume of water discharged will be determined with a flow meter (or equivalent), or as required by the applicable permit. The total volume of water discharged will not exceed the volume specified in the applicable permit.

## **6.0 WATER APPROPRIATION**

### **6.1 GENERAL**

Water may be drawn from local sources, such as lakes, streams, and private or municipal wells, for construction activities such as fugitive dust control, HDD drilling mud, buoyancy control, trench dewatering, and hydrostatic testing. The Project will follow applicable permit conditions for the appropriation of water and will only utilize sources approved by the applicable agencies. Refer to Enbridge's Fugitive Dust Control Plan for a description of the procedures that will be utilized for dust suppression on the construction ROW and access roads.

For appropriation from surface waters, Enbridge will install a mesh screen sized as approved by the applicable agencies on the intake hose to prevent fish entrainment.<sup>12</sup> The intake hose will be managed to minimize sediment intake from the waterbody bed. During withdrawal, adequate waterbody flow rates and volumes will be maintained to protect aquatic life and allow for downstream uses. If the waterbody does not have adequate water flow, an alternative agency-approved source will be used. The volume and rate of withdrawal will be monitored to comply with applicable permit conditions.

### **6.2 WATER SOURCES**

Water will only be withdrawn from agency-approved sources and in accordance with applicable permits. Water will not be transferred from one waterbody to another. No additives to the water are permitted unless written approval is received from Enbridge and applicable permits authorize such additives.

If surface water appropriation is scheduled to occur during possible periods of low flow, a backup source will be identified. Procedures for winter water appropriation are described in Enbridge's Winter Construction Plan.

### **6.3 FLOW MEASUREMENT**

At no time will the withdrawal rate for the water source exceed the rate specified in the applicable permits.

Enbridge will measure and document the withdrawal rate and total volumes of water appropriated with a flow meter (or equivalent), as required by the applicable permits.

### **6.4 WATER SAMPLING**

Where required by permit conditions, Enbridge will sample the water during appropriation. Sampling parameters and methodology are described in the applicable permits.

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<sup>12</sup> Mesh screens will be sized to 3/16-inch in Minnesota, 0.25-inch in North Dakota, and 1-inch or less in Wisconsin.

## **6.5 REGULATORY NOTIFICATION AND REPORTING**

Enbridge will notify appropriate agencies of the time of appropriations if required by the state appropriations permits. Enbridge will submit reports regarding the volume and quality of the water withdrawn if required by the applicable permits.

## **7.0 REVEGETATION AND MONITORING**

This section was developed based on the Minnesota Board of Water & Soil Resources (“BWSR”) Native Vegetation Establishment and Enhancement Guidelines (2019), and the Minnesota Wetland Restoration Guide (BWSR, 2014). Project-specific permit conditions and landowner requests (with exception to wetlands) for specific seed mixes (as indicated in the Project CLL) take precedence over the measures described in this section.

### **7.1 SITE PREPARATION**

Site preparation involves the following steps:

- Seed bed preparation;
- Planting of temporary cover crops (if appropriate);
- Installation of permanent erosion and sediment control BMPs; and
- Mulching.

#### **7.1.1 Seed Bed Preparation and Seeding Procedures**

After rough grading and before topsoil replacement, Enbridge will decompact the subsoil in actively cultivated areas and in non-agricultural areas (as directed by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity) to relieve soil compaction and promote root penetration as described in Section 1.18. Decompaction will not be conducted in non-farmed wetlands or MDNR-Administered Lands without prior approval from the agency.

After topsoil replacement, the soil will be tilled with a disc or rolling harrow, field cultivator, or chisel plow (or equivalent) to break up large clods and to prepare the soil surface. Suitable conditions generally include a firm soil surface that is not too loose or too compacted and will be prepared to accommodate the seeding equipment and method to be used (see Section 7.4).

Tillage and equipment operations related to seeding and mulching will be performed parallel to ground contours as much as practicable. Fertilizer and other soil amendments, if required, will be incorporated into the soil during seedbed preparation as specified by Enbridge in the Project-specific CLL requirements and permits in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. No soil amendments will be applied in wetlands unless directed by the appropriate agencies.

#### **7.1.2 Temporary Revegetation**

Enbridge’s temporary seed mixes (refer to Appendix C) were developed based on Minnesota BWSR seed mixes. The use of short-lived temporary cover crops (refer to Table 7.1-1) helps stabilize project sites and minimize the need for additional mulch in preparation of planning native seed mixes. Unless specifically requested by landowners or land managing agencies, Enbridge does not intend to establish temporary vegetation in actively cultivated land, standing water wetlands, and/or other standing water areas.

Table 7.1-1 Temporary Cover Crops	
Seed	Seeding Rate <sup>a</sup>
Oats	80-100 pounds/acre
Winter Wheat	75-100 pounds/acre
Soil Building Cover Crop (field pea/oats)	110 pounds/acre
<sup>a</sup> Seed rates are based on drill seed application and will vary based on site-specific conditions. Source: BWSR, 2019.	

If temporary cover crops are being used to stabilize slopes between 5 to 10 percent, the seeding rate should be increased by 35 pounds/acre. If slopes are greater than 10 percent, the seeding rate should be increased by 56 pounds/acre.

### 7.1.2.1 Timing for Temporary Vegetation

Generally, oats will be used for spring or summer revegetation, and winter wheat will be used in the fall. Temporary vegetation should be established at any time between **April 1 and October 15 or frozen soil**. Attempts at temporary revegetation after this date should be assessed on a site-specific basis and with approval from Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity (refer to Section 7.3.1). Refer to Section 1.9.1 for temporary stabilization timing requirements.

### 7.1.3 Permanent Erosion and Sediment Control Best Management Practices

Permanent erosion and sediment control BMP measures will be installed as described in Section 1.17. These controls will be left in place permanently and will not be removed following restoration.

### 7.1.4 Mulch

Mulch will be applied as described in Section 1.9.2.

### 7.1.5 Soil Amendments

Soil amendments may be applied to agricultural, pasture, and/or residential lands if requested by landowners and/or land managing agencies. Enbridge will apply phosphate-free fertilizers to areas within 100 feet of a waterway if soil amendments are required.

## 7.2 PROJECT SEED SPECIFICATIONS

Seed used will be purchased on a "Pure Live Seed" ("PLS") basis for seeding (both temporary and permanent) revegetation areas. Proposed seed sources will be submitted to Enbridge for review and approval prior to seed purchase in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Enbridge will arrange for the appropriate storage of the seed. Enbridge will utilize yellow tag seed, which is certified by the Minnesota Crop Improvement Association, when it is available. Seed tags will identify:

- name of mixture;
- lot number;

- weed seed percentage;
- other crop percentage;
- inert matter percentage;
- noxious weeds by name and number per pound;
- net weight; and
- labeler's name and address.

In addition, for each component in the mix the following information must be included on the label:

- kind;
- variety;
- pure seed percentage;
- germination percentage;
- hard seed percentage;
- dormant seed percentage;
- total viable percentage;
- origin; and
- test date.

Seed will be used within 5, 12, or 15 months of testing as required by applicable federal, Tribal, and state laws and regulations. The seed tags on the seed sacks will also certify that the seed is "Noxious Weed: None Found." The label must show any noxious weed seed by name and number per pound. If none were found in testing, then the label should state "Noxious Weeds: None Found." Any *Amaranthus* seeds found in the purity and/or noxious exam must be tested using a genetic test to determine if Palmer amaranth is present. If Palmer amaranth is identified in testing, the seed is not legal for sale in Minnesota. Seed rates used on the Project will be based on PLS rate, not actual weight basis. Therefore, to determine the correct application rate if not indicated on the seed tag, a correction calculation will be performed based the purity and total germination.<sup>13</sup> For example, a seed mix that has a specified 10 pounds PLS per acre, 95 percent total germination rate, and is 80 percent pure needs to be applied at the following rate:

$$(95\% \text{ total germination} \times 80\% \text{ purity})/100 = 76\% \text{ PLS}$$
$$10 \text{ pounds PLS per acre} / .76\% \text{ PLS} = 13.2 \text{ pounds per acre actual seeding rate}$$

The species components of individual mixes are subject to availability at the time of purchase. Grass species may be substituted with alternative native or non-invasive species that are included in the Natural Resources Conservation Service guidelines and subject to approval by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity. Any seed substitution must meet all the Project requirements as outlined. The seed tag must always reflect the species in the container and reflect any substitutions.

Seed tags will be collected during seeding activities. The tags will be reviewed by the EI prior to installation to ensure that the seed mix complies with regulatory and Enbridge specifications and

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<sup>13</sup> Percent total germination = (germination + hard seed + dormant).

that it is being applied to the correct location. Seed tags will be maintained for a minimum of 2 years after seeding along with planting records for each specific location. If bulk delivery of seed is made, the above information will still be made available to Enbridge. Off-loading/on-loading of seed will not be performed in a designated wetland area. Enbridge will notify the Minnesota Department of Agriculture, Minnesota Seed Regulatory Program Coordinator so that seed lots may be sampled and tested to confirm compliance with Minnesota Seed Law, as necessary.

Legume seed (if used) will be treated with an inoculant specific to the species and in accordance with the manufacturer's recommended rate of inoculant appropriate for the seeding method (broadcast, drill, or hydroseeding).

### 7.3 SEEDING PERIODS

Recommended seeding dates in Table 7.3-1 are based on the Minnesota BWSR Planting Date Guidance (2019). The dates below describe the conditions that favor establishment of various seed types.

Table 7.3-1 Recommended Seeding Dates						
Species Type and Season of Planting	Spring/Early Summer	Mid-Summer	Early Fall	Mid-Fall	Late Fall (Dormant Seeding)	Frost Seeding
	(see date below)	Jun 30-Aug 1	Aug 1-Sept 10	Sept 10-Oct 15	Oct 15-Frozen Soil	Feb 15-Apr 7
Cool-season Prairie Grasses	Apr 1-Jun 15	Not Recommended				
Warm-season Prairie Grasses	May 15-Jun 30		*	*		
Prairie Sedges and Forbs	May 15-Jun 30		*	*		
Wetland Grasses	Apr 1-Jun 30	Not Recommended		*		
Wetland Sedges and Forbs	Apr 1-June 30	Not Recommended		*		
State Native Construction Mix	Apr 1-Jun 15		*	*		
Oats Temporary Cover	Apr 1-Jun 15			*	*	*
Winter Wheat Temporary Cover	Not Recommended	*			*	*
Source: BWSR, 2019						
Legend						
High Success	Notes: Late fall dormant planting can be conducted earlier if National Weather Service soil temperature data is showing a consistent soil temperature below 40 degrees Fahrenheit for cool-season grasses and legumes or below 50 degrees Fahrenheit for native warm season grasses, forbs, and legume.					
Medium Success						
Not Recommended without Watering or Favorable Weather Conditions						
*Low Success						



Enbridge will delay seeding during frozen ground conditions until the applicable spring seeding period or will complete dormant seeding where conditions allow (refer to Section 7.3.1). Enbridge will install temporary erosion and sediment control BMPs during frozen conditions.

### **7.3.1 Dormant/Winter Seeding**

Dormant seeding is a method used after soil temperatures have cooled to 40 degrees Fahrenheit or cooler to prevent seed germination of cool-season grasses and legumes, and 50 degrees Fahrenheit or below for native warm season grasses, forbs, and legumes (BWSR, 2019). Dormant seeding is only practicable if the soil is not frozen and is preferably done before the first snowfall as the snow cover will prevent loss of seeds from wind and birds (BWSR, 2014). Procedures for applying soil amendments, seedbed preparation, seeding, and mulching are the same as outlined for permanent revegetation in Sections 7.1, and 7.2.

Winter or snow seeding can be implemented during early or late winter when there is less than 1 foot of snow and on a sunny day when seed can move into the soil surface (BWSR, 2019). The freeze/thaw action helps to set the seed firmly in the soil to prepare for spring growth. The seed bed must have been previously prepared for winter seeding to be successful, and it is not recommended for areas prone to spring flooding or running water (BWSR, 2014).

Where dormant or winter seeding is conducted, one or more of the following temporary erosion and sediment control BMPs will be put in place over the freshly seeded area unless the local soil conservation authority, landowner, or land managing agency specifies otherwise. The temporary measures will be in place within 48 hours of seeding, and are as follows:

- certified weed-free straw or hay mulch, at 90 percent cover, anchored;
- hydromulch, according to supplier specifications; and/or
- erosion control blanket.

Additional erosion and sediment control BMPs will be applied as requested by the EI.

## **7.4 SEEDING METHODS**

Seed will be applied uniformly at specified rates across the prepared construction workspace by drilling, broadcasting, hydroseeding, or air seeding. The EI will suspend seeding activities if conditions are such that equipment will cause rutting of the surface in the designated seeding areas. Enbridge will continue to monitor construction workspace conditions to resume seeding activities as site conditions improve and according to the general seeding timing restrictions listed in Section 7.3.

### **7.4.1 Drill Seeding**

The seeding rates provided with the seed mixes in Appendix C are based on seed drill application. Seed drills are commonly used, particularly where additional soil disturbance may cause erosion or weed germination. Advantages of this method include:

- more predictable results when correctly calibrated;
- seed placement below the surface protects the seed resulting in high germination rates;
- tilling prior to seeding is not required; and
- no disturbance of the existing vegetation.

However, there are limitations to where seed drills can be used, very clean seed is needed to avoid clogging the drill, and drills cannot be used for winter seeding. Seed drills also tend to favor the germination of grasses over forbs (BWSR, 2014).

A smooth, firm seedbed is required for this method. Recently tilled sites may require additional treatment such as disc harrowing and rolling to prepare an adequate seedbed and prevent seed from being buried too deep (BWSR, 2014 and 2019). Seeding equipment will be capable of uniformly distributing the seed and sowing it at the required depth. Drills will be equipped with a feeding mechanism that will provide a uniform flow of seed at the desired application rate. Double-disc furrow openers equipped with depth bands and packer wheels to firm the soil over the seed will be used where practicable.

#### **7.4.2 Broadcast Seeding**

Broadcast seeding can be applied to a wide range of surfaces and is the most common method of seeding wetlands. Broadcast seeding rate will increase the drill-seeding rate by approximately 10 to 20 percent depending on site-specific conditions. Seed will be uniformly distributed by a mechanical or hand operated seeder by making two or three passes at right angles to ensure the entire site has been seeded. Following seeding, cultipacking, harrowing, rolling, mulching, or hand raking will be used where conditions allow to keep the seeds in place, except when late fall or winter seeding and snow will promote seed to soil contact. Seed will not be buried deeper than one-half inch and smaller seed will be at the surface. Enbridge will allow the soil to settle after disking or cultipacking the site to smooth the seedbed. Winter broadcast seeding may be conducted if site conditions are appropriate to ensure adequate soil moisture and minimize loss from wind, birds and rodents (BWSR, 2014 and 2019) (see Section 7.3.1).

#### **7.4.3 Hydroseeding**

Hydroseeding is a preferred option for situations where hydrology conditions do not allow for the use of broadcast seeding equipment and seed can be directed on to a site with a hydroseeder. The seedbed must be loosened to allow spaces for seed to make good contact with the soil to prevent washing. Hydroseeding rate will increase the drill seeding rate by 10 to 20 percent depending on site-specific conditions, or the same as broadcast seeding rate. Seed will be applied alone or in a seed, fertilizer, and/or hydromulch slurry. If seeding is applied alone, the amount of hydromulch material will be adjusted to the seed slurry to show where seeding has taken place, providing a means to identify uniform cover of the construction workspace. Hydroseeders will provide continuous agitation and be capable of supplying a continuous, non-fluctuating flow of slurry. Enbridge will pre-approve all hydromulch products, which must be on the applicable state DOT product list. Hydromulch and liquid tackifier products containing plastic/polypropylene fiber additives and Malachite Green (colorant) will not be utilized on this Project.

### **7.5 PERMANENT REVEGETATION**

Permanent vegetation will be established in areas disturbed within the construction work area (permanent easement, TWS, and ATWS) except in actively cultivated areas and standing water wetlands. The seed mixes for permanent seeding include Minnesota state seed mixes that have been developed for a variety of habitats with the intent to increase diversity, create competition for invasive species, and promote plant community resiliency (BWSR, 2019). Enbridge's seed mixes (refer to Appendix C) were selected to augment revegetation via natural recruitment from

native seed stock in the topsoil and are not intended to change the natural species composition. Rates provided are assumed for a drill application and will be adjusted based on the selected application described in Section 7.4 and site-specific conditions (e.g., slope).

### **7.5.1 Timing of Final Seeding and Stabilization**

Upon final grading of the construction workspace, and upon the restoration stream banks as described in Section 2.6, seeding will occur according to the timelines presented in Section 7.3 as weather and soil conditions allow.

## **7.6 UPLAND CONSTRUCTION AREAS**

Appendix C includes upland seed mixes for restoring disturbed woodland and prairie (grassland) areas affected by the Project. These mixes include species that will provide for effective erosion control and revegetation of the project area. These seed mixes will be used by Enbridge as the standard upland mixes unless an alternate seed mix is specified by a landowner or land managing agency.

## **7.7 PERMANENT SEEDING OF WETLAND AREAS**

Enbridge will utilize the results of pre-construction wetland field delineations to identify the wetland type and associated plant communities, in addition to hydrological characteristics of the site. This information, along with site-specific conditions, will be utilized to determine the appropriate seed mix to install. No fertilizer, lime, or mulch will be applied in most wetlands, except peatlands as described in Section 7.7.3.

### **7.7.1 Sedge Meadows Fresh (Wet) Meadows, Wet to Wet-Mesic Prairies**

These communities are generally saturated up to 1 foot of the surface and transition upslope into upland plant communities or downslope into other wetland types. Remnant seed banks can sometimes be relied upon for some species in these communities. The natural revegetation process will be encouraged by the seeds and rhizomes in the topsoil spread back over the construction workspace after pipe installation. Non-standing water wetlands in Minnesota will be seeded with the appropriate Emergent Wetland, Wet Meadow, or Wet Prairie seed mixes provided in Appendix C.

### **7.7.2 Shallow and Deep Marsh, and Shallow, Open Water Communities**

Shallow marshes, deep marshes, and open water communities occur in areas with permanent to seasonal shallow water. The dominant vegetation type is emergent aquatic plants in shallow marshes with a transition to floating-leaved and submergent plants with increasing water depths (BWSR, 2019). Enbridge does not propose to seed standing water wetland areas. It is widely accepted that the reestablishment of vegetation within standing water wetlands occurs best through natural process without supplemental seeding, except where there is repeated disturbance or sediment accumulation (BWSR, 2019).

### **7.7.3 Peatland Communities**

Peatlands include open and coniferous bogs that consist of water-saturated soils composed of partly decayed remains of plants. As discussed in Sections 3.5 and 3.6 and presented in

Figures 32 and 33, construction equipment will operate off of construction mats and topsoil removal will be limited to the trench line. In Sphagnum-dominated peatlands, Enbridge will separate approximately 1 foot of the organic material and store it separately from the subsoil. Once the trench has been backfilled, Enbridge will uniformly spread the previously segregated organic material over the trench area. The application of straw mulch has been shown to improve Sphagnum moss establishment and survival by providing humid conditions. Enbridge will apply certified weed-free straw or hay at a rate of 1.5 tons/acre on top of the reintroduced Sphagnum moss where conditions allow (BWSR, 2014 and 2019).

#### **7.7.4 Shrub and Forested Wetland Communities**

Other than where applicable permits issued for the Project require specific restoration procedures, Enbridge proposes to allow natural reforestation of the TWS area within forested wetlands via stump sprouting, root sprouting, and natural recruitment.

### **7.8 PERMANENT SEEDING OF WATERBODY BANKS**

Enbridge will reestablish stream bank vegetation using the BWSR Riparian seed mixes for the northeast or south and west regions unless an alternate seed mix is requested by applicable agencies. Additional vegetation requirements may also be contained within Project-specific permits. Where a waterbody is located within a wetland, Enbridge will re-seed the banks with the applicable wetland seed mix described in Section 7.7. Refer to Section 2.6 for permanent stabilization timing requirements of waterbodies.

### **7.9 SPECIALIZED SEED MIXES**

Specialized seed mixes will be utilized for restoring areas discussed in the following sections.

#### **7.9.1 Agricultural Ditches**

Enbridge will utilize the BWSR Native Construction seed mix to restore the sides of agricultural ditches where appropriate based on site-specific conditions.

#### **7.9.2 Eroding Bank Stabilization**

Enbridge will utilize the BWSR Eroding Bank Stabilization pilot seed mix to restore and stabilize steep eroding slopes with early and late successional species where appropriate based on site-specific conditions.

#### **7.9.3 Landowner Requests**

Enbridge will provide other specialized seed mixes upon landowner request on a site-specific basis for agricultural and residential areas, which will be identified in the CLL:

- BWSR Conservation Grazing pilot seed mix for native prairie conservation grazing in the south and west Minnesota region;
- BWSR Native Forage Buffer pilot seed mix for haying once or twice per year;

- BWSR Beneficial Insects pilot seed mix to establish diverse vegetation for beneficial insects in agricultural areas for the south and west Minnesota region;
- Lawn mixes to reestablish residential lawns or other types of “turf-type” land cover; or
- Food plot mixes to provide a desirable food source for wildlife, specifically deer.

## **7.10 CONSERVATION RESERVE PROGRAM PROPERTIES**

Enbridge’s Land Agents will contact landowners where the construction workspace crosses land enrolled in Conservation Reserve Program (“CRP”). Enbridge will work with the respective landowners to identify the parcel-specific CRP seed mixes. CRP lands will be seeded at the direction of the landowner per the site-specific landowner CRP requirements for that parcel and no non-CRP approved seed mix will be planted on CRP lands. CRP parcels will also be seeded with Enbridge’s temporary cover seed mix. Seed for CRP seeding will meet the same criteria as other seed described in Section 7.2.

## **7.11 MANAGEMENT AND MONITORING**

Enbridge will monitor and address all areas where stabilization techniques have been implemented in accordance with conditions identified in the applicable Project permits and/or licenses, and Enbridge’s Post-Construction Monitoring Plan.

As described in Enbridge’s Invasive and Noxious Species Management Plan (Appendix B), Enbridge will take all necessary steps to ensure that invasive and noxious species and their propagating parts are not transferred from one location to another.

## **8.0 WINTER CONSTRUCTION**

Enbridge has prepared a Winter Construction Plan that describes the construction procedures that will differ from the procedures outlined in this EPP during frozen conditions. The Winter Construction Plan describes procedures for the following:

- Identifying “winter” or “frozen” conditions;
- Construction of frost/ice roads;
- Snow removal;
- Bridges;
- Trenching and Topsoil Segregation;
- Backfilling;
- Waterbody Crossing Techniques (open cut, dry crossings, and HDDs);
- Trench Excavation, Lowering-In, and Backfill;
- Construction Dewatering;
- Hydrostatic Testing and Discharges;
- Drilling Fluid Response, Containment, and Notification Procedures; and
- Site Stabilization and Restoration.

## **9.0 WASTE MANAGEMENT**

Enbridge will ensure proper handling, storage, and disposal of all solid and hazardous materials and wastes that are used or generated as a result of the Project. Enbridge will ensure that the materials and wastes associated with the Project are properly classified as hazardous materials and/or wastes in accordance with applicable federal and/or state criteria. Enbridge will ensure documentation is maintained to substantiate findings of the regulatory status of materials and/or wastes used and/or generated as a result of the Project.

Enbridge will ensure that all waste materials, including oil or other waste liquids generated as a result of Project work, are collected and placed into suitable DOT specification containers (i.e., labeled and meeting any relevant regulatory requirements). Enbridge will recycle wastes, such as motor oil, where there is an established recycling program available. Wastes such as grease or oily rags will be disposed of in accordance with state requirements. Throughout the duration of the Project, Enbridge will ensure areas are cleaned up and proper off-site disposal of all wastes generated during the Project within the time allowed by the regulations. No wastes will be left on Enbridge property, along the construction workspace, or buried in an excavation or otherwise disposed of on Enbridge property or ROW.

### **9.1 HAZARDOUS WASTES**

Enbridge is responsible for ensuring that all workers are properly trained in the proper storage, handling and disposal of hazardous wastes generated during construction. Enbridge will ensure that any hazardous waste generated from materials brought on-site (e.g., paint cleanup solvents, waste paints) are properly collected, stored, and disposed of in accordance with all applicable regulations. Enbridge will ensure that wastes are properly classified per the federal and state hazardous waste regulations and are properly containerized, marked with start accumulate dates, labeled and, if liquid, stored on-site with secondary containment and otherwise managed in accordance with all U.S. Environmental Protection Agency and DOT regulatory requirements. Enbridge will ensure proper handling, storage, and disposal of the hazardous waste. Personnel will be prohibited from placing, spilling, or pouring wastes onto the ground. Any release of the hazardous waste, hazardous materials, or hazardous substances as a result of the improper handling, storage, or disposal will be rectified to the satisfaction of Enbridge and all applicable regulatory agencies. Enbridge is responsible for immediately reporting the spill as described in Section 10.8.

### **9.2 ABRASIVE BLAST DEBRIS**

Enbridge will ensure that as much spent abrasive blast materials (sandblasting material) are contained and collected as practical and placed into appropriate containers. Enbridge will ensure containers are covered with appropriate means to prevent stormwater from entering the container or impacting stormwater runoff. Enbridge will ensure disposal of the spent abrasive in accordance with applicable federal, Tribal, state, and local regulatory requirements. Enbridge will ensure that spent abrasive is classified as a “hazardous” or “special” waste as defined by applicable federal and state regulations. If the spent abrasive is determined to be hazardous waste as a direct result of constituents of an Enbridge facility or equipment, Enbridge will coordinate proper disposal as previously discussed.

## **10.0 SPILL PREVENTION, CONTAINMENT, AND CONTROL MEASURES**

This section describes planning, prevention, and control measures to minimize impacts resulting from spills of fuels, petroleum products, or other regulated substances as a result of construction.

In the event of a suspected Enbridge pipeline release (or from an adjacent pipeline), Enbridge's Emergency Pipeline Control Center will be notified at 1-800-858-5253 (24-hours/day), as well as the Enbridge EI. Actions requiring emergency response will be coordinated by Enbridge.

### **10.1 PLANNING AND PREVENTION**

Enbridge requires proper planning and preventative measures be implemented to minimize the likelihood of spills, and to quickly and successfully clean up a spill should one occur.

This section sets forth minimum standards for handling and storing regulated substances and cleaning up spills. If the aggregate volume of petroleum stored in tanks and containers greater than or equal to 55 gallons will be equal to or more than 1,320 gallons for any site, Enbridge will prepare and implement a Spill Prevention, Containment, and Control ("SPCC") plan(s) that meets the requirements of 40 Code of Federal Regulations 112. This requirement also extends to any petroleum storage at Enbridge-managed construction yards.

Potential sources of construction-related spills include machinery and equipment failure, fuel handling, transfer accidents, and storage tank leaks. Enbridge will be responsible for implementing, at a minimum, the following planning and prevention measures.

### **10.2 ROLES AND RESPONSIBILITIES**

#### **10.2.1 Spill Coordinator**

A Spill Coordinator will be designated and approved by Enbridge. For all construction related spills, the Spill Coordinator will:

- report all spills to the Enbridge Representative immediately;
- in Minnesota, pursuant to Minnesota Statute Section 115.061, report discharges ("spills") of any material that may cause pollution of state waters immediately to the Minnesota Duty Officer (1-800-422-0798 or 651-649-5451) (see Appendix D);
- within the exterior boundaries of the FdL Reservation, report spills immediately to the FdL Resource Department (1-800-424-8802) (see Appendix D);
- in North Dakota, report discharges immediately to the North Dakota Department of Health or the North Dakota Hazardous Materials Emergency Assistance and Releases Reporting (1-800-472-2121 or 1-701-328-2121) (see Appendix D);
- in Wisconsin, report spills immediately to the Wisconsin Department of Natural Resources (1-800-943-0003);



- report spills to other appropriate federal, Tribal, state, and local agencies as required and described in Appendix D;
- mobilize on-site personnel, equipment, and materials for containment and/or cleanup commensurate with the extent of the spill;
- assist the Emergency Response Contractor (refer to a list of potential contractors provided in Appendix E) and monitor containment procedures to ensure that the actions are consistent with the requirements of this section;
- in consultation with Enbridge and appropriate agencies, determine when it is necessary to evacuate spill sites to safeguard human health;
- in consultation with Enbridge, coordinate with appropriate agencies the need to contact additional parties or agencies;
- complete a Spill Report Form within 24 hours of the occurrence of a spill, regardless of the size of the spill; and
- Prepare and administer the SPCC plan(s) prepared for storage of petroleum on Enbridge sites, if applicable.

### **10.2.2 Environmental Inspector**

The EI will monitor compliance with the provisions of this section to ensure that appropriate agency notifications are made, spill resources are allocated, and cleanup is accomplished in accordance with applicable agency requirements

### **10.2.3 Authorized Personnel**

Authorized Personnel are designated to handle fuel, lubricants, or other regulated substances. Authorized Personnel will be familiar with the requirements of this section and the consequences of non-compliance.

### **10.2.4 Construction Superintendent**

The Contractor's Construction Superintendent or representative will notify the EI immediately of any spill of a petroleum product or hazardous liquid, regardless of volume.

### **10.2.5 Construction Personnel**

Construction Personnel will notify the crew foreman or Spill Coordinator immediately of any spill of a petroleum product or hazardous liquid, regardless of volume.

## **10.3 TRAINING**

Enbridge will train all employees handling fuels and other regulated substances to follow spill prevention procedures. Enbridge will train all employees who handle fuels and other regulated substances to prevent spills and to quickly and effectively contain and clean up spills that may occur in accordance with applicable regulations.

## **10.4 SPILL AND FUELING EQUIPMENT**

- Each construction crew will have adequate absorbent materials and containment booms on hand, to enable the rapid cleanup of any spill that may occur.
- Enbridge will maintain spill kits containing a sufficient quantity of absorbent and barrier materials to adequately contain and recover foreseeable spills. These kits may include, but are not limited to, absorbent pads, straw bales, absorbent clay, sawdust, floor-drying agents, spill containment barriers, plastic sheeting, skimmer pumps, and holding tanks. This equipment will be located near fuel storage areas, near each waterbody crossing, and at other locations as necessary to be readily available to control foreseeable spills.
- Suitable plastic lining materials will be available for placement below and on top of temporarily stored contaminated soils and materials.
- All fueling vehicles, and where necessary, service vehicles, will carry materials adequate to control foreseeable spills. Such material may include, but not be limited to, absorbent pads, commercial absorbent material, plastic bags with ties, and shovels.
- The Spill Coordinator will inform the Authorized Personnel, Construction Personnel, and the Els of the locations of spill control equipment and materials and have them readily accessible during construction activity. Spill kits should be clearly labeled for quick and easy identification in the field.
- All fuel nozzles will be equipped with functional automatic shut-offs.
- Mobile refuelers transporting fuel to on-site construction equipment will travel only on approved access roads.

## **10.5 SUPERVISION AND INSPECTION**

Enbridge will perform a pre-construction inspection and test of applicable equipment to ensure that it is in good working order. During construction, Enbridge will regularly inspect hoses, pipes, valves, containers, and tanks to ensure equipment is in good condition, compatible with the substance stored, and is free of leaks, dents, or other defects. Any equipment that is found to be leaking or in need of repair or replacement will be immediately removed from service and repaired or replaced, prior to resuming work.

## **10.6 STORAGE AND HANDLING OF FUELS/HAZARDOUS LIQUIDS**

### **10.6.1 Fuel Storage – General**

Enbridge will follow proper fuel storage practices, including, but not limited to the following:

- Fuel storage will be at Contractor yards only or as approved by Enbridge in conformance with the required regulatory authorizations and all applicable federal, state and local regulations governing this activity.
- Proper signage at and adjacent to fuel storage areas to include “Fuel Storage Area – No Smoking within 50 feet.”

- Tools and materials needed for maintenance will be kept on-site. Such equipment may include, but not be limited to, plugs of various sizes, 3M tank patches, a hammer, assorted sizes of metal screws with rubber washers, a screwdriver, and plastic tape.
- Fuels, lubricants, waste oil, and any other regulated substances will not be stored in underground storage tanks.
- Storage tanks and containers will conform to all applicable industry codes (e.g., Steel Tank Institute, National Fire Protection Association, Unified Facilities Criteria).
- A suitable secondary containment structure or double-walled tank will be utilized at each fuel storage site. Secondary containment structures will be lined with suitable material (including plastic sheeting) and provide a minimum containment volume equal to 150 percent of the volume of the largest storage vessel.
- Secondary containment areas will not have drains. Precipitation may be drawn off as necessary. If visual inspection indicates that no spillage has occurred in the secondary containment structure, accumulated water may be drawn off and discharged in accordance with Section 5.0. If spillage has occurred in the structure or if visible sheen is present, accumulated waste will be drawn off and pumped into drum storage for appropriate off-site management.

### **10.6.2 Refueling**

All fuel dispensing operations will be attended by Authorized Personnel at all times. Authorized Personnel will be stationed at both ends of the hose during fueling unless both ends are visible and are readily accessible by one person.

### **10.6.3 Refueling, Maintenance, and Fuel Storage Near Wetlands and Waterbodies**

Enbridge requires that the storage of petroleum products, refueling, maintenance, and lubricating operations take place in upland areas that are more than 100 feet from wetlands, streams, and waterbodies (including drainage ditches), and water supply wells. In addition, the Contractor will store hazardous materials, chemicals, fuel, lubricating oils, and used oil, and perform concrete coating activities, outside these areas.

In certain instances, refueling or fuel storage within these areas may be unavoidable due to site-specific conditions or unique construction requirements (e.g., continuously operating pumps). These locations will be approved in advance by the EI. Site-specific precautions, in addition to those practices described above, will be taken when refueling or maintenance activities are required within 100 feet of streams, wetlands, or other waterbodies. These precautions include, but are not limited to:

- adequate amounts of absorbent materials and containment booms will be kept on hand by each construction crew to enable the rapid cleanup of any spill which may occur;
- if fuel will be stored within wetlands or near streams for refueling of continuously operating pumps, secondary containment will be used;

- secondary containment structures will be lined with suitable plastic sheeting, provide a containment volume of at least 150 percent of the storage vessel, and allow for at least 1 foot of freeboard; and
- adequate lighting will be provided for these locations and activities.

#### **10.6.4 Overnight Parking**

Overnight parking of equipment (including, but not limited to, light plants, generators, pumps, and machinery) is not allowed within 100 feet of a wetland or waterbody unless special containment provisions have been implemented and approved by the EI in advance.

### **10.7 INITIAL SPILL MANAGEMENT**

#### **10.7.1 Immediate Response**

Immediately upon discovery of any release of fuel, oil, hazardous material, or other regulated substance, or upon learning of conditions that will lead to an imminent spill, the person discovering the situation will:

- in Minnesota, pursuant to Minnesota Statute Section 115.061, report discharges (“spills”) of any material that may cause pollution of state waters immediately to the Minnesota Duty Officer (1-800-422-0798 or 651-649-5451) (see Appendix D);
- within the exterior boundaries of the FdL Reservation, report spills immediately to the FdL Resource Department (1-800-424-8802) (see Appendix D);
- in North Dakota, report discharges immediately to the North Dakota Department of Health or the North Dakota Hazardous Materials Emergency Assistance and Releases Reporting (1-800-472-2121 or 1-701-328-2121) (see Appendix D);
- in Wisconsin, report spills immediately to the Wisconsin Department of Natural Resources (1-800-943-0003);
- report spills to other appropriate federal, Tribal, state, and local agencies as required and described in Appendix D;
- if safe to do so, initiate actions to contain the fluid that has spilled or is about to spill, and initiate action to eliminate the source of the spill; and
- notify the crew foreman and/or the Spill Coordinator and provide them with the following information:
  - location and cause of the spill;
  - the type of material that has spilled; and
  - whether the spill has reached or is likely to reach any surface water.

Upon learning of a spill or a potential spill the Spill Coordinator will:

- assess the situation and determine the need for further action;

- direct subsequent activities and/or further assign responsibilities to other personnel; and
- notify the EI.

### **10.7.2 Mobilization**

The Spill Coordinator will mobilize on-site personnel, equipment, and materials for containment and/or cleanup commensurate with the extent of the spill. If the Spill Coordinator feels that a spill is beyond the scope of on-site equipment and personnel, the Spill Coordinator will immediately notify the Construction Superintendent that an Emergency Response Contractor is needed to contain and/or clean up the spill. Appendix E contains a list of potential Emergency Response Contractors. The Spill Coordinator will assist the Emergency Response Contractor and monitor containment procedures to ensure that the actions are consistent with the requirements of this section.

## **10.8 SPILL NOTIFICATION RESPONSIBILITIES**

### **10.8.1 Notification Volumes**

The Contractor's Construction Superintendent or representative will notify the Enbridge Representative and the EI immediately of any spill of a petroleum product or hazardous liquid, regardless of volume.

### **10.8.2 Spill Report Form**

The Spill Coordinator will complete a Spill Report Form for each release of a regulated substance, regardless of volume. The Spill Report Form will be submitted to the EI within 24 hours of the occurrence of a spill. Follow-up written reports, associated laboratory analyses, and other documentation may also be required separately on a site-specific basis as directed by the EI.

### **10.8.3 Agency Notification**

Enbridge will report spills to appropriate federal, Tribal, state, and local agencies immediately (or within the specific agency's required reporting thresholds if not immediate). A listing of federal, Tribal, state, and local agencies including reporting thresholds and timeframes is provided in Appendix D.

Enbridge, in coordination with the appropriate federal, Tribal, state, and local agencies will ensure that additional parties or agencies are properly notified. Additionally, Enbridge will ensure that all cleanup, monitoring, remediation, and reporting activities required by a jurisdictional agency are satisfactorily met and will maintain documentation to demonstrate this compliance.

## **10.9 SPILL CONTAINMENT, RESPONSE, AND REMEDIATION**

In the event of a release, Enbridge will abide by all applicable federal, Tribal, state and local regulations with respect to responding to and remediating the spill. Specific cleanup measures for both upland and wetland/waterbody spills are described below.

### 10.9.1 Spill Control – Upland Areas

- If a spill should occur during refueling operations, STOP the operation until the spill is controlled and the situation corrected.
- The source of the spill shall be identified and contained immediately.
- For large releases that occur on land (i.e., above the reportable limits as described in Appendix D), the spilled material will be contained and recovered immediately. Enbridge or, if necessary, an Emergency Response Contractor, will excavate contaminated soil.
- The recovered material and contaminated soil and other contaminated media will be treated and/or disposed of in accordance with all applicable federal, Tribal, state, and local agency requirements and Section 9.0.
- Smaller releases on land (i.e., below the reportable limits as described in Appendix D) shall be cleaned up with absorbent materials. Contaminated soil or other materials associated with these releases shall be collected and managed in accordance with applicable regulations and Section 9.0.
- To the best of ability, flowing spills will be contained and/or absorbed before reaching surface waters or wetlands.
- Absorbent material(s) will be placed over spills to minimize spreading and to reduce penetration into the soil.
- The Spill Coordinator, in consultation with the EI and appropriate agencies, will determine when spill sites will be evacuated as necessary to safeguard human health. Evacuation parameters will include consideration for the potential of fire, explosion, and hazardous gases.

### 10.10 SPILL CONTROL – WETLANDS AND WATERBODIES

In addition to the above measures, the following conditions apply if a spill occurs near or into a wetland or waterbody, regardless of size:

- If a spill occurs during refueling operations, **STOP** the operation until the spill can be controlled and the situation corrected.
- Enbridge will use absorbent booms and pads to contain and recover released materials in standing water, and plastic bags for storage and disposal of used absorbent booms and pads.
- Enbridge will excavate contaminated soils from wetlands and temporarily place them on plastic sheeting in a bermed area, a minimum of 100 feet away from the wetland. Contaminated soils will be covered with plastic sheeting while being temporarily stored and properly managed as soon as possible, in accordance with Sections 9.0 and 10.11.

## **10.11 STORAGE AND DISPOSAL OF CONTAMINATED MATERIALS**

- Appendix E lists potential treatment and disposal facilities for contaminated materials, petroleum products, and other construction-related wastes. Enbridge will recycle those wastes, such as motor oil, where there is an established recycling program available. Wastes such as grease or oily rags shall be disposed of in accordance with state requirements.
- Enbridge will store and dispose of all contaminated soils, absorbent materials, and other wastes in accordance with all applicable federal, Tribal, and state regulations.
- Only licensed carriers may be used to transport contaminated material from the site to a disposal facility.
- If it is necessary to temporarily store excavated soils on site, these materials will be placed on, and covered by, plastic sheeting, and the storage area bermed to prevent and contain runoff.

## **11.0 DRILLING FLUID RESPONSE, CONTAINMENT, AND NOTIFICATION PROCEDURES**

Construction of a pipeline may include the use of trenchless pressurized methods known as the HDD method. Section 3.6 of the Summary of Construction Methods and Procedures (Appendix A) provides a detailed description of this method. Throughout this section, this method is also referred to as “drilling.” The HDD method always includes the use of drilling fluid. The drilling fluid or water is pumped directly to the jets in the drill bit to help excavate the hole and minimize friction between the surrounding soils, creating a pressurized system. This differs from the horizontal bores described in Section 4.1 that may introduce drilling fluids but are non-pressurized and therefore will not have the potential for an inadvertent release outside of the bore pits. 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.

This section elaborates on measures to be implemented if an inadvertent release of drilling fluid occurs despite prevention efforts. Prior to the commencement of drilling operations, construction personnel involved will be informed as to the responsible party(ies) for release containment and response. Enbridge will ensure that the appropriate response personnel and containment equipment are on site for each drill. Enbridge will implement agency-approved Inadvertent Release Response Plans at each HDD location that describe the monitoring, containment, and recovery procedures based on site-specific conditions.

Procedures for HDD monitoring, containment, and recovery during frozen conditions are described in Enbridge’s Winter Construction Plan.

### **11.1 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 pipeline route throughout the process, as follows:

- Enbridge will inform construction inspectors on what to watch for and will make them aware of the importance of timely detection and response actions to any release of drilling fluid.
- At least one full-time personnel will continuously monitor the drill path by inspecting land surfaces and the waterbodies for surface migration 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, a flowing stream 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 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.



- The HDD operator will monitor the annular drilling fluid pressures during pilot hole operations.
- If the HDD operator identifies a sustained loss in fluid pressure or loss of circulation:
  - Shutdown will occur immediately;
  - The operator will immediately notify the construction inspectors of the assumed position of the drill tool; and
  - Enbridge will visually monitor the appropriate portion of the drill path where the drill tool is located to determine if an inadvertent return occurred. Enbridge may perform this monitoring by walking or by using a boat, as appropriate.
- Construction inspectors, EI(s), or the 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 contact the appropriate agencies, including the Minnesota State Duty Officer, if the release occurs in the State of Minnesota, immediately of a surface inadvertent release (refer to Appendix D).

## **11.2 CONTAINMENT, RESPONSE, AND CLEANUP EQUIPMENT**

Containment, response, and cleanup equipment will be available at both sides of an HDD crossing location prior to the commencement to assure a timely response in the event of an inadvertent release of drilling fluid. Containment and response equipment includes, but is not 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 (only necessary where operations are conducted outside of daylight hours); and
- Any other equipment specified by Enbridge based on site visit and specified in the site-specific Inadvertent Release Response Plans.

## **11.3 RESPONSE**

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 EI with the site name, size of release, initial date of release, and GPS location. The EI will photograph the release site and include with the daily inspection report. Enbridge will coordinate containment, response, cleanup and reporting activities with the applicable agencies.

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

### **11.3.1 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.
- If the amount of the surface release exceeds that which can be completely contained with hand-placed barriers, collection sumps may be used (with approval from Enbridge) to remove released drilling fluid by the use of portable pumps and hoses.
- Enbridge will consult with the appropriate regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions the HDD may proceed.

### **11.3.2 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 (see Section 11.5).
- Enbridge will consult with the appropriate regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions the HDD may proceed.

### **11.3.3 Waterbody Locations**

In the event of a drilling fluid release in waterbodies:

- 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.

- Enbridge will consult with the appropriate regulatory agencies to evaluate the circumstances of the release, discuss additional containment or cleanup requirements, and determine whether and under what conditions the HDD may proceed.

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 11.3-1, 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 waterways with significant currents.

TABLE 11.3-1 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	Sand bag isolation structure; vertical culvert	Sand bag isolation structure; vertical culvert	Sand bag 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 and plastic sheeting	Turbidity curtain; Geotextile pipeline weights cofferdam; vertical culvert; bladder dams; jersey barriers and plastic sheeting	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	Sandbag cofferdam; geotextile pipeline weights cofferdam; vertical culvert; jersey barriers and plastic sheeting	Sandbag cofferdam; geotextile pipeline weights cofferdam; vertical culvert; jersey barriers and plastic sheeting	Turbidity curtain; sand bags, bladder dams; water gates (as upstream diversion aid)

TABLE 11.3-1 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
	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)

Enbridge will implement the agency-approved Inadvertent Release Response Plans that provide site-specific information regarding features crossed by each HDD and containment and recovery response tailored to site-specific conditions. Enbridge will 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.

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.

#### 11.4 NOTIFICATION AND RESUMPTION OF SUSPENDED HDD OPERATIONS

The EI will be immediately notified of all drilling fluid releases. If the EI determines the release affects wetland or waterbody areas, they will immediately notify Enbridge Environment and Construction Management and the appropriate regulatory agencies, including the Minnesota State Duty Officer for releases that occur in the State of Minnesota (refer to Appendix D).

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

The conditions under which drilling operations can resume will be discussed with appropriate regulatory agencies and/or field representatives. If containment measures are functioning, and the circumstances and potential impacts of the release are understood, HDD operations will resume.

#### 11.5 CLEANUP

The following measures are to be considered 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 in containers for temporary storage prior to removal from the site to an off-site location that has the applicable landowner, agency or facility approval. Disposal locations may include landowner-approved agricultural lands for land farming, agency- and operator-approved gravel/sand mines, or landfill, or wastewater treatment facility as approved by the operators. Testing required by the landowner, applicable agency, or operator will be performed prior to disposal.
- 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.

## **11.6 RESTORATION AND POST-CONSTRUCTION MONITORING**

Following cleanup activities, restoration and revegetation of affected areas will be completed in accordance with all applicable local, state, Tribal, and federal permits in addition to Enbridge's EPP. Enbridge will monitor the release site as appropriate to assure adequate restoration.

## **11.7 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 IEMs;
- 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 (see Section 11.3), 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, including description of how access was achieved;
- 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).

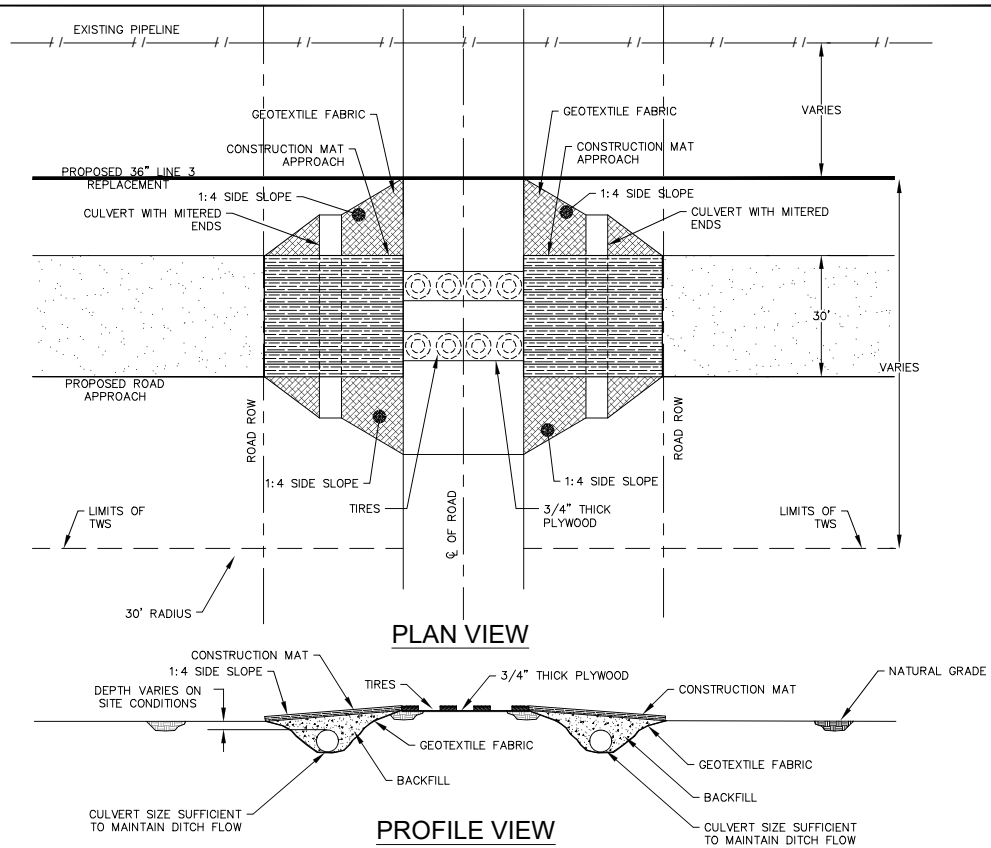
## 12.0 REFERENCES

- Minnesota Board of Water & Soil Resources (“BWSR”). 2014. Minnesota Wetland Restoration Guide. 2<sup>nd</sup> Edition. Available online at: <https://bwsr.state.mn.us/mn-wetland-restoration-guide>. Accessed August 2019.
- BWSR. 2019. Native Vegetation Establishment and Enhancement Guidelines. January 2019. Available online at: <https://bwsr.state.mn.us/sites/default/files/2019-07/Updated%20guidelines%20Final%2007-01-19.pdf>. Accessed August 2019.
- Minnesota Department of Natural Resources (“MDNR”). 2008. Natural Wild Rice in Minnesota: A Wild Rice Study document submitted to the Minnesota Legislature by the MDNR on February 15, 2008. Available online at: [https://files.dnr.state.mn.us/aboutdnr/reports/legislative/20080215\\_wildricestudy.pdf](https://files.dnr.state.mn.us/aboutdnr/reports/legislative/20080215_wildricestudy.pdf). Accessed August 2019.
- Minnesota Pollution Control Agency (“MPCA”). 2016. MPCA wild rice waters database. July 19, 2016. Available online at: <https://www.pca.state.mn.us/document/wq-s6-43xlsx>. Accessed August 2019.



## Figures


																
										LINE 3 REPLACEMENT TYPICAL TEMPORARY ROCK ACCESS APPROACH						
										DWN. BY: YL      DATE 06/07/16						
										CHK. KEH      01/11/18						
										PROD. ENG. MDM      01/11/18						
										PROD. MGR. BS      01/11/18						
H	ISSUED FOR REVIEW				DWA	11/04/19	KEH	MDM	PROD. MGR.		BS	01/11/18	SCALE	NTS	DWN. NO.	Figure 1
NL	REVISION-DESCRIPTION				BY	DATE	CHKD	APPD	CLIENT APP.							

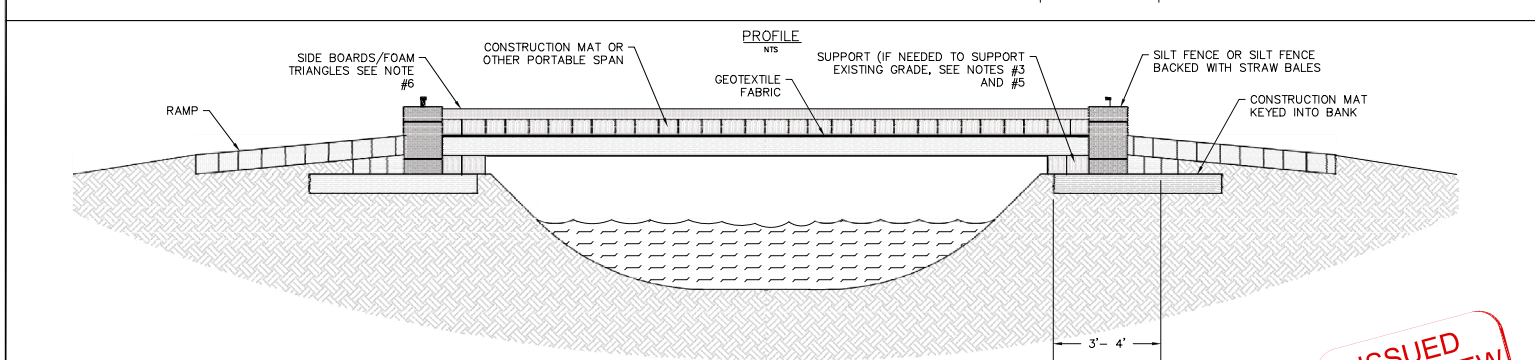
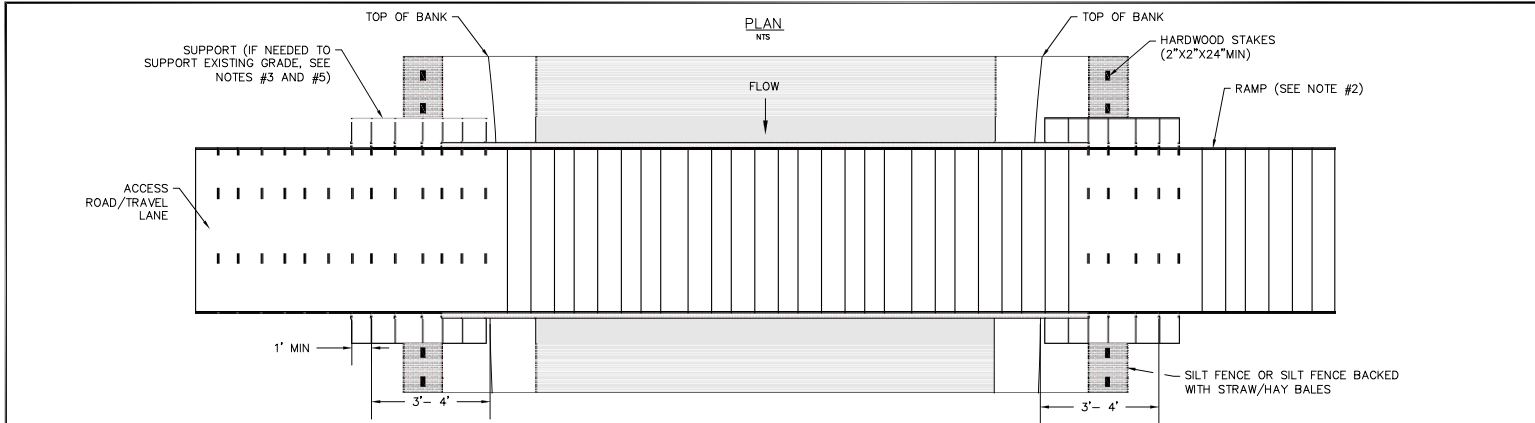


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FOR REVIEW**  
11/04/19

**NOTES:**

1. ALL CULVERT PIPE OR ROCK ENDS OF ROAD ACCESS PADS MUST HAVE A 60 DEGREE ANGLE ON EACH END FOR SAFETY.
2. ALL TIRES AND PLYWOOD MUST BE STORED OUTSIDE ROAD ROW.
3. CULVERTS MUST MEET REQUIREMENTS SET FORTH IN PERMITS FROM AUTHORITY WITH JURISDICTION.
4. TO BE USED ONLY WHERE APPROVED.
5. ALL SLOPES MUST HAVE A MINIMUM GRADE OF 1:4
6. USE 3"-6" DIAMETER CRUSHED ROCK AS FILL WITHIN WETLANDS.
7. CONTRACTORS SHALL SCRAPE OR BRUSH ANY DEBRIS FROM ROAD PER EPP.

												LINE 3 REPLACEMENT TYPICAL TEMPORARY CONSTRUCTION MAT APPROACH					
										DWG. BY: YL				DATE 06/07/19			
										CHK: KEH				01/11/18			
										PROJ. ENGR: MDM				01/11/18			
										PROJ. MGR: BS				01/11/18			
										CLIENT APP:		SCALE		NTS		DWG. NO.	
																Figure 2	

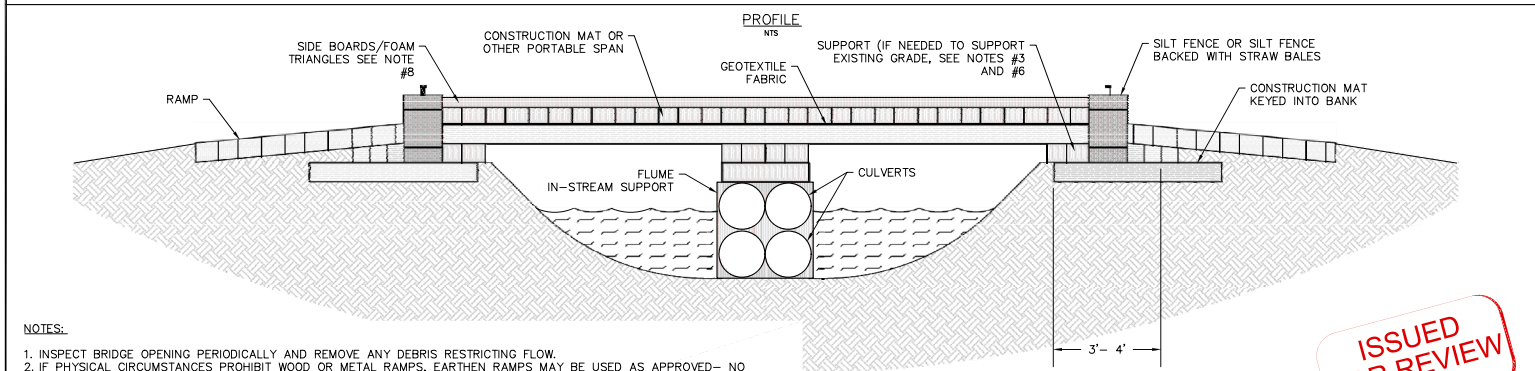
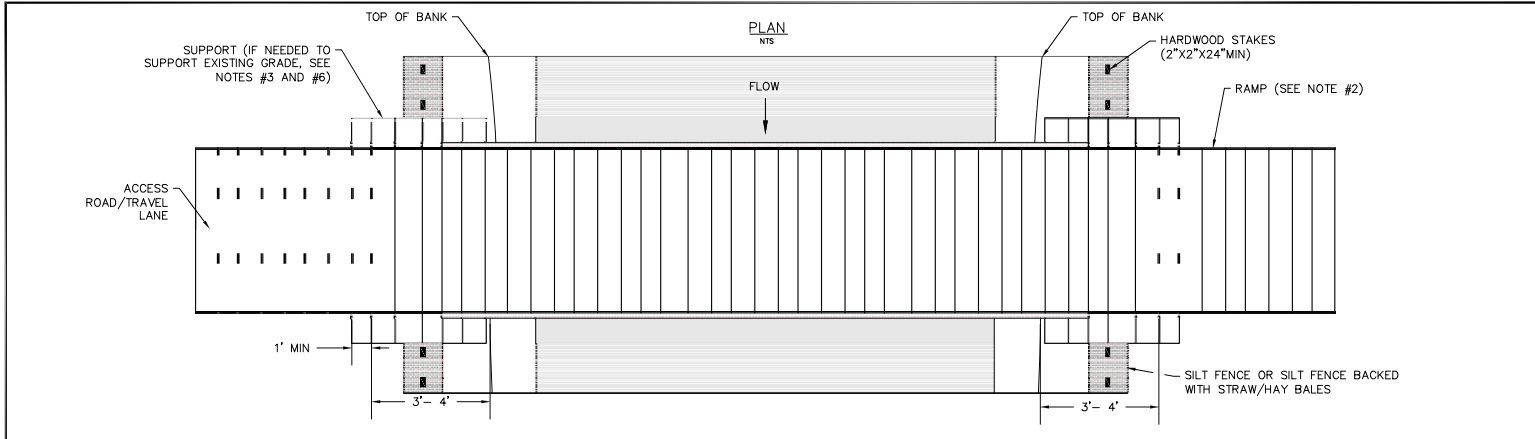


**NOTES:**

1. INSPECT BRIDGE OPENING PERIODICALLY AND REMOVE ANY DEBRIS RESTRICTING FLOW.
2. IF PHYSICAL CIRCUMSTANCES PROHIBIT WOOD OR METAL RAMPS, EARTHEN RAMPS MAY BE USED AS APPROVED- NO TOPSOIL.
3. INSPECT BRIDGE ELEVATION SO BRIDGE REMAINS SUPPORTED ABOVE OHWM.
4. THE BRIDGE MUST SPAN ABOVE OHWM TO OHWM AND IS APPROPRIATE FOR SPANS LESS THAN 13' TOP OF BANK TO TOP OF BANK.
5. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE COMPANY'S ENVIRONMENTAL PROTECTION PLAN.
6. SIDEBARDS WILL BE INSTALLED ON TEMPORARY BRIDGES TO MINIMIZE THE POTENTIAL FOR SEDIMENT TRANSPORT, AND AFFIXED TO THE OUTSIDE OF THE BRIDGE. GEOTEXTILE FABRIC, OR EQUIVALENT, MUST ALSO BE ADEQUATELY SECURED TO THE UNDERSIDE OF THE BRIDGE TO PREVENT MATERIAL FROM FALLING THROUGH THE BRIDGE DECK. THE GEOTEXTILE FABRIC OR AN EQUIVALENT SHOULD BE SECURED TO THE BOTTOM OF THE BRIDGE AND WRAPPED AROUND THE SIDEBARDS IN A CONTINUOUS FASHION.

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								<b>LINE 3 REPLACEMENT TYPICAL CLEAR SPAN BRIDGE</b>	
						DWN. BY: KEH CHK: NKD PROJ. MGR.: CP PROJ. MGR.: BS	DATE: 8/16/18 DATE: 8/16/18 DATE: 8/16/18 DATE: 8/16/18		
A	ISSUED FOR REVIEW	JDW	11/04/19	KEH	NKD			SCALE	NTS
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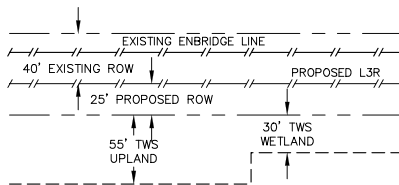
**NOTES:**

1. INSPECT BRIDGE OPENING PERIODICALLY AND REMOVE ANY DEBRIS RESTRICTING FLOW.
2. IF PHYSICAL CIRCUMSTANCES PROHIBIT WOOD OR METAL RAMPS, EARTHEN RAMPS MAY BE USED AS APPROVED— NO TOPSOIL.
3. INSPECT BRIDGE ELEVATION SO BRIDGE REMAINS SUPPORTED ABOVE OHWM.
4. THE CULVERT SUPPORT MUST BE ANCHORED TO THE STREAM BOTTOM AND MAY NOT BE SUPPORTED WITH FILL.
5. THE BRIDGE MUST SPAN ABOVE OHWM TO OHWM.
6. ADDITIONAL SUPPORT MUST BE ADDED ON TOP OF BANK AND UNDER SPAN IF THE SPAN IS 13' WIDE OR GREATER, OR IF INITIAL SUPPORT STARTS TO SETTLE.
7. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSPECTED AND MAINTAINED IN ACCORDANCE WITH THE COMPANY'S ENVIRONMENTAL PROTECTION PLAN.
8. SIDEBOARDS WILL BE INSTALLED ON TEMPORARY BRIDGES TO MINIMIZE THE POTENTIAL FOR SEDIMENT TRANSPORT, AND AFFIXED TO THE OUTSIDE OF THE BRIDGE. GEOTEXTILE FABRIC, OR EQUIVALENT, MUST ALSO BE ADEQUATELY SECURED TO THE UNDERSIDE OF THE BRIDGE TO PREVENT MATERIAL FROM FALLING THROUGH THE BRIDGE DECK. THE GEOTEXTILE FABRIC OR AN EQUIVALENT SHOULD BE SECURED TO THE BOTTOM OF THE BRIDGE AND WRAPPED AROUND THE SIDEBOARDS IN A CONTINUOUS FASHION.

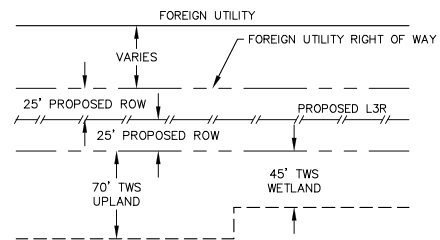
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11/04/19

						<b>ENBRIDGE</b>	
						LINE 3 REPLACEMENT TYPICAL NON-CLEAR SPAN BRIDGE	
						DATE	8/16/18
						CHK	NKD
						PROJ. ENGR.	8/16/18
						BS	8/16/18
						SCALE	NTS
						DWG. NO.	Figure 4
A	ISSUED FOR REVIEW	JDW	11/04/19	KEH	NKD		
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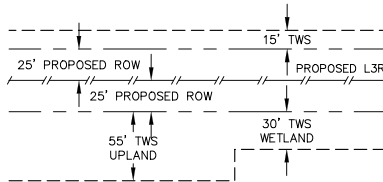
### CO-LOCATED WITH ENBRIDGE LINES



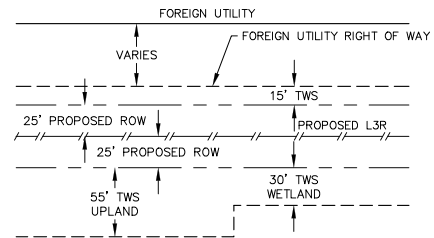
### CO-LOCATED WITH FOREIGN UTILITY



### GREENFIELD




### CO-LOCATED WITH FOREIGN UTILITY IN SATURATED WETLANDS



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#### NOTES:

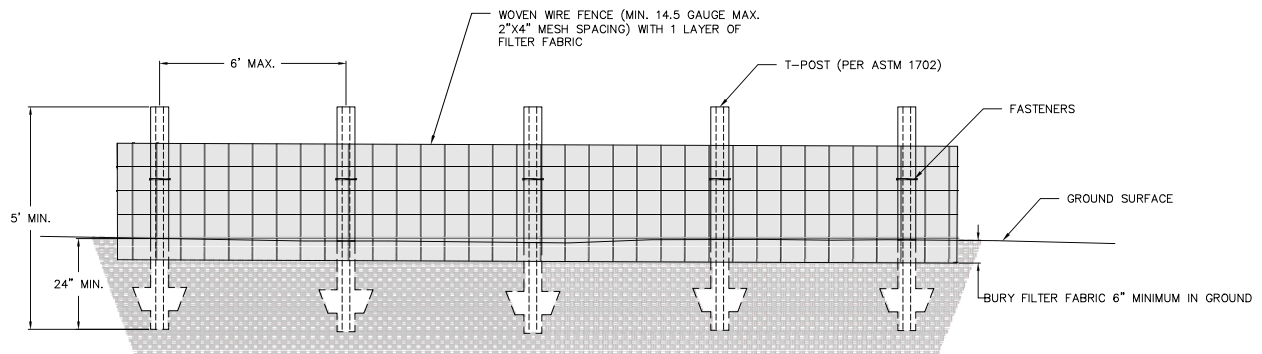
1. WORK SPACE AND LINE SPACING SHOWN IS TYPICAL FOR MOST SITUATIONS, TYPICAL CONSTRUCTION RIGHT OF WAY LIMITS ARE 120' IN UPLANDS, 95' IN WETLANDS.
2. ADDITIONAL NECK DOWNS MAY BE REQUIRED FOR ENVIRONMENTAL, AGENCY, OR LANDOWNER CONCERNS. REFER TO CONSTRUCTION ALIGNMENT SHEETS AND LINE LIST FOR FINAL CONSTRUCTION SPACING.
3. DIMENSIONS AND LOCATIONS OF ADDITIONAL TEMPORARY WORKSPACE VARY AND ARE BASED ON SITE SPECIFIC CONDITIONS.

								LINE 3 REPLACEMENT TYPICAL WORKSPACES AND PERMANENT ROW	
						DATE: 07/03/17	CHK: KEH		
						PROJ. ENGR: MDM	PROJ. MGR: BS	DATE: 08/04/17	SCALE
D	ISSUED FOR REVIEW	AJM	11/04/19	KEH	MDM	CLIENT APP.	NTS	DWG. NO.	Figure 5
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.			

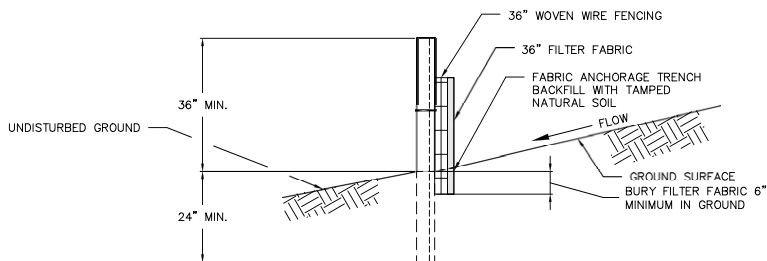


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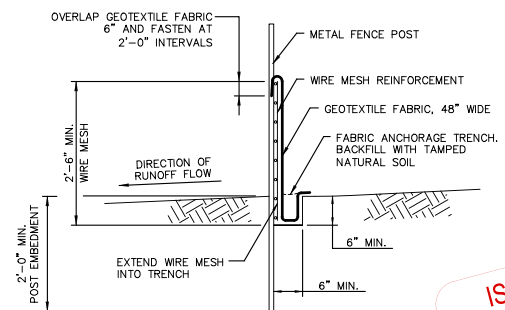
Figure 6



SUPER SILT FENCE  
PLAN



36\"/>



48\"/>

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11/04/19

**NOTES:**

1. FENCE POST SPACING SHALL NOT EXCEED 6' TO CENTER.
2. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO T-POSTS WITH EITHER ZIP TIES OR WIRE TIES THAT HAVE A MINIMUM TENSILE STRENGTH OF 50 LBS.
3. FILTER FABRIC TO BE FASTENED TO WOVEN WIRE FENCE.
4. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY SIX INCHES AND FOLDED.
5. MAINTENANCE SHALL BE PERFORMED AS NEEDED BY ENBRIDGE EPP.
6. ENBRIDGE WILL NOT REQUIRE SUBMITTALS AS SPECIFIED IN ASTM A702.
7. FILTER FABRIC WILL CONSIST OF SD WOVEN OR NON-WOVEN GEOTEXTILE MATERIAL THAT IS A GRAB TENSILE STRENGTH OF 100 LBS, AN APPARENT OPENING SIZE OF A NO. 30 SIEVE, A UV STABILITY 500 H AT 70%.


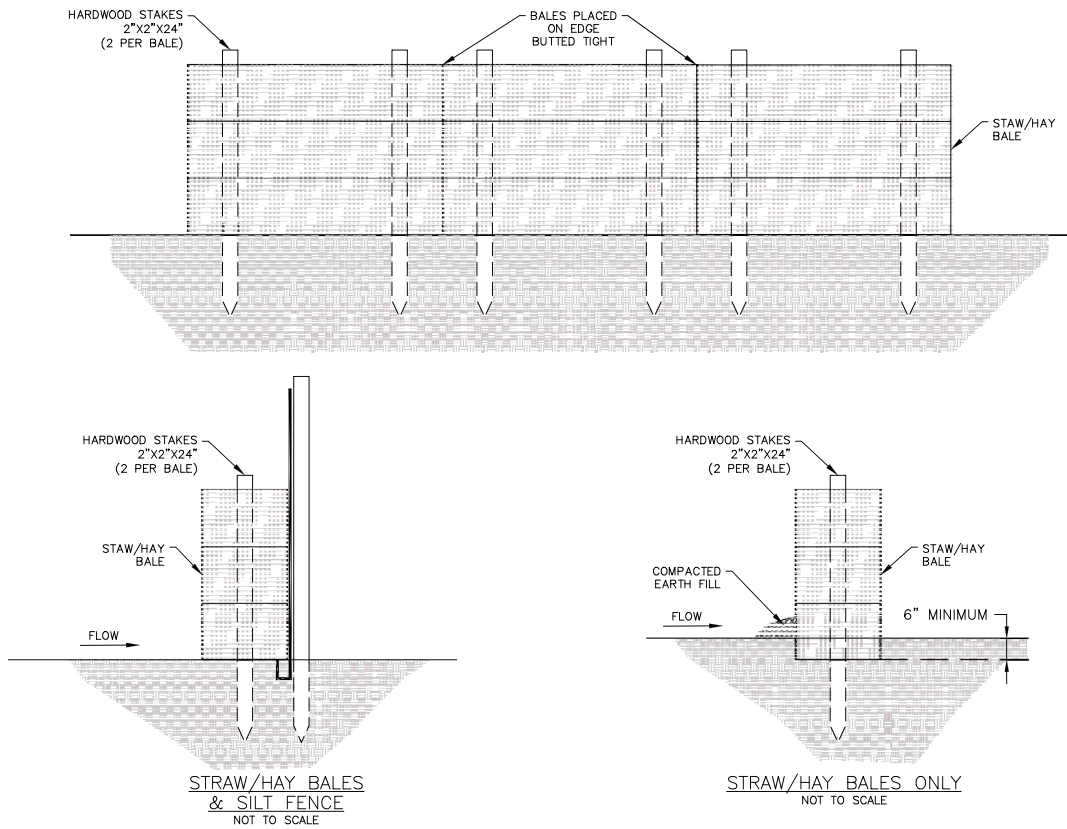

								LINE 3 REPLACEMENT TYPICAL SUPER SILT FENCE	
						DATE REC'D	DATE		
						CHK.	04/25/19		
						PROJ. ENGR.	04/30/19		
						PG	04/30/19		
						PROJ. MGR.	KD	04/30/19	
D	ISSUED FOR REVIEW					AJM	11/04/19	KEH	KD
NO.	REVISION-DESCRIPTION					BY	DATE	CHK'D	APP'D
								CLIENT APP.	
								SCALE	DWG. NO.
								NTS	Figure 7

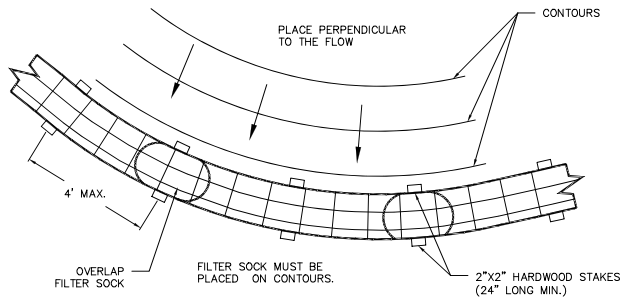
Figure 7



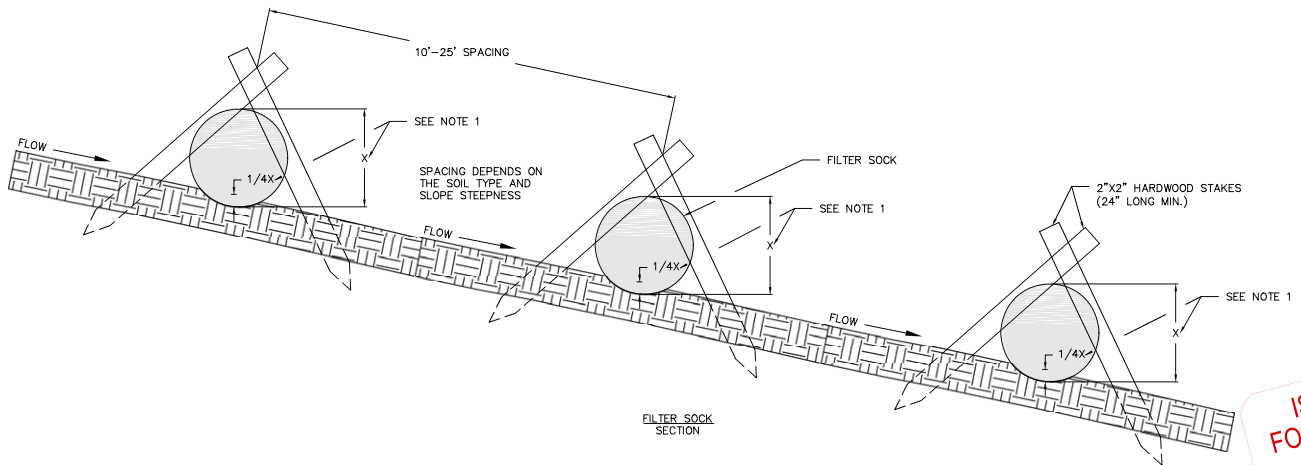


**ISSUED  
FOR REVIEW**  
11/04/19

							
						LINE 3 REPLACEMENT TYPICAL STRAW/HAY-BALE INSTALLATION	
						NTS	
						Figure 8	
</							



FILTER SOCK  
PLAN




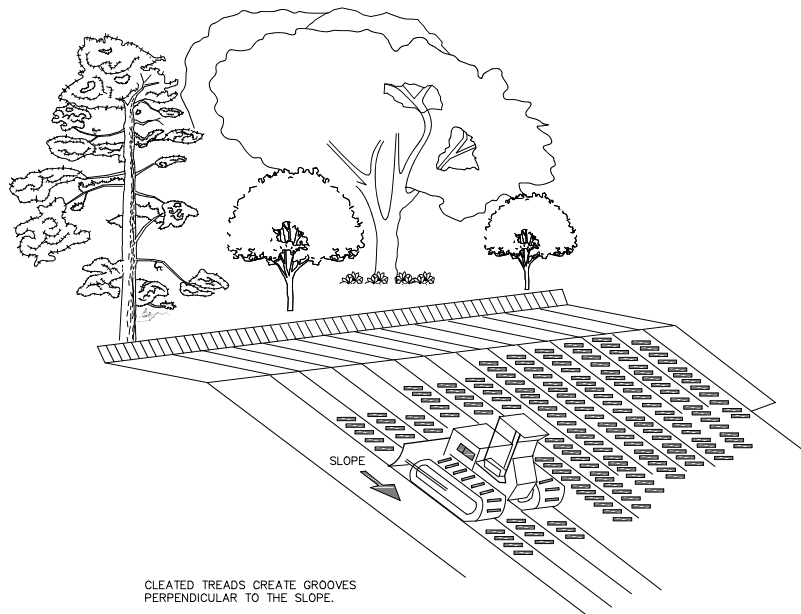
FILTER SOCK  
SECTION

**ISSUED  
FOR REVIEW**  
11/04/19

**NOTES:**


1. FILTER SOCKS RANGE FROM 4" TO 24" IN DIAMETER. X IS REPRESENTING THE DIAMETER OF THE SOCK.  $\frac{1}{4}X$  IS REPRESENTING THE DEPTH OF TRENCHING THE FILTER SOCK.

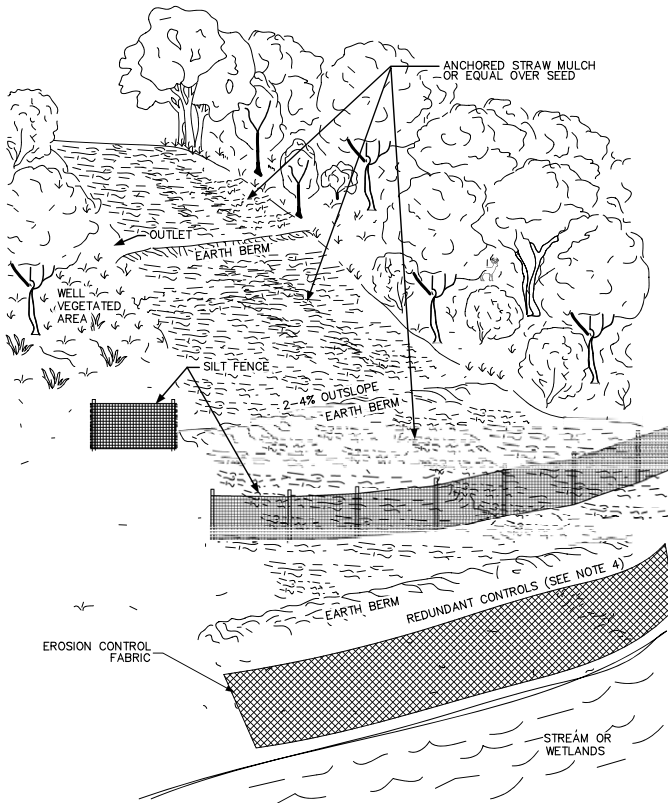
				DRAWN BY: JDW		DATE: 04/25/19	 LINE 3 REPLACEMENT TYPICAL FILTER SOCK	SCALE: NTS DWG. NO.: Figure 9
				CHK: KEH		DATE: 04/30/19		
				PROJ. ENGR: DG		DATE: 04/30/19		
				PROJ. MGR: KD		DATE: 04/30/19		
E	ISSUED FOR REVIEW	DWA	11/04/19	KEH	KD			
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.		



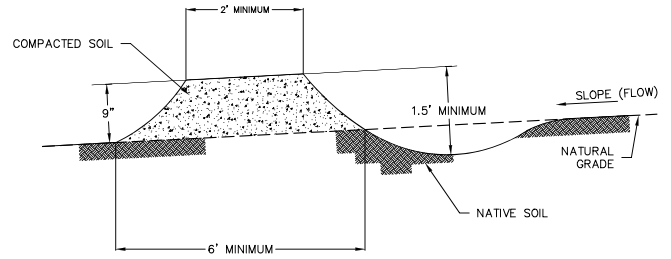
CLEATED TREADS CREATE GROOVES  
PERPENDICULAR TO THE SLOPE.

ISSUED  
FOR REVIEW  
11/04/19

											
										LINE 3 REPLACEMENT TYPICAL CAT TRACKING	
										SCALE	DWG. NO.
										NTS	Figure 10



PERSPECTIVE VIEW




EARTH BERM DETAIL

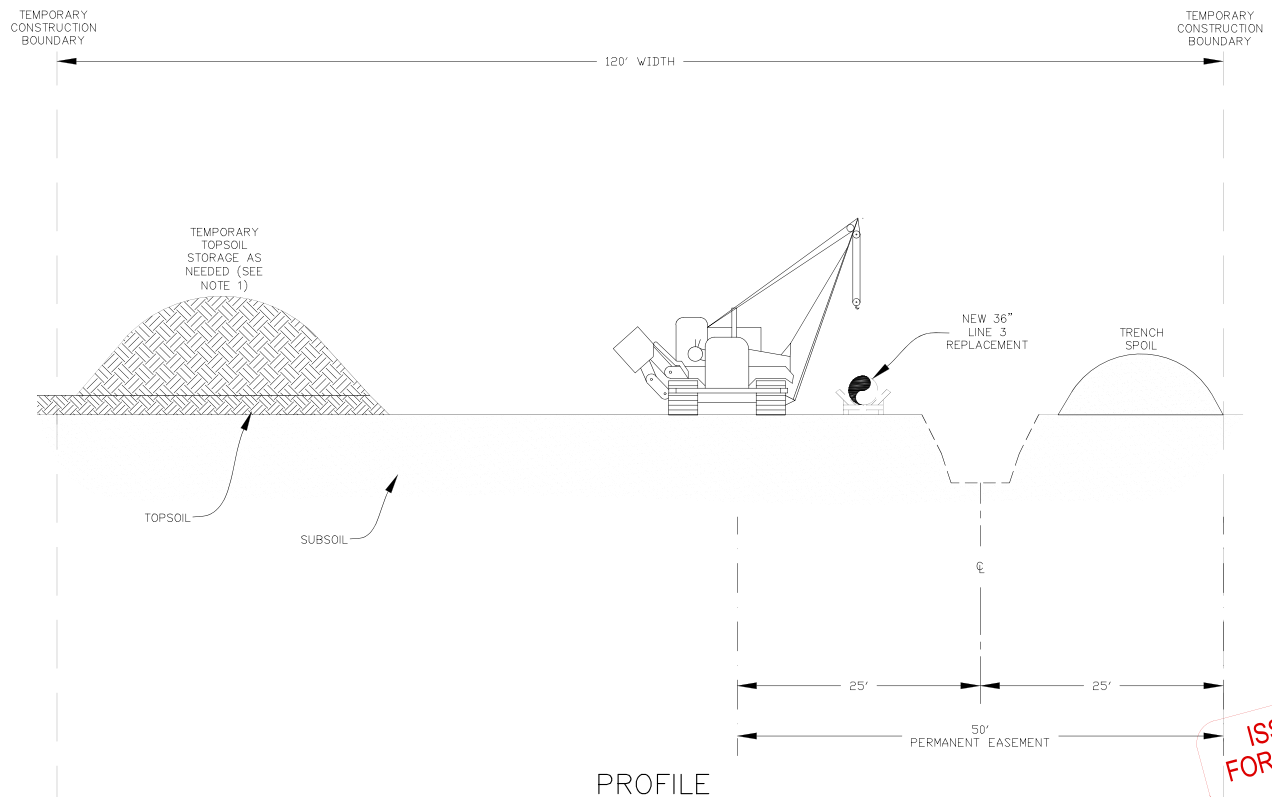
NOTES:

1. BERMS SHALL BE CONSTRUCTED WITH 2 TO 4 PERCENT OUTSLOPE.
2. BERMS SHALL BE OUTLETED TO WELL VEGETATED STABLE AREAS, FILTER SOCKS, SILT FENCES, STRAW BALES, ROCK APRONS, OR SUMPS.
3. SILT FENCE REMOVED WHEN VEGETATION ESTABLISHED.
4. LOWEST BERM MAY BE OMITTED IF SILT FENCE OR STRAW BALES ARE INSTALLED AT THAT LOCATION, SUBJECT TO APPROVAL.
5. SEE SECTION 2.2 REGARDING ECD PLACEMENT AT SURFACE WATERS.
6. BERMS SHALL BE PLACED AS LISTED BELOW:

SLOPE%	APPROXIMATE SPACING (FT)
3-5	250
5-15	200
15-25	150
>25	<100

ISSUED  
FOR REVIEW  
11/04/19

										
						DWG. NO. DATE		LINE 3 REPLACEMENT TYPICAL TEMPORARY SLOPE BREAKERS PERSPECTIVE & ELEVATION VIEW		
						CHK. DWA 10/25/19				
						CHK. KEH 10/25/19				
						PROJ. ENGR. DC 10/25/19				
						PROJ. MGR. KD 10/25/19		SCALE	NTS	DWG. NO. Figure 11
						CLIENT APP.				
A	ISSUED FOR REVIEW					DWA	11/04/19	KEH	KD	
NO.	REVISION-DESCRIPTION					BY	DATE	CHK'D	APP'D	



PROFILE

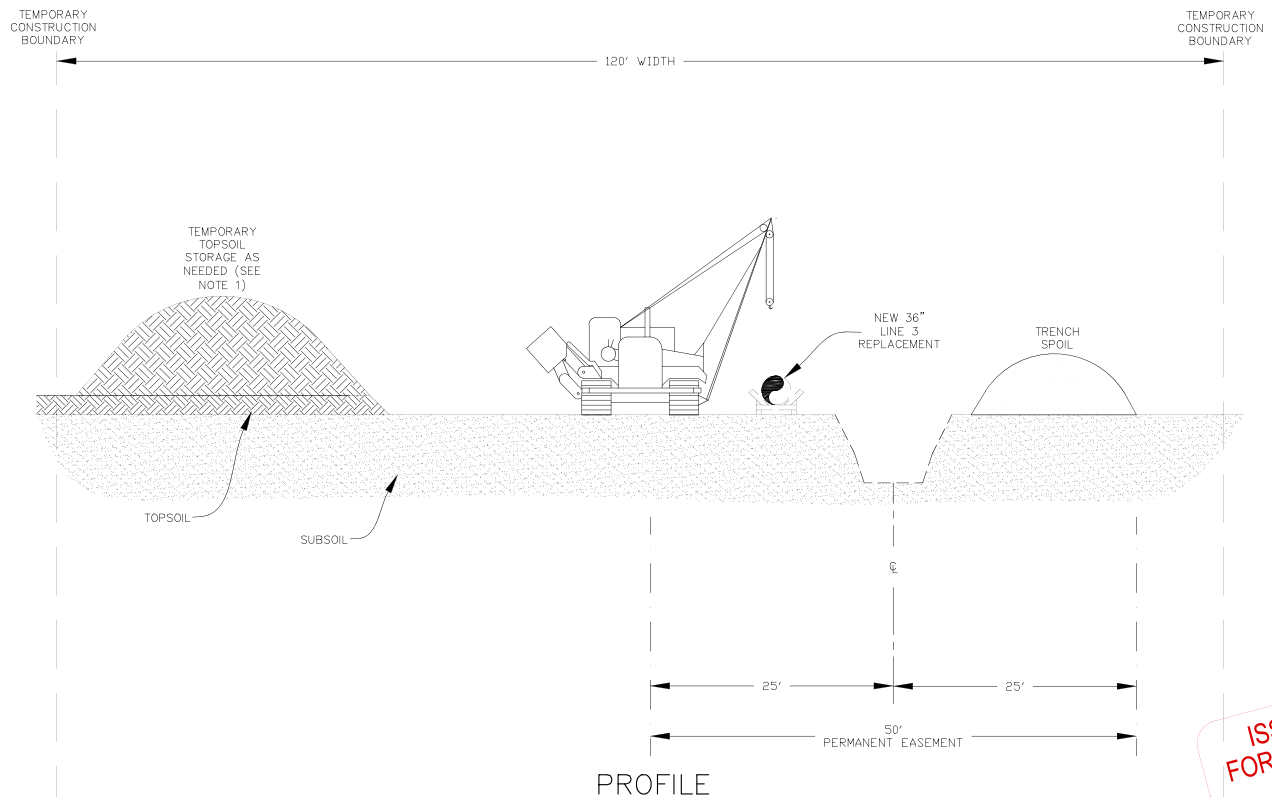
**ISSUED  
FOR REVIEW**  
11/04/19

NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATION APPROVED BY THE COMPANY.
2. TYPICALLY USED IN AGRICULTURAL AREAS INCLUDING ACTIVE CROPLAND, PASTURE AND HAYFIELDS.

					DATE: 11/01/19			<b>LINE 3 REPLACEMENT</b> TYPICAL TOPSOIL SEGREGATION FULL CONSTRUCTION WORKSPACE (25' WORKSPACE OFFSET)	
					CHK:	ND			
					PROJ. ENGR:	RF			
					PROJ. MGR:	TL			
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	TL				
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	TL	11/01/19	SCALE

NTS DWG. NO. Figure 12



PROFILE

ISSUED  
FOR REVIEW  
11/04/19

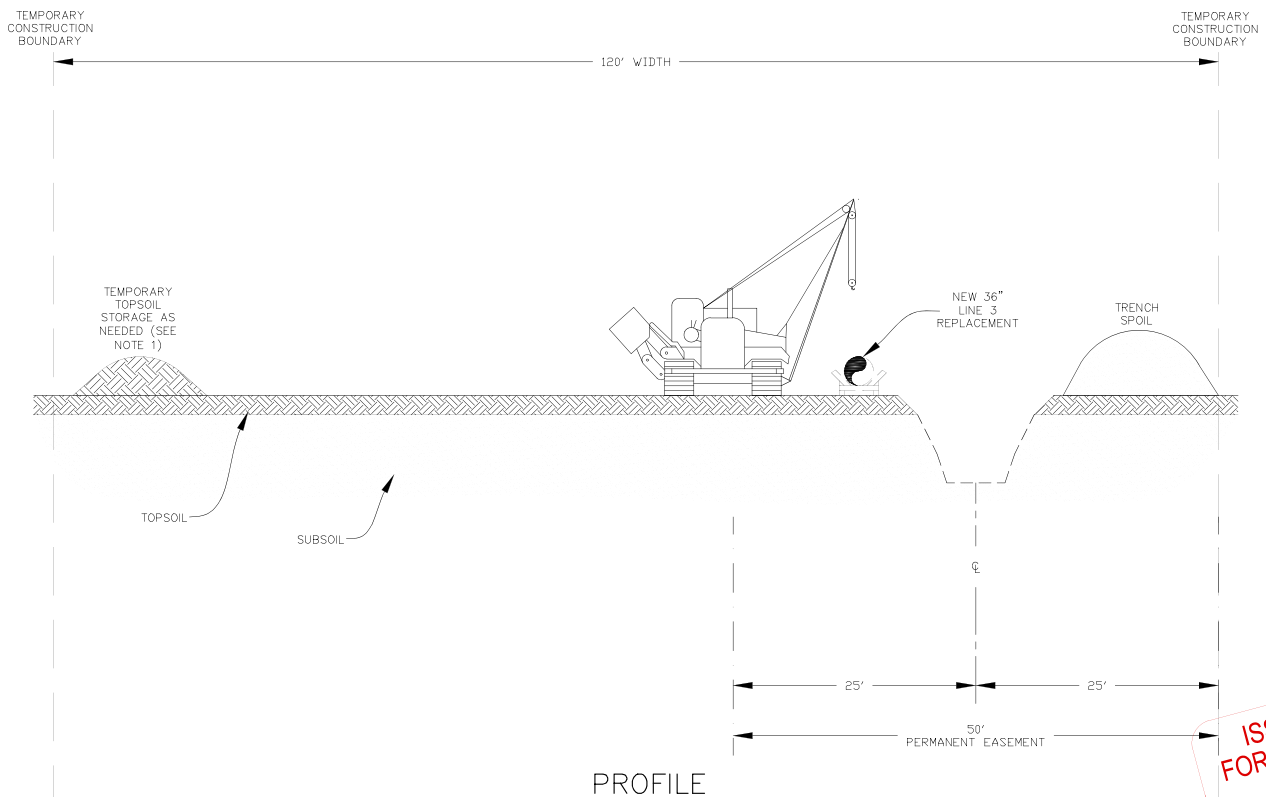
NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATION APPROVED BY THE COMPANY.
2. TYPICALLY USED IN AGRICULTURAL AREAS INCLUDING ACTIVE CROPLAND, PASTURE AND HAYFIELDS.

				DATE BY		CHK.	DATE
						ND	11/01/19
				PROD. ENGR.		RF	11/01/19
				PROD. MGR.		TL	11/01/19
				CLIENT APP.			
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	TL		
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	

**ENBRIDGE**  
LINE 3 REPLACEMENT  
TYPICAL TOPSOIL SEGREGATION  
FULL CONSTRUCTION WORKSPACE  
(40' WORKSPACE OFFSET)

SCALE NTS DWG. NO. Figure 13



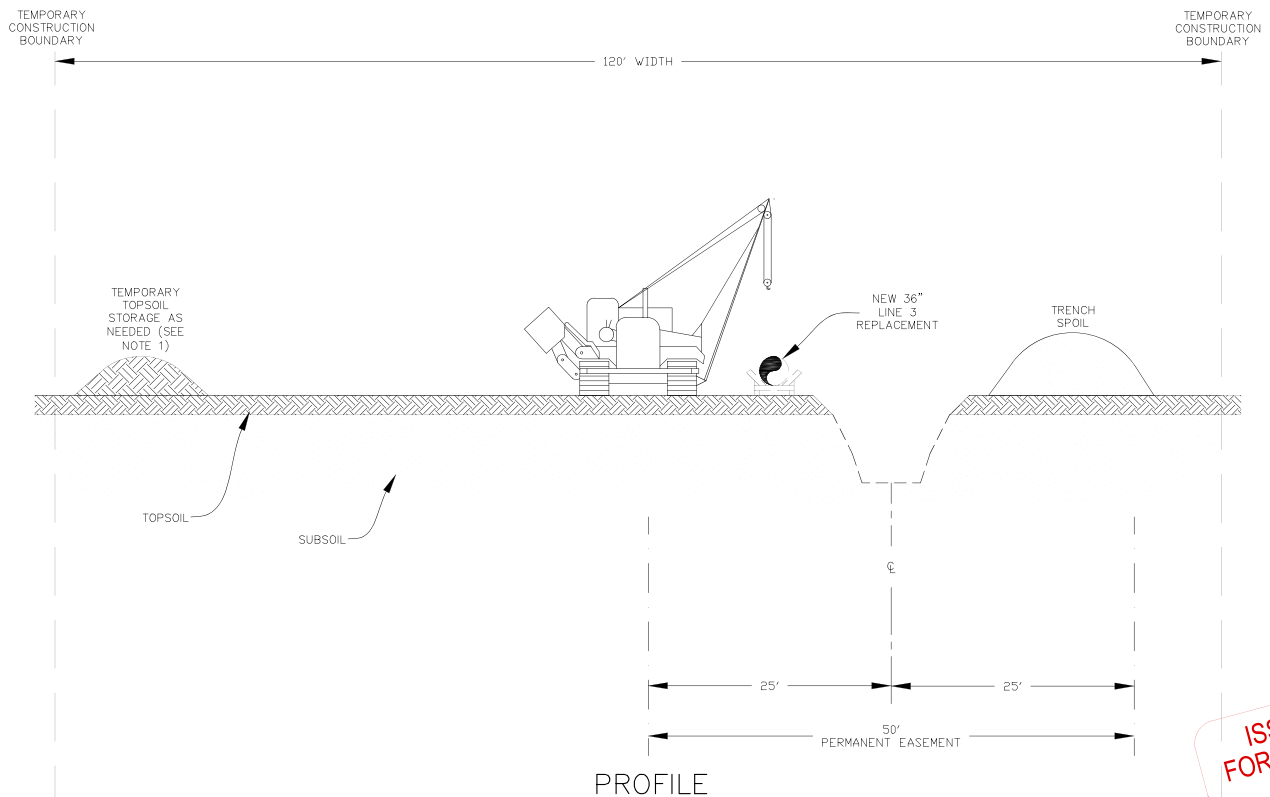
PROFILE

**ISSUED FOR REVIEW**  
11/04/19

NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATION APPROVED BY THE COMPANY.
2. TYPICALLY USED IN WETLANDS, FORESTED COMMUNITIES AND WHERE REQUESTED BY LANDOWNER OR LAND MANAGING AGENCY.
3. TOPSOIL NOT SEGREGATED IN STANDING WATER WETLANDS UNLESS SPECIFIED BY LANDOWNER OR LAND MANAGING AGENCY.

								<b>LINE 3 REPLACEMENT TYPICAL TOPSOIL SEGREGATION TRENCH LINE ONLY (25' WORKSPACE OFFSET)</b>	
						DRW. BY: KEH	DATE: 11/01/19		
						CHK. ND	DATE: 11/01/19		
						PROJ. ENGR. RF	DATE: 11/01/19		
						PROJ. MGR. TL	DATE: 11/01/19		
						CLIENT APP.	DATE: 11/01/19	SCALE: NTS	DWG. NO. Figure 14
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D				
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	TL				



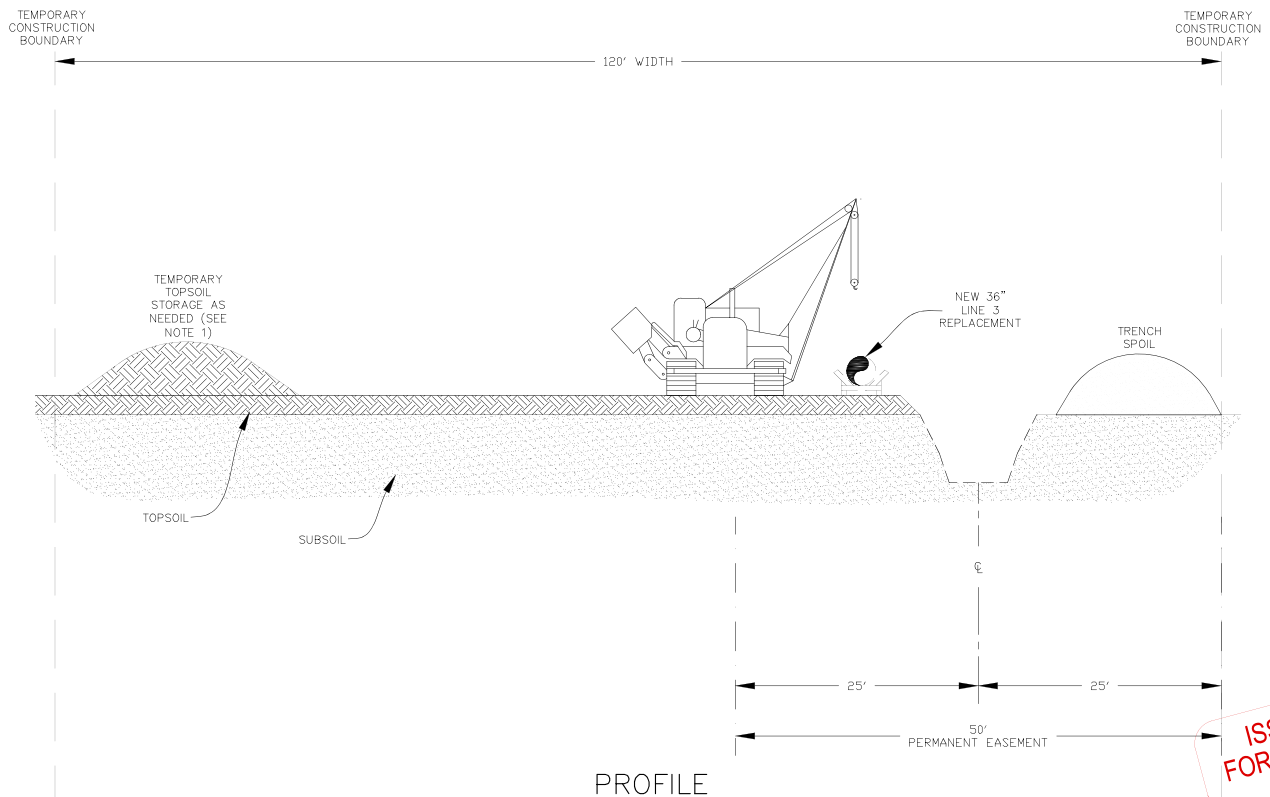
**ISSUED  
FOR REVIEW**  
11/04/19

**NOTES:**

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATION APPROVED BY THE COMPANY.
2. TYPICALLY USED IN WETLANDS, FORESTED COMMUNITIES AND WHERE REQUESTED BY LANDOWNER OR LAND MANAGING AGENCY.
3. TOPSOIL NOT SEGREGATED IN STANDING WATER WETLANDS UNLESS SPECIFIED BY LANDOWNER OR LAND MANAGING AGENCY.

						DWN: BY KEH DATE 11/01/19		 LINE 3 REPLACEMENT TYPICAL TOPSOIL SEGREGATION TRENCH LINE ONLY (40' WORKSPACE OFFSET)	
						CHK: ND	11/01/19		
						PROJ. MGR. RF	11/01/19		
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	TL	PROJ. MGR. TL	11/01/19	SCALE	
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.		NTS	DWG. NO. Figure 15



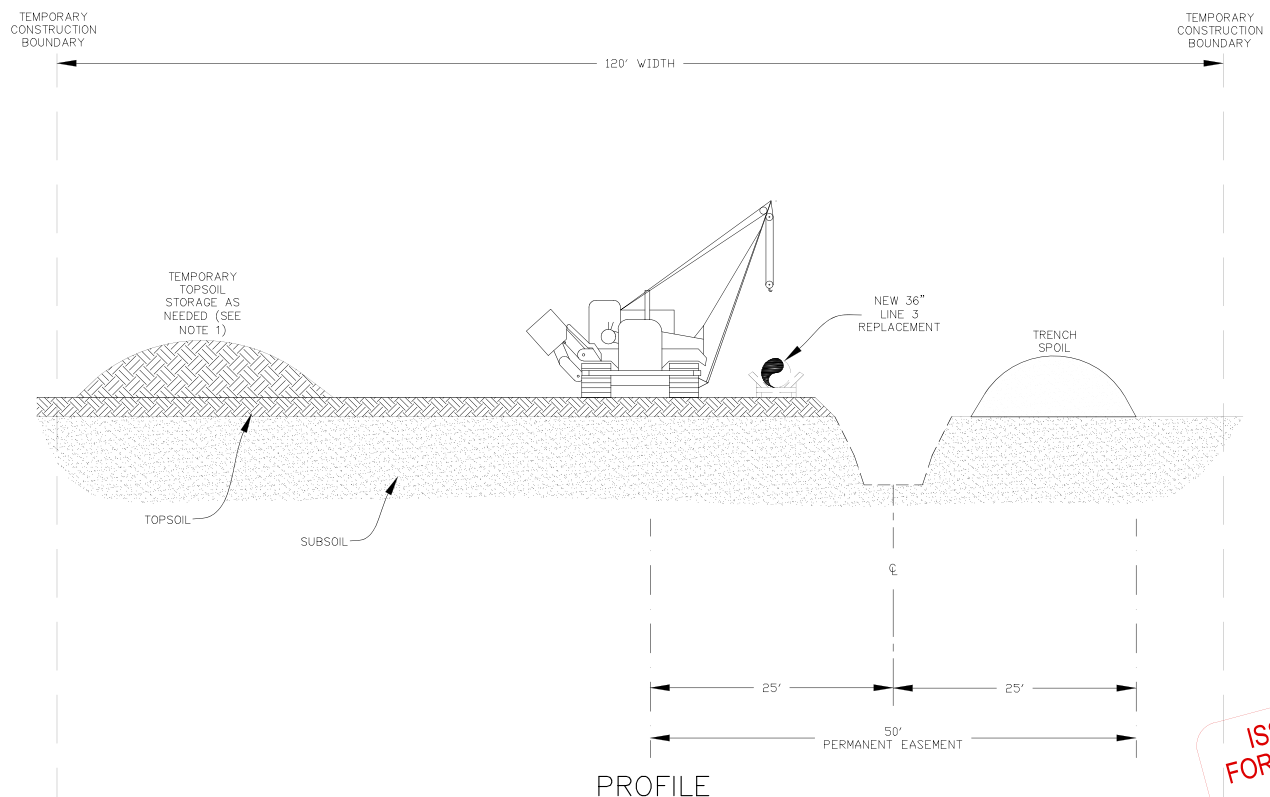


PROFILE

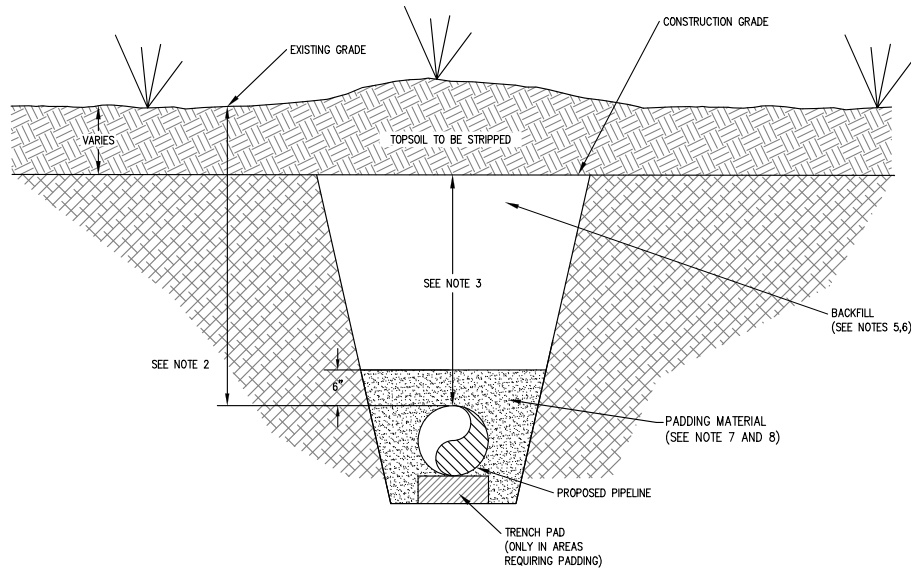
NOTES:

1. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATION APPROVED BY THE COMPANY.
2. ALTERNATIVE TOPSOIL SEGREGATION METHOD USED ON SITE SPECIFIC BASIS OR AS REQUESTED BY LANDOWNER OR LAND MANAGING AGENCY.

						DNL: 011		KEH	11/01/19
						CHK:		ND	11/01/19
						PROJ. MGR:		RF	11/01/19
						CLIENT APP:		TL	11/01/19
						SCALE		NTS	DWG. NO.
								Figure 16	



NTS	DWG. NO.	Figure 17
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#### NOTES

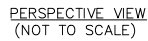
1. DEPTH OF COVER WILL VARY DEPENDING ON LAND USE.
2. (MN ONLY) MINIMUM OF 54" FROM CONSTRUCTION GRADE.
  - a. IN THE REQUISITE AREAS WHERE WE DO NOT HAVE A DEPTH OF COVER WAIVER SPECIFIC TO THE MN STATUTE 216G.07.
3. MINIMUM OF 48" FROM CONSTRUCTION GRADE UNLESS STATED OTHERWISE ON THE ALIGNMENT SHEETS OR LINE LIST.
  - a. (MN ONLY) IN THOSE AREAS WHEREIN WE HAVE A WAIVER OR ARE OUTSIDE OF THOSE AREAS DEFINED IN THE MN STATUTE 216G.07.
4. DEPTH OF COVER SHALL BE MEASURED AS THE SHORTEST DIMENSION FROM THE TOP OF THE PIPE, OR BUOYANCY CONTROL DEVICE TO THE GRADED RIGHT OF WAY.
5. REFER TO CONSTRUCTION SPECIFICATIONS REGARDING ROCK IN BACKFILL.
6. SIDE OF TRENCH TO BE SLOPED IN ACCORDANCE WITH OSHA SAFETY REGULATIONS REGARDING EXCAVATIONS.
7. THE PADDING MATERIAL SHALL BE PLACED ON THE PIPE USING A PROCEDURE THAT DOES NOT DAMAGE THE COATING OR PIPE.
8. THE MATERIAL USED FOR PADDING SHALL BE WELL GRADED FROM GRANULAR MATERIAL WITH A MAXIMUM PARTICLE SIZE OF 1.5 INCHES.

ISSUED  
FOR REVIEW  
11/04/19

#### MN STATUTE 216G.07 PROTECTING PUBLIC FACILITIES AND AGRICULTURAL LAND:

SUBDIVISION 1. DEPTH OF COVER, UNLESS WAIVED IN THE MANNER PROVIDED IN SUBDIVISION 2 OR 3, ANY PIPELINE INSTALLED AFTER MAY 28, 1979, SHALL BE BURIED WITH A MINIMUM LEVEL COVER OF NOT LESS THAN 4-1/2 FEET IN ALL AREAS WHERE THE PIPELINE CROSSES THE RIGHT-OF-WAY OF ANY PUBLIC DRAINAGE FACILITY OR ANY COUNTY, TOWN OR MUNICIPAL STREET OR HIGHWAY AND WHERE THE PIPELINE CROSSES CULTIVATED AGRICULTURAL LAND. WHERE THE PIPELINE CROSSES THE RIGHT-OF-WAY OF ANY DRAINAGE DITCH, THE PIPELINE SHALL BE AT LEAST 4-1/2 FEET BELOW THE AUTHORIZED DEPTH OF THE DITCH, UNLESS WAIVED IN THE MANNER PROVIDED IN SUBDIVISION 2 AND 3.

						ENBRIDGE	
						LINE 3 REPLACEMENT TYPICAL TRENCH AND BACKFILL REQUIREMENTS	
						DATE	06/13/16
						CHK.	KEH
						PROJ. ENGR.	MDM
						PROJ. MGR.	BS
						DATE	08/04/17
						SCALE	NTS
						DWG. NO.	Figure 18
D	ISSUED FOR REVIEW	AJM	11/04/19	KEH	RF		
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	



1. BAGS WILL NOT BE FILLED WITH TOPSOIL.
2. ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS.
3. TRENCH BREAKERS SHALL BE PLACED AS LISTED BELOW:

**PROFILE VIEW**  
(NOT TO SCALE)

TOPSOIL

BACKFILL MATERIAL

NATIVE SOILS

SLOPES >5%

**PLAN VIEW**  
(NOT TO SCALE)

SANDBAGS OR FOAM

PIPELINE

SANDBAGS OR FOAM EXTENDED INTO TRENCH WALL 6" MINIMUM

**FACE VIEW**  
(NOT TO SCALE)

TOPSOIL

PIPELINE

SANDBAGS OR FOAM EXTENDED INTO WALL 6" MINIMUM


**NOTES**

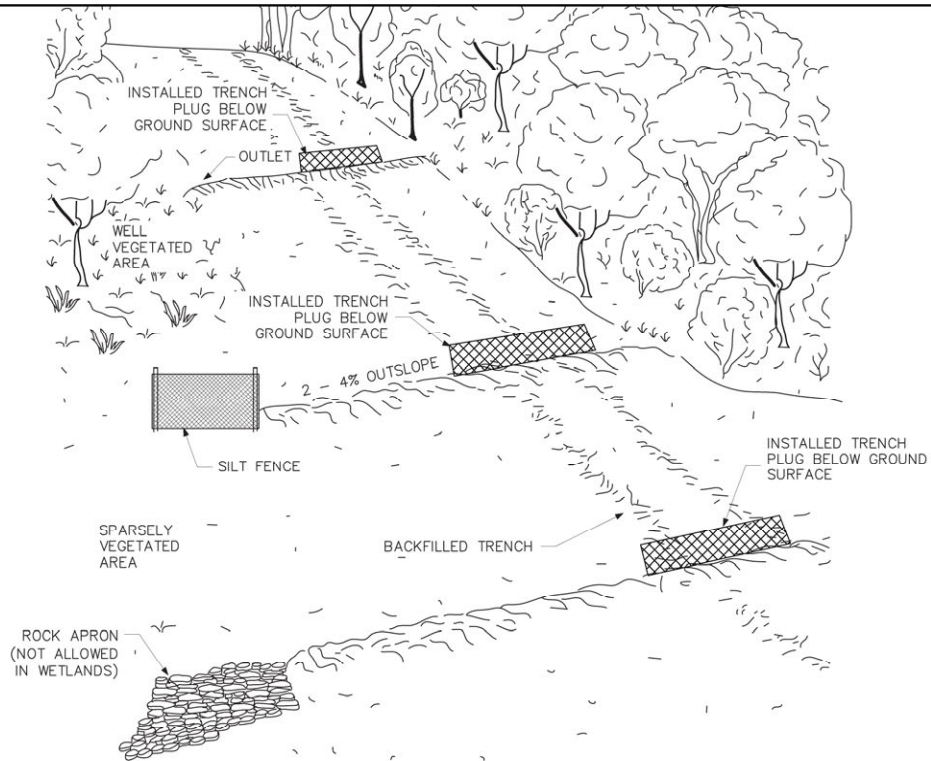
1. BAGS WILL NOT BE FILLED WITH TOPSOIL
2. ADDITIONAL INFORMATION INCLUDED IN OTHER DRAWINGS

NOTES

1. BAGS WILL NOT BE FILLED WITH TOPSOIL
2. ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS

ISSUED  
FOR REVIEW  
11/04/19

											
										DATE: DWG	DATE: 10/30/19
										CHK: KEH	10/30/19
										PROJ. ENGR: BG	10/30/19
										PROJ. MGR: KJR	10/30/19
										SCALE	1"=10'
										NTS	DWG. NO. Figure 19
A	ISSUED FOR REVIEW				DWG	11/04/19	KEH	KD			
NO.	REVISION-DESCRIPTION				BY	DATE	CHK'D	APP'D			



PERSPECTIVE VIEW  
(NOT TO SCALE)

NOTES:

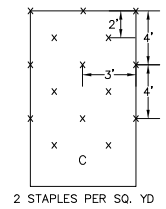
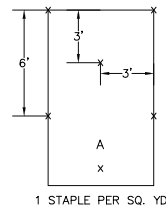
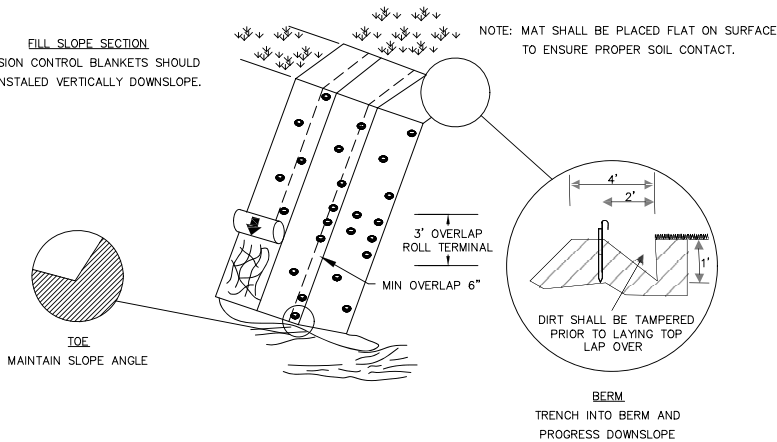
1. BERMS ARE PERMANENT.
2. SILT FENCE REMOVED WHEN VEGETATION ESTABLISHED.
3. LOWEST BERM MAY BE OMITTED IF SILT FENCE OR STRAW BALES ARE INSTALLED AT THAT LOCATION, SUBJECT TO APPROVAL.
4. BERMS SHALL BE OUTLETED TO WELL VEGETATED STABLE AREAS, FILTER SOCKS, SILT FENCES, STRAW BALES, ROCK APRONS, OR SUMPS.
5. BERMS SHALL BE PLACED AS LISTED BELOW.

SLOPE%	APPROXIMATE SPACING (FT.)
5	250
>5-15	200
15-25	150
>25	<100

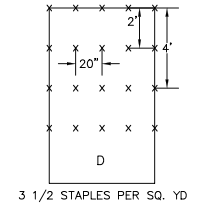
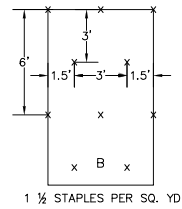
ISSUED  
FOR REVIEW  
11/04/19

				ENBRIDGE	
				LINE 3 REPLACEMENT TYPICAL PERMANENT SLOPE BREAKERS	
				DATE	8/16/18
				CHK	NKD
				PROJ. ENGR.	8/16/18
				PROJ. MGR.	8/16/18
				CLIENT APP.	
				SCALE	NTS
				DWG. NO.	Figure 20

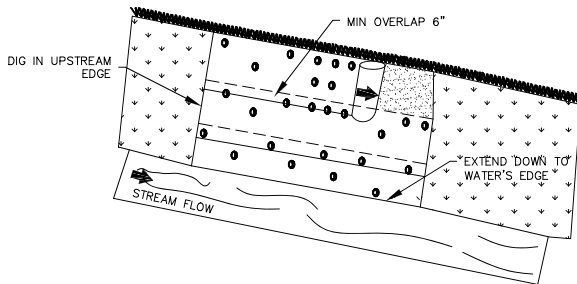
**FILL SLOPE SECTION**  
EROSION CONTROL BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE.



300	B	C	C	C	D
275					
250					
225					
200					
175					
150					
125					
100					
75					
50					
25					
FT					



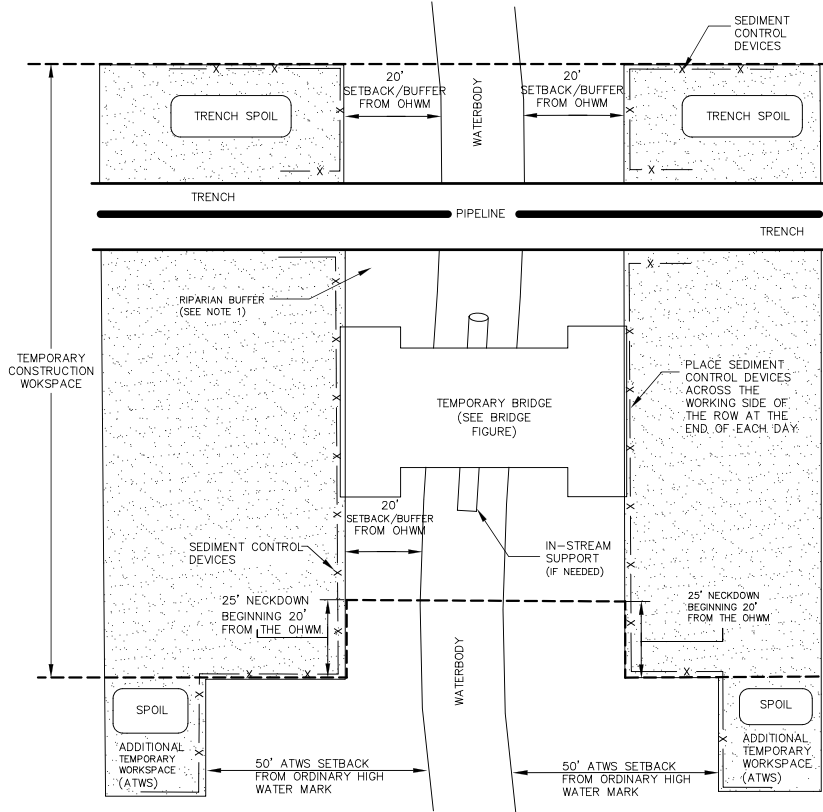
**STREAM CHANNEL**  
EROSION CONTROL BLANKETS SHOULD BE INSTALLED HORIZONTALLY WITH STREAM FLOW.



FOR OPTIMUM RESULTS, THESE RECOMMENDED STAPLE PATTERN GUIDES MUST BE FOLLOWED. SUGGESTED ANCHORING METHODS VARY ACCORDING TO THE MANUFACTURER. THIS CHART SHOWS HOW TO SLOPE LENGTHS AND HOW GRADIENTS AFFECT STAPLE PATTERNS.


**ISSUED FOR REVIEW**  
11/04/19

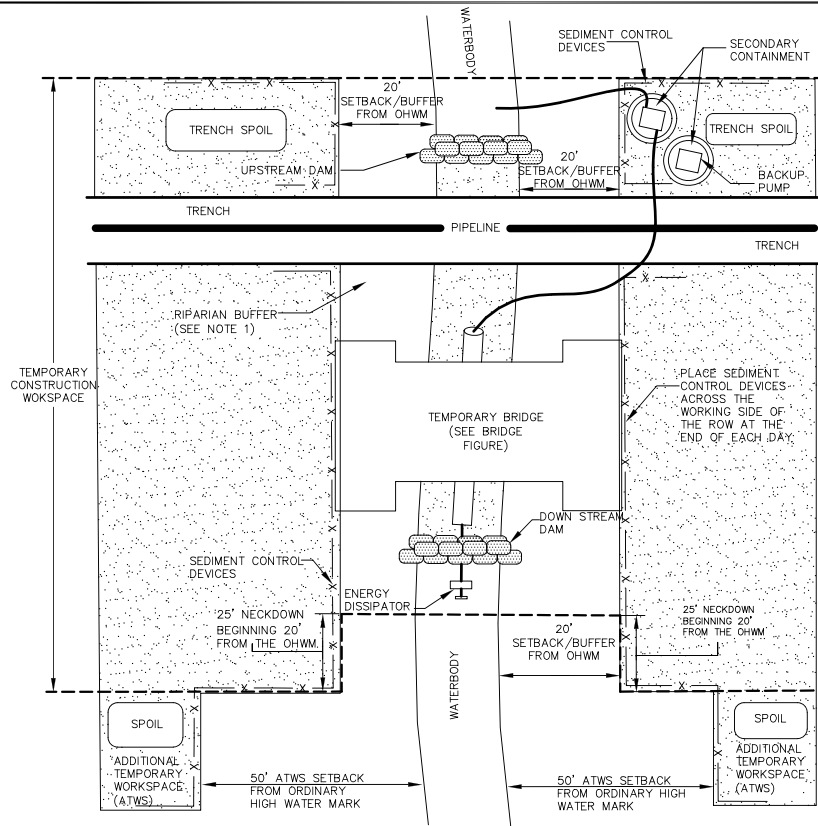
					ENBRIDGE	
					LINE 3 REPLACEMENT TYPICAL EROSION CONTROL BLANKET INSTALLATION & STAPLE PATTERNS	
					NTS	
					Figure 21	



# NOTES:

1. REFER TO 2.2 OF EPP FOR EROSION CONTROL REQUIREMENTS.
2. 50' ATWS SETBACK FROM ORDINARY HIGH WATER MARK (OHWM), AS CONDITIONS ALLOW, EXCEPT IN UPLAND AREAS OF CULTIVATED OR ROTATED CROPLAND OR OTHER DISTURBED LAND.

											
										LINE 3 REPLACEMENT	
										TYPICAL	
										WATERBURY CROSSING	
										OPEN CUT TRENCH METHOD	
										SCALE	
										NTS	
										DWG. NO.	
										Figure 22	



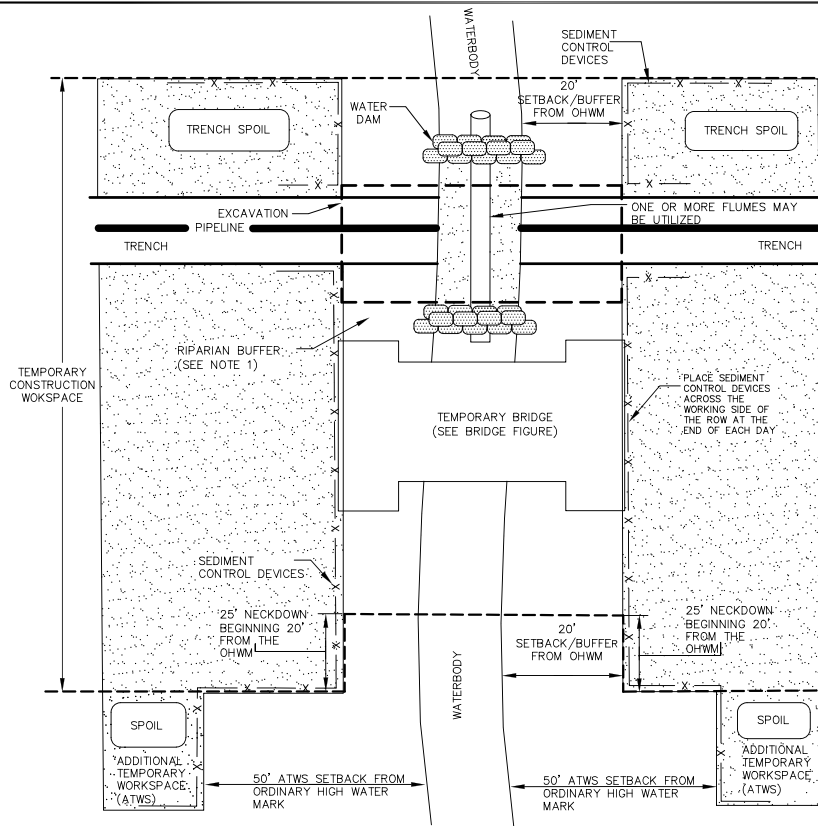
**ISSUED  
FOR REVIEW**  
11/04/19

**NOTES:**

1. REFER TO 2.2 OF EPP FOR EROSION CONTROL REQUIREMENTS.
2. 50' ATWS SETBACK FROM ORDINARY HIGH WATER MARK (OHWM), AS CONDITIONS ALLOW, EXCEPT IN UPLAND AREAS OF CULTIVATED OR ROTATED CROPLAND OR OTHER DISTURBED LAND.

						DATE: 04/25/19			<b>LINE 3 REPLACEMENT TYPICAL WATERBODY CROSSING DRY CROSSING-DAM AND PUMP METHOD</b>
						CHK: KEH	04/30/19		
						PROJ. ENGR: DC	04/30/19		
						PROJ. MGR: KD	04/30/19		
B	ISSUED FOR REVIEW	AJM	11/04/19	KEH	KD	CLIENT APP: KD	04/30/19	SCALE: NTS	DWG. NO. <b>Figure 23</b>
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	SCALE	NTS	DWG. NO.



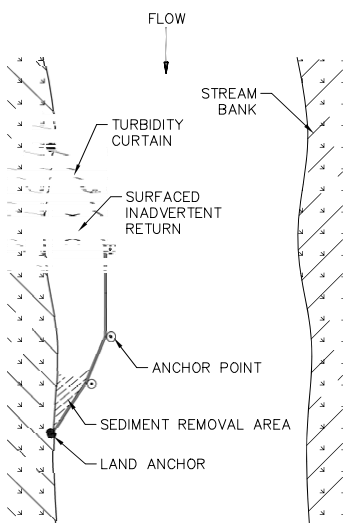


**ISSUED  
FOR REVIEW**  
11/04/19

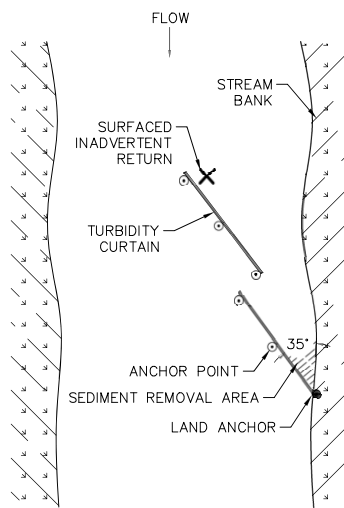
**NOTES:**

1. REFER TO 2.2 OF EPP FOR EROSION CONTROL REQUIREMENTS.
2. 50' ATWS SETBACK FROM ORDINARY HIGH WATER MARK (OHWM), AS CONDITIONS ALLOW, EXCEPT IN UPLAND AREAS OF CULTIVATED OR ROTATED CROPLAND OR OTHER DISTURBED LAND.

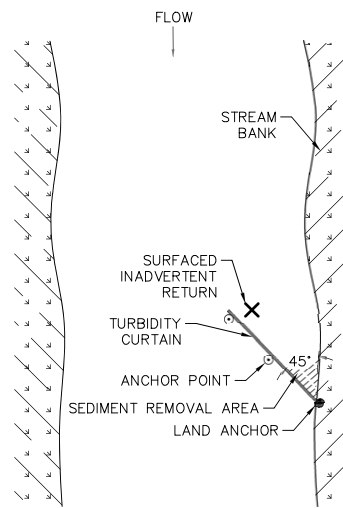
						LINE 3 REPLACEMENT TYPICAL WATERBODY CROSSING DRY CROSSING-FLUME METHOD	
						DATE: 04/25/19 CHK: KEH PROJ. ENGR: DC PROJ. MGR: KD	SCALE: NTS DWG. NO.: Figure 24
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	
B	ISSUED FOR REVIEW	AJM	11/04/19	KEH	KD		



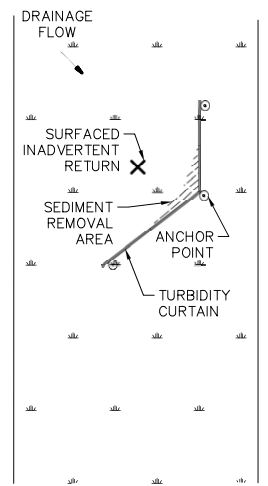
1 NEAR-SHORE  
PLAN VIEW



2 RAPID/MID-CHANNEL  
PLAN VIEW



3 MODERATE FLOW/SIDE-CHANNEL  
PLAN VIEW

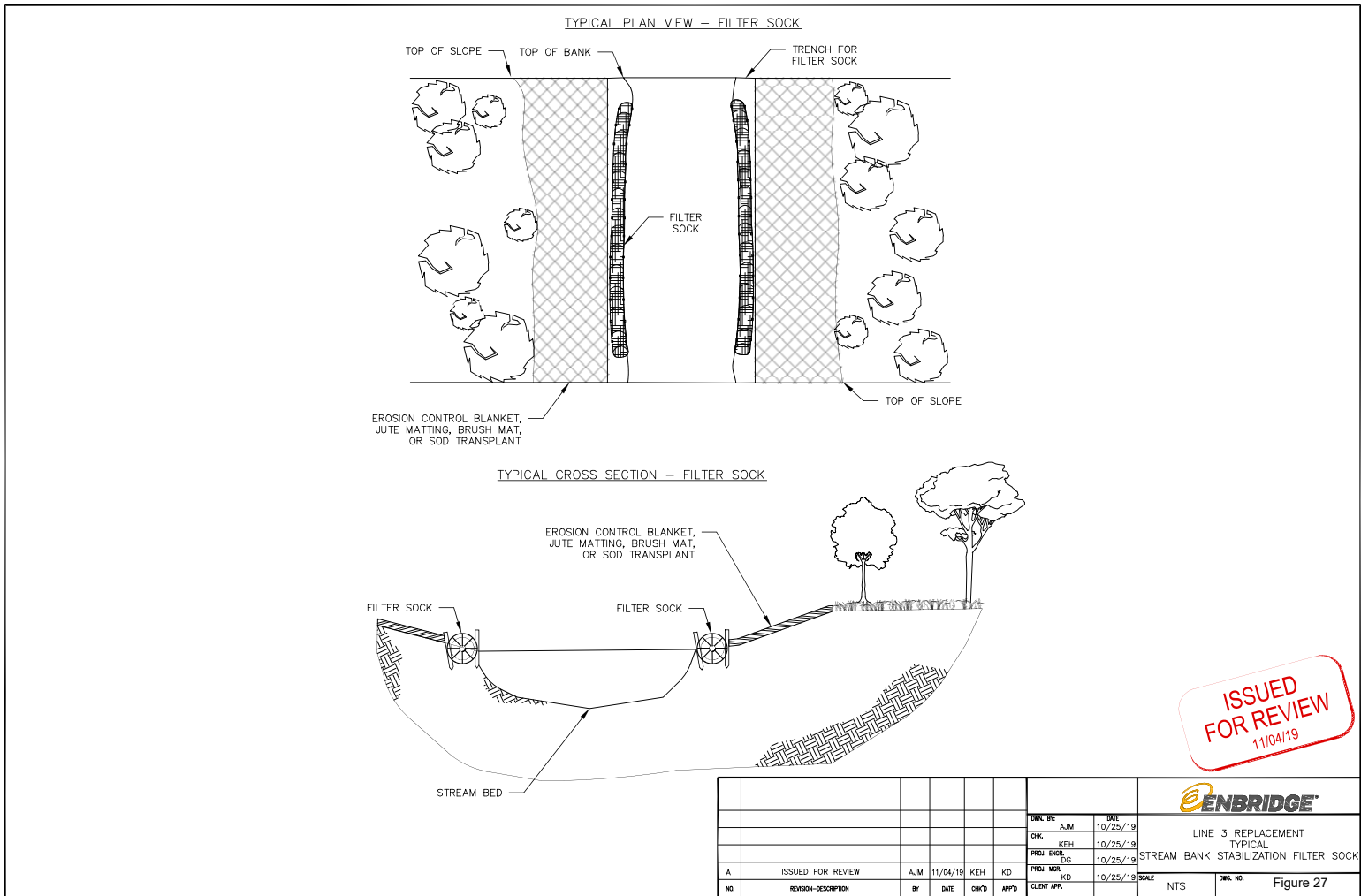


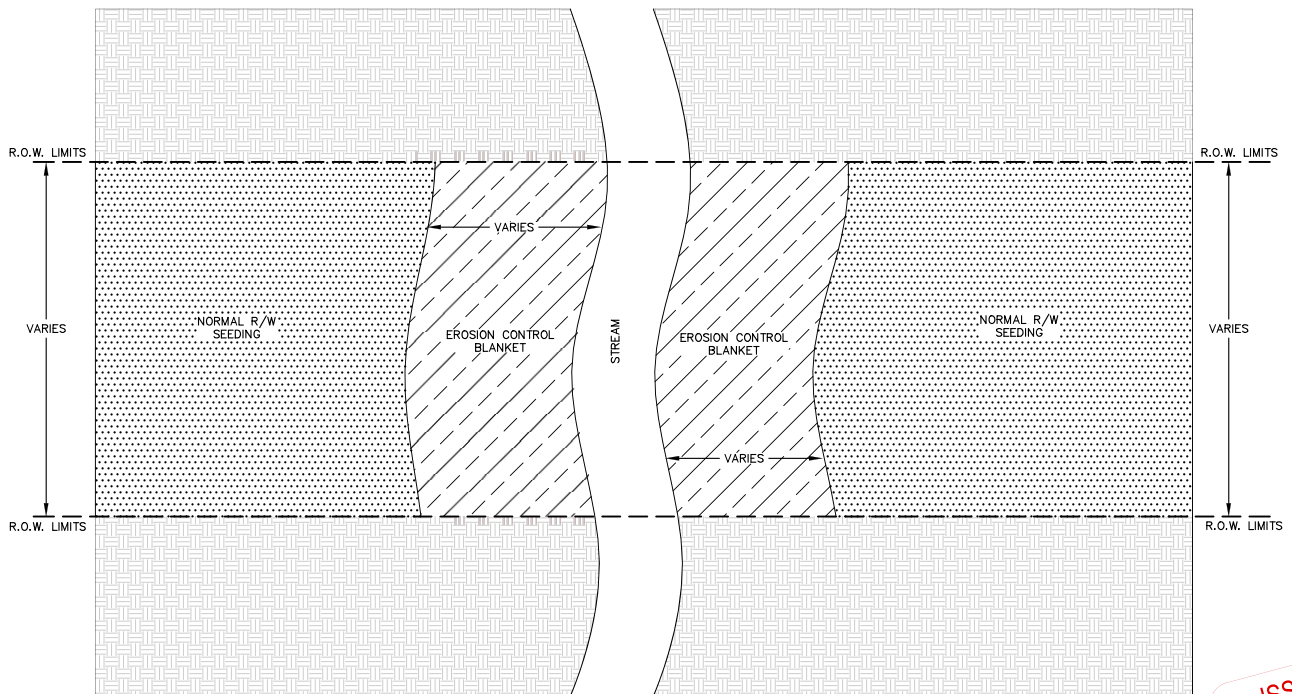
3 STANDING/STILL WATER  
PLAN VIEW

**ISSUED  
FOR REVIEW**  
11/04/19

				DWN. BY: KEH		DATE: 10/25/19		LINE 3 REPLACEMENT TYPICAL TURBIDITY CURTAIN INSTALLATIONS	
				CHK: NKD		DATE: 10/25/19			
				PRD. ENR: CP		DATE: 10/25/19			
				PRD. MGR: BS		DATE: 10/25/19			
A	ISSUED FOR REVIEW	JDW	11/04/19	KEH	NKD			SCALE: NTS	DWG. NO: Figure 25
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.			





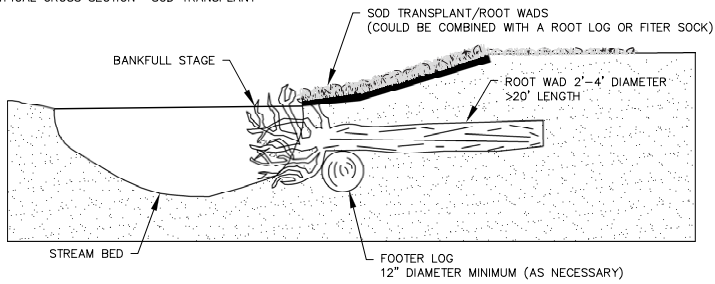


NOTE:  
EXTEND EROSION CONTROL FROM  
MEAN HIGH WATER LEVEL TO  
SEVERAL FEET BEHIND HIGH BANK

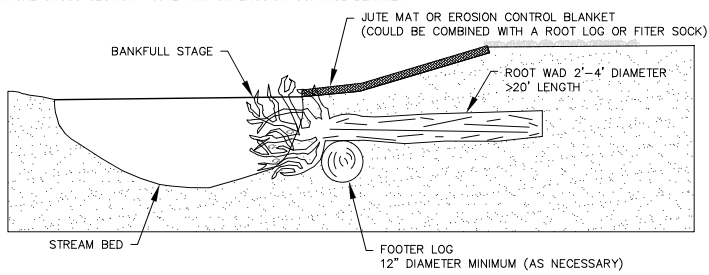
ISSUED  
FOR REVIEW  
11/04/19

								LINE 3 REPLACEMENT TYPICAL FINAL STREAM BANK STABILIZATION & EROSION CONTROL	
						DESIGNED BY: AJM CHECKED BY: KEH PROJECT NO.: 10/25/19	DATE: 10/25/19		
						PROJECT NO.: 10/25/19 PROJECT NO.: 10/25/19	DATE: 10/25/19		
A	ISSUED FOR REVIEW	AJM	11/04/19	KEH	KD	PROJECT NO.: 10/25/19	SCALE	NTS	DWG. NO. Figure 28
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.			

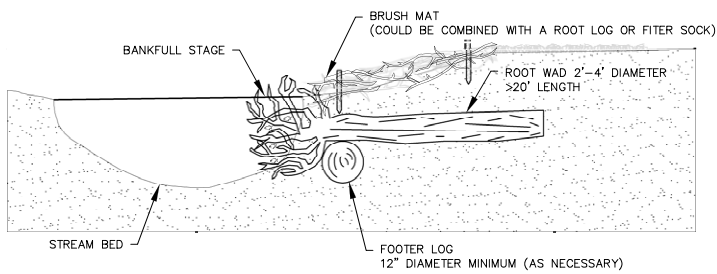
TYPICAL CROSS SECTION - SOD TRANSPLANT



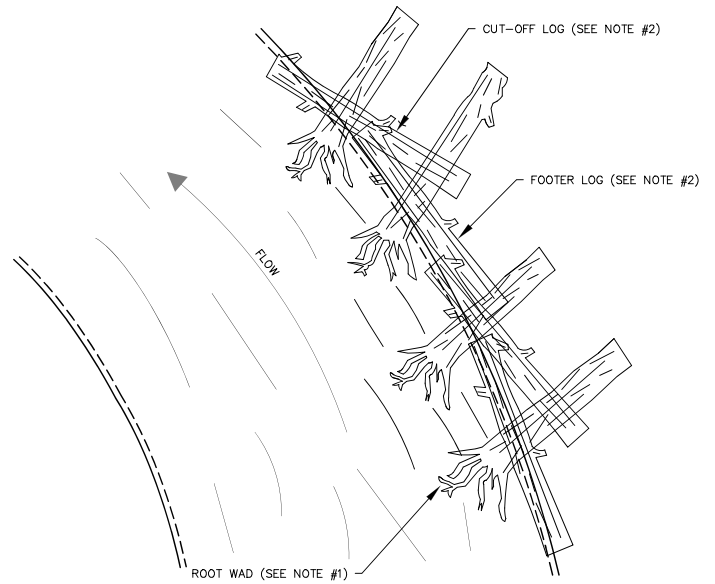
TYPICAL CROSS SECTION - JUTE MAT OR EROSION CONTROL BLANKET



TYPICAL CROSS SECTION - BRUSH MAT



TYPICAL PLAN VIEW - NATURAL MATERIAL REVETMENT

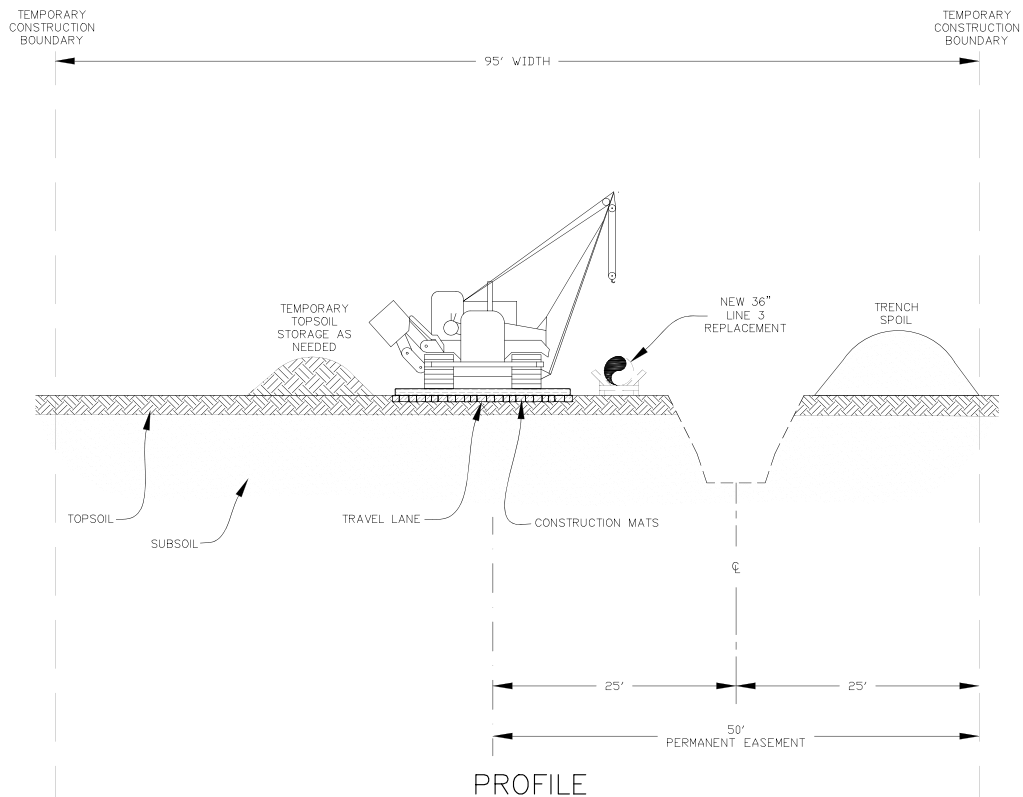


NOTES:

- #1 - ROOT WAD LOGS TO BE USED ON STEEP BANKS OR BASED ON AGENCY RECOMMENDATIONS.
- #2 - ROOT WAD LOGS TO BE ANCHORED APPROPRIATELY BASED ON SITE-SPECIFIC CONDITIONS OR AGENCY RECOMMENDATIONS.

ISSUED  
FOR REVIEW  
11/04/19

				DWA: DWA		DATE: 10/30/19		LINE 3 REPLACEMENT TYPICAL ROOT WAD - NATURAL MATERIAL REVETMENT	
				CHK: KEH		DATE: 10/30/19			
				PROJ. ENGR: DG		DATE: 10/30/19			
				PROJ. MGR: KD		DATE: 10/30/19			
A	ISSUED FOR REVIEW	DWA	11/04/19	KEH	KD			NTS	DWG. NO. Figure 29
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	SCALE		




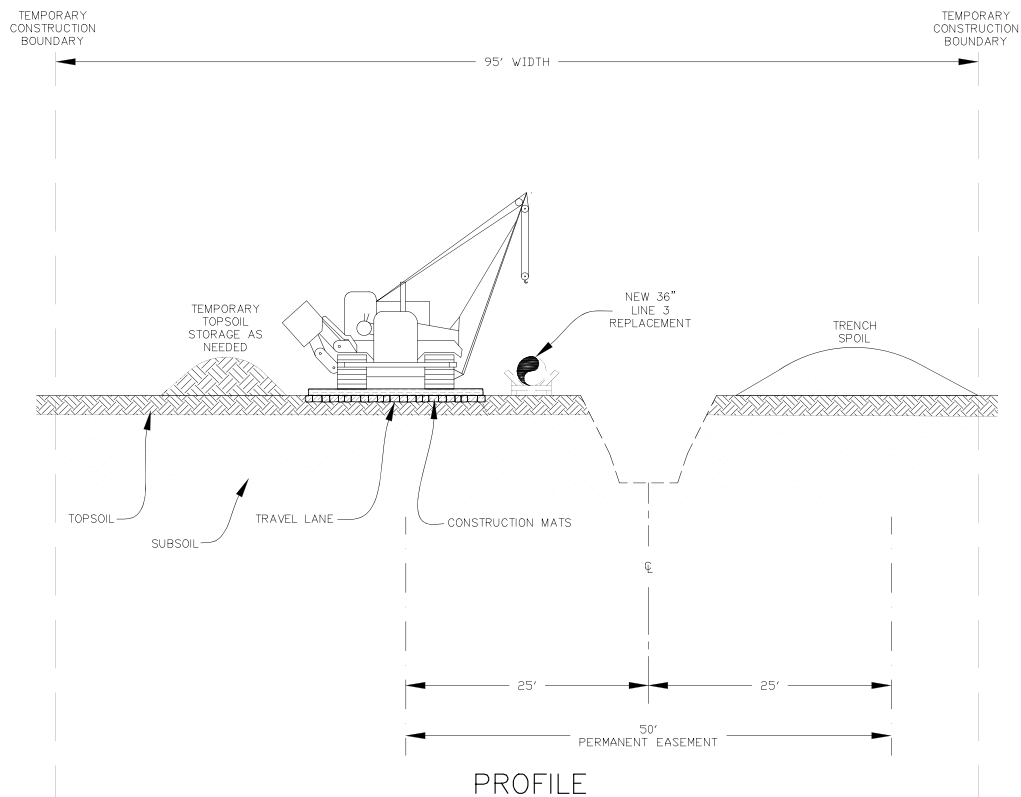
PROFILE

**ISSUED  
FOR REVIEW**  
11/04/19

NOTE:

1. TRENCH LINE ONLY SEGREGATION.

												LINE 3 REPLACEMENT TYPICAL UNSATURATED WETLAND CROSSING PROFILE (25' WORKSPACE OFFSET)	
										DATE: 11/01/19			
										CHK: KEH 11/01/19			
										CHK: ND 11/01/19			
										PROD. ENGR: RF 11/01/19			
										PROD. MGR: TL 11/01/19		SCALE	
										CLIENT APP: 11/01/19		NTS	
												DWG. NO.	
												Figure 30	



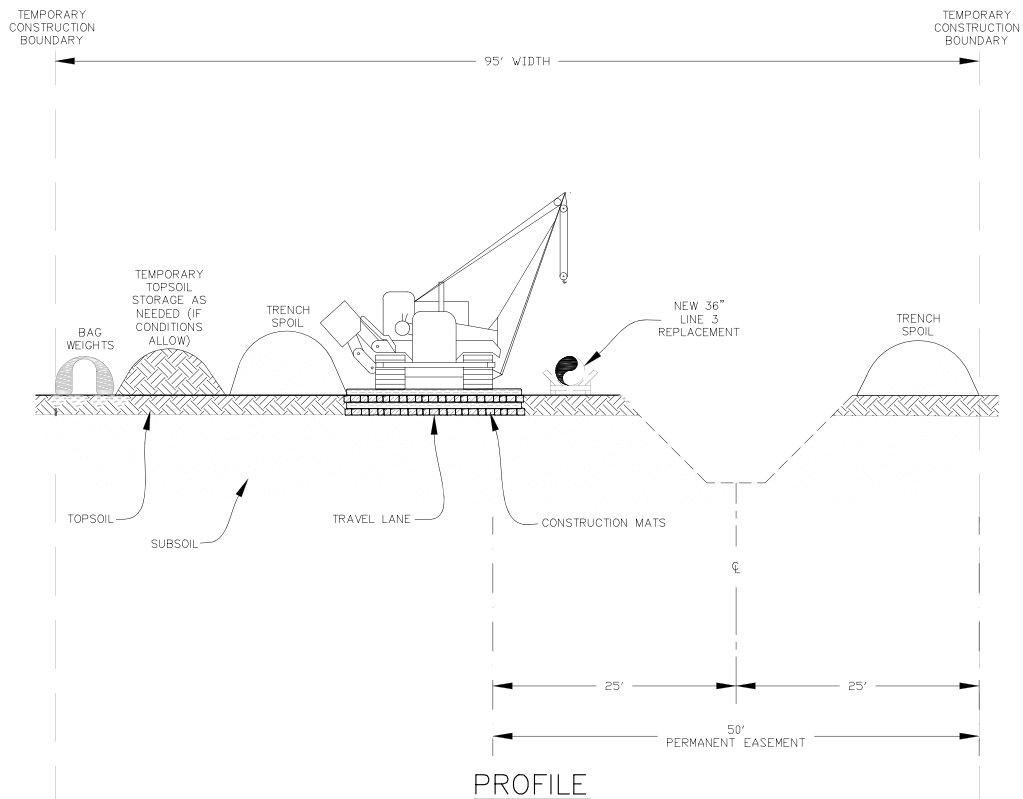
PROFILE

**ISSUED  
FOR REVIEW**  
11/04/19

NOTE:  
1. TRENCH LINE ONLY SEGREGATION.

								LINE 3 REPLACEMENT TYPICAL UNSATURATED WETLAND CROSSING PROFILE (40' WORKSPACE OFFSET)	
						DRW. BY: KEH	DATE: 11/01/19		
						CHK. ND	DATE: 11/01/19		
						PROJ. ENGR. RF	DATE: 11/01/19		
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	RF	PROJ. MGR. TL	DATE: 11/01/19	SCALE	NTS
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	DATE	DWG. NO.	Figure 31






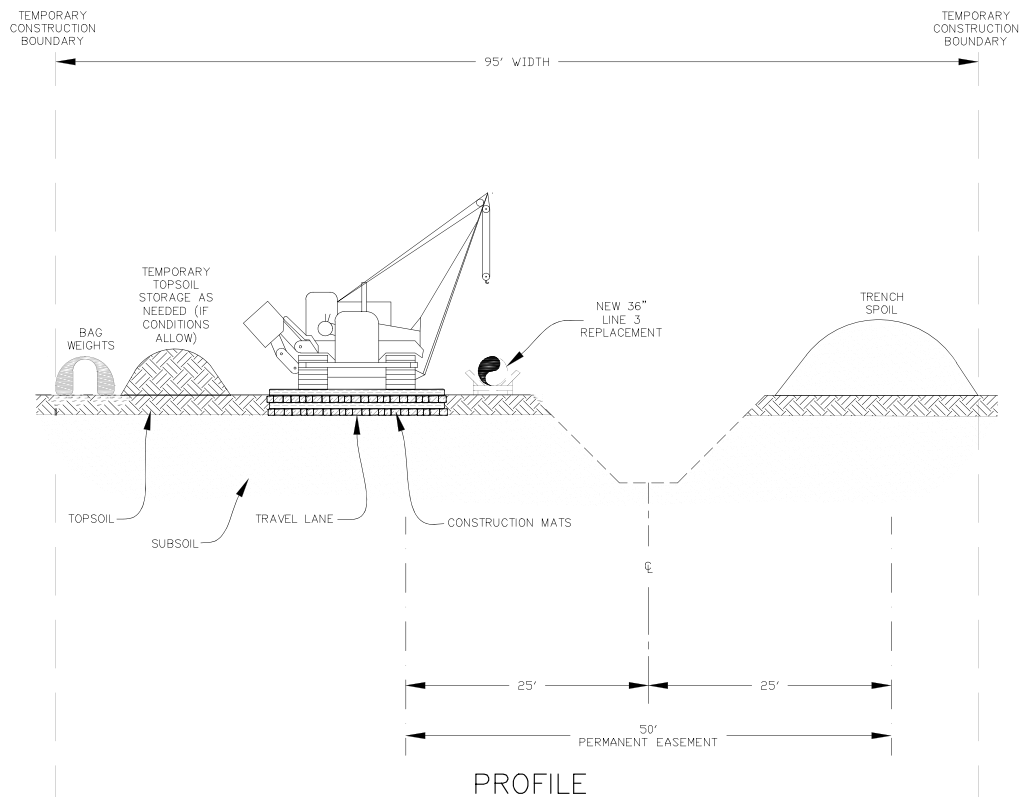
PROFILE

**ISSUED FOR REVIEW**  
11/04/19

NOTE:

1. TRENCH LINE ONLY SEGREGATION.


									
						DATE: 11/01/19		LINE 3 REPLACEMENT TYPICAL SATURATED WETLAND CROSSING PROFILE (25' WORKSPACE OFFSET)	
						CHK: ND	11/01/19		
						PROD. ENGR: RF	11/01/19		
						CLIENT APP: TL	11/01/19		
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	TL	SCALE		NTS	DWG. NO. Figure 32
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.			

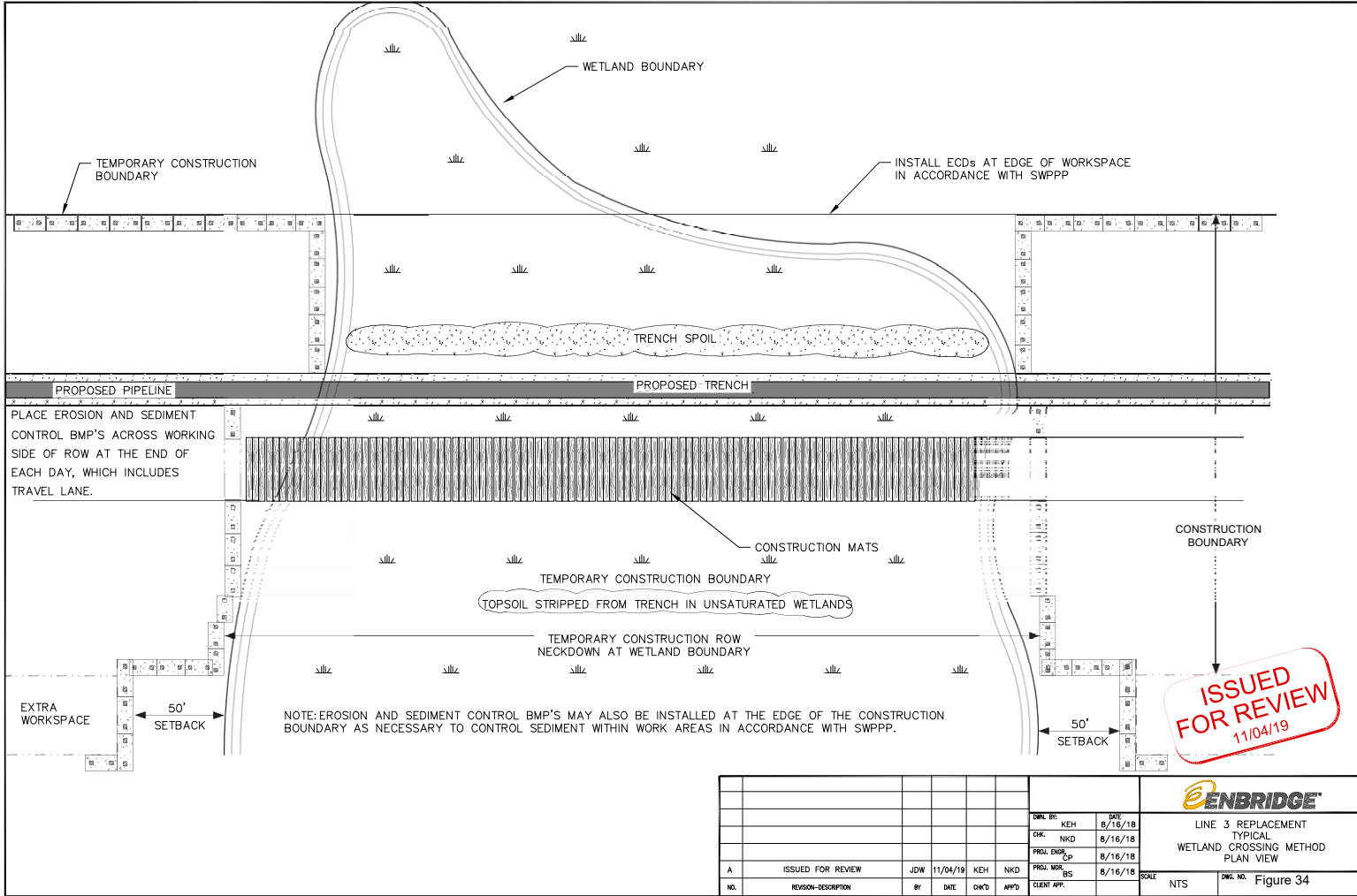


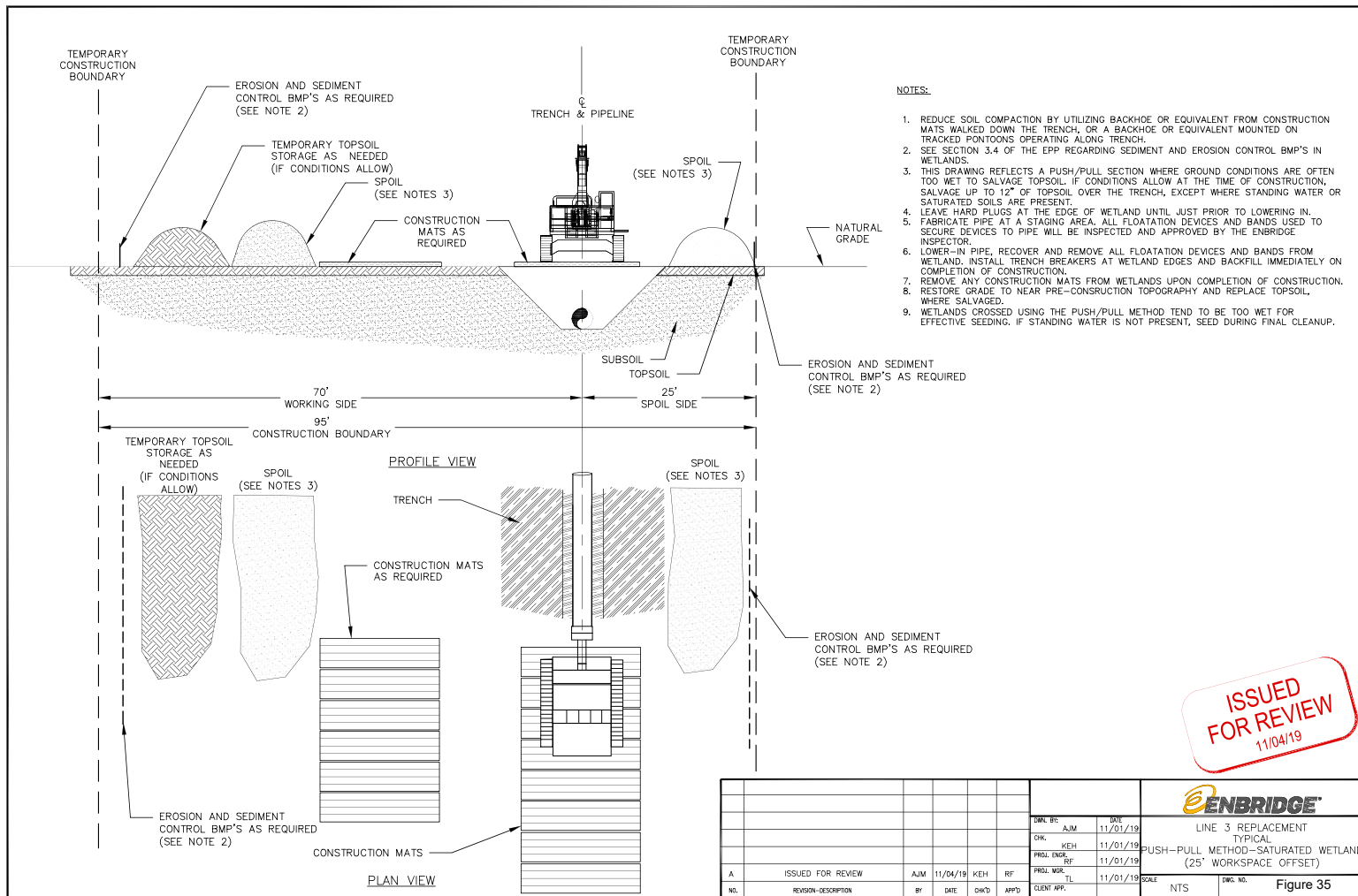
PROFILE

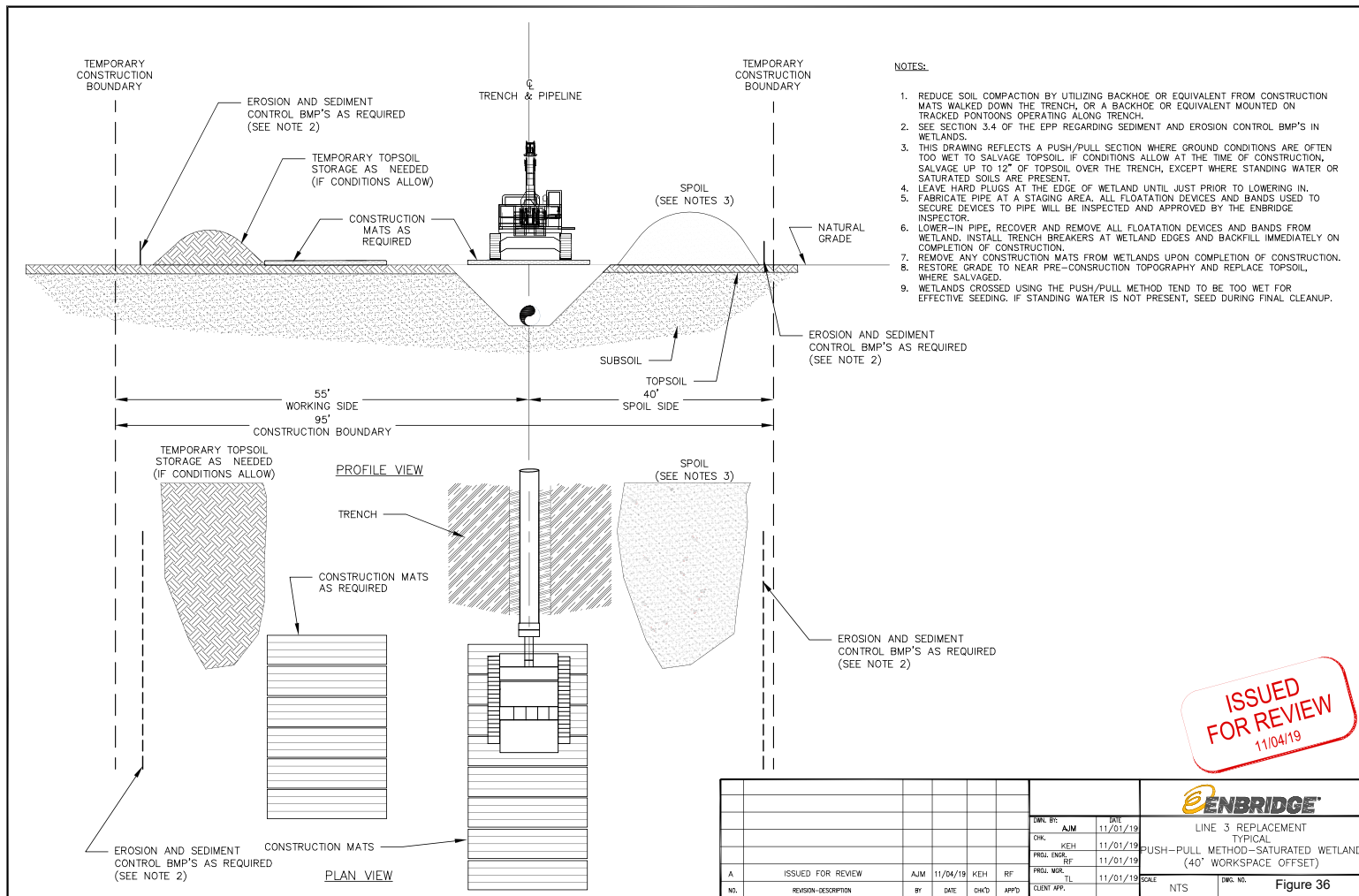
**ISSUED  
FOR REVIEW**  
11/04/19

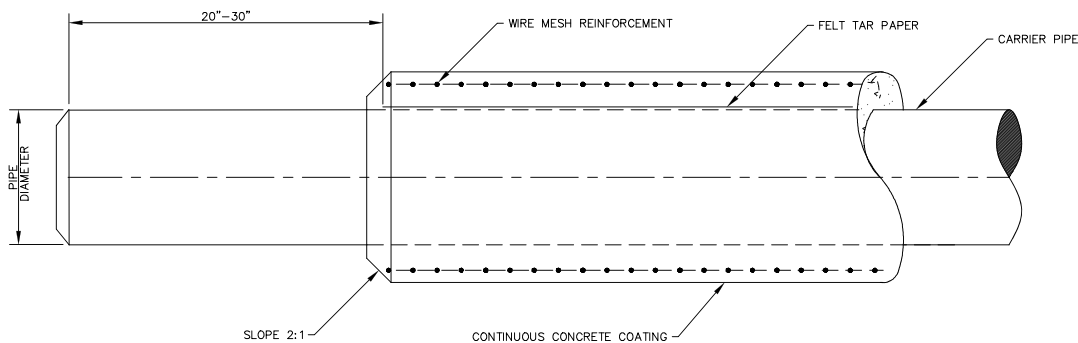
NOTE:  
1. TRENCH LINE ONLY SEGREGATION.

									
						DATE: 11/01/19		LINE 3 REPLACEMENT TYPICAL SATURATED WETLAND CROSSING PROFILE (40' WORKSPACE OFFSET)	
						CHK: ND 11/01/19			
						PROJ. ENGR. RF 11/01/19			
						PROJ. MGR. TL 11/01/19			
A	ISSUED FOR REVIEW	KEH	11/04/19	ND	TL	CLIENT APP.	SCALE	NTS	DWG. NO. Figure 33
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	SCALE	NTS	DWG. NO.

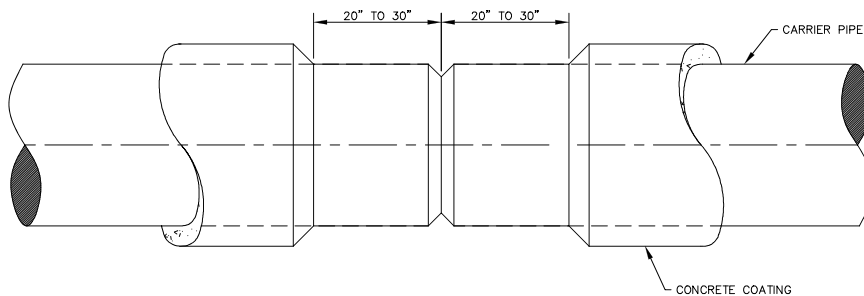








**CONTINUOUS CONCRETE COATING**



**DETAIL AT PIPE JOINT**

SEE NOTE 4

**NOTES:**

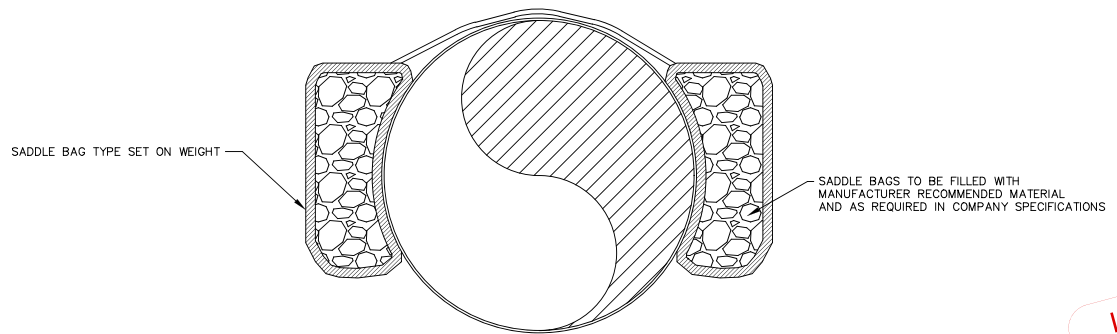
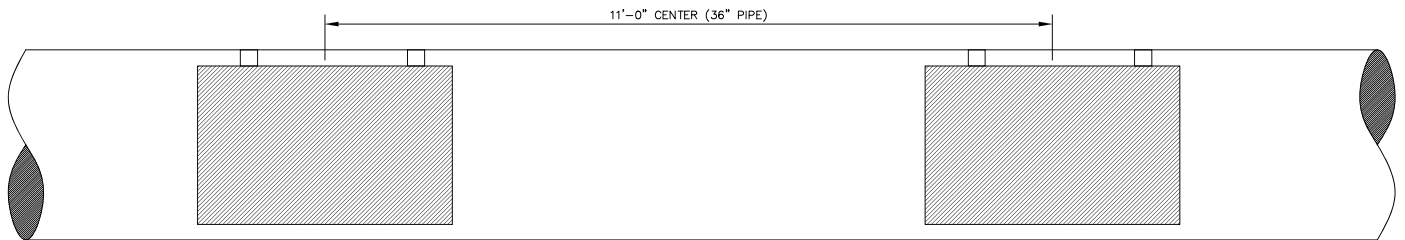
1. MINIMUM CONCRETE DENSITY SHALL BE 150 LB/FT.<sup>3</sup>
2. CONCRETE COATING CUTBACK SHALL BE 20\"-30\".
3. CONCRETE COATING THICKNESS TO PROVIDE A MINIMUM NEGATIVE BUOYANCY OF 10% IN FLUID TO BE DISPLACED.
4. MINIMUM ALLOWABLE COMPRESSION STRENGTH OF 3,000 PSI @28 DAYS.
5. ONE LAYER OF FELT TAR PAPER SHALL BE PLACE ALONG TOP OF PIPE TO PROTECT DURING CONCRETE POURING.
6. THE APPLICATION OF CONTINUOUS CONCRETE COATING SHALL ADHERE TO USPCS-SPEC-CCC-009 REV 1.
7. MESH REINFORCEMENT MATERIAL TO BE APPROVED BY COMPANY PRIOR TO USE.
8. REFER TO ALIGNMENT SHEETS, SITE SPECIFIC DRAWINGS, OR CONSTRUCTION STANDARDS FOR MINIMUM COATING THICKNESS.

**ISSUED  
FOR REVIEW**  
11/04/19

				DRAWN BY:	YL	DATE	06/13/16				
				CHECKED:	KEH	DATE	08/04/17				
				PROJECT ENGINEER:	NDW	DATE	08/04/17				
				PROJECT MANAGER:	BS	DATE	08/04/17				
D	ISSUED FOR REVIEW	DWA	11/04/19	NKD	RF						
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.		SCALE	NTS	DWG. NO.	Figure 37

**ENBRIDGE**


LINE 3 REPLACEMENT  
TYPICAL  
CONCRETE COATING



**ISSUED  
FOR REVIEW**  
11/04/19

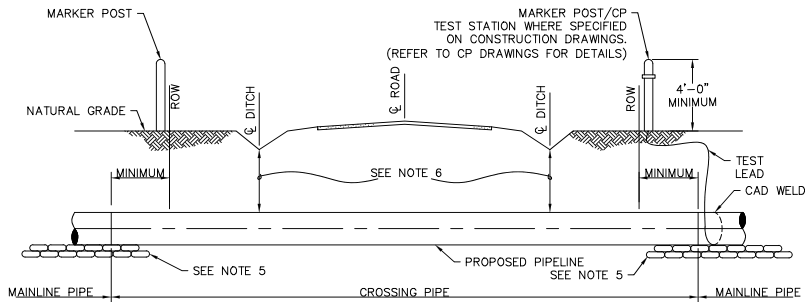
**NOTES:**

1. BAG WEIGHT TYPE AND MANUFACTURER TO BE APPROVED BY COMPANY REPRESENTATIVE.
2. USE IN WETLANDS ACCORDING TO ALIGNMENT SHEETS AND COMPANY REPRESENTATIVE.
3. WEIGHT TO BE 9000 LBS AT 11'-0" SPACING FOR 36" DIAMETER PIPELINE.
4. REFER TO USPCS-SPEC-PIPELINE-001 REV3 FOR ADDITIONAL REQUIREMENTS.

														
										DWN. BY:	YL	DATE	06/13/16	
										CHK:	KEH	08/04/17	LINE 3 REPLACEMENT	
										PROJ. ENGR:	MDW	08/04/17	BUOYANCY CONTROL	
										PROJ. MGR:	BS	08/04/17	SADDLE-BAG WEIGHTS	
D	ISSUED FOR REVIEW			AJM	11/04/19	NKD	RF							
NO.	REVISION-DESCRIPTION			BY	DATE	CHK'D	APP'D	CLIENT APP.	SCALE	NTS	DWG. NO.	Figure 38		



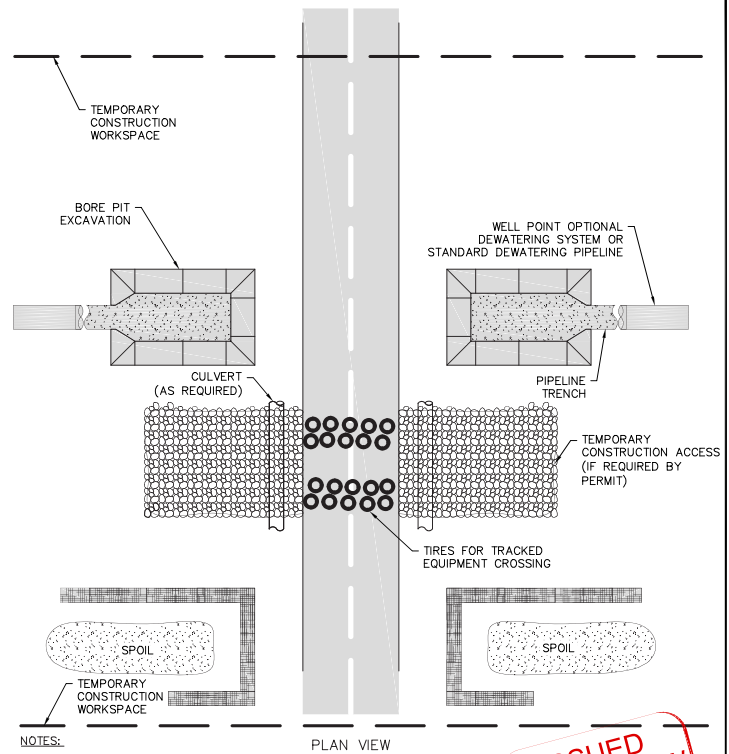




PROFILE VIEW

**NOTES:**


- CROSSING INSTALLATION SHALL BE IN ACCORDANCE WITH APPLICABLE ROAD PERMIT REQUIREMENTS.
- LOCATION, LENGTH OF CROSSING, MATERIALS, AND TESTING REQUIREMENTS SHALL BE AS STATED ON THE ALIGNMENT SHEETS.
- COUNTER BORE AND TAPER HEAVY WALL PIPE ENDS PER DWG B-TYP-CBORE-TAPER.
- SUPPORT MATERIAL TO BE SAND BAGS OR OTHER ENBRIDGE APPROVED MATERIAL.
- CONTRACTOR SHALL FIRMLY SUPPORT HEAVY WALL AND LINE PIPE WITH CONTINUOUS SUPPORT MATERIALS. SUPPORT MATERIAL SHALL EXTEND ACROSS TRANSITION WELD AND EXTEND A MINIMUM OF 3' OR UNTIL PIPE RESTS ON UNDISTURBED GROUND.
- AS A MINIMUM, THE DEPTH OF COVER UNDER ROAD DITCHES SHALL BE 48", AND UNDER THE ROAD SURFACE SHALL BE 60", UNLESS OTHERWISE REQUIRED BY THE ROAD CROSSING PERMIT. THE PIPELINE SHALL BE BURIED AT LEAST 54" BELOW THE AUTHORIZED DEPTH OF ANY PUBLIC DRAINAGE FACILITY.
- HEAVY WALL PIPE SHALL EXTEND BEYOND ROW LIMITS, INSTALLED LENGTH MAY VARY.

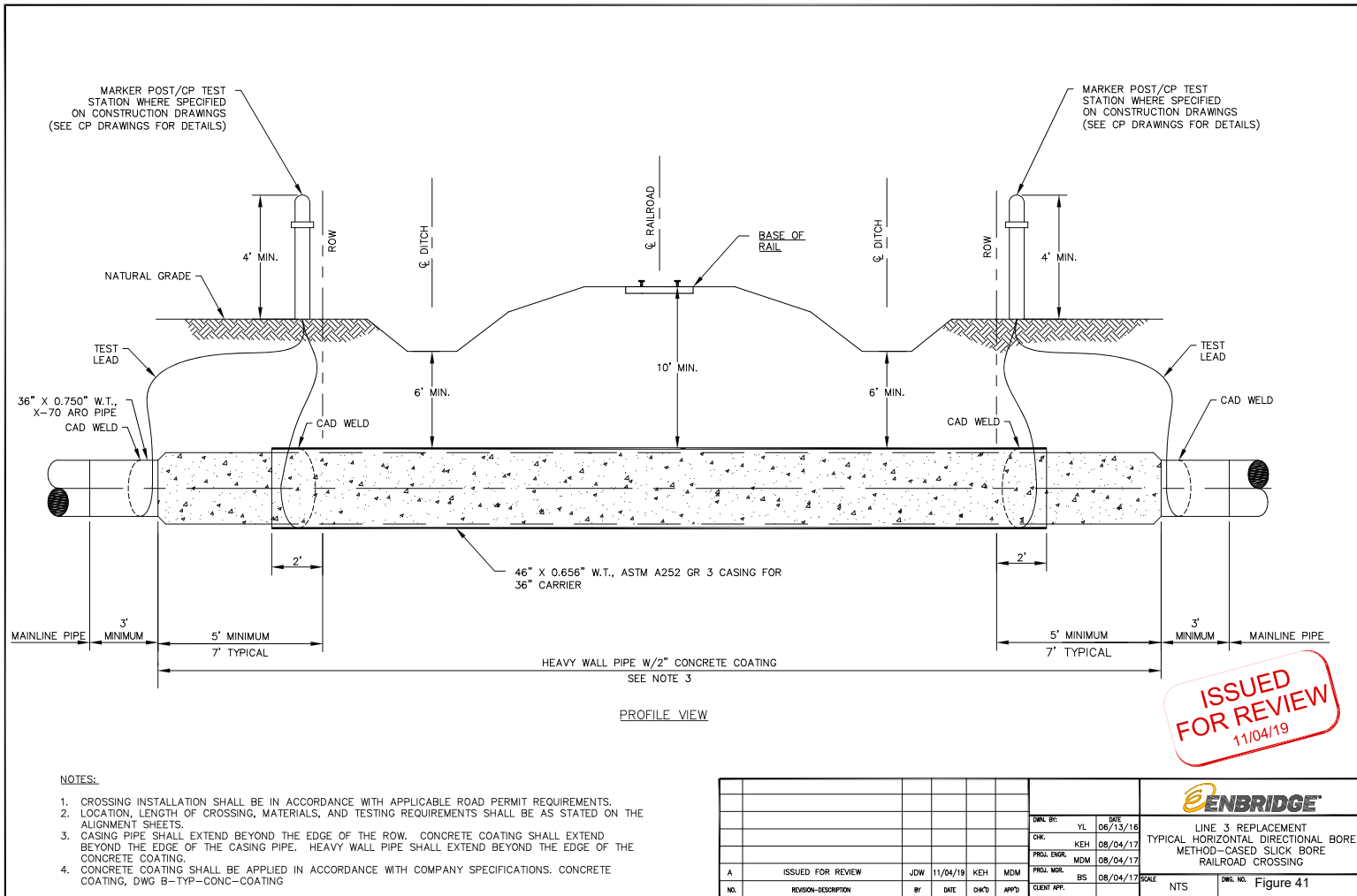


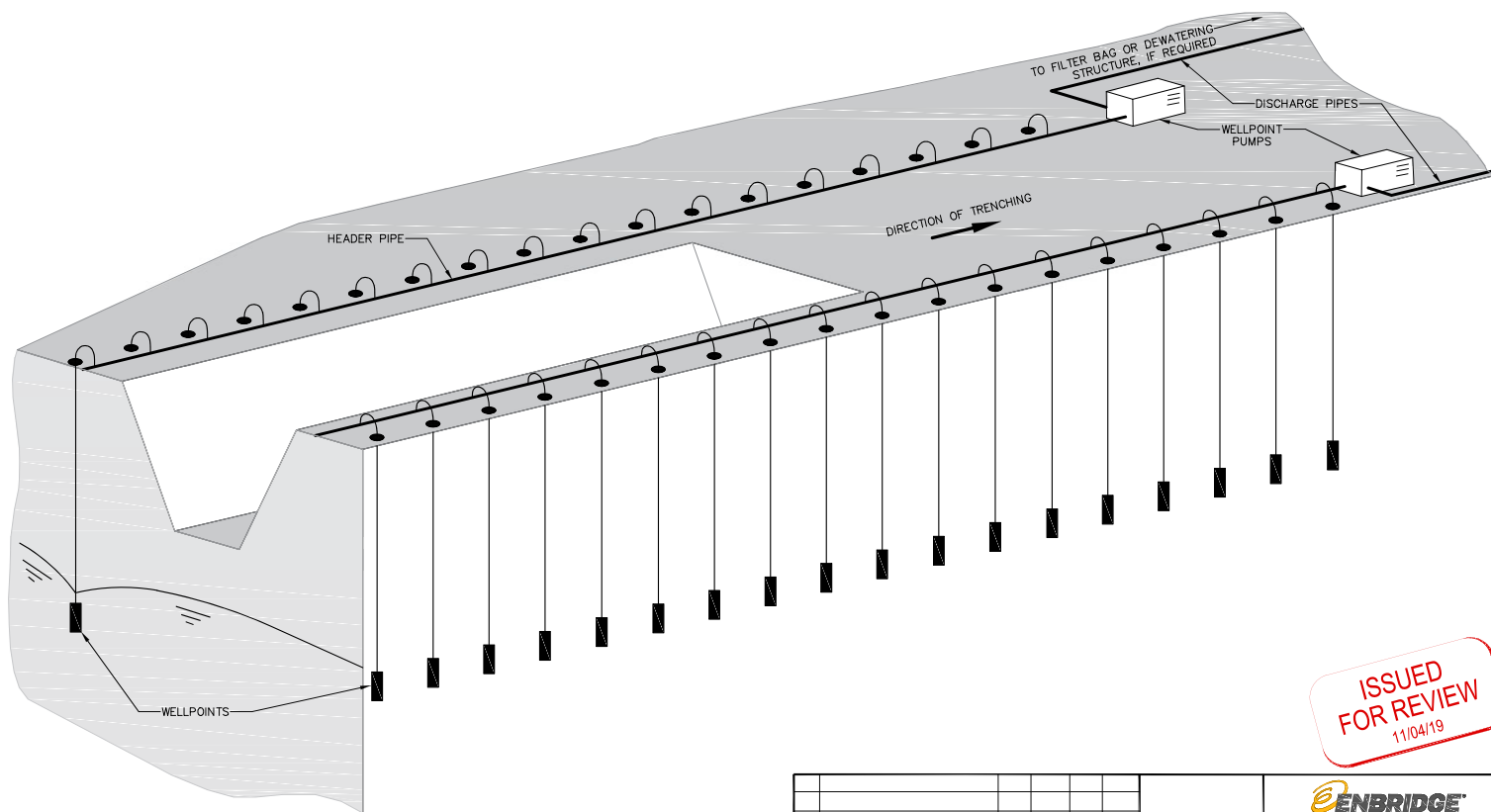
**NOTES:**

- PROCEDURES SHOWN IN THIS DRAWING APPLY TO IMPROVED ROADS.
- ROADS MUST BE CLEANED AFTER EQUIPMENT CROSSES AND DIRT PLACED IN SPOIL CONTAINMENT AREAS.
- TEMPORARY ACCESS MATERIALS MUST BE REMOVED UPON PROJECT COMPLETION.
- ADDITIONAL INFORMATION INCLUDED ON OTHER DRAWINGS OR PERMITS.
- CONSTRUCTION AREAS LOCATED OUTSIDE ROAD ROW.

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11/04/19


												
						DRAWN BY:	DATE	LINE 3 REPLACEMENT TYPICAL HORIZONTAL DIRECTIONAL BORE METHOD-UNCASED SLICK BORED ROAD CROSSING WITH SUPPORT				
						CHK:	06/13/16					
						PRD:	08/04/17					
						PRD:	08/04/17					
A	ISSUED FOR REVIEW	JDW	11/04/19	NKD	RF	PRD:	BS	08/04/17	SCALE	NTS	DWG. NO.	Figure 40
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.						





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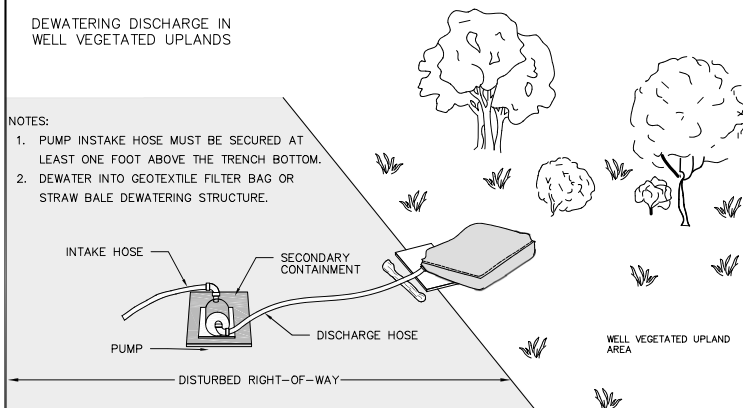
ISSUED  
FOR REVIEW  
11/04/19

											
										LINE 3 REPLACEMENT TYPICAL WELLPOINT DEWATERING SYSTEM	
										SCALE: NTS	
										DWG. NO. Figure 42	

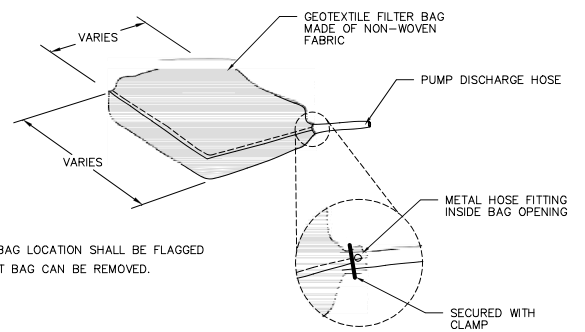
# DEWATERING DISCHARGE IN WELL VEGETATED UPLANDS

## NOTES:

1. PUMP INTAKE HOSE MUST BE SECURED AT LEAST ONE FOOT ABOVE THE TRENCH BOTTOM.
2. DEWATER INTO GEOTEXTILE FILTER BAG OR STRAW BALE DEWATERING STRUCTURE.



## GEOTEXTILE FILTER BAG



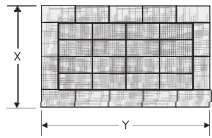
## NOTE:

1. FILTER BAG LOCATION SHALL BE FLAGGED SO THAT BAG CAN BE REMOVED.

**ISSUED FOR REVIEW**  
11/04/19

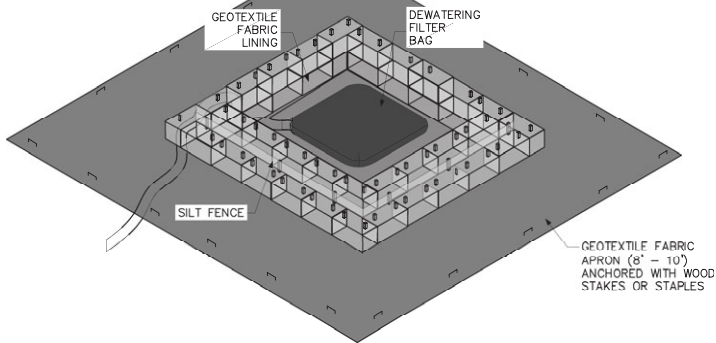
				DWA: DWA		DATE: 10/25/19	<p>LINE 3 REPLACEMENT TYPICAL GEOTEXTILE FILTER BAG DEWATERING—UPLAND</p>
				CHK: KEH		DATE: 10/25/19	
				PROJ. ENGR: DG		DATE: 10/25/19	
				PROJ. MGR: RD		DATE: 10/25/19	
A	ISSUED FOR REVIEW	DWA	11/04/19	NKD	RF		
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	SCALE: NTS

DWG. NO. Figure 43

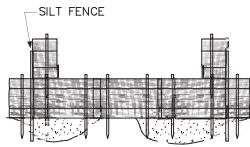


#### NOTES:

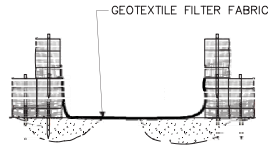
1. ARRANGE THE STRAW BALES TO THE X AND Y DIMENSIONS AS SPECIFIED BELOW.
2. IF BOTTOM OF STRUCTURE IS NOT LINED WITH STRAW BALES (OPTION 1), LINE ENTIRE STRUCTURE WITH GEOTEXTILE FILTER FABRIC.
3. THE HEIGHT OF THE STRUCTURE SHOULD BE 2 STRAW/HAY BALES ( 3 FEET).



PERSPECTIVE VIEW



OPTION 1

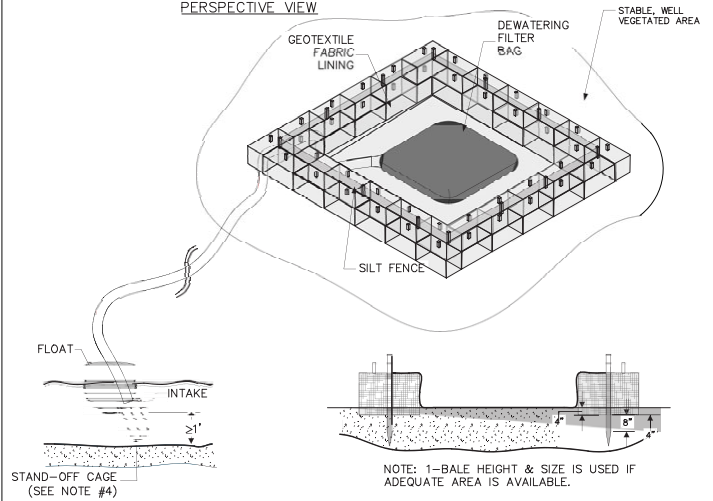


OPTION 2

NOTE: TYPICAL DIMENSIONS AND MAXIMUM PUMPING RATES ARE BASED ON INDUSTRY EXPERIENCE, BEST MANAGEMENT PRACTICES, AND PUMP SIZE (4"-8").

TYPICAL MINIMUM SUMP DIMENSIONS (FEET)		MAXIMUM PUMPING RATE GALLONS PER MINUTE
X	Y	
10	20	300
15	20	350
20	20	400
20	25	450
25	25	500
25	30	550
30	30	660

#### PERSPECTIVE VIEW



PUMP INLET

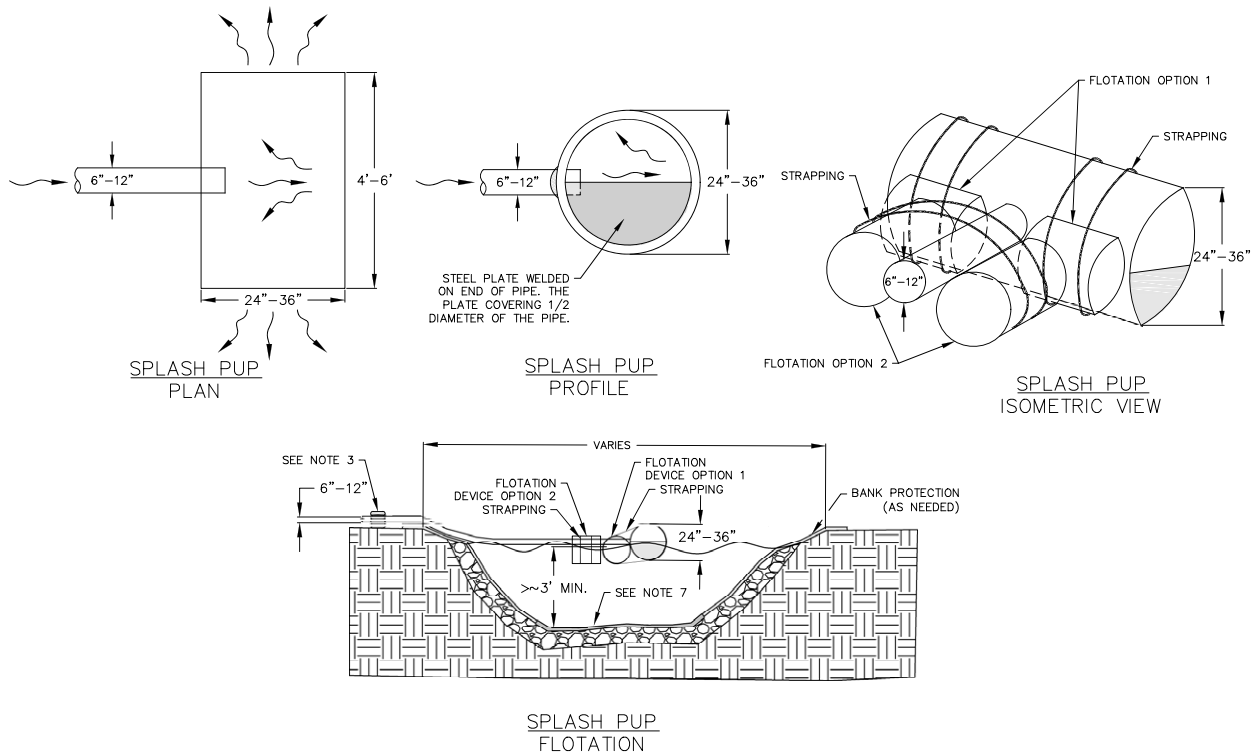
CROSS-SECTION OF STRUCTURE

#### NOTES:

1. SILT FENCE ENDS MUST BE WRAPPED TO JOIN TWO SECTIONS.
2. SILT FENCE SHALL BE ABOVE TOP OF BALES AND ANCHORED 6" BELOW GRADE.
3. SILT FENCE POST STAKING MUST BE 4 FEET OR LESS.
4. DEWATERING INTAKE HOSE SUPPORTED AT LEAST 1 FOOT FROM BOTTOM OF TRENCH BEING DEWATERED.
5. USE A FILTER BAG AT THE DISCHARGE HOSE END.
6. EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSPECTED AND MAINTAINED AS NEEDED TO MAINTAIN EFFICACY PER INDUSTRY STANDARDS.
7. MAINLINE HYDROSTATIC TEST DEWATERING STRUCTURES WILL BE REINFORCED USING INDUSTRY STANDARD OPTIONS TO PREVENT BALE MOVEMENT DURING DISCHARGE (e.g., CINCH STRAPS, WIRE, CATTLE GUARD FENCING).


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				LINE 3 REPLACEMENT TYPICAL STRAW/HAY BALE DEWATERING STRUCTURE	
				SCALE: NTS	DWG. NO. Figure 44
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D
A	ISSUED FOR REVIEW	JDW	11/04/19	KEH	NKD
		DATE	CHK'D	APP'D	CLIENT APP.
		11/04/19	KEH	NKD	

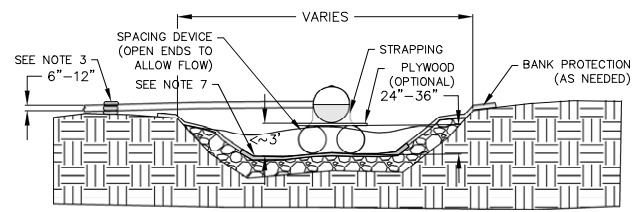
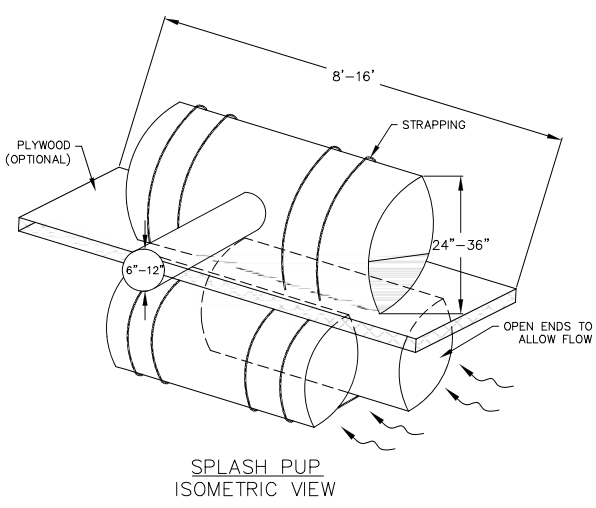
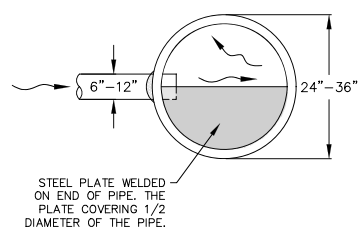
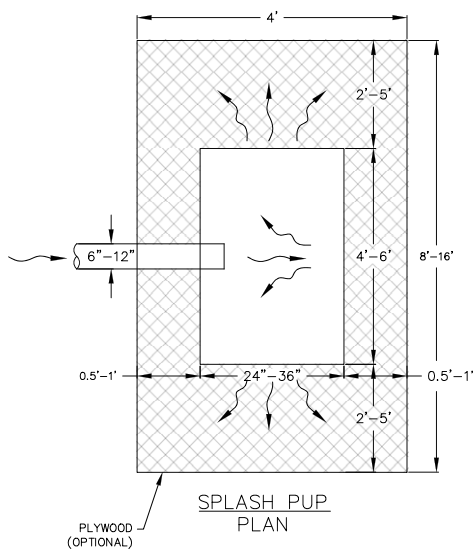


# NOTES:

1. AN ENERGY DISSIPATER SHALL BE UTILIZED FOR ALL DISCHARGES (OR THE LIKE).
2. ENERGY DISSIPATERS ARE UTILIZED IN CONJUNCTION WITH PERMIT REQUIRED TREATMENT.
3. DISCHARGE PIPING WILL BE SECURED TO PREVENT MOVEMENT ON SURFACE APPROACHING WATERBODY AS NEEDED.
4. FLOTATION DEVICE AND SPACING DEVICE TBD IN FIELD USING INDUSTRY STANDARD MATERIALS (eg. CLEAN PLASTIC BARREL).
5. BANK PROTECTION TBD (eg. PLASTIC SHEETING, TARP, OR PLYWOOD) AS NEEDED.
6. IF OPTIONAL PLYWOOD PROTECTION IS USED AND COMES INTO CONTACT WITH INFESTED WATERS, IT WILL BE DISPOSED OF AFTER DISCHARGE IS COMPLETED. OTHER MATERIALS WOULD BE DECONTAMINATED PER APPLICABLE PERMIT REQUIREMENTS IF PLANNED FOR REUSE.
7. INDUSTRY STANDARD MATERIAL (eg. PLYWOOD, GEOTEXTILE, ETC.) AS NEEDED TBD AT PRE DISCHARGE SITE MEETING.

											
										LINE 3 REPLACEMENT TYPICAL SPLASH PUP FLOTATION	

ISSUED  
FOR REVIEW  
11/04/19



**NOTES:**

1. AN ENERGY DISSIPATER SHALL BE UTILIZED FOR ALL DISCHARGES (OR THE LIKE).
2. ENERGY DISSIPATERS ARE UTILIZED IN CONJUNCTION WITH PERMIT REQUIRED TREATMENT.
3. DISCHARGE PIPING WILL BE SECURED TO PREVENT MOVEMENT ON SURFACE APPROACHING WATERBODY AS NEEDED.
4. FLOTATION DEVICE AND SPACING DEVICE TBD IN FIELD USING INDUSTRY STANDARD MATERIALS (eg. CLEAN PLASTIC BARREL).
5. BANK PROTECTION TBD (eg. PLASTIC SHEETING, TARP, OR PLYWOOD) AS NEEDED.
6. IF OPTIONAL PLYWOOD PROTECTION IS USED AND COMES INTO CONTACT WITH INFESTED WATERS, IT WILL BE DISPOSED OF AFTER DISCHARGE IS COMPLETED. OTHER MATERIALS WOULD BE DECONTAMINATED PER APPLICABLE PERMIT REQUIREMENTS IF PLANNED FOR REUSE.
7. INDUSTRY STANDARD MATERIAL (eg. PLYWOOD, GEOTEXTILE, ETC.) AS NEEDED TBD AT PRE DISCHARGE SITE MEETING.

\* USE 1 OR 2 4'x8' PLYWOOD SHEETS AS NEEDED TBD AT PRE DISCHARGE SITE MEETING.

**ISSUED FOR REVIEW**  
11/04/19

				DWG. NO. 04/25/19			LINE 3 REPLACEMENT TYPICAL SPLASH PUP SCOUR PREVENTION
				CHK. KEH	04/30/19		
				PROJ. ENGR. DG	04/30/19		
				PROJ. MGR. RD	04/30/19		
E	ISSUED FOR REVIEW	AJM	11/04/19	KEH	RF	SCALE	NTS
NO.	REVISION-DESCRIPTION	BY	DATE	CHK'D	APP'D	CLIENT APP.	DWG. NO. Figure 46

## **Appendix A**

### **Summary of Construction Methods and Procedures**





# Summary of Construction Methods and Procedures

Enbridge Energy, Limited Partnership • Line 3 Replacement Project

February 2020



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## **ACRONYMS AND ABBREVIATIONS**

ATWS	additional temporary workspace
BMP	best management practice
contractor yard or yard	pipeline, staging areas, and storage yards
EI	Environmental Inspector
EMCP	Environmental Monitor Control Plan
Enbridge	Enbridge Energy, Limited Partnership
EPP	Environmental Protection Plan
ESB	Electrical service building
HDD	horizontal directional drill
L3R or Project	Line 3 Replacement Project
OHWM	ordinary high water mark
PLM	Pipeline Maintenance

## 1.0 INTRODUCTION

This Summary of Construction Methods and Procedures (“Summary”) describes the various construction methods that Enbridge Energy, Limited Partnership (“Enbridge”) will utilize to construct the Line 3 Replacement Project (“L3R” or “Project”) through uplands, wetlands and waterbodies, and the decision-making process that occurs during design and in the field when identifying the appropriate crossing technique. The discussion of each construction method includes:

- Description of the construction methods and procedures;
- Conditions required to employ the method (applicability of the method);
- Site characteristics that require modification to standard construction techniques; and
- Environmental and/or constructability advantages and disadvantages associated with the method.

The purpose of this document is to provide a more complete description of the construction techniques that are outlined in Enbridge’s Environmental Protection Plan (“EPP”). The EPP contains elements of industry and company-wide best management practices (“BMPs”) that would be implemented during the execution of these construction techniques, such as erosion and sediment control measures; construction spill prevention, containment, and control; measures to prevent and contain inadvertent drilling fluid releases; invasive and noxious species control; and restoration/revegetation measures.

### 1.1 DESIGN PROCESS AND METHOD SELECTION OVERVIEW

The design process is iterative and starts with developing a basic design that satisfies the intended Project purpose and meets engineering design standards established by the U.S. Department of Transportation. Enbridge gathers, examines, and analyzes both field and desktop environmental data to inform the route and construction techniques, which is further refined by consultations with federal, state, and local regulatory agencies, landowners, and other stakeholders.

During the design and planning process, Enbridge identifies the preferred method of pipeline installation based on the engineering design standards (e.g., U.S. Department of Transportation), presence of wetland features, waterbody features, sensitive resources, landowner/community considerations, environmental regulations, and constructability considerations, including the ability to safely and effectively construct through the area. Specifically, these considerations include the following:

- Sensitive Resources:
  - Federally or state-designated high value waters (e.g., Wild and Scenic Rivers, canoe routes, Nationwide Rivers Inventory)
  - Wildlife or aquatic management areas
  - Section 303(d) impaired waters and other water quality considerations

- Infested waters (presence of aquatic invasive or noxious species)
- Presence of sensitive aquatic resources (e.g., federally or state-listed species, trout fisheries)
- Sensitive ecological communities (e.g., Sites of Biodiversity Significance)
- Fisheries concerns
- Wetland resources (types, extent)
- Recreational use
- Archaeological and historic resources
- Other issues identified by resource agencies
- Landowner/Community Considerations:
  - Homeowner and/or business access
  - Noise and/or lighting impacts
  - Traffic
  - Community access to sites (e.g., recreational areas, hunting)
  - Adjoining land use activities (e.g., grazing, organic farms)
  - Safety, security, and exposure of the public and workers
  - Other issues identified by land-managing agencies (e.g., off-road vehicle access)
- Constructability:
  - Season of construction
  - Topography
  - Geology and soils (e.g., presence of bedrock, cobble/boulders, soil competency/stability)
  - Geometry of the waterbody (straight, meanders)
  - Ability to manage water during crossing
  - Hydrology and soil saturation/inundation
  - Workspace limitations (e.g., roads, railroads, topography, sensitive resources)
  - Availability of equipment and access

- Duration of activity
- Risk (or probability of success)
- Cost

Enbridge identifies a primary and alternative crossing method for each waterbody crossing method, with some exceptions (discussed further in Section 4.0), based on these criteria and site-specific crossing conditions. In some cases, primary and alternative crossing methods are also defined for wetland crossings (discussed further in Section 3.0). Enbridge gathers information, such as wetland and waterbody field delineations, stream geomorphic field surveys, and/or geotechnical borings, and conducts risk assessments to inform these decisions. Enbridge also reviews construction reports from prior projects that have occurred in the vicinity of the proposed installations to determine if methods employed were successful or had complications.

The following sections describe the types of construction methods that could be employed to install the pipeline across uplands, wetlands, and waterbodies, and the specific conditions required for those methods to be feasible. These sections also describe the circumstances where a decision may be proposed in the field to change a construction method, or where additional tools may be utilized to ensure successful installation of the pipeline while minimizing adverse effects to the natural and/or human environment.

## **2.0 PROJECT COMPONENTS AND ASSOCIATED CONSTRUCTION PROCEDURES**

The following describes standard construction methods and procedures that may apply to both upland and wetland environments, as noted. Additional details on the upland construction method BMPs are provided in Sections 1.8 through 1.21 of the EPP.

### **2.1 RIGHT-OF-WAY ACCESS**

As described in Section 1.4 of the EPP, Enbridge will utilize the haul routes, access roads, or shoo-flies to access the construction workspace.

Enbridge will maintain existing roads, improve existing trails or roads, or build new roads as needed and approved through applicable permits. Maintenance activities may include back-blading, and/or placement of fill or construction mats where needed on the existing road grade and as agreed upon with the road authority. Gravel will only be added to maintain existing roads that have an existing gravel road base, or to develop permanent access roads, if needed. If gravel is installed on a road that is not permanently maintained for the Project, it will be removed and the area will be restored to pre-construction conditions following construction unless the road authority or landowner requests that it remain in place.

Activities that occur beyond the existing road grade, such as widening (including tree removal), placement of construction mats in wetlands, placement of structures within the Ordinary High Water Mark ("OHWM") of waterbodies, or development of a new road, are considered improvements requiring environmental survey and applicable permits and authorizations. Enbridge will confine maintenance and improvements on haul routes to the legal road easement as established by the corresponding road authority. Haul routes will only be improved where needed and in most cases, these improvements will be left in place once construction is complete and where agreed to by the road authority.

Construction mats (see Section 3.1) or rock on top of geotextile fabric will be used for roads within wetlands and will be removed once construction is complete. Ice/frost roads may be used during frozen conditions as described in Enbridge's Winter Construction Plan. Typical drawings for rock and construction mat approaches are provided in Figures 1 and 2 of the EPP.

Temporary access roads and shoo-flies utilized during construction will be widened to approximately 30 feet. After construction, Enbridge will return improved temporary access roads and shoo-flies to their pre-construction condition unless the road authority, landowner, or land-managing agency requests that the improvements be left in place. Enbridge will maintain permanent access roads to aboveground facilities (e.g., pump stations, mainline valves) throughout Project operation.

### 2.1.1 Bridges and Culverts

As described above, Enbridge will utilize existing public roads as haul routes and to access the workspace as much as possible. Generally, the bridges and culverts associated with existing roads will be sufficient to allow the passage of construction equipment and vehicles. However, in some cases, improvements to existing infrastructure may be needed, such as:

- Air bridges or construction mats over existing infrastructure;
- Extension of culverts to widen the travel lane; and/or
- Additional in-stream supports.

For new access roads or shoo-flies over a waterbody, and road approaches to the construction workspace, the following infrastructure may be installed as appropriate for site-specific conditions:

- Clear span bridges: Temporary clear span bridges will typically be used to cross waterbodies that are less than 13 feet from top of bank to top of bank with stable banks. No direct excavation of the waterbody bed or in-stream supports are required.
- Non-clear span bridges: Typically used to cross waterbodies with top of bank to top of bank 13 feet wide or greater as required by Enbridge's engineering specifications, or where additional stabilization is required to ensure the bridge installation allows for the safe passage of construction equipment and vehicles. Installation of infrastructure or supports within the OHWM are required.
- Culverts/flumes: Cylinder or box-shaped structures placed in the waterbody channel below the OHWM to allow water flow. The size and shape of the culvert is dependent on the waterbody.

Table 2.1-1 summarizes the site-specific conditions, advantages, and disadvantages associated with these bridge and culver types.



**TABLE 2.1-1  
Types of Bridges**

Type	Description	Applicability	Advantages	Disadvantages
Clear Span Type Bridge (construction mats or engineered structures)	Construction of temporary bridge utilizing construction mats or an imported engineered portable bridge material from top of bank to top of bank without instream supports (refer to Figure 3 of the EPP).	Suitable for waterbodies less than 13 feet wide top of bank to top of bank with stable banks. Regular bridge maintenance required. Preferred bridge type to provide safe crossing for heavy construction equipment.	<ul style="list-style-type: none"> <li>• Strong, removable, and portable bridge that can be optimally located</li> <li>• Limited in-stream disturbance</li> <li>• Limited sediment release</li> <li>• Maintains streamflow</li> <li>• Maintains fish passage</li> </ul>	<ul style="list-style-type: none"> <li>• Specialized equipment/crew required</li> <li>• Substantial amount of work may be necessary to transport and/or construct</li> <li>• Limited span for construction mat bridges and cap may be required</li> <li>• Regular maintenance of erosion and sediment controls required</li> <li>• Possible sediment release from bank and approach disturbance or if cap used over construction mat bridge</li> <li>• May cause interference on navigable waterways</li> <li>• Bridges need to be keyed into the banks</li> </ul>
Non-clear Span Bridge (construction mats or engineered structures with instream supports)	Construction of temporary bridge utilizing construction mats or an imported engineered portable bridge material from top of bank to top of bank with instream supports (e.g., mats or flume) (refer to Figure 4 of the EPP).	Suitable for waterbody crossings 13 feet wide or greater top of bank to top of bank with stable banks. Can be used on larger watercourses with multiple bridge spans and instream supports. Regular bridge maintenance required. Preferred bridge type to provide safe crossing for heavy construction equipment.	<ul style="list-style-type: none"> <li>• Strong, removable, and portable bridge that can be optimally located</li> <li>• Limited in-stream disturbance</li> <li>• Limited sediment release</li> <li>• Maintains streamflow</li> <li>• Maintains fish passage</li> </ul>	<ul style="list-style-type: none"> <li>• Specialized equipment/crew required</li> <li>• Substantial amount of work may be necessary to transport and/or construct</li> <li>• Limited span for construction mat bridges and cap may be required</li> <li>• Regular maintenance of erosion and sediment controls required</li> <li>• Possible sediment release from bank, approach, and instream support disturbance or if cap used over construction mat bridge</li> <li>• May cause interference on navigable waterways</li> <li>• Bridges need to be keyed into the banks</li> </ul>

TABLE 2.1-1 Types of Bridges				
Type	Description	Applicability	Advantages	Disadvantages
Culvert/Flume	Place steel flume pipe or culvert to allow waterbody flow. Place ramp over culvert or flume using construction mats. Rock may be placed on top geotextile fabric over culvert or flume in waterbodies or ditches at road approaches to support construction traffic (refer to Figure 1 of the EPP).	Appropriate for small or medium-sized waterbodies with or without flow and with defined channel and banks. Used where streamflow and fish passage are of concern.	<ul style="list-style-type: none"> <li>Limited sediment release</li> <li>Maintains stream flow and fish passage</li> </ul>	<ul style="list-style-type: none"> <li>Sediment release when filling around the culvert/flume and upon removal</li> <li>Susceptible to washout during high flow</li> <li>Icing in winter may block flow and fish passage</li> <li>May require bank grading</li> <li>Some culverts may not be able to withstand heavy construction traffic</li> <li>Requires specialized materials such as sand bags and select fill</li> </ul>
Source: Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association, 2005.				

### **2.1.2 Bridge and Culvert Design**

Equipment bridges and culverts will be designed to meet the requirements of the applicable agencies and local authorities. Bridges will be installed parallel to the pipeline centerline so that equipment does not need to turn while working or crossing the bridge. For bridges that are installed on designated canoe routes, the bridge height will be designed to allow for adequate clearance to allow recreational users to pass safely under the bridge. Enbridge may also prepare site-specific bridge or culvert designs at specific wetland or waterbody crossings for agency approval, as required.

Enbridge has engineering specifications that require in-stream supports on bridges crossing waterbodies 13 feet wide or greater top of bank to top of bank with stable banks. In-stream supports will not be installed in or removed from waterbodies during agency-timing restrictions unless approved by the agency. Bridges will not restrict flow or pool water while the bridge is in place and will be constructed with clean materials. Bridges will be designed to prevent soil from entering the waterbody (refer to Figures 3 and 4 of the EPP).

## **2.2 CONSTRUCTION YARDS**

In order to construct the pipeline, staging areas, and storage yards (collectively referred to as “construction yards” or “yards”) will be strategically located outside of the right-of-way along the route. Yards will be sited in accordance with local permits, as required. These areas are used to stockpile pipe, and other equipment required during construction. Yards provide parking for construction equipment and employee trucks, and locations for offices and trailers. Yards may also be used to clean equipment, or prepare materials for use, such as concrete coating of pipe segments.

Enbridge will seek previously disturbed areas in proximity to the route to utilize as a yard site, such as gravel pits, railroad yards, cleared fields, or parking areas. Yards will be cleared and may be covered in rough stone gravel and/or construction mats as needed. Yards may also be fenced for security purposes. After construction is complete, yards will be restored back to pre-construction conditions unless otherwise requested by the landowner.

## **2.3 TEMPORARY AND PERMANENT RIGHTS-OF-WAY**

Construction in upland<sup>1</sup> areas will generally require a 120-foot-wide construction workspace.<sup>2</sup> The construction workspace will allow for temporary storage of topsoil and trench spoil (nonworking side), as well as accommodate the safe operation of construction equipment and a travel lane (working side) (refer to Section 2.4). Topsoil will also be stored on the working side. The 50-foot-

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<sup>1</sup> Uplands: Uplands are defined as an elevated region of land lying above the level where water flows or collects in basins.

<sup>2</sup> The terms “construction right-of-way,” “temporary construction right-of-way,” “construction workspace,” and “temporary construction workspace” define the primary mainline workspace area required for installation of L3R. For clarity, Enbridge will generically use “construction workspace” instead of “temporary construction right-of-way,” “temporary construction workspace,” or “construction right-of-way” as the terminology for 1) the permanent right-of-way; and 2) the temporary construction area (which includes the following defined terms: Temporary Workspace and Additional Temporary Workspace). All construction equipment and vehicles will be confined to this approved construction workspace.

wide permanent right-of-way<sup>3</sup> will be wholly contained within the 120-foot-wide construction workspace. Table 2.3-1 presents the typical construction workspace and permanent right-of-way dimensions that will be used for pipeline construction and operation in upland and wetland areas (refer to Section 3.0 for a description of construction methods and workspace dimensions in wetland areas). Figure 5 of the EPP presents the temporary construction workspace<sup>4</sup> and permanent right-of-way configurations when co-located with existing Enbridge or third-party pipelines or utilities, and in greenfield<sup>5</sup> locations. Overall, the L3R will be co-located<sup>6</sup> with other Enbridge pipelines; third-party pipelines or utilities; or roads, railroads, or highways for the majority of the route.

<b>Route Segment</b>	<b>Permanent Right-of-Way (feet)</b>	<b>Temporary Construction Workspace (feet)</b>	<b>Total Land Requirements (feet)</b>
Co-located with Enbridge Pipeline	50 (~25 new)	70 (uplands)	120 (uplands)
		45 (wetlands)	95 (wetlands)
Co-located with Foreign (Third-Party) Utility	50	70 (uplands)	120 (uplands)
		45 (wetlands)	95 (wetlands)
Co-located with Foreign Utility in Saturated Wetlands	50	70 (uplands)	120 (uplands)
		45 (wetlands)	95 (wetlands)
Greenfield	50	70 (uplands)	120 (uplands)
		45 (wetlands)	95 (wetlands)

During construction, topsoil and subsoil will be separated and stored within the construction workspace.

Where co-located with Enbridge's existing pipelines, Enbridge will use approximately 40 feet of existing permanent right-of-way as temporary workspace that will revert back to permanent right-of-way after construction (see Figure 5 of the EPP). The offset distance between L3R and an existing foreign pipeline or utility will vary, as presented in Figure 5 of the EPP.

## 2.4 TRAVEL LANES

As described in Section 2.3, the working side of the construction workspace will include a travel lane to allow for the safe passage of construction vehicles and equipment. Temporary equipment bridges will be used (upon approval by the appropriate agency) at waterbody crossings (including small waterways such as ditches and intermittent streams) where there is a potential for stormwater runoff or rain events to transport sediment downstream from equipment crossing the waterway. Refer to Sections 2.1.1 and 2.1.2 for additional information on bridge and culvert types and design.

<sup>3</sup> Permanent right-of-way: The legally acquired land rights used to install, maintain, operate, and access L3R.

<sup>4</sup> Temporary workspace: Land located adjacent to and contiguous with the proposed right-of-way.

<sup>5</sup> Greenfield: The term "greenfield" refers to land that has not previously been used for another pipeline, utility, road, or railroad right-of-way. For the purposes of this document, the term greenfield is applied to land that is more than 250 feet away from an existing parallel pipeline, utility, road, or railroad right-of-way.

<sup>6</sup> Co-located: Co-located is any portion of the route that is within 250-feet from the centerline of a known utility.

## 2.5 ADDITIONAL TEMPORARY WORKSPACES

Additional temporary workspaces (“ATWS”)<sup>7</sup> will be required outside of the typical construction workspace to facilitate specific aspects of construction. For example, ATWS will be needed at select locations such as steep slopes, roads, waterbodies, and some wetland crossings, and where it is necessary to cross under existing pipelines or foreign utilities, HDD sites, and other special circumstances to stage equipment and materials, and store spoil. Enbridge will also use ATWS to accommodate equipment and resources used for appropriating and discharging water. The dimensions of ATWS will vary according to site-specific conditions.

Enbridge may also require ATWS for:

- construction equipment and working personnel to travel safely within the Project’s construction site;
- environmental monitoring and mitigation to be employed as required; and
- continuous ingress/egress for emergency equipment and personnel.

Enbridge attempts to locate ATWS outside of wetlands wherever practicable. However, ATWS may be sited in select wetlands where the wetland is adjacent to a waterbody, road, railroad, foreign utility crossing, pipeline cross-over, and/or where required based on site-specific conditions with prior approval from the applicable regulatory agencies.

## 2.6 PIPELINE CONSTRUCTION SEQUENCE

Enbridge will install the replacement pipeline using industry-accepted construction methods. Pipeline construction will typically follow a sequential process, which includes: development of construction yards, survey and staking of the construction workspace and roads, access road and haul route improvements, clearing, installation of erosion and sediment control BMPs, site preparation, pipe stringing, bending, welding, coating, trenching, lowering-in, backfilling, hydrostatic testing,<sup>8</sup> and cleanup, grading, and restoration. In most areas, these construction processes will proceed in an orderly assembly-line fashion with construction crews moving along the construction workspace (see Figure 2.6-1). Appropriate safety measures will be implemented before excavation begins, including notification through the One-Call system to ensure third-party utilities and adjacent pipelines are properly marked. Four-way sweeps<sup>9</sup> will also be conducted to positively locate any existing underground utilities. Pipe, valves, and fittings will be transported to the workspace and placed along the workspace. Construction crews will use temporary access roads and shoo-flies for ingress/egress to the Project workspace where travel down the workspace is not feasible.

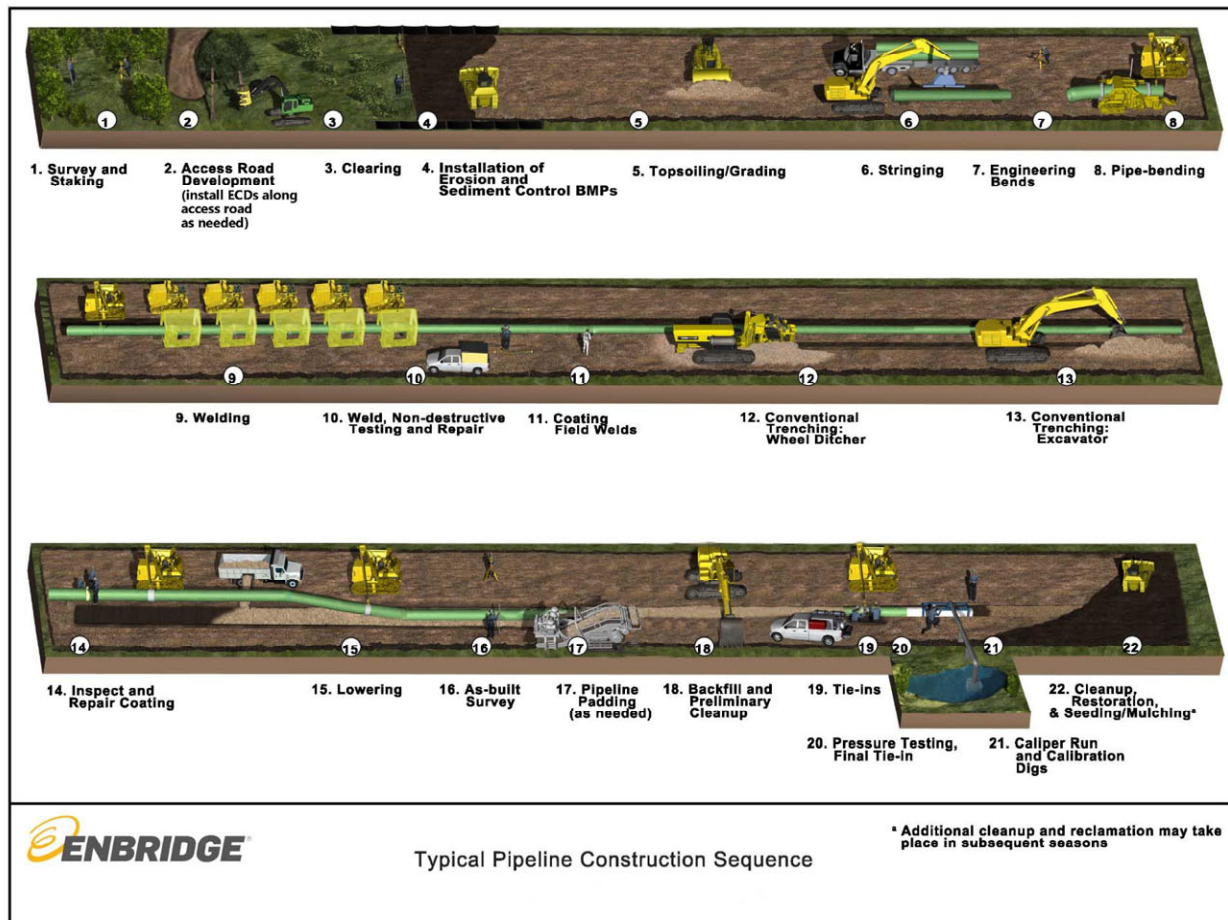
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<sup>7</sup> ATWS: ATWS is temporary construction workspace needed when encountering environmental features that require special construction methods.

<sup>8</sup> Hydrostatic testing: Hydrostatic testing is a process of verifying the integrity of the pipeline before it is placed into service. Hydrostatic testing involves filling the pipeline with water to a designated pressure and holding it for a specified period of time.

<sup>9</sup> A four-way sweep is a method of locating underground utilities that involves scanning the ground with electromagnetic induction or ground-penetrating radar equipment to detect the presence of buried features; it does not involve digging or other ground-disturbing activities. The term “four-way sweep” comes from the fact that an area typically is scanned (or swept) in at least four directions.

Figure 2.6-1: Typical Pipeline Construction Sequence



## 2.7 MINIMUM DEPTH OF COVER

In accordance with federal requirements (49 Code of Federal Regulations 195.248), the depth of cover between the top of the pipe and the ground level, road bed, or river bottom can range between 18 to 48 inches, depending on the location of the pipe and the presence of rock, which is provided below (see Table 2.7-1).

Table 2.7-1 Depth of Cover Requirements		
Location	Cover in inches	
	Normal Excavation	Rock Excavation <sup>a</sup>
Industrial, commercial, and residential areas	36	30
Crossing of inland bodies of water with a width of at least 100 ft. from high water mark to high water mark	48	18
Drainage ditches at public roads and railroads	36	36
Deepwater port safety zones	48	24
Gulf of Mexico and its inlets in waters less than 15 feet deep as measured from mean low water	36	18
Other offshore areas under water less than 12 feet deep as measured from mean low water	36	18
Any other area	30	18
<sup>a</sup> Rock excavation is any excavation that requires blasting or removal by equivalent means.		

Minnesota Statute § 216G.07, Subd. 1 requires that the pipeline trench be excavated to a depth of at least 54 inches of backfill from ground surface to the top of pipeline in all areas where the pipeline crosses the right-of-way of any public drainage facility; or any county, town, or municipal street or highway; and where the pipeline crosses cultivated agricultural land. This depth requirement may be waived as described in Minnesota Statute § 216G.07, Subd. 2; however, the pipe must still be buried to a minimum depth that complies with the federal requirements outlined in Table 2.7-1. While Enbridge will seek waivers for Minnesota state depth of cover requirements in some circumstances, it will meet all federal depth of cover requirements and also target a nominal 48 inches of cover across the Project.

In addition, agencies have requested additional depth of coverage at certain wetland and waterbody crossings. Enbridge will work with the agencies to determine the appropriate depth of cover at these locations. This design change will be reflected in the construction alignment sheets and applicable site-specific drawings. Following installation of the pipeline, Enbridge will confirm that the pipe depth meets federal and state requirements through civil survey.

## 2.8 ASSOCIATED FACILITIES

Facility construction will follow the same initial sequential process as mainline pipeline construction, including survey and staking, clearing, and site preparation.

### 2.8.1 Pump Stations

Pump stations will be located at regular intervals along the pipeline to boost the pressure lost due to friction as the liquids move through the pipe. All pump stations will be installed on property that has been or will be purchased by Enbridge in fee.

Each pump station property will include a:

- Pumphouse building;
- Electrical service building (“ESB”);
- Substation;
- Permanent access road and parking area;
- Snow storage area(s);
- Containment basin; and
- Infiltration basin or wet sedimentation basin.

Prior to excavation, four-way sweeps will be conducted to positively locate any existing underground utilities. Temporary construction trailers will be placed, material laydown areas<sup>10</sup> prepared, and temporary utilities (e.g., power, telephone) will be installed at the site. Topsoil will be stripped and stored prior to initiating excavation work.

The pumphouse building footprint will measure approximately 120 feet by 70 feet and the excavation will vary between approximately 5 to 10 feet deep depending on site-specific conditions. Typical construction procedures for the building foundation are to excavate the foundation base depth, establish concrete foundations, fill, and construct. Dewatering of the excavations will occur as described in Section 5.0 of the EPP and applicable permit conditions.

Several components at the pump station site will require foundation footings, including the pumphouse, ESB, and substations. Foundation footings will consist of either poured concrete piers or helical footings that will average between 10 to 15 feet deep but may extend up to 40 feet deep depending on site specific conditions.

The piping associated with the pump stations will either be welded onsite or pre-fabricated spools made from fabrication shops will be installed. All station piping will be pressure tested after on-site installation. Pressure testing will be completed with a liquid test medium that will be trucked on- and off-site. Piping will be tested for 4.25 hours if above grade; below grade piping will be tested for 8.25 hours. There will be three pressure tests per facility; one test for the mainline piping inside the station, one test for the station piping, and one for the drain line piping.

The modular-designed ESBs will be placed onsite and all associated electrical and controls equipment will be installed. Power and control cables will be routed, and additional pre-operational testing can begin once the system(s) are energized. All sites will require the construction of a new electrical substation.

The containment basin, wet sedimentation basin, or infiltration basin associated with each facility will be designed and constructed in accordance with the applicable federal and Minnesota Pollution Control Agency requirements.

Upon completion of all pre-operational testing, the equipment will be flooded with crude oil according to the detailed flood plans developed for each site. Equipment operation will then be verified. Final site civil work and painting will be completed, and the pump station property will be fenced in and gated to restrict access to the site. The area within the fence will be graveled and/or

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<sup>10</sup> Material laydown area: A material laydown area is a piece of land where materials are stored and staged for construction.



maintained as grass. Once all final checks have been completed, the facility will be turned over to Enbridge Operations for service.

## 2.8.2 Valves

Valves<sup>11</sup> will be installed concurrently with the mainline pipe. Each valve site will consist of:

- one 8-foot by 14-foot building constructed 3 feet above grade on helical footings that do not require excavations or grout to install;
- one 36-inch mainline gate valve with electrical actuator and pressure transmitters on both upstream and downstream of the valve;
- ESB and associated electrical and controls equipment;
- service entrance and permanent access road; and
- security fencing and signage.

Refer to Figure 2.8-1 for a typical mainline valve layout.

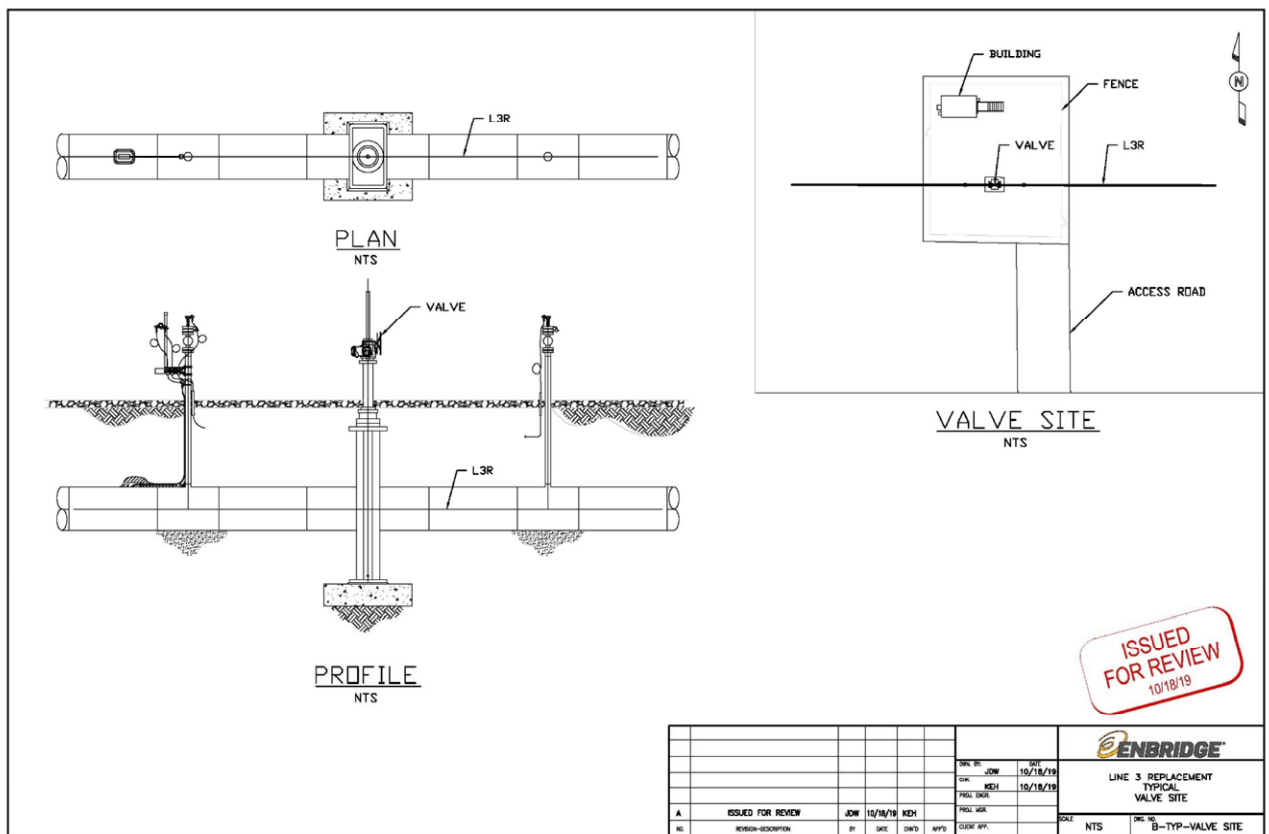
Excavations at valve sites will be required to connect valve components to the belowground pipeline. The excavation dimensions are approximately 15 feet wide by 15 feet long by 15 feet deep, stepped back to 20 feet wide by 20 feet long at the ground surface. The mainline valve footing will be concrete 1.5 feet thick on a 1-foot thick gravel pad with the footing surface located just over 5 feet (5 feet 1 3/8 inches) below the installed centerline of the pipe. Total depth of the excavation is therefore anticipated to be approximately 13 to 15 feet below ground surface. Additional excavation will include cable routing trenches that will be approximately 24 inches deep and 12 inches wide.

After backfilling is complete, the valve will be filled with water and hydrostatically tested as part of the mainline spread hydrostatic test. The ESB will be placed and all associated electrical and controls equipment will be installed. Power and control cables will be routed, and additional pre-operational testing will begin once the system(s) are energized. Some sites will require the construction of a new electrical service.

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<sup>11</sup> Valve: A valve is a piece of equipment used to control the flow of crude oil inside the pipeline. The valve acts as a gateway that can be opened and closed. A mainline valve describes an entire aboveground facility on the pipeline that is equipped with shutoff valves capable of stopping pipeline flow in the event of an emergency or for maintenance. A slide gate valve is a particular type of shutoff valve that operates by sliding a steel plate across the entire diameter of the pipe to seal off flow.

Figure 2.8-1: Line 3 Replacement Project Typical Mainline Valve Layout



Upon completion of all pre-operational testing, the valve will be ready for use. Equipment operation will be re-checked and final site civil work including fencing installation, permanent access road construction, and painting will be completed. The valve site within the fenced area will be graveled. After the final site civil work is complete, the site will be cleaned up and restored. After all final checks have been completed, the valve site will be turned over to Enbridge Operations for service.

### 2.8.3 Corrosion Protection

A cathodic protection<sup>12</sup> and impressed current mitigation systems will be constructed for L3R. Construction of this system includes both anode arrays installed in both conventional beds near the surface as well as in deep wells. Construction of cathodic protection systems includes excavation of soils at the site of installation. Methods utilized typically involve digging a trench for a cable using a mini-excavator, or ground trenching equipment such as a Ditch Witch. The technique used to install the cables associated with the cathodic protection system is similar to the methods used for installing fiber optic or telephone lines used for communications, which typically requires an approximately 30-foot-wide construction workspace.

Conventional surface bed type cathodic protection systems will be installed between 300 and 600 feet perpendicular to the pipeline. Anodes will be installed in either vertical or horizontal fashion and cables will be trenched to connect the anodes electrically to the protected metallic structures. Enbridge will also construct deep well cathodic protection systems where the anodes will be installed vertically in a well using construction methods similar to that of water wells. Deep well cathodic protection systems are normally installed closer to the pipeline, with the anodes themselves installed deeper (200 to 400 feet deep) than a conventional surface bed.

Both types of systems utilize native backfill for areas where trenching for the cable occurs. However, the area directly around the anodes will be backfilled with a more suitable backfill such as coke breeze.<sup>13</sup> Additionally, in a deep well cathodic protection system, a natural clay plug will be installed above the anodes to seal the well and prevent water from entering the hole.

### 2.8.4 Pipeline Maintenance Shops

Pipeline Maintenance ("PLM") shops are strategically located along the pipeline route and are staffed by operations personnel. The PLM shops are stocked with equipment needed during operations and maintenance of the pipeline.

Construction will proceed similar to the pump stations, beginning with initial survey, staking, and four-way sweeps. The site will then be cleared and stripped of topsoil to prepare for excavation activities. Excavations will be made for the building foundations, septic and well, power, and

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<sup>12</sup> Cathodic protection: Cathodic protection is a method for safeguarding the pipeline against corrosion. In a cathodic protection system, the metal to be protected (the pipeline) is connected to a metal that corrodes more easily (*anode array* or *anode groundbed*). The metal that corrodes more easily corrodes instead of the pipeline. Cathodic protection can be achieved by using reactive anode metals that are electrically connected to the pipeline (also known as a *galvanic anode* systems) or by using inert anode metals and impressing an electric current on the system (also known as an *impressed current* system). Enbridge's proposed cathodic protection system includes anode arrays installed in conventional beds near the ground surface as well as in deeper wells.

<sup>13</sup> Coke Breeze: Coke breeze is common carbonaceous backfill material used in cathodic protection. It provides a conductive path for current flow and ensures optimal effectiveness of the cathodic protection system.

communication. The excavation for the building will be approximately 125 feet by 75 feet by 6 feet deep to accommodate the foundations. Once foundations are poured, the excavation will be backfilled to rough grade and the building will be constructed.

After the building is constructed, the site will be stabilized, fenced, signed, and turned over to Enbridge Operations for their use.

### **3.0 PIPELINE CONSTRUCTION THROUGH WETLANDS**

#### **3.1 RIGHT-OF-WAY ACCESS**

Enbridge will use the construction workspace and only approved roads to access wetland areas. Construction mats will be placed along the travel lane within delineated wetlands within the construction workspace and along access roads (refer to Section 2.1). Enbridge may use the following types of construction mats:

- **Timber Mats:** Timber mats are available in a variety of sizes and are constructed of hardwood materials that are bolted together. Timber mats are suitable for all vehicle types present on the construction workspace, have high durability under traffic, and are easily installed and removed using typical construction equipment. Timber mats are suitable for use in all soil conditions for all pipeline construction activities.
- **Laminated Mats:** Laminated mats are available in a variety of sizes and are constructed of laminated wood materials. Laminated mats are suitable for all vehicle types but are limited in their weight bearing capacity (e.g., 600 pounds per square inch). They have high durability and are easily installed and removed using typical construction equipment. Laminated mats are suitable for use in most soil conditions but should not be used in extremely saturated conditions. Laminated mats can be used on access roads, at drill pads, and for storage and staging of equipment.

#### **3.2 CHOOSING A CONSTRUCTION METHOD**

Table 3.2-1 summarizes the wetland crossing techniques Enbridge intends to utilize during construction, the site-specific conditions required for the method to be feasible, and the advantages and disadvantages associated with each technique. Enbridge will typically install the pipelines through wetlands with moderate- to high-bearing strength soils using standard upland crossing methods utilizing construction mats or equivalent to avoid rutting, minimizing disturbance to soils and vegetation, and to ensure safe and stable working surfaces for construction equipment and personnel.

Enbridge may install the pipeline through saturated wetlands with low bearing strength soils by using push-pull techniques, if practicable, or by using standard upland crossing techniques with frost/ice roads during frozen conditions (see Enbridge's Winter Construction Plan for additional information). In some cases, Enbridge may install sheet piling within the trench to stabilize the trench walls. Enbridge may install the pipelines through narrow wetlands or ditches adjacent to roads or railroads and sensitive wetlands or riparian areas adjacent to waterbody crossings using trenchless techniques such as a non-pressurized horizontal bore method or the HDD (pressurized) method.

**TABLE 3.2-1**  
**Pipeline Wetland Installation Methods**

Method (Season)	Description <sup>a</sup>	Site Characteristics	Applicable Wetland Type(s) <sup>b</sup>	Advantages	Disadvantages
Trench: Modified Upland Construction Method (open cut) (Spring-Fall/non-frozen)	Conduct construction from construction mats or equivalent (refer to Figures 30 and 31 from the EPP). Multiple layers of construction mats may be required in saturated wetland conditions (refer to Figures 32 and 33 of the EPP). Vegetation is cut at ground surface to maintain the root structure and seed bank in the soil profile along the travel lane.	Suitable in wetlands with unsaturated mineral soils constructed during non-frozen conditions. Also, suitable in saturated wetlands (typically <12-inch inundation) with moderate to high bearing strength, shallow peat soils over mineral substrate, or forested peatlands where roots provide a relatively firm foundation for construction mats or equivalent.	The following wetland types are typically suitable, as along as the criteria described in the Site Characteristics column is also met: <ul style="list-style-type: none"> <li>• Wet/Wet Mesic Prairie</li> <li>• Fresh (Wet) Meadow</li> <li>• Sedge Meadow</li> <li>• Alder Thicket</li> <li>• Shrub-Carr</li> <li>• Floodplain Forest</li> <li>• Hardwood Swamp</li> <li>• Coniferous Swamp</li> </ul>	<ul style="list-style-type: none"> <li>• Relatively quick construction/installation</li> <li>• No need for specialized equipment</li> <li>• Minimizes impacts on soils and vegetation by limiting disturbance to Trench-Line only and operating off of construction mats</li> <li>• Facilitates revegetation from seedbank and provides favorable plant growth conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Clearing and brush removal required along travel lane in forested wetlands</li> <li>• Potential need for wider than normal trench and therefore additional construction workspace to avoid trench sidewall slump in loose, poorly graded sands</li> <li>• Multiple mat layers may be required in some wetlands; additional time for installation and removal of construction mats,</li> <li>• Potential compaction of the travel lane; additional restoration efforts of travel lane may be needed as compressed surface rebounds</li> </ul>
Trench: Modified Upland Construction Method (open cut) (Winter/Freeze down)	Conduct construction from frost/ice roads, and/or construction mats, or equivalent (refer to Appendix A of the Winter Construction Plan). Topsoil segregation performed as practicable but modified dependent on depth of frost and thickness of topsoil. May use a ripper to break up frozen topsoil over the trench line only. Topsoil in spoil storage graded smooth to minimize mixing during backfilling. Vegetation is cut at ground surface to maintain the root structure and seed bank in soil profile along the travel lane.	Suitable for wetlands with unsaturated mineral soils or saturated or shallow inundated wetlands with moderate to low strength peat over mineral soils during frozen conditions.	The following wetland types are typically suitable, as along as the criteria described in the Site Characteristics column is also met: <ul style="list-style-type: none"> <li>• Wet/Wet Mesic Prairie</li> <li>• Fresh (Wet) Meadow</li> <li>• Sedge Meadow</li> <li>• Alder Thicket</li> <li>• Shrub-Carr</li> <li>• Floodplain Forest</li> <li>• Hardwood Swamp</li> <li>• Coniferous Swamp</li> <li>• Shallow Marsh</li> <li>• Coniferous Bog</li> <li>• Open Bog</li> </ul>	<ul style="list-style-type: none"> <li>• Relatively quick construction/installation</li> <li>• Minimizes impacts on wetland soils and vegetation by limiting to disturbance to Trench-Line only and operating off of frost/ice roads or construction mats</li> <li>• Stable foundations for spoil storage and travel lane</li> <li>• Facilitates revegetation from seedbank and provides favorable plant growth conditions</li> </ul>	<ul style="list-style-type: none"> <li>• Potential need for wider than normal trench and therefore additional construction workspace to avoid trench sidewall slump in loose, poorly graded sands</li> <li>• Susceptible to winter thaw; limited to freezing conditions and contingency required for thawing conditions</li> <li>• Additional safety concerns associated with cold weather work</li> <li>• Potential for mixing of topsoil and subsoil during excavation</li> <li>• Backfilling of frozen spoil piles may result in subsidence of the trench during thaw introducing potential increase in backfill volume and/or additional restoration efforts</li> <li>• If post-thaw restoration is necessary, mats will typically be left in place increasing the period of disturbance</li> <li>• Frost/ice roads often require a water source</li> </ul>

**TABLE 3.2-1**  
**Pipeline Wetland Installation Methods**

<b>Method (Season)</b>	<b>Description <sup>a</sup></b>	<b>Site Characteristics</b>	<b>Applicable Wetland Type(s)<sup>b</sup></b>	<b>Advantages</b>	<b>Disadvantages</b>
Trench: Push-Pull Method: Backhoe (Spring-Fall)	Use a backhoe (or equivalent) to excavate the trench operating from construction mats "walked" down the trenchline (refer to Figures 35 and 36 of the EPP). Push-pull or float and sink the pre-assembled pipe then backfill. May or may not use a travel lane depending on conditions with backfilling occurring from the spoil storage side or the working side. When a travel lane is used, vegetation will be cut above the ground surface to maintain the root structure and seed bank in the soil profile. May or may not require trench dewatering.	Suitable in saturated wetlands (typically >12-inch inundation) with relatively competent peat soils, shallow peat over mineral soils, or forested peatlands with moderate bearing strength soils.	The following wetland types are typically suitable, as along as the criteria described in the Site Characteristics column is also met: <ul style="list-style-type: none"> <li>• Shallow Marsh</li> <li>• Deep Marsh</li> <li>• Shallow, Open Water</li> <li>• Coniferous Bog</li> <li>• Open Bog</li> </ul>	<ul style="list-style-type: none"> <li>• Minimizes impacts on wetland soils and vegetation</li> <li>• No specialized equipment needed and allows for construction in unfrozen, saturated wetlands</li> <li>• Reduced heavy equipment traffic</li> </ul>	<ul style="list-style-type: none"> <li>• Topsoil segregation typically not practical; inability to maintain a cohesive spoil pile due to liquid nature of soil</li> <li>• Potential for stranding of the excavator if extremely loose, deep peat soils are encountered unexpectedly</li> <li>• Additional workspace required for pipe assembly or pipe may be fabricated off-site and brought in as a drag section</li> <li>• Due to lack of travel lane, additional adjacent workspace required for equipment turnarounds</li> <li>• May require spread move around</li> </ul>

**TABLE 3.2-1**  
**Pipeline Wetland Installation Methods**

Method (Season)	Description <sup>a</sup>	Site Characteristics	Applicable Wetland Type(s) <sup>b</sup>	Advantages	Disadvantages
Push-Pull Method: Swamphoe (Spring-Fall)	Excavate the trench using a backhoe (or equivalent) mounted on tracked pontoons operating along the trenchline (refer to Figures 35 and 36 of the EPP). Push-pull or float and sink the pre-assembled pipe then backfill. May or may not use a travel lane depending on conditions with backfilling occurring from the spoil storage side or the working side. When a travel lane is used, vegetation will be cut above the ground surface to maintain the root structure and seed bank in the soil profile. May or may not require trench dewatering.	Suitable in saturated (typically > 12-inch inundation) emergent and scrub-shrub wetlands with loose, deep peat soils or floating mat peat, low-bearing strength soils.	The following wetland types are typically suitable, as along as the criteria described in the Site Characteristics column is also met: <ul style="list-style-type: none"> <li>• Shallow Marsh</li> <li>• Deep Marsh</li> <li>• Shallow, Open Water</li> <li>• Coniferous Bog</li> <li>• Open Bog</li> </ul>	<ul style="list-style-type: none"> <li>• Allows for construction in saturated wetlands during unfrozen conditions</li> <li>• Reduced heavy equipment traffic</li> </ul>	<ul style="list-style-type: none"> <li>• Specialized equipment (i.e., swamphoe) required</li> <li>• Topsoil segregation typically not practical; inability to maintain a cohesive spoil pile due to liquid nature of soil</li> <li>• Potential for spoil settlement preventing complete replacement of backfill and potentially resulting in open water along the trenchline</li> <li>• Additional adjacent workspace required for pipe assembly or pipe may be fabricated off-site and brought in as a drag section</li> <li>• Additional adjacent workspace may be required for equipment turnarounds</li> <li>• Slower than normal construction progress in the wetland due to equipment speed</li> <li>• May require spread move around</li> </ul>
Trenchless: Bore (Non-Pressurized)	Bore under feature from bore pit on one side to bore pit on the other side with or without casing (see Figures 40 and 41 of the EPP). Non-pressurized water or bentonite may be introduced if soil conditions dictate; any release will travel back along the path of the pipe and into the bore pit.	Suitable for narrow highways, roads, railroads, and watercourses. Not suitable where there are high water tables, loose sand/gravel substrates, or adjacent steep slopes.	The following wetland types are typically suitable, as along as the criteria described in the Site Characteristics column is also met: <ul style="list-style-type: none"> <li>• Wet/Wet Mesic Prairie</li> <li>• Fresh (Wet) Meadow</li> <li>• Sedge Meadow</li> <li>• Alder Thicket</li> <li>• Shrub-Carr</li> <li>• Floodplain Forest</li> <li>• Hardwood Swamp</li> <li>• Coniferous Swamp</li> </ul>	<ul style="list-style-type: none"> <li>• Avoids surface ground disturbance in the wetland or ditch adjacent to the feature crossed</li> <li>• No sediment release</li> <li>• No potential for inadvertent release outside of the bore pits</li> </ul>	<ul style="list-style-type: none"> <li>• Requires additional workspace for bore pits, spoil piles, and sump(s)</li> <li>• Large excavations required on both sides of the crossing</li> <li>• Deep bore pits may require sump pump or well point dewatering system and/or sheet-piling</li> <li>• Slower than trench crossing techniques</li> </ul>

**TABLE 3.2-1**  
**Pipeline Wetland Installation Methods**

Method (Season)	Description <sup>a</sup>	Site Characteristics	Applicable Wetland Type(s) <sup>b</sup>	Advantages	Disadvantages
Trenchless: HDD (Pressurized)	Place a rig on one side of the wetland and drill a small-diameter pilot-hole under the feature along a prescribed profile (see Figure 26 of the EPP). Upon completion of the pilot-hole, use 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. Once the hole is reamed to the appropriate size, the welded pipe section is then pulled back through the hole.	Suitable to cross sensitive wetland areas and riparian wetlands adjacent to waterbody crossings depending on site-specific topography and the local geologic substrate. Feasibility limitations in high flow artesian conditions, areas of glacial till or outwash interspersed with boulder and cobbles, fractured bedrock, or non-cohesive coarse sands and gravels. Geotechnical borings and hydrofracture risk analysis are performed to determine HDD feasibility and potential for inadvertent returns.	All wetland types that meet the criteria described in the Site Characteristics column.	<ul style="list-style-type: none"> <li>• No sediment release unless an inadvertent return occurs</li> <li>• Avoids surface ground disturbance in riparian wetlands adjacent to sensitive or large waterbodies</li> <li>• Limits vegetation disturbance to within the permanently maintained easement</li> <li>• Significantly reduces clean-up and restoration between entry and exit points</li> </ul>	<ul style="list-style-type: none"> <li>• Potential for inadvertent release of drilling fluids (refer to Section 11.0 of the EPP)</li> <li>• Requires ATWS on both sides of the crossings to stage construction, fabricate the pipeline, and store materials</li> <li>• Tree and brush clearing is necessary for operations</li> <li>• Requires obtaining water to formulate the drilling fluid, buoyancy control, as well as hydrostatic testing</li> <li>• Feasibility and success depends on substrate</li> <li>• Requires specialized equipment (limited availability)</li> <li>• Pull string area along the alignment for the same length of the crossing to allow continuous pullback</li> <li>• Requires a straight alignment for the length of the HDD</li> <li>• May require several weeks to complete the HDD</li> </ul>
<p>Notes:</p> <p><sup>a</sup> For all methods except HDD, vegetation and trees within wetlands will be cut off at ground level along the entire workspace, leaving existing root systems intact; clearing debris will be removed from the wetland for disposal. For the HDD method, vegetation and trees within the wetland will be removed along 30 feet of the permanent right-of-way to allow for aerial inspection of the pipe during operations.</p> <p><sup>b</sup> Typical wetland types (Eggers and Reed, 2014) suitable for the referenced crossing method; the construction technique selected will depend on the site-specific conditions described in the site characteristics column.</p> <p>Source: Canadian Energy Pipeline Association, Canadian Association of Petroleum Producers, Canadian Gas Association, 2018.</p>					



### 3.3 TRENCH: MODIFIED UPLAND CONSTRUCTION METHOD

The modified upland construction method (also referred to as open cut or the standard wetland construction method) differs from standard upland construction method to minimize disturbance to the wetland features. These main differences, described in more detail in Section 3.0 of the EPP, include:

- 1) Reducing the construction workspace compared to uplands (from 120 to 95 feet) (refer to Table 2.3-1, and Figure 5 of the EPP);
- 2) Performing workspace clearing using low ground-pressure equipment or operating off construction mats or ice/frost roads to limit disturbance to the wetland (Section 3.2 of the EPP and the Winter Construction Plan);
- 3) Clearing vegetation in wetlands to the ground level, but leaving intact root wads except over the trench line (Section 3.2 of the EPP);
- 4) Installing and maintaining erosion and sediment control BMPs to prevent sediment flow from uplands into wetlands (Section 3.4 of the EPP);
- 5) Trench-Line-Only topsoil segregation, involving stripping and segregating up to 1 foot of the organic layer/topsoil from the trench line and storing the material separate from trench spoil to preserve the native seed stock from wetlands without standing water. In standing water wetlands, the Contractor will attempt to segregate as much of the soil surface as possible based on site and saturation conditions (Section 3.6.1 of the EPP); and
- 6) Implementing restoration techniques suitable to wetland conditions, as described in Section 7.7 of the EPP.

As described in Table 3.2-1, this technique is suitable in wetlands with unsaturated mineral soils constructed during unfrozen conditions or can be used in saturated wetlands (typically <12-inch inundation) with moderate to high bearing strength, shallow peat soils over mineral substrate, or forested peatlands where roots provide a relatively firm foundation for construction mats or equivalent. It can also be used in wetlands with unsaturated mineral soils or saturated wetlands with moderate to low strength peat over mineral soils during frozen conditions.

Because this method does not require any specialized equipment, it proceeds more quickly than other wetland construction methods, which further minimizes disturbance to wetland soils and vegetation. By limiting the removal of root wads to the trench line, the integrity of adjacent soils is maintained, and the seed bed remains undisturbed. The use of low-ground pressure equipment, construction mats, and/or ice/frost roads also further reduces soil compaction issues.

Mat travel lanes are typically a single layer (Figures 30 and 31 of the EPP); however, there may be cases in saturated areas where more than one layer of mats must be placed to provide a stable working surface (Figures 32 and 33 of the EPP). Enbridge will remove the mats during final cleanup activities. If there are multiple layers of mats, Enbridge will probe the soil after mats have been removed to verify that no additional mats remain.

Sheet-piling may be used at wetland crossing locations in order to stabilize the trench, or to assist with water management. At potential sheet-piling locations, a test hole may be dug in proximity to the crossing location to assess soil stability and other conditions (e.g., bedrock, cobbles,

boulders), and to determine if the crossing will be conducive to the installation of sheet piling. Based on these results, a decision will be made between Enbridge Construction and the Environmental Compliance team.

Once the pipe has been installed, trench breakers will be installed as appropriate (see Section 1.13 of the EPP). As described in Section 3.9 of the EPP, Enbridge will backfill the trench in wetlands to an elevation similar to the adjacent areas outside the ditch line and will add a slight crown of approximately 3 to 6 inches (depending on soil type) over the backfilled trench to allow for subsidence. Periodic breaks in the crown will be implemented to allow for normal hydrologic flow across the backfilled trench. Crowning will not extend beyond the previously excavated trench limits. Restoration will proceed as described in Section 7.0 of the EPP. Enbridge will monitor wetlands after construction as described in Enbridge's Post-Construction Monitoring Plan.

### **3.4 TRENCH: PUSH-PULL METHOD**

Push-pull technique can only be utilized in non-frozen conditions where there is sufficient inundation to push-pull or float the pipe. If these conditions do not exist at the time of the crossing, then the modified upland construction technique will be utilized.

The push-pull method is utilized in saturated wetlands (greater than 12-inch inundation) with relatively competent peat soils, shallow peat over mineral soils, floating mat peat, forested peatlands with moderate bearing soils strengths, emergent and scrub-shrub wetlands with loose, deep peat soils, or floating mat peat, low-bearing strength soils (refer to Section 3.7.1 and Figures 35 and 36 of the EPP). This technique can also be used to cross waterbodies located within these wetland complexes. The trench is excavated using a backhoe (or equivalent) operating either from construction mats in more stable soils, or from an excavator mounted on tracked pontoons along the trenchline. As discussed in Section 3.3, multiple layers of construction mats may be installed to provide a stable surface in these saturated wetland areas. Sheet-piling may also be installed to assist with trench stability and groundwater management.

The pre-assembled pipe is then pushed-pulled or floated into position across the wetland. Usually this fabrication requires use of ATWS adjacent to the construction workspace. Once the pipeline is in position, floats, if used, will be removed and the pipe will sink; buoyancy control methods may be used (refer to Section 3.7.3 and Figures 37 and 38 of the EPP). Trench breakers will be used as appropriate. The trench will then be backfilled using a backhoe or equivalent working from construction mats or by low ground pressure equipment, and the wetland will be restored as near as practicable to pre-construction conditions.

Enbridge will monitor wetlands after construction as described in Enbridge's Post-Construction Monitoring Plan.

### **3.5 TRENCHLESS: BORE (NON-PRESSURIZED)**

The conventional non-pressurized bore method is typically used to cross features such as road or railroad features; however, wetlands and waterbodies adjacent to these features may also be crossed in conjunction with the bore crossing (refer to Section 4.0 of the EPP).

To prepare for a bore, a bore pit is excavated on both sides of the feature being crossed of sufficient size to house the boring machine and tracks or cradle. The excavations have to be deep enough to ensure the equipment is laid on the correct grade and in line in order to ensure that the

bore is drilled correctly. Excavations vary in length depending on the depth of the feature being crossed, length of the bore, and soil conditions, but average around 15 feet deep and 15 feet wide.

An auger bore uses a revolving cutting head that is located at the leading end of an auger assembly to excavate the soil. Common practice is to use a sacrificial casing pipe the same diameter and length as the carrier pipe at the crossing. The spoil is then transported back to the shaft area by the rotation of the helical auger within the sacrificial casing pipe.

A pneumatic hammer (also called a thumper) may be used in place of the auger system and may be used on moderate length bores (under 200 feet) in good to fair soil conditions. Thumping uses an air compressor and hammering device attached to the end of the sacrificial casing pipe. The open-ended casing pipe is then driven through the crossing, filling itself with spoil material until it reaches the exit point. Proper elevation and direction are monitored by line of sight, water level, electronic smart level and/or a transit.

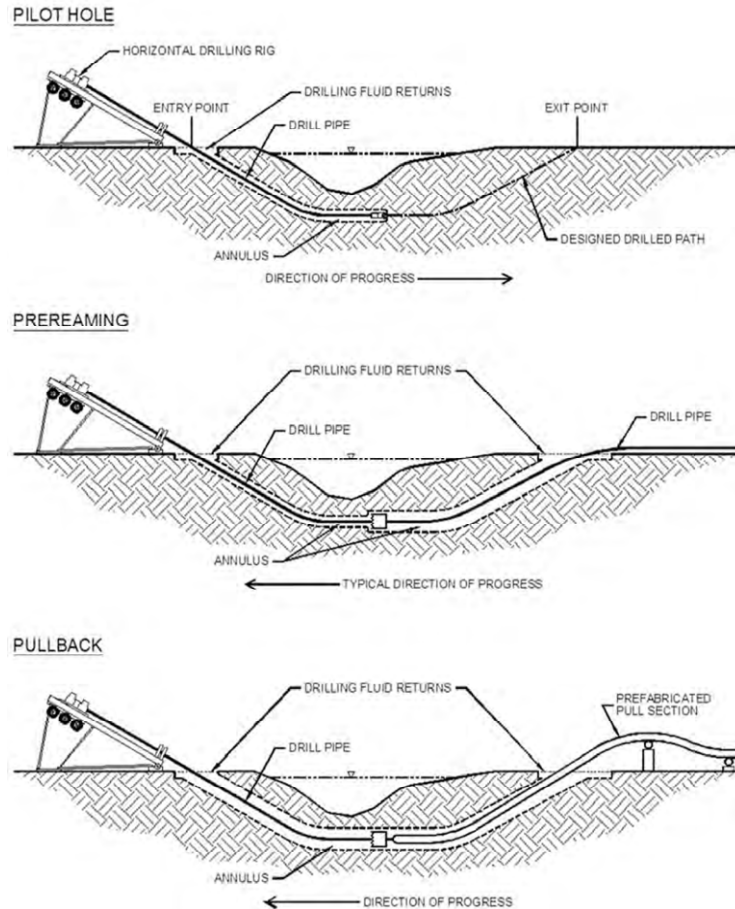
Water and bentonites can be introduced if soil conditions dictate in order to lubricate the sacrificial casing pipe, allowing it to move through the ground more freely; approved chemical additives may also be introduced. Pressurized water or drilling mud is never used to hold the hole open, as it will be during an HDD (see Section 3.6); therefore, there is no risk for an inadvertent return of drilling mud at these locations. If drilling mud is needed at these locations, any release will travel back along the path of the pipe and into the bore pit. Once the sacrificial casing pipe has ran the length of the bore, the carrier pipe is temporarily attached and pulled through.

Once the bore is completed, the bore pits will be backfilled and any wetland impacts will be restored as described in Section 7.0 of the EPP after the tie-in has been completed. Enbridge will monitor these wetland areas after construction as discussed in the Post-Construction Monitoring Plan.

### **3.6 TRENCHLESS: HORIZONTAL DIRECTIONAL DRILL METHOD (PRESSURIZED)**

The HDD method is a trenchless crossing technique that involves drilling a hole underneath sensitive resources and installing a pre-fabricated pipe segment through the hole. No direct excavation to the banks or beds of the feature being crossed is involved. Installation of a pipeline by HDD is accomplished in three stages as illustrated in Figure 3.6-1. The first stage consists of directionally drilling a small-diameter pilot hole at an entry point along a designed directional path to an exit point. The second stage involves enlarging this pilot hole to a diameter suitable for installation of the pipeline. The third stage consists of pulling the prefabricated pipe section from the exit point back into the enlarged hole to the entry point. A guidance system is used to accurately track the location of the drill cutting head.

The HDD method utilizes drilling fluid (also referred to as drilling mud) that is pumped under pressure through the inside of the drill pipe to lubricate the drill bit and convey drill cuttings back to the drill entry point, where it is reconditioned and re-used in a closed, circulating process (refer to Section 3.6.1 for additional discussion of drilling fluids).



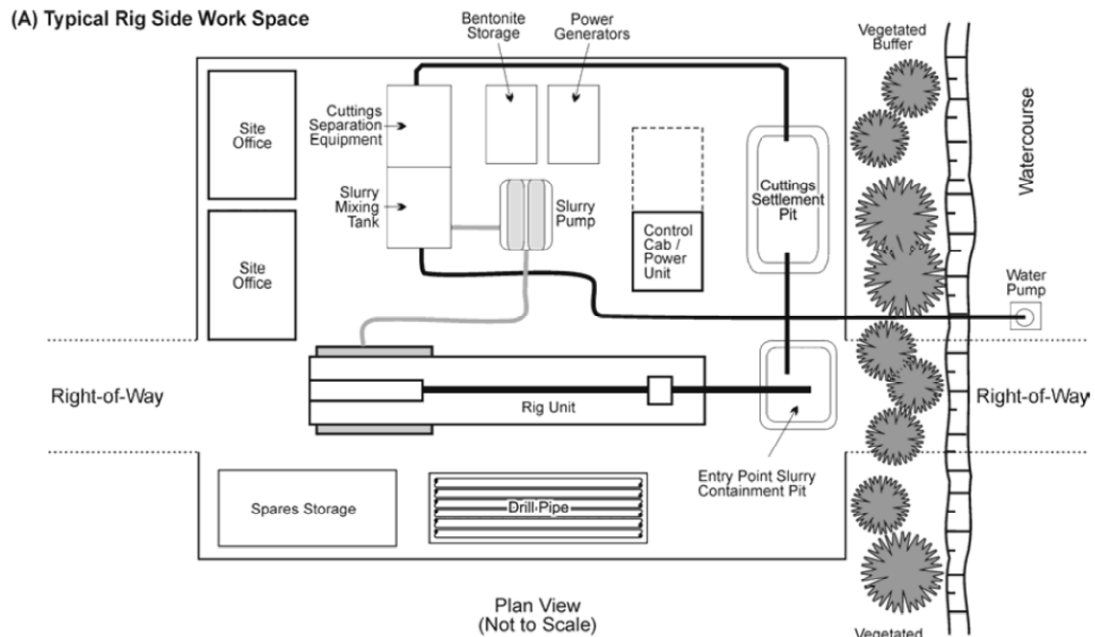
**Figure 3.6-1: General Stages of an HDD**

The entry pit is where the main drilling activities occur and where drill rig and drilling mud system is staged. Refer to Figure 3.6-2 for a typical configuration of an HDD entry workspace (rig side).

The exit point is where pipe installation is accomplished by attaching a pipeline pull section behind a reaming assembly at the exit point, then pulling the reaming assembly and pull section back to the drilling rig. Refer to Figure 3.6-3 for a typical configuration of an HDD exit workspace (pullback).

Should the entry or exit points be located within wetlands, Enbridge will mat the entire workspace within wetlands for the staging of equipment and materials. Once the drill and tie-in is completed, the construction mats will be removed, the entry and exit pits will be backfilled and the wetland will be restored as described in Section 7.0 of the EPP. Enbridge will monitor these wetland areas after construction as discussed in the Post-Construction Monitoring Plan.

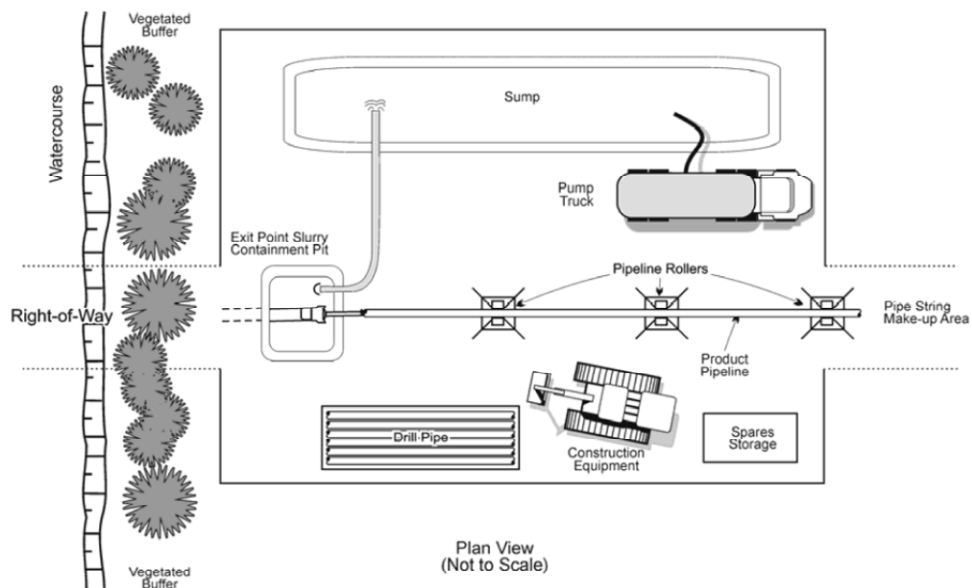
**Figure 3.6-2: HDD Typical Workspace Configuration – Entry/Rig Side**



Source: Canadian Association of Petroleum Producers, 2005. Pipeline Associated Watercourse Crossings, 3<sup>rd</sup> Edition.

**Figure 3.6-3: HDD Typical Workspace Configuration – Exit/Pullback**

**(B) Typical Pipe Side Layout**



Source: Canadian Association of Petroleum Producers, 2005. Pipeline Associated Watercourse Crossings, 3<sup>rd</sup> Edition.

Enbridge does not present an alternate crossing method for proposed HDD crossings. If the primary drill path fails during the crossing, Enbridge will consider an alternate drill path before abandoning use of the HDD method for an alternative, non-HDD crossing method. If necessary, alternate drill paths will be selected by analyzing geotechnical studies and after review of site-specific conditions. Enbridge will consult with the appropriate permitting agencies as needed for approval of new drill paths and workspace.

### **3.6.1 Technical Feasibility Considerations**

The design and feasibility of an HDD is determined by factors including the length, depth, and curvature (i.e., profile) of the proposed drill; surrounding topography; pipeline diameter; availability and orientation of land on which to assemble the HDD pipeline segment; land use constraints; and geotechnical suitability of the subsurface environment. Enbridge conducts geotechnical surveys at each the proposed HDD site to determine the subsurface conditions and identify potential obstacles. This information, along with the HDD design and layout and any other available data, is used to model the capacity of the soil to withstand the pressures of the drill and avoid widening or creating a fracture (hydraulic fracturing) through which drilling mud fluid will migrate. This information is consolidated in a Hydrofracture Report for each site.

#### **3.6.1.1 Composition of Drilling Fluid**

Drilling fluid is primarily composed of water and a viscosifier,<sup>14</sup> typically naturally occurring clay in the form of bentonite mixed with small amounts of extending polymers to increase its yield (high yield bentonite); meaning that more drilling fluid can be produced with less bentonite clay.

Various additives may also be used to enhance the performance of the bentonite-based drilling mud. Chemical drilling additives help control sand content and flow, water hardness, keep the bore hole open and stable, prevent groundwater inundation and allow the bentonite to yield properly. Small amounts of drilling mud additives are added to the bentonite and water slurry. Enbridge will only use those drilling mud additives approved by the appropriate agencies.

#### **3.6.1.2 Functions of Drilling Fluid**

The principal functions of drilling fluid in HDD pipeline installation include:

- Transportation of Spoil – Drilled spoil, consisting of excavated soil or rock cuttings, is suspended in the fluid and carried to the surface by the fluid stream flowing in the annulus between the wall of the hole and the pipe.
- Cleaning and Cooling of Cutters – High velocity fluid streams directed at the cutters remove drilled spoil build-up on bit or reamer cutters. The fluid also cools the cutters.
- Reduction of Friction – Friction between the pipe and the wall of the hole is reduced by the lubricating properties of the drilling fluid.
- Hole Stabilization – The drilling fluid stabilizes the drilled or reamed hole. This is critical in HDD pipeline installation as holes are often in loose soil formations and are uncased. Stabilization is accomplished by the drilling fluid building up a wall cake and exerting a

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<sup>14</sup> A viscosifier is a thickening agent.

positive pressure on the hole wall. Ideally, the wall cake will seal pores and produce a bridging mechanism to hold soil particles in place.

- Transmission of Hydraulic Power – Power required to turn a bit and mechanically drill a hole is transmitted to a downhole motor by the drilling fluid.
- Hydraulic Excavation – Soil is excavated by erosion from high velocity fluid streams directed from jet nozzles on bits or reaming tools.
- Soil Modification – Mixing of the drilling fluid with the soil along the drilled path facilitates installation of a pipeline by reducing the shear strength of the soil to a near fluid condition. The resulting soil mixture can then be displaced as a pipeline is pulled into it.

### **3.6.1.3 Inadvertent Returns**

HDD involves the subsurface discharge of drilling fluids. Because the drilling fluid is pressurized, it can be lost beyond the immediate vicinity of the drill hole and will flow in the path of least resistance, resulting in lost drilling fluids in the subsurface environment or inadvertent returns to the ground surface. This loss of drilling fluid is also referred to as an inadvertent release.

Drilling parameters may be adjusted to maximize drilling fluid circulation and minimize the risk of inadvertent returns. However, the possibility of lost circulation and inadvertent returns cannot be eliminated. Enbridge has developed contingency plans addressing possible remedial action for review by the appropriate agencies.

Section 11.0 of the EPP describe the procedures that will be implemented during the execution of an HDD to monitor, contain, and recover a potential inadvertent release.

## **4.0 PIPELINE CONSTRUCTION THROUGH WATERBODIES**

Table 4.0-1 describes the waterbody crossing techniques Enbridge intends to utilize during construction, the site-specific conditions required for the method to be feasible, and the advantages and disadvantages associated with each technique. Enbridge will typically use the open cut technique through dry or frozen waterbodies, or where flow isolation is not feasible. Dry crossing techniques are suitable for low flow streams with defined banks where isolation is feasible. Similar to wetland crossings, sheet-piling may be used at waterbody crossing locations in order to stabilize the trench, stabilize the stream banks, or to assist with water management (see Section 3.3). Enbridge may also install the pipelines through narrow waterbodies or ditches adjacent to roads or railroads and sensitive waterbodies or riparian areas adjacent to waterbody crossings using trenchless techniques such as a non-pressurized bore method or the HDD (pressurized) method.

Enbridge's construction contractor(s) and Environmental Inspectors ("EIs") will monitor upcoming weather forecasts to determine if significant rainfall is anticipated during construction.

Refer to Sections 2.1 through 2.4 and 2.6 of the EPP for details regarding construction procedures and mitigation measures for each crossing method. The EPP also details procedures for temporary and permanent stabilization. When construction is complete at each waterbody crossing, revegetation and monitoring will occur as described in Section 7.0 of the EPP. After construction, Enbridge will monitor waterbodies crossed by the construction workspace as discussed in Enbridge's Post-Construction Monitoring Plan.



**TABLE 4.0-1  
Pipeline Waterbody Installation Methods**

Method	Description	Applicability	Advantages	Disadvantages
Trench: Open Cut (Non-Isolated)	Open-cut crossing technique that involves trenching through the dry or frozen waterbody with no perceptible flow, or while water continues to flow across the in-stream work area (refer to Figure 22 of the EPP).	Suitable for ephemeral and intermittent waterbodies where there is no perceptible flow (dry or frozen), such as agricultural ditches. This method may also be used in waterbodies that are part of a wetland complex where isolating the flow is not feasible. In Minnesota, these are primarily waterbodies located within large, saturated wetlands, and waterbodies impacted by beaver dams.	<ul style="list-style-type: none"> <li>• Rapid construction/installation</li> <li>• No need for specialized equipment</li> <li>• Compatible with granular substrates and some rock</li> <li>• Minimizes period of in-stream activity</li> <li>• Maintains streamflow</li> <li>• No sediment release or relatively short duration of sediment release (&lt;24 hours)</li> </ul>	<ul style="list-style-type: none"> <li>• May require implementation of erosion and sediment control BMPs to mitigate sediment release during excavation and backfilling</li> <li>• May interrupt streamflow</li> </ul>
Trench: Dry Crossing (Isolated): 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 (refer to Figure 23 of the EPP).	Suitable for streams with low flow and defined banks where fish passage is not of concern. Works best in non-permeable substrate and preferred for crossing meandering channels.	<ul style="list-style-type: none"> <li>• Maintains streamflow</li> <li>• Minimal release and transport of sediment downstream that is not likely to result in effects on aquatic habitat</li> <li>• Relatively dry working conditions</li> <li>• May reduce trench sloughing and trench width</li> </ul>	<ul style="list-style-type: none"> <li>• Minor sediment release during dam construction, dam removal and as water flushes over area of construction</li> <li>• Fish salvage may be required from dried up reach within the workspace</li> <li>• Short-term barrier to fish movement</li> <li>• Specialized equipment and materials required</li> <li>• Seepage may occur in coarse, permeable substrate</li> </ul>
Trench: Dry Crossing (Isolated): 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 (refer to Figure 24 from the EPP).	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.	<ul style="list-style-type: none"> <li>• Maintains streamflow</li> <li>• May allow fish passage</li> <li>• Minimal release and transport of sediment downstream that is not likely to result in negative effects on aquatic habitat</li> <li>• Relatively dry or no flow working conditions</li> <li>• May reduce trench sloughing and trench width</li> </ul>	<ul style="list-style-type: none"> <li>• Minor sediment release during dam construction, removal and as water flushes over area of construction</li> <li>• Fish salvage may be required from dried up reach within the construction workspace</li> <li>• Short-term barrier fish passage if water velocity in culvert is too high</li> <li>• Difficult to trench and lay pipe, especially large diameter pipe, under flume pipe</li> <li>• Work area may not stay dry in coarse, permeable substrate</li> <li>• Seepage may occur in coarse, permeable substrate</li> </ul>

**TABLE 4.0-1**  
**Pipeline Waterbody Installation Methods**

Method	Description	Applicability	Advantages	Disadvantages
Trenchless: Bore (Non-Pressurized)	Bore under watercourse from bore pit on one side to bore pit on the other side with or without casing (see Figures 40 and 41 of the EPP). Non-pressurized water or bentonite may be introduced if soil conditions dictate; any release will travel back along the path of the pipe and into the bore pit.	Suitable for fine-textured impermeable soils and deep water table. Used most commonly for highway, road, and railroad crossings and can include adjacent ditches. Requires a slightly incised watercourse with approach slopes that are absent or slight.	<ul style="list-style-type: none"> <li>• Avoids surface ground disturbance in the waterbody or ditch adjacent to the feature crossed.</li> <li>• No sediment release</li> <li>• No potential for inadvertent release outside of the bore pits</li> <li>• No disturbance of streambed or banks</li> <li>• Maintains normal streamflow</li> <li>• Maintains fish passage</li> </ul>	<ul style="list-style-type: none"> <li>• Requires additional workspace for bore pits, spoil piles, and sump(s)</li> <li>• Large excavations required both sides of the crossing</li> <li>• Deep bore pits may require sump pump or well point dewatering system and/or sheet-piling</li> <li>• Slower than trench crossing techniques</li> </ul>
Trenchless: HDD (Pressurized)	Place a rig on one side of the waterbody and drill a small-diameter pilot hole under the feature along a prescribed profile (see Figure 26 of the EPP). Upon completion of the pilot hole, the use 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. Once the hole is reamed to the appropriate size, the welded pipe section is then pulsed back through the hole.	Suitable to cross sensitive or particularly deep, wide, or high-flow waterbodies depending on site-specific topography and the local geologic substrate. Feasibility limitations in areas of glacial till or outwash interspersed with boulder and cobbles, fractured bedrock, or non-cohesive coarse sands and gravels. Geotechnical borings and hydrofracture risk analysis are performed to determine HDD feasibility and potential for inadvertent returns.	<ul style="list-style-type: none"> <li>• No sediment release unless an inadvertent return occurs</li> <li>• Avoids surface disturbance of the riparian area and stream bed and banks</li> <li>• Limits vegetation disturbance to within the permanently maintained easement</li> <li>• Maintains normal streamflow</li> <li>• Maintains fish passage</li> <li>• May enable construction during restricted activity windows for sensitive fisheries with agency approval</li> <li>• Significantly reduces clean-up and restoration between entry and exit points</li> </ul>	<ul style="list-style-type: none"> <li>• Potential for inadvertent release of drilling fluids (refer to Section 11.0 of the EPP)</li> <li>• Requires ATWS on both sides of the crossings to stage construction, fabricate the pipeline, and store materials</li> <li>• Tree and brush clearing is necessary for operations</li> <li>• Requires obtaining water to formulate the drilling fluid, buoyancy control, as well as hydrostatic testing</li> <li>• Feasibility and success depends on substrate</li> <li>• Requires specialized equipment (limited availability)</li> <li>• Pull string area along the alignment for the same length of the crossing to allow continuous pullback</li> <li>• Requires a straight alignment for the length of the HDD</li> <li>• May require several weeks to complete the HDD</li> </ul>

Sources:

Canadian Association of Petroleum Producers, Canadian Energy Pipeline Association, and Canadian Gas Association, 2005.  
Canadian Energy Pipeline Association, Canadian Association of Petroleum Producers, Canadian Gas Association, 2018.

#### **4.1 TRENCH: OPEN CUT (NON-ISOLATED) METHOD**

The open cut (non-isolated) crossing method involves digging a trench through the waterbody, placing the pipe in the trench, backfilling the trench, and restoring the contours of the stream bed and banks to pre-construction conditions. Enbridge will further reduce the workspace by 25 feet starting 20 feet from the OHWM at waterbody crossings (95-foot-wide corridor) (refer to Figure 22 of the EPP). In order to excavate a trench and install the pipe across the waterbody, vegetation will need to be cleared from the top of the stream bank to the water's edge within the 95-foot-wide construction workspace. Following restoration, Enbridge will maintain a 10-foot-wide corridor centered on the pipeline free of woody shrubs, and a 30-foot-wide corridor free of trees within the riparian area of the waterbody crossing to maintain the integrity of the pipeline (see Figure 4.1-1).

Open cut crossings are typically completed within 24 to 48 hours depending on the size of the watercourse as described in Section 2.1 of the EPP. Open cut crossing methods typically involve trenching through the waterbody while it is dry or frozen to the bottom (no perceptible flow) and direct excavation of the trench through the banks and bed of the watercourse can proceed similar to upland construction techniques. Construction while the waterbody is dry or frozen avoids the potential for sediment release during in-channel work.

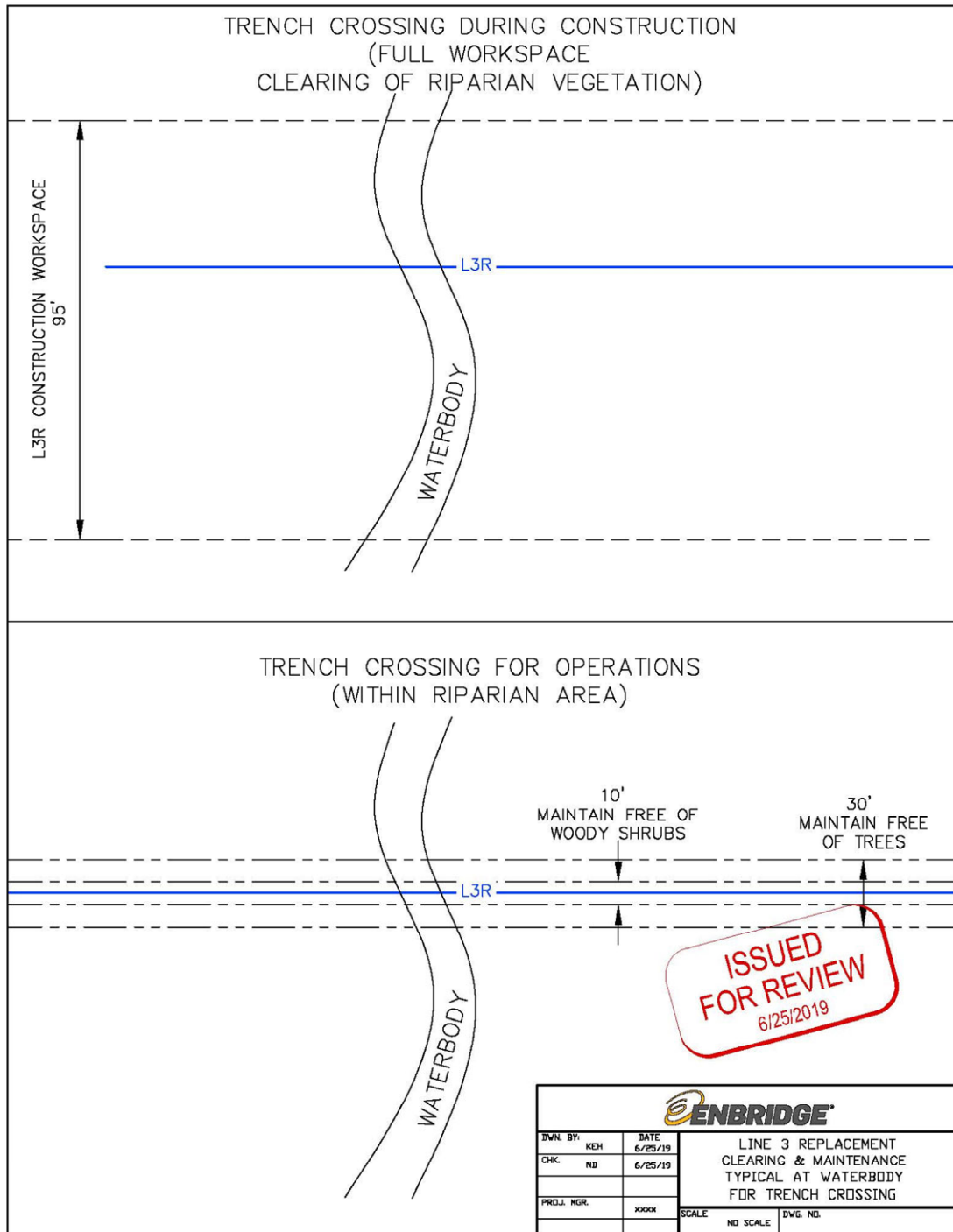
Crossing of waterbodies when they are dry or frozen and not flowing may proceed using the open cut trench crossing technique in accordance with the EPP, provided that the EI verifies that water is unlikely to flow between initial disturbance and final stabilization of the feature. This applies to features that an agency has identified as waterbodies, but that field delineations determined were wetlands based on conditions at the time of survey. If unanticipated flow conditions develop during construction of a given waterbody, Enbridge's EIs will be notified immediately to determine the extent of the flow and will install additional erosion and sediment control BMPs as necessary. If flows are significant, and sedimentation is likely to occur, work will be stopped, or Enbridge will switch to a dry crossing technique with agency approval.

There are additional locations where, due to surrounding saturated wetlands, it is not feasible to isolate the waterbody flow and an open cut trench crossing may be proposed. The push-pull method can sometimes be implemented at these locations (refer to Section 3.4). However, if there is no manner to isolate the feature and/or manage water, a standard open cut through the flowing waterbody may be the only feasible method for pipe installation.

#### **4.2 TRENCH: DRY (ISOLATED) METHODS**

Dry crossing (isolated) methods also involve digging a trench through the waterbody, placing the pipe in the trench, backfilling the trench, and restoring the contours of the stream bed and banks to pre-construction conditions, but the stream is diverted around the work area. Dry (isolated) crossings use either the dam and pump or flume technique. Both methods dam the stream both upstream and downstream of the crossing. The water is then routed around the dry work area either by pumping water through hoses or through a flume pipe. As described in Section 2.5.2 of the EPP, dams may consist of sand bags, inflatable dams, aqua-dams, sheet piling, and/or steel plates. The trench is then excavated in the dry work area to install the pipe. The construction work area will also be dewatered and discharged into well-vegetated area on an adjacent stream bank as described in Section 5.1 of the EPP. Dry crossings are typically completed within 24 to 48 hours depending on the size of the watercourse as described in Section 2.1 of the EPP.

**Figure 4.1-1: Vegetation Clearing during Construction and Operations at Trench Crossings of Waterbodies**



As with the open cut crossing method, Enbridge will further reduce the workspace by 25 feet starting 20 feet from the OHWM at waterbody crossings (95-foot-wide corridor) (refer to Section 2.2, and Figures 23 and 24 of the EPP). In order to excavate a trench and install the pipe across the waterbody, vegetation will need to be cleared from the top of the stream bank to the water's edge within the 95-foot-wide construction workspace. Following restoration, Enbridge will maintain a 10-foot-wide corridor centered on the pipeline free of woody shrubs, and a 30-foot-wide corridor free of trees within the riparian area of the waterbody crossing to maintain the integrity of the pipeline (see Figure 4.1-1).

In locations where the stream banks are stable, but conditions are too saturated to effectively dewater from the construction workspace, Enbridge will conduct a modified dam and pump method. The only difference from the standard dam and pump method and this modified technique is that Enbridge will not dewater the trench and will utilize buoyancy control methods (see Section 3.7.3 of the EPP) as appropriate to sink the pipe to the bottom of the trench.

The dry crossing technique can also be implemented in frozen conditions if there is perceptible flow. Winter construction procedures for dry crossing techniques are described in Enbridge's Winter Construction Plan.

Enbridge will consider switching to an open cut crossing technique at a waterbody previously identified as a dry crossing if:

- the waterbody is dry or frozen at the time of crossing as described in Section 4.1; or
- when there are water management concerns based on field conditions at the time of the crossing, such as downstream obstructions that cause ponding, or a high water table.

In either case, Enbridge will seek agency concurrence on any changes to crossing methods prior to initiating the crossing.

#### **4.3 TRENCHLESS: BORE (NON-PRESSURIZED)**

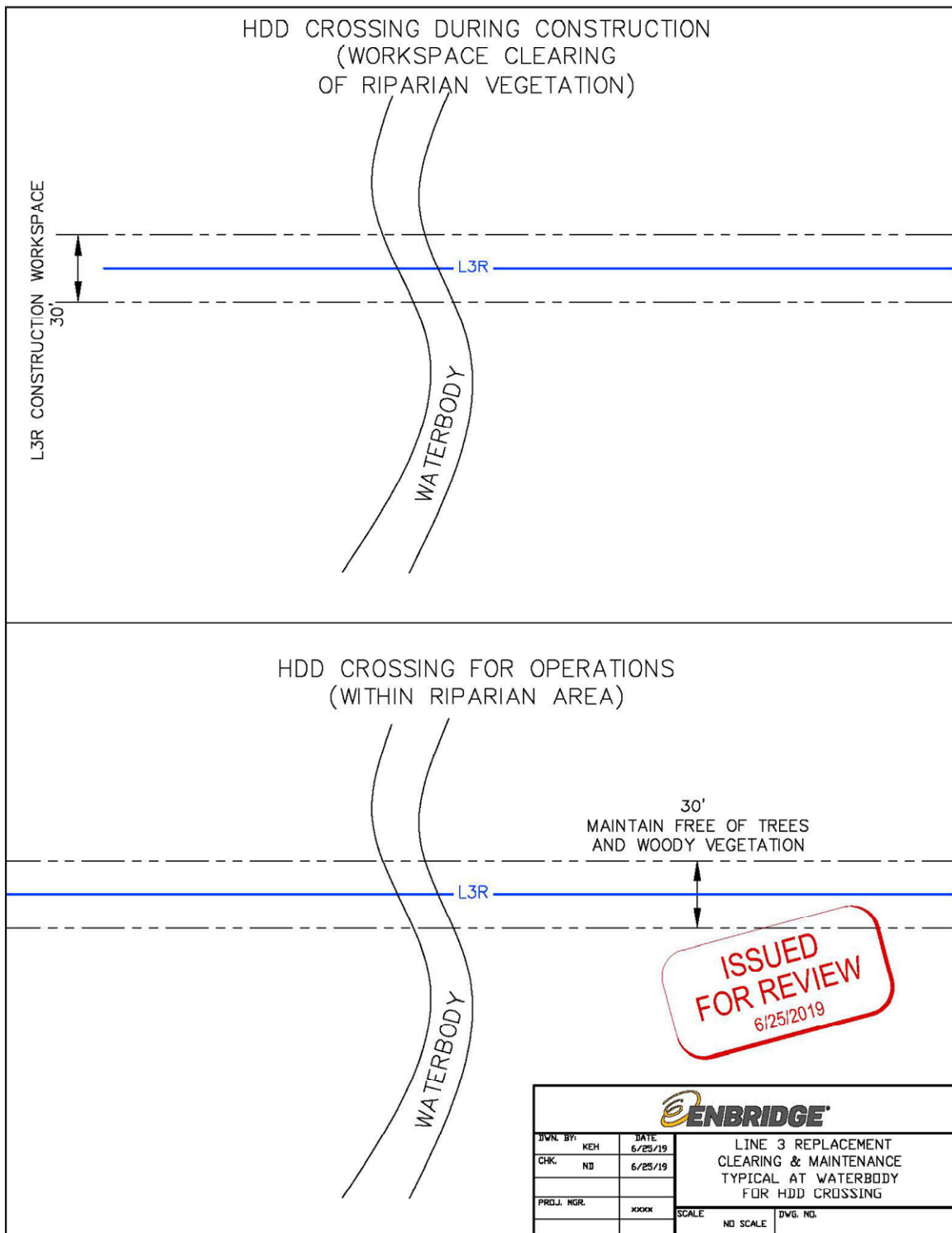
Refer to Section 3.5 for a discussion of this method.

#### **4.4 TRENCHLESS: HORIZONTAL DIRECTIONAL DRILL METHOD (PRESSURIZED)**

Refer to Section 3.6 for a full description of this method. In order to monitor for inadvertent drilling fluid release, and to allow access to the waterbody for water appropriation, riparian vegetation will need to be cleared within a 30-foot-wide corridor along the drill path. Following restoration, Enbridge will maintain the 30-foot-wide corridor centered on the pipeline free of woody vegetation to maintain the integrity of the pipeline and to facilitate aerial inspection (see Figure 4.4-1).

The containment and recovery methods of an inadvertent release in a waterbody differ from a release in a wetland and are described in Section 11.0 of the EPP.

**Figure 4.4-1: Vegetation Clearing during Construction and Operations at Horizontal Directional Drill Crossings of Waterbodies**



## 4.5 UNFORESEEN CONDITIONS

Enbridge may need to implement alternative crossing methods or locations due to the following situations, including but not specifically limited to:

- Significant fluctuation in water level (i.e., up or down) at the time of installation and/or significant changes to soil conditions at the time of installation (e.g., trench wall stability);
- Change in time of year of construction due to the timing of permit issuance (i.e., timing restrictions);
- Weather conditions at the time of installation; and
- Failure of HDD method.

Enbridge identifies a primary and alternative crossing method for waterbody crossings, with the exception of HDD crossings (see Section 3.6). In the case of an unforeseen condition that makes the primary crossing method not practicable, Enbridge will proceed with the alternative crossing method with agency approval.

## 5.0 REFERENCES

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**Appendix B**  
**Invasive and Noxious Species Management Plan**



# Invasive and Noxious Species Management Plan

Enbridge Energy, Limited Partnership • Line 3 Replacement Project

February 2020



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Attachment B	Terrestrial Invasive and Noxious Plant Species List
Attachment C	Terrestrial Plant Invasive and Noxious Species Survey Results
Attachment D	Treatment Methods for the Terrestrial Plant Invasive and Noxious Species
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Attachment F	Equipment Cleaning Log
Attachment G	Minnesota Aquatic Invasive Species Guide

## **ACRONYMS AND ABBREVIATIONS**

BMPs	best management practices
Enbridge	Enbridge Energy, Limited Partnership
EPP	Environmental Protection Plan
FDL	Fond du Lac Band of Lake Superior Chippewa
HDD	horizontal directional drill
INS	invasive and noxious species
L3R or Project	Line 3 Replacement Project
MDA	Minnesota Department of Agriculture
MDNR	Minnesota Department of Natural Resources
NDDA	North Dakota Department of Agriculture
Plan	Invasive and Noxious Species Management Plan
USDA	U.S. Department of Agriculture

## 1.0 INTRODUCTION

Enbridge Energy, Limited Partnership (“Enbridge”) is committed to minimizing the spread of invasive and noxious species (“INS”) as defined by law or regulation (Attachment A), 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 3 Replacement Project (“L3R” or “Project”). The L3R route extends approximately 330 miles across the state of Minnesota, and an additional 12 miles in North Dakota. As proposed, of the majority of the route is co-located with Enbridge’s existing mainline system, foreign utilities, or transportation corridors (e.g., road, railroad).

### 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 spread of INS identified within the Project construction workspace,<sup>1</sup> access roads, and improved haul routes in compliance with law or regulation. 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, access roads, and improved haul routes, through pre-construction surveys, publicly available datasets, or monitoring.

Management strategies for INS on the Project are outlined below by INS group: terrestrial plant species, aquatic species, and tree pests (including oak wilt).

## 2.0 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 Minnesota Department of Agriculture (“MDA”) as Prohibited Noxious Weeds; or North Dakota Department of Agriculture (“NDDA”) and/or Pembina County, North Dakota as Noxious; or species otherwise determined to be invasive by the Minnesota Department of Natural Resources (“MDNR”) on MDNR-Administered Lands or Fond du Lac Band of Lake Superior Chippewa (“FDL”) within the exterior boundaries of the FDL Reservation (see Attachment B).

### 2.1 MINNESOTA REGULATIONS

In Minnesota, 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

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<sup>1</sup> The terms “construction right-of-way,” “temporary construction right-of-way,” “construction workspace,” and “temporary construction workspace” define the primary mainline workspace area required for installation of L3R. For clarity, Enbridge will generically use “construction workspace” instead of “temporary construction right-of-way,” “temporary construction workspace,” or “construction right-of-way” as the terminology for 1) the permanent right-of-way; and 2) the temporary construction area (which includes the following defined terms: Temporary Workspace and Additional Temporary Workspace). Additional Temporary Workspace is temporary construction workspace needed when encountering environmental features that require special construction methods. All construction equipment and vehicles will be confined to this approved construction workspace.

USDA; or 2) listed as “eradicate”<sup>2</sup> or “control”<sup>3</sup> (see Table 2.1-1) under the “Prohibited Noxious Weed” category by the MDA.

Table 2.1-1 Minnesota Department of Agriculture Prohibited Noxious Weeds			
Eradicate List		Control List	
Species	Common Name	Species	Common Name
<i>Amaranthus palmeri</i>	Palmer Amaranth	<i>Berberis vulgaris</i>	Common Barberry
<i>Celastrus orbiculatus</i>	Oriental Bittersweet	<i>Cardamine impatiens</i>	Narrowleaf Bittercress
<i>Centaurea diffusa</i>	Diffuse Knapweed	<i>Carduus acanthoides</i> <sup>a</sup>	Plumeless Thistle
<i>Centaurea jacea</i> <sup>a</sup>	Brown Knapweed	<i>Centaurea stoebe</i> <sup>a</sup>	Spotted Knapweed
<i>Centaurea solstitialis</i>	Yellow Starthistle	<i>Cirsium arvense</i> <sup>a</sup>	Canada Thistle
<i>Centaurea x moncktonii</i>	Meadow Knapweed	<i>Euphorbia esula</i> <sup>a</sup>	Leafy Spurge
<i>Conium maculatum</i>	Poison Hemlock	<i>Lythrum salicaria</i> <sup>a</sup>	Purple Loosestrife
<i>Cynanchum louiseae</i>	Black Swallow-wort	<i>Pastinaca sativa</i> <sup>a</sup>	Wild Parsnip
<i>Digitalis lanata</i>	Grecian Foxglove	<i>Tanacetum vulgare</i> <sup>a</sup>	Common Tansy
<i>Dipsacus fullonum</i>	Common Teasel		
<i>Dipsacus laciniatus</i>	Cutleaf Teasel		
<i>Heracleum mantegazzianum</i> <sup>b</sup>	Giant Hogweed		
<i>Humulus japonicus</i>	Japanese Hops		
<i>Linaria dalmatica</i>	Dalmatian Toadflax		
Notes:			
<sup>a</sup> Indicates species that have been documented in the Project area based on pre-construction surveys.			
<sup>b</sup> This species is also listed as noxious by the USDA.			

On MDNR-Administered Lands, the INS management objectives are to minimize the spread of documented occurrences of terrestrial plant INS that are: 1) listed as Noxious by the USDA; 2) listed as “Prohibited Noxious Weeds,” “Restricted Noxious Weeds,” or “Specially Regulated Plants” by the MDA; or 3) listed as invasive by MDNR Operational Order 113 (see Attachment B). In addition, Enbridge will adhere to the requirements set forth by the MDNR licenses and lease agreements.

On the FDL Reservation, the INS management objectives are to minimize the spread of documented occurrences of INS that are: 1) listed as Noxious by the USDA; 2) listed as “Prohibited Noxious Weeds,” “Restricted Noxious Weeds,” or “Specially Regulated Plants” by the MDA; 3) listed as invasive by MDNR Operational Order 113; or 4) listed as invasive by the Minnesota Invasive Species Advisory Council or the Minnesota Invasive Terrestrial Plants and Pests Center as requested by the FDL. Enbridge will coordinate with the FDL regarding ongoing terrestrial plant INS prevention and control efforts per the requirements of FDL permits.

<sup>2</sup> Prohibited noxious weeds placed on the noxious weed eradicate list are plants that are not currently known to be present in Minnesota or are not widely established. These species must be eradicated (Minnesota Statute §18.771 (b)(1)).

<sup>3</sup> Prohibited noxious weeds placed on the noxious weed control list are plants that are already established throughout Minnesota or regions of the state. Species on this list must be controlled (Minnesota Statute §18.771 (b)(1)).

## 2.2 NORTH DAKOTA REGULATIONS

In North Dakota, the INS management objectives 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 noxious (see Table 2.2-1) by the NDDA or Pembina County, North Dakota (NDDA, 2017; NDDA, 2019).

Table 2.2-1 North Dakota Department of Agriculture and Pembina County, North Dakota Noxious Weeds <sup>a</sup>	
Species	Common Name
<i>Amaranthus palmeri</i>	Palmer Amaranth
<i>Artemisia absinthium</i> <sup>b</sup>	Absinth Wormwood
<i>Bassia scoparia</i> <sup>b</sup>	Kochia
<i>Carduus nutans</i> <sup>b</sup>	Musk Thistle
<i>Centaurea diffusa</i>	Diffuse Knapweed
<i>Centaurea repens</i>	Russian Knapweed
<i>Centaurea stoebe</i> <sup>b</sup>	Spotted Knapweed
<i>Cirsium arvense</i> <sup>b</sup>	Canada Thistle
<i>Cynoglossum officinale</i>	Houndstongue
<i>Euphorbia esula</i> <sup>b</sup>	Leafy spurge
<i>Linaria dalmatica</i>	Dalmatian Toadflax
<i>Linaria vulgaris</i> <sup>b</sup>	Yellow Toadflax
<i>Lythrum salicaria</i> <sup>b</sup>	Purple Loosestrife
<i>Tamarisk spp.</i>	Saltcedar
<i>Tanacetum vulgare</i> <sup>b</sup>	Common Tansy
Notes:	
<sup>a</sup>	NDDA, 2017; NDDA, 2019.
<sup>b</sup>	Indicates species that have been documented in the Project area based on pre-construction surveys.

## 2.3 TERRESTRIAL PLANT INVASIVE AND NOXIOUS SPECIES SURVEYS

Enbridge conducted terrestrial INS plant surveys between 2015 to 2019 along a 50-foot-wide buffer on the construction workspace, and 30-foot-wide buffer on access roads and improved haul routes focused on MDNR-administered tracts and lands within the exterior boundaries of the FDL Reservation. Surveys have been completed on 100 percent of MDNR-administered lands and 80 percent of the entire Project construction workspace, access roads, and improved haul routes.

Enbridge survey crews identified 46 terrestrial plant INS and mapped their locations (see Attachment C). No USDA Noxious Weeds were observed. Brown knapweed (*Centaurea jacea*), a species that must be eradicated in Minnesota, was observed at three locations. The most commonly observed INS was Canada thistle (*Cirsium arvense*), a Prohibited Noxious Weed in Minnesota and North Dakota that must be controlled by all landowners. Tables 2.2-1 and 2.2-2 note MDA and NDDA species identified during surveys.

As described in Section 1.1 of the EPP, signs will be posted on the construction workspace or along access roads or improved haul routes to identify INS infestations.

## **2.4 STANDARD BEST MANAGEMENT PRACTICES**

Enbridge has committed to several Best Management Practices (“BMPs”) described in the Environmental Protection Plan (“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 as described in Appendix A of the EPP;
- Limiting grading and topsoil segregation to trench-line-only in wetlands and forested vegetation communities as described in Section 1.10.1 of the EPP;
- Installing construction mats for travel lanes in wetlands and other specific locations as described in Appendix A of the EPP, and Section 3.1 of the EPP;
- Utilizing certified weed-free mulch as described in Section 1.9.2 of the EPP;
- Removing accumulated sediment from silt fence when depth reaches one-third of height as described in Section 1.9 of the EPP;
- Stabilizing workspaces, including spoil piles, within 14 days after construction activities have ceased, and within 7 days in areas within 1 mile of special impaired waters as described in Section 1.9.1 of the EPP;
- Utilizing Minnesota Board of Water & Soil Resources native seed mixes and adapted restoration guidelines as described in Section 7.0 and Appendix C of the EPP;
- Decompacting subsoil as described in Sections 1.18 and 7.11 of the EPP; and
- Utilizing seed mixes labelled “Noxious Weeds: None Found” as required by regulations and will utilize yellow tag seed when available (Section 7.2 of the EPP).

Construction activities in agricultural lands will proceed as described in the Agricultural Protection Plan.

Enbridge has also prepared a Post-Construction Wetland and Waterbody Monitoring Plan that includes monitoring and performance standards for INS within these features. Similar monitoring and performance standards for MDNR-administered lands will be included in the Vegetation Management Plan (see Section 2.6).

## **2.5 ACTIVE MANAGEMENT STRATEGIES FOR TERRESTRIAL PLANT INVASIVE AND NOXIOUS SPECIES**

This section outlines the active management strategies and BMPs that may be implemented by Enbridge to minimize the spread of documented occurrences of terrestrial plant INS. Active management practices will vary depending on the property administrator/owner (e.g., MDNR-Administered Lands, FDL Reservation), land use (e.g., organic farm), and will be selected based on the site-specific conditions, timing, and INS ecology.



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 Sections 1.16, 3.9, and 7.3 of the EPP, Enbridge will continue to monitor and manage terrestrial INS until the revegetation performance standards have been met (refer to Section 2.6).
- Post-Construction Monitoring: Enbridge will perform post-construction monitoring at wetlands and waterbodies as described in Enbridge's Post-Construction Wetland and Waterbody Monitoring Plan. Enbridge will manage INS as described in this Plan until the performance standards described in the Post-Construction Wetland and Waterbody Monitoring Plan have been met. Enbridge will also establish performance standards for MDNR-administered lands in the Vegetation Management Plan.

As described in Sections 1.4 and 1.5 of the EPP, construction, restoration, and post-construction monitoring activities are restricted to the construction workspace and designated access roads and haul routes. 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.

Prior to construction, Enbridge will prioritize INS sites and select the appropriate management strategy, timing, and frequency of application to be applied at each INS site. For sites located on MDNR-administered lands, Enbridge will coordinate with the appropriate land-managing division and INS staff. Enbridge will work directly with the FDL Resource Management Department for lands within the external boundaries of the FDL Reservation.

### **2.5.1 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.

- Require personnel that will work within the construction workspace, access roads, and improved haul routes to view the MDNR land-based prevention staff training video “Cleaning to Avoid Spreading Terrestrial Invasive Species.”
- Require personnel that will work within the construction workspace, access roads and improved haul routes to review the Minnesota Department of Transportation “Minnesota Noxious Weeds” guide, or excerpts of this guide that highlight known INS in the Project area.

## 2.5.2 Pre-Treatment

Pre-treatment will be prioritized for INS listed by the MDA as Prohibited Noxious Weeds that must be eradicated or controlled in Minnesota (Table 2.1-1). Where possible, Enbridge will pre-treat known locations of terrestrial plant INS by 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 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.

Attachments D and E provide potential treatment methods for each of the 46 species identified during INS surveys. A treatment method or combination of methods will be selected based on several considerations, including MDA status (i.e., eradicate or control) 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.

Pre-treatment strategies and methods, while taking into account all of the considerations noted above, are generally prescribed in Attachment D. Treatment implementation plans will include a decision-making process for personnel conducting treatments to prescribe the most effective and efficient methods for adapting to site-specific and species-specific circumstances and responses.

## **Pesticide Use and Application**

Enbridge will only utilize those pesticides (including herbicides) and methods of application approved by the MDA, MDNR, and the U.S. Environmental Protection Agency in the state of Minnesota. For proposed use of herbicides on MDNR-administered lands, Enbridge will prepare a Pre-Treatment Plan for review and approval by the appropriate MDNR land-managing division and INS staff prior to implementation. 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, or gardens, and sensitive environmental resources. Enbridge 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 state laws regarding the use of those herbicides.

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. The landowner may request that there be no application of pesticides on any part of the site within the landowner's property. Enbridge will provide notice of pesticide application to affected landowners and known beekeepers operating apiaries within 3 miles of the site at least 14 days prior to such application. If the landowner or land-managing agency does not approve the use of pesticides, an alternative treatment method will be selected. Enbridge will keep proper documentation of the locations where pesticides have been used.

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 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.

### **2.5.3 Alternative Best Management Practices**

In areas where pre-treatment cannot be implemented prior to clearing, a combination of the following BMPs may be implemented, where appropriate and as determined prior to construction.

## **Full Construction Workspace Topsoil Segregation**

Enbridge may implement full construction workspace topsoil segregation 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).

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 full construction workspace 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.

## **Access Roads and Improved Haul Routes**

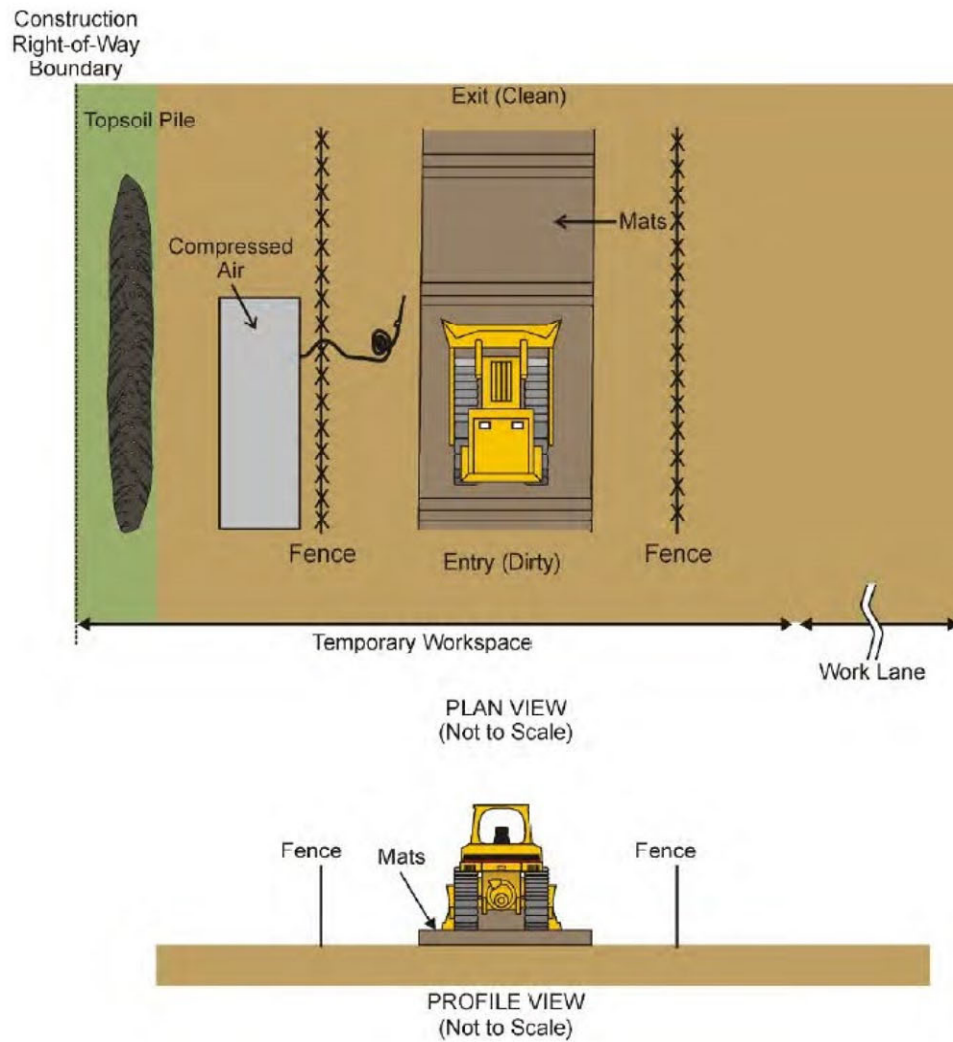
Enbridge does not propose to implement additional BMPs for INS that have been identified adjacent to existing access roads or improved haul routes. Enbridge will either add fill or construction mats to widen existing access roads or haul routes, which will prevent spread of existing infestations in those areas. Where construction mats are used, Enbridge will clean the construction mats before use at another non-infested site as described in the “Cleaning Stations” section.

## **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. 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 construction yards for storage and/or cleaning prior to re-use. Construction mats will be stored on top of plastic tarps or geotextile fabric to prevent the spread of seeds. Removal of dirt and plant material will be documented in a cleaning log (see Attachment F). See Figure 2.5-1 for a typical drawing of a cleaning station.

Mechanical means (initial scrape down followed by blow down) 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 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.

**Figure 2.5-1 Typical Compressed Air Cleaning Station**



*Representation Only*

## 2.6 PERFORMANCE STANDARDS

Enbridge proposes the following performance standards for terrestrial INS in uplands as determined during restoration:

- Absolute percent cover of INS within the construction workspace is similar to absolute percent cover in adjacent undisturbed areas outside of the construction workspace within the same community type.

The INS performance standards in wetlands and riparian areas are described in the Post-Construction Wetland and Waterbody Monitoring Plan. Additional INS performance criteria for MDNR-administered lands will be described in the Vegetation Management Plan.

## 3.0 INVASIVE AQUATIC SPECIES

The MDNR regulates non-native and invasive aquatic plants and wild animals and designates infested waters. Non-native invasive aquatic species present in the Project area, include the zebra mussel (*Dreissena polymorpha*), faucet snail (*Bithynia tentaculata*), and Eurasian watermilfoil (*Myriophyllum spicatum*). A guide to aquatic invasive species identification is provided in Attachment G.

Aquatic invasive species are typically spread via movement of equipment used in infested waters, such boats, docks, and other equipment. Faucet snail can close their shell with their operculum and survive out of water for multiple days (MDNR, 2019b). Adult zebra mussels can survive out of the water up to 21 days in wet conditions. The larvae of the zebra mussel are microscopic and may spread in any water-containing device (MDNR, 2019c). Eurasian watermilfoil spreads primarily through vegetative fragmentation whereby a fragment from the plant breaks off, grows roots, and establishes a new plant; it looks similar to and may hybridize with native beneficial watermilfoils, including the northern watermilfoil (MDNR, 2019d).

The L3R crosses over 200 waterbodies in the state of Minnesota and will appropriate from water sources to support horizontal directional drills (“HDDs”), hydrostatic testing, and fugitive dust control. Most equipment and construction activities will be in the water (either for crossing or water appropriation) for 24 hours or less. Equipment exposed to water for longer periods of time<sup>4</sup> includes HDD equipment (refer to the Summary of Construction Methods and Procedures in Appendix A of the EPP for a complete description), and in-stream bridge supports. HDD installation can take several weeks to complete, and in-stream bridge supports may remain in the water through restoration (see Section 2.6.3 of the EPP).

Enbridge has reviewed MDNR’s list of designated infested waters (MDNR, 2019a) and has removed designated infested waters as water sources where practical in an effort to reduce the potential risk of spread of these species. Based on the MDNR’s list of infested waters (MDNR, 2019a), only one of the water sources currently proposed as a primary source for use has aquatic INS (see Table 3.0-1); the other three sources are contingency sources that would only be used if there is inadequate water flow at the primary source. In all cases, Enbridge will discharge back to the source water or infiltrate the discharge to control potential spread of INS (see Section 3.1.1).

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<sup>4</sup> Higher risk equipment is defined as equipment that is in the water for longer periods; the longer period of exposure the higher the risk (Zook and Phillips, 2012).

Further, none of the currently designated infested waters will be crossed using trenching methods that require in-water work.

Table 3.0-1 Line 3 Replacement Proposed Infested Water Sources						
Milepost	County	Water Name	Crossing Method	Infestation Species	Appropriation Purpose	Proposed Discharge Method
801.8	Kittson	Red River	HDD	Zebra mussel	HDD and Mainline Hydrostatic Test Appropriation	Back to source or infiltration
991.2	Wadena	Shell River	HDD	Faucet snail	HDD (winter contingency only)	Back to source
993.3	Wadena	Crow Wing River	HDD	Faucet snail	HDD (winter contingency only)	Back to source
1120.3	Carlton	Chub Lake	N/A	Eurasian water-milfoil	Mainline Hydrostatic Test Appropriation (contingency only)	Back to source

### 3.1 MANAGEMENT STRATEGIES FOR INVASIVE AQUATIC SPECIES

To minimize the spread of invasive aquatic species in Minnesota and North Dakota, Enbridge will implement the following procedures when working in waterbodies in compliance with Minnesota Statute 84D.10 Subd. 4, and consistent with the *Recommended Uniform Minimum Protocols and Standards for Water Craft Interception Programs for Dreissenid Mussels in the Western United States* (Zook and Phillips, 2012 as cited by Minnesota Statutes 84D.01), and MDNR and North Dakota Game and Fish recommendations (MDNR, 2019e; North Dakota Game and Fish, 2016). As described in Section 1.1 of the EPP, Enbridge will post signs at designated infested waters.

#### 3.1.1 Procedures at Any State 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 state watercourses, regardless of designated 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<sup>5</sup> before use in another waterbody:
  - clean with heated (to at least 140 degrees Fahrenheit) high-pressure washer;
  - rinse with water above 140 degrees Fahrenheit for at least 10 seconds (e.g., pumps); or
  - dry for 5 days prior to using at another waterbody.

<sup>5</sup> [https://www.dnr.state.mn.us/invasives/preventspread\\_watercraft.html](https://www.dnr.state.mn.us/invasives/preventspread_watercraft.html) and [https://files.dnr.state.mn.us/natural\\_resources/invasives/protect-waters.pdf](https://files.dnr.state.mn.us/natural_resources/invasives/protect-waters.pdf).

- 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 in accordance with applicable permits.
- Felt-soled waders will not be allowed for use in any state watercourse because felt can easily trap, and thus potentially transport, invasive species.

### **3.1.2 Designated Infested Waters**

- If equipment has been used in a designated infested water, Enbridge will implement one or more of the following decontamination procedures<sup>5</sup> before use in another waterbody:
  - clean with heated (to at least 140 degrees Fahrenheit) high-pressure washer; or
  - rinse with water above 140 degrees Fahrenheit for at least 10 seconds (e.g., pumps); or
  - dry for 5 days prior to using at another waterbody.
- 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 in accordance with applicable permits.
- If personnel enter infested waterbodies, personnel will scrub clothes, waders, boots, and other personal gear with a stiff brush to remove debris.

### **3.1.3 Public Watercourses,<sup>6</sup> Sensitive Non-Public Watercourses, and Surface Water Appropriation Sites<sup>7</sup>**

- Enbridge will implement the procedures described in Section 3.1.2 at public watercourses, the non-public watercourses identified in Table 3.1-1, and 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<sup>8</sup> either back to source or infiltrate in an upland area at least 300 feet from any watercourse and in accordance with applicable permits.

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<sup>6</sup> Public water or public waters means those waters of the state identified under Minnesota Statutes, section 103G.005, subdivision 15 or 15a, or 103G.201, as shown on the public water inventory maps.

<sup>7</sup> Surface water appropriation sites submitted to the MDNR as part of the Water Appropriation Permit Application for HDD and Hydrostatic Testing Activities (MPARS Reference No. 2018-3690).



Table 3.1-1 Line 3 Replacement Non-Public Sensitive Watercourses			
Approximate Milepost	County	Waterbody Survey ID	Waterbody Name
867.4	Red Lake	s-152n43w4-a	Unnamed Ditch
893.9	Polk	s-150n39w19-d	Unnamed Ditch
894.2	Polk	s-150n39w30-a	County Ditch No. 89
894.8	Polk	s-150n39w29-a	Unnamed Ditch
894.8	Polk	s-150n39w29-b	Unnamed Ditch
894.9	Polk	s-150n39w29-c	Unnamed Ditch
999.6	Cass	CAC5006aWB	Unnamed Ditch
1056.6	Aitkin	s-51n26w33-b	Unnamed Tributary to Moose Lake
1081.5	Aitkin	s-51n22w22-a	Unnamed Stream
1084.4	Aitkin	s-51n22w24-a	Unnamed Stream
1108.3	Carlton	s-49n18w18-b	Unnamed Tributary to Stoney Brook

## 4.0 INVASIVE TREE PESTS

Invasive tree pests occur in the Project area as well, including the native eastern larch beetle (*Dendroctonus simplex*) and non-native emerald ash borer (*Agrilus planipennis*). Eastern larch beetle infests tamarack trees (eastern larch or *Larix laricina*). Adults of the eastern larch beetle emerge in the spring from infected wood; removal of infected tamaracks prior to spring can reduce the spread of the disease (Seybold et al., 2002). Emerald ash borer larvae feed on all species of ash trees. Most of the species' life cycle occurs underneath the bark; early indications of infestation are bark removal or flecking from woodpeckers that eat the larvae (MDNR, 2019f).

As described in Sections 1.8 and 3.2 of the EPP, Enbridge would clear vegetation in upland and wetland areas and would generally dispose of non-merchantable timber and slash by mowing, chipping, grinding and/or hauling off site to an approved disposal facility. Merchantable timber would be disposed of in accordance with Enbridge contract specifications and applicable permits and licenses. The Project does not cross any existing quarantine areas for tree pests<sup>8</sup>; therefore, no special management strategies have been proposed. Enbridge Environmental will monitor quarantine notifications during construction; should any portion of the Project come under quarantine during construction, Enbridge would consult with applicable agencies to identify the appropriate management procedures.

### 4.1 OAK WILT

In the event that a healthy oak tree adjacent to the construction workspace is damaged or wounded during construction activities in counties where the oak wilt fungus is present, Enbridge will treat the cut surface with water-based paint, a pruning/wound sealer, or shellac to prevent further spread of the disease. Treated trees will be inspected by the Environmental Inspector.

<sup>8</sup> <https://www.mda.state.mn.us/plants-insects/pest-regulations>.

## 5.0 REFERENCES

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**Attachment A**  
**Noxious and Invasive Species Regulations**

Attachment A NOXIOUS AND INVASIVE SPECIES REGULATIONS			
Region	Regulatory Category	Agency <sup>a</sup>	Reference
Federal	Federal Noxious Weeds (aquatic and terrestrial plants)	USDA-APHIS	<a href="https://plants.usda.gov/java/noxious?rptType=Federal">https://plants.usda.gov/java/noxious?rptType=Federal</a>
	Federal Seed Act	USDA-AMS	<a href="https://www.ams.usda.gov/rules-regulations/fsa">https://www.ams.usda.gov/rules-regulations/fsa</a>
	All-States Noxious Weed Seed List	USDA-AMS	<a href="https://www.ams.usda.gov/sites/default/files/media/StateNoxiousWeedsSeedList.pdf">https://www.ams.usda.gov/sites/default/files/media/StateNoxiousWeedsSeedList.pdf</a>
	Federal Plant Pest Protection Act	USDA-APHIS	<a href="https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases">https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases</a>
	Interstate Regulations: Pest movement restriction	USDA-APHIS	<a href="https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs">https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs</a>
North Dakota	State Aquatic Nuisance Species	NDGFD	<a href="https://gf.nd.gov/ans/species">https://gf.nd.gov/ans/species</a>
	State Noxious Weeds	NDDA	<a href="https://www.nd.gov/ndda/plant-industries/noxious-weeds">https://www.nd.gov/ndda/plant-industries/noxious-weeds</a>
	County/City Noxious Weeds	Defining County/City	<a href="https://www.nd.gov/ndda/sites/default/files/resource/2018%20Feb%20-%20City%20County%20Noxious%20Weeds%20List.pdf">https://www.nd.gov/ndda/sites/default/files/resource/2018%20Feb%20-%20City%20County%20Noxious%20Weeds%20List.pdf</a>
Minnesota	State Prohibited, Regulated, Unregulated Nonnative, and Unlisted Nonnative Invasive Species (wild animals and aquatic plants)	MDNR	<a href="https://www.dnr.state.mn.us/invasives/laws.html">https://www.dnr.state.mn.us/invasives/laws.html</a>
	State Prohibited, Restricted, and Specially Regulated Noxious Weeds (terrestrial plants)	MDA	<a href="https://www.mda.state.mn.us/plants-insects/minnesota-noxious-weed-list">https://www.mda.state.mn.us/plants-insects/minnesota-noxious-weed-list</a>
	County Noxious Weeds	MDA	<a href="https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/countynoxiousweeds">https://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/countynoxiousweeds</a>
	Seed Regulations	MDA	<a href="https://www.mda.state.mn.us/plants-insects/buying-and-selling-seed-minnesota">https://www.mda.state.mn.us/plants-insects/buying-and-selling-seed-minnesota</a>
	State Plant Pest Act (insects and terrestrial plants)	MDA	<a href="http://www.mda.state.mn.us/plants/pestmanagement/invasivesunit/pestindex.aspx">http://www.mda.state.mn.us/plants/pestmanagement/invasivesunit/pestindex.aspx</a>
	State ballast water regulations (aquatic organisms)	MPCA	<a href="https://www.pca.state.mn.us/water/vessel-discharge">https://www.pca.state.mn.us/water/vessel-discharge</a>
<sup>a</sup> APHIS: Animal Plant Health Inspection Service MDA: Minnesota Department of Agriculture MDNR: Minnesota Department of Natural Resources MPCA: Minnesota Pollution Control Agency NDDA: North Dakota Department of Agriculture NDGFD: North Dakota Game and Fish Department USDA: United States Department of Agriculture			

**Attachment B**  
**Terrestrial Invasive and Noxious Plant Species List**

**Attachment B - Terrestrial Invasive and Noxious Plant List**

<b>Species</b>	<b>Common Name</b>	<b>List Source<sup>1</sup></b>	<b>MISAC Status</b>
<i>Acer ginnala</i>	Maple, Amur	MISAC; MDA (S); Op Order 113	Moderate/Established
<i>Acer platanoides</i>	Maple, Norway	MISAC; MITPPC (71.85); Op Order 113	Severe/Established
<i>Aegopodium podagraria</i>	Goutweed	MISAC	Minimal/Established
<i>Ailanthus altissima</i>	Tree of Heaven	MISAC; MDA (R); Op Order 113	Not likely to establish
<i>Albizia julibrissin</i>	Mimosa	MISAC	Not likely to establish
<i>Allaria petiolaria</i>	Garlic Mustard	MISAC; MITPPC (76.38); MDA (R); Op Order 113	Severe/Established
<i>Alnus glutinosa</i>	Black Alder	MISAC	Considered/not ranked
<i>Amaranthus palmeri</i>	Palmer Amaranth	MITPPC (73.72); MDA (E); Op Order 113; NDDA	NA
<i>Ampelopsis brevipedunculata</i>	Porcelain Berry	MISAC; MDA (R); Op Order 113	Watch/Unknown
<i>Anchusa arvensis</i>	Common Bugloss	MISAC	Minimal/Established
<i>Arctium minus</i>	Burdock, Common	MISAC	Minimal/Established
<i>Arctium nemorosum</i>	Burdock, Woodland	MISAC	Watch/Unknown
<i>Artemisia absinthium</i>	Absinth Wormwood	NDDA	NA
<i>Berberis thunbergii</i>	Japanese Barberry	MISAC; MITPPC (74.87); MDA (C); Op Order 113	Moderate/Established
<i>Berberis vulgaris</i>	European or Common Barberry	MISAC; MITPPC (72.84); MDA (R); Op Order 113	Severe/Established
<i>Berteroa incana</i>	Alyssum, hoary	MISAC; MITPPC (69.09)	Severe/Established
<i>Campanula rapunculoides</i>	Creeping Bellflower	MISAC	Minimal/Established
<i>Cannabis sativa</i>	Hemp	MISAC	Minimal/Established
<i>Caragana arborescens</i>	Siberian Peashrub	MITPPC (57.16); Op Order 113	NA
<i>Cardamine impatiens</i>	Narrowleaf Bittercress	MITPPC (57.73); MDA (C); Op Order 113	NA
<i>Carduus acanthoides</i>	Thistle, plumeless	MISAC; MITPPC (77.39); MDA (C); Op Order 113	Severe/Established
<i>Carduus nutans</i>	Thistle, musk	MISAC; NDDA	Severe/Established
<i>Celastrus orbiculatus</i>	Oriental Bittersweet	MISAC; MITPPC (74.87); MDA (E); Op Order 113	Severe/Not in state
<i>Centaurea debeauxii</i>	Meadow Knapweed	MITPPC (71.69)	NA
<i>Centaurea diffusa</i>	Diffuse Knapweed	MDA (E); Op Order 113; NDDA	NA
<i>Centaurea jacea</i>	Brown Knapweed	MDA (E); Op Order 113	NA
<i>Centaurea repens</i>	Russian Knapweed	NDDA	NA
<i>Centaurea solstitialis</i>	Yellow Star Thistle	MITPPC (71.46); MDA (E); Op Order 113	NA
<i>Centaurea stoebe</i> (Syn. <i>Centaurea maculosa</i> )	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113; NDDA	Severe/Established
<i>Centaurea x moncktonii</i>	Meadow Knapweed	MDA (C); Op Order 113	NA
<i>Chelidonium majus</i>	Celandine	MISAC	Watch/Unknown
<i>Chicorium intybus</i>	Chicory	MISAC	Watch/Unknown
<i>Cirsium arvense</i>	Thistle, Canada	MISAC; MITPPC (82.76); MDA (C); Op Order 113; NDDA	Severe/Established
<i>Cirsium palustre</i>	Thistle, marsh	MISAC	Severe/Not in state
<i>Cirsium vulgare</i>	Thistle, bull	MISAC	Minimal/Established
<i>Conium maculatum</i>	Poison Hemlock	MITPPC (54.15); MDA (E)	NA
<i>Convallaria majalis</i>	Lily-of-the-Valley	MISAC	Moderate/Established
<i>Convolvulus arvensis</i>	Field bindweed	MISAC	Moderate/Established
<i>Cuscuta spp.</i>	Dodder	USDA	NA
<i>Cynanchum louiseae</i> (Syn. <i>Vincetoxicum nigrum</i> )	Black Swallow-wort	MISAC; MITPPC (74.16); MDA (E); Op Order 113	Severe/Not in state
<i>Cynoglossum officinale</i>	Houndstongue	MITPPC (69.68); NDDA	NA
<i>Daucus carota</i>	Carrot, wild	MISAC; MITPPC (52.84); MDA (R); Op Order 113	Moderate/Established
<i>Digitalis lanata</i>	Foxglove, Grecian	MISAC; MITPPC (56.00); MDA (E); Op Order 113	Severe/Established
<i>Digitalis purpurea</i>	Foxglove, Garden	MISAC	Watch/Unknown
<i>Dioscorea oppositifolia</i>	Chinese Yam	MISAC	Not likely to establish
<i>Dipsacus fullonum</i> (Syn. <i>Dipsacus sylvestris</i> )	Teasel, common	MISAC; MITPPC (55.59); MDA (E); Op Order 113	Moderate/Not in state
<i>Dipsacus laciniatus</i>	Teasel, cut leaf	MISAC; MDA (E); Op Order 113	Moderate/Established
<i>Echinochloa crusgalli</i>	Barnyard grass	MISAC	Minimal/Established
<i>Echinops sphaerocephalus</i>	Globe Thistle	MISAC	Moderate/Not in state
<i>Elaeagnus angustifolia</i>	Russian Olive	MISAC	Minimal/Established
<i>Elaeagnus umbellata</i>	Autumn Olive	MISAC; Op Order 113	Severe/Established
<i>Elytrigia repens</i>	Quackgrass	MISAC	Moderate/Established
<i>Epipactis helleborine</i>	Helleborine	MISAC	Minimal/Established
<i>Euonymus alatus</i>	Burning Bush, Winged Euonymus	MISAC; MITPPC (56.39)	Watch/Unknown
<i>Euphorbia cyparissias</i>	Spurge, Cypress	MISAC	Moderate/Established
<i>Euphorbia esula</i>	Spurge, Leafy	MISAC; MITPPC (79.05); MDA (C); Op Order 113; NDDA	Severe/Established

**Attachment B - Terrestrial Invasive and Noxious Plant List**

<b>Species</b>	<b>Common Name</b>	<b>List Source<sup>1</sup></b>	<b>MISAC Status</b>
<i>Filipendula ulmaria</i>	Queen of the meadow	MISAC	Watch/Unknown
<i>Frangula alnus</i>	Buckthorn, glossy (all cultivar)	MISAC; MITPPC (86.73); MDA (R); Op Order 113	Severe/Established
<i>Galium odoratum</i>	Sweet Woodruff	MISAC	Considered/not ranked
<i>Glechoma hederacea</i>	Creeping Charlie	MISAC	Moderate/Established
<i>Gypsophila paniculata</i>	Baby's-breath	MISAC	Watch/Unknown
<i>Hedera Helix</i>	English Ivy	MISAC	Watch/Unknown
<i>Hemerocallis fulva</i>	Orange Day Lily	MISAC	Moderate/Established
<i>Heracleum mantegazzianum</i>	Giant Hogweed	MISAC; MITPPC (64.95); MDA (E); Op Order 113	Severe/Not in state
<i>Hesperis matronalis</i>	Dame's Rocket	MISAC	Moderate/Established
<i>Hieracium auranticum</i>	Orange Hawkweed	MITPPC (60.52)	NA
<i>Hieracium caespitosum</i>	Meadow Hawkweed	MITPPC (60.46)	NA
<i>Humulus japonicus</i>	Japanese Hops	MISAC; MITPPC (70.09); MDA (E); Op Order 113	Watch/Unknown
<i>Hypericum perforatum</i>	St. John's wort	MISAC	Moderate/Established
<i>Inula britannica</i>	Elecampane	MISAC	Moderate/Established
<i>Kochia scoparia</i>	Mexican Fireweed	MITPPC (71.30); NDDA	NA
<i>Lathyrus latifolius</i>	Everlasting Pea	MISAC	Watch/Unknown
<i>Leonurus cardiaca</i>	Motherwort	MISAC	Minimal/Established
<i>Lespedeza cuneata</i>	Lespedeza, Chinese	MISAC	Severe/Not in state
<i>Leucanthemum lacustre</i>	Daisy, Portuguese	MISAC	Watch/Unknown
<i>Leucanthemum vulgare</i>	Daisy, oxeye	MISAC	Moderate/Established
<i>Linaria dalmatica</i>	Dalmation Toadflax	MISAC; MITPPC (71.58); MDA (E); Op Order 113; NDDA	Moderate/Established
<i>Linaria vulgaris</i>	Butter-and-eggs	MISAC; NDDA	Minimal/Established
<i>Lonicera japonica</i>	Japanese Honeysuckle	MISAC	Watch/Unknown
<i>Lonicera maackii</i>	Honeysuckle, Amur	MISAC; MDA (R); Op Order 113	Severe/Not in state
<i>Lonicera morrowii</i>	Honeysuckle, Morrow's	MISAC; MITPPC (89.55); MDA (R); Op Order 114	Severe/Established
<i>Lonicera tatarica</i>	Tartarian Honeysuckle	MISAC; MITPPC (85.14); MDA (R); Op Order 115	Severe/Established
<i>Lonicera x bella</i>	Honeysuckle, Bela	MISAC; MDA (R); Op Order 116	Severe/Established
<i>Lotus corniculatus</i>	Bird's-foot trefoil	MISAC; MITPPC (68.72); Op Order 113	Severe/Established
<i>Lupinus polyphyllus</i>	Big-leaf Lupine	MISAC	Minimal/Established
<i>Lythrum salicaria</i>	Purple Loosestrife	MISAC; MDA (C); Op Order 113; NDDA	Severe/Established
<i>Maclura pomifera</i>	Osage Orange	MISAC	Considered/not ranked
<i>Medicago lupulina</i>	Black medic	MISAC	Minimal/Established
<i>Mellilotus alba</i>	White Sweetclover	MITPPC (70.33)	NA
<i>Mellilotus officinalis</i>	Yellow Sweetclover	MITPPC (71.49)	NA
<i>Microstegium vimineum</i>	Japanese Stilt Grass	MISAC	Not likely to establish
<i>Morus alba</i>	Mulberry, White	MISAC	Moderate/Established
<i>Pastinaca sativa</i>	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	NA
<i>Paulownia tomentosa</i>	Princess Tree	MISAC	Watch/Unknown
<i>Phalaris arundinacea</i>	Reed canary grass	MISAC; MITPPC (78.18); Op Order 113	Severe/Established
<i>Phellodendron amurense</i>	Japanese Cork Tree	MISAC	Watch/Unknown
<i>Phleum pratense</i>	Timothy	MISAC	Watch/Unknown
<i>Phragmites australis</i>	Common Reed - Non-native subspecies	MITPPC (86.32); MDA (R); Op Order 113	NA
<i>Polygonum cuspidatum</i> (Syn. <i>Polygonum japonica</i> )	Japanese Knotweed	MISAC; MITPPC (78.28); MDA (S); Op Order 113	Severe/Established
<i>Polygonum sachalinense</i>	Giant Knotweed	MISAC; MITPPC (74.47); MDA (S); Op Order 113	Severe/Established
<i>Populus alba</i>	Poplar, White	MISAC	Minimal/Established
<i>Populus nigra</i>	Lombardy Poplar	MISAC	Considered/not ranked
<i>Potentilla argentea</i>	Cinquefoil, Silver	MISAC	Considered/not ranked
<i>Potentilla recta</i>	Cinquefoil, Sulphur	MISAC	Considered/not ranked
<i>Pueraria montana</i>	Kudzu	MISAC	Not likely to establish
<i>Quercus acutissima</i>	Sawtooth Oak	MISAC	Watch/Unknown
<i>Ranunculus acris</i>	Buttercup, tall	MISAC	Moderate/Established
<i>Rhamnus cathartica</i>	Buckthorn, common or European	MISAC; MITPPC (84.38); MDA (R); Op Order 113	Severe/Established
<i>Robinia hispida</i>	Locust Bristly	MISAC	Watch/Unknown
<i>Robinia pseudocacia</i>	Locust, black	MISAC; MDA (R); Op Order 113	Severe/Established
<i>Robinia viscosa</i>	Locust, clammy	MISAC	Watch/Unknown
<i>Rosa multiflora</i>	Multiflora Rose	MISAC; MITPPC (69.26); MDA (R); Op Order 113	Severe/Established
<i>Rosa rugosa</i>	Rugosa Rose	MISAC	Watch/Unknown



**Attachment B - Terrestrial Invasive and Noxious Plant List**

<b>Species</b>	<b>Common Name</b>	<b>List Source<sup>1</sup></b>	<b>MISAC Status</b>
<i>Salix alba</i>	Willow, White	MISAC	Minimal/Established
<i>Salix fragilis</i>	Willow, Crack	MISAC	Minimal/Established
<i>Salix x rubens</i>	Willow, Hybrid	MISAC	Moderate/Established
<i>Saponaria officinalis</i>	Bouncing Bet	MISAC	Minimal/Established
<i>Securigera varia</i> (Syn. <i>Coronilla varia</i> )	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	Severe/Established
<i>Silene latifolia</i>	Campion, White	MISAC	Minimal/Established
<i>Silene vulgaris</i>	Campion, Bladder	MISAC	Minimal/Established
<i>Silybum marianum</i>	thistle, milk	MISAC	Severe/Not in state
<i>Solanum dulcamara</i>	Bittersweet Nightshade	MISAC	Minimal/Established
<i>Sonchus arvensis</i>	Sowthistle, perennial	MISAC	Moderate/Established
<i>Sorbus aucuparia</i>	European Mountain-ash	MISAC	Minimal/Established
<i>Tamarisk spp.</i>	Saltcedar	NDDA	NA
<i>Tanacetum vulgare</i>	Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113; Pembina	Severe/Established
<i>Torilis japonica</i>	Japanese Hedge-parsley	MITPPC (48.01)	NA
<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	NA
<i>Trifolium hybridum</i>	Clover, Alsike	MISAC	Considered/not ranked
<i>Trifolium pratense</i>	Clover, Red	MISAC	Minimal/Established
<i>Trifolium repens</i>	Clover, White	MISAC	Moderate/Established
<i>Ulmus pumila</i>	Siberian Elm	Op Order 113	NA
<i>Verbascum thapsus</i>	Mullein	MISAC	Minimal/Established
<i>Viburnum opulus</i>	Europ. Highbush Cranberry	MISAC	Moderate/Established

<sup>1</sup> MDA-Minnesota Department of Agriculture (E-Eradicate, C-Control, S- Special); Op Order 113-Minnesota Department of Natural Resources Operational Order 113; MISAC-Minnesota Invasive Species Advisory Council; MITPPC-Minnesota Invasive Terrestrial Plants and Pests Center; NDDA-North Dakota Department of Agriculture; Pembina-Pembina County, North Dakota

**Attachment C**

**Terrestrial Plant Invasive and  
Noxious Species Survey Results**

Attachment C INS Documented from 2015-2019 within the L3R Construction Right-of-Way <sup>a</sup>							
County	Scientific Name	Common Name	Listing <sup>b</sup>	Land Owner / Administrator			Total
				FDL <sup>c</sup>	MDNR <sup>c</sup>	Other <sup>d</sup>	
Aitkin	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	3	-	3
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	3	-	3
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	24	10	34
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	17	1	18
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	28	3	31
	<i>Phragmites australis</i>	Common Reed	MITPPC (86.32); MDA (R); Op Order 113	-	6	-	6
	<i>Securigera varia</i>	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	18	2	20
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	37	6	43
Carlton	<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	-	12	2	14
	<i>Arctium minus</i>	Common Burdock	MISAC	3	-	-	3
	<i>Berteroa incana</i>	Hoary Alyssum	MISAC; MITPPC (69.09)	21	-	-	21
	<i>Campanula rapunculoides</i>	Creeping Bellflower	MISAC	5	-	-	5
	<i>Caragana arborescens</i>	Siberian Peashrub	MITPPC (57.16); Op Order 113	1	-	-	1
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	26	-	6	32
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	79	12	15	106
	<i>Cirsium vulgare</i>	Bull Thistle	MISAC	36	-	-	36
	<i>Convolvulus arvensis</i>	Field bindweed	MISAC	3	-	-	3
	<i>Daucus carota</i>	Wild Carrot	MISAC; MITPPC (52.84); MDA (R); Op Order 113	16	-	-	16
	<i>Echinochloa crusgalli</i>	Barnyard Grass	MISAC	11	-	-	11
	<i>Elytrigia repens</i>	Quackgrass	MISAC	26	-	-	26
	<i>Euphorbia esula</i>	Leafy Spurge	MISAC; MITPPC (79.05); MDA (C); Op Order 113	3	-	-	3
	<i>Glechoma hederacea</i>	Creeping Charlie	MISAC	1	-	-	1
	<i>Hemerocallis fulva</i>	Orange Day Lily	MISAC	1	-	-	1
	<i>Hieracium spp.</i>	Hawkweed	MITPPC (60.52/60.46)	63	-	-	63
	<i>Hypericum perforatum</i>	St. John's Wort	MISAC	3	-	-	3
	<i>Leucanthemum vulgare</i>	Oxeye Daisy	MISAC	45	-	-	45
	<i>Linaria vulgaris</i>	Butter-and-Eggs	MISAC	7	-	-	7
	<i>Lonicera x bella</i>	Bell's Honeysuckle	MISAC; MDA (R); Op Order 113	6	-	-	6
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	55	-	-	55
	<i>Lupinus polyphyllus</i>	Big-leaf Lupine	MISAC	3	-	-	3
	<i>Lythrum salicaria</i>	Purple Loosestrife	MISAC; MDA (C); Op Order 113	2	-	-	2
	<i>Medicago lupulina</i>	Black Medic	MISAC	14	-	-	14

Attachment C							
INS Documented from 2015-2019 within the L3R Construction Right-of-Way <sup>a</sup>							
County	Scientific Name	Common Name	Listing <sup>b</sup>	Land Owner / Administrator			Total
				FDL <sup>c</sup>	MDNR <sup>c</sup>	Other <sup>d</sup>	
	<i>Melilotus spp.</i>	Sweetclover	MITPPC (70.33/71.49)	20	-	-	20
	<i>Pastinaca sativa</i>	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	15	-	-	15
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	79	1	-	80
	<i>Phleum pratense</i>	Timothy	MISAC	62	-	-	62
	<i>Potentilla argentea</i>	Silver Cinquefoil	MISAC	14	-	-	14
	<i>Potentilla recta</i>	Sulphur Cinquefoil	MISAC	15	-	-	15
	<i>Ranunculus acris</i>	Tall Buttercup	MISAC	16	-	-	16
	<i>Securigera varia</i>	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	1	-	-	1
	<i>Silene latifolia</i>	White Campion	MISAC	27	-	-	27
	<i>Solanum dulcamara</i>	Bittersweet Nightshade	MISAC	1	-	-	1
	<i>Sonchus arvensis</i>	Perennial Sowthistle	MISAC	11	-	-	11
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	144	18	43	205
	<i>Trifolium spp.</i>	Clover	MISAC	57	-	-	57
	<i>Verbascum thapsus</i>	Common Mullein	MISAC	3	-	-	3
	<i>Viburnum opulus</i>	Highbush Cranberry	MISAC	1	-	-	1
Cass	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	2	2
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	2	8	10
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	1	38	39
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	2	-	2
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	3	-	3
	<i>Securigera varia</i>	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	3	-	3
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	5	9	14
	<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	-	2	-	2
Clearwater	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	2	85	87
	<i>Carduus nutans</i>	Musk Thistle	MISAC	-	-	2	2
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	7	112	119
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	5	129	134
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	2	-	2
	<i>Lythrum salicaria</i>	Purple Loosestrife	MISAC; MDA (C); Op Order 113	-	-	2	2
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	2	-	2
	<i>Rhamnus cathartica</i>	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	11	11
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	6	39	45

Attachment C							
INS Documented from 2015-2019 within the L3R Construction Right-of-Way <sup>a</sup>							
County	Scientific Name	Common Name	Listing <sup>b</sup>	Land Owner / Administrator			Total
				FDL <sup>c</sup>	MDNR <sup>c</sup>	Other <sup>d</sup>	
	<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	-	3	-	3
Hubbard	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	2	87	89
	<i>Centaurea jacea</i>	Brown Knapweed	MDA (E); Op Order 113	-	-	1	1
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	2	120	122
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	1	87	88
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	-	2	2
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	2	1	3
	<i>Rhamnus cathartica</i>	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	1	1
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	2	64	66
	<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	-	2	1	3
Kittson	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	20	20
Marshall	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	1	1
	<i>Centaurea jacea</i>	Brown Knapweed	MDA (E); Op Order 113	-	-	2	2
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	74	74
	<i>Pastinaca sativa</i>	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	-	-	3	3
	<i>Rhamnus cathartica</i>	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	9	9
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	-	3	3
Pembina	<i>Bassia scoparia</i>	Kochia	NDDA	-	-	2	2
	<i>Cirsium arvense</i>	Canada Thistle	NDDA	-	-	29	29
	<i>Euphorbia esula</i>	Leafy Spurge	NDDA	-	-	2	2
	<i>Tanacetum vulgare</i>	Common Tansy	NDDA	-	-	2	2
Pennington	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	1	1
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	-	1	1
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	7	47	54
	<i>Pastinaca sativa</i>	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	-	-	1	1
	<i>Rhamnus cathartica</i>	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	4	7	11
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	2	2	4
	<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	-	-	1	1
Polk	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	22	22
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	-	21	21
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	23	23
	<i>Phragmites australis</i>	Common Reed	MITPPC (86.32); MDA (R); Op Order 113	-	-	1	1

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County	Scientific Name	Common Name	Listing <sup>b</sup>	Land Owner / Administrator			Total
				FDL <sup>c</sup>	MDNR <sup>c</sup>	Other <sup>d</sup>	
Red Lake	<i>Rhamnus cathartica</i>	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	2	2
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	-	5	5
	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	-	6	6
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	-	3	3
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	-	32	32
	<i>Rhamnus cathartica</i>	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	-	-	4	4
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	-	-	1	1
	<i>Berteroa incana</i>	Hoary Alyssum	MISAC; MITPPC (69.09)	1	-	-	1
St. Louis	<i>Campanula rapunculoides</i>	Creeping Bellflower	MISAC	2	-	-	2
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	16	-	-	16
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	6	-	-	6
	<i>Cirsium vulgare</i>	Bull Thistle	MISAC	7	-	-	7
	<i>Daucus carota</i>	Wild Carrot	MISAC; MITPPC (52.84); MDA (R); Op Order 113	2	-	-	2
	<i>Echinochloa crusgalli</i>	Barnyard Grass	MISAC	7	-	-	7
	<i>Elytrigia repens</i>	Quackgrass	MISAC	3	-	-	3
	<i>Hieracium spp.</i>	Hawkweed	MITPPC (60.52/60.46)	8	-	-	8
	<i>Hypericum perforatum</i>	St. John's Wort	MISAC	4	-	-	4
	<i>Leucanthemum vulgare</i>	Oxeye Daisy	MISAC	14	-	-	14
	<i>Lonicera x bella</i>	Bell's Honeysuckle	MISAC; MDA (R); Op Order 113	2	-	-	2
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	68	2	-	70
	<i>Lythrum salicaria</i>	Purple Loosestrife	MISAC; MDA (C); Op Order 113	2	-	-	2
	<i>Medicago lupulina</i>	Black Medic	MISAC	6	-	-	6
	<i>Melilotus spp.</i>	Sweetclover	MITPPC (70.33/71.49)	16	-	-	16
	<i>Pastinaca sativa</i>	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	9	-	-	9
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	9	1	-	10
	<i>Phleum pratense</i>	Timothy	MISAC	67	-	-	67
	<i>Potentilla argentea</i>	Silver Cinquefoil	MISAC	1	-	-	1
	<i>Potentilla recta</i>	Sulphur Cinquefoil	MISAC	1	-	-	1
	<i>Ranunculus acris</i>	Tall Buttercup	MISAC	7	-	-	7
	<i>Securigera varia</i>	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	2	-	2
	<i>Sonchus arvensis</i>	Perennial Sowthistle	MISAC	4	-	-	4
	<i>Tanacetum vulgare</i>	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113	142	3	-	145

Attachment C INS Documented from 2015-2019 within the L3R Construction Right-of-Way <sup>a</sup>							
County	Scientific Name	Common Name	Listing <sup>b</sup>	Land Owner / Administrator			Total
				FDL <sup>c</sup>	MDNR <sup>c</sup>	Other <sup>d</sup>	
	<i>Trifolium spp.</i>	Clover	MISAC	66	-	-	66
Wadena	<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	-	6	1	7
	<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	-	1	2	3
	<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113	-	7	6	13
	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	-	1	-	1
	<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	-	3	-	3
	<i>Securigera varia</i>	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	-	5	2	7
	<i>Toxicodendron radicans</i>	Poison Ivy	MDA (S)	-	3	1	4
<b>Total</b>				<b>1,366</b>	<b>282</b>	<b>1,228</b>	<b>2,876</b>
<sup>a</sup> Includes Permanent Right-of-Way, Temporary Workspace, Additional Temporary Workspace, and Access Roads. <sup>b</sup> MISAC - Minnesota Invasive Species Advisory Council; MITPPC - Minnesota Invasive Terrestrial Plants and Pests Center; MDA - Minnesota Department of Agriculture (E-Eradicate, C-Control, S-Special); Op Order 113 - Minnesota Department of Natural Resources Operational Order 113; NDDA – North Dakota Department of Agriculture. <sup>c</sup> Three MDNR-administered properties overlap with the FDL reservation; therefore, observed occurrences within the overlapping boundaries are counted under both the FDL and MDNR categories. <sup>d</sup> "Other" includes private land and public land that is not administered by the MDNR.							

**Attachment D**

**Treatment Methods for the Terrestrial Plant Invasive  
and Noxious Species**



Attachment D Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	Common Name	List Source <sup>a</sup>	Characteristics <sup>b</sup>	Growing Season Management <sup>b</sup>
<i>Arctium minus</i>	Common Burdock	MISAC	<ul style="list-style-type: none"> <li>• Biennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - roadsides, ditch banks, old field, pasture</li> <li>• Seed propagation</li> <li>• First year rosette of large, heart-shaped, hairy leaves; Second year upright stem, 3' - 10' tall with broad, woody leaves and purple flowers, burs</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application to first year rosette Oct. - Nov.</li> </ul>
<i>Artemisia absinthium</i>	Absinth Wormwood	NDDA	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - pasture, old field, roadsides</li> <li>• Seed propagation</li> <li>• woody upright stem, 3' - 5' tall with deeply lobed leaves and many yellow flower heads</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application June - Sept.</li> </ul>
<i>Bassia scoparia</i>	Kochia	NDDA	<ul style="list-style-type: none"> <li>• Annual, herbaceous</li> <li>• Dry soils, disturbed sites - cropland, pastures, fields, roadsides</li> <li>• Seed propagation</li> <li>• Multiple upright stems, 1' - 6' tall with 2" lance-shaped leaves</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application May - Sept.</li> </ul>
<i>Berteroa incana</i>	Hoary Alyssum	MISAC; MITPPC (69.09)	<ul style="list-style-type: none"> <li>• Annual, herbaceous</li> <li>• Dry soils, disturbed sites - roadsides, trail sides, gravelly stream banks, pastures, fields</li> <li>• Seed propagation</li> <li>• Multiple upright stems, 7" - 30" tall with small white flowers and seed pods</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - June</li> </ul>
<i>Campanula rapunculoides</i>	Creeping Bellflower	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry soils - fields, stream banks, woodlands, prairies, roadsides, oak savannas, urban areas</li> <li>• Propagation through seeds and rhizomes</li> <li>• Upright stem, 1' - 3' tall with purple bell-shaped flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application May - Sept.</li> </ul>
<i>Caragana arborescens</i>	Siberian Peashrub	MITPPC (57.16); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, shrub</li> <li>• Dry-mesic soils - coniferous forest, hardwood forest, forest edge, rights-of-way, trail sides</li> <li>• Seed propagation</li> <li>• Multi-stemmed, up to 18' tall with tubular yellow flowers and 1" - 2" log seed pods</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide cut stem / basal bark application year-round</li> </ul>
<i>Carduus acanthoides</i>	Plumeless Thistle	MISAC; MITPPC (77.39); MDA (C); Op Order 113	<ul style="list-style-type: none"> <li>• Biennial, herbaceous</li> <li>• Dry - mesic soils - pastures, woodlands, waste areas, roadsides, ditches, stream banks</li> <li>• Seed propagation - development of large seed bank in short period of time</li> <li>• Upright stem, 1' - 4' tall with pink - purple terminal flowers and winged, spiny leaves</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - June and Oct. - Nov.</li> <li>• See Attachment E for details</li> </ul>
<i>Carduus nutans</i>	Musk Thistle	MISAC	<ul style="list-style-type: none"> <li>• Biennial, herbaceous</li> <li>• Dry to mesic soils - woodland, waste areas, roadsides, ditches, stream banks</li> <li>• Propagation through seed and tap root regeneration</li> <li>• First year basal rosette. Second year singular, upright stem, 1' - 7' tall with pink - purple terminal flowers and spiny wings from leaf bases</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - June and Oct. - Nov.</li> <li>• See Attachment E for details</li> </ul>
<i>Centaurea jacea</i>	Brown Knapweed	MDA (E); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Cool, mesic soils - wet meadow, ditches, woodlands</li> <li>• Seed propagation</li> <li>• Multi-branched, 8" - 32" tall with pink - purple terminal disk flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application May - Nov.</li> <li>• See Attachment E for details</li> </ul>
<i>Centaurea stoebe</i>	Spotted Knapweed	MISAC; MITPPC (93.35); MDA (E); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - old field, rail / road rights-of-way, gravel pits</li> <li>• Seed propagation</li> <li>• Multi-branched, 8" - 32" tall with pinkish - cream terminal disk flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application May - Nov.</li> <li>• See Attachment E for details</li> </ul>
<i>Cirsium arvense</i>	Canada Thistle	MISAC; MITPPC (82.76); MDA (C); Op Order 113; NDDA	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - old field, roadsides, open woodland, prairie, wet meadow</li> <li>• Propagation through seed, root cuttings, rhizomes</li> <li>• Hairy, upright stem, 2' - 6' tall with purple terminal flowers and spiny edged leaves</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May and Sept. - Oct.</li> <li>• Herbicide cut stem application May - June</li> <li>• See Attachment E for details</li> </ul>
<i>Cirsium vulgare</i>	Bull Thistle	MISAC	<ul style="list-style-type: none"> <li>• Biennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - pasture, roadsides, ditch banks</li> <li>• Seed propagation</li> <li>• Singular upright stem, 3' - 6' tall with purple disk shaped terminal flowers and spine tipped leaf lobes</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application to first year rosette Oct. - Nov.</li> </ul>
<i>Daucus carota</i>	Wild Carrot	MISAC; MITPPC (52.84); MDA (R); Op Order 113	<ul style="list-style-type: none"> <li>• Biennial, herbaceous</li> <li>• Dry to mesic soils, disturbed sites</li> <li>• Propagation through seed and tap root regeneration</li> <li>• First year basal rosette. Second year singular, upright stem, 3' - 4' tall with flat-top compound umbel of small white flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application to first year rosette June - Sept.</li> <li>• See Attachment E for details</li> </ul>
<i>Echinochloa crusgalli</i>	Barnyard Grass	MISAC	<ul style="list-style-type: none"> <li>• Annual, herbaceous grass</li> <li>• Mesic soils, disturbed sites - cropland, roadsides, river banks, lawns, old fields</li> <li>• Seed propagation</li> <li>• Sprawling stems, up to 5' tall with dense clusters of knot-like flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May</li> </ul>
<i>Elytrigia repens</i>	Quackgrass	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous grass</li> <li>• Dry - mesic soils, disturbed sites - cropland, roadsides, river banks, lawns, old fields</li> <li>• Propagation through seed and rhizomes</li> <li>• Upright stems, 1' - 4' tall with 25" wide leaf blades</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May</li> </ul>
<i>Euphorbia esula</i>	Leafy Spurge	MISAC; MITPPC (79.05); MDA (C); Op Order 113; NDDA	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils</li> <li>• Seed propagation</li> <li>• Upright stem, 1' - 3' tall with small yellowish-green flowers and a milky sap</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May and Sept. - Oct.</li> <li>• See Attachment E for details</li> </ul>

Attachment D Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	Common Name	List Source <sup>a</sup>	Characteristics <sup>b</sup>	Growing Season Management <sup>b</sup>
<i>Glechoma hederacea</i>	Creeping Charlie	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Mesic soils, degraded/disturbed sites - semi-shaded to shaded</li> <li>• Propagation through seeds and stolons</li> <li>• Creeping square stems, 2' long with blue - purple flowers and palmate leaves</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application Oct. - Nov.</li> <li>• <b>See Attachment E for details</b></li> </ul>
<i>Hemerocallis fulva</i>	Orange Day Lily	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils - roadsides, fields, stream banks</li> <li>• Propagation through seed and root segments</li> <li>• Upright stem, 2' - 5' tall with large orange flowers and sword-like leaves</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application early spring</li> </ul>
<i>Hieracium</i> spp.	Hawkweed	MITPPC (60.46)	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry soils, disturbed sites - old field, pasture, roadsides</li> <li>• Propagation through seeds and rhizomes</li> <li>• Upright stem, 10" - 20" tall with dense clusters of orange - yellow flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - June</li> </ul>
<i>Hypericum perforatum</i>	St. John's Wort	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry soils, disturbed sites - fields, pastures, waste areas, forest edges</li> <li>• Propagation through seeds and rhizomes</li> <li>• Branched, upright stem, 1' - 5' tall with yellow terminal flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - June</li> </ul>
<i>Leucanthemum vulgare</i>	Oxeye Daisy	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - old field, pasture</li> <li>• Propagation through seeds and rhizomes</li> <li>• Upright stem, 1' - 2' tall with terminal flowers of white petals with a central yellow disc</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - June</li> </ul>
<i>Linaria vulgaris</i>	Butter-and-Eggs	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - old field, pasture, railroad yards, roadsides, waste places</li> <li>• Propagation through seeds and segmented roots</li> <li>• Upright stem, up to 4' tall with bright yellow flowers with a long spur arranged in clusters along the stem</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May and Sept. - Oct.</li> <li>• <b>See Attachment E for details (<i>Linaria dalmatica</i>)</b></li> </ul>
<i>Lonicera</i> spp.	Honeysuckle	MISAC; MITPPC (89.55); MDA (R); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, shrub</li> <li>• Forest edges, disturbed sites, open upland, roadsides, old field/pasture</li> <li>• Propagation through seed and vegetative sprouting</li> <li>• Multi-stemmed, 6' - 15' tall with fragrant white, pink, red or yellow flowers or red/purple to orange berries</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application June - Oct.</li> <li>• Herbicide cut stem / basal bark application year-round</li> <li>• <b>See Attachment E for details</b></li> </ul>
<i>Lotus corniculatus</i>	Bird's-foot Trefoil	MISAC; MITPPC (68.72); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Dry soils, disturbed sites - roadsides, old fields, prairies</li> <li>• Propagation through seeds and rhizomes</li> <li>• Sprawling stems, 12" - 24" tall with bright yellow, pea-like flowers pinnately compound leaves</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application June - Oct.</li> <li>• Herbicide cut stem / basal bark application year-round</li> <li>• <b>See Attachment E for details</b></li> </ul>
<i>Lupinus polyphylus</i>	Big-leaf Lupine	MISAC	<ul style="list-style-type: none"> <li>• Perennial, Herbaceous</li> <li>• Dry - mesic soils, disturbed sites - fields, roadsides</li> <li>• Propagation through seeds, rhizomes</li> <li>• Upright stem, 2' - 4' tall with pea-shaped purple flowers on spike-like racemes</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application May - June</li> </ul>
<i>Lythrum salicaria</i>	Purple Loosestrife	MISAC; MDA (C); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Mesic - wet soil, aquatic habitats/wetlands - ditches, wet meadow, stream banks, marshes</li> <li>• Propagation through seed and rhizomes</li> <li>• Upright, wood-like stem, 4' - 7' tall with spikes of pinkish - purple flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application May - Oct.</li> <li>• Herbicide cut stem application June - July</li> <li>• <b>See Attachment E for details</b></li> </ul>
<i>Medicago lupulina</i>	Black Medic	MISAC	<ul style="list-style-type: none"> <li>• Annual, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - roadsides, fields, lawns, waste areas</li> <li>• Seed propagation</li> <li>• Sprawling stem, 2" - 30" tall with small pea-like yellow flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - Oct.</li> </ul>
<i>Mellilotus</i> spp.	Sweetclover	MITPPC (71.49)	<ul style="list-style-type: none"> <li>• Biennial, herbaceous</li> <li>• Dry soil - prairies, savannas, dunes, roadsides, old fields</li> <li>• Seed propagation</li> <li>• First year bi-lobed leaflets; Second year branched, upright stems, 3' - 5' tall with dense racemes of small white flowers</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application early spring</li> </ul>
<i>Pastinaca sativa</i>	Wild Parsnip	MITPPC (78.86); MDA (C); Op Order 113	<ul style="list-style-type: none"> <li>• Monocarpic biennial, herbaceous</li> <li>• Dry - mesic soils, disturbed sites - old field, roadsides, abandoned lots</li> <li>• Seed propagation</li> <li>• First year basal rosette; Second year upright stem, 4' - 6' tall with flat umbels of small yellow flowers</li> </ul>	<ul style="list-style-type: none"> <li>• Herbicide foliar application to first year rosette May - June and Sept. - Oct.</li> <li>• <b>See Attachment E for details</b></li> </ul>
<i>Phalaris arundinacea</i>	Reed Canary Grass	MISAC; MITPPC (78.18); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, herbaceous</li> <li>• Mesic - wet soil, aquatic habitats/wetlands - ditches, wet meadow, stream banks, marshes</li> <li>• Propagation through seed and rhizomes</li> <li>• Upright grass, 2' - 6' tall with 0.5" wide leaf blade and up to 0.5" long ligule</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May</li> </ul>
<i>Phleum pratense</i>	Timothy	MISAC	<ul style="list-style-type: none"> <li>• Perennial, herbaceous grass</li> <li>• Dry soils, disturbed sites - fields, woodland edges, roadsides, embankments, vacant lots</li> <li>• Seed propagation</li> <li>• Upright stem, 12" - 40" with .33" wide leaf blades and a terminal 2" - 4" terminal spike</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar application April - May</li> </ul>
<i>Phragmites australis</i>	Common Reed	MITPPC (86.32); MDA (R); Op Order 113	<ul style="list-style-type: none"> <li>• Perennial, herbaceous grass</li> <li>• Shorelines of rivers/lakes, pond edges, marshes, roadside ditches</li> <li>• Propagation through seed, root fragments, rhizomes</li> <li>• Grass stems, up to 15' tall form dense clusters</li> </ul>	<ul style="list-style-type: none"> <li>• In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>• Herbicide foliar / cut stem application Aug. - Oct. (after flower)</li> <li>• <b>See Attachment E for details</b></li> </ul>

Attachment D Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	Common Name	List Source <sup>a</sup>	Characteristics <sup>b</sup>	Growing Season Management <sup>b</sup>
Potentilla argentea	Silver Cinquefoil	MISAC	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Dry soil - fields, prairies, roadsides</li> <li>Propagation through seed and root segment</li> <li>Sprawling stem, 1' - 20" tall with palmately compound leaves and yellow flowers at top of stem</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May</li> </ul>
Potentilla recta	Sulphur Cinquefoil	MISAC	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Dry soil - fields, prairies, roadsides</li> <li>Propagation through seed and root segment</li> <li>Upright stem, 12" - 30" tall with palmately compound leaves and pale yellow flowers at top of stem</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May</li> </ul>
Ranunculus acris	Tall Buttercup	MISAC	<ul style="list-style-type: none"> <li>Perennial herbaceous</li> <li>Mesic soils, disturbed areas - old field, field edges, woodland edges, roadsides</li> <li>Seed propagation</li> <li>Upright stem, 1' - 3' tall with yellow terminal flowers on long stalks</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May</li> </ul>
Rhamnus cathartica	Common Buckthorn	MISAC; MITPPC (84.38); MDA (R); Op Order 113	<ul style="list-style-type: none"> <li>Perennial, woody shrub</li> <li>Forest edges, woodland understory</li> <li>Propagation through seed and vegetative sprouting</li> <li>Singular stem, 20' - 26' tall with small green flowers or purplish-black berries</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application June - Oct.</li> <li>Herbicide cut stem / basal bark application year-round</li> <li>See Attachment E for details</li> </ul>
Securigera varia	Crown Vetch	MISAC; MITPPC (77.32); MDA (R); Op Order 113	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Mesic soils, disturbed areas - roadsides</li> <li>Old field/pastures, roadsides</li> <li>Propagation through seed and rhizomes</li> <li>Reclining, dense masses of 2' - 6' stems with umbels of small pinkish flowers and pinnate leaves</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application May - Oct.</li> <li>Herbicide cut stem / basal bark application year-round</li> <li>See Attachment E for details</li> </ul>
Silene latifolia	White Campion	MISAC	<ul style="list-style-type: none"> <li>Annual, herbaceous</li> <li>Dry soils, disturbed sites - cropland, field edges, roadsides, shorelines, waste areas</li> <li>Propagation through seeds and root segments</li> <li>Upright stem, 1' - 4' tall with downy foliage and showy white flower</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide resistant</li> <li>Regular mowing and cultivation prior to going to seed</li> </ul>
Solanum dulcamara	Bittersweet Nightshade	MISAC	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Mesic soils - thickets, woodland, waste areas</li> <li>Propagation through seeds and rhizomes</li> <li>Vine, 2' - 8' long with flowers of purple petals and yellow stamens; Red berries</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May and Sept. - Oct.</li> </ul>
Sonchus arvensis	Perennial Sowthistle	MISAC	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Dry - mesic soils, disturbed sites - cultivated fields, pastures, woodlands, roadsides, gardens</li> <li>Propagation through seed, root cuttings, rhizomes</li> <li>Upright stem, 2' - 5' tall with bright yellow terminal flowers</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May and Sept. - Oct.</li> </ul>
Tanacetum vulgare	Common Tansy	MISAC; MITPPC (91.39); MDA (C); Op Order 113; NDDA	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Dry-mesic, well drained soil, disturbed areas - trails edges, roadsides, pastures, old field, stream banks</li> <li>Propagation through seed, root cuttings, rhizomes</li> <li>Upright, woody-like stem, 2' - 5' tall with flat clusters of yellow, button-like flowers</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application May - Nov.</li> <li>See Attachment E for details</li> </ul>
Toxicodendron radicans	Poison Ivy	MDA (S)	<ul style="list-style-type: none"> <li>Perennial, shrub</li> <li>Prairie, woodland, disturbed sites - roadsides, trail sides, fencerows, parks</li> <li>Propagation through seed and rhizomes</li> <li>Dense shrub, 1' - 2' tall with three shiny leaves, small green flowers, tannish berries</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application May - July</li> <li>Herbicide cut stem application Aug. - Nov.</li> <li>See Attachment E for details</li> </ul>
Trifolium spp.	Clover	MISAC	<ul style="list-style-type: none"> <li>Perennial, herbaceous</li> <li>Mesic soils - open woodland, roadsides, lawns, fields</li> <li>Propagation through seeds and stoloniferous stems</li> <li>Upright stem, 3" - 6" tall with round flower head</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May</li> </ul>
Verbascum thapsus	Common Mullein	MISAC	<ul style="list-style-type: none"> <li>Biennial, herbaceous</li> <li>Dry soils, disturbed areas - pasture, old field, wastelands</li> <li>Seed propagation</li> <li>First year thick, fuzzy-leaved rosette; Second year upright stem, 2' - 6' tall with long wooly leaves and small yellow flowers on terminal spikes</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application April - May and Sept. - Oct.</li> </ul>
Viburnum opulus	Highbush Cranberry	MISAC	<ul style="list-style-type: none"> <li>Perennial, shrub</li> <li>Mesic soil - Forest edges, disturbed sites, open upland, roadsides, old field/pasture</li> <li>Propagation through seed and vegetative sprouting</li> <li>Multi-stemmed, 10' tall with white flowers or red berries</li> </ul>	<ul style="list-style-type: none"> <li>In sensitive areas, mechanical means of control will be implemented (e.g. mowing, hand pulling, or digging)</li> <li>Herbicide foliar application June - Oct.</li> <li>Herbicide cut stem / basal bark application year-round</li> </ul>

Attachment D				
Treatment Methods for the INS Plant Species Identified within the L3R Construction Right-of-Way and Access Roads				
Species	Common Name	List Source <sup>a</sup>	Characteristics <sup>b</sup>	Growing Season Management <sup>b</sup>
<sup>a</sup> MISAC - Minnesota Invasive Species Advisory Council; MITPPC - Minnesota Invasive Terrestrial Plants and Pests Center; MDA - Minnesota Department of Agriculture (E-Eradicate, C-Control, S-Special, R-Restricted); Op Order 113 - Minnesota Department of Natural Resources Operational Order 113; NDAA - North Dakota Department of Agriculture. <sup>b</sup> Plant characteristics and management methods provided are generalized. Additional technical instruction is necessary from herbicide manufacturers or agencies prior to implementation. Provided characteristics and methodologies are derived from: Minnesota Department of Transportation. Minnesota Noxious Weeds. 2018. <a href="http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf">http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf</a> Ohio State University. Pocket Gardener. <a href="https://hvp.osu.edu/pocketgardener/source/index.html">https://hvp.osu.edu/pocketgardener/source/index.html</a> Wisconsin Department of Natural Resources. Terrestrial Invasive Species. 2015. <a href="https://dnr.wi.gov/topic/invasives/species.asp?filterBy=Terrestrial&amp;filterVal=Y">https://dnr.wi.gov/topic/invasives/species.asp?filterBy=Terrestrial&amp;filterVal=Y</a> University of California. Statewide Integrated Pest Management Program. <a href="http://ipm.ucanr.edu/">http://ipm.ucanr.edu/</a> Ohio State University. Ohio Perennial and Biennial Weed Guide. <a href="http://www.oardc.ohio-state.edu/weedguide/index.php">http://www.oardc.ohio-state.edu/weedguide/index.php</a> Minnesota Department of Natural Resources. Invasive Terrestrial Plants. <a href="https://www.dnr.state.mn.us/invasives/terrestrialplants/index.html">https://www.dnr.state.mn.us/invasives/terrestrialplants/index.html</a> North Dakota State University. Identification and Control of Invasive and Troublesome Weeds in North Dakota. 2018. <a href="https://www.ag.ndsu.edu/publications/crops/identification-and-control-of-invasive-and-troublesome-weeds-in-north-dakota">https://www.ag.ndsu.edu/publications/crops/identification-and-control-of-invasive-and-troublesome-weeds-in-north-dakota</a> University of California. Weed Research and Information Center. Weed Control in Natural Areas in the Western United States. 2013. <a href="https://wric.ucdavis.edu/information/natural%20areas/natural_areas_common_A-B.htm">https://wric.ucdavis.edu/information/natural%20areas/natural_areas_common_A-B.htm</a> Washington State. King County. Weed Identification photos - Index for identification and control of noxious weeds. 2019. <a href="https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification.aspx">https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification.aspx</a> U.S. Forest Service. Invasive Species Program - Species Profiles. 2016. <a href="https://www.fs.fed.us/invasivespecies/speciesprofiles/index.shtml">https://www.fs.fed.us/invasivespecies/speciesprofiles/index.shtml</a> Minnesota Wildflowers. A Field Guide to the Flora of Minnesota. <a href="https://www.minnesotawildflowers.info/">https://www.minnesotawildflowers.info/</a> PennState Extension. Weed Identification and Control. <a href="https://extension.psu.edu/pests-and-diseases/pest-disease-and-weed-identification/weed-identification-and-control">https://extension.psu.edu/pests-and-diseases/pest-disease-and-weed-identification/weed-identification-and-control</a> Texas A&M Agrilife Extension. AquasPlant. <a href="https://aquasplant.tamu.edu/plant-identification/category/emergent-plants/">https://aquasplant.tamu.edu/plant-identification/category/emergent-plants/</a> Pacific Northwest Extension. Pest Management Handbooks. Weed Management Handbook. <a href="https://pnwhandbooks.org/weed">https://pnwhandbooks.org/weed</a>				

**Attachment E**

**Minnesota Department of Transportation  
Minnesota Noxious Weeds Guide**

# Minnesota Noxious Weeds

Includes Native and Nonnative Look-alike Species for Comparison



Oriental bittersweet, *Prohibited: Eradicate*

2017-10-26

# Minnesota State Listed Noxious Weeds

	Page	Common Name	Scientific Name	Family
Prohibited: Eradicate	4	<a href="#">Black swallow-wort</a>	<i>Cynanchum louiseae</i> Kartesz & Gandhi	Asclepiadaceae
	5-6	<a href="#">Common / cutleaf teasel</a>	<i>Dipsacus fullonum</i> L. and <i>D. laciniatus</i> L.	Dipsacaceae
	7	<a href="#">Dalmatian toadflax</a>	<i>Linaria dalmatica</i> (L.) Mill.	Scrophulariaceae
	8	<a href="#">Giant hogweed</a>	<i>Heracleum mantegazzianum</i> Sommier & Levier	Apiaceae
	9	<a href="#">Grecian foxglove</a>	<i>Digitalis lanata</i> Ehrh.	Scrophulariaceae
	10	<a href="#">Japanese hops</a>	<i>Humulus japonicus</i> Siebold & Zucc.	Cannabaceae
	11	<a href="#">Oriental bittersweet</a>	<i>Celastrus orbiculatus</i> Thunb.	Celastraceae
	12	<a href="#">Palmer amaranth</a>	<i>Amaranthus palmeri</i> S. Watson	Amaranthaceae
	13	<a href="#">Poison hemlock</a>	<i>Conium maculatum</i> L.	Apiaceae
	14	<a href="#">Yellow starthistle</a>	<i>Centaurea solstitialis</i> L.	Asteraceae
	15-16	<a href="#">Brown knapweed</a>	<i>Centaurea jacea</i> L.	Asteraceae
		<a href="#">Meadow knapweed</a>	<i>Centaurea x moncktonii</i> C.E. Britton [ <i>jacea</i> × <i>nigra</i> ]	Asteraceae
		<a href="#">Diffuse knapweed</a>	<i>Centaurea diffusa</i> Lam.	Asteraceae
Prohibited: Control	17	<a href="#">Spotted knapweed</a>	<i>Centaurea stoebe</i> L. subsp. <i>micranthos</i> (Gugler) Hayek	Asteraceae
	18	<a href="#">Barberry, common</a>	<i>Berberis vulgaris</i> L.	Berberidaceae
	19	<a href="#">Canada thistle</a>	<i>Cirsium arvense</i> (L.) Scop.	Asteraceae
	20	<a href="#">Plumeless thistle</a>	<i>Carduus acanthoides</i> L.	Asteraceae
	21	<a href="#">Leafy spurge</a>	<i>Euphorbia esula</i> L.	Euphorbiaceae
	22	<a href="#">Narrowleaf bittercress</a>	<i>Cardamine impatiens</i> L.	Brassicaceae
	23	<a href="#">Purple loosestrife</a>	<i>Lythrum salicaria</i> L. and <i>Lythrum virgatum</i> L.	Lythraceae
	24	<a href="#">Common tansy</a>	<i>Tanacetum vulgare</i> L.	Asteraceae
	25	<a href="#">Wild parsnip</a>	<i>Pastinaca sativa</i> L.	Apiaceae
Restricted Noxious Weeds	26	<a href="#">Asian bush honeysuckles</a>	<i>Lonicera</i> spp.	Caprifoliaceae
	27	<a href="#">Black locust</a>	<i>Robinia pseudoacacia</i> L.	Fabaceae
	28	<a href="#">Crown Vetch</a>	<i>Securigera varia</i> (L.) Lassen	Fabaceae
	29	<a href="#">Common buckthorn</a>	<i>Rhamnus cathartica</i> L.	Rhamnaceae
	30	<a href="#">Glossy buckthorn</a>	<i>Frangula alnus</i> Mill.	Rhamnaceae
	31	<a href="#">Garlic mustard</a>	<i>Alliaria petiolata</i> (M. Bieb.) Cavara & Grande	Brassicaceae
	32-33	<a href="#">Japanese barberries</a>	<i>Berberis thunbergii</i> DC. and listed hybrids and cultivars.	Berberidaceae
	34	<a href="#">Multiflora rose</a>	<i>Rosa multiflora</i> Thunb.	Rosaceae
	35	<a href="#">Nonnative phragmites</a>	<i>Phragmites australis</i> (Cav.) Trin. Ex Steud. subsp. <i>Australis</i>	Poaceae
	36	<a href="#">Porcelain berry</a>	<i>Ampelopsis brevipedunculata</i> (Maxim) Trautv.	Vitaceae
	37	<a href="#">Tree-of-heaven</a>	<i>Ailanthus altissima</i> (Mill.) Swingle	Simaroubaceae
	38	<a href="#">Wild carrot</a>	<i>Daucus carota</i> L.	Apiaceae
Specially Regulated	39	<a href="#">Amur maple</a>	<i>Acer ginnala</i> Maxim.	Aceraceae
	40-41	<a href="#">Knotweed, Japanese</a>	<i>Polygonum cuspidatum</i> Siebold & Zucc.	Polygonaceae
		<a href="#">Knotweed, giant</a>	<i>Polygonum sachalinense</i> F. Schmidt ex Maxim.	Polygonaceae
	42	<a href="#">Poison ivy - western</a>	<i>Toxicodendron rydbergii</i> (Small) Green	Anacardiaceae
		<a href="#">Poison ivy - common</a>	<i>T. radicans</i> (L.) Kuntze subsp. <i>negundo</i> (Greene) Gillis	Anacardiaceae

Each Specially Regulated species is subject to unique restrictions. See notes on [page 74](#)

Scientific names (genus and species) were sourced from : [USDA Plants Database](#)



Dalmatian toadflax



Japanese hops



Garlic mustard



## Plant descriptions provided for comparison: nonnative and native Minnesota plants.

Following are plants, commonly misidentified as a species on the noxious weed list. It is important to identify and protect the native plants, while at the same time managing the State listed noxious weeds.

As for the nonnatives listed here, while these plants may be aggressive on some sites, management is usually not a high priority.

Nonnative Plants Provided for comparison	Page	Common Name	Scientific Name	Family
	43	<a href="#">Alfalfa</a>	<i>Medicago sativa</i> L.	Fabaceae
		<a href="#">Hairy vetch</a>	<i>Vicia villosa</i> Roth	Fabaceae
	44	<a href="#">Balkan catchfly</a>	<i>Silene csereii</i> Baumgarten	Caryophyllaceae
	45	<a href="#">Carrot look-alikes</a>	Various genus and species of the carrot family	Apiaceae
	46	<a href="#">Chervil, wild</a>	<i>Anthriscus sylvestris</i> (L.) Hoffm.	Apiaceae
	47	<a href="#">Musk or nodding thistle</a>	<i>Carduus nutans</i> L.	Asteraceae
Minnesota Native Plants Provided for comparison	48	<a href="#">Yellow rocket</a>	<i>Barbarea vulgaris</i> W.T. Aiton	Brassicaceae
	Page	Common Name	Scientific Name	Family
	49	<a href="#">American bittersweet</a>	<i>Celastrus scandens</i> L.	Celastraceae
	50	<a href="#">American vetch</a>	<i>Vicia americana</i> Muhl. Ex Willd.	Fabaceae
		<a href="#">Canadian milkvetch</a>	<i>Astragalus canadensis</i> L.	Fabaceae
	51	<a href="#">Cherries / wild plum</a>	<i>Prunus</i> spp.	Rosaceae
	52	<a href="#">Common hops</a>	<i>Humulus lupulus</i> L.	Cannabaceae
	53	<a href="#">Cow-parsnip</a>	<i>Heracleum maximum</i> W. Bartram	Apiaceae
	54	<a href="#">Cucumber, wild and bur</a>	<i>Echinocystis lobata</i> Michx. and <i>Sicyos angulatus</i> L.	Cucurbitaceae
	55	<a href="#">Fireweed</a>	<i>Chamerion angustifolium</i> (L.) Holub subsp. <i>angustifolium</i>	Onagraceae
	56	<a href="#">Golden alexanders</a>	<i>Zizia</i> spp.	Apiaceae
	57	<a href="#">Goldenrods</a>	<i>Solidago</i> spp.	Asteraceae
	58	<a href="#">Grape, riverbank</a>	<i>Vitis riparia</i> Michx.	Vitaceae
	59	<a href="#">Honeysuckles, native</a>	<i>Diervilla lonicera</i> and <i>Lonicera</i> spp.	Caprifoliaceae
	60	<a href="#">Native phragmites</a>	<i>Phragmites australis</i> subsp. <i>americanus</i> Saltonstall	Poaceae
	61	<a href="#">Sumacs</a>	<i>Rhus typhina</i> L. and <i>R. glabra</i> L.	Anacardiaceae
	62	<a href="#">Swamp thistle</a>	<i>Cirsium muticum</i> Michx.	Asteraceae
	63	<a href="#">Virginia creeper / Woodbine</a>	<i>Parthenocissus quinquefolia</i> (L.) Planch.	Vitaceae
			<i>P. vitacea</i> (Knerr) Hitch.	
	64	<a href="#">Water hemlock</a>	<i>Cicuta maculata</i> L.	Apiaceae
	65	<a href="#">Yarrow, Common</a>	<i>Achillea millefolium</i> L.	Asteraceae

66-71 [Citations](#) to images and web links to reference materials.

72 [Control Calendar](#): Suggested timing of control options

74 [Definitions](#) of noxious weed categories.



Field thistle (native)



Cow parsnip (native)



Stiff goldenrod (native)



## Prohibited: Eradicate

## Black swallow-wort : *Cynanchum louiseae* Kartesz & Gandhi



**Identification:** Synonyms: *C. nigrum* (L.) Pers., non Cav.; *Vincetoxicum nigrum* (L.) Moench

**Plant:** A perennial, herbaceous vine with a twining habit reaching heights of 3-8 feet.

Only milkweed family member in Minnesota that vines. Also, plants have clear sap, not milky.

**Leaves:** Opposite, shiny and dark green foliage has a smooth (toothless) edge terminated by a pointed tip. Leaves are somewhat oval at 3-4 inches long by 2-3 inches wide.

**Flower:** Clustered, small (1/4 inch) dark purple flowers with five downy, thickened petals.

**Bloom time is June to July.**

**Fruit and seed:** Slender pods, taper to a point at about 1½-3 inches. Pods are described as milkweed-like and at maturity split open to release flattened seeds carried on the wind by downy, filamentous fibers.

**Life History:** Herbaceous vine that dies back to the ground every winter. Below ground rhizomes sprout to create a group of stems. With more stems, plants in full sun will produce more flowers and set more seed ( up to 2,000/meter square). Long distance wind dispersal of seeds can begin in late July. Seeds contain one to four embryos which helps to ensure germination. Seed viability is potentially 5 years.

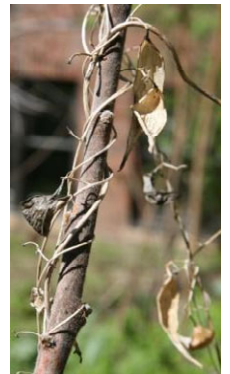
**Habitat:** Prefers full sun in upland soils. Disturbances, natural or human caused, provide an opening in which black swallow-wort can gain a foothold. Old fields, grasslands, road or rail corridors, quarries and other disturbed areas provide excellent habitat.

**Management:** Goals should be to control seed production and stimulate competitive plant cover. **Manual** removal and destruction of plants and root crowns will meet these goals.

**Repeated mowing or cutting** can impact plants, but will not eradicate a population. After early season mowing or cutting, plans must be in place to monitor and repeat the process as necessary. Black swallow-wort if cut early in the season can still produce seed that year and the goal of cutting is to eliminate seed production. If seeds are present, clean equipment before moving offsite.

**Prescribed fire** can be used in conjunction with other management efforts to encourage stands of native grasses that will compete with black swallow-wort for resources. Monitoring will be necessary to control resprouting and seedlings that germinate after burns are completed.

**Herbicide** applications should target plants at or beyond flowering stage. As plants reach maturity, foliar applications of glyphosate or triclopyr ester cover enough surface area to potentially deliver a lethal dose to the root system. Timing the application prior to pod formation may limit the production of viable seed that season. Applying herbicide to early emerging plants with limited foliar area will likely result in roots remaining viable and plants resprouting.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar					Treat actively growing plants - once flowering has begun. Treat plants having enough foliage to carry a lethal dose to the root system.				
	Cut stem									
	Mow									
	Don't mow					Follow-up mowing to control seed production.				
Flowering Period										

## Prohibited: Eradicate

## Common teasel : *Dipsacus fullonum* L.



**Identification:** Compare to [Cutleaf teasel](#) (next page) flower bracts and leaves.

**Plant:** Herbaceous, monocarpic perennial (plant dies after bearing fruit), first identifiable as a basal rosette. At maturity 2-7 feet tall with erect, ridged and prickly stems.

**Leaves:** On upright stems - opposite, stalkless (sessile), cup-forming, up to 12 inches long by 3 inches wide, hairless, yellowish to reddish-green, *lance-shaped with a wavy edged margin*. Central leaf vein forms a whitish line on top with stout prickles below.

**Flower:** Many irregular, 4-parted and white to lavender flowers. Dense, cylindrically clustered heads up to 4 inches tall and 1½ inches wide.

*Stiff and spiny flower bracts are very narrow (linear) and may be taller than flower clusters.*



**Bloom time is June to October.**

**Fruit and seed:** Each floret or small flower produces one capsule containing a grayish-brown, slightly hairy seed.

**Life History:** During the rosette stage, which may extend beyond one season, the plant creates a substantial tap root, up to 24 inches long by 1 inch wide at the crown.

Each flower head can produce upwards of 2000 seeds with germination success of 30-80%. Seed on immature heads may still ripen. Seed is viable for approximately two years with typical dispersal up to 50 feet. Seed may be transported longer distances via water.

**Habitat:** Disturbed, open sunny site with moist to dry soils. Common on roadsides and disturbed areas.

### **Management:**

**Cutting** of roots below ground and removal of as much as possible will limit sprouting. Accomplish cutting and removal of either life stage with tools such as dandelion pullers or a sharp shovel.

**Mowing** of the rosette stage does not kill the plant, however mowing of the flowering stalks can disrupt seed production. After mowing or cutting of flowering plants monitor for new flower heads. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

**Prescribed fire** can be used to increase competition from native warm season grasses, if they are present. Fire can also be used in combination with follow-up herbicide treatments. Keep in mind, high density infestations (large numbers of plants) will not burn well.

**Herbicides** such as metsulfuron methyl, clopyralid, triclopyr or 2,4-D amine are broadleaf specific herbicides that work on teasel at the rosette stage. Glyphosate is applicable but care must be exercised since it is not broadleaf specific.



Above: Bracts may be longer than flower head

Image right: common teasel (L), cutleaf teasel (R).



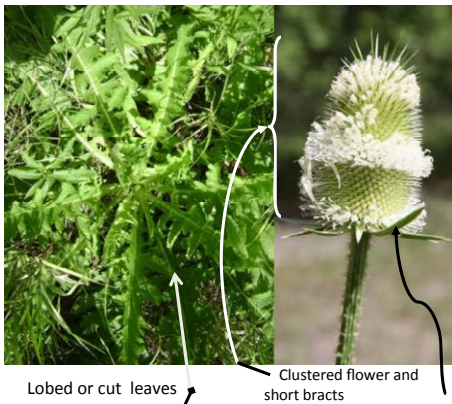
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
Flowering Period	Mow									
	Don't mow									

Not applicable.

Mowing is not recommended: mowing does not kill the plant and flowering may still occur. Seed dispersal can occur if mature plants are mowed. Mower scalping creates a good seed bed.

Prohibited: Eradicate

## Cutleaf teasel : *Dipsacus laciniatus* L.



**Identification:** Compare to [common teasel](#) (previous page) flower bracts and leaf shape.

**Plant:** Herbaceous, monocarpic perennial (plant dies after bearing fruit), first identifiable as a basal rosette. Matures to 2-7 feet tall with erect, ridged and prickly stems.

**Leaves:** On upright stems - opposite, stalkless (sessile), cup-forming, up to 12 inches long by 3 inches wide, hairless, lance-shaped, lobed with sinuses cut almost to the midrib. Prominent leaf vein with stout prickles below.

**Flower:** Many irregular, 4-parted and white to lavender flowers. Dense, cylindrically clustered heads up to 4 inches tall and 1½ inches wide.

**Spiny, stiff flower bracts are not taller than flower cluster and are wider than cut-leaf teasel.**

**Bloom time is July to September.**

**Fruit and seed:** Each floret or small flower produces one capsule containing a grayish-brown, slightly hairy seed.

**Life History:** During the rosette stage, which may extend beyond one season, the plant creates a substantial tap root, up to 24 inches long by 1 inch wide at the crown.

Each flower head can produce upwards of 2000 seeds with germination success of 30-80%. Seed on immature heads may reach viability. Seed is viable for approximately 2 years with typical dispersal up to 50 feet. Seed may be transported longer distances via water.

**Habitat:** Disturbed, open sunny site with moist to dry soils. Common on roadsides and disturbed areas.

### **Management:**

**Cutting** of roots below ground and removal of as much as possible will limit sprouting. Accomplish cutting and removal of either life stage with tools such as dandelion pullers or a sharp shovel.

**Mowing** of the rosette stage does not kill the plant, however mowing of the flowering stalks can disrupt seed production. After mowing or cutting of flowering plants monitor for new flower heads. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

**Prescribed fire** can be used to increase competition from native warm season grasses, if they are present. Fire can also be used in combination with follow-up herbicide treatments. Keep in mind, high density infestations (large numbers of plants) will not burn well.

**Herbicides** such as metsulfuron methyl, clopyralid, triclopyr or 2,4-D amine are broadleaf specific herbicides that work on teasel at the rosette stage. Glyphosate is applicable but care must be exercised since it is a non-selective herbicide.

Left: teasel flowering on short stems after being mowed.

Right: Prickles underside of leaf.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
Flowering Period	Mow									
	Don't mow									



Prohibited: Eradicate

Dalmatian toadflax : *Linaria dalmatica* (L.) Mill.



**Identification:** Compare to introduced [Balkan catchfly](#) (*Silene csereii*). See page 44.

**Plant:** A short-lived herbaceous perennial up to 4 feet tall. Base may be woody and plant is often branched. Waxy stems and leaves have a bluish-gray color.

**Leaves:** Alternate leaves 1-3 inch in length clasp stems, are wider and more heart-shaped than similarly flowered butter-and-eggs (*Linaria vulgaris*).

**Flower:** Erect, spike-like racemes of yellow flowers with orangey center markings. Flowers are 1-1½ inches long with slender spurs extending downward from the back.

**Bloom time is May to September.**

**Fruit and Seed:** On average 140-250 seeds are contained in ½ inch long pods. Seeds are dark in color, flattened, angular and 3-edged with a slight, narrow wing on each edge. Mature plants produce up to 500,000 seeds with soil viability up to 10 years.

**Life History:** Reproduction is primarily by seed that is viable in the seedbank up to 10 years, but the plant also forms colonies via vegetative reproduction from roots.

**Habitat:** Rapidly colonizes disturbed sites such as roadsides, rail right-of-way, and other locations including cultivated ground. Prefers a drier site in coarse, well-drained soils.



**Management:** Recommendation - identify and treat early.

**Eradication** is the goal in Minnesota; therefore, biological control is not a compatible option at this time.

**Prescribed fire** can set plants back and drain some energy while **mowing** can prevent or delay seed production. However, both stimulate vegetative reproduction, thus potentially increasing stem counts. Monitor the infestation and consider follow-up treatments of periodic mowing and / or herbicide treatments.

Manual methods including, **cutting, hand pulling or tillage** if done repeatedly and in conjunction with other treatments may control infestations. **Grazers** eat the flowers, but may also carry the seeds.

**Herbicide** formulations of chlorsulfuron, dicamba, imazapic or picloram have had reported success. Also, combinations of picloram and chlorsulfuron or imazapic and chlorsulfuron or diflufenzopyr and picloram and chlorsulfuron are being used in some areas. Re-treatment is likely necessary.

Below center: early season regrowth.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn	Fire does not kill rhizomes. Result is likely an increased stem count.								
	Foliar									
	Cut stem									
	Mow	Mowing can prevent seed production, but forces vegetative reproduction.								
	Don't mow	Therefore, after mowing, monitoring and repeating the process is likely necessary.								
Flowering Period										

Prohibited: Eradicate

Giant hogweed : *Heracleum mantegazzianum* Sommier & Levier



**Identification:** Compare to native [cow-parsnip](#) (*Heracleum lanatum*). See page 53.

**Plant:** Herbaceous, biennial giant at 10-15 feet tall (potentially 20 feet). When flowering the second year, 2-4 inch diameter hollow stalks are mottled reddish-purple with sturdy bristles.

**Leaves:** Alternate, up to 5 feet across, compound leaves with 3 deeply incised (cut) leaflets which may be further divided. The spotted leaf stalks, underside of leaves and stems are covered with coarse white hairs.

**Flower:** Large, flat umbels of small white florets create massive displays up to 2½ feet in diameter.

**Bloom time** is June to July.

**Fruit and Seed:** Seed is large, flattened, with visible brown resin canals.

**Life History:** A single flower head can produce upwards of 1500 seeds. First season basal rosette foliage can be 1-5 feet across with flower stalks typically appearing in the second season. When plants die a large bare patch of soil results which creates a good seed bed and potential erosion problems.

**Habitat:** Moist soils of woodlands and riparian zones with partial shade as found on woodland edges.



**Management:** **Caution!** Use protective clothing, goggles or face mask. **Caution!** Phytophotodermatitis, contact with bristles (stiff hairs) or sap of plants (i.e., phyto) when combined with exposure to sunlight (i.e., photo) can cause severe blistering and swelling (i.e., dermatitis).

**Manual methods** including cutting and removal by hand are effective on small infestations. The focus of this method is to prevent seed production. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Root systems can be weakened by repeated cutting but consider removal for best results. After cutting, monitor sites for follow-up treatment needs.

**Herbicide** applications of triclopyr or glyphosate are effective when applied early season to basal rosettes. If manual methods such as cutting are used early in the season, plan on returning to chemically treat re-sprouts.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar	Before the plant flowers.						Treat rosettes		
	Cut stem									
	Mow						Cut and remove roots and			
	Don't mow						or seeds by hand for disposal.			
Flowering Period										

Prohibited: Eradicate

## Grecian foxglove : *Digitalis lanata* Ehrh.



### Identification:

**Plant:** Herbaceous, perennial beginning its first year as a basal rosette with a single flowering stalk from 2-5 feet tall in subsequent years.

**Leaves:** Alternate, smooth, stalk-less upper leaves with toothless edges are narrow (lance-shaped). Basal leaves are more oval with rounded tips and are densely woolly.

**Flower:** Many tubular flowers attached to a central stalk (raceme) with bloom progression from the bottom to the top of the stalk. Flowers have a brown or purple veined upper hood and a creamy-white, elongated lower lip.

**Bloom time** is June to July.

**Fruit and seed:** Seed capsules are 2-parted and split to release tiny reddish-brown seed with 3-4 year viability. The hook (stiff, persistent style of the flower) on the seed pods are easily caught on clothing or fur and transported to new locations.

**Life History:** A perennial plant that blooms following its first year as a basal rosette. Each flower produces numerous seeds that are viable for up to 4 years. Small wingless seeds are easily transported by birds, animals, human activity as well as wind and water.

**Habitat:** Minnesota sites are in full sun to partial shade along roads, woodland edges and in open fields.

**Management:** **Caution!** Grecian foxglove contains toxins (cardiac glycosides) that potentially can be absorbed through the skin. These compounds are harmful to livestock and humans. Do not pull or handle this plant without protective clothing, in particular, rubber gloves and long sleeves are required.

**Repeated mowing or cutting** to prevent flowering throughout the year and over several years can drain plants of energy and help control an infestation. Since flowering can occur on mowed, short stems follow-up treatments with herbicide may be necessary.

**Prescribed fire**, there is no research information available at this time.

**Herbicide** applications in May and again in July are beneficial to knock down plants before flowering can occur. A fall application is also recommended to kill basal rosettes that were missed earlier or that developed during the season. Metsulfuron-methyl formulations are recommended for good control.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									



## Prohibited: Eradicate

## Japanese hops : *Humulus japonicus* Siebold & Zucc.



Below left: Male flower structure.  
Below right: Female flower structure.



**Identification:** Compare to native [common hops](#) (*Humulus lupulus*). See page 52.

Compare to native [cucumbers, wild and bur](#) (*Echinocystis lobata* and *Sicyos angulatus*). See page 54.

Compare to native [Virginia creeper/woodbine](#) (*Parthenocissus* spp.). See page 63.

**Plant:** Herbaceous, annual vine trailing on the ground or climbing vegetation and infrastructure. Stems are covered with downward pointing prickles.

**Leaves:** Opposite, 2-5 inches long and almost as wide, with 5-7 (maybe 9) palmate lobes. Compare to common hops: typically 3-lobed occasionally 5. Japanese hops leaves are rough and edges are toothed. Two bracts (stipules) are at leaf stalk bases and the leaf stalks (petioles) are as long or longer than the leaves.

**Flower:** Male flowers and female flowers are on separate plants (dioecious). Flowers are small and greenish to reddish, not showy. Male flowers are branched clusters (panicles) while the female flowers are drooping structures that are rather plump and composed of overlapping reddish bracts or scales (hops).

**Bloom time is July into August.**

**Fruit and Seed:** Single flattened seeds from each female flower. Each inflorescence produces several seeds that mature in September.

**Life History:** An annual plant germinating early spring and growing quickly as summer progresses. Vines quickly cover small trees and shrubs weighing them down to the point of breakage and limiting their sunlight. Japanese hops flower in July-August, seeds mature in September. Soon after a killing frost, fragile vines fall apart dispersing their seed.

**Habitat:** Tolerant of disturbed roadside conditions if there is moist soil. Species prefers conditions found in riparian areas including full sunlight and exposed soils that are moist and rich.

**Management:** **Caution!** Stem prickles are known to irritate the skin, long clothing and gloves are recommended.

Manual methods including **cutting** and **pulling**, while labor intensive, can be successful on small infestations. Efforts should be focused on early season work when plants are small and limited entanglement with surrounding vegetation or structures has occurred.

If the area is accessible to **mowers** and vines have limited structure for climbing, such as trees and fences, then **mowing** is an effective method to control maturity and seed production.

**Herbicides** include pre-emergent and post-emergent applications. Both are useful since this is an annual plant with prolific seed production capabilities. Pre-emergent should be applied prior to the growing season beginning in late March or early April. Once germination has occurred a switch to foliar applications should be made in an effort to keep plants from maturing and producing seed.

Below: Stem prickles



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Post-emerge									
	Pre-emerge									
	Mow									
	Don't mow									
Flowering Period										

## Prohibited: Eradicate

## Oriental bittersweet : *Celastrus orbiculatus* Thunb.



**Identification:** Compare to native [American bittersweet](#) (*Celastrus scandens*). See page 49.

**Plant:** Woody, twining, perennial vines up to 60 feet long, reaches tree tops and covers fences. Stem diameters of 4 inches documented in Minnesota.

**Leaves:** Alternate, fine rounded teeth on the leaf edge, dark green and shiny turning yellow in autumn. Typically, elliptical with a blunt leaf tip and nearly as wide as long at 2-5 inches.

**Flower:** Female flowers are small, inconspicuous, greenish clumped (3-7) in leaf axils along stems. Dioecious species, male and female flowers on separate plants. Male flowers are also axillary but may be terminal. Compare white pollen on male flowers to *yellowish pollen on American bittersweet flowers*. Also, *American bittersweet flowers are similar in size and color but are found only terminal on vine branches (on the ends)*.

**Bloom time is May to June.**

**Fruit and Seed:** Along the vine in leaf axils are potentially 3-7 yellowish, 3-parted capsules enclosing reddish-colored, 3-parted, berry-like arils. Each part contains 1-2 seeds; therefore, potential total of 3-6 seeds per fruit. Dioecious, separate fruiting (female) and non-fruiting (male) plants. *American bittersweet's 3-parted fruit is more red, the 3-parted capsules more orange and fruits are terminal on the vine branches (on the ends)*.

**Life History:** Vegetative reproduction occurs from below-ground rhizomes, above-ground stolons and suckering of roots. Birds will eat the fruits (arils) during the winter and disperse the seeds. Seeds germinate late spring.

**Habitat:** Readily invades disturbed, open, sunny sites, yet Oriental bittersweet is moderately tolerant of shade allowing it to grow in open woodlands.

**Management:**

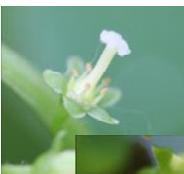
**Prescribed fire** research has shown that basal sprouting is stimulated and stand density increases dramatically.

**Cutting** of stems can be used to kill above ground portions of plants especially if the infestation is covering large areas or is climbing high into forest canopy. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). Combine with herbicide applications for best results.

**Herbicides** that act systemically such as formulations of triclopyr or glyphosate can be applied as foliar, basal bark or cut stem applications. Foliar applications are reserved for easy to reach foliage, re-sprouting or along fence lines. Once foliage is out of reach, application to cut stems or basal bark will yield the best results.



Above: location of fruit is in leaf axils (where leaves attach to stem).



**Left above:** greenish, female flower.  
**Left below:** greenish male flower, note white pollen grains on anthers of the upper flower.



**Right:** Light brown seeds. Each structure is 3 parted and each part contains 1-2 seeds. Image shows 5 seeds from a single fruit.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn	Burning is not recommended								
	Basal Bark									
	Foliar									
	Cut stem									
	Mow									
	Don't mow									
	Flowering Period									



## Prohibited: Eradicate

## Palmer amaranth : *Amaranthus palmeri* S. Watson



Above: male plants have soft flower spikes, female flower spikes have sharp bracts (below - upper right).

Below: poinsettia-like foliage, white V-shaped markings (inset), and thick stems.



**Identification:** Palmer amaranth is one of several native pigweeds and is native to southwestern deserts of the United States. [Link: Pigweed Identification, a pictorial guide.](#)

**Plant:** Herbaceous, annual plant, a potential growth rate of 2-3 inches per day. Plants attain heights of 6-8 feet, potentially 10 feet. Stems are stout, up to 2 inches thick and without hairs (smooth). Top-view of plants as foliage develops resembles a poinsettia.

**Leaves:** Alternate, green color, some plants with white V-shaped markings on leaves. Elliptical to diamond-shaped leaf blades terminated by a small spine. Petioles up to 2-3 times longer than leaves, image at right.

**Flower:** Plants are dioecious with male and female flowers on separate plants. Flowers are not showy, but flower spikes are significant and useful in positive identification.

**Bloom time is June to Sept.** Flowers can occur 8 weeks post-emergence to end of season.

**Fruit and seed:** Seeds are dark colored and extremely small. Research shows pigweeds including palmer amaranth can produce upwards of 250,000 or more seeds per plant.

**Life History:** Seedling emergence can occur throughout the growing season; thus, flowering and seed set can persist late into the season. **Monitoring** is a necessary activity for control efforts. Seeds germinate in spring if within an inch of soil surface. Research on pigweeds suggests if seed is buried deeper than 3 inches viability is decreased annually with a potential longevity of approximately 3 years. Research on redroot pigweed (*A. retroflexus*) and waterhemp (*A. rudis*) suggests longevity can be as short as 3-4 years in Mississippi/Illinois or as long as 12 years in Nebraska.

**Habitat:** Native habitat is desert climate, species performs well during heat of summer. Pigweeds are shade intolerant.

**Management:** Preventing establishment is key. Proper identification and frequent scouting to limit seed production.

**Repeated mowing or cutting** are not effective at controlling Palmer amaranth infestations. Continue monitoring and consider alternative methods such as cultivation, manual methods like hand-pulling or herbicide applications.

**Prescribed fire** has the potential to kill seedlings and drain energy from maturing plants, but fire should be considered as a tool to strengthen the health and competitive advantage of the desirable plant community.

Biotypes have shown resistance to **herbicides** in groups 2, 3, 5, 9 and 27 (Group number - check herbicide labels).

Yet, **herbicide** applications both pre- and post- emergent are possible. Roger Becker (Univ. of MN, Agronomist) provided the following comment: "There are many products that will control the pigweed group across the different labeled sites, but the challenge will be knowing what the resistance of the particular biotype is that gets here (Minnesota), if at all. Many of the standard ROW (right-of-way) broadleaf materials will control non-resistant palmer."

Useful herbicides in group 4 include 2,4-D, aminocyclopyrachlor, aminopyralid, clopyralid, and dicamba. Group 2 herbicides include imazapyr, imazapic, metsulfuron and sulfometuron. Nonselective glyphosate, group 9 and glufosinate, group 10 can be used depending on crop tolerance traits or desired vegetation outcomes for non-cropland sites.



White petiole bent back over a green leaf blade.

For best results,  
treat plants when they are small,  
under 1 foot tall.

As plants mature,  
use approved higher rates of  
herbicides.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn	Use fire to improve environment for competing native plant community.								
	Post-emerge									
	Pre-emerge									
	Mow									
Flowering Period	Don't mow									

## Prohibited: Eradicate

## Poison Hemlock : *Conium maculatum* L.



**Caution** All plant parts are **poisonous to humans** and livestock. **Caution**

It is reported that toxin can be absorbed through bare skin! Wear appropriate PPE.

**Identification:** Compare to [wild carrot](#) and native [water hemlock](#) on pages 38 and 64. Also compare to [carrot look-alikes](#), [wild chervil](#) and [common yarrow](#) on pages 45, 46 and 65.

**Plant:** Herbaceous, biennial, first year as a basal rosette and second year poison hemlock is a branched, 3-7 feet tall, robust plant. Stems are smooth (no hairs), hollow, appear ridged due to veins and are light green, mottled (spotted) with purplish spots.

**Leaves:** Alternate, generally triangular in form. Doubly or triply pinnately compound up to 18 inches long by 12 inches wide. Leaflets are fern-like, deeply divided and typically twice as long (2 inches) as wide (1 inch). Basal leaves tend to be larger and have longer petioles than upper stem leaves. Petiole to stem attachments are covered by a sheath.

**Flower:** Flat or slightly dome-shaped open compound umbels of 3-16 umbellets with 12-25 five-petaled, white florets. There are small ovate-lanceolate bracts with elongated tips under main umbels. Bracts are also present under umbellets.

**Bloom time is variable - June to August.**

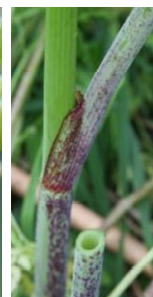
**Fruit and Seed:** Paired seeds are 1/8 inch tall schizocarps, these split at maturity becoming two carpels. Each carpel is a seed, flattened on 1 side and lined vertically by broken ridges described as wavy ribs. There are no hairs.

**Habitat:** Partial shade is tolerated but preference is full sun with moist fertile soils. Often found near water or in riparian zones. Can tolerate drier conditions.

### **Management:**

If performed frequently **cutting** or **mowing** are effective control methods to prevent seed production. Same is true for hand pulling, however roots and root fragments remaining in soil may resprout. Monitor and plan additional treatments. **Prescribed fire** as a tool should be used to improve the health of surrounding native vegetation. Fire will kill seedlings and top kill other plants; however, after the fire healthy root systems will likely resprout.

**Foliar herbicide** applications to plants at rosette stage or during active growth (before flowering). Herbicide formulations with 2,4-D or 2,4-D including dicamba or triclopyr have produced good results. Nonselective herbicides such as glyphosate (concentration of 41% or greater) formulations can also produce results. Other potential choices are formulations including aminopyralid, chlorsulfuron, clopyralid, dicamba, imazapic, imazapyr, metsulfuron-methyl or 2,4-D plus picloram.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar	
	Burn		Stimulate surrounding vegetation								
Herbicide	Foliar		Target pre-flower.								
			Target rosette								
	Mow	Mowing must be repeated to prevent flowering									
	Don't mow		When seed is present								
Flowering Period											

Prohibited: Eradicate

## Yellow starthistle : *Centaurea solstitialis* L.



A member of the knapweeds, genus [Centaurea](#).

### Identification:

**Plant:** Herbaceous, annual with heights of 6 to 36 inches. Plants start as a biennial or winter annual with a basal rosette the first season. Mature plants are described as bushy with a grayish or bluish cast to otherwise green color.

**Leaves:** Basal leaves are lobed, dandelion-like at about 8 inches. Basal leaves may not persist as plants bolt to flower. Stem leaves are alternate, narrow to oblong and an extended leaf attachment provides a winged appearance to stems.

**Flower:** Approximately 1 inch long flowers with substantial  $\frac{1}{4}$  inch yellowish spines emanating from bracts beneath flowers. Flowers are terminal and solitary on stems.

Bloom time is June to August.

**Fruit and Seed:** Each terminal flower produces between 35 to 80 plumeless or plumed seeds.

**Life History:** Yellow starthistle is a strong invader. Due to a lack of tufting on some seeds, reliance is on animals and humans for movement any distance from parent plants.

**Habitat:** Periods of summer drought favor infestations on disturbed sites such as roadsides. Also an invader of prairies, fields, woodlands and pastures where spines can cause injury to grazing animals.

**Management:** **Caution!** Gloves and long sleeves are recommended. Knapweeds have chemical and in some species physical defenses. These are known skin irritants.

Limit movement of seed on grazing animals, mowing equipment and vehicles.

**Eradication** is the goal in Minnesota; therefore, biological control is not a compatible option at this time.

**Mowing,** monitor infestations and time mowing at early flowering stages, soon after spine development.

**Herbicide** formulations of aminopyralid, clopyralid or picloram applied as foliar applications early in the growing season appear to be most effective.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									



## Prohibited: Eradicate

## Knapweed complex : *Centaurea* spp.



Top: Brown Knapweed, images Bugwood.org  
Middle: Meadow Knapweed, images T. Jacobson  
Below: *Spotted* (left), *Diffuse* (center), *Russian* (right)  
Image: Bugwood.org.



Prohibited: Eradicate Brown Knapeed: *Centaurea jacea* L.  
Prohibited: Eradicate Diffuse Knapeed: *Centaurea diffusa* Lam.  
Prohibited: Eradicate Meadow Knapeed: *Centaurea x moncktonii* C. E. Britton [*jacea* × *nigra*]  
Not listed Russian Knapeed: *Acroptilon repens* (L.) DC. - synonym: *Centaurea repens* L.  
Prohibited: Control Spotted Knapeed: *Centaurea stoebe* L. ssp. *micranthos* (Gugler)

Advice, spotted Knapeed is established in Minnesota. Learn to identify it and recognize when something is different.  
Please report infestations that are not easily identified as spotted Knapeed to  
Early Detection and Distribution Mapping System EDDMaps or Minnesota Department of Agriculture's Arrest the Pest.  
Compare Knapeeds on pages 15, 16 and 17. Compare to thistles (pages 19, 20, 47 and 62) and alfalfa / vetches (pages 43 and 50).

### Identification:

Species / Characteristic	Brown	Diffuse	Meadow	Russian (Not Listed in Minnesota)	Spotted (Prohibited: Control)
Root Types	Short-lived perennial,	Short-lived perennial, tap root	Short-lived perennial,	Long-lived perennial, creeping perennial, root spread horizontal.	Short-lived perennial, tap root.
Bracts	Brown, with a tan papery tip (edge)	Rigid, spine-like tips	Long fringed (insect-like) Coppery, shiny (mature).	Rounded bracts, smooth papery transparent tips	Darkened tip, short fringe.
Flowers	Rose to Purplish, 1-1½ inch wide.	Variable - white to rose Occasionally purplish	Rose to purplish ¾ inch wide.	Pink to lavender ¾ to ½ inch	Pinkish, cream is rare Approximately 1 inch
Leaves	Not as deeply lobed as spotted Knapeed	Basal leaves deeply and finely, divided with wide lobes.	Basal leaves mostly unlobed, smooth.	Basal leaves are seldom divided, roughly fuzzy.	Gray-green, Deeply lobed leaves, roughly fuzzy
Habitats	Prefers moist cooler soils.	Dry soils, disturbed sites	Moist soils, wet prairies	Dry to moist soils, saline soils, disturbed sites	Dry to moist soils, disturbed sites

Table adapted from sources: <http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/knapweed.pdf>  
<http://bugwoodcloud.org/mura/mipn/assets/File/KnapweedBrochure072814WEB.pdf>

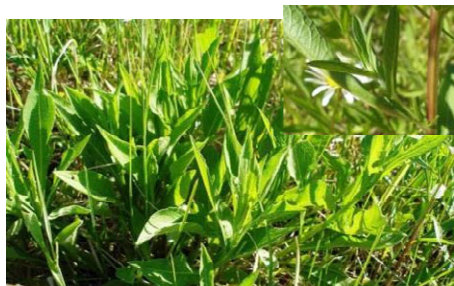
**Plants:** Herbaceous, typically short-lived perennials or biennial. Knapweeds ascend from woody root crowns and reach heights of 8 to 32 inches. Typically, multi branched with solitary, terminal disk flowers.

**Leaves:** Simple, alternate, green foliage. *Spotted* Knapeed has foliage with fine hairs and a blue-gray color, while *meadow* Knapeeds foliage is smooth and a green color. Some species are deeply lobed (*spotted*) while others like *brown* Knapeed may not be lobed. In all species, basal leaves tend to be larger than the lance-shaped leaves above.

**Flower:** Flower colors varying from white to purplish make color a less reliable species identifier. Typically flowers are solitary, terminal to branches, purplish disk flowers that are surrounded by 5-petaled florets. Bracts that cover the bulb-like bases of flowers are 2-parted and the bract characteristics are diagnostic to species, especially the bract tips. Refer to the table above for comparison.

## Prohibited: Eradicate

## Knapweed complex : *Centaurea* spp.



Top: Brown knapweed  
Images: Bugwood.org

Middle: Meadow knapweed  
Images: Tom Jacobson, MnDOT.

Bottom left: Diffuse knapweed  
Image: Bugwood.org

Bloom time is June to September.

Fruit and seed: Small (less than ¼ inch) (2-3 mm), some have short, bristly hairs (pappus) at the top. A typical achene (seed) of the Aster family but pappus is limited and wind will not carry seeds.

Life History: Reproduction is by seed which can be moved by water, animals, and birds. Human activities are significant transporters of seed in products like mulch, soil or hay and straw. Seed is also potentially moved on construction or farm equipment, recreational vehicles, as well as on personal automobiles, clothes and recreational gear. Depending on species, seed viability can be up to eight years.

*Currently unlisted and not known to be in Minnesota, Russian knapweed is a long-lived perennial with deep roots, potentially to 20 feet. Its roots are dark colored and scaly. Russian knapweeds foliage is blue-gray and has fine hairs, similar to spotted knapweed. It is reported that seed production of Russian knapweed is 'limited' but infestations spread aggressively by roots.*

Habitat: *Brown and Meadow knapweeds* prefer moist soil types found along water, wet grasslands or meadows, irrigation ditches, roadsides and openings in woodlands. In contrast, other knapweeds tolerate drier sites such as old fields, road and rail right-of ways, gravel pits or similar disturbed areas.

All prefer full sun locations with the exception of *brown knapweed* being tolerant of partial shade.

**Threat to Minnesota:** potential development of hybrids that can take advantage of intermediate niches.

Management: **Caution!** When handling knapweed plants gloves and long sleeves are recommended since knapweeds have defenses that are known skin irritants.

**Hand pulling** or **digging** while time consuming can be an effective step when coupled with chemical treatments. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

**Repeated mowing** or **cutting** can reduce seed production, but sites must be monitored and applications likely repeated or followed up with herbicide treatments.

**Prescribed fire** can be used to encourage stands of native grasses that will compete with knapweeds. However, monitoring is needed to check for knapweed germination in bare soil soon after burns are completed.

**Herbicide** foliar applications with formulations including aminopyralid, clopyralid, or picloram have proven effective in controlling knapweeds.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar		Foliar treatments target rosettes.							
	Cut stem									
	Mow									
	Don't mow									
	Flowering Period									

Prohibited: Control

Spotted knapweed : *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek



Above: basal rosette,  
Middle right:  
basal foliage,  
Middle Left: linear foli-  
age near top of plant,  
Bottom right: flowers.

**Identification:** Compare to [knapweed complex](#) members. See pages 15 and 16.

Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

*Advice, spotted knapweed is established in Minnesota. Learn to identify it and recognize when something is different.*

**Plant:** Herbaceous, short-lived perennial living 1-4 years. Initial stage is a rosette before the plant produces 1-6 stems ranging from 1-4 feet tall.

**Leaves:** Simple, alternate, grayish-green basal rosette leaves up to 6 inches long have deep sinuses. Alternate leaves on mature stems vary from smaller, 1-3 inch, versions of the basal leaves to very small linear leaves near the top.

**Key difference:** *meadow / brown knapweed* - green leaves, lacking lobes.

**Flower:** Strongly resemble the flowers of thistles in their pink to purple color (rarely white) and multi-parted texture. Below the petals, flowers are held together by bracts that are stiff and tipped with darkened hairs (see image above).

**Compare bract tips;** brown - brown, tan papery edge; diffuse - rigid, sharp spines - *terminal spine can be 1/8 inch long*; meadow - long fringed; Russian - rounded, opaque with transparent tips; and spotted - dark tip, short fringe.

Bloom time is July to September.

**Fruits and Seed:** Small (1/8 inch long), brownish, tufted, seeds.

**Life History:** Allelopathic properties (chemicals exuded by the plant) can suppress the germination of seeds of other plants nearby. Plant removal can lead to bare patches of soil subject to erosion.

Seeds are the primary means of reproduction and a mature plant produces thousands of seeds that may remain viable for up to 5 years. Wind disperses seeds short distances while animal and human activity disperse it far and wide.

**Habitat:** In contrast to meadow knapweed's preference to moist sites, spotted knapweed prefers disturbed sites with gravelly or sandy dry soils. Roadsides, abandoned lots, old fields and gravel pits are habitat that support infestations.

**Management:** **Caution!** Knapweeds are known skin irritants, therefore; if handling knapweed plants gloves and long sleeves are recommended.

**Biological controls** approved for use in Minnesota are seedhead weevils (*Larinus minutus* and *L. obtusus*) and a root-boring weevil (*Cyphocleonus achates*). Weevils are collected July through September and released on infestation sites larger than 1/3 acre. When a combination of seedhead and root boring weevils work together, infestations can be reduced over a number of years.

While **cutting, mowing** and **prescribed fire** can encourage competition from native grasses and help reduce the extent of an infestation they will likely not eradicate it. Early spring prescribed fire is compatible with biological control.

**Herbicide** formulations including aminopyralid, clopyralid, glyphosate, imazapyr, aminocyclopyrachlor or picloram have demonstrated control with foliar applications.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar		Foliar treatments target rosettes.							
	Cut stem									
	Mow									
Flowering Period	Don't mow									



Compare flower similarities to [Canada thistle](#), page 19.

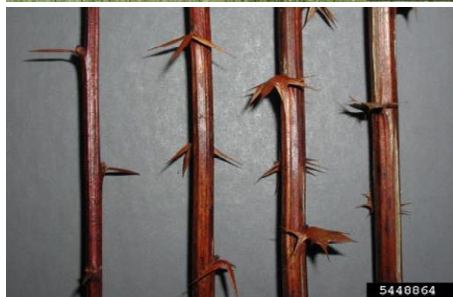


## Prohibited: Control

## Common Barberry : *Berberis vulgaris* L.



5448973



5448864

Above: common barberry spine variations.



5448857

Above: common barberry leaf variations.



5448987



5448972

**Identification:** Compare to [Japanese barberry](#) on pages 32-33 and [Korean barberry](#) on page 33.

**Plant:** Deciduous shrub reaching 8-10 feet in height and up to 6 feet in width. Slender branches are straight between nodes, strongly grooved and common barberry may have single or multi-branched spines, usually 3-branched possibly 5. Bark on second year stems is gray as opposed to reddish second year branches of Korean barberry.

**Key difference** - *Japanese barberry* spines, usually single maybe 3-branched. *Korean* has 1-5 (7), often 3, flat spines.

**Leaves:** Alternate, but clustered not appearing alternate, simple leaves are ovate, narrow near the base, toothed on the edges, described as finely serrate, as few as 8, often 16 to 30 spiny teeth. In particular, young shoots have spiny leaves.

**Key difference** - *Japanese barberry* leaves have smooth edges (no teeth). *Korean barberry* has toothed leaf edges.

**Flower:** Drooping, 1-2 inch long clusters (racemes) of 10-20 yellow, ½ inch long flowers. Flowers are somewhat showy, however; fragrance is not described as pleasant.

**Key difference** - *Japanese barberry* has 1-4 flowers hanging in loose clusters. *Korean barberry* has 10-25 flowers.

**Bloom time** is May to June.

**Fruit and Seed:** Fruit is an oblong berry, up to ½ inch long, bright red and fleshy. Berries persist into and through winter. Each fruit contains 1-3 seeds. Based on studies in Minnesota and North Dakota the US Forest Service fire effects database indicates seed viability of 7-9 years in soil.

**Key difference** - *Japanese barberry* berries are ¼ to ⅝ inch long with dry flesh. *Korean barberry* has ¼ inch fleshy berries and fruits are more rounded - not as oblong.

**Life History:** Most propagation is by seed dispersal. Birds are a primary disperser. Vegetative reproduction is important to persistence. Mainly through sprouting from rhizomes and lower branches may root at points of ground contact.

**Habitat:** Typically, found in open or lightly shaded woods. Also found in pastures, fencerows and roadsides in full sun.

### **Management:**

**Cutting** or **mowing** can be effective once mature shrubs are removed. Follow-up with frequent mowing to control regeneration or utilize other treatments as needed.

Repeated **prescribed fire** can damage above ground parts and drain energy from shrubs; however, resprouting will likely occur. Monitor after fire and follow up as necessary with additional treatments.

As with most woody species, there are several methods to apply **herbicide**. **Foliar** applications should be made when plants are fully leafed out and for best effect while plants are fruiting. Active ingredients include dicamba + 2,4-D, glyphosate, metsulfuron-methyl and triclopyr. **Cut stump** treatments using glyphosate or triclopyr will likely be successful and **basal bark** treatments with triclopyr or imazapyr formulations are also effective.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow									
	Don't mow									
Flowering Period										

## Prohibited: Control

## Canada thistle : *Cirsium arvense* (L.) Scop.



**Identification:** Compare to native [swamp thistle](#) (*Cirsium muticum*). See page 62.  
Compare to nonnative [musk thistle](#) (*Carduus nutans*). See page 47.  
Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.  
Compare flower similarities to [spotted knapweed](#), page 17.

**Plant:** Herbaceous, perennial with grooved, non-spiny, hairy and typically upright stems to a height of 2-6+ feet tall.

**Leaves:** Alternate, simple, pinnately lobed leaves that are generally lance-shaped. The leaves are irregularly lobed, with toothed, spiny edges. The leaves are stalkless (sessile) and at maturity are downy or hairy on the underside.

**Flower:** Male and female (dioecious) ¼ inch flowers occur singly on the end of branches. The disk or composite inflorescence is comprised of numerous purple to pinkish small florets. Bracts below the inflorescence do not have spines on the tips.

**Bloom time is June to October.**

**Fruit and Seed:** Tufted light brown seeds are easily dispersed by wind.

Do not mow after seed has developed as this strongly aids seed dispersal.

**Life History:** Reproduction can occur from seed, root cuttings and from rhizomes. Clonal stands are common and spread significant from roots that can grow horizontally 10-12 feet per year.

**Habitat:** A successful inhabitant of disturbed areas such as roadsides and old fields but will also move into open woodlands and prairies. This species is also found where water levels fluctuate such as in wet meadows, along stream banks and ditches.

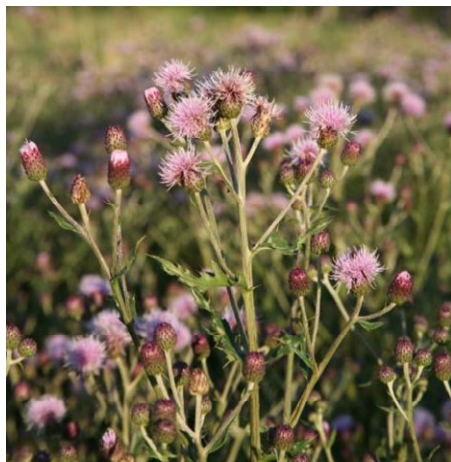
### **Management:**

A **biological control** is under investigation, stem-mining weevil (*Ceutorhynchus litura*). This insect is available from commercial vendors and is acceptable for distribution in Minnesota.

**Cutting or mowing** should target plants that are approximately 3 inches tall and the process must be repeated throughout the season to maintain the plants at 3 inches or less in height. Continuing this approach for several years can drain the plants of reserves.

Repeated **prescribed fire** can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

**Herbicide** foliar sprays with formulations of clopyralid, aminopyralid, or metsulfuron-methyl. These foliar applications are made as the plants bolt, prior to flower set, or in late summer/early autumn to rosettes.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										



## Prohibited: Control

## Plumeless thistle : *Carduus acanthoides* L.



**Identification:** Compare to native [swamp thistle](#) (*Cirsium muticum*). See page 62.  
Compare to nonnative [musk thistle](#) (*Carduus nutans*). See page 47.  
Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

**Plant:** Herbaceous, biennial reaching heights of 1-4 feet. Unlike native thistles, the stems of plumeless thistle are winged and spiny.

**Leaves:** Edges of rosette leaves are wavy with yellowish spines. Stem leaves are alternate, attached directly to stems and typically have hairs on bottoms along mid-veins.

**Flower:** Numerous stem branches support terminal, single, composite flowers that are ½ to 1½ inches wide. Linear or narrow bracts with short spines are found immediately below pink to purple flowers.

**Bloom time is July to October.**

**Fruit and Seed:** Small seeds approximately 1/16 inch long described as straw colored and tufted with fibers on the terminal end. The fibers aid in wind dispersal.

**Life History:** Reproduction is by seed and seeding is prolific building a large seed bank in a short period of time. Thus, control measures should focus on eliminating seed production and exhaustion of seed banks. Movement is greatly increased by animal and/or human activities such as mowing or haying.

It is reported that musk thistle (*Carduus nutans*) and plumeless thistle hybridize.

**Habitat:** Found on dry to moist soils in pastures, woodlands, waste areas, along roadsides, ditches and stream banks.

### **Management:**

**Cutting** taproots 1-2 inches below ground is effective but time consuming for large numbers of plants. **Mowing** should be timed at flower bud stage to prevent seed production and should be repeated 2-3 times per season to be effective. Avoid spreading seed with hay or straw and with mowing and vehicle movement through infestations.

**Prescribed fire** can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

**Herbicide** applications timed at the early bolting phase are foliar applications of 2,4-D ester or dicamba formulations. For foliar applications at the budding to flower stage or fall applications to basal rosettes turn to formulations of aminopyralid, clopyralid, metsulfuron-methyl or triclopyr.



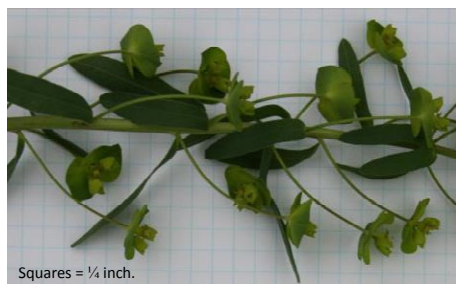
		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									

## Prohibited: Control

## Leafy spurge : *Euphorbia esula* L.



Above: Flower and bracts.  
Right: Cut stem exuding white latex.



Squares = 1/4 inch.



**Identification:** Similar to invasive cypress spurge (*E. cyparissias*). Due to bloom period overlap confused with introduced yellow rocket (*Barbarea vulgaris*). Compare to yellow rocket, page 48.

**Plant:** Herbaceous, perennial to 3 feet tall. *Cypress spurge* is 8-14 inches tall. Broken stems of many *Euphorbia* spp. produce a milky sap (latex) that is a good identification characteristic.

**Leaves:** Alternate, linear to lance-like, bluish-green and 1-4 inches in length. *Cypress spurge* leaves are approximately 1 inch in length, alternate or whorled and narrower than leafy spurge leaves.

**Flower:** There are no petals or sepals on the small yellowish-green flowers. Upper stem leaves or bracts develop just below flowers and are yellow-green in color providing the appearance of yellowish petaled flowers. The bracts develop before the true flowers.

**Bloom time is May to August.**

**Fruit and Seed:** Three-celled capsules that expel seeds up to 20 feet. Each cell contains a seed.

**Life History:** Leafy and cypress spurge reproduction can be vegetative from buds on roots, rhizomes and root cuttings. The ability to reproduce vegetatively makes these plants difficult to control. Deep roots to 21 feet and extensive horizontal roots allow plants to store vast reserves providing the ability to recover after removal attempts. Seed production is significant with plants producing on average 140 seeds per stem. Seeds can remain viable in the soil up to 8 years.

**Habitat:** Leafy and cypress spurge readily invade dry sites in full sun, but tolerance of a range of conditions allows them to invade moist, rich soils as well.

**Management:** **Caution!** Some people are sensitive to the sap of spurges and develop skin rashes after pulling or handling plants, so gloves and long clothing are recommended. The milky sap is toxic to cattle and horses.

**Biological controls** are available for controlling leafy spurge. Flea beetles (*Aphthona lacertosa*) are widely used in Minnesota. Flea beetles are collected late May to early June and released on infested sites larger than 1/3 acre. Additionally in Minnesota, stem and root boring beetles (*Oberea erythrocephala*) provide some control. Early spring prescribed fire is compatible with biological control on this plant species.

**Cutting or mowing** if timed before flower development can reduce or limit seed production. Grazing goats and sheep can effectively limit the spread of infestations.

**Prescribed fire** is another tool that helps drain plants of reserve energy. Control of spurges typically requires a multi-tactic approach - eliminate or reduce seeding, exhaust seed banks, and drain reserves of existing plants while attempting to encourage native plants for competitive cover. So, consider spring mowing or fire with a fall application of imazapic.

**Herbicide** controls are applied as foliar applications and usually involve formulations of aminocyclopyrachlor, picloram, 2,4-D, glyphosate, dicamba, or imazapic. Repeated applications are likely necessary.



Left: Leafy spurge

Right: Cypress spurge.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

## Prohibited: Control

## Narrowleaf bittercress : *Cardamine impatiens* L.



### Identification:

**Plant:** Herbaceous, annual or biennial starting its first season as a basal rosette and in the second season sending up a smooth flower stem to approximately two feet in height.

**Leaves:** Basal rosette leaves are pinnately compound with 3-11 round lobed leaflets. Alternate leaves on flowering stems, while still pinnately compound, likely will not have rounded lobes but 6-20 lance or arrowhead shaped leaflets. Edges of flowering stem leaves may be smooth or sharply toothed.

An important differentiation from other plants can be found at the point where leaves attach to stems, look for narrow pointed ears or auricles that grasp and may extend beyond stems.

**Flower:** Small (0.1 inch), white 4-parted flowers. White petals may not be present.

**Bloom time is May to August.**

**Fruit and Seed:** Similar to other mustard family members, seed pods are long (0.6 - 0.8 inch) and slender. Seed ripens from May to September and is dispersed short distances from plants.

**Life History:** Reproduction is by seed. Seed pods average 10-24 seeds and individual plants can produce thousands of seeds. Movement of seeds is aided by water, animals and human activities.

**Habitat:** Moist woodlands, forested areas and on margins of thickets. River bottom sites, streambanks and other moist areas are very good habitat and provide avenues for dispersal. This species can tolerate a variety of conditions and has been reported in areas such as roadsides, vacant lots, as well as yards and gardens.

**Management:** Recommendations at this time focus on hand pulling infestations.

Good advice from the Minnesota Department of Agriculture in reference to controlling narrowleaf bittercress;

"Following guidelines for controlling other biennial mustards such as garlic mustard, *Alliaria petiolata*, may be helpful."

**Hand pulling** timed to prevent flower and/or seed production is recommended. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). Subsequent re-treatments will be required due to germination and recruitment from the seedbank. If infestations are large or dense, consider the need for ground cover to prevent erosion and to provide competing vegetation.

**Prescribed fire** in spring to top-kill basal rosettes and seedlings. Follow-up treatment with **herbicide** is imperative after seedling germination to further slow growth of infestations.

**Herbicide** applications to foliage with formulations of triclopyr, metsulfuron-methyl, or imazapic.

Use glyphosate or 2,4-D after native plants have entered dormancy and narrowleaf bittercress is still active.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									



## Prohibited: Control

## Purple loosestrife : *Lythrum salicaria* L.



Listing includes European wand loosestrife (*Lythrum virgatum* L.).

**Identification:** Compare to native [fireweed](#) (*Chamerion angustifolium*). See page 55.

**Plant:** Herbaceous, wetland perennial, 4-7 feet tall with a 4 to 6 sided wood-like stem.

**Leaves:** Opposite, sometimes whorled, lance-shaped, and downy with a slightly wavy yet smooth edge. Leaf pairs are positioned at right angles to the leaf pairs above and below.

**Flower:** Each plant can have from one to many spikes of pinkish-purple flowers. Center of the flower is yellowish and surrounded by 5-7 petals that have a wrinkled appearance.

**Bloom time is July to September.**

**Fruit and seed:** Tiny seeds are released from 2-parted capsules.

**Life History:** Reproduction by seeds and rhizomes produce large monoculture infestations.

**Habitat:** Purple loosestrife can be found on upland sites but is best known as an invader of wetlands or aquatic habitats such as ditches, wet meadows, ponds, marshes, river and stream banks as well as lake shores. Purple loosestrife disrupts aquatic habitats as it displaces wetland emergent species.

### **Management:**

**Biological controls** in the form of two leaf feeding beetles of the same genus (*Galerucella californiensis* and *G. pusilla*) have been very effective in Minnesota.

**Mowing** is seldom an option due to wet environments. **Cutting** of flower spikes can be an effective control of seed production. **Hand pulling** or **digging** of plants can also be effective but care should be taken to remove entire root systems if possible. Resprouting can occur from roots and root segments left in the ground or on the site. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

**Herbicide** formulations labeled for use on rights-of-way and near water; 2,4-D, glyphosate, imazamox, metsulfuron-methyl+aminopyralid, triclopyr, imazapyr and aminocyclopyrachlor.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

## Prohibited: Control

## Common tansy : *Tanacetum vulgare* L.



**Identification:** Compare to native [goldenrods](#) (*Solidago* spp.). See page 57.

**Plant:** Herbaceous, perennial reaching 2-5 feet in height. Stems appear woody, are slightly hairy to smooth and at the base are purplish-red.

**Leaves:** Alternate, pinnately divided, toothed on edges and 2-12 inches long, typically smaller near the top of plants. Leaves are strongly aromatic when crushed.

**Flower:** Single stems support multi-branched, flat clusters of bright yellow button-like flowers. Each ¼-½ inch wide button is comprised of many small florets and the flower heads, like the leaves, are strongly aromatic.

**Key difference -** Note the lack of ray petals surrounding the flower heads. Compare to [goldenrods](#) which have ray petals.

Bloom time is July to October.

**Fruit and seed:** Small, yellowish-brown, dry, 5-toothed crowned seeds.

**Life History:** Reproduction is both vegetative from rhizomes and root fragments or by seed. Seeds are dispersed by wind, water and human activities such as vehicle traffic and mowing.

**Habitat:** Found most often in open, disturbed areas typical of stream and river banks, trail edges, roadsides, gravel pits and old farmsteads or pastures. Can be found in riparian areas, but most often in dry, well drained soils in full sun.

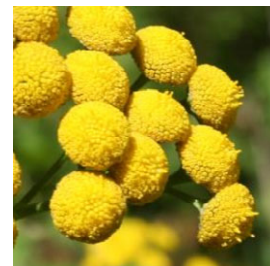
**Management:** **Caution!** The alkaloids contained in common tansy are toxic to livestock and humans if consumed in quantity. Toxins can potentially be absorbed through skin, gloves are recommended when handling or pulling this plant.

**Mechanical** methods like **tilling** can spread common tansy by spreading small root segments. **Pulling** also may leave root segments in the ground which may resprout.

**Cutting or mowing** to prevent seed production can be effective and should be timed just prior to flowering.

**Prescribed fire** can eliminate competition and create favorable conditions for common tansy by opening the canopy and preparing bare soil. Thus, fire can make an infestation worse; however, fire can be used to remove dead material to improve follow-up herbicide application providing better contact and potentially better control.

**Herbicide** formulations of metsulfuron-methyl, imazapyr, glyphosate or 2,4-D provide good control when applied as foliar applications in spring.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar		Foliar treatments target rosettes.							
	Cut stem									
	Mow									
	Don't mow									
Flowering Period										

## Prohibited: Control

## Wild parsnip : *Pastinaca sativa* L.



**Identification:** Compare to [golden alexanders](#) (*Zizia aurea*) and

[heart-leaved golden alexanders](#) (*Z. aptera*), both native. See page 56.

**Plant:** Herbaceous, classed as a monocarpic perennial (plant dies after bearing fruit). Early life form is a basal rosette with mature stems developing a hollow, grooved flowering stalk potentially reaching 5 feet.

**Leaves:** Basal rosette leaves can be 6 inches in height and are pinnately compound with 5-15 leaflets. Flowering stalk leaves are alternate, 2-5 leaflets that become smaller near the top of the stem. Leaflets are coarsely toothed, sinuses cut to varying depths creating lobes of various sizes. The base of the leaf stalks wrap or clasp the grooved stem.

**Flower:** 12-35, 5-petaled, small yellow flowers on wide, flat umbels of 15-25 umbellets approximately 2 to 6 inches across.

**Bloom time is June to July.**

**Fruit and Seed:** Flattened, yet ridged, oval seeds.

**Life History:** Typical life span is two years, first year a basal rosette. At this stage, it is one of the first plants to green up in the spring and one of the last to brown down in autumn providing good opportunities for scouting and treating. Mid to late summer, mature second-year plants will bolt, flower and set dozens of seed per plant. Seeds are moved off infested sites by animal and human activity or wind and water movement. Seed is reported to be viable in soil for up to 4 years.

**Habitat:** Disturbed sites such as roadsides and abandoned fields or lots. Can occur in wet meadows but dry to mesic soils are more typical. Full to partial sun is a must for this species.

**Management:** **Caution!** Use protective clothing, goggles or face mask. Contact with the sap of the plant (i.e., phyto) when combined with exposure to sunlight (i.e., photo) can cause severe blistering and swelling (i.e., dermatitis) - phytophotodermatitis.

If **cutting** or **mowing** after seed set, clean equipment to leave seeds on the infested site. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#). If a site is mowed early in the season it must be monitored as plants will likely re-sprout, bolt and flower.

**Prescribed fire** can be used to encourage stands of native grasses for competition. However, follow-up treatments (herbicide or cutting) are still required to prevent seed production.

**Herbicide** controls include foliar applications of 2,4-D or metsulfuron-methyl to the rosette stage during May and June and again in September or October. If glyphosate is to be applied to rosettes, it is recommended to hold off until late fall to prevent damage to desirable plants that should then be dormant.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									



## Restricted

## Asian bush honeysuckles : *Lonicera* spp.



Tatarian honeysuckle (*L. tatarica* L.),  
Morrow's honeysuckle (*L. morrowii* Gray),  
Bell's or 'Bella' honeysuckle (*L. × bella* Zabel [*morrowii* × *tatarica*]),  
Amur honeysuckle (*L. maackii* [Rupr.] Herder) - not known to be in Minnesota.

**Identification:** Compare to native [honeysuckles](#). See page 59.

**Plant:** Perennial woody shrubs, multi-stemmed and ranging in heights of 6-15 feet tall (Bell's to 20 feet, Amur to 30 feet). All nonnative bush honeysuckles have hollow stems with a brownish pith (image upper right).

**Leaves:** Opposite, egg-shaped to lanceolate (*Amur* has lance-shaped with drawn out tips). Other species have rounded to acute leaf tips with tapered, straight or heart-shaped leaf bases. Surfaces range from smooth and hairless on Tatarian to pubescent (hairy) on Amur and Morrow's. Leaf lengths are 1 to 2½ inches.

**Flower:** Fragrant pairs of tubular flowers approximately ¾ to 1 inch across. Color ranges from cream to white (Amur and Morrow's) or pink (Bell's) fading to yellow. Tatarian produces white, pink or red to crimson not fading to yellow.

**Bloom time is mid May to early June.**

**Fruit and Seed:** Most species bright red, Tatarian red to orange. The ¼ inch berries are in clusters of 2-4, mature in late summer and are readily eaten by birds that then disperse the oval, flattened seeds. *Amur honeysuckle fruit can be dark red to purplish, persists into winter and is held on stalks (peduncles) shorter than the leaf stalks (petioles).*

**Life History:** Vegetative sprouting aids renewal of shrubs. As mentioned above, seed dispersal is mainly by birds.

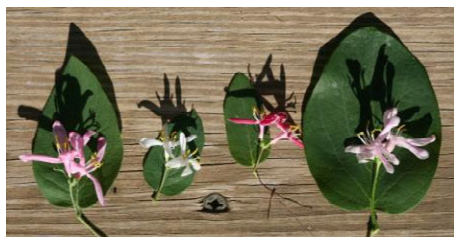
**Habitat:** Shade-intolerant plants often found along the forest edges (image upper left). Also found in disturbed, open upland sites such as roadsides, and abandoned pastures or fields.

**Management:** **Prescribed fire** can be useful to kill seedlings, and drain energy from mature plants. **Mowing (cutting)** can prevent or delay seed production but typically is not considered an eradication method. Monitor the infestation and utilize follow-up treatments of additional mowing and/or herbicide.

For small numbers of plants, **manual methods** including **cutting, digging, or hand pulling** if done repeatedly **and in conjunction** with other treatments can control infestations. Monitor and consider supplemental herbicide treatments. When pulling and digging suspend roots above ground to ensure they dry out. Plants should be disposed of onsite or contained (e.g., bagged) and removed to an approved facility.

**Foliar herbicide** treatments with formulations of metsulfuron, dicamba, picloram + 2,4-D, triclopyr + 2,4-D, imazapyr or glyphosate at full leaf out during the active growing season.

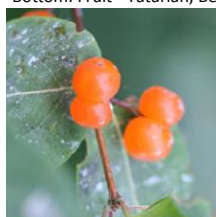
**Cut stem or basal bark** applications at any time with 2,4-D, imazapyr, or triclopyr formulations. Additionally, for **cut stem** options include picloram or glyphosate and for **basal bark** treatments options also include aminopyralid.



Top: Honeysuckle in sunlight, on the forest edge.

Center: Honeysuckle leaf and flower color variations.

Bottom: Fruit - Tatarian, Bella or Morrow's and Amur.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
	Foliar									
Herbicide	Basal Bark									
	Cut stem									
	Mow									
	Don't mow									
	Flowering Period									

## Restricted

## Black Locust : *Robinia pseudoacacia* L.



### Identification:

A native of eastern US, an aggressive, introduced invader in Minnesota.

**Plant:** Woody perennial, large trees attaining heights ranging from 40-60 feet tall (potentially 80 feet). Bark is dark gray-brown with deep furrows between flat-topped ridges. Vigorous sprouts and young shoots are greenish-colored and have paired spines up to 1 inch long at the base of leaves.

**Leaves:** Alternate, pinnately compound with 11-19 leaflets creating leaves 3-8 inches long. Oblong leaflets about ¾ to 2¼ inches long by ¼ to 1¼ inches wide. Leaf surfaces are dull dark green to blue-green and paler beneath.

**Flower:** Before leaves reach full expansion, showy racemes of ¾ inch long white to creamy white, pea-like flowers appear. Fragrant flowers attract early season pollinators.



Bloom time is June.

**Fruit and Seed:** Flat pods about 2-4 inches long by ½ inch wide turning brown at maturity. Pods contain 4-8 seeds.

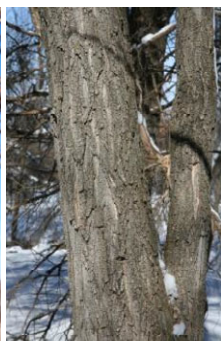
**Life History:** A nitrogen fixing legume that produces a shallow root system. Most reproduction is vegetative, the species sprouts vigorously from roots and stumps. Many stands of trees are clonal stands. It is reported that while black locust produces seed they seldom germinate.

**Habitat:** Performs well in full sun on well drained soils where there is little competition. Does well in disturbed areas such as roadsides, abandoned fields and woodland sites that are degraded. Has been used in the past for mine soil (spoils) reclamation due to its tough nature and nitrogen fixing capability.

### Management:

**Mechanical** methods such as **cutting** or **mowing** are seldom worth the time or effort since the plants are strong sprouters from root and stump. All of these mechanical methods can have limited effects, but eradication or even good control is unlikely. The same is true of **prescribed fire**.

**Basal bark or cut stump herbicide** applications with either aminopyralid or clopyralid formulations including bark oil are effective. Other formulations for **cut stump** might include dicamba, glyphosate, imazapyr, triclopyr or combinations of picloram + 2,4-D, triclopyr + 2,4-D, or aminopyralid + triclopyr. Growing season **foliar** applications can be made with the same active ingredients; aminopyralid and clopyralid. Additionally, metsulfuron, picloram + 2,4-D, glyphosate and imazapyr are labeled for use.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn							Monitor and follow-up.		
	Foliar				When fully leafed out and actively growing.					
Herbicide	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow		Mow frequently to control seedlings.							
	Don't mow									
	Flowering Period									



## Restricted

## Crown Vetch : *Securigera varia* (L.) Lassen



Synonym: *Coronilla varia* L., also known as purple crown vetch.

**Identification:** Compare to nonnatives [alfalfa](#), [hairy vetch](#). See page 43.  
Compare to native [American vetch](#). See page 50.  
Compare to native [Canadian milkvetch](#). See page 50.

**Plant:** Erect, perennial plant at 1-2 feet tall that forms dense tangled masses of reclining 2-6 feet long stems.

**Leaves:** Alternate, compound leaves, odd-pinnate with 11-25 oval, smooth-edged leaflets often with a minutely pointed tip. Leaves are stalkless.

**Flower:** Up to 6 inch long, erect flower stalks support dense umbels or crown-like clusters of 10-25, 5-parted, 1/8-1/2 inch long pinkish flowers.

**Bloom time is May to September.**

**Fruit and Seed:** Erect, narrow, multi-segmented, pointy-tipped, angular pods containing up to 12 seeds are clustered at ends of upright stalks. See seed pod images lower left.

**Life History:** Colonies develop rapidly as plants produce lots of seed and also spread aggressively via vegetative rhizomes. Seed is reported to remain viable for as long as fifteen years. Unattractive, large brown patches in winter and early spring help identify crown vetch infestations.

**Habitat:** Old fields, pastures and roadsides. Crown vetch has been planted extensively for forage products and along roadsides and steep embankments for erosion control.

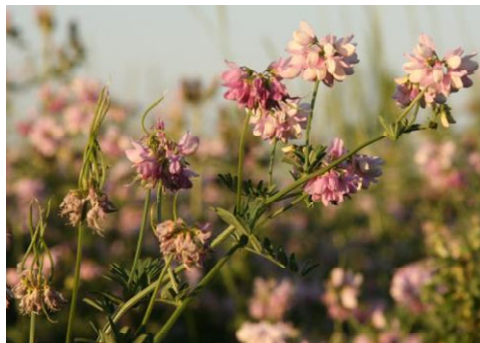
### Management:

**Cutting or mowing** will reduce vigor but not eliminate an infestation. Plan to mow several times a season and monitor to time operations with a goal to prevent seed set.

**Prescribed fire** can be used with other management tactics to encourage stands of native grasses that will compete for resources. However, monitoring is necessary as crown vetch will resprout after burns.



Roadside infestation being held in check by mowing and herbicide applications.



There is a long list of active ingredients applied as a **foliar herbicide** applications. Active ingredients include, but may not be limited to, 2,4-D, aminopyralid, clopyralid, dicamba, glyphosate, metsulfuron-methyl, sulfometuron, picloram and triclopyr. Recommendation is to apply aminopyralid before flower while others are recommended for application during active growing periods.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn		Late Spring							
Herbicide	Foliar		During active growth periods.							
	Mow		Mowing must be repeated							
	Don't mow					Prevent flower and seed.				
	Flowering Period									

## Restricted

## Common buckthorn : *Rhamnus cathartica* L.



**Identification:** Compare to the native [cherries and wild plum](#) (*Prunus* spp.). See page 51.

**Plant:** Tall shrub at 20-26 feet with potential to become a small tree reaching 36 feet. Often one to a few stems with diameters up to 5-6 inches and occasionally larger. Light-colored lenticels on shiny gray to brown bark leads to confusion with young native cherries and plums (*Prunus* spp.). Many twigs are terminated by a small **thorn-like spine between dark colored, scale covered buds.**

**Leaves:** **Sub-opposite**, at times appearing opposite and on fast growing sprouts alternate. Shiny green, 1-2½ inches, oval with tiny teeth on leaf edges. Veins curving to the tip of the leaf (arcuate venation) provide a strong identification characteristic and green leaves persisting into autumn.

**Flower:** **Dioecious**, male and female flowers on separate plants, small, 4-parted and green.

**Bloom time is May to June.**

**Fruit and Seed:** Fruit on female plants only. At maturity a purplish-black, small (¼ inch), berry-like fruit held close to the stem in clusters. Strong identification characteristic are these blackish fruits held close to twigs late into winter. Typically, 3-4 seeds per fruit.

**Life History:** Reproduction is by seed and dispersal is often aided by birds. Heavy seed production combined with stems and stumps that sprout vigorously when damaged make control difficult.

**Habitat:** A strong competitor on upland sites in a variety of soil types and moisture regimes. Common buckthorn thrives in the understory, on the forest edge or in full sun often to complete exclusion of other species.

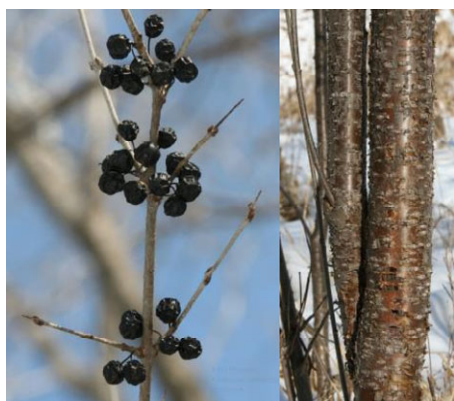
### **Management:**

Keep in mind, if funds and/or time are limited female plants are the fruit producers and should be targeted first. Caution should be exercised to avoid creating large bare patches and/or extensive soil disturbance. Both scenarios lead to soil erosion and create good seed beds for common buckthorn regeneration.

**Hand pulling** or the mechanical advantage provided by a **weed-wrench** can help control small infestations. **Cutting** of stems must be accompanied by herbicide treatments or resprouting will occur. **Mowing** is typically not an option in sensitive wetland areas, but on upland sites may be a useful tool in seedling and small diameter stem control.

**Prescribed fire** is used to control seedlings and small diameter stems and if used consistently can drain larger plants of reserves and provide control. However, sprouting will occur and a follow-up herbicide application should be considered.

**Herbicide** formulations of triclopyr, imazapyr, metsulfuron-methyl, 2,4-D, glyphosate or picloram are used as foliar applications. Herbicides include triclopyr or glyphosate for late autumn into winter applications to basal bark, cut stumps or frill cuts.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar			When fully leafed out. During active growth.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow	Mow frequently to control seedlings.								
	Don't mow									
Flowering Period										

## Restricted

## Glossy buckthorn : *Frangula alnus* Mill.

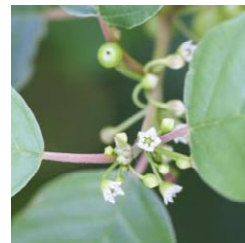


**Identification:** Compare to the native [cherries and wild plum](#) (*Prunus* spp.). See page 51.

**Plant:** Shrub or small tree at 20 feet in height, often multi-stemmed with prominent light-colored lenticels on dull grayish to dark brown bark. Heartwood may be orange to pinkish and sapwood may be yellowish, both can facilitate identification. **No thorns or spines!** There are no bud scales protecting overwintering buds - referred to as naked buds.

**Leaves:** **Alternate**, glossy, 2-3 inch length with prominent parallel veins terminating near a smooth edge. Undersides are slightly hairy and dull. Leaves will likely persist longer in autumn than native deciduous shrubs, but they will turn yellow and drop.

**Flower:** **Monoecious**, male and female parts present in flowers. Therefore, all shrubs can fruit. Not showy, small, 5-petaled, yellowish and borne in clusters in the leaf axils.



**Bloom time is May to July.**

**Fruit and Seed:** Clustered in leaf axils along the stem, initially reddish maturing to purplish-black in late summer into autumn. Each fruit contains 2-3 seeds, dispersed by birds.

**Life History:** Reproduction is by seed and while birds disperse the seed, dense thickets suggest many seeds drop close. Shades out native shrubs and forbs creating monocultures in sites that typically support very diverse flora.

**Habitat:** An invader of wetlands, including sedge meadows, sensitive acidic bogs and calcareous fens. Tolerant of shade, yet will perform well in full sun on upland sites.

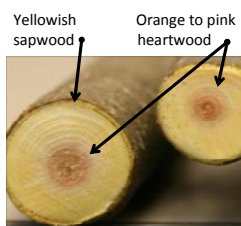
### Management:

Caution should be exercised to avoid creating large bare patches and/or extensive soil disturbance. Both scenarios lead to soil erosion and create good habitat for glossy buckthorn regeneration.

**Hand pulling** or the mechanical advantage provided by a weed-wrench can help control small infestations. **Cutting** of stems must be accompanied by herbicide treatments or resprouting will occur. **Mowing** is typically not an option in sensitive wetland areas, but on upland sites may be a useful tool in seedling and small diameter stem control.

On upland sites **prescribed fire** can be used to control seedlings and small diameter stems and if used consistently can drain larger plants of reserves and provide control. However, sprouting will occur and a follow-up herbicide application should be considered.

**Herbicide** formulations of triclopyr, imazapyr, metsulfuron-methyl, 2,4-D, glyphosate or picloram are used as foliar applications. Herbicides include triclopyr or glyphosate for late autumn into winter applications to basal bark, cut stumps or frill cuts.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Basal Bark									
	Cut stem									
	Mow									
Flowering Period	Don't mow									
	Flowering Period									



## Restricted

## Garlic mustard : *Alliaria petiolata* (M. Bieb.) Cavara & Grande



### Identification:

**Plant:** Herbaceous, biennial with first year plants being basal rosettes. Second year flowering plants can attain heights of 4 feet and can produce more than one flowering stem.

**Leaves:** Basal rosettes with coarsely toothed, kidney-shaped foliage remains green through winter. Foliage on flowering stems is alternate, triangular, coarsely toothed and stalked. Foliage has the odor of garlic when crushed.

**Flower:** Clustered, 4-parted, white flowers are approximately ¼ inch across.

**Bloom time is April to June.**

**Fruit and Seed:** The 1-2½ inch long slender seed pods are very recognizable and contain numerous black, shiny seeds.

**Life History:** Reproduction is by seed that matures June into July and can be dispersed about 6 inches when pods burst at maturity. Seed remains viable in soil for up to 5 years.

**Habitat:** An invader of shady, moist forests or woodland settings but also invades oak savannas and disturbed areas in full sun. It is reported that garlic mustard will inhibit the growth of beneficial fungi associated with native plants thus causing a decline in herbaceous cover.

**Management:** **Biological controls** are under investigation, but none are approved for release at this time. One insect being studied is *Ceutorhynchus scrobicollis*, a crown and stem-mining weevil.

**Manual** methods include pulling plants in early spring prior to flowering (seed set is almost coincidental with flowering) and cutting plants back to the ground as they bolt for flowering, prior to flower opening. Monitor the site as cutting may need to be repeated. If mature flowers (or seed pods) are present, plants should be disposed of onsite or contained (e.g., bagged) and removed to an approved facility.

**Prescribed fire** in spring to top-kill basal rosettes and seedlings. Follow-up treatment with **herbicide** is imperative after seedling germination to further slow growth of infestations.

**Herbicide** applications to foliage with formulations of triclopyr, metsulfuron-methyl, or imazapic. Use glyphosate or 2,4-D after native plants have entered dormancy and garlic mustard is still active.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									

## Restricted

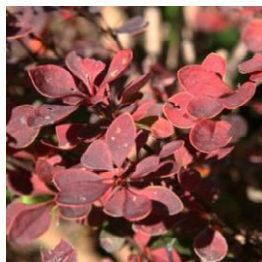
## Japanese barberry : *Berberis thunbergii* DC.



Above: *B. thunbergii* in flower late May.

Below left: *B. thunbergii* 'Erecta'

Below right: *B. thunbergii* 'Rose Glow' (top) and  
*B. thunbergii* 'Sparkle' (bottom)



**Identification:** Compare to [common barberry](#) (*B. vulgaris*) on page 18.

More images and regulated cultivars [next page](#).

**Plant:** Perennial woody shrubs, multi-stemmed, typically 3-6 feet tall (potentially to 8 feet tall). Stems are grooved or angular and ranging in color from gray to reddish-brown. Single (possibly 3 branched) ½ inch long spines occur at nodes where leaves attach. Lateral spine branches if present may be very small.

**Leaves:** Alternate, typically clustered so not appearing alternate. Leaves are simple, narrow near the twig and described as obovate (wider towards the end). The leaf edge or margin is smooth (*B. koreana* and *B. vulgaris* have teeth) and occasionally there is a minute spine tip or point at the ends of leaves.

**Flower:** Small (¼ to ½ inch) yellowish flowers suspended under the foliage. Therefore not considered showy. Japanese barberry flowers are typically individual but flowers may be in clusters of 2-4 while Korean barberry (*B. koreana*) may have up to 20 flowers per raceme (cluster). See fruit of Korean barberry in upper right-hand image on [next page](#).

**Bloom time is May to early June.**

**Fruit and Seed:** Bright red, dry flesh, a true berry that persists into and through winter (image next page, bottom right: fruit at leaf out in April). The ½ inch long ellipsoidal berries, like the flowers, will be solitary or in clusters of 2-4.

**Life History:** Seed production is strong and this special regulation targets species and cultivars producing on average more than 600 seeds. Seed bank viability (longevity) is not well understood; although, a report on *B. thunbergii* 'Beth' states that the seed remain viable up to 10 years. Reproduction can also be vegetative via root sprouts and shrub branches may root if in contact with the ground.

**Habitat:** Prefers well drained soils in full sun to partial or deep shade. Forest edges, open forests and other woodlands yet also found in old fields, areas of disturbance and can survive in wetland soils.

**Management:** **Prescribed fire** (or direct flame from a propane torch) can be useful to kill seedlings, and drain energy from mature plants. **Mowing (cutting)** can prevent or delay seed production but typically is not considered an eradication method. Monitor the infestation and utilize follow-up treatments of mowing and/or herbicide.

For small numbers of plants **manual methods** including **cutting, digging, and hand pulling** if done repeatedly **and in conjunction** with other treatments can control infestations. Monitor and consider supplemental herbicide treatments. When pulling and digging suspend roots above ground to ensure they dry out. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

**Foliar herbicide** treatments with metsulfuron products at full leaf out during the active growing season. Additionally, dicamba + 2,4-D, triclopyr or glyphosate at full leaf out while the plants are fruiting during the growing season.

**Cut stem** applications at any time with glyphosate or triclopyr formulations can also be useful.

**Basal bark** treatments at any time with imazapyr or triclopyr products have proven effective.

Wild type, single and paired flowers.

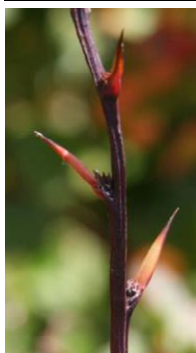


		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Basal Bark	When fully leafed out. During active growth.								
	Cut stem	Any time.								
	Mow	Mow frequently to control seedlings.								
	Don't mow									
Flowering Period										



Restricted

## Japanese barberry : *Berberis thunbergii* DC.



Above: 'Tara' (Emerald Carousel®; *B. koreana* × *B. thunbergii* hybrid)

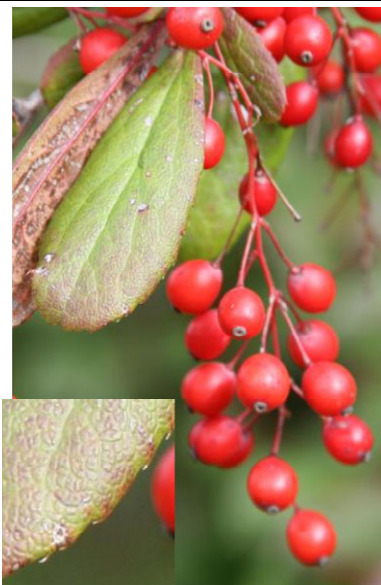
Above left: Grooved, reddish-brown stem, single spines at nodes.

Above center: Foliage and racemes of fruits. Above right: Form



Left: *B. thunbergii*  
'Bailone'  
Ruby Carousel®

Right: *B. thunbergii*  
'Bailtwo'  
Burgundy Carousel®



Above: *B. koreana* images for comparison.

Toothy foliage (serrulate margin) and more than 10 rounded fruits per raceme

Inset: Close-up of Korean barberry leaf edge.  
Below: Unknown *Berberis* species / cultivar holding fruit at leaf out in April.

### Japanese barberry cultivars to be phased out and then prohibited from sale.

These plants average greater than 600 seeds per plant and began a three-year phase-out period in Minnesota beginning January 1, 2015.

'Angel Wings' 'Antares' 'Anderson' (Lustre Green™) var. *atropurpurea*  
'Crimson Velvet' 'Erecta' 'Gold Ring' 'Inermis' 'Kelleris' 'Kobold'  
'Marshall Upright' 'Painter's Palette' 'Pow Wow' 'Red Rocket' 'Rose Glow'  
'Silver Mile' 'Sparkle'  
'JN Redleaf' (Ruby Jewel™) 'JN Variegated' (Stardust™) 'Monomb' (Cherry Bomb™)  
'Bailgreen' (Jade Carousel®) 'Bailone' (Ruby Carousel®) 'Bailtwo' (Burgundy Carousel®)  
'Bailsel' (Golden Carousel®; *B. koreana* × *B. thunbergii* hybrid)  
'Tara' (Emerald Carousel®; *B. koreana* × *B. thunbergii* hybrid) Wild Type (parent species - green barberry)



Restricted

## Multiflora rose : *Rosa multiflora* Thunb.



### Identification:

**Plant:** Shrub with 6-13 feet long, wide arching canes reaching 6-15 feet tall. Canes armed with stiff, downward curved prickles (thorns) form an impenetrable thicket.

**Leaves:** Alternate, pinnately compound, 5-11 sharply-toothed leaflets. The oval leaflets are nearly smooth on the topside and are covered with short hairs below. A unique feature are fringed stipules where leaves attach to stems.

**Flower:** Numerous, showy flowers. Five-parted, fragrant, white to slightly pink, ½-1½ inches across.

**Bloom time is May to July.**

**Fruit and Seed:** Numerous rose hips, ¼ inch diameter, bright red to orange-red, hairless or smooth. Hips are on a wide branched structure and persist into winter.

**Life History:** Plants reproduce by seed and by cane tips with ground contact taking root. The plants are prolific seed producers and seeds are viable in seed banks for up to 20 years.

**Habitat:** Readily invades disturbed areas such as woodlands, prairies, roadsides, along streams and has become a problem in pastures where the thorns discourage grazing.

### Management:

**Cutting or mowing** frequently during the growing season (3-6 times) for 2-4 years can achieve good control of infestations. **Prescribed fire** in the spring will provide good control of small stems and seedlings.

**Herbicide** applications to cut stems and to resprout stems with systemic herbicides such as glyphosate have proven successful. As with most species, late season applications of herbicides are effective as plants are moving photosynthates to storage in root systems.



Images clockwise order: Iowa (IA) and Illinois (IL)  
UR: White, five-parted flower (IA, 2009-6-11).  
LR: Wide branched, maturing ¼ in. hips (IL, 2015-10-16).  
LL: Compound leaves (IA). Thorns, stipules and hips (IL).  
UL: Fringed stipules and downward curved thorns (IA).

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									



## Restricted

## Nonnative phragmites or common reed (nonnative subspecies)



### ***Phragmites australis* (Cav.) Trin. Ex Steud. subsp. *australis***

Compare to [native phragmites](#) (*P. australis* subsp. *americanus*), Page 60.

#### **Identification:**

**Plant:** A perennial grass reaching heights of 15 feet. Dense stands develop from rhizomatous root systems with live stems and dead stems intermingled. Hollow stems are green in summer and yellow in winter.

**Leaves:** Dark green, grass-like elongated foliage that is at most 1½ inches wide. Leaf sheaths are typically retained on culms (stems) into winter even if leaves drop from dead culms. *Compare to native phragmites that sheds leaves and leaf sheaths.*

**Flower:** Bushy panicles of purplish or golden flowers appear in July.

**Bloom time is July to September.**

**Fruit and Seed:** Large, dense seed heads become gray-brown. Hairy seeds give heads a fuzzy, fluffed appearance.

**Life History:** Rhizomes, rhizome fragments, root runners and copious amounts of seed provides common reed a strong competitive edge. It forms such dense stands and thick root systems that all native plants can be forced out. Rhizome segments can break free and coupled with seed production plants readily move into and take over new areas.

**Habitat:** Shorelines of lakes and rivers as well as pond edges and freshwater marshes. Disturbed areas and roadsides can support common reed very well.

**Management:** Once established, chemical treatments are recommended as a first step in restoration efforts.

**Cutting or mowing** will not kill plants or eradicate infestations, but can be effective at slowing the spread.

**Prescribed fire** after the plant has flowered. Used prior to herbicide treatments, fire (or mowing) removes biomass improving herbicide application to regrowth. Do not burn prior to flowering, as this timing may only encourage growth.

**Herbicide** applications, aquatic formulations of imazapyr or glyphosate are effective, even on established stands.

Rapid recognition of infestations and treatments soon after increase effectiveness. Late summer/early autumn herbicide applications to foliage or to cut stems are best and repeat treatments in subsequent seasons are likely necessary.



Glumes or seed covers vary in length. Upper and lower glumes are longer on the native subspecies. Best analyzed under a microscope.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn					After flower				
	Foliar					After Flower				
	Cut stem					After Flower				
	Mow		Mowing must be repeated							
	Don't mow									
Flowering Period										

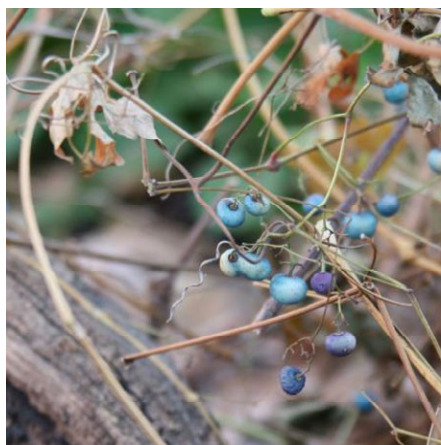


## Restricted

## Porcelain Berry : *Ampelopsis brevipedunculata* (Maxim) Trautv.



Image by: Paul Kortebein



Family: Vitaceae, same genus as *Vitis* (grapes).

Synonyms: *A. brevipedunculata* (Maxim.) Trautv. var. *maximowiczii* (Regel) Rehder

*A. glandulosa* (Wall.) Momiy. var. *brevipedunculata* (Maxim.) Momiy.

*A. heterophylla* (Thunb.) Siebold & Zucc.

*A. heterophylla* (Thunb.) Siebold & Zucc. var. *brevipedunculata* (Regel) C.L. Li

**Identification:** Compare to native [riverbank grape](#) (*Vitis riparia*). See page 58.

**Plant:** Perennial, woody vines that climb trees or structures with assistance of tendrils. Like riverbank grape, tendrils occur opposite leaves. Bark of porcelain berry is gray and retains smoothness with age and the pith is white.

**Key differences** - Riverbank grape has dark brown bark that peels in narrow, vertical strips.

**Leaves:** Alternate, simple leaves with a cordate (heart-shaped) base and 3-5 palmate coarsely toothed lobes separated by deep sinuses. Some leaves may resemble wild grape leaves.

**Key differences** - Riverbank grape has shallow sinuses between 3 distinct palmate, coarsely toothed lobes.

**Flower:** Inconspicuous, panicles of greenish flowers occur opposite leaves.

**Bloom time is June to August.**

**Fruit and Seed:** Shiny, brightly colored berries in hues of blue to purple mature in September and October. Each berry contains 2-4 seeds and seed viability is reported to be 'several' years.

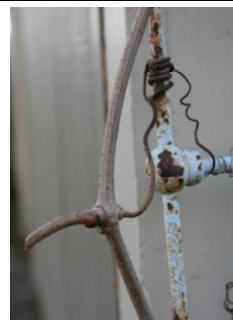
**Life History:** Water may play a small part in seed movement but predominant means of dispersal is by birds and small mammals that have fed on the colorful berries. Vegetative reproduction is also possible. Vines have strong root systems and will resprout after cutting.

**Habitat:** When found, typically in riparian (floodplain) areas that are not permanently wet. Full sun to partial shade on forest edges, stream banks, thickets and other such places.

### Management:

Acceptable control can be attained with **mechanical** methods such as **hand pulling** or **cutting** (possibly **mowing**). However, after cutting, plants will resprout so there should be a plan to monitor and follow up cutting treatments with additional cutting or herbicide treatments. Follow-up to monitor for new seedlings will also be required.

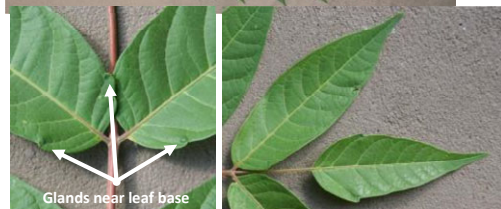
For large infestations **herbicide** applications are likely the most cost effective approach. Systemic herbicides for woody brush control such as glyphosate and triclopyr have been used effectively as **foliar** or **basal bark / cut stem** treatments.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Foliar		During active growth or cut and treat resprouts.							
	Cut stem					Basal bark (with oil) or cut stem				
	Mow		Mowing, when possible, must be repeated							
	Don't mow						When seed is present			
Flowering Period										

## Restricted

## Tree-of-Heaven : *Ailanthus altissima* (Mill.) Swingle



Synonyms: *A. glandulosa* Desf. and *Toxicodendron altissimum* Mill.

**Identification:** Compare to native [sumacs](#) (*Rhus typhina* and *R. glabra*). See page 61.

**Plant:** Tree, woody perennial plant that can attain heights of 70 feet. Very thick twigs with dime-sized leaf scars aid winter identification. Cutting twigs reveals a soft white pith.

**Leaves:** Alternate, 1-4 feet long, odd-pinnate compound with 11-25 (up to 40) leaflets. Leaflets are 3-5 inches long by up to 2 inches wide, smooth edged with 1-5 distinct glands (bumps) near leaflet bases. **Key difference:** leaflets are smooth edged, unlike toothy sumac leaflets.

**Flower:** Clusters of small yellowish-green flowers are showy due to the sheer number of flowers per cluster. Species is predominantly dioecious (male and female flowers on separate trees).

**Bloom time is June.**

**Fruit and Seed:** Clusters of 1-1½ inch long twisted samaras develop mid-summer. A pinkish hue develops, then maturing to light tan. Samaras are documented to wind disperse up to 300 feet.

**Life History:** Trees sprout vigorously from stumps when cut or broken and there is also strong root sprouting potential. Trees in the 12 to 20 year age class produce lots of seed. Seed bank capability is reported to be low, but initial seed viability is high. Allelopathic (chemical) effects prevent germination of other plants near tree-of-heaven.

**Habitat:** Tolerant of urban stresses including pollution, soil disturbance, nutrient poor soils, drought conditions (once established), compaction, salty roadside soils and prefers full sun.

**Management:** Prevention is key - early detection and removal is recommended.

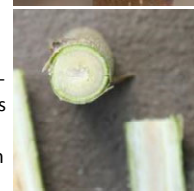
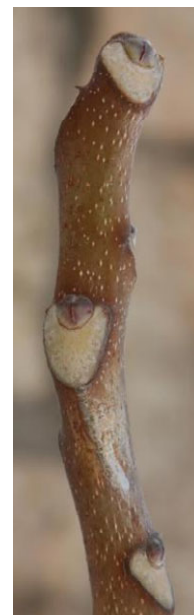
**Cultural** methods like **Cutting** or **mowing** are beneficial but should be followed up with good monitoring. Goal with these methods is to prevent flower and seed.

**Prescribed fire**, where applicable, can top kill seedlings and or saplings. The goal would be to strengthen the native plant community.

**Herbicide** applications of glyphosate during July through September are effective when applied to **cut stumps**. Other active ingredients would include triclopyr, dicamba, and imazapyr. Stumps should be cut as low as possible to minimize surface area from which potential resprouts occur.

**Hack-and-squirt** applications with dicamba, glyphosate, imazapyr, picloram or triclopyr formulations are effective. In addition, **basal bark** treatments with triclopyr or imazapyr active ingredients in oil are also recommended.

At full leaf-out during active growth, **foliar** applications with 2,4-D, glyphosate, imazapyr, picloram or triclopyr are also effective when targeting smaller trees and resprouts.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar			When fully leafed out and active growth.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow	Mow frequently to control seedlings.								
	Don't mow									
Flowering Period										



## Restricted

## Queen Anne's Lace (wild carrot) : *Daucus carota* L.



**Identification:** Compare to nonnative [poison hemlock](#) and [carrot look-alikes](#).

Compare to native [water hemlock](#). See pages 13, 45 and 64.

**Plant:** Herbaceous, biennial, first year as a basal rosette. Basal leaves are clustered, up to 5 inches long and arch away from a central location. Second year flowering plants attain heights of 3-4 feet on hollow stems that are hairy to sparsely hairy and striped with light colored lines.

**Leaves:** Alternate, fern-like, finely divided leaves are widely spaced on upper stems and up to 4 inches across by 2 inches wide. Stem and basal leaves are fern-like, finely divided, narrowly lobed described as bipinnate-pinnatifid. Underside of leaves may be slightly hairy along veins. Leaves are attached to stems with sheaths, also a trait of family members.

**Flower:** Similar to other family members - many small (1/8 inch), 5-petaled, white flowers (florets) make up a flat-topped compound umbel 2-5 inches across. Compound umbels are dense with 20-90 umbellets of which each has 15-60 flowers. Often, outer flower petals are large in comparison to others and a central flower (or flowers) of the compound umbel is purplish (not always present).

Another distinguishing characteristic in this family are bracts beneath flower umbels. Some family members have few if any bracts, wild carrot has very prominent often branched bracts under main umbels and smaller sometimes linear (un-branched) bracts under umbellets making up the larger floral display.

**Bloom time is June to September.** For about two months various bloom stages within infestations.

**Fruit and Seed:** Each floret produces 2 seeds (a schizocarp splits into carpels). Seeds are flat and bristly to catch passing fur or clothing. Entire seed clusters may break off plants in winter to roll across the snow distributing seed.

**Life History:** Infestations spread mainly by seed. Seeds are reported to be viable for as long as seven years. Deep tap roots are difficult to remove and provide strong energy reserve for resprouting.

**Habitat:** Preferred habitat is dry to moist, disturbed soils in full sunlight. Tolerant of a variety of soils and partial shade

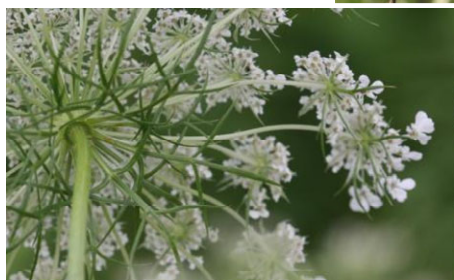
### Management:

If performed frequently **cutting** or **mowing** are effective control methods. Same is true for hand pulling, roots and root fragments remaining in the soil may resprout. Monitor infestations and plan on additional treatments.

**Prescribed fire** as a tool should be used to improve the health of surrounding native vegetation. Wild carrot will likely not outcompete healthy vegetation and will decline on its own.

**Foliar herbicide** applications to plants at rosette stage with 2,4-D or 2,4-D formulations including dicamba or triclopyr have produced good results. Nonselective herbicides such as glyphosate formulations can also produce results.

Use herbicides wisely, 2,4-D **resistant** wild carrot populations have been identified in Michigan.



		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn	Stimulate surrounding vegetation								
	Foliar	Target seedlings or rosettes								
	Mow	Mowing must be repeated to prevent flowering								
	Don't mow	When seed is present								
Flowering Period										

## Specially Regulated

## Amur Maple : *Acer ginnala* Maxim.



### Identification:

**Plant:** Woody perennial, large shrub or small tree up to 20 feet in height. Mature bark is faint gray developing thin vertical stripes.

**Leaves:** Opposite, 1-3 inch long simple leaves are three lobed with center lobe extending past shorter side lobes and edges (margins) are doubly toothed. Bright green early in the season and producing brilliant fall colors in hues of red, yellow and gold-orange.

**Flower:** Fragrant, but not showy, loose clusters of pale yellow to creamy white flowers appear in early spring.

**Bloom time** is mid May to early June.

**Fruit and Seed:** Approximately ¾ to 1 inch long, paired, winged seed structures called samaras. The samara pair hang at close to a right angle almost parallel to one another. Initially, seed is very red in color, maturing to a light brown.

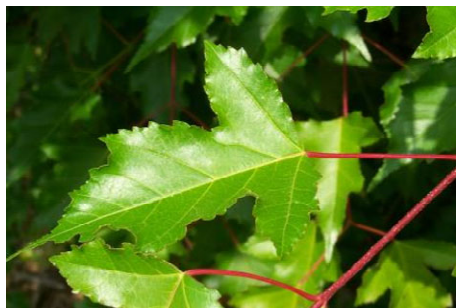
**Life History:** Species is a prolific seed producer. Small animals or birds may spread seeds but wind is likely the force behind most seed dispersal. Species stump sprouts but reproduction by vegetative means is not a strong characteristic.

**Habitat:** Preferences are to full sun or partial shade in well drained moist soils. However, the species is considered tough and specimens will tolerate dry conditions, salt and pH range of 6.1 to 7.5. A frequent invader of savannas, prairies and open forests where native shrubs, trees and forbs can be displaced.

**Management:** Prescribed fire will set back plants and may top kill seedlings but plants will likely resprout.

**Manual methods** including **hand pulling or cutting** can eliminate small infestations of seedlings and saplings while **digging or cutting** larger material can be effective. Monitor and follow up with additional treatments as necessary.

Small plants or resprouting stumps can be treated with **foliar applications** of triclopyr formulations or glyphosate. **Cut stem** treatments with glyphosate or triclopyr are effective as well as **basal bark** treatments with triclopyr.



***Specially Regulated**  
is a unique category.  
See [page 74](#).*

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
	Burn									
Herbicide	Foliar			When fully leafed out and actively growing.						
	Basal Bark	Any time.								
	Cut stem	Any time except during heavy sap flow.								
	Mow	Mow frequently to control seedlings.								
	Don't mow									
Flowering Period										



## Specially Regulated

## Knotweed complex : Japanese and giant



Three knotweeds, often referred to as bamboo, are described here. They are large perennial plants with non-woody stems. Stems are smooth, green with reddish-brown blotches and hollow between swollen nodes where leaves attach. All three have branched flower structures at these leaf attachments holding many small, creamy white to greenish flowers.

**Japanese knotweed Identification:** *Polygonum cuspidatum* Siebold & Zucc.

Synonyms: *Fallopia japonica* (Houtt.) Ronse Decr. , *Reynoutria japonica* Houtt.

**Plant:** Height 5-8 feet (10 feet), potentially multiple branches. Typically, only female flowers.

**Leaves:** Alternate, simple, can be 2 to 7 inches long with a truncate base (mostly straight across). Tips of leaves are acuminate (narrowed to an abrupt point) and undersides of leaves along veins may have brown, fuzzy ridges.

**Flowers:** Typically female flowers only. Japanese knotweed has branched flower structures that are longer than nearby leaves, those of giant knotweed are shorter than nearby leaves.

**Bohemian knotweed Identification :**

*Polygonum xbohemicum* (J. Chrtek & Chrtková) Zika & Jacobson [*cuspidatum* x *sachalinense*]

Synonym: *Fallopia x bohemica* (Chrtek & Chrtková) J.P. Bailey

Synonym: *Reynoutria x bohemica* Chrtek & Chrtková

**Bohemian:** an intermediate hybrid with characteristics of both parents, Japanese and Giant.

**Plant:** Heights from 6 to 16 feet. Typically few, but potentially several branches.

**Leaves:** Alternate, simple, can be 2 to 12 inches long and width about 2/3 of length. Leaf bases may be straight across (see Japanese) or rounded (heart-shaped like Giant). Leaf tip may be blunt, gradually tapered or pointed. Few to no hairs on the leaf edges (margin) and veins under leaves may have stiff, broad-based, small hairs.

**Flowers:** Often perfect flowers (male + female). Male flowers consist of anthers attached to long stamens extending beyond a flower's petals. Structure is branched with variable length.

**Giant knotweed Identification :** *Polygonum sachalinense* F. Schmidt ex Maxim.

Synonym: *Fallopia sachalinensis* (F. Schmidt ex Maxim.) Ronse Decr.

Synonym: *Reynoutria sachalinensis* (F. Schmidt ex Maxim.) Nakai

**Plant:** Larger plant attaining heights of 9 to 20 feet. Typically few or no branches.

**Leaves:** Alternate, simple, can be up to 12 inches across and 6-14 inches long (width about 2/3 of length) with rounded lobes at the base (heart-shaped). Tips of leaves are blunt and undersides of leaves may have scattered (segmented) hairs early in the season.

**Flowers:** Perfect flowers (male + female) and fertile. Branched, flower structures of giant knotweed are compact, shorter than nearby leaves.

**Bloom time is August to September.**

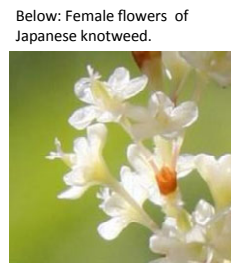
**Seeds:** Small, black, 3-sided. Reported as not commonly produced on Japanese knotweed.



Above: Bohemian knotweed.



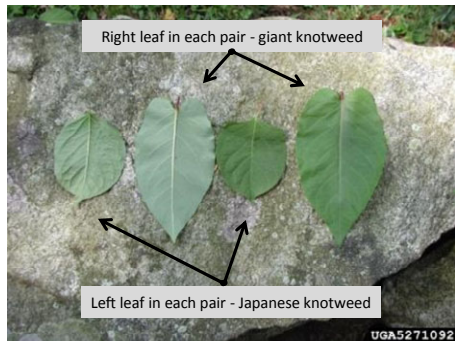
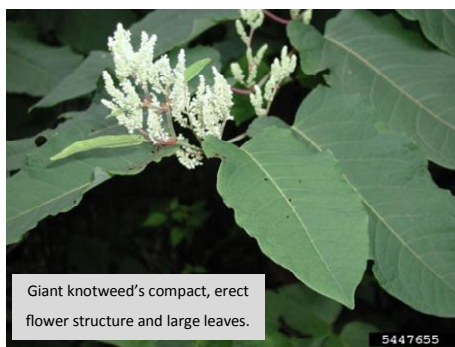
Above: Extended male stamens + anthers of Bohemian.



Below: Female flowers of Japanese knotweed.

## Specially Regulated

## Knotweed complex : Japanese and giant



Common Name	Plant form	Leaves	Leaves, underside	Flowers
Japanese knotweed	5-10 feet multiple branches	1-4 inches long, ¾ as wide leaf base - straight across	along veins, scabers brownish, ridges, fuzzy	branched, loose typically female
Bohemian knotweed (hybrid)	6-16 feet, few to several branches	2-12 inches long, ¾ as wide leaf base - variable	along veins, short, triangular hairs	branched, variable form female or perfect
Giant knotweed	9-20 feet few or no branches	7-16 inches long, ¾ as wide leaf base - heart shaped	along veins, hairs scattered, segmented	branched, compact perfect and fertile

**Life History:** It is believed that seed production is limited (especially, *Japanese*) and most reproduction is vegetative. Even small root parts will re-sprout after plants are manually removed or moved. Stem fragments resulting from mowers or other machinery can sprout if nodes are present and in contact with moist soil. Plants uprooted by flooding, digging or other mechanical means will likely re-root if left in contact with moist soil.

Seeds, if produced, are said to be viable four to five years if near the soil surface and up to 15 years if buried.

**Habitat:** Prefers moist soils in full sun to partial shade. Plants readily inhabit moist roadside ditches, wetlands, and areas along rivers and streams. However, plants will thrive on dry soils.

**Management:** Most research has been carried out on *Japanese knotweed*.

Develop a four to five year plan. **Prescribed fire** in spring can set plants back and drain some energy while **mowing** can prevent or delay seed production. However, both can stimulate vegetative reproduction, thus potentially increasing stem counts. After treatments, monitor approximately 60 feet beyond original infestations and utilize follow-up treatments of periodic mowing and/or herbicide. Reasoning, root system spread can be up to 60 feet. Manual methods should not be considered eradication tools. These include **cutting, digging, hand pulling, grazing or tarping** if done repeatedly and in conjunction with other treatments may control infestations. Monitor and consider supplemental herbicide treatments. Preferably, propagating plant parts should be disposed of onsite or when necessary contained (e.g., bagged) and removed to an approved facility. For more information on these options, please read [MDA's guide on removal and disposal](#).

Prior to **foliar herbicide** treatments with aminopyralid, glyphosate, imazapyr, triclopyr, or 2,4-D it is recommended that the plants be cut twice when 3 feet tall. Follow those cuttings with a fall **foliar application** when regrowth is 3 feet tall and still actively growing. **Cut stem applications** with glyphosate, triclopyr or triclopyr + 2,4-D can be made at anytime during active growth when the plants are over 3 feet tall. **Stem injection** treatments with glyphosate can be made anytime during active growth periods. See glyphosate's supplemental label for hollow stem injection.

*Any management efforts may result in bare ground; therefore, all treatment planning should include revegetation.*

***Specially Regulated** is a unique category. **Unadvisable** to plant these species within 100 feet of a water body or its designated floodplain. See [page 74](#).*

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Inject			During active growth, treat when 3' tall.						
	Foliar	Mow / cut twice - fall treatment.								
	Cut stem			During active growth, treat when 3' tall.						
	Mow	Mowing is not recommended. If used, collect cuttings, monitor and repeat. Follow-up with herbicide treatments at 3 feet of regrowth in fall.								
Don't mow										
Flowering Period										

Specially Regulated

Poison ivy : *Toxicodendron radicans* (L.) Kuntze



**Identification:** **Common poison ivy** [*T. radicans* (L.) Kuntze subsp. *negundo* (Greene) Gillis] is potentially a larger shrub (up to 10 feet) and possibly a vine in southeastern Minnesota’s riparian areas.

While both species are subject to regulation, information provided below focuses on **western poison ivy** [*T. rydbergii* (Small) Green] which is a frequently occurring shrubby plant with an extensive natural range across Minnesota.

**Plant:** A 1-2 foot **native** shrub with gray to tan bark and little if any branching.

**Leaves:** Alternate, compound leaves, 3 shiny or dull surfaced leaflets. Leaflet edges are variable from smooth to very coarsely toothed. Lower leaf surfaces are pale and often hairy.

**Flower:** Small, greenish flowers on erect spikes (panicles). Flower spikes are borne in leaf axils on new or current years growth with male and female flowers on separate plants (dioecious).

**Bloom time is June to July.**

**Fruit and Seed:** Creamy white to tannish berry-like drupes, approximately ¼ inch diameter. Drupes mature in August through September and persist through the winter providing a good identification characteristic on female plants.

**Life History:** Forms dense colonies by seed and through vegetative reproduction from surface or subsurface rhizomes.

**Habitat:** Invades disturbed areas such as roadsides, trail sides, fencerows, parks and can also be found in prairie (full sun) and forested settings (partial shade).

***Specially Regulated** is a unique category. Poison ivy, although irritating to humans, is a native plant that benefits wildlife by providing a food source to birds, small mammals and large browsers. See [page 74](#).*

**Management:** **Caution!** Use protective clothing, rubber gloves and long sleeves, contact with the sap (urushiol) from broken plant parts can cause blistering (dermatitis), even during the winter months. **Caution!** Smoke from burning poison ivy can deliver urushiol to airways and lungs. Do not compost as resprouting can occur and urushiol may persist in compost. Urushiol can stay on pets, tools, toys and other objects for long periods to be effectively transferred and cause irritation at a later date.

**Grazing, cutting or mowing** can inhibit flowering but must be continued in order to deplete energy reserves in the plants and to deplete the seed bank.

**Prescribed fire** generates potentially harmful smoke, see cautionary note above. So, while prescribed fire can provide control and often does control infestations of poison ivy, this tool should not be the first choice.

**Herbicide** formulations of triclopyr, 2,4-D, glyphosate, imazapyr or aminocyclopyrachlor applied to foliage or to cut stems are effective. Repeat applications will be required to exhaust seed banks.



Left: Shrub form  
Above: Vine form

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow	Mow frequently to prevent flower and seed production.								
	Don't mow									
Flowering Period										



## Nonnative

## Alfalfa : *Medicago sativa* L.



**Identification:** Provided for comparison to crown vetch and purple flowered weeds such as thistles or knapweeds. Return to [crown vetch](#) (page 28).

Return to [knapweed complex](#) (pgs. 15 and 16) or [spotted](#) knapweed (pg. 17).

Return to [Canada](#) or [plumeless](#) thistles (pgs. 19, 20).

**Plant:** Fabaceae family, 4-sided stem supports a 1-3 foot tall plant.

**Leaves:** Alternate, 3-parted, compound leaves with individual leaflets measuring ¾ to 1½ inches long, stipulate (leaf-like appendages where leaves attach to stems).

**Key difference** - Thistles and knapweeds have simple leaves not compound.

**Flower:** 5-parted, purplish to blue (occasionally cream colored) and approximately ¼ to ½ inch long. Alfalfa has a clustered, somewhat conical flower head.

**Key difference** - Thistles and knapweeds are disk flowers with ray flowers on the edges.

**Bloom time** is June to September.

**Fruit and Seed:** Coiled pods, mature to a brown color.

**Habitat:** Introduced to North America for livestock forage and is an agriculture crop. Common in roadside ditches, and similar disturbed areas.



## Nonnative

## Hairy Vetch : *Vicia villosa* Roth.



**Identification:** Provided for comparison to crown vetch and purple flowered weeds.

Also compare to [American vetch](#), a Minnesota native. See page 50.

Return to [crown vetch](#) (pg. 28), [knapweeds](#) (pgs. 15, 16, 17) or [thistles](#) (pgs. 19, 20).

**Plant:** Fabaceae family, hairy vetch is a nonnative, short-lived perennial (biennial) with a spreading, viny form and has tendrils that assist climbing nearby plants up to 3 feet.

**Leaves:** Alternate, compound leaves, pinnately divided. Hairy vetch has 5-10 pairs of leaflets and tendrils are often found terminal on the compound leaves.

**Key difference** - Crown vetch has no stipules, no leaf stalk and no tendrils.

**Flower:** Hairy vetch has 10-40, 5-parted, pink to purple flowers about ¼ inch in length in a one-sided cluster.

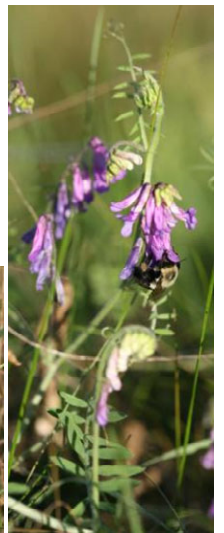
**Key difference** - Crown vetch has a dense cluster (crown-like) - not one-sided or spike-like.

**Bloom time** is May to September.

**Fruit and Seed:** Pea-like pods, ½-¾ inch long, that hang.

**Key difference** - crown vetch's pods stand erect, they are angled, and multi-segmented.

**Habitat:** Old fields, pastures and roadsides.



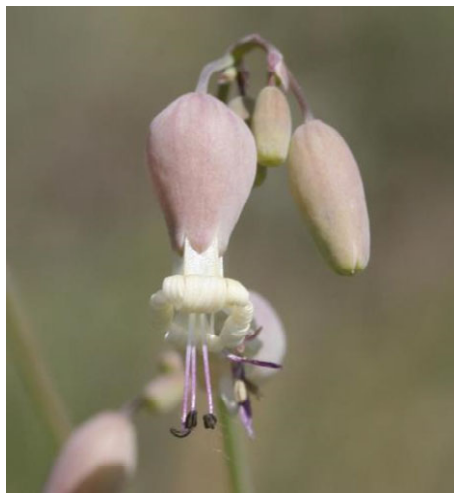


## Nonnative

## Balkan catchfly : *Silene csereii* Baumgarten



Above: Calyx tapered both ends, parallel veins.  
Below: Curled petals, purplish stamens.



**Identification:** Provided for comparison to [Dalmatian toadflax](#) on page 7.

*Strongly resembles Dalmatian toadflax's gray-green foliage color and form as well as habitat preference.*

**Plant:** Similar to and often confused with bladder-campion (*Silene vulgaris*). Classed as a biennial/perennial that stands as tall as 40 inches. Stems are smooth, pale grayish-green.

**Leaves:** Opposite, simple leaves have entire margins (no teeth on leaf edges), smooth, waxy and grayish-green.

**Key difference** - *Leaves of Dalmatian toadflax are alternate on the stem, not opposite.*

**Flower:** Flowers are five-parted, white with petals that are often rolled. The flower typically has purple tinged stamens extending forward and behind the petals is a smooth bladder-like calyx or cup that will hold the seeds. The calyx is light green, tapers at the ends and has parallel veins.

**Key difference** - *Flowers are significantly different. Dalmatian toadflax has yellow snapdragon like flowers, while Balkan catchfly has creamy-white, 5-parted flowers.*

**Bloom time is May to October.**

**Fruit and Seed:** Held in the calyx or bladder behind the petals. At maturity the bladder turns light tannish-brown and the five tips curl backward.

**Habitat:** Full sun, dry, disturbed sites such as roadsides, abandoned lots, fields and gravel pits.

Opposite, simple leaves, clasping and blue-gray.

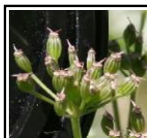


Form, opposite foliage, and plants are blue-gray.



## Nonnative

## Carrot look-alikes : *Apiaceae* family examples



Caraway



Caraway	( <i>Carum carvi</i> L.)	[biennial, 1-4 feet tall forb]	pictures upper left,
Burnett saxifrage	( <i>Pimpinella saxifraga</i> L.)	[perennial, 2-3 feet tall forb]	pictures lower left,
Japanese hedge parsley	( <i>Torilis japonica</i> [Houtt.] DC.)	[annual, 2-6 feet tall forb]	pictures lower right,

**Identification:** Provided for comparison to [wild carrot](#) also known as [Queen Anne's lace](#) on page 38.

**Plant:** Herbaceous, life cycles and heights provided above. All examples on this page and including wild carrot are smaller statured members of the family. Compare floral structures, foliage, seeds and in particular bracts (presence or lack of) under the flower umbels and umbellets as defining characteristics.

**Leaves:** All have alternate foliage. Caraway has compound leaves that are deeply divided into very linear narrow segments. Burnett saxifrage has pinnately compound leaves - basal leaves in particular have oval, toothed leaflets. As leaves ascend the stem they become smaller and deeply lobed (pinnatifid). Of these three plants, Japanese hedge parsley foliage is closest in resemblance to wild carrot and basal leaves are divided in 3-5 parts. These members of the carrot family have leaves that are smaller near the top of the plant.

**Flower:** Five-petaled, all are white and all are held as flat or slightly dome-shaped clusters (compound umbels). All have loose, open umbels unlike wild carrots tighter, denser umbel. Caraway has 5-15 umbellets.

**Key differences** - Wild carrot has obvious, showy, branched bracts beneath umbels. The three plants listed on this page have few if any narrow, linear bracts. Caraway may have up to 4, Burnett saxifrage may have 1 bract while Japanese hedge parsley may have 2 or more narrow bracts at bases of compound umbels and up to 8 tiny bracts under umbellets.

**Bloom time is variable** - June to September.

**Fruit and Seed:** All are described as schizocarps splitting at maturity to two carpels (individual seeds). Caraway has elongated ridged seeds at about ¼ inch long, Burnett saxifrage seeds are about ¼ inch in length, flattened, rounded with slight ridges while seeds of Japanese hedge parsley are about ¼ inch long and bristly with hooked hairs.

**Key difference** - Wild carrot seeds are also about ¼ inch with ridges covered by stiff bristles (not hooked). At maturity wild carrot folds its seed structure into what is often described as a bird's nest.

**Habitat:** All prefer at least partial shade to full sun with caraway preferring full sun. All take advantage of disturbance to become established and all do well on roadsides. Japanese hedge parsley thrives along woodland edges.



Burnett  
saxifrage



Japanese  
hedge parsley





## Nonnative

## Wild chervil : *Anthriscus sylvestris* (L.) Hoffm.



Above: Disturbed woodland edge and ribbed, hairy stems with a clasping leaf attachment.

Below: Bract-like appendages at umbel base and Bracts at umbellet bases. Inset: appendages may not persist.



**Identification:** Also a member of the Carrot, Parsley family (Apiaceae).  
*Provided for comparison to [poison hemlock](#) and [wild carrot](#), pages 13 and 38 respectively.*  
*Compare to [Carrot look-alikes](#) and [water hemlock](#), pgs. 45, and 64.*

**Plant:** Herbaceous biennial that stands as tall as 5 feet (2-5 feet). Stems are hollow, ribbed, and mostly green with fine hairs, especially along the ribs.

**Key difference** - *Poison hemlock stems are smooth and spotted purple, not hairy or ridged.*

**Leaves:** Alternate, doubly pinnately compound leaves are smooth and shiny on the upper surface with short hairs below. Vein patterns are more pronounced than on poison hemlock.

**Key difference** - *poison hemlock leaves have no hairs and venation is not as pronounced.*

**Flower:** Structure of the inflorescence is a compound umbel. Each umbel is comprised of 4-15 umbellets each with 3-10 white, 5-parted, florets.

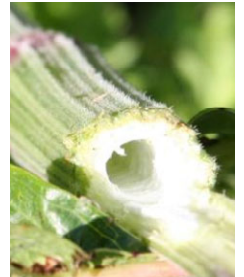
**Bloom time is April to June.**

**Fruit and Seed:** Like other carrot family members, compound umbels of 2-parted seeds. In this species the styles persist resulting in a "beaked" seed (a pointed tip). Seed matures to 1/8 inch long and develops a dark brown color.

**Habitat:** Part shade to full sun, moist soils, disturbed sites such as roadsides, abandoned lots, fields and gravel pits.

Grooved rachis.

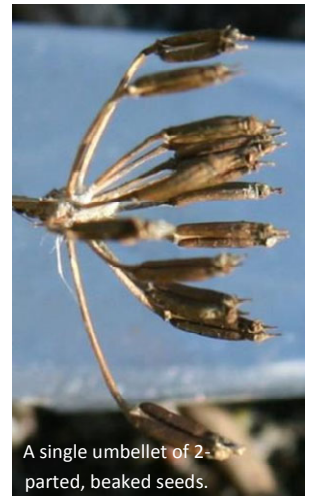
Doubly, pinnately compound leaves with distinct venation.



Above: Hollow, ribbed stem with fine hairs.



Above: Seedlings.



A single umbellet of 2-parted, beaked seeds.

## Nonnative

## Musk or nodding thistle : *Carduus nutans* L.



**Identification:** Provided for comparison to [Canada](#) and [plumeless](#) thistles on pages 19 and 20.

Compare to native [swamp thistle](#) (*Cirsium muticum*). See page 62.

Compare to nonnatives [alfalfa](#) and [hairy vetch](#). See page 43.

**Plant:** Herbaceous, biennial thistle, basal rosette in its first season. Second season, mature flowering stalks 1-7 feet tall.

**Leaves:** Rosettes can be twenty inches or more in diameter with rosette foliage deeply lobed, a light colored midrib and leaf edges that are light colored and spiny. Foliage on flowering stalks is alternate with spiny wings from leaf bases onto the stem and both surfaces are without hairs. Compare to [plumeless thistle](#) foliage that is hairy below.

**Flower:** Large at 1½-3 inches wide and deep pinks to purple. Composite flowers are solitary on branch ends, often nodding with large dark-colored spiny bracts beneath. Compare to [plumeless thistle's](#) flowers that are ½ to 1½ inches wide with short spiny bracts and winged, spiny stems.

**Bloom time** is June to August.

**Fruit and Seed:** Seeds are tufted with feathery plumes that are easily wind dispersed and most are deposited within 160 feet of plants. Do not mow after seed has developed as this strongly aids dispersal.

**Life History:** Plants have thick taproots but no rhizomes; thus, musk thistle is not clonal. Seed production is high with individual plants producing thousands of seed which can persist in seed banks up to 10 years.

**Habitat:** Infestations are found on dry to moist soils in woodlands, waste areas, roadsides, ditches and stream banks.

### **Management:**

**Cutting** taproots 1-2 inches below ground is effective but time consuming for large numbers of plants. **Mowing** should be timed at flower bud stage to prevent seed production and should be repeated 2-3 times per season to be effective. Care should be taken to avoid spreading seed with hay or straw and with mowing and vehicle movement through infestations.

**Prescribed fire** can be used to encourage stands of native grasses that will outcompete thistle. However, monitoring is needed to check for thistle that germinates in bare soil soon after burns are completed.

**Herbicide** applications timed at the early bolting phase are foliar applications of 2,4-D ester or dicamba formulations. For foliar applications at the budding to flower stage or fall applications to basal rosettes turn to formulations of aminopyralid, clopyralid, metsulfuron-methyl or triclopyr.

		April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.-Mar
Herbicide	Burn									
	Foliar									
	Cut stem									
	Mow									
Flowering Period	Don't mow									



## Nonnative

## Yellow rocket : *Barbarea vulgaris* W. T. Aiton



**Identification:** Provided for comparison to [leafy spurge](#) on page 21.

**Plant:** Yellow rocket (a.k.a. winter cress, garden yellowrocket) was introduced from Eurasia and is common in Minnesota. A biennial plant (also described as perennial) that forms a basal rosette its first year. Subsequent growing seasons, flower stalks are erect at 8 to 36 inches tall, typically multi-branched and terminated by clusters of bright yellow flowers.

**Leaves:** Basal leaves and some stem leaves are pinnately lobed to deeply toothed and up to 6 inches in length. Often the terminal end of leaves is a larger rounded lobe in addition to 1-4 lesser side lobes. Leaves near the top of the plant are alternate, typically smaller, oval and often stalkless.

**Key difference** - Leaves of leafy spurge are simple (not lobed) and narrowly linear at 1-4 inches in length.

**Flower:** Crowded, rounded clusters of bright yellow stalked flowers. Flower clusters are terminal to branch ends. Individual flowers range from 1/8 to 1/2 inch wide and have 4 bright yellow petals. As flower clusters elongate, flowers are produced above with seed pods produced below.

**Key difference** - Leafy spurge has greenish-yellow flowers without petals. The greenish-yellow bracts beneath the true flowers provide the appearance of a petaled flower. Confusion occurs due to overlap in bloom periods.

**Bloom time** is April to June.

**Fruit and Seed:** Slender pods develop along stems as flower clusters stretch upwards. The roundish pods are approximately 1 inch long, upward curved and contain small brown seeds at maturity.

**Habitat:** Considered a weed of lawns, gardens and agricultural fields. Often along roadsides and other disturbed sites. An infestation of yellow rocket indicates a disturbed site on which ground cover of native forbs and grasses is thin.



## Minnesota Native

## American bittersweet : *Celastrus scandens* L.

Squares = ¼ inch.



Oriental bittersweet, yellowish husks, fruit in leaf axils

American bittersweet, orange husks and bright red arils

**Identification:** Provided for comparison to [Oriental bittersweet](#) on page 11.

**Plant:** Woody vine, twining, no tendrils or aerial roots to assist in climbing.

**Leaves:** Alternate, elliptic to oblong or obovate, typically twice as long as wide. At bud break, leaf edges unroll in a scroll-like fashion.

**Flower:** Terminal panicles of numerous 5-parted flowers. Dioecious plants (male and female) producing small, rather inconspicuous whitish flowers.

**Key difference** - terminal panicles. Flower location is observable on early growth.

Bloom time is May to June.

**Fruit and Seed:** Like the flowers, **terminal** panicles. **Orange** colored husks covering bright red 3-parted arils (fleshy, berry-like fruits) containing 1-2 seeds each. Fruits persist into late winter.

**Key differences** - terminal clusters, orange colored husks, bright red 3-parted arils.

**Habitat:** Typically found in rich soil, full to partial sun often along roadsides and woodland edges.



Terminally clustered fruits, orange husks and bright red arils.



Foliage typically twice as long as wide. Oriental tends toward oval. Note the drawn out leaf tip.



Staminate (male) flowers with yellow pollen.



Pistillate (female) flowers clustered at branch ends

[Back to Index Page 2](#)



## Minnesota Native

## Canadian Milkvetch : *Astragalus canadensis* L.



**Identification:** Provided for comparison to [crown vetch](#) on page 28.

**Plant:** **Fabaceae** family, 1-3 feet tall perennial with ridged, pubescent stems.

**Leaves:** Alternate, odd-pinnate, compound leaves with 21-31 oblong leaflets, about 1½ inches long. Leaves measure 5 to 9 inches long and there are no tendrils.

**Key difference** - crown vetch has 11-25 oval leaflets.

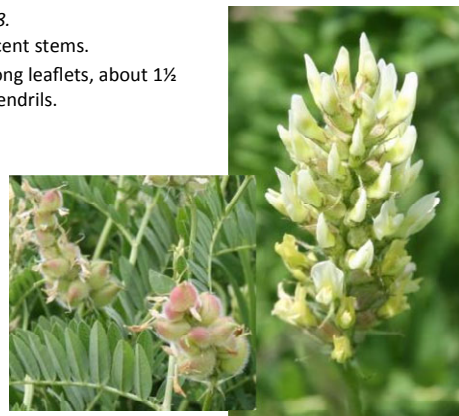
**Flower:** 5-parted, cream colored and approximately ¼ inch long. Milkvetch has a tall, spike-like, clustered, conical flower head with as many as 75 flowers.

**Key difference** - Crown vetch has a purple to pink short, dense cluster (crown-like).

**Bloom time** is June to September.

**Fruit and Seed:** Thickened, fuzzy, 2-parted pods with a pointed tip, mature to a brown color.

**Habitat:** Used for livestock forage and as an agriculture crop. Common in roadside ditches, and similar disturbed areas.



## Minnesota Native

## American vetch : *Vicia americana* Muhl. Ex Willd.



**Identification:** Provided for comparison to [crown vetch](#) and purple flowered weeds.

Also compare to [alfalfa](#) and [hairy vetch](#), nonnative family members.

**Plant:** **Fabaceae** family, American vetch is a native perennial with a spreading, viny form and typically has tendrils that assist in climbing nearby plants up to 3 feet.

**Leaves:** Alternate, compound leaves, pinnately divided. American vetch has 4-8 pairs of leaflets and tendrils terminal on the compound leaves. American vetch has toothed stipules at the base of its compound leaves.

**Key difference** - Crown vetch has no stipules, no leaf stalks and no tendrils.

**Flower:** American vetch has 2-9 flowers in a one-sided cluster. Flowers are 5-parted, pink to purple and about ¼ inch in length.

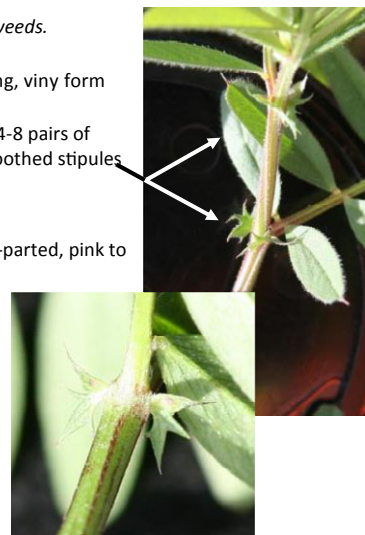
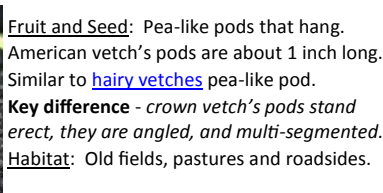
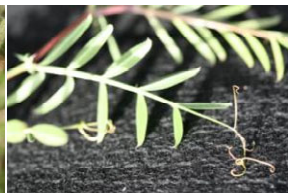
**Key difference** - Crown vetch has a dense crown-like flower cluster.

**Bloom time** is May to September.

**Fruit and Seed:** Pea-like pods that hang. American vetch's pods are about 1 inch long. Similar to [hairy vetches](#) pea-like pod.

**Key difference** - crown vetch's pods stand erect, they are angled, and multi-segmented.

**Habitat:** Old fields, pastures and roadsides.



## Minnesota Native

## Cherries and American plum : *Prunus* spp.



Above: Mature, bright red, solitary or paired fruit and foliage of pin cherry.

Below: Flower of black cherry and maturing fruit of chokecherry.



Black cherry (*P. serotina* Ehrh.) Pin cherry (*P. pensylvanica* L. f.)  
Choke cherry (*P. virginiana* L.) American plum (*P. americana* Marshall)

**Identification:** Provided for comparison to [common](#) and [glossy](#) buckthorn on pages 29 and 30.

**Plant:** Plums, chokecherry and fire or pin cherry are small sized trees. Black cherry may be a small tree, but reaches medium to large tree status. All have smooth, gray to brown bark that is often shiny and lenticled. Couple that bark and American plum's thorn-like twigs and it is no surprise that these species are frequently confused with buckthorn.

**Leaves:** Alternate, elliptic to oblong or ovate, typically finely toothed with acuminate or drawn out leaf tips.

**Key difference** - *Prunus* species have glands on the leaf petioles. Additionally, arcuate venation of common buckthorn.

**Flower:** Numerous 5-parted, white, fragrant flowers are fairly showy or obvious. Cherries have panicles of white fragrant flowers while the plum's white flowers are clustered along the stem. In Minnesota American plum (wild plum) is one of the earliest trees to bloom, typically small groups of trees clumped along forest edges.

**Key difference** - 5-parted, white, fragrant flowers are fairly showy or obvious.

**Bloom time is May to June.**

**Fruit and Seed:** Choke and black cherries panicles (loose, hanging clusters) of black fruit are readily taken by birds. Pin or fire cherry fruits mature to a bright red. Plums have a ¾-1 inch, reddish to purplish fruit that contains a large seed.

**Key difference** - birds eat fruits of cherries and plums after ripening. Buckthorn fruits remain on shrubs into late winter.

**Habitat:** Typically found in rich soil, full to partial sun often along roadsides and woodland edges.

Below: Thorns of wild plum on dead branches. Wild plum flowers and fruit.





## Minnesota Native

## Common hops : *Humulus lupulus* L.



Hooked stem hairs early spring (May).



Male flowers, 3-lobed, opposite leaves.

**Identification:** Provided for comparison to [Japanese hops](#) on page 10.

**Plant:** Herbaceous, perennial vine, rhizomatous (spreads by rhizomes). Leaf petioles and annual stems with stout hooked hairs. Image at left is of developing, hooked hairs in May.

**Leaves:** Opposite, for the most part 3 lobed (up to 5 lobes), higher on the vine leaves may be unlobed. Typically, a cordate (heart shaped) base to the leaf and leaves nearly as broad as long.

**Key difference** - 3 (maybe 5) lobed leaves, higher on the vine leaves may be unlobed.

**Flower:** Inconspicuous, wind pollinated and dioecious (male and female) plants.

**Bloom time** is July to August.

**Fruit and Seed:** Fruiting structure is cone like, comprised of papery bladders covering individual seeds. Fragrant when crushed. Fruit persists into late winter (see image at right).

**Key difference** - native common hops fruit structure is fragrant when crushed.

**Habitat:** Moist soils, disturbed sites in woodlots and along fencerows.



Opposite leaves.



Winter fruit, fragrant.



Fruit, 3-lobed and un-lobed leaves.



Male flowers, 3-lobed, opposite leaves.



Female flowers, 3-lobed, and un-lobed opposite leaves.



5-lobed, 3-lobed, opposite leaves.

## Minnesota Native

## Cow-parsnip : *Heracleum maximum* W. Bartram



Synonym: Common cow-parsnip (*Heracleum lanatum* Michx.)

**Identification:** Provided for comparison to [giant hogweed](#) on page 8.

**Plant:** Perennial, single-stemmed large plants at 3-10 feet tall. Fuzzy stems are hollow and described as foul smelling. **Key difference** - hogweed has purplish stems with coarse hairs.

**Leaves:** Alternate, compound, 3-parted with toothed, palmate leaflets. The petiole or leaf stalk has an enlarged base that clasps the stem.

**Key difference** - hogweed has strongly dissected leaves up to 5 feet wide.

**Flower:** 8-30 small, white, 5-parted flowers with notched petals, in a 4-8 inch flat umbel, 8-30 umbellets. Cow parsnips outer flower petals are often larger, irregular, and notched.

Bloom time is June to July.

**Fruit and Seed:** Many flattened fruits that when dry split into 2 seeds. See left-hand image.

**Habitat:** Often found in rich, moist soils along streams or river bottoms in full to partial sun.

**Caution:** Although to a lesser extent, cow parsnip can cause blistering rashes similar to giant hogweed. Again, plant sap reacting with sunlight - phytophotodermatitis.



Clasping, 3-parted leaf, fuzzy stems.



Outer flowers, larger, notched and irregular.





## Minnesota Native

## Cucumbers : *Echinocystis lobata* Michx. and *Sicyos angulatus* L.

Wild cucumber (*Echinocystis lobata*) and bur cucumber (*Sicyos angulatus*).

**Identification:** Provided for comparison to [Japanese hops](#) on page 10.

Compare to native [common hops](#). See page 52.

**Plant:** Annual vines (non woody) with tendrils, often found covering shrubs and small trees to approximately 20 feet.

**Leaves:** Simple, alternate, 3-5 triangular lobed wild cucumber leaves have small teeth along the leaf edge. Bur cucumber differs with its 3-5 shallowly lobed leaves having hairy undersides as well as sticky hairs on its stems.

**Flower:** Wild cucumber has creamy white flowers with 6 strap-like petals. These are male flowers. One rarely noticed female flower is at the end of the flower spike. Bur cucumber has 5-petaled greenish-white male flowers clustered and separate from the female flowers clustered elsewhere on the plant.

**Bloom time** is July to September.

**Fruit and Seed:** Solitary, prickly bladders distinguish wild cucumber from bur's grouped, up to 10, prickly pods.

**Habitat:** Can be found growing side-by-side. Plants can be found in partial shade to full sun along the edge of the woods or in thickets or open areas with moist soils.



Above: Bur cucumber foliage and flowers.

Below: Bur cucumber foliage and prickly seed structure.



**Key difference** - Both cucumber species have prickly seed structures.

Below: Wild cucumber



Above: Wild cucumber hanging on a fence in winter

**Key difference** - cucumber vines have tendrils.



Above: Bladder-like seed pod remaining in winter, seeds dispersed.

Below: Wild cucumber foliage and flowers.



## Minnesota Native

## Fireweed : *Chamerion angustifolium* (L.) Holub ssp. *angustifolium*



Synonym: *Epilobium angustifolium* L.

**Identification:** Provided for comparison to [purple loosestrife](#) on page 23.

**Plant:** Perennial, erect, rounded, single stems reaching 2-6 feet tall. **Key difference** - rounded stem, not 4-6 sided.

**Leaves:** Alternate, crowded leaves that are lance-like and stalkless. **Key difference** - alternate (not opposite).

**Flower:** Four-parted, colors range from pink to purple. The flowers are showy at  $\frac{3}{4}$  to  $1\frac{1}{2}$  inches wide and arranged along a tall terminal spike. **Key difference** - Fireweed has four-parted flowers (purple loosestrife has 5-parted flowers).

**Bloom time** is June to August.

**Fruit and Seed:** Long, slender capsules or pods that split to release small seeds with long tufted hairs.

**Habitat:** Often present following burns on moist soils at forest edges or in clearings.





## Minnesota Native

## Golden alexanders : *Zizia* spp.



Golden alexander [*Z. aurea* (L.) W.D.J. Koch] and heart-leaved golden alexander [*Z. aptera* (A. Gray) Fernald].

**Identification:** Provided for comparison to [wild parsnip](#) on page 25.

**Plant:** Herbaceous, perennial reaching 1-2 feet tall.

**Key difference** - golden alexanders smooth, shiny stems compared to the grooved stem of wild parsnip.

**Leaves:** Alternate 2-3 inch stem leaves, mostly 3-parted with finely toothed edges. Basal leaves of heart-leaved golden alexanders are simple and oval (heart-shaped) while those of golden alexanders are compound like upper stem leaves.

**Key difference** - the basal leaves of wild parsnip are pinnately compound with 5-15 leaflets.

**Flower:** Terminal panicles of numerous 5-parted, yellow flowers.

**Bloom time** is May to July.

**Fruit and Seed:** Similar to wild parsnips. Ridged - when mature appears dry and splits into 2 parts.

**Key difference** - wild parsnip seeds are typically larger and flatter.

**Habitat:** Moderately moist to wet - sandy, loamy soils, full sun to shade.



*Z. aptera* heart-shaped basal leaves.  
Ridged seed, few if any bracts.





Pyramidal inflorescence of Canada goldenrod

**Identification:** Provided for comparison to [common tansy](#) on page 24.

In particular, compare common tansy to stiff goldenrod (*Solidago rigida* L.).

**Plant:** Perennial plants, often clumped, typically erect, single stems. Species typically ranges in height from 1-4 feet while species may reach heights of 7 feet.

**Leaves:** Alternate, simple, depending on species leaves are lance shaped, may or may not be toothed and may or may not be hairy.

**Key difference** - *tansy foliage is pinnately divided, toothed and aromatic when crushed.*

**Flower:** Yellow ray flowers typically arranged in branched clusters. Depending on species the inflorescence may be pyramidal, flat-topped or one-sided.

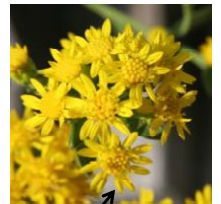
**Key difference** - *goldenrod flowers have ray petals surrounding central, disk-like florets.*

Bloom time is late July through September.

**Fruit and Seed:** Dry, light seeds often tufted with light-colored to brownish hairs easily carried by wind.

**Key difference** - *Tansy seed is not tufted and persists into winter in the flower heads.*

**Habitat:** goldenrod species thrive in a variety of sites. They can be found in dry to wet prairies, dry to moist forests and on a variety of roadsides. Partial to full sun.



Ray petals of  
stiff goldenrod



Flat-topped inflorescence of stiff goldenrod



One-sided inflorescence of gray goldenrod



## Minnesota Native

## Riverbank Grape : *Vitis riparia* Michx.



**Identification:** Provided for comparison to [porcelain berry](#) on page 36.

**Plant:** Perennial, woody, vines climbing into trees and structures or spreading over low growing vegetation. Height can be variable and up to 80 feet. Tendrils opposite some leaves assist climbing and support. Stems of grape vines can attain diameters of 7-8 inches with bark maturing to dark brown and shredding from stems in narrow strips.

**Key difference** - *Porcelain berry's bark does not shed in vertical strips.*

**Leaves:** Alternate, simple, cordate (heart-shaped) leaves are sharply toothed and palmately lobed, often three distinct lobes. Leaves may be up to 6 inches long and 4 across. Upper leaf surface is typically dark green and smooth while underside may be whitish. There may or may not be hairs along the major veins.

**Key difference** - *Porcelain berry's leaves are often deeply divided by sinuses.*

**Flower:** Often dioecious, male and female flowers on separate plants, occasionally flowers are perfect (all reproductive parts). Hanging panicles of greenish-yellow, 5-parted flowers are not showy. Most are held opposite a leaf.

**Bloom time is May to late June.**

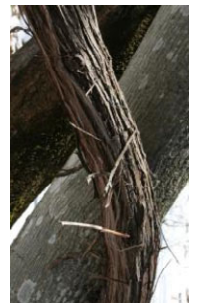
**Fruit and Seed:** Green berries (grapes), covered by a whitish film (glaucous), that mature to a purple color. Berries contain 1 to 4 seeds.

**Key difference** - *Porcelain berry has shiny, berries in hues of blue/purple.*

**Habitat:** Grapes prefer full sun but will tolerate partial shade. Preference is moist soils and as the name implies, riverbank grapes are often found in river bottoms climbing into trees where there is good sunlight at forest edges and in openings.



Above and below: June 13 - flowers, leaves and tendrils of grape on the Anoka sandplain.



## Minnesota Native

## Honeysuckles : *Diervilla lonicera* and *Lonicera* spp.



Above: Landscape use of northern bush honeysuckle.  
Yellow tubular flowers, and serrated, lance shaped foliage.

Below:  
Left 2 images - fly honeysuckle foliage, fruit and flower.  
Second from right - rounded foliage of vining hairy honeysuckle  
and extreme right is red flower, fused foliage of wild honeysuckle.



Northern bush honeysuckle [shrub] (*Diervilla lonicera* Mill.) - pictures upper right and left, fly honeysuckle [shrub] (*Lonicera canadensis* Marsh.) - pictures lower left, swamp fly honeysuckle [shrub] (*L. oblongifolia* [Goldie] Hook.) - not pictured, mountain fly honeysuckle [shrub] (*L. villosa* [Michx.] J. A. Schultes) - not pictured, hairy honeysuckle [vine] (*L. hirsuta* Eat.) - picture second from lower right, wild honeysuckle [vine] (*L. dioica* L.) - picture lower right.

**Identification:** Provided for comparison to [Asian bush honeysuckles](#) on page 26.

**Plant:** Shrubs range in heights up to 3 feet for northern bush honeysuckle on up to 6 feet for fly honeysuckles. Twining vines may be sprawling, standing weakly or climbing to heights of 9-15 feet (hairy and wild) on up to 24 feet for the uncommon grape honeysuckle.

**Key difference** - Native bush honeysuckles have solid piths, typically white. Vine forms have hollow stems, white piths.

**Leaves:** Opposite. It is difficult to generalize leaf types and shapes for these species. Bush honeysuckle has lance-shaped leaves with a long tip, serrated and ciliated margins with hairs possibly present on surfaces or mid-veins. Fly honeysuckles have elliptical to oblong shapes with blunt or acute tips. Vining honeysuckles tend to have rounded or ovate leaves except terminal leaf pairs tend to be fused (see image at right).

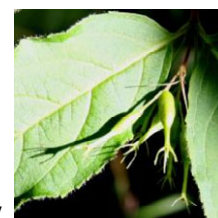
**Key difference** - Northern bush honeysuckle has serrated, lance shaped foliage. Vining honeysuckles tend to have rounded foliage with the terminal pair fused.

**Flower:** Tubular. Northern bush honeysuckles have a yellow flower (image left) while wild honeysuckles are red (image lower right). Others, like fly honeysuckle, vary from pale yellow to white.

**Bloom time is typically May to July.** Northern bush honeysuckle as late as September.

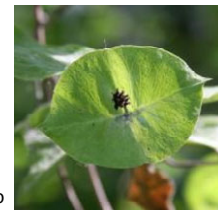
**Fruit and Seed:** Typically berry-like, typically red except for bush honeysuckles beaked, capsule with sepals attached.

**Habitat:** Woodland habitats with some species tolerant of deeper shade while others require partial sun. Swamp fly and mountain fly honeysuckles are typically found in moist soils such as forested swamps or bogs.



Above: northern bush honeysuckles beaked, capsule fruit.

Below: Vining honeysuckles fused terminal leaves.





## Minnesota Native

## Native phragmites : *Phragmites australis* ssp. *americanus* Saltonstall



**Left: Introduced** - diffuse fungal spots and leaf sheaths intact on yellow winter stems.

**Right: Native** - sharply defined fungal spots may be present on some stems and note the maroon to pink color.

Images 2012/12/04.



**Left: Introduced** - green stems at the nodes.

**Right: Native** - maroon to pink color at the stem nodes.



**Above: Introduced** - larger, grayish, fuzzy seed head.

**Right: Native** - smaller, golden, some fuzziness to seed heads.

Complete nomenclature from USDA GRIN: *Phragmites australis* (Cav.) Trin. ex Steud. subsp. *americanus* Saltonstall

**Identification:** Provided for comparison to [nonnative phragmites](#) on page 35.

**Plant:** Perennial grass. Stand density can be similar to introduced common reed but, stands often have other native plants interspersed. In comparison to introduced form, native plants are typically shorter and foliage appears yellowish.

**Leaves:** Summer leaves are yellowish. Leaves and leaf sheaths will drop from plants in winter leaving bare reddish stems (photo at left). Ligule length determined under a dissecting microscope is diagnostic, typically > 1.0mm.

**Flower:** Approximately 3-4 months after spring growth begins.

**Bloom time is June-September.**

**Fruit and Seed:** Plumes are sparse and likely not persistent through winter. Glume lengths are diagnostic and as with ligules a dissecting microscope is useful for measurement and comparison.

**Habitat:** Native phragmites occurs near water sources such as rivers, streams, shorelines of ponds and lakes as well as within wetland systems including wet roadside ditches.



**Native** phragmites seed heads tend to be less dense, less fuzzy and typically not as large.



**Left foreground: Introduced** - dark green foliage with larger, grayish, seed heads.

**Right background: Native** - yellowish foliage with smaller, golden, seed heads.



**Native** phragmites has maroon stems at the nodes or segment joints.

Image 2009/11/02

[Back to Index Page 2](#)

## Minnesota Native

## Sumacs : *Rhus typhina* L. and *R. glabra* L.



Staghorn sumac [shrub] (*R. typhina* L.) - pictures left.  
Smooth sumac [shrub] (*R. glabra* L.) - pictures right,

**Identification:** Provided for comparison to [tree-of-heaven](#) on page 37.

**Plant:** Shrubs ranging in heights up to 18 feet for smooth sumac and staghorn sumac considered a shrub or small tree at heights up to 36 feet (or taller). Both smooth and staghorn sumac develop clonal, multi-stemmed, colonies. The names are indicative of the hairiness of the plants. Smooth sumac has smooth bark, fruits and foliage while staghorn has very fuzzy twigs, fruit and leaf parts.

**Key difference - Tree-of-heaven** has smooth twigs similar to smooth sumac, but twigs and small branches of tree-of-heaven are very stout with very large leaf scars.

**Leaves:** Alternate, odd pinnate compound. Smooth sumac has 9-23 hairless, sessile (no stalk) leaflets while staghorn sumac has 13-27 hairy, sessile leaflets. In particular the petioles (stalks that leaflets attach to) of staghorn sumac are fuzzy as is the mid-vein on the underside of the leaflet. Both species have serrated (toothed) leaflet edges. Leaflet color of the sumacs is darker green on top surface and pale green, almost whitish, on the bottom.

**Key difference - Tree-of-heaven** has 11-25 or more smooth leaflets that have smooth edges and glands near leaf bases. Leaf color is a consistent green top and bottom.

**Flower:** Dioecious species, male and female flowers on separate plants. Pyramidal multi-branched, stalks of greenish, 5-parted flowers. Many ¼ inch greenish flowers are somewhat showy as they are held on terminal, pyramidal structures that can be up to 15 inches tall by 9 inches wide.

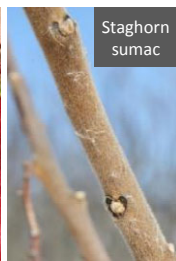
**Bloom time** is typically late June into July.

**Fruit and Seed:** The pyramidal structure of female flowers will be replaced by red fruits called drupes, each contains a single seed. Individual fruits of smooth sumac are covered by very short red hairs while those of staghorn are covered by very noticeable fuzzy, reddish hairs. Fruits of both species while rounded are slightly flattened and will hold on through winter and potentially into the following summer.

**Key difference - Tree-of-heaven**, clusters of slightly twisted, single-seeded samaras.

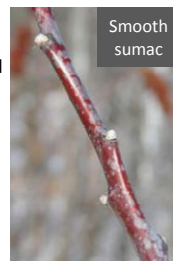


Above: Greenish male flowers of smooth sumac. July 18, BWCAW.  
Below: Smooth sumac fruit October 15th near Mankato.



Staghorn sumac

**Habitat:** Both sumac species prefer full sun. Both are found along forest edges and in forest openings. However, they may also be found near lakes or rivers or even on the drier extremes of rocky outcrops, prairie and savanna habitats. Sumacs are a common sight along dry roadsides.



Smooth sumac





## Minnesota Native

## Swamp thistle : *Cirsium muticum* Michx.



**Identification:** Provided for comparison to nonnative thistles; [Canada](#) and [plumeless](#) thistle on pages 19, 20.

See also: [BWSR Featured Plant: Minnesota's Thistles](#), Publication date 2013-3-6.

**Plant:** Biennial, mature plants from 2-7 feet tall with multiple-branches terminated by many heads. Stems are not spiny but woolly, especially lower portions of the plant.

**Leaves:** Alternate, deeply divided leaves have lance-like or oblong segments that are described as softly spiny.

**Flower:** Purples to pinks typically not white. Composite flowers are 1½ inches wide held together by whitish, woolly, non-spiny bracts that have a visible light-colored dorsal (central) ridge.

**Bloom time** is July to October.

**Fruit and Seed:** Tufted seed matures and is wind-dispersed late summer into autumn.

**Habitat:** Swamps, bogs and areas like wet meadows, moist woods and thickets.

**Key difference - Woolly, non-spiny bracts with a light colored dorsal ridge.**

**Key difference - Deeply divided foliage that is softly spiny. Stems are hairy or woolly, not spiny.**



## Minnesota Native

## Woodbine : *Parthenocissus* spp.



Woodbine, palmately compound leaves.



Woodbine climbing a fence post.



Virginia creeper, aerial roots holding onto elm bark.

Welby Smith describes the flower petals as "Boat-shaped."



Virginia creeper [*Parthenocissus quinquefolia* (L.) Planch.] and woodbine [*P. vitacea* (Knerr) Hitchc.], synonym: *P. inserta* (Kerner) K. Fritsch.

**Identification:** Provided for comparison to [Japanese hops](#) on page 10.

Compare to native [common hops](#) on page 52.

**Plant:** Woody, perennial vines, with tendrils that assist climbing into trees and onto structures (Virginia creeper and woodbine) or sprawling on the forest floor (woodbine). Virginia creeper may develop aerial roots while woodbine does not. Tendrils of Virginia creeper develop adhesive disks while tendrils of woodbine usually attach by wrapping around an object, seldom developing adhesive disks.

**Leaves:** Alternate, palmately compound with 4-5 leaflets (typically 5). Leaflet bases are tapered and the leaf edges are toothed (possibly doubly toothed).

**Key difference** - Leaves of *Japanese hops* are simple not palmately compound.

**Flower:** Both species have greenish flowers held on compound cymes (branched, flat-topped structures with terminal flowers opening first). Virginia creeper's structure has a central axis while woodbine's does not.

**Bloom time is June to July.**

**Fruit and Seed:** Fruits are berries, bluish at maturity and held on red structures.

**Key difference** - *Japanese hops* does not produce berries.

**Habitat:** Virginia creeper is often found in forest interiors where it climbs high into the canopy. Woodbine on the other hand will sprawl over the ground, on fences, rock piles unless it encounters a structure or tree suitable for climbing. Full sun to partial shade of the forest, moist soils, along fencerows or found growing on disturbed sites where animals and birds have dropped the seeds.



Fall foliage and blue berries.



Adhesive disks at tendril ends.



## Minnesota Native

## Water Hemlock : *Cicuta maculata* L.



United States Dept. of Agriculture fact sheet states: "the most violently toxic plant that grows in North America."

**Caution** All plant parts (foliage, seeds, stems, roots) are **poisonous to humans** and livestock. **Caution** Reported that toxin can be absorbed through bare skin! Wear appropriate PPE - gloves, long sleeves, and long pants.

**Identification:** Provided for comparison to [wild carrot](#) on page 38. Also, compare to [poison hemlock](#) on page 13.

**Plant:** Herbaceous, biennial (short-lived perennial), first year as a basal rosette and second year water hemlock is a lightly branched, 3-6 feet tall, plant. Stems are smooth (no hairs), hollow (lower portion), appear ridged due to veins and are light green or pinkish or reddish purple.

**Key difference** - wild carrot stems are hollow and sparingly hairy to hairy. Stems are not spotted, see poison hemlock.

**Leaves:** Alternate, generally triangular in form. Compound leaves are pinnate or doubly pinnate with 3-7 leaflets. Leaflets are not fern-like. Leaflets are 1-4 inches long by ½- 1¼ inches wide. Leaflets are toothed and veins appear to terminate in the notch between teeth - not at the tip. Petiole to stem attachments are partially covered by a sheath.

**Flower:** Petals are notched at the tip and narrowed at the base. Flowers are five-petaled, white and held as flat or slightly dome-shaped, loose, open compound umbels. Each umbel is comprised of 10-20 domed umbellets each holding 12-15 flowers. Main branches (rays) of umbels are not subtended by bracts. Secondary branches of umbellets have lanceolate bracts with scarious (thin, dry, membranous) margins.

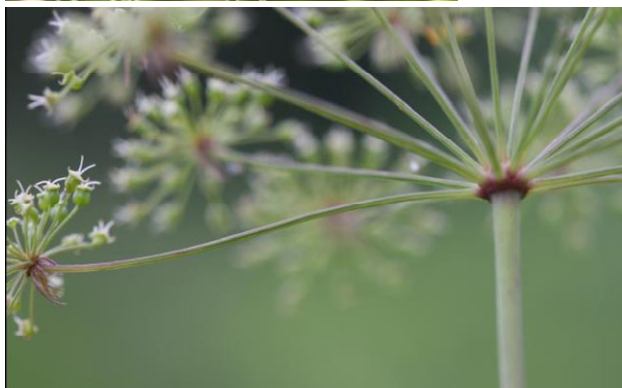
**Key differences** - wild carrot has obvious, showy, branched bracts beneath flower umbels and umbellets.

**Bloom time is variable** - June to August.

**Fruit and Seed:** Seeds are schizocarps splitting at maturity to two carpels (individual seeds). Seeds are ⅛ inch long and angular. There are no hairs.

**Key difference** - Wild carrot seeds are also about ⅛ inch with ridges covered by stiff bristles. At maturity wild carrot folds its seed structure into what is often described as a bird's nest.

**Habitat:** Partial shade is tolerated but preference is full sun with wet to moist fertile soils with organic material. Often found in wet meadows and pastures and other similar sites like moist to wet roadside ditches. Prefers more moisture than poison hemlock and typically, does not compete or occur with poison hemlock.



## Minnesota Native

## Common yarrow : *Achillea millefolium* L.



**Identification:** Provided for comparison to [poison hemlock](#) and [wild carrot](#), pages 13 and 38 respectively. Compare to [Carrot look-alikes](#), [wild chervil](#) and [water hemlock](#), pgs. 45, 46, and 64.

**Plant:** Perennial, herbaceous plant reaching heights of 1-2 (3) feet. Stems are pale green, hollow and typically covered with fine hairs. Plants are often unbranched except near the top.

**Leaves:** Alternate, narrow and finely divided - single or double pinnate - very fern like. Stem leaves are sessile (no leaf stalk) and near top of plants, typically smaller. Leaflets are longest at the middle of the rachis and shorter near the tip and base.

**Flower:** Terminal branched flower structures (compound corymb) of numerous 5-parted flower heads. Each flower head consists of 5 ray florets and 5 disk florets. Florets are typically whitish to pale cream. White flowers on a flat-topped structure brings about confusion with the carrot family.

**Key difference** - terminal **branched** panicles or compound corymb versus carrot families compound umbels.

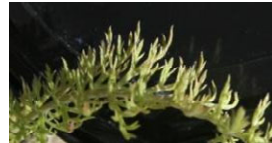
**Bloom time** is June to September.

**Fruit and Seed:** Like the flowers, terminal panicles. Florets are replaced by seeds (achenes) lacking hairs. Roots are rhizomatous - thus colonies can be formed.

**Habitat:** Mesic to dry soils, full to partial sun often in prairies, along roadsides and woodland edges.



Typical form with flowers terminal to branches. Branches may be few.



Leaf Bases to ----- > Leaf Tips



Images of pinnately, compound foliage. Very finely divided, very fern-like.

Top leaf - sessile stem leaf. Bottom leaf - petioled basal leaf.



End of season, dry flower structure. Historically used in architectural modeling as trees.

## Citations / Resources:

### Prohibited: Eradicate

#### **Black swallow-wort:** *Cynanchum louiseae* Kartsch & Gandhi Page 4

Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<https://www.invasive.org/weedcd/pdfs/wgw/blackswallowwort.pdf>  
<http://www.invasive.org/browse/subinfo.cfm?sub=3398>

#### **Common teasel:** *Dipsacus fullonum* L. Page 5

Image citations – Bugwood.org:  
Flowering head close-up - David Cappaert, Michigan State University,  
Flower group, basal rosettes, seed head - Steve Dewey, Utah State University.  
Identification and management:  
<http://www.illinoiswildflowers.info/weeds/plants/teasel.htm>  
<http://www.fs.fed.us/database/feis/plants/forb/dipspp/all.html>  
<http://www.invasiveplantatlas.org/subject.html?sub=3018>

#### **Cutleaf teasel:** *Dipsacus laciniatus* L. Page 6

Image citations: Dave Hanson and Tina Markeson, MnDOT.  
Identification and management:  
<http://dnr.wi.gov/topic/Invasives/fact/CutLeavedTeasel.html>  
<http://www.invasiveplantatlas.org/subject.html?sub=5545>  
[http://www.missouriplants.com/Whiteopp/Dipsacus\\_laciniatus\\_page.html](http://www.missouriplants.com/Whiteopp/Dipsacus_laciniatus_page.html)

#### **Dalmatian toadflax:** *Linaria dalmatica* (L.) Mill. Page 7

Image citation: all images - Dave Hanson, MnDOT  
Identification and management: <http://www.cwma.org/Dalmatian.html>  
[http://wiki.bugwood.org/HPIPM:Dalmatian\\_toadflax](http://wiki.bugwood.org/HPIPM:Dalmatian_toadflax)  
<http://www.invasiveplantatlas.org/subject.html?sub=5939>  
<https://www.cabi.org/isc/datasheet/30827>

#### **Giant hogweed:** *Heracleum mantegazzianum* Sommier & Levier Page 8

Image citations – Bugwood.org:  
Flower - Leslie J. Mehrhoff, University of Connecticut,  
Flower and pen - USDA APHIS PPQ Archive, USDA APHIS PPQ,  
Leaf - Donna R. Ellis, University of Connecticut,  
Foliage to human - Thomas B. Denholm, New Jersey Department of Agriculture.  
Identification and management:  
<http://www.invasiveplantatlas.org/subject.html?sub=4536>  
<http://dnr.wi.gov/topic/Invasives/fact/GiantHogweed.html>

#### **Grecian foxglove:** *Digitalis lanata* Ehrh. Page 9

Image citations: Dave Hanson and Tina Markeson, MnDOT,  
Identification and management:  
<http://www.minnesotawildflowers.info/flower/grecian-foxglove>  
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/foxglove.aspx>

#### **Japanese hops:** *Humulus japonicus* Siebold & Zucc. Page 10

Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
[https://science.nature.nps.gov/.NPS\\_Field\\_Guide\\_JapaneseHop.pdf](https://science.nature.nps.gov/.NPS_Field_Guide_JapaneseHop.pdf)  
<http://dnr.wi.gov/topic/Invasives/fact/JapaneseHops.html>

#### **Oriental bittersweet:** *Celastrus orbiculatus* Thunb. Page 11

Image citations: Ken Graeve and Dave Hanson, MnDOT.  
Identification and management: <https://www.cabi.org/isc/datasheet/12009>  
<https://www.invasive.org/weedcd/pdfs/wgw/orientalbittersweet.pdf>  
<http://dnr.wi.gov/topic/Invasives/fact/OrientalBittersweet.html>  
<http://www.invasive.org/browse/subinfo.cfm?sub=3012>

#### **Palmer amaranth:** *Amaranthus palmeri* S. Watson Page 12

Foliage images: Aaron Hager, University of Illinois at Urbana-Champaign.  
Image citations from Bugwood.org:  
Leaf/petiole and plant form - Ross Recker, University of Wisconsin - Madison,  
Female seed spike and thick stem - Rebekah D. Wallace, University of Georgia.  
Identification and management:  
Becker, Roger. University of Minnesota. Herbicide recommendations. Email.  
<http://www.ksre.ksu.edu/bookstore/pubs/s80.pdf>  
<http://www.extension.org/pages/65209/palmer-amaranth-amaranthus-palmeri>  
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/palmeramaranth.aspx>  
<http://www.weeds.iastate.edu/mgmt/2014/Palmer%20amaranthICMv2.0.pdf>

#### **Poison hemlock:** *Conium maculatum* L. Page 13

Image citation: all images - Dave Hanson, MnDOT.  
Identification: <https://gobotany.newenglandwild.org/species/conium/maculatum/>  
[http://www.illinoiswildflowers.info/weeds/plants/poison\\_hemlock.htm](http://www.illinoiswildflowers.info/weeds/plants/poison_hemlock.htm)

#### **Yellow starthistle:** *Centaurea solstitialis* L. Page 14

Image citations – Bugwood.org: Bolting stage - Cindy Roche,  
Flower up-close - Peggy Greb, USDA Agricultural Research Service,  
Mature foliage, basal rosette - Steve Dewey, Utah State University.  
Identification and management:  
<https://www.invasive.org/weedcd/pdfs/wgw/yellowstarthistle.pdf>  
<http://www.invasive.org/browse/subinfo.cfm?sub=4390>  
[https://www.fs.fed.us/foresthealth/technology/pdfs/...Biocontrol\\_Yellow\\_Starthistle.pdf](https://www.fs.fed.us/foresthealth/technology/pdfs/...Biocontrol_Yellow_Starthistle.pdf)

#### **Knapweed complex:** Page 15-16

Identification and management: <http://wiki.bugwood.org/Archive:Knapweed>  
<http://www.ag.ndsu.edu/pubs/plantsci/weeds/w1146.pdf>  
<http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/Brochures/knapweed.pdf>

#### **Brown knapweed:** *Centaurea jacea* L. Page 15-16

Image citations – Bugwood.org:  
Flower - Rob Routledge, Sault College; Flower side view - Cindy Roche.  
Foliage and form - Bruce Ackley, The Ohio State University,  
Identification and management:  
[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=250066298](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250066298)  
<http://www.invasiveplantatlas.org/subject.html?sub=5278>  
<http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artmar06/bj-knapweed.html>



Citations / Resources continued:

**Meadow knapweed:** *Centaurea moncktonii* C. E. Britton Page 15-16  
Image citation: all images - Tom Jacobson, MnDOT.  
Identification and management:  
[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=250068128](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250068128)  
<http://www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/noxiouslist/meadowkw.aspx>

**Diffuse knapweed:** *Centaurea moncktonii* C. E. Britton Page 15-16  
Image citation: Steve Dewey, Utah State University, Bugwood.org  
K. George Beck and James Sebastian, Colorado State University, Bugwood.org  
Identification and management:  
<http://www.cwma.org/DiffuseKnapweed.html>

**Russian knapweed:** *Acroptilon repens* (L.) DC. Page 15-16  
Currently not listed in Minnesota.  
Identification and management:  
<http://extension.colostate.edu/topic-areas/natural-resources/russian-knapweed-3-111/>

Prohibited: Control

**Spotted knapweed:** *Centaurea stoebe* L. ssp. *micranthos* (Gugler) Hayek Page 17  
Image citation:  
Flower top/side views, basal rosette, rosette foliage - Dave Hanson, MnDOT.  
Image citations – Bugwood.org: Foliage - James H. Miller, USDA Forest Service.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/spotted-knapweed>  
Discussion and management considerations:  
[http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=250068126](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250068126)  
<http://dnr.wi.gov/topic/Invasives/fact/SpottedKnapweed.html>  
[http://wiki.bugwood.org/Centaurea\\_stoebe\\_ssp\\_micranthos](http://wiki.bugwood.org/Centaurea_stoebe_ssp_micranthos)  
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/spottedknapweed.aspx>

**Barberry, common:** *Berberis vulgaris* L. Page 18  
Image citations: Bugwood.org: Leslie J. Mehrhoff, University of Connecticut.  
Identification and management:  
<https://robotany.newenglandwild.org/species/berberis/vulgaris/>  
<https://robotany.newenglandwild.org/dkey/berberis/> (dichotomous key)  
Japanese Barberry control information:  
[https://mipncontroldatabase.wisc.edu/search?name=Berberis thunbergii#plants](https://mipncontroldatabase.wisc.edu/search?name=Berberis_thunbergii#plants)

**Canada thistle:** *Cirsium arvense* (L.) Scop. Page 19  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<http://www.minnesotawildflowers.info/flower/canada-thistle>  
<http://dnr.wi.gov/topic/Invasives/fact/CanadaThistle.html>

**Plumeless thistle:** *Carduus acanthoides* L. Page 20  
Image citation: all images - Dave Hanson, MnDOT.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/plumeless-thistle>  
Identification and management:  
<http://dnr.wi.gov/topic/Invasives/fact/PlumelessThistle.html>  
[http://wiki.bugwood.org/HPIPM:Plumeless\\_thistle](http://wiki.bugwood.org/HPIPM:Plumeless_thistle)

**Leafy spurge:** *Euphorbia esula* L. Page 21  
Image citation: all images - Dave Hanson, MnDOT.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/leafy-spurge>  
<http://www.mda.state.mn.us/plants/pestmanagement/weedcontrol/noxiouslist/leafyspurge.aspx>

**Narrowleaf bittercress:** *Cardamine impatiens* L. Page 22  
Image citations – Bugwood.org: Leslie J. Mehrhoff, University of Connecticut.  
Identification and management:  
<http://www.minnesotawildflowers.info/flower/narrow-leaf-bittercress>  
<http://www.invasive.org/browse/subinfo.cfm?sub=11539>

**Purple loosestrife:** *Lythrum salicaria* L. and *Lythrum virgatum* L. Page 23  
Image citation: all images - Dave Hanson, MnDOT.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/purple-loosestrife>  
Write-up on identification and control options:  
<https://www.invasive.org/weedcd/pdfs/gwg/purpleloosestrife.pdf>  
<http://wiki.bugwood.org/Archive:Loosestrife>  
<http://dnr.wi.gov/topic/Invasives/fact/PurpleLoosestrife.html>  
<http://www.dnr.state.mn.us/invasives/aquaticplants/purpleloosestrife/index.html>

**Common tansy:** *Tanacetum vulgare* L. Page 24  
Image citation: all images - Dave Hanson, MnDOT.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/common-tansy>  
Identification and management:  
<http://dnr.wi.gov/topic/Invasives/fact/Tansy.html>  
<http://www.fs.fed.us/database/feis/plants/forb/tanvul/all.html>

**Wild parsnip:** *Pastinaca sativa* L. Page 25  
Image citation: all images - Dave Hanson, MnDOT.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/wild-parsnip>  
Identification and management:  
<http://dnr.wi.gov/topic/Invasives/fact/WildParsnip.html>  
[http://wiki.bugwood.org/Pastinaca\\_sativa](http://wiki.bugwood.org/Pastinaca_sativa)

Citations / Resources continued:

**Restricted Noxious weeds:**

- Asian bush honeysuckles:** *Lonicera* spp. Page 26  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)  
Smith, Welby R. 2008. *Trees and shrubs of Minnesota: the complete guide to species identification*. Minneapolis, MN: University of Minnesota Press.
- Black locust:** *Robinia pseudoacacia* L. Page 27  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)  
<http://mipncontroldatabase.wisc.edu/>  
[https://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs144p2\\_015112.pdf](https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_015112.pdf)
- Crown vetch:** *Securigera varia* (L.) Lassen Page 28  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
[http://www.illinoiswildflowers.info/weeds/plants/crown\\_vetch.htm](http://www.illinoiswildflowers.info/weeds/plants/crown_vetch.htm)  
<http://mipncontroldatabase.wisc.edu/>
- Common buckthorn:** *Rhamnus cathartica* L. Page 29  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<http://dnr.wi.gov/topic/Invasives/fact/CommonBuckthorn.html>  
[http://wiki.bugwood.org/Rhamnus\\_cathartica](http://wiki.bugwood.org/Rhamnus_cathartica)
- Glossy buckthorn (and all cultivars):** *Frangula alnus* Mill. Page 30  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<http://dnr.wi.gov/topic/Invasives/fact/GlossyBuckthorn.html>  
[http://wiki.bugwood.org/Frangula\\_alnus](http://wiki.bugwood.org/Frangula_alnus)  
<http://www.fs.fed.us/database/feis/plants/shrub/fraaln/all.html>
- Garlic mustard:** *Alliaria petiolata* (M. Bieb.) Cavara & Grande Page 31  
Image citation: all images - Dave Hanson, MnDOT.  
Images and good identification write-up: Minnesota wildflowers  
<http://www.minnesotawildflowers.info/flower/garlic-mustard>  
Management:  
[http://www.ipm.msu.edu/invasive\\_species/garlic\\_mustard](http://www.ipm.msu.edu/invasive_species/garlic_mustard)
- Japanese barberry:** *Berberis thunbergii* DC. Page 32- 33  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and Management: <http://www.mipn.org/control.html>  
Dirr, Michael. 2009. *Manual of Woody Landscape Plants* (full citation page 69)  
<http://dnr.wi.gov/topic/Invasives/fact/JapaneseBarberry.html>  
Seed viability: <http://www.invasive.org/weedcd/pdfs/srs/2008/barberry.pdf>

- Multiflora rose:** *Rosa multiflora* Thunb. Page 34  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and Management:  
<http://dnr.wi.gov/topic/Invasives/fact/MultifloraRose.html>  
[http://wiki.bugwood.org/Rosa\\_multiflora#MANAGEMENT.2FMONITORING](http://wiki.bugwood.org/Rosa_multiflora#MANAGEMENT.2FMONITORING)
- Nonnative phragmites:** *Phragmites australis* (Cav.) Trin. Ex Steud. Page 35  
Image citations: Ken Graeve and Dave Hanson, MnDOT.  
Identification and Management:  
<http://dnr.wi.gov/topic/Invasives/fact/Phragmites.html>  
[http://www.nmca.org/PHRAG\\_FIELD\\_GUIDE.pdf](http://www.nmca.org/PHRAG_FIELD_GUIDE.pdf)  
<https://www.invasive.org/weedcd/pdfs/wgw/commonreed.pdf>
- Porcelain berry:** *Ampelopsis brevipedunculata* (Maxim.) Trautv. Page 36  
Image citations: Foliage image - Paul Kortebein.  
Other images - Dave Hanson, MnDOT.  
Identification and management:  
<https://www.nps.gov/plants/alien/pubs/midatlantic/ambr.htm>
- Tree-of-Heaven:** *Ailanthus altissima* (Mill.) Swingle Page 37  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<https://www.invasive.org/weedcd/pdfs/wgw/treeofheaven.pdf>  
<http://www.ecolandscaping.org/05/invasive-plants/tree-of-heaven-an-...fact-sheet>  
<http://mipncontroldatabase.wisc.edu/>
- Wild carrot:** *Daucus carota* L. Page 38  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<https://www.minnesotawildflowers.info/flower/queen-annes-lace>  
[Controlling Wild Carrot in Hay fields and Pastures](#)  
[Controlling wild carrot](#)

**Specially Regulated Plants:**

- Amur maple:** *Acer ginnala* Maxim. Page 39  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and management:  
<http://www.invasiveplantatlas.org/subject.html?sub=3965>  
<http://dnr.wi.gov/topic/Invasives/fact/AmurMaple.html>

Citations / Resources continued:

Specially Regulated Plants:

**Knotweed, Japanese:** *Polygonum cuspidatum* Siebold & Zucc. Page 40-41  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and Management:  
<http://www.mipn.org/control.html>  
<http://dnr.wi.gov/topic/Invasives/fact/JapaneseKnotweed.html>  
<http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/invasive-knotweeds/japanese-knotweed.aspx>

**Knotweed, giant:** *Polygonum sachalinense* F. Schmidt ex Maxim. Page 40-41  
Image citation: all images -  
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org  
Identification and Management:  
<http://www.mipn.org/control.html>  
<http://dnr.wi.gov/topic/Invasives/fact/GiantKnotweed.html>  
<http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/invasive-knotweeds.aspx>

**Knotweed, Bohemian:** *Polygonum xbohemicum* (J. Chrtěk & Chrtěková) Zika & Jacobson  
Image citations: Dave Hanson, MnDOT and  
see citations for Japanese and giant knotweeds, pages 40-41.  
Identification and management:  
[https://www.for.gov.bc.ca/hra/publications/invasive\\_plants/Knotweed\\_key\\_BC\\_2007.pdf](https://www.for.gov.bc.ca/hra/publications/invasive_plants/Knotweed_key_BC_2007.pdf)  
<http://www.kingcounty.gov/s.../weed-identification/invasive-knotweeds/bohemian-knotweed.aspx>  
Download Montana State university Guide:  
[Biology, Ecology and management of the Knotweed complex \(Polygonum species\)](#)

**Poison ivy:** western [*Toxicodendron rydbergii* (Small) Green] Page 42  
common [*T. radicans* (L.) Kuntze ssp. *negundo* (Greene) Gillis]  
Image citation: all images - Dave Hanson, MnDOT.  
Identification and Management:  
[http://www.nps.gov/public\\_health/info/factsheets/fs\\_pivy.htm](http://www.nps.gov/public_health/info/factsheets/fs_pivy.htm)  
<https://mdc.mo.gov/trees-plants/problem-plant-control/nuisance-native-plants/poison-ivy-control>  
[http://www.dnr.state.mn.us/trees\\_shrubs/deciduous/poisonivy.html](http://www.dnr.state.mn.us/trees_shrubs/deciduous/poisonivy.html)

Web links verified January, 2018.

Miscellaneous images: Dave Hanson, MnDOT  
Cover photo: Oriental bittersweet in  
Winona, County on October 26, 2017..  
Photos page 2: Dalmatian toadflax,  
Japanese hops and garlic mustard.  
Photos page 3: field thistle, cow parsnip  
and stiff golden rod.

Page 69: Dave Hanson, MnDOT  
Biological control images including:  
spotted knapweed root weevil, loose-  
strife beetle, leafy spurge flea beetle and  
spotted knapweed seedhead weevil.

Miscellaneous image: MnDOT  
Page 69: herbicide application.

Miscellaneous images: Ken Graeve, MnDOT  
Page 69: mowing and prescribed fire.

Nonnative Plants:

**Alfalfa:** *Medicago sativa* L. Page 43  
Image citations – Bugwood.org:  
Foliage - Gerald Holmes, Valent USA Corporation,  
Flower - Keith Weller, USDA Agricultural Research Service.  
Identification:  
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=4213>

**Hairy vetch:** *Vicia villosa* Roth Page 43  
Image citation: all images - Dave Hanson, MnDOT.  
Identification:  
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=5382>  
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=Coronilla%20varia>

**Balkan catchfly:** *Silene csereii* Baumgarten Page 44  
Image citation: Dave Hanson and Ken Graeve, MnDOT.  
Identification:  
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=5045>  
<http://www.minnesotawildflowers.info/flower/balkan-catchfly>

**Carrot look-alikes:** Various species of carrot family members Page 45  
Image citation: all images - Dave Hanson, MnDOT.  
Identification:  
<https://www.minnesotawildflowers.info/flower/caraway>  
<https://www.minnesotawildflowers.info/flower/burnet-saxifrage>  
<http://www.invasiveplantatlas.org/subject.html?sub=12275>  
<https://www.minnesotawildflowers.info/flower/japanese-hedge-parsley>

**Chervil, wild:** *Anthriscus sylvestris* (L.) Hoffm. Page 45  
Image citation: all images - Dave Hanson, MnDOT.  
Identification:  
<https://www.minnesotawildflowers.info/flower/wild-chervil>

**Musk or nodding thistle:** *Carduus nutans* L. Page 46  
Image citation: all images - Dave Hanson, MnDOT.  
Other images and good identification write-up: Missouri Plants  
[http://www.missouriplants.com/Pinkalt/Carduus\\_nutans\\_page.html](http://www.missouriplants.com/Pinkalt/Carduus_nutans_page.html)

**Yellow rocket:** *Barbarea vulgaris* W. T. Aiton. Page 47  
Image citation: Dave Hanson and Tina Markeson, MnDOT.  
Identification:  
<http://wisflora.herbarium.wisc.edu/taxa/index.php?taxon=2718>  
<http://www.minnesotawildflowers.info/flower/garden-yellow-rocket>

Citations / Resources continued:

Minnesota Native Plants:

**American bittersweet:** *Celastrus scandens* L. Page 48

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<http://dendro.cnre.vt.edu/dendrology/syllabus/factsheet.cfm?ID=913>

**American vetch:** *Vicia americana* Muhl. Ex Willd. Page 49

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<https://www.minnesotawildflowers.info/flower/american-vetch>

**Canadian milkvetch:** *Astragalus canadensis* L. Page 49

Image citation: all images - Dave Hanson, MnDOT.

Identification:

[http://www.illinoiswildflowers.info/prairie/plantx/can\\_milkvetchx.htm](http://www.illinoiswildflowers.info/prairie/plantx/can_milkvetchx.htm)

<https://www.minnesotawildflowers.info/flower/canada-milkvetch>

**Cherries and wild plum:** *Prunus* spp. Page 50

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://wisflora.herbarium.wisc.edu/imagelib/index.php>

Genera: *Prunus*

**Common hops:** *Humulus lupulus* L. Page 51

Image citation: all images - Dave Hanson, MnDOT.

Identification:

[http://www.hort.purdue.edu/newcrop/duke\\_energy/humulus\\_lupulus.html](http://www.hort.purdue.edu/newcrop/duke_energy/humulus_lupulus.html)

**Cow-parsnip:** *Heracleum lanatum* Michx. Page 52

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/common-cow-parsnip>

**Cucumbers, wild and bur:** *Echinocystis lobata* Michx. and *Sicyos angulatus* L. Page 53

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/wild-cucumber>

<http://www.minnesotawildflowers.info/flower/bur-cucumber>

**Fireweed:** *Chamerion angustifolium* (L.) Holub ssp. *angustifolium* Page 54

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/fireweed>

**Golden alexanders:** *Zizia aurea* (L.) W.D.J. Koch and *Z. aptera* (A. Gray) Fernald Page 55

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<http://www.minnesotawildflowers.info/flower/golden-alexanders>

<http://www.minnesotawildflowers.info/flower/heart-leaved-alexanders>

**Goldenrods:** *Solidago* spp. Page 56

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/>

Search plant name: *solidago*

**Grape, riverbank:** *Vitis riparia* Michx. Page 57

Image citations: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

**Native honeysuckles:** *Diervilla lonicera* Mill. and *Lonicera* spp. Page 58

Image citation: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

Page 59

**Native phragmites:** *Phragmites australis* (Cav.) Trin. ex Steud. ssp. *americanus* Saltonstall

Image citations: Ken Graeve and Dave Hanson, MnDOT.

Identification: <http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?451454>

[https://www.nrcs.usda.gov/Internet/FSE\\_PLANTMATERIALS/publications/idpmctn11494.pdf](https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmctn11494.pdf)

<http://greatlakesphragmites.net/basics/native-vs-invasive/>

**Sumac, Staghorn and Smooth:** *Rhus typhina* L. and *R. glabra* L. Page 60

Image citations: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

**Swamp thistle:** *Cirsium muticum* Michx. Page 61

Image citation: all images - Dave Hanson, MnDOT.

Identification: <http://www.minnesotawildflowers.info/flower/swamp-thistle>

**Virginia creeper and woodbine:** *Parthenocissus* spp. Page 62

Image citation: all images - Dave Hanson, MnDOT.

Identification:

Smith, Welby R. 2008. *Trees and shrubs of Minnesota*. (full citation page 69).

**Water hemlock:** *Cicuta maculata* L. Page 63

Image citation: all images - Dave Hanson, MnDOT.

Identification:

[http://www.illinoiswildflowers.info/wetland/plants/water\\_hemlock.htm](http://www.illinoiswildflowers.info/wetland/plants/water_hemlock.htm)

**Yarrow, Common:** *Achillea millefolium* L. Page 61

Image citation: all images - Dave Hanson, MnDOT.

Identification:

<https://www.minnesotawildflowers.info/flower/common-yarrow>

<http://www.illinoiswildflowers.info/weeds/plants/yarrow.htm>

#### Additional Book and Web Resources:

Black Merel R., Emmet J. Judziewicz. 2009. *Wildflowers of Wisconsin and the Great Lakes Region: a comprehensive field guide*. Univ of Wisconsin Press. 275 pages.

Dirr, Michael. 2009. *Manual of woody landscape plants: their identification, ornamental characteristics, culture, propagation and uses*. Champaign, Ill: Stipes Pub.

Invasive.org – images at Bugwood. Online. <http://www.invasive.org/species/forbs.cfm>  
Factsheets. Online. [Weeds Gone Wild: Alien Plant Invaders of Natural Areas](#).

Midwest Invasive Plant Network. Online. <http://www.mipn.org/>  
Education, identification, control and management.

Minnesota Department of Agriculture. Online.  
- [Noxious weed list](#) and Fact sheets - [Noxious weed law](#)  
- [Biological control](#) - [Pest management](#)

Minnesota Department of Transportation. 2011. *Herbicide Options for Vegetation Control on Mn/DOT Rights-of-Way*. Internal Document.  
[herbicidepreseasonables.pdf](#)

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Online. [Terrestrial Invasive Species: List, Factsheets, Images](#)



**Biological Controls**

**Mowing or Other Mechanical Means**

**Herbicide**

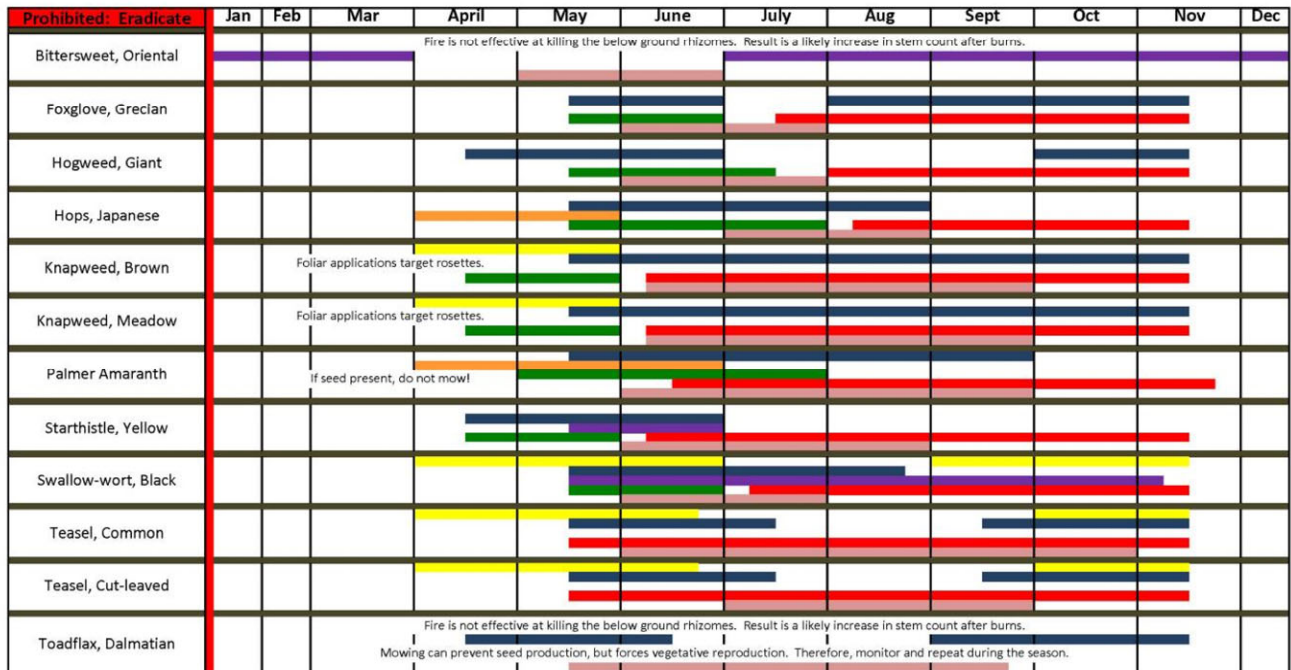
**Prescribed Fire**

Management tactics can take many forms and should be based on predefined vegetation management goals.

Suggested timing of management tactics or control options can be found in graphical form on the following two pages.

Timings are based on recommendations described in the many resources listed on the previous pages.

Suggested Timing of Control Options for  
Minnesota Noxious Weed Species (2016)



N:\\_Programs\Roadside\_Veg\_Mngt\Pesticide\Herbicide-options-calendar\2016-Herbicide\_tables-cheat-sheets\2016\_Management-calendar.xlsx

dih (March, 2016).



Suggested Timing of Control Options for  
Minnesota Noxious Weed Species (2016)

Prohibited: Control	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Bittercress, Narrowleaf												
Knapweed, Spotted												
Loosestrife, Purple												
Parsnip, Wild												
Spurge, Leafy												
Tansy, Common												
Thistle, Canada												
Thistle, Plumeless												
Restricted	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Buckthorn, Glossy												
Buckthorn, Common												
Mustard, Garlic												
Nonnative Phragmites												
Rose, Multiflora												
Specially Regulated	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Barberry, Japanese												
Knotweed, Japanese or giant												
Poison Ivy, Common or Western												

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dih (March, 2016).



Definitions of the noxious weed categories from the Minnesota Department of Agriculture web page:

<http://www.mda.state.mn.us/en/plants/pestmanagement/weedcontrol/noxiouslist.aspx>

#### State Prohibited Noxious Weeds

Prohibited noxious weeds are annual, biennial, or perennial plants that the commissioner designates as having the potential or are known to be detrimental to human or animal health, the environment, public roads, crops, livestock or other property. There are two regulatory listings for prohibited noxious weeds in Minnesota:

1. **Eradicate List:** Prohibited noxious weeds that are listed to be eradicated are plants that are not currently known to be present in Minnesota or are not widely established. These species must be eradicated, meaning all of the above and below ground parts of the plant must be destroyed, as required by Minnesota Statutes, Section 18.78. Additionally, no transportation, propagation, or sale of these plants is allowed. Measures must also be taken to prevent and exclude these species from being introduced into Minnesota.
2. **Controlled List:** Prohibited noxious weeds listed to be controlled are plants established throughout Minnesota or regions of the state. Species on this list must be controlled, meaning efforts must be made to prevent the spread, maturation and dispersal of any propagating parts, thereby reducing established populations and preventing reproduction and spread as required by Minnesota Statutes, Section 18.78. Additionally, transportation, propagation, or sale of these plants is prohibited.

#### Restricted Noxious Weeds

Restricted noxious weeds are plants that are widely distributed in Minnesota and are detrimental to human or animal health, the environment, public roads, crops, livestock or other property, but whose only feasible means of control is to prevent their spread by prohibiting the importation, sale, and transportation of their propagating parts in the state except as allowed by Minnesota Statutes, Section 18.82. Plants designated as Restricted Noxious Weeds may be reclassified if effective means of control are developed.

#### Specially Regulated Plants

Specially regulated plants are plants that may be native species or have demonstrated economic value, but also have the potential to cause harm in non-controlled environments. Plants designated as specially regulated have been determined to pose ecological, economical, or human or animal health concerns. Plant specific management plans and or rules that define the use and management requirements for these plants will be developed by the Minnesota Department of Agriculture for each plant designated as specially regulated. Measures must also be taken to minimize the potential for harm caused by these plants.

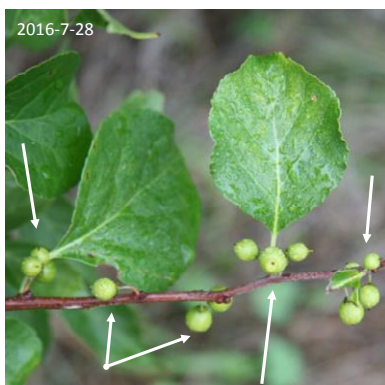
**Amur maple:** Sellers shall affix a label that advises buyers to only plant Amur maple and its cultivars in landscapes where the seedlings will be controlled by mowing or other means. Amur maple should be planted at least 100 yards from natural areas. [Return](#) to Amur maple.

**Knotweeds, giant and Japanese:** Any person, corporation, business or other retail entity distributing Japanese and/or giant knotweeds for sale within the state, must have information directly affixed to the plant or container packaging that it is being sold with, indicating that it is inadvisable to plant this species within 100 feet of a water body or its designated flood plain as defined by Minnesota Statute 103F.111, Subdivision 4. [Return](#) to knotweeds.

**Poison ivy:** Must be eradicated or controlled for public safety along rights-of-ways, trails, public accesses, business properties open to the public or on parts of lands where public access for business or commerce is granted. Must also be eradicated or controlled along property borders when requested by adjoining landowners. [Return](#) to poison ivy.

# Minnesota Noxious Weeds

<http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf>

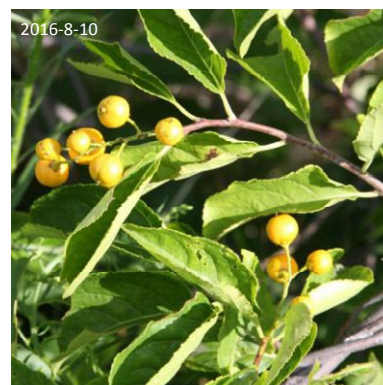


This book has two parts; part 1 (index pg. 2) contains terrestrial noxious weeds and part 2 (index pg. 3) contains look-alike plants.

For example, compare:

**Left:** Noxious weed, Oriental bittersweet (*Celastrus orbiculatus*) that has flowers and fruits in leaf axils along its vine (white arrows).

**Right:** Native plant, American bittersweet (*Celastrus scandens*) has flowers and fruits only at the terminus of branches.



Index on page 2 contains terrestrial noxious weeds listed under:

Minnesota Noxious Weed Law:  
Find more information at:  
[Minnesota Department of Agriculture](#).

Index on page 3 contains a list of terrestrial nonnative and native species often mistaken for the associated noxious weeds.

These terrestrial plant descriptions are provided in an effort to prevent mistaken identities.

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Reference herein to any specific commercial products, process, or service by tradename, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement, recommendation, or favoring by MnDOT and the State of Minnesota.

Scientific names (genus and species) were sourced from : [USDA Plants Database](#)

# Minnesota Noxious Weeds

<http://www.dot.state.mn.us/roadsides/vegetation/pdf/noxiousweeds.pdf>

The index on page 2 contains  
terrestrial noxious weeds listed under  
Minnesota Noxious Weed Law

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January, 2018



**Attachment F**  
**Equipment 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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**Attachment G**  
**Minnesota Aquatic Invasive Species Guide**



# AIS

Identification Guide

A Minnesota  
Handbook









# ALS Identification Guide

*Second edition*



MINNESOTA AQUATIC INVASIVE SPECIES  
RESEARCH CENTER *in partnership with*  
UNIVERSITY OF MINNESOTA | EXTENSION

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Funding for the development of this book is provided in part by the Environment and Natural Resources Trust Fund, the Clean Water Fund, and private donations.

# How to use this book

This ID book contains tips for identifying a number of aquatic invasive species (AIS) that are considered high-risk to Minnesota waters, as well as some common native lookalike species.

As you look at identifying characteristics and descriptions in the pages that follow, bear in mind that colors and sizes can be variable. These are general guidelines, not definitive taxonomic identification characteristics. Whenever possible, we highlighted key or unusual characteristics about a species, but specimens can often look very similar. They may also sometimes be found outside of the suggested habitats. If you are in doubt as to whether you have found an AIS, be sure to submit a report to the DNR using EDDMapS or the Great Lakes Early Detection Network (GLEDN) app, or by contacting a DNR AIS Specialist.

You will notice two different styles of maps in this book: for native species, we use watershed maps to highlight where species are generally found. Again, this can vary — these maps are a guideline. For invasive species, we use county maps to provide more localized distribution information. Maps are current using available data as of February 2018.

For more information on this book and AIS research, please visit [www.maisrc.umn.edu](http://www.maisrc.umn.edu).



# If you find an AIS

If you find an aquatic invasive species occurrence, follow these steps:

## 1. Use EDDMapS to submit the report.

You can do this using the GLEDN app on your mobile device or on the EDDMapS website at [www.eddmaps.org/Midwest](http://www.eddmaps.org/Midwest). You should include:

- The date and time you made the observation.
- The species you believe you have found.
- The location you made the observation. Be specific.
- Photographs of the specimens.

## 2. Take photos of the AIS.

You should take multiple photos, including:

- Photos of the entire plant or animal (or as much as can clearly be captured in the frame).
- Close-ups of identifying features (such as leaves, fins, shape, colors, etc.).
- A photo that has an object in it for scale (such as a coin or a ruler).
- One photo of the general area where the AIS was found.

## 3. Collect a sample of the AIS.

- For animals such as invertebrates and fish, collect the entire animal.
- For smaller animals such as zebra mussels or spiny waterflea, you may want to include a few animals.
- For plants, you want to include as much of the plant as you reasonably can. Try to collect portions of the stem with leaves attached, any flowering structures if present, reproductive parts such as flowers or fruits, and organs such as tubers, turions, roots and rhizomes.
- Place the collected sample in a sealed container, something as simple as a Ziploc bag will do. If you have a large animal, like a carp, put it on ice in a cooler. You may also choose to wrap the plant or animal in a damp paper towel or newspaper prior to putting it into its container.
- Put a piece of paper with the location the sample was collected, the date of collection, and your name and contact information on it in the container with your sample. Be sure to write in pencil so that it doesn't bleed or run when wet.

## 4. Contact your local AIS specialist.

- Inform them that you have a sample of a suspected AIS and ask for further direction on what they would like you to do with it.
- The contact information for AIS Specialists is on the DNR's website: [www.dnr.state.mn.us/invasives/ais/contacts.html](http://www.dnr.state.mn.us/invasives/ais/contacts.html)

## 5. If you are using the GLEDN app, be sure to upload your report from the queue.

The DNR is responsible for confirming and communicating new AIS occurrences. Do not make public announcements of AIS findings.

If you are interested in learning more about AIS identification and citizen science, consider becoming an AIS Detector. Visit [www.aisdetectors.org](http://www.aisdetectors.org) for more information.



# Acknowledgements

The contents of this book have been reviewed for scientific accuracy by researchers and experts from the Minnesota Aquatic Invasive Species Research Center and the Minnesota Department of Natural Resources, including:

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# Quick reference guide

## Eurasian watermilfoil

	Eurasian watermilfoil	Northern watermilfoil	Hybrid watermilfoil	Coontail	Water marigold	White water crowfoot	Bladderworts
Leaves alternate						x	x
Bladders present on leaves							x
Leaves whorled	x	x	x	x	x		
Leaflets on a central axis	x	x	x				
Leaves with <12 leaflets (4-11)		x					
Leaves with ≥12 leaflets (12-20)	x		x				

## Hydrilla

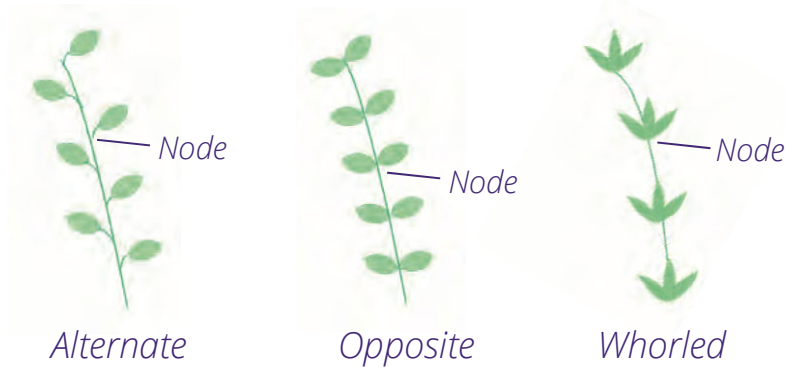
	Hydrilla	Brazilian waterweed	Elodea (waterweed)
≤ 3 leaves in a whorl			x
≥ 3 leaves in a whorl	x (usually 5)	x (usually 4)	
Showy white flowers		x	
Serrated leaf margins	x	x (under magnification)	
Produces tubers and turions	x		

## Starry stonewort

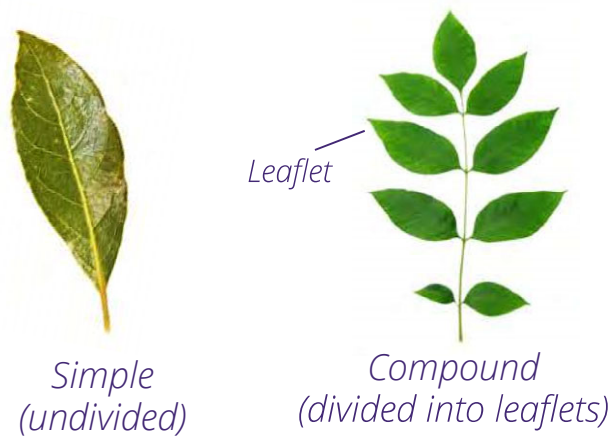
	Starry stonewort	<i>Chara spp.</i>	<i>Nitella spp.</i>	Sago pondweed	Water stargrass
Alternate, flat leaves					x
Branching needle-like leaves				x	
Whorled branchlets, like stem	x	x	x		
Strong odor		Some species			
Rough stems		x			
Forked branchlets	x		x		
Forked tips symmetrical			x		
Stays rigid out of water	x				
Star-shaped bulbils	x				

# Introduction to aquatic plants

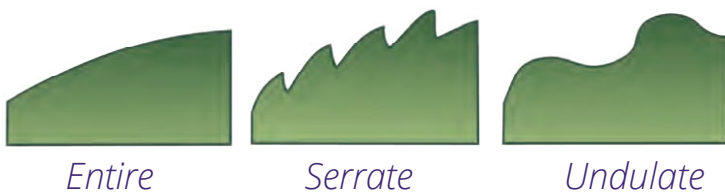
## Leaf arrangement:



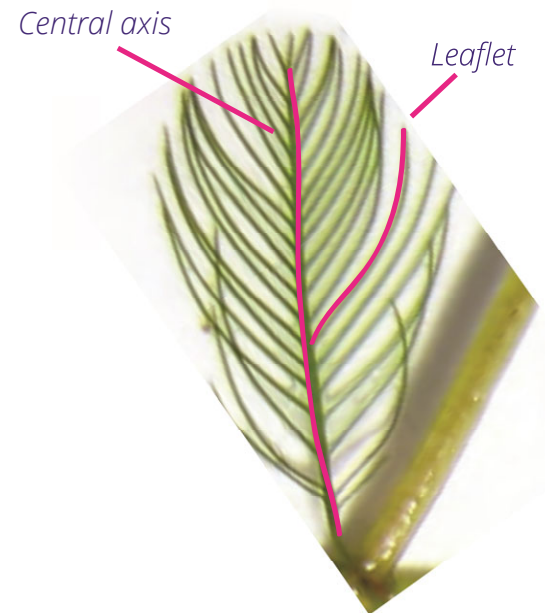
## Leaf type:



## Leaf margins:



## Whorled leaf





# INVASIVE

## Eurasian watermilfoil

*Myriophyllum spicatum*

### KEYS TO ID

- Feathery looking with four leaves per whorl
- Leaves have central axis with 12 – 20 leaflet pairs
- Can grow up to 10 feet long
- Produces pink and white flowers on spike above surface
- Leaves become limp when taken out of water

### LOOKS SIMILAR TO

- Northern watermilfoil (native)
- Coontail (native)
- Bladderworts (native)
- White water crowfoot (native)
- Water marigold (native)

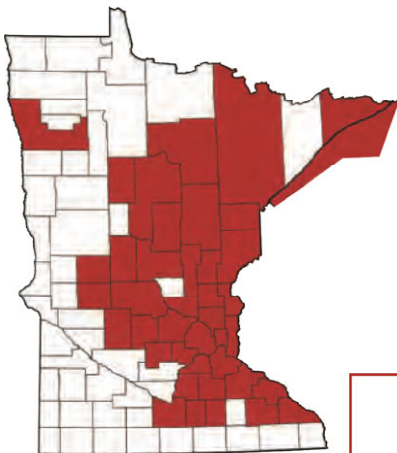
*Note: Eurasian watermilfoil is known to hybridize with northern watermilfoil.*

*Hybrid watermilfoil is also considered invasive and should be reported.*

### WHERE TO LOOK

- In lakes, ponds, and slow-moving areas of rivers or streams
- Grows best in depths of 3 – 15 feet

### CURRENTLY FOUND



*Above-surface flowers*

*Four leaves per whorl with 12 – 20 leaflet pairs per leaf*



# NATIVE

## Northern watermilfoil

*Myriophyllum sibiricum*

### KEYS TO ID

- Four leaves per whorl
- Each leaf has between 4 – 11 leaflet pairs
- Leaves have a central axis and are rigid when taken out of water

### LOOKS SIMILAR TO

- Eurasian watermilfoil (invasive)
- Coontail (native)
- Bladderworts (native)
- Water marigold (native)
- White water crowfoot (native)
- Minnesota has six native milfoil species; this is the most common

### WHERE TO LOOK

- In depths of up to 20 feet

### CURRENTLY FOUND



*Four leaves per whorl  
with 4 – 11 leaflet pairs per leaf*





# NATIVE

## Coontail

*Ceratophyllum demersum*

### KEYS TO ID

- Leaves have no central axis and are branching
- Can grow up to six feet long
- Often free-floating

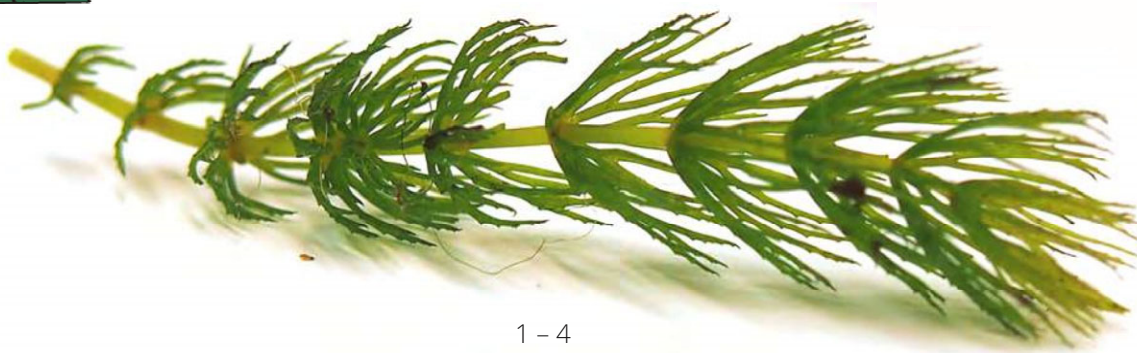
### LOOKS SIMILAR TO

- Eurasian watermilfoil (invasive)
- Water marigold (native)
- Northern watermilfoil (native)
- Bladderworts (native)
- White water crowfoot (native)

### WHERE TO LOOK

- In water up to 20 feet deep
- Upper leaves may reach surface and form dense patches
- Can become highly abundant and form "oil slicks" when it dies back

### CURRENTLY FOUND



# NATIVE

## Bladderworts

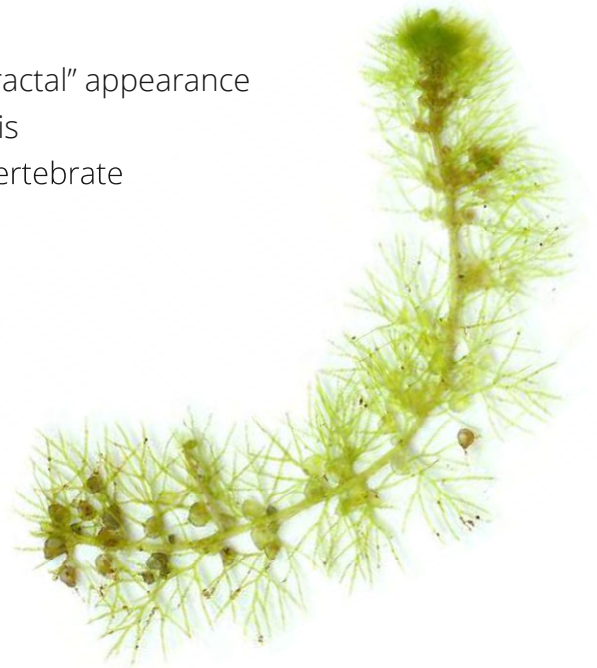
*Utricularia* spp.

### KEYS TO ID

- Thin leaves branching and zig-zagging can give a “fractal” appearance
- Leaves are highly dissected and have no central axis
- Has bladders, some of which may be filled with invertebrate victims of these carnivorous plants
- Has snapdragon-like flowers

### LOOKS SIMILAR TO

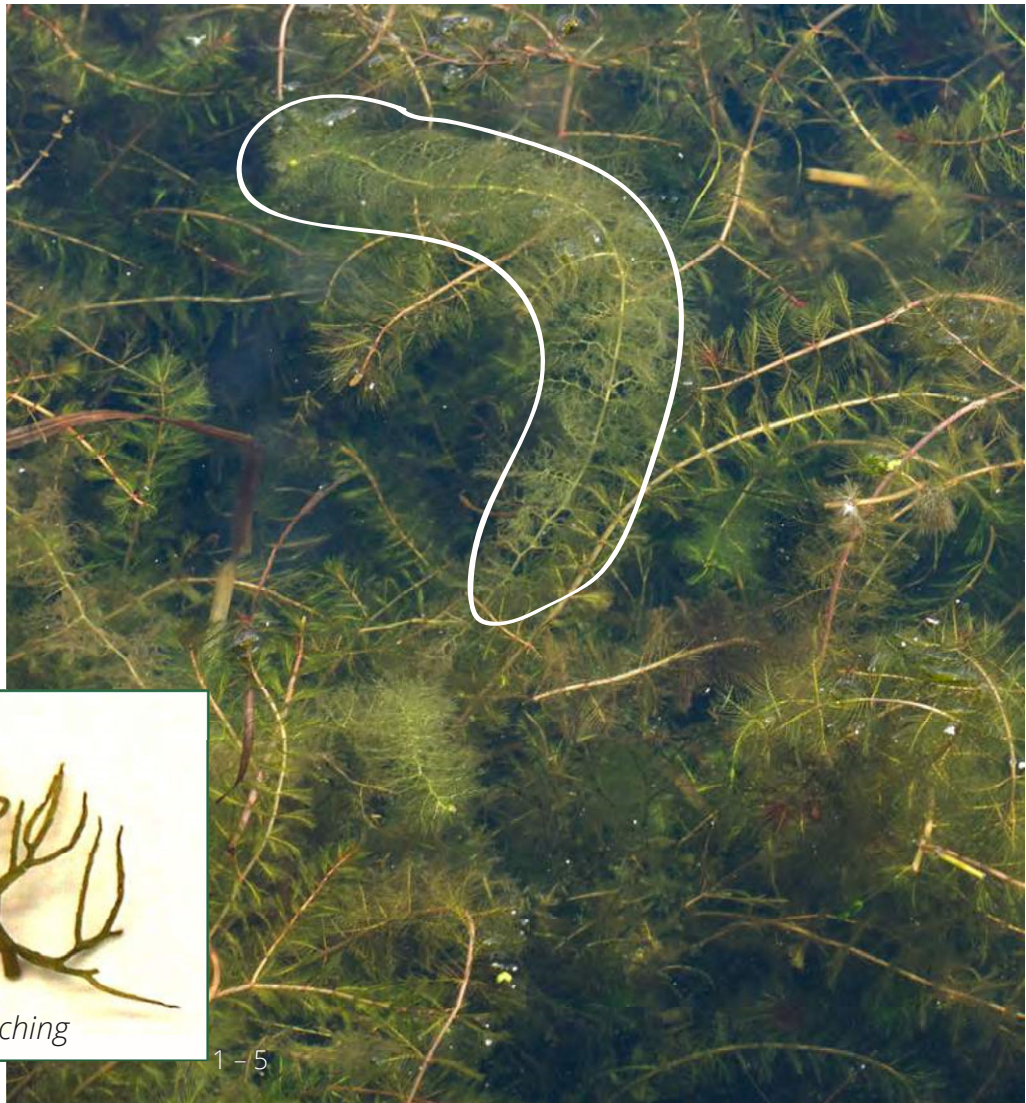
- Eurasian watermilfoil (invasive)
- Northern watermilfoil (native)
- Coontail (native)
- Water marigold (native)
- White water crowfoot (native)
- Minnesota has eight bladderwort species



### WHERE TO LOOK

- Usually found in shallow waters
- Can be either free-floating or buried in the sediment

### CURRENTLY FOUND



*Branching*



# NATIVE

## White water crowfoot

*Ranunculus aquatilis*

### KEYS TO ID

- Grows in mats on the water's surface
- Alternating leaves are highly dissected
- Produces flowers with yellow centers and five white petals
- Often has modified leaves at surface

### LOOKS SIMILAR TO

- Eurasian watermilfoil (invasive)
- Water marigold (native)
- Northern watermilfoil (native)
- Bladderworts (native)
- Coontail (native)

### WHERE TO LOOK

- In ponds, slow-moving streams, and marshes
- Can grow up to 1 to 6 inches above water's surface

### CURRENTLY FOUND



# NATIVE

## Water marigold

*Bidens beckii* (formerly *Megalodonta beckii*)

### KEYS TO ID

- Opposite to whorled, highly dissected leaves that are variable along stems
- Leaves do not have a central axis
- Produces yellow buttercup flowers with more than five petals in mid- to late-summer
- Has two simple emergent leaves under the flower that are serrated

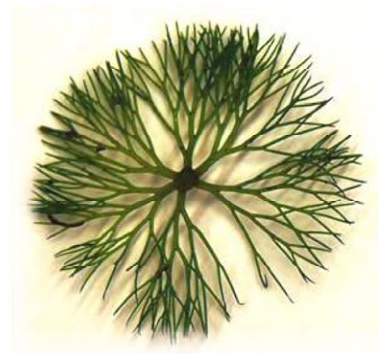
### LOOKS SIMILAR TO

- Eurasian watermilfoil (invasive)
- Coontail (native)
- Northern watermilfoil (native)
- Bladderworts (native)
- White water crowfoot (native)

### WHERE TO LOOK

- In water up to 12 feet deep
- Flowers are above water

### CURRENTLY FOUND





# INVASIVE

## Hydrilla

*Hydrilla verticillata*

### KEYS TO ID

- Submersed plant that grows into thick mats
- Leaves are bright green with a midvein down the center and are between  $\frac{1}{8}$  and  $\frac{3}{4}$  inches long
- Leaves directly attached to stem (stalkless) in whorls of 3 – 10; often 5
- Ascending stems can grow up to 30 feet long
- Tubers or turions may be present
- Leaves have sharply toothed serrated edges that may require a hand lens to see



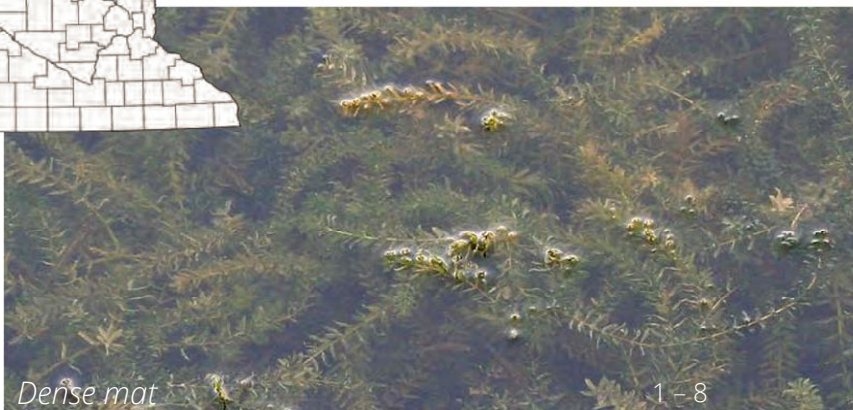
### LOOKS SIMILAR TO

- *Elodea* (native)
- Brazilian waterweed (invasive)

### WHERE TO LOOK

- Streams, lakes, and ponds
- In shallow or deep waters
- May invade deep waters where native plants can't grow
- Has not been found in Minnesota

### CURRENTLY FOUND



Dense mat



# NATIVE

## Common waterweed

*Elodea canadensis*

### KEYS TO ID

- Whorls of 3 oval-shaped leaves; whorls of 4 may occur
- Can grow up to three feet tall
- Leaves have smooth edges and are between  $\frac{1}{4}$  and  $\frac{2}{3}$  inches long
- Small white flowers visible above water in the summer



Three leaves per whorl

### LOOKS SIMILAR TO

- Hydrilla (invasive)
- Brazilian waterweed (invasive)
- Minnesota has three native *Elodea* species

### WHERE TO LOOK

- In water up to 10 feet deep
- Near stream inlets
- May be free-floating

### CURRENTLY FOUND



# INVASIVE

## Brazilian waterweed

*Egeria densa*

### KEYS TO ID

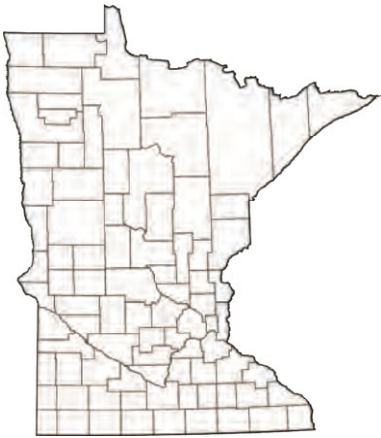
- Leaves in whorls of 4 to 6
- Leaves are between  $\frac{3}{8}$  and 1.5 inches long
- Small white flowers with 3 petals may be visible
- Can form dense mats that look bushy
- Serrated leaf margins may be visible under magnification

### LOOKS SIMILAR TO

- *Elodea* (native)
- *Hydrilla* (invasive)

### WHERE TO LOOK

- Submersed; can be free-floating or rooted
- Commonly used in home aquaria
- No established populations in Minnesota





# INVASIVE

## Starry stonewort

*Nitellopsis obtusa*

### KEYS TO ID

- Long, smooth branchlets are attached in whorls of 5 – 8 and branch asymmetrically at tips
- Stems are smooth
- Small, star-shaped bulbils form on clear threads at base of plant and may be found above or below the sediment surface
- Small, orange spheres called antheridia may be visible, these are male reproductive structures
- Branchlets typically several inches long, longer than *Chara* or *Nitella*
- Can fill water column and form surface mats

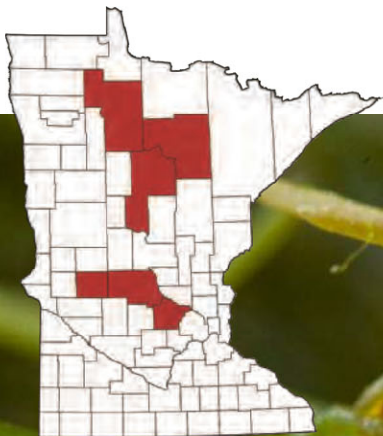
### LOOKS SIMILAR TO

- Native *Chara* (native)
- Native *Nitella* (native)
- Sago pondweed (native)
- Water stargrass (native)

### WHERE TO LOOK

- In shallow, still water and near accesses

### CURRENTLY FOUND



Below: orange antheridia



# NATIVE

## Muskgrasses

*Chara spp.*

### KEYS TO ID

- Stems are typically rough and crunchy
- Thin branchlets form whorls around thin stems
- Branchlets are not forked at tips
- May produce bulbils, but not star-shaped
- May have musky odor



*Whorled branchlets*

### LOOKS SIMILAR TO

- Starry stonewort (invasive)
- Native *Nitella* (native)
- Sago pondweed (native)
- Water stargrass (native)
- Minnesota has nine *Chara* species

### WHERE TO LOOK

- Fully submerged
- Along lake bottoms forming patches called meadows

### CURRENTLY FOUND





# NATIVE

## Stoneworts

*Nitella spp.*

### KEYS TO ID

- Stems are smooth
- Branchlets fork into two or three tips at end
- Unlike starry stonewort, forked tips are of equal length
- Typical branchlets are around an inch in length; much shorter than starry stonewort
- Becomes limp when out of water

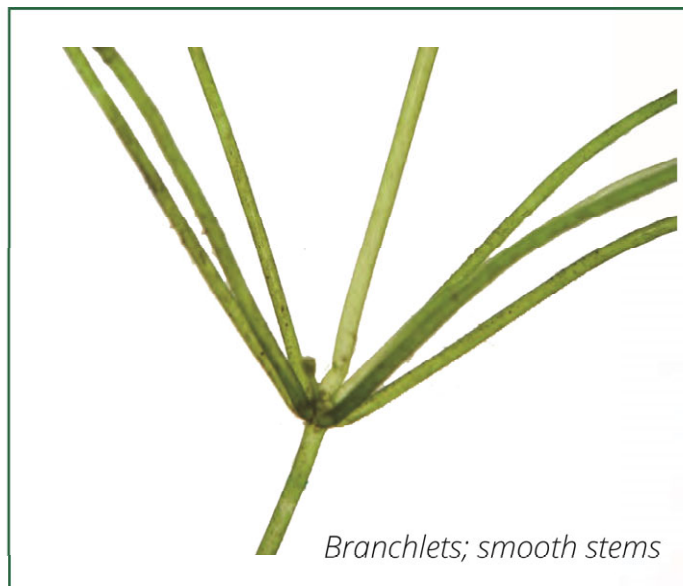
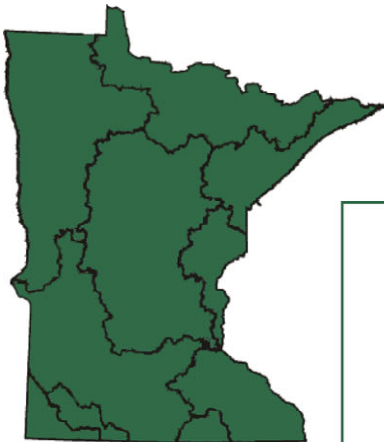
### LOOKS SIMILAR TO

- Starry stonewort (invasive)
- Native *Chara* (native)
- Sago pondweed (native)
- Water stargrass (native)

### WHERE TO LOOK

- Often in deeper zones of lake
- At depths up to 30 feet

### CURRENTLY FOUND



*Branchlets; smooth stems*



# NATIVE

## Sago pondweed

*Stuckenia pectinata*

### KEYS TO ID

- Has narrow, stiff leaves alternating off the slender stem
- The base of leaves are tightly attached to stem for about 1/4 of an inch before coming off the stem
- Produces clusters of egg-shaped fruits
- Leaves are very fine and almost look like pine needles
- Grows up to three feet tall

### LOOKS SIMILAR TO

- Starry stonewort (invasive)
- Native *Chara* (native)
- Native *Nitella* (native)
- Water stargrass (native)

### WHERE TO LOOK

- Usually in shallow waters up to six feet
- Entirely submersed in water

### CURRENTLY FOUND





# NATIVE

## Water stargrass

*Heteranthera dubia*

### KEYS TO ID

- Small yellow flowers visible above water in mid- to late-summer
- Leaves lack a visible midvein
- Slender and branching stems with alternating leaves
- Leaves are narrow and flat
- May create dense mats

### LOOKS SIMILAR TO

- Starry stonewort (invasive)
- Native *Chara* (native)
- Sago pondweed (native)
- Native *Nitella* (native)

### WHERE TO LOOK

- Mostly in shallow waters and near stream banks
- On sandy or muddy bottoms

### CURRENTLY FOUND





# INVASIVE

## Curly-leaf pondweed

*Potamogeton crispus*

### KEYS TO ID

- Thin, submerged leaves have distinct “teeth” and wavy edges
- Produces turions that look like small, greenish-brown pinecones
- Generally the first pondweed to come up in the spring; dies back in midsummer
- Leaves do not clasp around stem where they connect

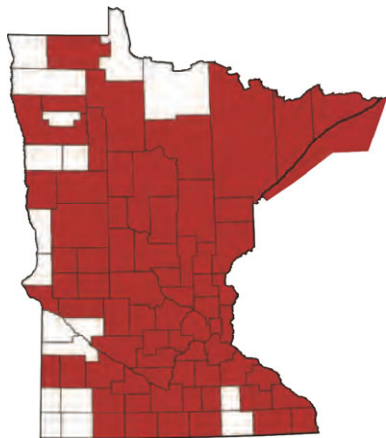
### LOOKS SIMILAR TO

- Clasping-leaf pondweed (native)

### WHERE TO LOOK

- Lakes, rivers, and streams in waters up to 15 feet deep

### CURRENTLY FOUND



*Teeth on edges*



*Turions*



# NATIVE

## Clasping-leaf pondweed

*Potamogeton richardsonii*

### KEYS TO ID

- Leaves alternate along the stem
- Leaves are wide and wavy, but don't have "teeth" like curly-leaf pondweed
- Leaves clasp around stem

### LOOKS SIMILAR TO

- Curly-leaf pondweed (invasive)
- Also called Richardson's pondweed

### WHERE TO LOOK

- Fully submersed
- In water up to 12 feet

### CURRENTLY FOUND



*Leaves clasping stems*



# Quick reference guide

## Rusty crayfish

	Rusty crayfish	Clearwater crayfish	Calico crayfish	Virile crayfish
Red spot on carapace	x			
Black band on pincers	x	x		
Dark v-shaped mark on abdomen		x		
Notched gap in pincers			x	
Orange tip on pincers	x	x	x	x
Blue tint & white bumps on claws				x
Oval gap when pincers closed	x	x		

## Zebra and quagga mussels

	Zebra mussels	Quagga mussels	Native mussels	Asian clam	Snails
Adults attach to hard surfaces	x	x			x
Two shells	x	x	x	x	
Symmetric shape				x	
Ridges on shell			Some species	x	
Spiral-shaped shell					x
Striped pattern	Zig-zags	Rings	Some species		
Flattened ventral edge	x		Some species		
Curved line where shells meet		x	Some species		
Coloration lightens toward hinge		x	Some species		

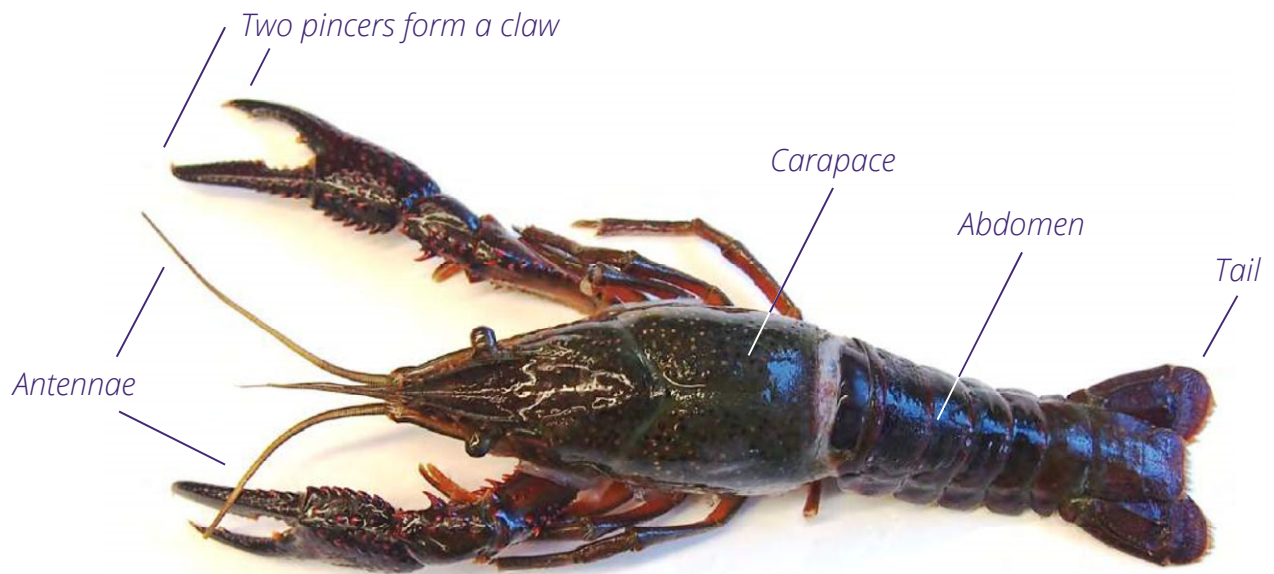
## Spiny waterflea

	Spiny waterflea	Fishhook waterflea	Other zooplankton
Long, spine-like tail	x	x	
Barbs on tail	x	x	
Black eyespot(s)	x	x	x
Egg sac (on females)	Round, bulbous	Long, pointed	
Hook at end of tail		x	
Can clump on angling gear	x	x	x

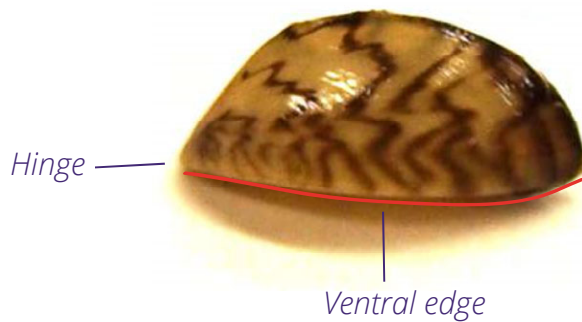


# Introduction to invertebrates

Crayfish



Mussels and clams



Snails



# INVASIVE

## Rusty crayfish

*Orconectes rusticus*

### KEYS TO ID

- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- Red spots on the sides of carapace
- Small black bands at the tip of each pincer on claws
- When claws close, there is an oval-shaped gap
- Can grow up to 5 inches long

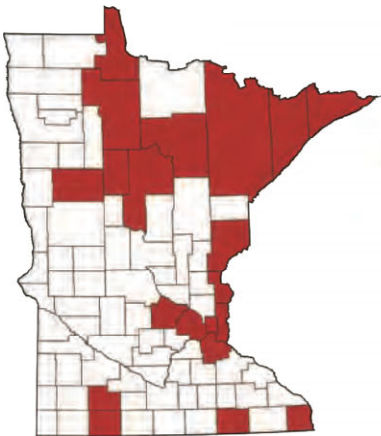
### LOOKS SIMILAR TO

- Red swamp crayfish (invasive)
- Northern clearwater crayfish (native)
- Calico crayfish (native)
- Virile crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

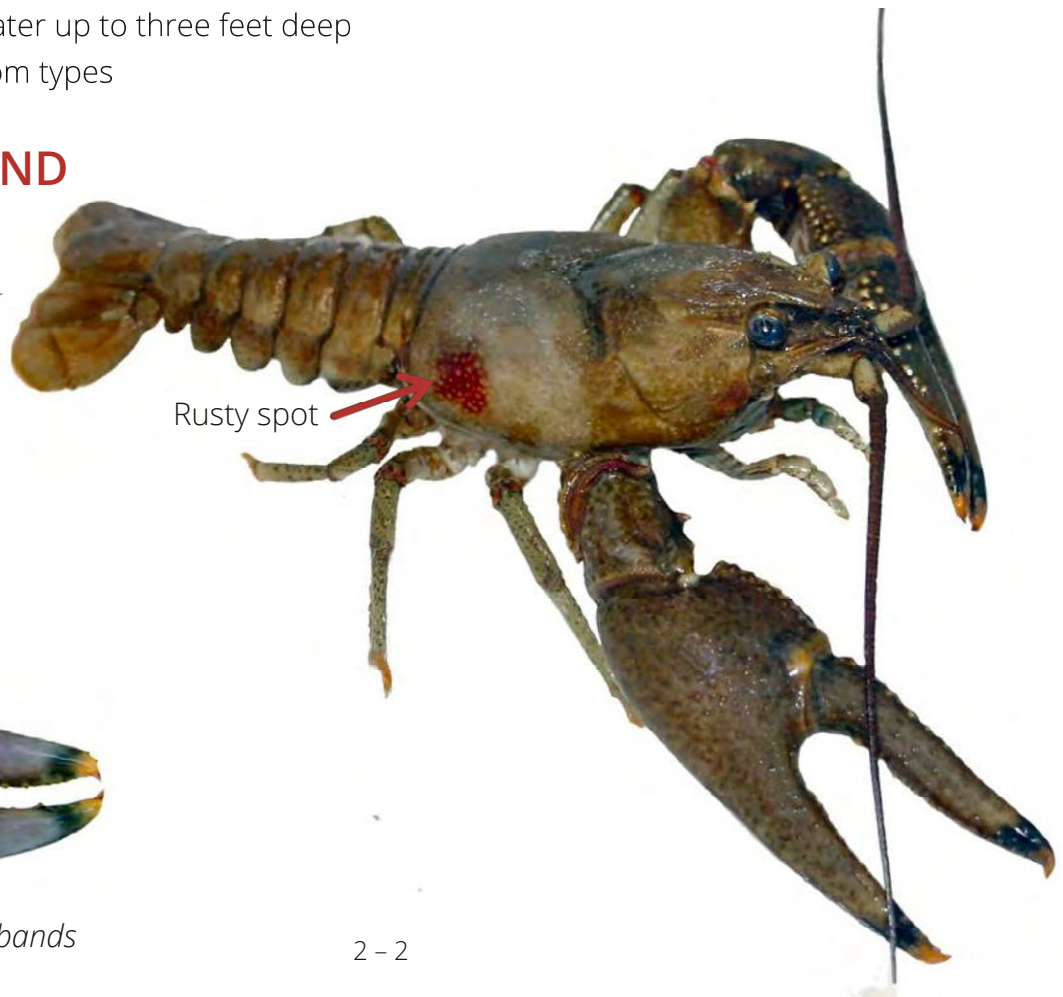
### WHERE TO LOOK

- Often found in shallow water up to three feet deep
- On a wide variety of bottom types

### CURRENTLY FOUND



*Oval-shaped gap and black bands*





# INVASIVE

## Red swamp crayfish

*Procambarus clarkii*

### KEYS TO ID

- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- Can grow up to 5 inches
- Red bumps on claws
- Black wedge-shaped stripe on top of abdomen

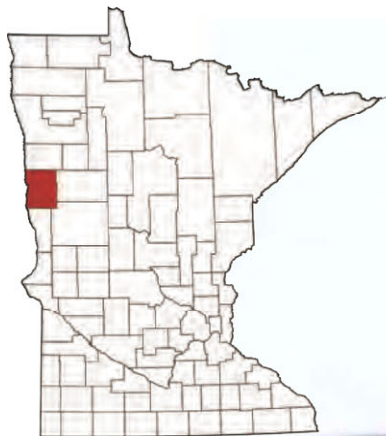
### LOOKS SIMILAR TO

- Rusty crayfish (invasive)
- Northern clearwater crayfish (native)
- Calico crayfish (native)
- Virile crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

### WHERE TO LOOK

- All types of freshwater
- Burrowed into bottoms of lakes, rivers, and ponds

### CURRENTLY FOUND





# NATIVE

## Northern clearwater crayfish

*Orconectes propinquus*

### KEYS TO ID

- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- No red spot on side of carapace
- Claws are similar to rusty crayfish with black band at the tip
- Dark wedge-shaped marking down abdomen
- Can grow up to 4.5 inches

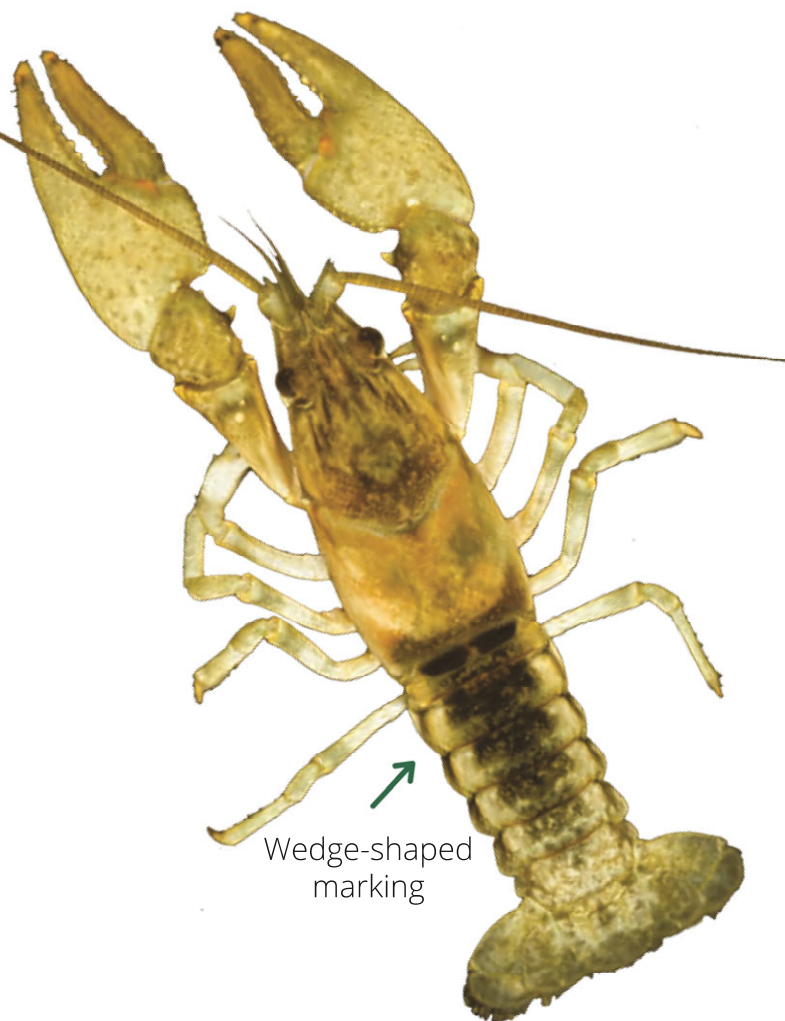
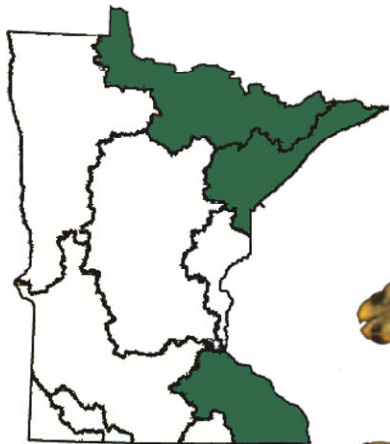
### LOOKS SIMILAR TO

- Rusty crayfish (invasive)
- Red swamp crayfish (invasive)
- Calico crayfish (native)
- Virile crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

### WHERE TO LOOK

- In clear, rocky streams and rocky lake shores

### CURRENTLY FOUND



# NATIVE

## Calico crayfish

*Orconectes immunis*

### KEYS TO ID

- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- No red spot on carapace
- Distinctive notch in the pincers of their claws
- Can grow up to 3.5 inches

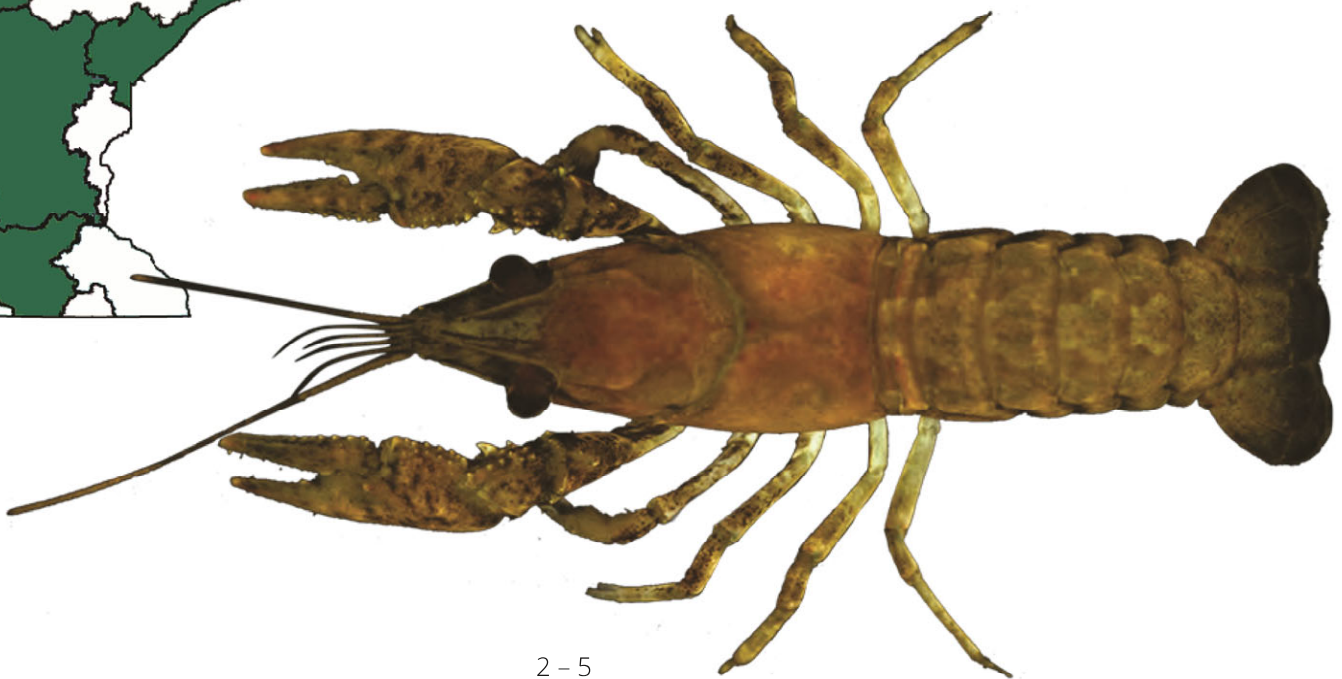
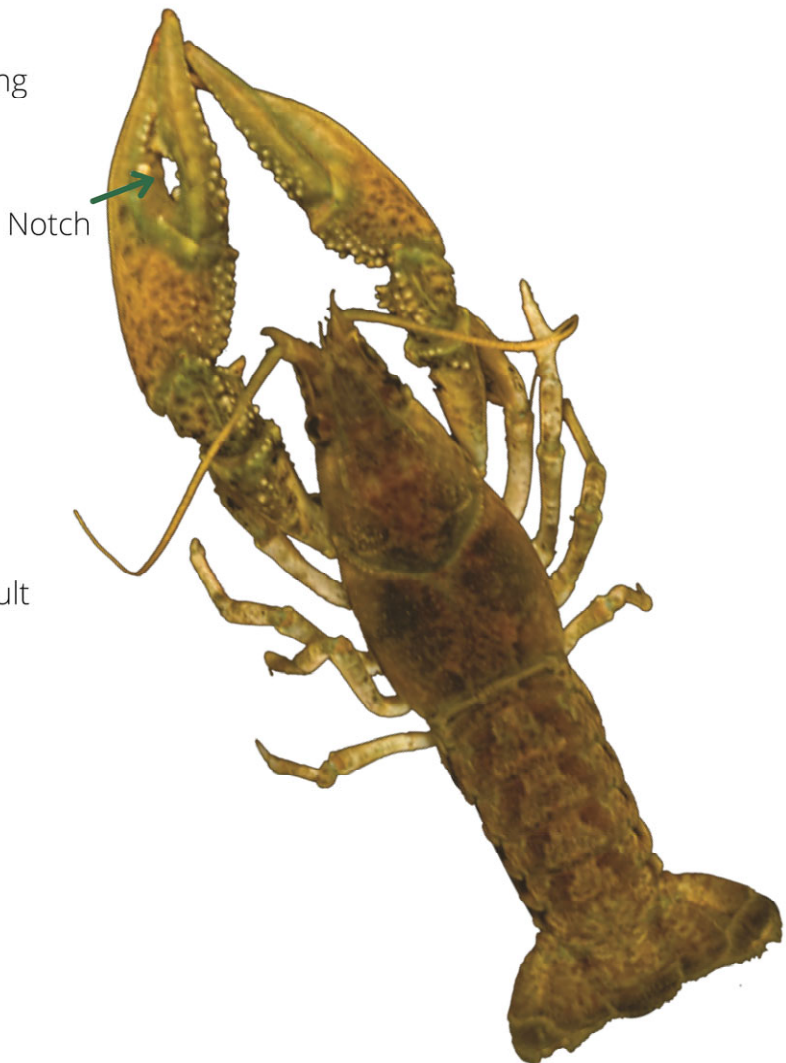
### LOOKS SIMILAR TO

- Rusty crayfish (invasive)
- Red swamp crayfish (invasive)
- Virile crayfish (native)
- Northern clearwater crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

### WHERE TO LOOK

- In shallow waters under plants for cover
- Will burrow in muddy bottoms of ponds

### CURRENTLY FOUND





# NATIVE

## Virile crayfish

*Orconectes virilis*

### KEYS TO ID

- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- No red spot on side of carapace
- Narrow claws with no black band
- Claws may have a blue tint with small white bumps
- Can grow up to 5 inches

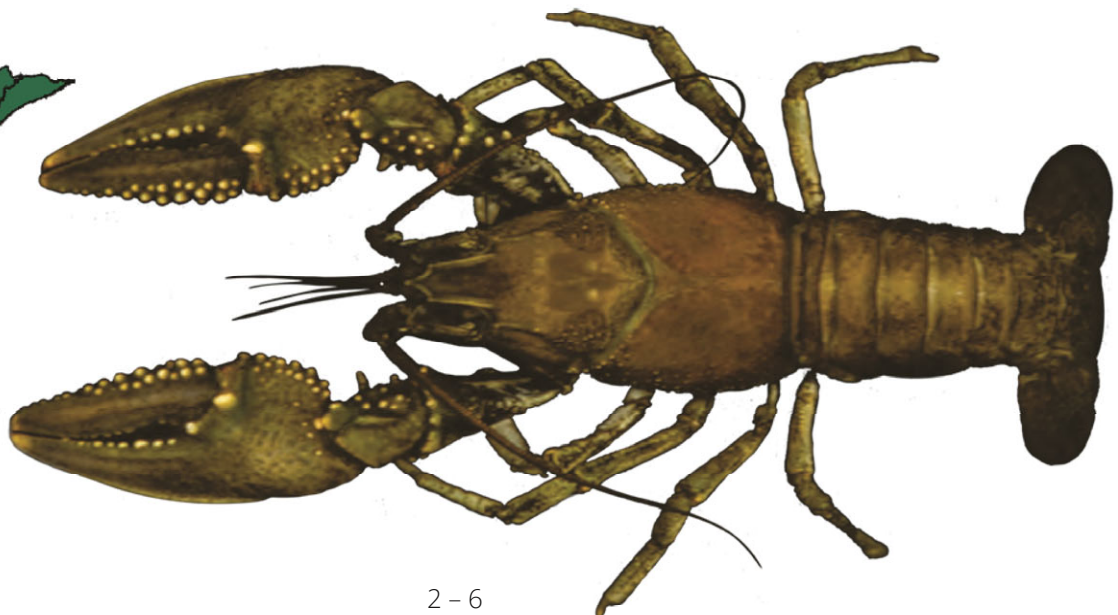
### LOOKS SIMILAR TO

- Rusty crayfish (invasive)
- Red swamp crayfish (invasive)
- Calico crayfish (native)
- Northern clearwater crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

### WHERE TO LOOK

- In a wide variety of habitats
- Under stones in lakes, streams, and wetlands
- Not found in swift-moving waters

### CURRENTLY FOUND



# INVASIVE

## Zebra mussels

*Dreissena polymorpha*

### KEYS TO ID

- Stripes are generally in zigzag pattern
- Pattern is variable; some may lack striping altogether and can be solid tan or brown
- Have a flat edge and won't topple over when set on it
- Shells form straight line when closed
- Range from  $\frac{1}{8}$  of an inch to 2 inches

### LOOKS SIMILAR TO

- Quagga mussels (invasive)
- Asian clam (invasive)
- Chinese mystery snail (invasive)
- Native snails (native)
- Native mussels (native)



*Stripes are zigzag*



*Byssal threads*

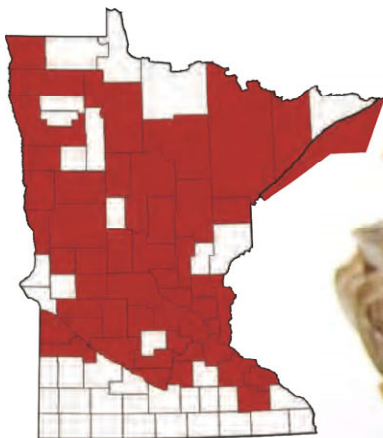


*Straight line*

### WHERE TO LOOK

- Often found attached to submerged objects (such as boats and docks as well as plants and rocks)
- May leave behind byssal threads when removed
- Newly settled mussels are usually in shallow areas; adults are common in depths of 10 to 20 feet

### CURRENTLY FOUND



*Zebra mussels covering native mussel*



# INVASIVE

## Quagga mussels

*Dreissena rostriformis "bugensis"*

### KEYS TO ID

- Stripes are in rings
- Wide range of coloration – some may appear to have almost no striping
- Will topple over when placed on ventral edge
- Shells form S-shape when closed
- Range from  $\frac{1}{8}$  of an inch to 2 inches

S-shape



### LOOKS SIMILAR TO

- Zebra mussels (invasive)
- Chinese mystery snail (invasive)
- Asian clam (invasive)
- Native mussels (native)
- Native snails (native)



### WHERE TO LOOK

- Often found attached to submerged objects (such as boats and docks as well as plants and rocks)
- May leave behind byssal threads when removed
- May inhabit softer substrates (such as silt) and deeper water than zebra mussels



### CURRENTLY FOUND





# INVASIVE

## Asian clam

*Corbicula fluminea*

### KEYS TO ID

- Bivalve that ranges from light to dark in color
- Symmetric shape; rounder than zebra mussels
- Shells have rigid concentric rings
- Can grow up to 2 inches

### LOOKS SIMILAR TO

- Zebra mussels (invasive)
- Quagga mussels (invasive)
- Chinese mystery snail (invasive)
- Native snails (native)
- Native mussels (native)

### WHERE TO LOOK

- In soft substrates like sand or mud

### CURRENTLY FOUND





# NATIVE

## Freshwater mussels

*Family Unionidae*

### KEYS TO ID

- Have two shells (bivalves) with an asymmetrical shell shape
- Grow significantly larger than zebra mussels, quagga mussels, and Asian clam
- 48 different species live in Minnesota
- Often called clams

### LOOKS SIMILAR TO

- Zebra mussels (invasive)
- Chinese mystery snail (invasive)
- Asian clam (invasive)
- Quagga mussels (invasive)
- Native snails (native)
- Collectively called “unionids”

### WHERE TO LOOK

- Embedded in the bottom of lakes and rivers throughout Minnesota

### CURRENTLY FOUND



*Top: Native mussel on its own.*

*Bottom: Native mussel being smothered by zebra mussels. The uncovered part of this mussel was buried in the river bottom.*



# INVASIVE

## Chinese mystery snail

*Cipangopaludina chinensis*

### KEYS TO ID

- Grow up to 2 inches long
- Light to dark brown
- Have an operculum ("trapdoor") covering opening which is missing when dead

### LOOKS SIMILAR TO

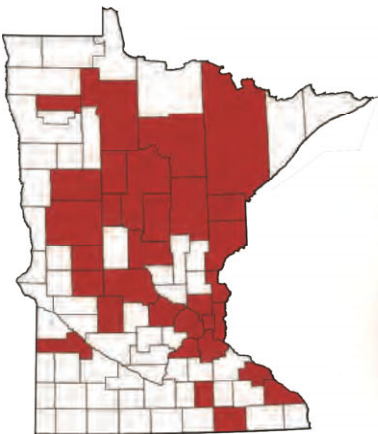
- Zebra mussels (invasive)
- Quagga mussels (invasive)
- Asian clam (invasive)
- Native mussels (native)
- Native snails (native)



### WHERE TO LOOK

- In lakes and slow-moving rivers

### CURRENTLY FOUND





**KEYS TO ID**

- Single shell with spirals
- Generally under 2 to 3 inches

**LOOKS SIMILAR TO**

- Zebra mussels (invasive)
- Quagga mussels (invasive)
- Chinese mystery snail (invasive)
- Asian clam (invasive)
- Native mussels (native)

**WHERE TO LOOK**

- Most aquatic habitats (from woodland pools to streams, rivers, wetlands, ponds, and lakes) throughout the state

**CURRENTLY FOUND****Pond snail****Ramshorn snail****Limpet snail**

Limpet snails are native to Minnesota but do not have the typical spiraled shell, and can be found attached to other animals or objects — often leading to confusion with zebra or quagga mussels.



# INVASIVE

## Spiny waterflea

*Bythotrephes longimanus*

### KEYS TO ID

- Range from  $\frac{1}{4}$  to  $\frac{5}{8}$  of an inch
- Have long, spiny tails with 1 – 4 pairs of barbs
- Have distinctive black eyespots
- Females may have bulbous brood chamber on back
- Most abundant during late summer and autumn

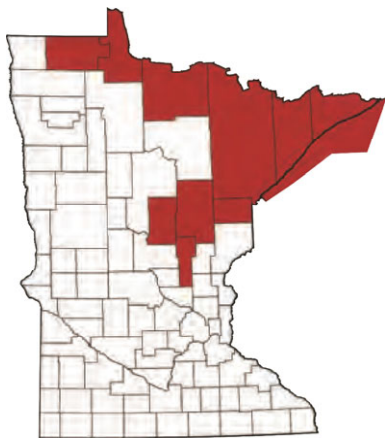
### LOOKS SIMILAR TO

- Fishhook waterflea (invasive)
- *Leptodora* (native)
- *Chaoborus* (native)

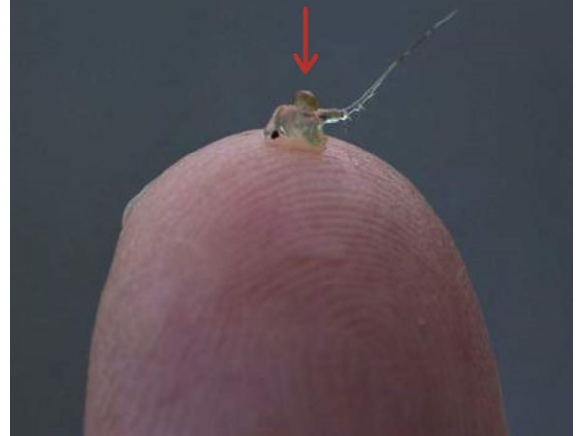
### WHERE TO LOOK

- Most often found on fishing line or other equipment in clumps that resemble a gelatinous blob
- Usually found in deep lakes but can establish in shallow lakes and rivers
- Suspended in water column

### CURRENTLY FOUND



Brood chamber holding early development eggs



Spiny waterflea with three pairs of barbs

# INVASIVE

## Fishhook waterflea

*Cercopagis pengoi*

### KEYS TO ID

- Range from about ¼ to ½ inch
- Have long tail with up to three pairs of barbs and a characteristic “hook” near the end
- Have distinctive eyespot
- Females may have pointed brood chamber on back

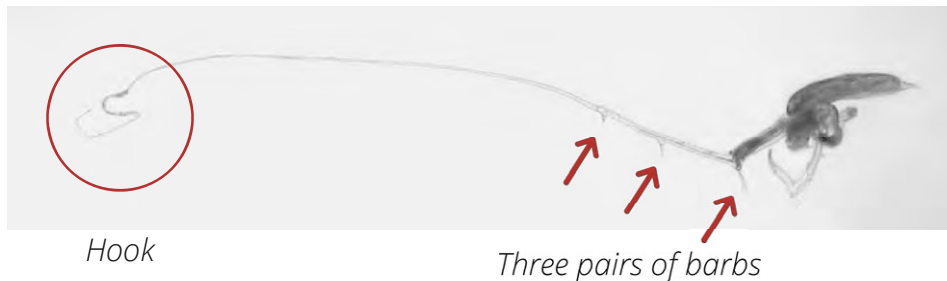
### LOOKS SIMILAR TO

- Spiny waterflea (invasive)
- *Leptodora* (native)
- *Chaoborus* (native)

### WHERE TO LOOK

- Clogged on nets or other fishing gear
- Brackish and freshwater lakes
- Has not been found in Minnesota

### CURRENTLY FOUND





# NATIVE

## Predatory zooplankton

*Leptodora sp.* and larval *Chaoborus sp.*

### KEYS TO ID

- No long, spine-like tail
- *Leptodora* grow up to 0.8 inches long with two antennae and one eye
- *Chaoborus* have two small eyes at the front of their bodies, lack spines on their tail, and also lack long antennae
- Both are almost entirely transparent

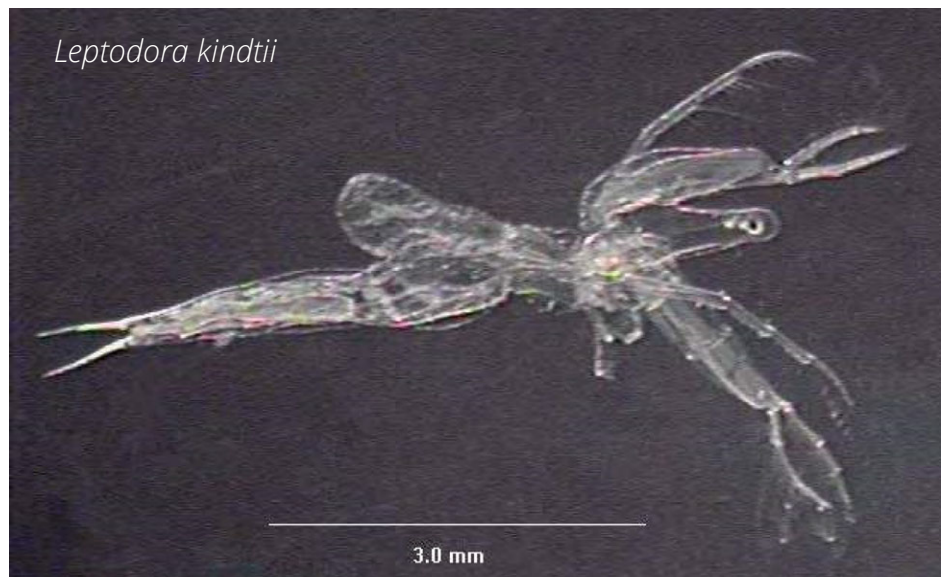
### LOOKS SIMILAR TO

- Spiny waterflea (invasive)
- Fishhook waterflea (invasive)

### WHERE TO LOOK

- Collected on fishing line
- Very widespread throughout Minnesota

### CURRENTLY FOUND





# Quick reference guide

## Bighead and silver carp

	Bighead carp	Silver carp	Gizzard shad	Mooneye	Shiners
Color	Gray with dark patches; silvery white underside	Silver; sometimes with a green hue	Silver-white	Silver	Varies
Eye location	Center below midline	Center below midline	Center above midline	Center above midline	Center above midline
Keel	Short	Long	Long	Short	
Shoulder spot			X		
Teeth				X	
Long final ray of dorsal fin			X		

## Round goby

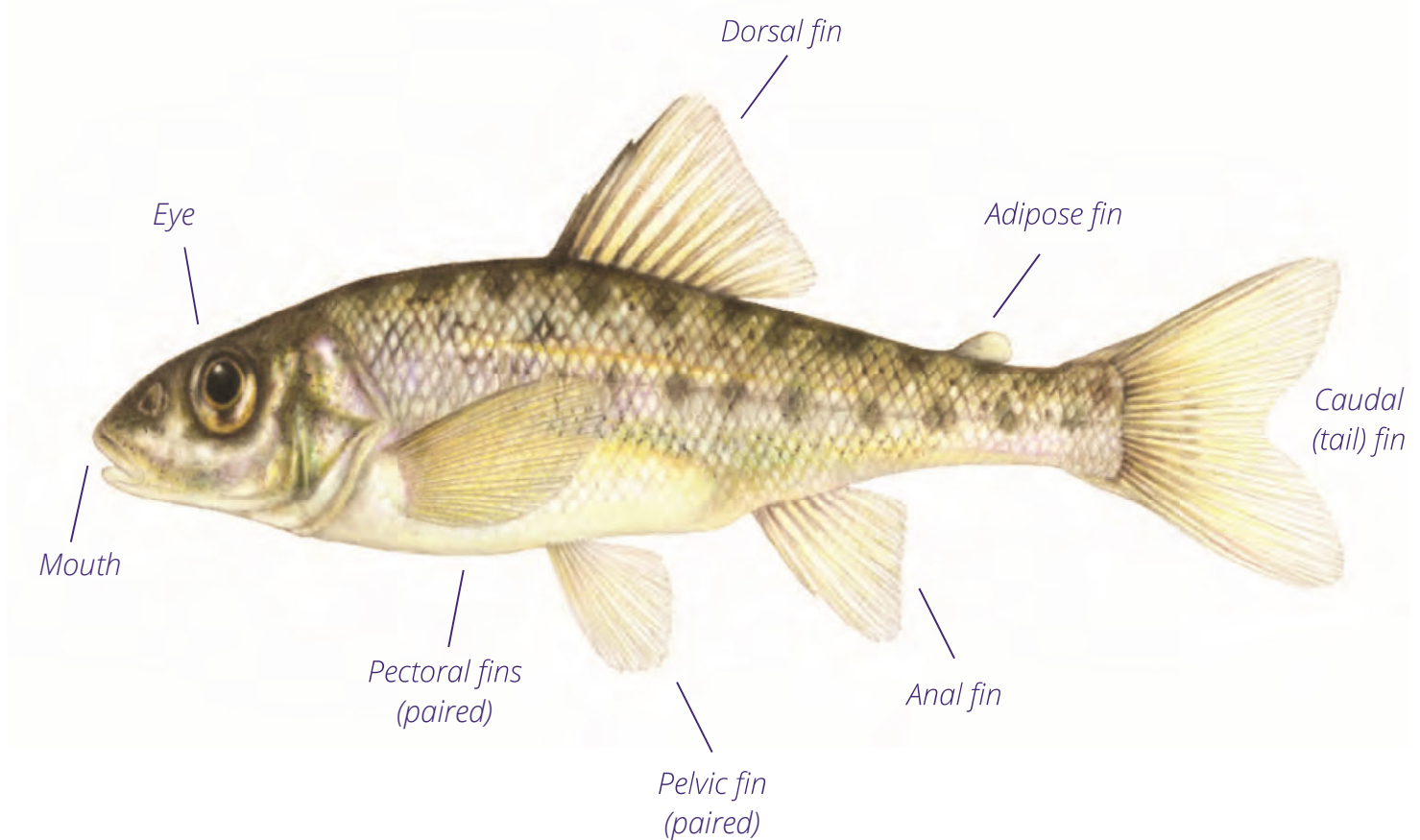
	Round goby	Tubenose goby	Sculpins
Color	Mottled browns, blacks, grays, and olives — white or cream underside	Mottled brown on light brown, olive, or tan — white or cream underside	Variable brown markings
Black spot on first dorsal fin	X		
Separated 1st and 2nd dorsal fins	X	X	
Fused pelvic fins	X	X	

## Ruffe

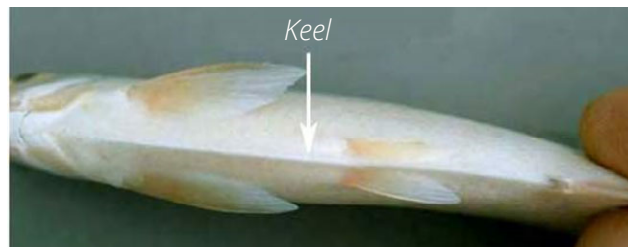
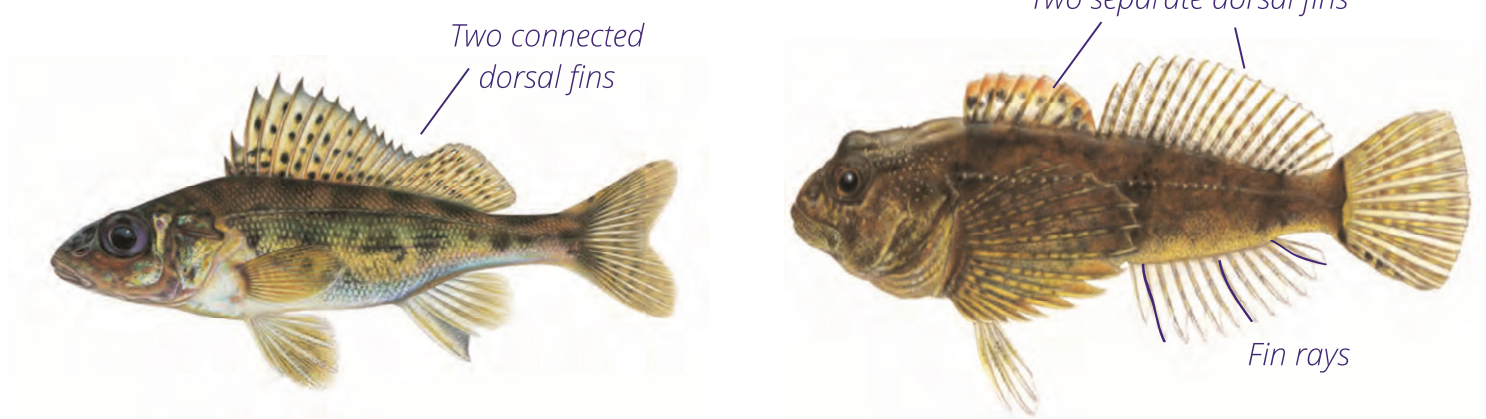
	Ruffe	Walleye	Yellow perch	Sauger
Color	Tans, grays, olive, and silvers with irregular dark blotches; white-cream	Brown/olive with mottling, white-cream underside	Brownish-green with dark vertical bars, white-cream underside	Brown/gray with mottling, white-cream underside
Mouth extends past front of eye		X	X	X
White tip at base of caudal fin		X		
Fused 1st and 2nd dorsal fins	X			

# Introduction to fish

## Fish characteristics



## Variations in fins



# INVASIVE

## Bighead carp

*Hypophthalmichthys nobilis*

### KEYS TO ID

- Dark gray with black blotches on back and sides
- Eyes point downward; center of the eye is even with or below the midline
- No teeth in upper or lower jaw
- Short keel between pelvic and anal fins
- Average size of Bighead carp caught in Minnesota is nearly 40 inches; early life stage could be confused with minnows

### LOOKS SIMILAR TO

- Silver carp (invasive)
- Gizzard shad (native)
- Mooneye (native)
- Emerald shiner (native)

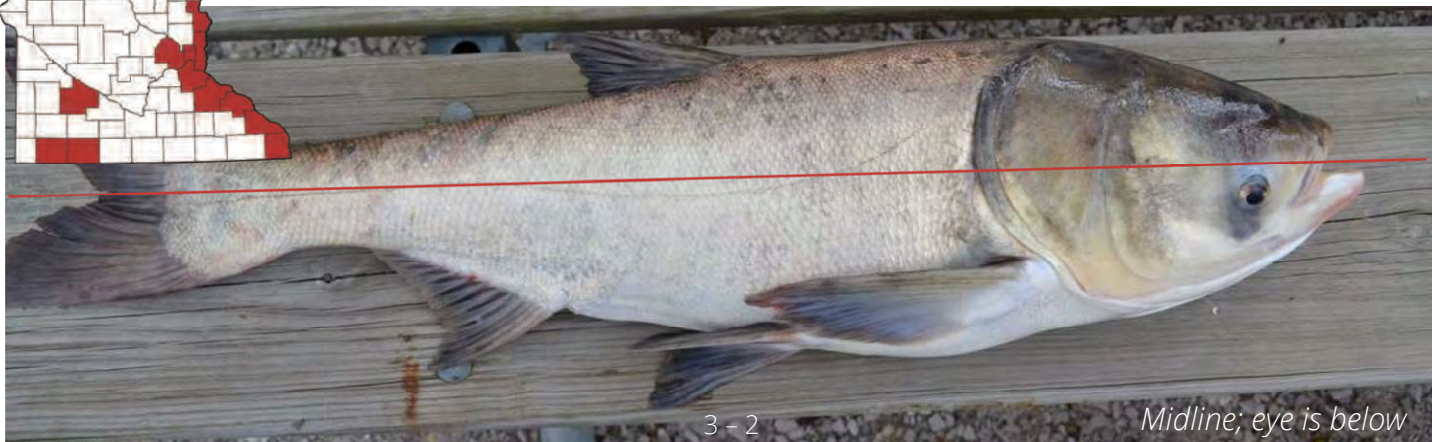
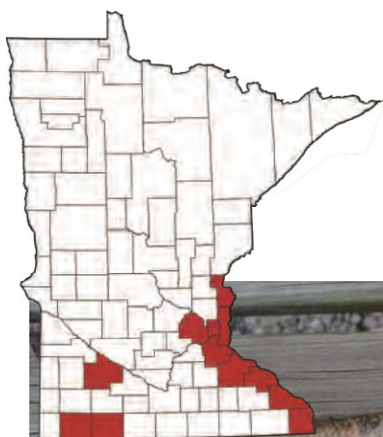
### WHERE TO LOOK

- Prefer turbulent, nutrient-rich rivers
- Need flowing water to reproduce; will use backwaters and slow areas other times of the year
- No known established populations in Minnesota; individuals have been caught intermittently



Juvenile

### CURRENTLY FOUND





# INVASIVE

## Silver carp

*Hypophthalmichthys molitrix*

### KEYS TO ID

- Silver in color; can be greenish on back
- Eyes point downward
- Center of the eye is even with or below the midline
- No teeth in upper or lower jaw
- Long keel that extends in front and behind pelvic fins
- Average size of Silver carp caught in Minnesota is nearly 33 inches; early life stage could be confused with minnows

### LOOKS SIMILAR TO

- Bighead carp (invasive)
- Gizzard shad (native)
- Mooneye (native)
- Emerald shiner (native)

### WHERE TO LOOK

- Can jump up to ten feet in the air
- Prefer turbulent, nutrient-rich rivers; can tolerate a wide range of temperatures
- Need flowing water to reproduce; will use backwaters and slow areas other times of the year
- No known established populations in Minnesota; individuals have been caught intermittently

### CURRENTLY FOUND



Fry (top)  
Adult (middle)  
Juvenile (bottom)

# NATIVE

## Gizzard shad

*Dorosoma cepedianum*

### KEYS TO ID

- Silver to white with a distinguishing shoulder spot
- Last ray on dorsal fin much longer than the others
- Upper edge of the eye located above the tip of the upper lip
- No teeth in upper or lower jaw
- Generally grow about 8 – 12 inches

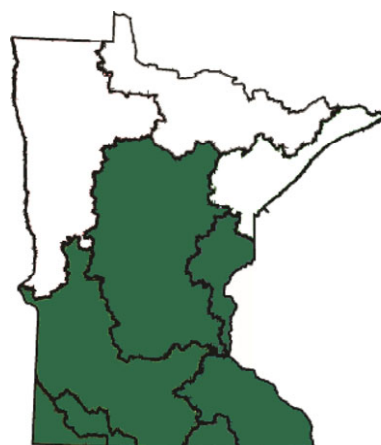
### LOOKS SIMILAR TO

- Bighead carp (invasive)
- Silver carp (invasive)
- Mooneye (native)
- Emerald shiner (native)

### WHERE TO LOOK

- Prefer shallow waters with soft, muddy bottoms
- Also found in slow-moving areas of rivers

### CURRENTLY FOUND





# NATIVE

## Mooneye

*Hiodon tergisus*

### KEYS TO ID

- Silver in color
- Keel extends from anal to pelvic fin
- Upper edge of the eye is located above the tip of the upper jaw
- Has teeth on both jaws and roof of mouth
- Grow up to 15 inches long

### LOOKS SIMILAR TO

- Bighead carp (invasive)
- Silver carp (invasive)
- Gizzard shad (native)
- Emerald shiner (native)

### WHERE TO LOOK

- Prefer large, clear lakes and rivers

### CURRENTLY FOUND





NATIVE

# Emerald shiner

*Notropis atherinoides*

## KEYS TO ID

- Emerald-silver color on its sides
- Upper edge of the eye is located above the tip of the upper jaw
- No teeth on upper or lower jaw
- Generally grow about 3 – 4 inches

## LOOKS SIMILAR TO

- Bighead carp (invasive)
- Silver carp (invasive)
- Mooneye (native)
- Gizzard shad (native)

## WHERE TO LOOK

- Tend to shoal in large groups near surface of the water at dusk to feed

## CURRENTLY FOUND





# INVASIVE

## Round goby

*Neogobius melanostomus*

### KEYS TO ID

- Young gobies are solid gray; older fish are light gray with dark blotches
- Fused pelvic fin – which no native fish have – can resemble a suction cup
- First and second dorsal fins are separate
- Prominent black spot on first dorsal fin
- Has fine scales on body
- Usually less than 6 inches

### LOOKS SIMILAR TO

- Tubenose goby (invasive)
- Native Sculpins including mottled, slimy, spoonhead, and deepwater (native)

### WHERE TO LOOK

- Lakes and slow-moving rivers
- Areas with vegetation cover and rocky bottoms
- Found in Lake Superior but not yet in inland lakes

### CURRENTLY FOUND



*Above: Fused pelvic fin*

*Below: Dark spot on dorsal fin*



# INVASIVE

## Tubenose goby

*Proterorhinus marmoratus*

### KEYS TO ID

- Has fused pelvic fins, which no native fish have
- Does not have black spot on dorsal fin
- First and second dorsal fins are separate
- Nostril extends beyond lower lip
- Has fine scales on body and grows to about 4 inches

### LOOKS SIMILAR TO

- Round goby (invasive)
- Native Sculpins including mottled, slimy, spoonhead, and deepwater (native)

### CURRENTLY FOUND



### WHERE TO LOOK

- In slow-moving, shallow water less than 15 feet with lots of plant cover
- Found in Lake Superior but not in inland lakes



*Note nostril extending beyond bottom lip and lack of black spot on dorsal fin.*





**KEYS TO ID**

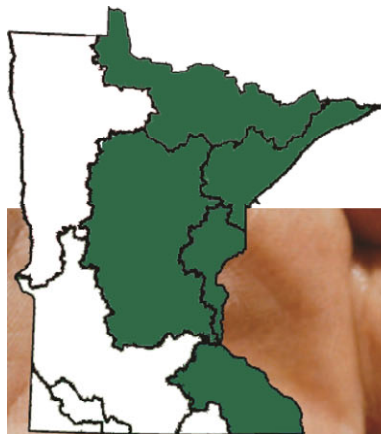
- Vary from light tan to dark brown with mottled blotches
- Fused first and second dorsal fin
- Scaleless body
- Have two separated pelvic fins
- Grow between 4.5 and 6 inches long

**LOOKS SIMILAR TO**

- Round goby (invasive)
- Tubenose goby (invasive)
- Includes mottled, slimy, spoonhead, and deepwater sculpins

**WHERE TO LOOK**

- Usually found in rocky areas
- Sometimes found in headwaters of creeks or small rivers

**CURRENTLY FOUND**

*Lateral view of a Mottled sculpin showing coloring (below)*



*Underside of a Slimy sculpin with separated pelvic fins (right)*



# INVASIVE

## Ruffe

*Gymnocephalus cernuus*

### KEYS TO ID

- Olive- to gold-brown on its back with yellow-white underside
- Fused dorsal fins with dark spots
- Small, downturned mouth that does not expand past the front of the eye
- Sharp spines on gill cover
- Generally less than 6 inches long

### LOOKS SIMILAR TO

- Walleye (native)
- Sauger (native)
- Yellow perch (native)

### WHERE TO LOOK

- Prefer cooler waters
- Often in deep, offshore areas
- Lakes, reservoirs, and slow-moving rivers
- Found in Lake Superior but not in inland lakes



### CURRENTLY FOUND



# NATIVE

## Walleye

*Sander vitreus*

### KEYS TO ID

- Golden-brown to yellow in color; dorsal fin has dark blotches
- Separated first and second dorsal fins
- White spot on tip of tail
- Mouth extends past the eye
- Eyes point outward
- Grows larger than ruffe

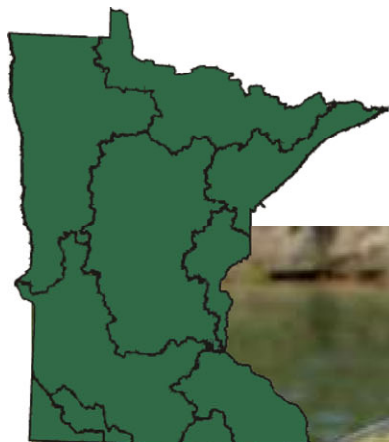
### LOOKS SIMILAR TO

- Ruffe (invasive)
- Sauger (native)
- Yellow perch (native)

### WHERE TO LOOK

- In the shelter of aquatic vegetation

### CURRENTLY FOUND





# NATIVE

## Sauger

*Sander canadensis*

### KEYS TO ID

- Sandy to dark brown with 3 – 4 dark patches along back and sides
- Dorsal fins are separated and have rows of dark spots
- Mouth extends past the eye
- Grows larger than ruffe

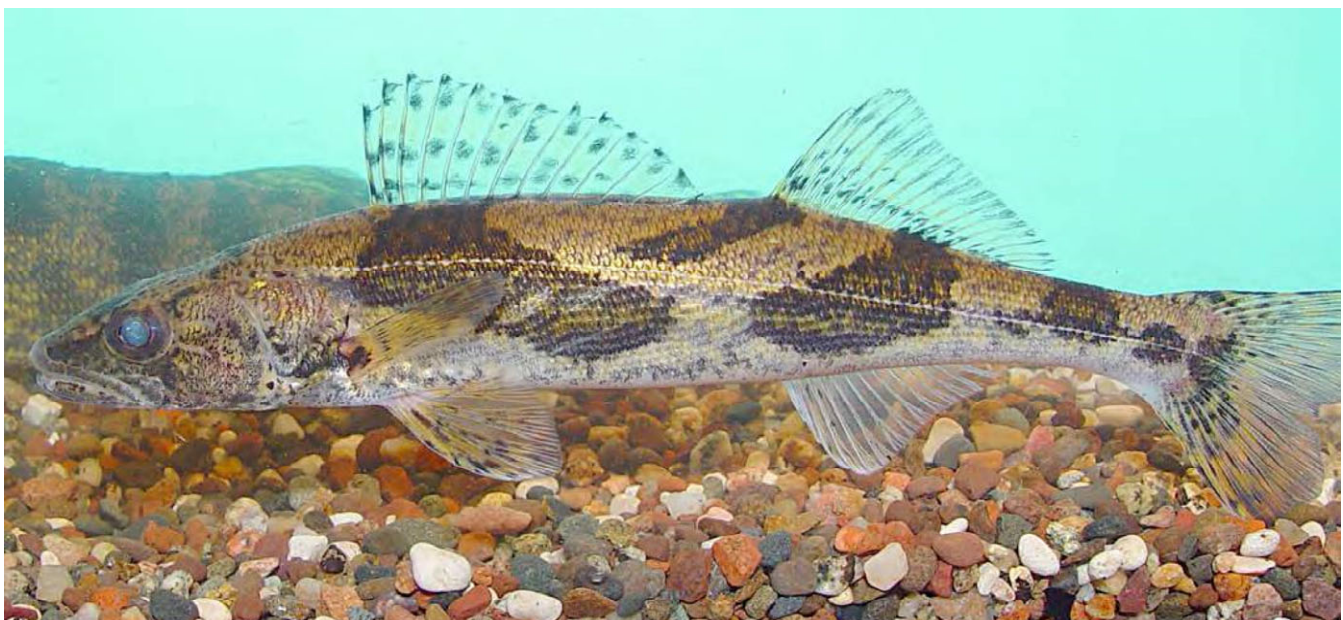
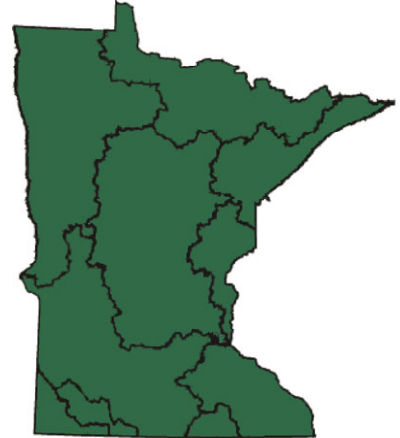
### LOOKS SIMILAR TO

- Ruffe (invasive)
- Yellow perch (native)
- Walleye (native)

### WHERE TO LOOK

- Likely to be found in deep pools
- Areas of high turbidity, low stream velocity, and deep water

### CURRENTLY FOUND





# NATIVE

## Yellow perch

*Perca flavescens*

### KEYS TO ID

- Green on top with 6 to 9 stripes down yellow sides
- Separated dorsal fins
- No distinct spots
- Grows larger than ruffe

### LOOKS SIMILAR TO

- Ruffe (invasive)
- Sauger (native)
- Walleye (native)

### WHERE TO LOOK

- Abundant in lakes and backwaters of large rivers
- Prefer to be near vegetation

### CURRENTLY FOUND



Yellow perch (top)  
Invasive ruffe (bottom)

# Glossary

**Adipose fin:** Located between the dorsal fin and caudal fin; have no spines or rays and are soft

**Alternate leaves:** Leaves are attached to the stem singly and on alternate sides

**Anal fin:** Located on the underside of a fish between the tail and pelvic fins, near the anus

**Antheridia:** Male reproductive structures that are small and orange to red on starry stonewort

**Ascending stem:** A stem growing upward

**Axis:** The main stem about which plant parts such as branches are arranged

**Bivalve:** An animal that has two shells that meet at a hinge

**Branchlet:** A small branch or a subdivision of a branch

**Bulbil:** Asexual reproductive structure found on some charophytes. Bulbils of starry stonewort are white and star-shaped

**Byssal threads:** A mass of strong, silky filaments which mussels use to attach to surfaces

**Carapace:** A hard shell on the backs of crayfish

**Caudal fin:** Also known as a tail fin, it is located at the end of the fish and propels and steers the fish

**Dissected:** Leaves that are deeply or repeatedly divided

**Dorsal fin:** Located on the top of a fish, it may be a single fin, with or without spines, or consist of two connected or unconnected parts — a sharp-spined part and a soft-rayed part

**Fractal:** When similar patterns recur at progressively smaller scales

**Fry:** Immature fish from the time they hatch to the time they become fingerlings

**Gill cover:** A flap of skin protecting a fish's gills

**Hybridize:** To produce hybrids; crossbreed

**Invasive species:** Species that are not native to a given ecosystem, and cause (or have high potential to cause) harm, whether economic, environmental, or harm to human health

**Invertebrate:** An animal that lacks a spine

**Keel:** A ridge on the belly of the fish which is present only in some species

**Leaflet:** A part or division of a compound leaf

**Midvein:** The vein in the center of a leaf

**Mottled:** Marked with spots or smears of color

**Node:** The place on the stem where a leaf or branch is attached (or has been attached)

**Pectoral fins:** Located on both sides of the fish near the gill; help with balance, steering, and controlling depth

**Pelvic fins:** Located on the bottom of the fish in front of the anal fin; help balance the fish and keep it level

**Serrated:** Having a saw-toothed edge or margin notched with toothlike projections

**Shoal:** When fish group together, for social purposes

**Submersed/submerged:** Submersed plants are usually found entirely underwater, but the flowers and fruits may rise above the water surface. They are rooted in the sediment and have underwater leaves

**Substrate:** The surface on which an organism lives, grows, or obtains its nourishment

**Tubers:** A short, thick stem that grows underground and can produce a new plant

**Turbidity:** A measure that provides an estimate of the cloudiness of water due to silt, organic and inorganic matter, plankton, and microscopic organisms

**Turions:** A vegetative bud that detaches from a parent plant and can produce new plants via asexual reproduction

**Ventral edge:** On a bivalve, the surface opposite the hinge

**Water column:** A conceptual column of water from lake surface to bottom sediments

**Whorl:** A ring of 3 or more similar structures radiating from a common point



# Photo credits

## PLANTS

Leaf arrangements: Cayte · Compound leaves: Evelyn Fitzgerald  
Simple leaf: Benjamint444 · Leaf margins: Debivort  
Whorled leaf with midvein: Christian Fischer  
Eurasian watermilfoil flower and close-up: Paul Skawinski, UW-Extension Lakes  
Bladderwort: Christa Rittberg  
White water crowfoot: Trish Steel  
Water marigold flower: Peter Dziuk  
*Hydrilla*: Michael J. Grodowitz, U.S. Army Engineer Research and Development Center; Tim Krynak; J.M.Garg  
Elodea stalk: Minnehaha Creek Watershed District  
Brazilian waterweed: David Liu, Minnehaha Creek Watershed District; Lamiot; Lara Gudmundsdottir  
Starry stonewort: Dave Hansen; Paul Skawinski, Aquatic Plants of the Upper Midwest  
Native *chara*: Christian Fischer; Megan Weber  
Native *Nitella*: Kristian Peters; Paul Skawinski, Aquatic Plants of the Upper Midwest  
Sago pondweed fruit: Christian Fischer  
Water stargrass: Paul Skawinski, Aquatic Plants of the Upper Midwest  
Curly-leaf pondweed: Paul Skawinski, UW-Extension Lakes; Leslie J. Mehrhoff  
Clasping leaf pondweed: Paul Skawinski, Aquatic Plants of the Upper Midwest

## INVERTEBRATES

Rusty crayfish: Jeff Gunderson  
Northern clearwater crayfish: Chris Taylor  
Calico crayfish: Chris Taylor  
Virile crayfish: Chris Taylor  
Quagga mussels (in pile): Megan Weber  
Freshwater mussels (in pile): U.S. Fish and Wildlife Service  
Asian clam: Minnehaha Creek Watershed District; Böhringer Friedrich  
Limpet snail: Alfredo Eloisa  
Spiny waterflea: Donn Branstrator; Jeff Gunderson; Minnehaha Creek Watershed District  
Fishhook waterflea: J. Liebig, NOAA GLERL; Mart Simm  
*Chaoborus*: Piet Spaans  
*Leptodora*: Great Lakes Environmental Research Laboratory

## FISH

Illustrations of trout perch, sculpin, and ruffe: Joseph Tomelleri  
Keel: John Lyons  
Bighead carp: Asian Carp Regional Coordinating Committee  
Juvenile silver carp: Michigan Sea Grant; Adult silver carp: Asian Carp Regional Coordinating Committee  
Gizzard shad: Brian Gratwicke; Chad Thomas  
Mooneye: Konrad Schmidt  
Emerald shiner: Andrew Kornacki; Konrad Schmidt  
Round goby: Peter van der Sluijs  
Tubenose goby: John Lyons; Harka Ákos  
Slimy sculpin: John Lyons  
Ruffe: Tiit Hunt; USGS  
Walleye in hand: John Lyons; Adult walleye: USFWS  
Sauger: Konrad Schmidt  
Yellow perch: USFWS; Yellow perch with ruffe: John Lyons

Photos not otherwise credited are (c) Christine Lee, Minnesota Aquatic Invasive Species Research Center



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## **Appendix C**

### **Seed Mixes**

21-111

## Oats Cover Crop

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
Oats	<i>Avena sativa</i>	112.08	100.00	100.00%	44.54
	<b>Totals:</b>	<b>112.08</b>	<b>100.00</b>	<b>100.00%</b>	<b>44.54</b>
<b>Purpose:</b>	Temporary cover crop for spring and summer plantings				
<b>Planting Area:</b>	Statewide				



## Winter Wheat Cover Crop

21-112

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
Winter Wheat	<i>Triticum aestivum</i>	112.09	100.00	100.00%	26.08
	<b>Totals:</b>	<b>112.09</b>	<b>100.00</b>	<b>100.00%</b>	<b>26.08</b>
<b>Purpose:</b>	Temporary cover crop for fall plantings				
<b>Planting Area:</b>	Statewide				



## Soil Building Cover Crop

21-113

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
Field Pea	<i>Pisum sativum</i>	56.04	50.00	45.46%	3.44
	<b>Total Forbs</b>	<b>56.04</b>	<b>50.00</b>	<b>45.46%</b>	<b>3.44</b>
Oats	<i>Avena sativa</i>	67.25	60.00	54.54%	26.72
	<b>Total Cover Crop</b>	<b>67.25</b>	<b>60.00</b>	<b>54.54%</b>	<b>26.72</b>
	<b>Totals:</b>	<b>123.29</b>	<b>110.00</b>	<b>100.00%</b>	<b>30.16</b>
<b>Purpose:</b>	Temporary cover crop with soil building function.				
<b>Planting Area:</b>	Statewide				

## Woodland Edge Northwest

36-411

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	0.56	0.50	1.42%	1.85
side-oats grama	<i>Bouteloua curtipendula</i>	1.12	1.00	2.81%	2.20
fringed brome	<i>Bromus ciliatus</i>	0.84	0.75	2.12%	3.04
kalm's brome	<i>Bromus kalmii</i>	2.24	2.00	5.64%	5.88
bluejoint	<i>Calamagrostis canadensis</i>	0.07	0.06	0.18%	6.40
poverty grass	<i>Danthonia spicata</i>	0.43	0.38	1.06%	3.46
nodding wild rye	<i>Elymus canadensis</i>	1.12	1.00	2.81%	1.91
slender wheatgrass	<i>Elymus trachycaulus</i>	1.12	1.00	2.81%	2.53
Virginia wild rye	<i>Elymus virginicus</i>	1.96	1.75	4.93%	2.70
little bluestem	<i>Schizachyrium scoparium</i>	0.07	0.06	0.18%	0.35
Indian grass	<i>Sorghastrum nutans</i>	0.56	0.50	1.40%	2.19
<b>Total Grasses</b>		<b>10.09</b>	<b>9.00</b>	<b>25.36%</b>	<b>32.50</b>
common yarrow	<i>Achillea millefolium</i>	0.03	0.03	0.09%	2.00
blue giant hyssop	<i>Agastache foeniculum</i>	0.13	0.12	0.35%	4.10
lead plant	<i>Amorpha canescens</i>	0.03	0.03	0.09%	0.15
Tall Thimbleweed	<i>Anemone virginiana</i>	0.03	0.03	0.08%	0.30
columbine	<i>Aquilegia canadensis</i>	0.03	0.03	0.08%	0.40
prairie sage	<i>Artemisia ludoviciana</i>	0.03	0.03	0.09%	2.90
white prairie clover	<i>Dalea candida</i>	0.07	0.06	0.16%	0.40
purple prairie clover	<i>Dalea purpurea</i>	0.20	0.18	0.51%	1.00
flat-topped aster	<i>Doellingeria umbellata</i>	0.03	0.03	0.09%	0.80
ox-eye	<i>Heliopsis helianthoides</i>	0.04	0.04	0.12%	0.10
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.07	0.06	0.17%	0.91
smooth wild rose	<i>Rosa blanda</i>	0.11	0.10	0.28%	0.10
black-eyed susan	<i>Rudbeckia hirta</i>	0.35	0.31	0.86%	10.35
upland white aster	<i>Solidago ptarmicoides</i>	0.07	0.06	0.16%	1.30
tall meadow-rue	<i>Thalictrum dasycarpum</i>	0.15	0.13	0.35%	0.92
American vetch	<i>Vicia americana</i>	0.15	0.13	0.37%	0.10
golden alexanders	<i>Zizia aurea</i>	0.15	0.13	0.36%	0.51
<b>Total Forbs</b>		<b>1.68</b>	<b>1.50</b>	<b>4.21%</b>	<b>26.33</b>
Oats	<i>Avena sativa</i>	28.02	25.00	70.43%	11.14
<b>Total Cover Crop</b>		<b>28.02</b>	<b>25.00</b>	<b>70.43%</b>	<b>11.14</b>
<b>Totals:</b>		<b>39.79</b>	<b>35.50</b>	<b>100.00%</b>	<b>69.96</b>
<b>Purpose:</b>	Partly shaded grassland planting for native roadsides, reclamation, etc.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands Province. Mn/DOT District 2(west).				

## Woodland Edge Northeast

36-311

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
fringed brome	<i>Bromus ciliatus</i>	2.24	2.00	5.98%	8.10
bluejoint	<i>Calamagrostis canadensis</i>	0.15	0.13	0.37%	12.90
poverty grass	<i>Danthonia spicata</i>	0.56	0.50	1.50%	4.60
nodding wild rye	<i>Elymus canadensis</i>	1.40	1.25	3.72%	2.38
slender wheatgrass	<i>Elymus trachycaulus</i>	2.24	2.00	5.96%	5.06
fowl bluegrass	<i>Poa palustris</i>	0.98	0.87	2.59%	41.50
False Melic	<i>Schizachne purpurascens</i>	0.28	0.25	0.75%	2.90
	<b>Total Grasses</b>	<b>7.85</b>	<b>7.00</b>	<b>20.87%</b>	<b>77.44</b>
common yarrow	<i>Achillea millefolium</i>	0.03	0.03	0.09%	2.00
pearly everlasting	<i>Anaphalis margaritacea</i>	0.02	0.02	0.05%	1.30
flat-topped aster	<i>Doellingeria umbellata</i>	0.04	0.04	0.12%	1.00
tall cinquefoil	<i>Drymocallis arguta</i>	0.07	0.06	0.19%	5.30
large-leaved aster	<i>Eurybia macrophylla</i>	0.02	0.02	0.05%	0.18
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.16	0.14	0.42%	2.10
smooth wild rose	<i>Rosa blanda</i>	0.18	0.16	0.47%	0.15
black-eyed susan	<i>Rudbeckia hirta</i>	0.29	0.26	0.77%	8.70
gray goldenrod	<i>Solidago nemoralis</i>	0.07	0.06	0.18%	6.80
upland white aster	<i>Solidago ptarmicoides</i>	0.04	0.04	0.13%	1.00
Lindley's Aster	<i>Symphyotrichum ciliolatum</i>	0.03	0.03	0.10%	1.00
smooth aster	<i>Symphyotrichum laeve</i>	0.16	0.14	0.43%	2.90
American vetch	<i>Vicia americana</i>	0.56	0.50	1.50%	0.38
	<b>Total Forbs</b>	<b>1.68</b>	<b>1.50</b>	<b>4.50%</b>	<b>32.81</b>
Oats	<i>Avena sativa</i>	28.02	25.00	74.63%	11.14
	<b>Total Cover Crop</b>	<b>28.02</b>	<b>25.00</b>	<b>74.63%</b>	<b>11.14</b>
	<b>Totals:</b>	<b>37.55</b>	<b>33.50</b>	<b>100.00%</b>	<b>121.39</b>
<b>Purpose:</b>	Partly shaded grassland planting for native roadsides, reclamation, etc in north-central and northeast MN				
<b>Planting Area:</b>	Laurentian Mixed Forest Province excluding Chippewa Plains, Pine Moraines & Outwash Plains, and Mille Lacs Uplands subsections. Mn/DOT Districts 1 & 2(east).				

## Woodland Edge South & West

36-211

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	1.12	1.00	2.90%	3.68
side-oats grama	<i>Bouteloua curtipendula</i>	1.12	1.00	2.89%	2.20
kalm's brome	<i>Bromus kalmii</i>	1.68	1.50	4.34%	4.40
nodding wild rye	<i>Elymus canadensis</i>	1.40	1.25	3.61%	2.38
bottlebrush grass	<i>Elymus hystrix</i>	0.36	0.32	0.91%	0.88
slender wheatgrass	<i>Elymus trachycaulus</i>	1.40	1.25	3.64%	3.18
switchgrass	<i>Panicum virgatum</i>	0.07	0.06	0.17%	0.30
little bluestem	<i>Schizachyrium scoparium</i>	0.69	0.62	1.79%	3.40
Indian grass	<i>Sorghastrum nutans</i>	1.12	1.00	2.89%	4.40
	<b>Total Grasses</b>	<b>8.97</b>	<b>8.00</b>	<b>23.14%</b>	<b>24.82</b>
common yarrow	<i>Achillea millefolium</i>	0.03	0.03	0.09%	2.00
blue giant hyssop	<i>Agastache foeniculum</i>	0.11	0.10	0.28%	3.20
white snakeroot	<i>Ageratina altissima</i>	0.03	0.03	0.09%	1.70
white prairie clover	<i>Dalea candida</i>	0.19	0.17	0.50%	1.20
Canada tick trefoil	<i>Desmodium canadense</i>	0.16	0.14	0.42%	0.29
ox-eye	<i>Heliopsis helianthoides</i>	0.15	0.13	0.38%	0.30
wild bergamot	<i>Monarda fistulosa</i>	0.07	0.06	0.18%	1.60
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.07	0.06	0.17%	0.90
Clayton's sweet cicely	<i>Osmorhiza claytonii</i>	0.07	0.06	0.17%	0.06
smooth wild rose	<i>Rosa blanda</i>	0.07	0.06	0.17%	0.06
black-eyed susan	<i>Rudbeckia hirta</i>	0.20	0.18	0.52%	6.10
Lance-leaved Figwort	<i>Scrophularia lanceolata</i>	0.06	0.05	0.14%	3.20
zigzag goldenrod	<i>Solidago flexicaulis</i>	0.02	0.02	0.05%	0.50
showy goldenrod	<i>Solidago speciosa</i>	0.07	0.06	0.18%	1.80
smooth aster	<i>Symphyotrichum laeve</i>	0.07	0.06	0.19%	1.30
American vetch	<i>Vicia americana</i>	0.20	0.18	0.52%	0.14
golden alexanders	<i>Zizia aurea</i>	0.12	0.11	0.33%	0.46
	<b>Total Forbs</b>	<b>1.68</b>	<b>1.50</b>	<b>4.38%</b>	<b>24.80</b>
Oats	<i>Avena sativa</i>	28.02	25.00	72.48%	11.14
	<b>Total Cover Crop</b>	<b>28.02</b>	<b>25.00</b>	<b>72.48%</b>	<b>11.14</b>
	<b>Totals:</b>	<b>38.67</b>	<b>34.50</b>	<b>100.00%</b>	<b>60.75</b>
<b>Purpose:</b>	Partly shaded grassland planting for native roadsides, reclamation, etc.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				

## Dry Prairie Northwest

35-421

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
side-oats grama	<i>Bouteloua curtipendula</i>	1.35	1.20	10.89%	2.64
blue grama	<i>Bouteloua gracilis</i>	0.84	0.75	6.81%	11.00
kalm's brome	<i>Bromus kalmii</i>	1.01	0.90	8.17%	2.64
nodding wild rye	<i>Elymus canadensis</i>	1.12	1.00	9.09%	1.91
slender wheatgrass	<i>Elymus trachycaulus</i>	1.12	1.00	9.11%	2.54
porcupine grass	<i>Hesperostipa spartea</i>	0.50	0.45	4.09%	0.11
junegrass	<i>Koeleria macrantha</i>	0.28	0.25	2.23%	18.00
little bluestem	<i>Schizachyrium scoparium</i>	1.68	1.50	13.63%	8.26
sand dropseed	<i>Sporobolus cryptandrus</i>	0.22	0.20	1.86%	15.00
	<b>Total Grasses</b>	<b>8.13</b>	<b>7.25</b>	<b>65.88%</b>	<b>62.10</b>
Prairie Wild Onion	<i>Allium stellatum</i>	0.03	0.03	0.27%	0.12
Canada milk vetch	<i>Astragalus canadensis</i>	0.08	0.07	0.61%	0.42
white prairie clover	<i>Dalea candida</i>	0.07	0.06	0.55%	0.42
purple prairie clover	<i>Dalea purpurea</i>	0.12	0.11	0.99%	0.60
Canada tick trefoil	<i>Desmodium canadense</i>	0.06	0.05	0.45%	0.10
stiff sunflower	<i>Helianthus pauciflorus</i>	0.03	0.03	0.31%	0.05
ox-eye	<i>Heliopsis helianthoides</i>	0.07	0.06	0.55%	0.14
rough blazing star	<i>Liatris aspera</i>	0.03	0.03	0.23%	0.15
dotted blazing star	<i>Liatris punctata</i>	0.02	0.02	0.18%	0.05
wild bergamot	<i>Monarda fistulosa</i>	0.03	0.03	0.27%	0.77
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.03	0.03	0.27%	0.45
prairie coneflower	<i>Ratibida columnifera</i>	0.07	0.06	0.55%	0.93
black-eyed susan	<i>Rudbeckia hirta</i>	0.07	0.06	0.55%	2.03
gray goldenrod	<i>Solidago nemoralis</i>	0.02	0.02	0.17%	2.00
heath aster	<i>Symphyotrichum ericoides</i>	0.01	0.01	0.14%	1.10
smooth aster	<i>Symphyotrichum laeve</i>	0.03	0.03	0.27%	0.61
heart-leaved alexanders	<i>Zizia aptera</i>	0.06	0.05	0.50%	0.24
	<b>Total Forbs</b>	<b>0.84</b>	<b>0.75</b>	<b>6.86%</b>	<b>10.18</b>
Oats	<i>Avena sativa</i>	3.36	3.00	27.26%	1.34
	<b>Total Cover Crop</b>	<b>3.36</b>	<b>3.00</b>	<b>27.26%</b>	<b>1.34</b>
	<b>Totals:</b>	<b>12.33</b>	<b>11.00</b>	<b>100.00%</b>	<b>73.62</b>
<b>Purpose:</b>	Regional dry prairie reconstruction for wetland mitigation, ecological restoration, or conservation program plantings.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands Province, Red River Prairie Section, Hardwood Hills subsection of the MN & NE IA Morainal Section, far western portions of the Laurentian Mixed Forest Province. Mn/DOT Districts 2(west) & 4(north).				



## Dry Prairie General

35-221

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	0.78	0.70	1.92%	2.57
side-oats grama	<i>Bouteloua curtipendula</i>	3.36	3.00	8.22%	6.61
blue grama	<i>Bouteloua gracilis</i>	0.56	0.50	1.37%	7.35
kalm's brome	<i>Bromus kalmii</i>	0.82	0.73	2.00%	2.14
nodding wild rye	<i>Elymus canadensis</i>	1.12	1.00	2.74%	1.91
junegrass	<i>Koeleria macrantha</i>	0.28	0.25	0.69%	18.37
little bluestem	<i>Schizachyrium scoparium</i>	3.36	3.00	8.22%	16.53
Indian grass	<i>Sorghastrum nutans</i>	0.78	0.70	1.92%	3.09
prairie dropseed	<i>Sporobolus heterolepis</i>	0.13	0.12	0.34%	0.73
<b>Total Grasses</b>		<b>11.21</b>	<b>10.00</b>	<b>27.42%</b>	<b>59.30</b>
blue giant hyssop	<i>Agastache foeniculum</i>	0.07	0.06	0.17%	2.07
lead plant	<i>Amorpha canescens</i>	0.10	0.09	0.26%	0.42
butterfly milkweed	<i>Asclepias tuberosa</i>	0.07	0.06	0.17%	0.10
Canada milk vetch	<i>Astragalus canadensis</i>	0.07	0.06	0.18%	0.40
bird's foot coreopsis	<i>Coreopsis palmata</i>	0.07	0.06	0.16%	0.21
white prairie clover	<i>Dalea candida</i>	0.07	0.06	0.15%	0.39
purple prairie clover	<i>Dalea purpurea</i>	0.21	0.19	0.51%	1.02
Canada tick trefoil	<i>Desmodium canadense</i>	0.07	0.06	0.18%	0.13
stiff sunflower	<i>Helianthus pauciflorus</i>	0.07	0.06	0.17%	0.09
rough blazing star	<i>Liatris aspera</i>	0.04	0.04	0.12%	0.25
wild bergamot	<i>Monarda fistulosa</i>	0.07	0.06	0.15%	1.42
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.07	0.06	0.15%	0.83
large-flowered beard tongue	<i>Penstemon grandiflorus</i>	0.07	0.06	0.17%	0.32
black-eyed susan	<i>Rudbeckia hirta</i>	0.35	0.31	0.84%	10.32
gray goldenrod	<i>Solidago nemoralis</i>	0.04	0.04	0.10%	3.86
heath aster	<i>Symphyotrichum ericoides</i>	0.04	0.04	0.10%	2.58
smooth aster	<i>Symphyotrichum laeve</i>	0.07	0.06	0.17%	1.26
hoary vervain	<i>Verbena stricta</i>	0.15	0.13	0.34%	1.29
<b>Total Forbs</b>		<b>1.68</b>	<b>1.50</b>	<b>4.09%</b>	<b>26.96</b>
Oats	<i>Avena sativa</i>	28.02	25.00	68.49%	11.13
<b>Total Cover Crop</b>		<b>28.02</b>	<b>25.00</b>	<b>68.49%</b>	<b>11.13</b>
<b>Totals:</b>		<b>40.91</b>	<b>36.50</b>	<b>100.00%</b>	<b>97.39</b>
<b>Purpose:</b>	General dry prairie mix for native roadsides, ecological restoration, or conservation program plantings.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				

35-441

## Mesic Prairie Northwest

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	1.12	1.00	9.08%	3.67
side-oats grama	<i>Bouteloua curtipendula</i>	1.35	1.20	10.89%	2.64
nodding wild rye	<i>Elymus canadensis</i>	1.12	1.00	9.09%	1.91
slender wheatgrass	<i>Elymus trachycaulus</i>	1.12	1.00	9.11%	2.54
porcupine grass	<i>Hesperostipa spartea</i>	0.47	0.42	3.82%	0.11
switchgrass	<i>Panicum virgatum</i>	0.20	0.18	1.59%	0.90
little bluestem	<i>Schizachyrium scoparium</i>	1.68	1.50	13.66%	8.28
Indian grass	<i>Sorghastrum nutans</i>	1.35	1.20	10.91%	5.29
	<b>Total Grasses</b>	<b>8.41</b>	<b>7.50</b>	<b>68.15%</b>	<b>25.33</b>
Prairie Wild Onion	<i>Allium stellatum</i>	0.03	0.03	0.27%	0.12
Canada milk vetch	<i>Astragalus canadensis</i>	0.07	0.06	0.54%	0.37
white prairie clover	<i>Dalea candida</i>	0.07	0.06	0.55%	0.42
purple prairie clover	<i>Dalea purpurea</i>	0.10	0.09	0.83%	0.50
Canada tick trefoil	<i>Desmodium canadense</i>	0.09	0.08	0.77%	0.17
ox-eye	<i>Heliopsis helianthoides</i>	0.07	0.06	0.55%	0.14
rough blazing star	<i>Liatris aspera</i>	0.03	0.03	0.28%	0.18
great blazing star	<i>Liatris pycnostachya</i>	0.07	0.06	0.54%	0.24
wild bergamot	<i>Monarda fistulosa</i>	0.03	0.03	0.27%	0.77
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.03	0.03	0.27%	0.45
Virginia mountain mint	<i>pycnanthemum virginianum</i>	0.04	0.04	0.34%	3.00
prairie coneflower	<i>Ratibida columnifera</i>	0.07	0.06	0.55%	0.93
black-eyed susan	<i>Rudbeckia hirta</i>	0.08	0.07	0.59%	2.20
heath aster	<i>Symphyotrichum ericoides</i>	0.01	0.01	0.14%	1.10
smooth aster	<i>Symphyotrichum laeve</i>	0.03	0.03	0.27%	0.61
blue vervain	<i>Verbena hastata</i>	0.10	0.09	0.77%	2.91
golden alexanders	<i>Zizia aurea</i>	0.19	0.17	1.56%	0.70
	<b>Total Forbs</b>	<b>1.12</b>	<b>1.00</b>	<b>9.09%</b>	<b>14.81</b>
Oats	<i>Avena sativa</i>	2.80	2.50	22.76%	1.12
	<b>Total Cover Crop</b>	<b>2.80</b>	<b>2.50</b>	<b>22.76%</b>	<b>1.12</b>
	<b>Totals:</b>	<b>12.33</b>	<b>11.00</b>	<b>100.00%</b>	<b>41.25</b>
<b>Purpose:</b>	Regional mesic prairie reconstruction for wetland mitigation, ecological restoration, or conservation program plantings.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands Province, Red River Prairie Section, Hardwood Hills subsection of the MN & NE IA Morainal Section, may extend into the far western portions of the Laurentian Mixed Forest Province. Mn/DOT Districts 2(west) & 4(north).				

35-241

## Mesic Prairie General

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	2.24	2.00	5.48%	7.35
side-oats grama	<i>Bouteloua curtipendula</i>	1.79	1.60	4.39%	3.53
kalm's brome	<i>Bromus kalmii</i>	0.56	0.50	1.37%	1.47
nodding wild rye	<i>Elymus canadensis</i>	1.31	1.17	3.20%	2.23
slender wheatgrass	<i>Elymus trachycaulus</i>	1.12	1.00	2.73%	2.53
switchgrass	<i>Panicum virgatum</i>	0.07	0.06	0.17%	0.32
little bluestem	<i>Schizachyrium scoparium</i>	1.79	1.60	4.39%	8.82
Indian grass	<i>Sorghastrum nutans</i>	2.24	2.00	5.48%	8.82
prairie dropseed	<i>Sporobolus heterolepis</i>	0.08	0.07	0.18%	0.39
	<b>Total Grasses</b>	<b>11.21</b>	<b>10.00</b>	<b>27.39%</b>	<b>35.46</b>
blue giant hyssop	<i>Agastache foeniculum</i>	0.07	0.06	0.15%	1.82
lead plant	<i>Amorpha canescens</i>	0.07	0.06	0.15%	0.25
common milkweed	<i>Asclepias syriaca</i>	0.04	0.04	0.10%	0.06
butterfly milkweed	<i>Asclepias tuberosa</i>	0.04	0.04	0.10%	0.06
Canada milk vetch	<i>Astragalus canadensis</i>	0.07	0.06	0.17%	0.39
white prairie clover	<i>Dalea candida</i>	0.07	0.06	0.17%	0.44
purple prairie clover	<i>Dalea purpurea</i>	0.21	0.19	0.51%	1.03
Canada tick trefoil	<i>Desmodium canadense</i>	0.07	0.06	0.18%	0.13
stiff sunflower	<i>Helianthus pauciflorus</i>	0.07	0.06	0.17%	0.09
ox-eye	<i>Heliopsis helianthoides</i>	0.15	0.13	0.34%	0.29
rough blazing star	<i>Liatris aspera</i>	0.03	0.03	0.08%	0.18
great blazing star	<i>Liatris pycnostachya</i>	0.03	0.03	0.09%	0.13
wild bergamot	<i>Monarda fistulosa</i>	0.07	0.06	0.17%	1.61
stiff goldenrod	<i>Oligoneuron rigidum</i>	0.07	0.06	0.17%	0.94
black-eyed susan	<i>Rudbeckia hirta</i>	0.35	0.31	0.86%	10.56
heath aster	<i>Symphyotrichum ericoides</i>	0.03	0.03	0.09%	2.30
smooth aster	<i>Symphyotrichum laeve</i>	0.07	0.06	0.17%	1.26
blue vervain	<i>Verbena hastata</i>	0.04	0.04	0.12%	1.50
hoary vervain	<i>Verbena stricta</i>	0.07	0.06	0.17%	0.64
golden alexanders	<i>Zizia aurea</i>	0.07	0.06	0.15%	0.23
	<b>Total Forbs</b>	<b>1.68</b>	<b>1.50</b>	<b>4.11%</b>	<b>23.89</b>
Oats	<i>Avena sativa</i>	28.02	25.00	68.50%	11.14
	<b>Total Cover Crop</b>	<b>28.02</b>	<b>25.00</b>	<b>68.50%</b>	<b>11.14</b>
	<b>Totals:</b>	<b>40.91</b>	<b>36.50</b>	<b>100.00%</b>	<b>70.49</b>
<b>Purpose:</b>	General mesic prairie mix for native roadsides, ecological restoration, or conservation program plantings.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				

## Emergent Wetland

34-181

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
American slough grass	<i>Beckmannia syzigachne</i>	0.78	0.70	14.07%	12.92
tall manna grass	<i>Glyceria grandis</i>	0.28	0.25	4.98%	6.40
rice cut grass	<i>Leersia oryzoides</i>	0.34	0.30	5.93%	3.70
	<b>Total Grasses</b>	<b>1.40</b>	<b>1.25</b>	<b>24.98%</b>	<b>23.02</b>
river bulrush	<i>Bolboschoenus fluviatilis</i>	0.85	0.76	15.20%	1.20
bristly sedge	<i>Carex comosa</i>	0.20	0.18	3.63%	2.00
lake sedge	<i>Carex lacustris</i>	0.07	0.06	1.19%	0.24
tussock sedge	<i>Carex stricta</i>	0.04	0.04	0.77%	0.75
least spikerush	<i>Eleocharis acicularis</i>	0.11	0.10	1.94%	2.50
marsh spikerush	<i>Eleocharis palustris</i>	0.11	0.10	2.03%	1.90
Torrey's rush	<i>Juncus torreyi</i>	0.04	0.04	0.85%	25.00
Three-square bulrush	<i>Schoenoplectus pungens</i>	0.26	0.23	4.54%	1.00
soft stem bulrush	<i>Schoenoplectus tabernaemontani</i>	0.49	0.44	8.78%	5.00
woolgrass	<i>Scirpus cyperinus</i>	0.06	0.05	1.02%	32.00
	<b>Total Sedges and Rushes</b>	<b>2.24</b>	<b>2.00</b>	<b>39.95%</b>	<b>71.59</b>
Sweet flag	<i>Acorus americanus</i>	0.31	0.28	5.53%	0.67
common water plantain	<i>Alisma triviale</i>	0.45	0.40	8.00%	9.70
marsh milkweed	<i>Asclepias incarnata</i>	0.31	0.28	5.67%	0.50
broad-leaved arrowhead	<i>Sagittaria latifolia</i>	0.34	0.30	6.07%	6.80
giant bur reed	<i>Sparganium eurycarpum</i>	0.55	0.49	9.80%	0.09
	<b>Total Forbs</b>	<b>1.96</b>	<b>1.75</b>	<b>35.07%</b>	<b>17.76</b>
	<b>Totals:</b>	<b>5.60</b>	<b>5.00</b>	<b>100.00%</b>	<b>112.37</b>
<b>Purpose:</b>	Emergent wetland restoration for use in wetland mitigation, shoreline restoration, wet stormwater ponds where emergent vegetation is desired.				
<b>Planting Area:</b>	Statewide				

## Wet Meadow South and West

34-271

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
fringed brome	<i>Bromus ciliatus</i>	1.23	1.10	9.18%	4.45
bluejoint	<i>Calamagrostis canadensis</i>	0.06	0.05	0.41%	5.00
Virginia wild rye	<i>Elymus virginicus</i>	1.12	1.00	8.37%	1.55
rice cut grass	<i>Leersia oryzoides</i>	0.28	0.25	2.07%	3.10
tall manna grass	<i>Glyceria grandis</i>	0.17	0.15	1.26%	3.90
fowl manna grass	<i>Glyceria striata</i>	0.11	0.10	0.83%	3.30
fowl bluegrass	<i>Poa palustris</i>	0.39	0.35	2.88%	16.50
	<b>Total Grasses</b>	<b>3.36</b>	<b>3.00</b>	<b>25.00%</b>	<b>37.80</b>
bristly sedge	<i>Carex comosa</i>	0.24	0.21	1.78%	2.36
pointed broom sedge	<i>Carex scoparia</i>	0.06	0.05	0.43%	1.60
awl-fruited sedge	<i>Carex stipata</i>	0.19	0.17	1.40%	2.10
tussock sedge	<i>Carex stricta</i>	0.03	0.03	0.21%	0.50
fox sedge	<i>Carex vulpinoidea</i>	0.16	0.14	1.13%	5.00
path rush	<i>Juncus tenuis</i>	0.04	0.04	0.34%	15.00
dark green bulrush	<i>Scirpus atrovirens</i>	0.20	0.18	1.48%	30.00
woolgrass	<i>Scirpus cyperinus</i>	0.09	0.08	0.67%	50.00
	<b>Total Sedges and Rushes</b>	<b>1.01</b>	<b>0.90</b>	<b>7.44%</b>	<b>106.56</b>
marsh milkweed	<i>Asclepias incarnata</i>	0.27	0.24	2.03%	0.43
common boneset	<i>Eupatorium perfoliatum</i>	0.02	0.02	0.18%	1.30
grass-leaved goldenrod	<i>Euthamia graminifolia</i>	0.01	0.01	0.06%	1.00
spotted Joe pye weed	<i>Eutrochium maculatum</i>	0.02	0.02	0.18%	0.75
autumn sneezeweed	<i>Helenium autumnale</i>	0.03	0.03	0.23%	1.30
sawtooth sunflower	<i>Helianthus grosseserratus</i>	0.04	0.04	0.30%	0.20
great lobelia	<i>Lobelia siphilitica</i>	0.02	0.02	0.13%	2.90
blue monkey flower	<i>Mimulus ringens</i>	0.01	0.01	0.07%	6.80
Virginia mountain mint	<i>Pycnanthemum virginianum</i>	0.07	0.06	0.53%	5.10
giant goldenrod	<i>Solidago gigantea</i>	0.02	0.02	0.14%	1.50
eastern panicled aster	<i>Symphyotrichum lanceolatum</i>	0.03	0.03	0.22%	1.50
red-stemmed aster	<i>Symphyotrichum puniceum</i>	0.19	0.17	1.42%	5.00
tall meadow-rue	<i>Thalictrum dasycarpum</i>	0.01	0.01	0.12%	0.11
blue vervain	<i>Verbena hastata</i>	0.15	0.13	1.12%	4.61
bunched ironweed	<i>Vernonia fasciculata</i>	0.03	0.03	0.28%	0.30
Culver's root	<i>Veronicastrum virginicum</i>	0.01	0.01	0.12%	4.20
golden alexanders	<i>Zizia aurea</i>	0.28	0.25	2.06%	1.00
	<b>Total Forbs</b>	<b>1.23</b>	<b>1.10</b>	<b>9.19%</b>	<b>38.00</b>
Oats	<i>Avena sativa</i>	7.85	7.00	58.37%	3.12
	<b>Total Cover Crop</b>	<b>7.85</b>	<b>7.00</b>	<b>58.37%</b>	<b>3.12</b>
	<b>Totals:</b>	<b>13.45</b>	<b>12.00</b>	<b>100.00%</b>	<b>185.48</b>
<b>Purpose:</b>	Wet meadow / Sedge meadow reconstruction for wetland mitigation or ecological restoration projects				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				



34-371

## Wet Meadow Northeast

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
fringed brome	<i>Bromus ciliatus</i>	2.24	2.00	16.04%	8.10
Bluejoint	<i>Calamagrostis canadensis</i>	0.11	0.10	0.78%	10.00
Virginia wild rye	<i>Elymus virginicus</i>	1.68	1.50	11.99%	2.31
tall manna grass	<i>Glyceria grandis</i>	0.28	0.25	1.96%	6.30
fowl bluegrass	<i>Poa palustris</i>	0.73	0.65	5.19%	31.00
	<b>Total Grasses</b>	<b>5.04</b>	<b>4.50</b>	<b>35.96%</b>	<b>57.71</b>
tussock sedge	<i>Carex stricta</i>	0.04	0.04	0.35%	0.85
pointed broom sedge	<i>Carex scoparia</i>	0.06	0.05	0.39%	1.50
dark green bulrush	<i>Scirpus atrovirens</i>	0.22	0.20	1.56%	33.00
woolgrass	<i>Scirpus cyperinus</i>	0.07	0.06	0.51%	40.00
	<b>Total Sedges and Rushes</b>	<b>0.39</b>	<b>0.35</b>	<b>2.81%</b>	<b>75.35</b>
Canada anemone	<i>Anemone canadensis</i>	0.11	0.10	0.82%	0.30
marsh milkweed	<i>Asclepias incarnata</i>	0.27	0.24	1.95%	0.43
flat-topped aster	<i>Doellingeria umbellata</i>	0.11	0.10	0.81%	2.50
common boneset	<i>Eupatorium perfoliatum</i>	0.10	0.09	0.68%	5.00
grass-leaved goldenrod	<i>Euthamia graminifolia</i>	0.04	0.04	0.31%	5.00
spotted Joe pye weed	<i>Eutrochium maculatum</i>	0.16	0.14	1.15%	5.00
blue monkey flower	<i>Mimulus ringens</i>	0.03	0.03	0.24%	25.00
giant goldenrod	<i>Solidago gigantea</i>	0.03	0.03	0.20%	2.30
eastern panicled aster	<i>Symphyotrichum lanceolatum</i>	0.03	0.03	0.28%	2.00
	<b>Total Forbs</b>	<b>0.90</b>	<b>0.80</b>	<b>6.44%</b>	<b>47.53</b>
Oats	<i>Avena sativa</i>	7.68	6.85	54.79%	3.05
	<b>Total Cover Crop</b>	<b>7.68</b>	<b>6.85</b>	<b>54.79%</b>	<b>3.05</b>
	<b>Totals:</b>	<b>14.01</b>	<b>12.50</b>	<b>100.00%</b>	<b>183.64</b>
<b>Purpose:</b>	Wet meadow / Sedge meadow reconstruction for wetland mitigation or ecological restoration.				
<b>Planting Area:</b>	Laurentian Mixed Forest Province. Mn/DOT Districts 1, 2(east) and 3A.				

## Wet Prairie

34-262

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	1.12	1.00	6.89%	3.67
fringed brome	<i>Bromus ciliatus</i>	1.68	1.50	10.38%	6.08
bluejoint	<i>Calamagrostis canadensis</i>	0.04	0.04	0.27%	4.00
Virginia wild rye	<i>Elymus virginicus</i>	1.96	1.75	12.07%	2.70
tall manna grass	<i>Glyceria grandis</i>	0.17	0.15	1.02%	3.80
fowl manna grass	<i>Glyceria striata</i>	0.12	0.11	0.73%	3.50
switchgrass	<i>Panicum virgatum</i>	0.84	0.75	5.16%	3.85
fowl bluegrass	<i>Poa palustris</i>	0.22	0.20	1.39%	9.60
Indian grass	<i>Sorghastrum nutans</i>	0.56	0.50	3.44%	2.20
prairie cordgrass	<i>Spartina pectinata</i>	0.56	0.50	3.41%	1.20
	<b>Total Grasses</b>	<b>7.29</b>	<b>6.50</b>	<b>44.76%</b>	<b>40.60</b>
wooly sedge	<i>Carex pellita</i>	0.06	0.05	0.32%	0.47
tussock sedge	<i>Carex stricta</i>	0.02	0.02	0.17%	0.48
fox sedge	<i>Carex vulpinoidea</i>	0.11	0.10	0.66%	3.50
dark green bulrush	<i>Scirpus atrovirens</i>	0.11	0.10	0.72%	17.74
woolgrass	<i>Scirpus cyperinus</i>	0.03	0.03	0.18%	16.00
	<b>Total Sedges and Rushes</b>	<b>0.34</b>	<b>0.30</b>	<b>2.05%</b>	<b>38.19</b>
Canada anemone	<i>Anemone canadensis</i>	0.03	0.03	0.21%	0.09
marsh milkweed	<i>Asclepias incarnata</i>	0.09	0.08	0.55%	0.14
Canada tick trefoil	<i>Desmodium canadense</i>	0.56	0.50	3.41%	1.00
flat-topped aster	<i>Doellingeria umbellata</i>	0.06	0.05	0.34%	1.20
common boneset	<i>Eupatorium perfoliatum</i>	0.03	0.03	0.23%	2.00
grass-leaved goldenrod	<i>Euthamia graminifolia</i>	0.02	0.02	0.11%	2.00
spotted Joe pye weed	<i>Eutrochium maculatum</i>	0.04	0.04	0.30%	1.50
autumn sneezeweed	<i>Helenium autumnale</i>	0.06	0.05	0.35%	2.39
sawtooth sunflower	<i>Helianthus grosseserratus</i>	0.06	0.05	0.38%	0.30
great blazing star	<i>Liatris pycnostachya</i>	0.02	0.02	0.17%	0.10
great lobelia	<i>Lobelia siphilitica</i>	0.01	0.01	0.05%	1.40
blue monkey flower	<i>Mimulus ringens</i>	0.01	0.01	0.05%	6.40
Virginia mountain mint	<i>Pycnanthemum virginianum</i>	0.09	0.08	0.55%	6.50
red-stemmed aster	<i>Symphyotrichum puniceum</i>	0.09	0.08	0.56%	2.40
blue vervain	<i>Verbena hastata</i>	0.17	0.15	1.06%	5.25
bunched ironweed	<i>Vernonia fasciculata</i>	0.03	0.03	0.23%	0.30
Culver's root	<i>Veronicastrum virginicum</i>	0.02	0.02	0.14%	6.00
golden alexanders	<i>Zizia aurea</i>	0.28	0.25	1.76%	1.03
	<b>Total Forbs</b>	<b>1.68</b>	<b>1.50</b>	<b>10.45%</b>	<b>40.00</b>
Oats	<i>Avena sativa</i>	6.95	6.20	42.74%	2.76
	<b>Total Cover Crop</b>	<b>6.95</b>	<b>6.20</b>	<b>42.74%</b>	<b>2.76</b>
	<b>Totals:</b>	<b>16.25</b>	<b>14.50</b>	<b>100.00%</b>	<b>121.55</b>
<b>Purpose:</b>	Wet prairie reconstruction for wetland mitigation or ecological restoration.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				

## Wetland Rehabilitation

34-171

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/sq ft
Virginia wild rye	<i>Elymus virginicus</i>	3.36	3.00	56.61%	4.63
fowl bluegrass	<i>Poa palustris</i>	1.12	1.00	18.89%	47.80
	<b>Total Grasses</b>	<b>4.48</b>	<b>4.00</b>	<b>75.50%</b>	<b>52.43</b>
fox sedge	<i>Carex vulpinoidea</i>	0.22	0.20	3.85%	7.50
path rush	<i>Juncus tenuis</i>	0.18	0.16	3.03%	59.00
dark green bulrush	<i>Scirpus atrovirens</i>	0.40	0.36	6.70%	60.00
woolgrass	<i>Scirpus cyperinus</i>	0.09	0.08	1.51%	50.00
	<b>Total Sedges and Rushes</b>	<b>0.90</b>	<b>0.80</b>	<b>15.09%</b>	<b>176.50</b>
nodding bur marigold	<i>Bidens cernua</i>	0.15	0.13	2.45%	1.00
Water Horehound	<i>Lycopus americanus</i>	0.37	0.33	6.29%	23.15
blue monkey flower	<i>Mimulus ringens</i>	0.04	0.04	0.67%	30.00
	<b>Total Forbs</b>	<b>0.56</b>	<b>0.50</b>	<b>9.41%</b>	<b>54.15</b>
	<b>Totals:</b>	<b>5.94</b>	<b>5.30</b>	<b>100.00%</b>	<b>283.08</b>
<b>Purpose:</b>	Interseeding into establishing wetlands after weed control spraying. Also suitable for two to five year short term soil stabilization for areas with saturated soils.				
<b>Planting Area:</b>	Statewide				

## Riparian South and West

34-261

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
American slough grass	<i>Beckmannia syzigachne</i>	1.52	1.36	4.30%	24.90
riverbank wild rye	<i>Elymus riparius</i>	0.56	0.50	1.58%	0.53
Virginia wild rye	<i>Elymus virginicus</i>	1.96	1.75	5.56%	2.70
tall manna grass	<i>Glyceria grandis</i>	0.28	0.25	0.80%	6.50
fowl manna grass	<i>Glyceria striata</i>	0.10	0.09	0.29%	3.00
rice cut grass	<i>Leersia oryzoides</i>	0.18	0.16	0.51%	2.00
fowl bluegrass	<i>Poa palustris</i>	0.94	0.84	2.66%	40.00
prairie cordgrass	<i>Spartina pectinata</i>	0.34	0.30	0.96%	0.74
	<b>Total Grasses</b>	<b>5.88</b>	<b>5.25</b>	<b>16.66%</b>	<b>80.37</b>
tussock sedge	<i>Carex stricta</i>	0.04	0.04	0.13%	0.80
pointed broom sedge	<i>Carex scoparia</i>	0.07	0.06	0.21%	2.00
fox sedge	<i>Carex vulpinoidea</i>	0.22	0.20	0.65%	7.50
path rush	<i>Juncus tenuis</i>	0.03	0.03	0.09%	10.00
dark green bulrush	<i>Scirpus atrovirens</i>	0.13	0.12	0.38%	20.00
woolgrass	<i>Scirpus cyperinus</i>	0.06	0.05	0.15%	30.00
	<b>Total Sedges and Rushes</b>	<b>0.56</b>	<b>0.50</b>	<b>1.61%</b>	<b>70.30</b>
marsh milkweed	<i>Asclepias incarnata</i>	0.13	0.12	0.38%	0.21
common boneset	<i>Eupatorium perfoliatum</i>	0.03	0.03	0.11%	2.00
spotted Joe pye weed	<i>Eutrochium maculatum</i>	0.07	0.06	0.18%	2.00
autumn sneezeweed	<i>Helenium autumnale</i>	0.06	0.05	0.17%	2.50
giant sunflower	<i>Helianthus giganteus</i>	0.08	0.07	0.22%	0.25
spotted touch-me-not	<i>Impatiens capensis</i>	0.06	0.05	0.17%	0.08
great lobelia	<i>Lobelia siphilitica</i>	0.03	0.03	0.09%	5.00
blue monkey flower	<i>Mimulus ringens</i>	0.01	0.01	0.02%	5.07
Virginia mountain mint	<i>Pycnanthemum virginianum</i>	0.06	0.05	0.16%	4.00
tall coneflower	<i>Rudbeckia laciniata</i>	0.06	0.05	0.15%	0.25
giant goldenrod	<i>Solidago gigantea</i>	0.02	0.02	0.07%	2.00
blue vervain	<i>Verbena hastata</i>	0.17	0.15	0.46%	5.00
bunched ironweed	<i>Vernonia fasciculata</i>	0.07	0.06	0.18%	0.50
	<b>Total Forbs</b>	<b>0.84</b>	<b>0.75</b>	<b>2.36%</b>	<b>28.86</b>
Oats	<i>Avena sativa</i>	28.02	25.00	79.37%	11.14
	<b>Total Cover Crop</b>	<b>28.02</b>	<b>25.00</b>	<b>79.37%</b>	<b>11.14</b>
	<b>Totals:</b>	<b>35.31</b>	<b>31.50</b>	<b>100.00%</b>	<b>190.66</b>
<b>Purpose:</b>	Native riparian and floodplain plantings for wetland mitigation, ecological restoration, or general permanent cover after culvert or bridge work. Tolerates partial shade.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				

## Riparian Northeast

34-361

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
American slough grass	<i>Beckmannia syzigachne</i>	1.68	1.50	4.78%	27.64
Bluejoint	<i>Calamagrostis canadensis</i>	0.07	0.06	0.19%	6.00
riverbank wild rye	<i>Elymus riparius</i>	0.56	0.50	1.57%	0.53
Virginia wild rye	<i>Elymus virginicus</i>	2.24	2.00	6.33%	3.08
tall manna grass	<i>Glyceria grandis</i>	0.28	0.25	0.80%	6.50
fowl manna grass	<i>Glyceria striata</i>	0.10	0.09	0.29%	3.00
rice cut grass	<i>Leersia oryzoides</i>	0.17	0.15	0.49%	1.93
fowl bluegrass	<i>Poa palustris</i>	0.78	0.70	2.23%	33.50
	<b>Total Grasses</b>	<b>5.88</b>	<b>5.25</b>	<b>16.68%</b>	<b>82.18</b>
tussock sedge	<i>Carex stricta</i>	0.04	0.04	0.13%	0.80
pointed broom sedge	<i>Carex scoparia</i>	0.07	0.06	0.21%	2.00
fox sedge	<i>Carex vulpinoidea</i>	0.22	0.20	0.65%	7.50
path rush	<i>Juncus tenuis</i>	0.03	0.03	0.09%	10.00
dark green bulrush	<i>Scirpus atrovirens</i>	0.13	0.12	0.38%	20.00
woolgrass	<i>Scirpus cyperinus</i>	0.06	0.05	0.15%	30.00
	<b>Total Sedges and Rushes</b>	<b>0.56</b>	<b>0.50</b>	<b>1.61%</b>	<b>70.30</b>
marsh milkweed	<i>Asclepias incarnata</i>	0.13	0.12	0.38%	0.21
flat-topped aster	<i>Doellingeria umbellata</i>	0.04	0.04	0.13%	1.00
common boneset	<i>Eupatorium perfoliatum</i>	0.06	0.05	0.16%	3.00
grass-leaved goldenrod	<i>Euthamia graminifolia</i>	0.08	0.07	0.22%	9.00
spotted Joe pye weed	<i>Eutrochium maculatum</i>	0.12	0.11	0.34%	3.70
giant sunflower	<i>Helianthus giganteus</i>	0.08	0.07	0.22%	0.25
spotted touch-me-not	<i>Impatiens capensis</i>	0.03	0.03	0.11%	0.05
blue monkey flower	<i>Mimulus ringens</i>	0.02	0.02	0.05%	13.00
giant goldenrod	<i>Solidago gigantea</i>	0.02	0.02	0.05%	1.50
blue vervain	<i>Verbena hastata</i>	0.25	0.22	0.68%	7.35
	<b>Total Forbs</b>	<b>0.84</b>	<b>0.75</b>	<b>2.34%</b>	<b>39.06</b>
Oats	<i>Avena sativa</i>	28.02	25.00	79.37%	11.14
	<b>Total Cover Crop</b>	<b>28.02</b>	<b>25.00</b>	<b>79.37%</b>	<b>11.14</b>
	<b>Totals:</b>	<b>35.31</b>	<b>31.50</b>	<b>100.00%</b>	<b>202.67</b>
<b>Purpose:</b>	Native riparian and floodplain plantings for wetland mitigation, ecological restoration, or general permanent cover after culvert or bridge work. Tolerates partial shade.				
<b>Planting Area:</b>	Laurentian Mixed Forest Province. Mn/DOT Districts 1, 2(east) and 3A.				



## Native Construction

32-241

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	<i>Andropogon gerardii</i>	1.40	1.25	3.30%	4.60
side-oats grama	<i>Bouteloua curtipendula</i>	1.12	1.00	2.64%	2.21
fringed brome	<i>Bromus ciliatus</i>	1.57	1.40	3.69%	5.67
nodding wild rye	<i>Elymus canadensis</i>	2.24	2.00	5.26%	3.82
slender wheatgrass	<i>Elymus trachycaulus</i>	2.80	2.50	6.57%	6.33
Virginia wild rye	<i>Elymus virginicus</i>	2.24	2.00	5.26%	3.09
switchgrass	<i>Panicum virgatum</i>	0.84	0.75	1.97%	3.85
fowl bluegrass	<i>Poa palustris</i>	0.67	0.60	1.57%	28.50
Indian grass	<i>Sorghastrum nutans</i>	1.12	1.00	2.63%	4.40
	<b>Total Grasses</b>	<b>14.01</b>	<b>12.50</b>	<b>32.89%</b>	<b>62.47</b>
Canada tick trefoil	<i>Desmodium canadense</i>	0.08	0.07	0.20%	0.15
partridge pea	<i>Chamaecrista fasciculata</i>	0.30	0.27	0.72%	0.27
wild bergamot	<i>Monarda fistulosa</i>	0.02	0.02	0.04%	0.39
black-eyed susan	<i>Rudbeckia hirta</i>	0.10	0.09	0.23%	3.00
hoary vervain	<i>Verbena stricta</i>	0.06	0.05	0.13%	0.50
	<b>Total Forbs</b>	<b>0.56</b>	<b>0.50</b>	<b>1.32%</b>	<b>4.31</b>
Oats	<i>Avena sativa</i>	28.02	25.00	65.79%	11.14
	<b>Total Cover Crop</b>	<b>28.02</b>	<b>25.00</b>	<b>65.79%</b>	<b>11.14</b>
	<b>Totals:</b>	<b>42.59</b>	<b>38.00</b>	<b>100.00%</b>	<b>77.91</b>
<b>Purpose:</b>	Mid-term soil stabilization using native species. Also suitable for sides of agricultural drainage ditches or low-diversity mesic prairie planting.				
<b>Planting Area:</b>	Tallgrass Aspen Parklands, Prairie Parkland, and Eastern Broadleaf Forest Provinces. Mn/DOT Districts 2(west), 3B, 4, Metro, 6, 7 & 8.				

# BWSR Pilot Seed Mixes

## PILOT SEED MIXES:

These new “Pilot” seed mixes have been developed for a variety of restoration, conservation and stormwater uses. Goals were to meet the needs of common project types and to create direction for emerging topics such as biofuels, buffers, conservation grazing, and pollinators. All of the mixes were developed for specific functions and incorporate pollinator habitat to the extent possible. The mixes will remain as pilot mixes for a couple years until we understand how they are performing before we work to make them official state mixes. In many cases these mixes should be considered starting points for developing site specific mixes.

Note: Oats cover crop is included as a component of these seed mixes with the exception of some wetland mixes where cover species are not necessary. Winter wheat (at a similar rate to oats) may be selected in some cases where germination is needed later in the fall, followed by further green-up the following spring (oats will not come back the follow spring unless it re-establishes from seed).

### Finalized

## Eroding Bank Stabilization Northwest & South

Function: Conservation

Intent: Stabilized steep eroding slopes with both early and later successional species.

Planting Area: NW & S

Specialization: NRCS 342

	Scientific Name	Common Name	Seeds/ sq ft	Rate (lb/ac)	% Mix (by sqft)	% Mix (by wt)
<b>Cover</b>	Avena sativa	Oats* (See Cover crop note)	11.14	37.91		
	Total Guild:		11.14	37.91	17.74%	76.6%
<b>Forb</b>	Achillea millefolium	Common Yarrow	0.7	0.01		
	Rudbeckia hirta	Black-eyed Susan	2.49	0.07		
	Verbena hastata	Blue Vervain	1.9	0.06		
	Total Guild:		5.09	0.14	8.11%	0.3%
<b>Graminoid</b>	Andropogon gerardii	Big Bluestem	5.5	1.50		
	Bromus ciliatus	Fringed Brome	3	0.82		
	Elymus canadensis	Canada Wild Rye	2.8	1.47		
	Elymus riparius	Riverbank Wild Rye	0.175	0.16		
	Elymus trachycaulus	Slender Wheatgrass	5.3	2.62		
	Elymus virginicus	Virginia Wild Rye	3	1.94		
	Panicum virgatum	Switchgrass	3.05	0.59		

Poa palustris	Fowl Bluegrass	16	0.34
Sorghastrum nutans	Indian Grass	6.6	1.50

Total Guild:	45.425	10.94	72.34%	22.1%
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## Legume

Astragalus canadensis	Canada Milk Vetch	0.2	0.04
Chamaecrista fasciculata	Partridge Pea	0.2	0.20
Dalea purpurea	Purple Prairie Clover	0.5	0.09
Desmodium canadense	Canada Tick Trefoil	0.19	0.09
Vicia americana	American Vetch	0.051	0.07

Total Guild:	1.141	0.49	1.82%	1.0%
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Total Seed Mix:	62.796	49.48
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# BWSR Pilot Seed Mixes

## PILOT SEED MIXES:

These new “Pilot” seed mixes have been developed for a variety of restoration, conservation and stormwater uses. Goals were to meet the needs of common project types and to create direction for emerging topics such as biofuels, buffers, conservation grazing, and pollinators. All of the mixes were developed for specific functions and incorporate pollinator habitat to the extent possible. The mixes will remain as pilot mixes for a couple years until we understand how they are performing before we work to make them official state mixes. In many cases these mixes should be considered starting points for developing site specific mixes.

Note: Oats cover crop is included as a component of these seed mixes with the exception of some wetland mixes where cover species are not necessary. Winter wheat (at a similar rate to oats) may be selected in some cases where germination is needed later in the fall, followed by further green-up the following spring (oats will not come back the follow spring unless it re-establishes from seed).

## Finalized

## Conservation Grazing South & West

Function: Production

Intent: Native prairie conservation grazing for southern and western MN

Planting Area: S & W

Specialization: NRCS 643 & 512

Scientific Name	Common Name	Seeds/ sq ft	Rate (lb/ac)	% Mix (by sqft)	% Mix (by wt)
<b>Cover</b>					
Avena sativa	Oats* (See Cover crop note)	1.42	4.83		
Total Guild:		1.42	4.83	2.69%	33.8%

## Forb

Coreopsis palmata	Bird's Foot Coreopsis	0.15	0.04
Helianthus maximiliani	Maximilian's Sunflower	0.4	0.08
Liatris aspera	Rough Blazing Star	0.4	0.07
Monarda fistulosa	Wild Bergamot	1.4	0.05
Potentilla arguta	Prairie Cinquefoil	2.4	0.03
Ratibida pinnata	Gray-headed Coneflower	1	0.09
Rudbeckia hirta	Black-eyed Susan	10	0.30
Sisyrinchium campestre	Field Blue-eyed Grass	0.17	0.01
Symphyotrichum laeve	Smooth Aster	0.6	0.03
Verbena stricta	Hoary Vervain	1.5	0.15
Viola pedatifida	Bearded Birdfoot Violet	0.14	0.01
Zizia aurea	Golden Alexanders	0.8	0.20

		Total Guild:	18.96	1.06	35.85%	7.4%
<b>Graminoid</b>						
Andropogon gerardii	Big Bluestem		3	0.82		
Bouteloua curtipendula	Side-oats Grama		4	1.80		
Bromus kalmii	Kalm's Brome		0.9	0.31		
Elymus canadensis	Canada Wild Rye		1	0.52		
Elymus trachycaulus	Slender Wheatgrass		1	0.50		
Elymus virginicus	Virginia Wild Rye		1	0.65		
Koeleria macrantha	Junegrass		2	0.03		
Panicum virgatum	Switchgrass		2	0.39		
Schizachyrium scoparium	Little Bluestem		5	0.91		
Sorghastrum nutans	Indian Grass		4	0.91		
Sporobolus heterolepis	Prairie Dropseed		4	0.68		
		Total Guild:	27.9	7.52	52.76%	52.6%
<b>Legume</b>						
Astragalus canadensis	Canada Milk Vetch		1.2	0.19		
Chamaecrista fasciculata	Partridge Pea		0.1	0.10		
Dalea candida	White Prairie Clover		1.3	0.19		
Dalea purpurea	Purple Prairie Clover		1.7	0.31		
Lespedeza capitata	Round-headed Bush Clover		0.3	0.10		
		Total Guild:	4.6	0.89	8.70%	6.2%
		Total Seed Mix:	52.88	14.30		



# BWSR Pilot Seed Mixes

## PILOT SEED MIXES:

These new “Pilot” seed mixes have been developed for a variety of restoration, conservation and stormwater uses. Goals were to meet the needs of common project types and to create direction for emerging topics such as biofuels, buffers, conservation grazing, and pollinators. All of the mixes were developed for specific functions and incorporate pollinator habitat to the extent possible. The mixes will remain as pilot mixes for a couple years until we understand how they are performing before we work to make them official state mixes. In many cases these mixes should be considered starting points for developing site specific mixes.

Note: Oats cover crop is included as a component of these seed mixes with the exception of some wetland mixes where cover species are not necessary. Winter wheat (at a similar rate to oats) may be selected in some cases where germination is needed later in the fall, followed by further green-up the following spring (oats will not come back the follow spring unless it re-establishes from seed).

### Finalized

## Native Forage Buffer Mix South & West

Function: Buffers

Intent: Native buffer seed mix that can be hayed once or twice a year

Planting Area: S & W

Specialization: NRCS 393

	Scientific Name	Common Name	Seeds/ sq ft	Rate (lb/ac)	% Mix (by sqft)	% Mix (by wt)
<b>Cover</b>						
	Avena sativa	Oats* (See Cover crop note)	11.14	37.91		
		Total Guild:	11.14	37.91	21.85%	74.6%
<b>Forb</b>						
	Helianthus maximilianii	Maximilian's Sunflower	0.3	0.06		
	Ratibida pinnata	Gray-headed Coneflower	2.15	0.20		
		Total Guild:	2.45	0.26	4.81%	0.5%
<b>Graminoid</b>						
	Andropogon gerardii	Big Bluestem	8	2.18		
	Bromus ciliatus	Fringed Brome	2	0.54		
	Bromus kalmii	Kalm's Brome	1	0.35		
	Elymus canadensis	Canada Wild Rye	3	1.57		
	Elymus trachycaulus	Slender Wheatgrass	4	1.98		
	Elymus virginicus	Virginia Wild Rye	3	1.94		
	Panicum virgatum	Switchgrass	7	1.36		
	Sorghastrum nutans	Indian Grass	6	1.36		

Total Guild:	34	11.28	66.69%	22.2%
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**Legume**

Chamaecrista fasciculata	Partridge Pea	0.99	0.99
Dalea candida	White Prairie Clover	1.3	0.19
Dalea purpurea	Purple Prairie Clover	1.1	0.20

Total Guild:	3.39	1.38	6.65%	2.7%
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Total Seed Mix:	50.98	50.83
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## PILOT SEED MIXES:

These new “Pilot” seed mixes have been developed for a variety of restoration, conservation and stormwater uses. Goals were to meet the needs of common project types and to create direction for emerging topics such as biofuels, buffers, conservation grazing, and pollinators. All of the mixes were developed for specific functions and incorporate pollinator habitat to the extent possible. The mixes will remain as pilot mixes for a few years until we understand how they are performing before we work to make them official state mixes. In many cases these mixes should be considered starting points for developing site specific mixes.

Note: Oats cover crop is included as a component of these seed mixes with the exception of some wetland mixes where cover species are not necessary. Winter wheat (at a similar rate to oats) may be selected in some cases where germination is needed later in the fall, followed by further green-up the following spring (oats will not come back the follow spring unless it re-establishes from seed).

## Finalized

## Beneficial Insects South & West

Function: Pollinator

Intent: Establishment of diverse vegetation for beneficial insects in agricultural areas

Planting Area: S & W

Specialization:

	Scientific Name	Common Name	Seeds/ sq ft	Rate (lb/ac)	% Mix (by sqft)	% Mix (by wt)
<b>Cover</b>						
	Avena sativa	Oats* (See Cover crop note)	11.14	37.91		
	Total Guild:		11.14	37.91	12.79%	82.3%

## Forb

Achillea millefolium	Common Yarrow	2	0.03
Agastache foeniculum	Blue Giant Hyssop	2.1	0.06
Allium stellatum	Prairie Wild Onion	0.28	0.07
Amorpha canescens	Lead Plant	0.37	0.06
Asclepias syriaca	Common Milkweed	0.16	0.11
Asclepias tuberosa	Butterfly Milkweed	0.071	0.04
Asclepias verticillata	Whorled Milkweed	0.1	0.02
Coreopsis palmata	Bird's Foot Coreopsis	0.15	0.04
Drymocallis arguta	Tall Cinquefoil	5.3	0.06
Echinacea angustifolia	Narrow-leaved Purple Conefl	0.115	0.04
Helenium autumnale	Autumn Sneezeweed	2.98	0.06
Helianthus maximilianii	Maximilian's Sunflower	0.3	0.06

Helianthus pauciflorus	Stiff Sunflower	0.074	0.05
Heliopsis helianthoides	Ox-eye	0.9	0.39
Liatris aspera	Rough Blazing Star	0.37	0.06
Liatris ligulistylis	Northern Plains Blazing Star	0.19	0.05
Monarda fistulosa	Wild Bergamot	1.2	0.05
Monarda punctata	Horsemint	0.7	0.02
Oligoneuron rigidum	Stiff Goldenrod	0.94	0.06
Penstemon digitalis	Foxglove Beardtongue	2.98	0.06
Penstemon grandiflorus	Large-flowered Beard Tongue	0.4	0.08
Pycnanthemum virginianum	Virginia Mountain Mint	3.81	0.05
Rudbeckia hirta	Black-eyed Susan	0.7	0.05
Sisyrinchium campestre	Field Blue-eyed Grass	0.2	0.03
Solidago speciosa	Showy Goldenrod	1.6	0.05
Symphyotrichum ericoides	Heath Aster	1.7	0.02
Symphyotrichum laeve	Smooth Aster	1.1	0.05
Symphyotrichum novae-angliae	New England Aster	1	0.04
Tradescantia bracteata	Bracted Spiderwort	0.23	0.06
Verbena hastata	Blue Vervain	7	0.20
Zizia aptera	Heart-leaved Alexanders	0.26	0.06
Zizia aurea	Golden Alexanders	0.82	0.20

Total Guild:	40.10	2.28	46.04%	4.9%
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## Graminoid

Bouteloua curtipendula	Side-oats Grama	3	1.36
Elymus canadensis	Canada Wild Rye	2	1.05
Koeleria macrantha	Junegrass	17	0.23
Schizachyrium scoparium	Little Bluestem	8	1.45
Sporobolus heterolepis	Prairie Dropseed	1.85	0.31

Total Guild:	31.85	4.40	36.57%	9.6%
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## Legume

Chamaecrista fasciculata	Partridge Pea	1	1.01
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Dalea candida	White Prairie Clover	1.5	0.21
Dalea purpurea	Purple Prairie Clover	1.5	0.27

Total Guild:		4	1.49	4.59%	3.2%
Total Seed Mix:		87.09	46.08		



**Appendix D**  
**Spill Reporting-Agency Contacts**

Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
<b>Federal Contacts</b>						
National Response Center	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface	Release of a hazardous substance in an amount equal to or greater than its reportable quantity under CERCLA	Immediately	1-800-424-8802	40 CFR 302 – Designation, Reportable Quantities, and Notification	
Environmental Protection Agency Region V (MN / WI)	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-312-353-2000	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	
Environmental Protection Agency Region VIII (ND)	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-303-312-6312	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	
<b>Tribal Contacts</b>						
Bois Forte	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-218-742-9825	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	St. Louis County dispatch

Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
Fond du Lac	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface	Release of a hazardous substance in an amount equal to or greater than its reportable quantity under CERCLA	Immediately	1-800-424-8802	Wetlands Protection and Management Ordinance #03/06  Fond du Lac Band of Lake Superior Chippewa Ordinance #04/06 Brownfield Oversight and Enforcement	For spills that have occurred in and/or adjacent to wetlands, notification of containment and clean-up is required within 3 days after commencement of activity.
Grand Portage	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-218-387-3030	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	Cook County dispatch
Leech Lake	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface	Release of a hazardous substance in an amount equal to or greater than its reportable quantity under CERCLA	Immediately	1-888-622-9225  1-218-335-7400	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	

Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
Lower Sioux	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-507-637-4036	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability  Water quality for Lower Sioux Jurisdictional Waters	Lower Sioux Police dispatch
Mille Lacs	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-888-860-8250	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	Mille Lacs County dispatch
Prairie Island	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	651-267-4000	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	

Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
Red Lake	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-218-679-3313	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	
Shakopee	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-952-445-1411	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	Scott County Emergency dispatch
Upper Sioux	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-800-422-0798 (in State) or 651-649-5451	40 CFR 117 – Determination of Reportable Quantities for Hazardous Substances  Clean Water Act § 311 – Oil and Hazardous Substance Liability	MN State Duty Officer hotline
White Earth	Any quantity of discharged oil that violates state water quality standards, causes a film or sheen on water's surface or leaves sludge or emulsion beneath the surface		Immediately	1-218-983-3281	W.E.E.C 200.00 Wetlands Code	



Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
<b>State Contacts</b>						
Minnesota Pollution Control Agency	Any discharge of material which may cause pollution.	No minimum quantity for crude oil. Any spill >5 gallons of refined petroleum product. Spills of any quantity of all other chemicals or materials should be reported.	Immediately upon discovery.	Minnesota State Duty Officer 1-800-422-0798 (In State) or (651) 649-5451	Minnesota Statute 115.061	Follow up report established after initial response.
North Dakota Department of Environmental Quality	Any incident or spill which may potentially result in pollution of waters of the state, either surface or groundwater or that may potentially have adverse effects to human health.	No minimum requirement. All spills that may potentially have adverse effects on human health and any historical contamination discovered during environmental investigations.	Immediately upon discovery.	North Dakota Department of Environmental Quality  North Dakota Hazardous Materials Emergency Assistance and Spill Reporting  1-800-472-2121 (In State)  1-701-328-5210 (Out of State)	North Dakota Administrative Code NDAC 33-16-02.1-1	Follow up report established after initial response.

Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
Wisconsin Department of Natural Resources	All spills are reportable if they adversely threaten or impact air, lands, and waters of the State as either a single discharge or an accumulation of past and present discharges or threaten or cause acute or chronic impacts to human health.	All spills are reportable unless they meet the following criteria: 1) spill is contained on an impervious surface; 2) <5 gallons of petroleum products onto a pervious surface or runs off an impervious surface; 3) <1 gallon of gasoline onto a pervious surface or runs off an impervious surface.	Immediately of any discharge not exempted by the statute.	24-hour WI DNR reporting number 1-800-943-0003	Chapter 292.11 of the Wisconsin Statutes, Chapter NR 706 Wisconsin Administrative Code	Follow up report established after initial response.
<b>County Contacts – Minnesota</b>						
Kittson County Emergency Management	As Needed			Scot Olson (218) 843-2113	Kittson County 2015 Hazard Mitigation Plan	
Marshall County Emergency Services	As Needed			Josh Johnston (218) 745-5841	Marshall County, MN Hazard Mitigation Plan 2016 Update	
Pennington County Emergency Management	As Needed			Erik Beitel (218) 683-7087		
Wadena County Emergency Management	As Needed			Tyler Wheeler (218) 631-7795	Wadena County Multi-Hazard Mitigation Update 2015-2020	
Polk County Emergency Management	As Needed			Jody Beauchane, Director (218) 470-8263	Polk County, MN Hazard Mitigation Plan (July 2015)	
Red Lake County Emergency Management	As Needed			Mitch Bernstein (218) 253-2996		

Spill Reporting Contacts						
Agency	Water	Soil	Notification Period	24-Hour Reporting Hotline	Regulation/Code	Comments
Clearwater County Emergency Management	As Needed		8:00 AM – 4:30 PM Monday – Friday	(218) 694-6226		
Hubbard County Emergency Management	As Needed			Brian Halbasch (218) 732-2588		
Cass County Emergency Management	As Needed			Chad Emery (218) 547-7437	Cass County Hazard Mitigation Plan	
Crow Wing County Emergency Management	As Needed			Scott Goddard, Sheriff (218) 829-4749		
Aitkin County Emergency Management	As Needed			Dispatch (non-emergency) (218) 927-7400		
Carlton County Emergency Management	As Needed			Steve VanKekerix, Director (218) 384-9539		
St Louis County Emergency Management	As Needed			Sheriff's Office Emergency Management Division (218) 336-4340		
<b>County Contacts – North Dakota</b>						
Pembina County Emergency Management	As Needed			Andrew Kirking (701) 265-4849		
<b>County Contacts – Wisconsin</b>						
Douglas County Emergency Management	As Needed		8:00 AM – 4:30 PM Monday – Friday	Dave Sletten, Director (715) 395-1497		

## **Appendix E**

### **Emergency Response Contractors/ Disposal and Treatment Facilities**

## Emergency Response Contractors

The Contractor will dispose of all wastes according to applicable federal, state, and local requirements. A listing of potential Emergency Spill Response Contractors and is provided below, and waste disposal facilities by state are provided in the pages that follow. This list was developed from state-wide databases. This list represents firms operating at the time the database was produced. The Contractor is responsible for verifying if a contractor or facility is currently operating under appropriate permits or licenses. The Contractor is responsible for ensuring wastes are disposed of properly.

Spill Response Contractors		
Company	City/State	Phone Number
<b>North Dakota</b>		
Clean Harbors Environmental	Williston, ND	(701) 774-2201 (800) 645-8265
Garner Environmental Services	Williston, ND	(701) 577-1200 (855) 774-1200
Absorbent & Safety Solutions	Watford City, ND	(701) 838-4558
Minnesota Limited	Berthold, ND	(701) 453-3700
Bobs Oilfield Service Inc	Belfield, ND	(701) 575-4666
Keitu Engineers & Consultants, Inc.	Mandan, ND	(701) 667-1800
<b>Minnesota</b>		
Bay West Environmental	St. Paul, MN	(800) 279-0456 (651) 291-0456
West Central Environmental Consultants Inc.	Morris, MN	(800) 422-8356 (888) 923-2778
Minnesota Limited	Bemidji, MN	(218) 755-9595
OSI Environmental	Bemidji, MN	(800) 585-8838
OSI Environmental	Eveleth, MN	(800) 777-8542
Bay West Environmental	Duluth, MN	(800) 279-0456 (218) 740-0110
<b>Wisconsin</b> - <i>The Contractor should consult with the WDNR Northern Regional Spill Coordinator (John Sager: phone (715) 365-8959) for assistance when selecting a spill response contractor.</i>		





EMERGENCY RESPONSE WASTE MANAGEMENT GUIDANCE

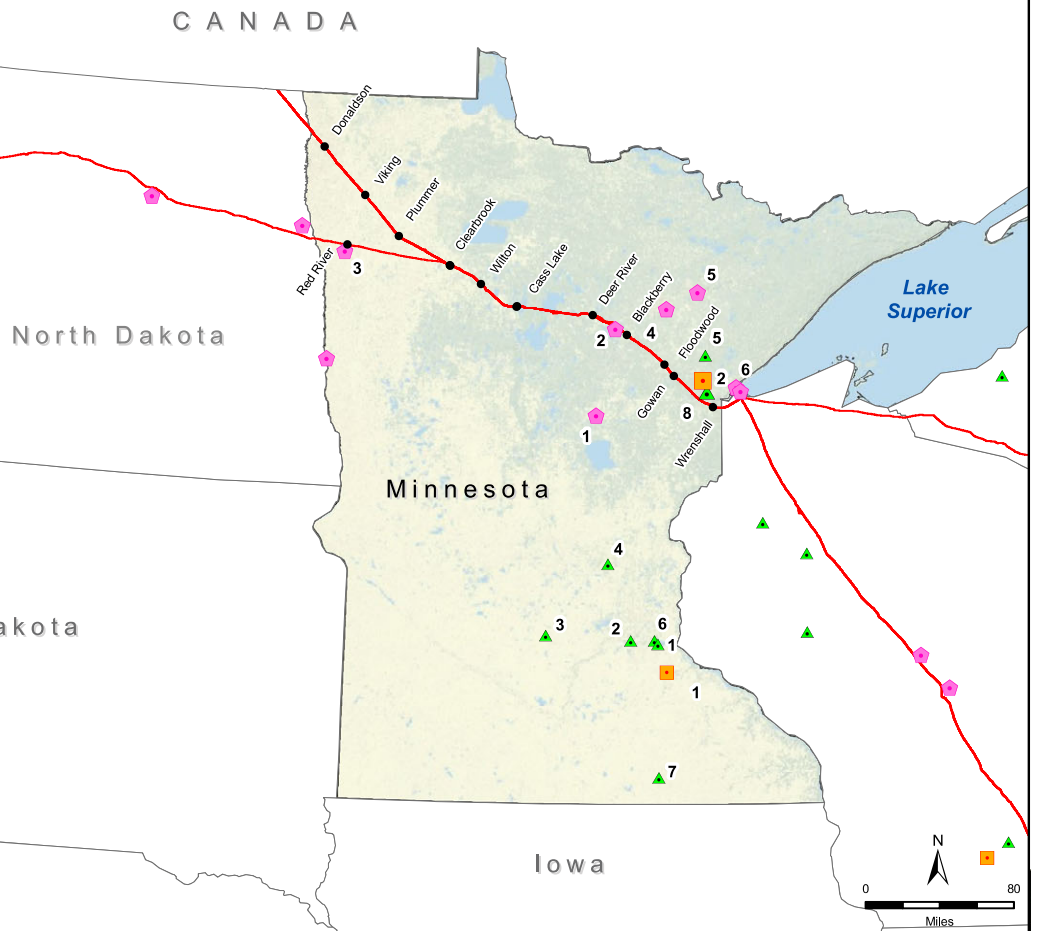
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Facility ID	Facility (Minnesota)
<b>Hazardous Waste Facilities</b>	
1	Clean Harbors, Cannon Falls
2	Safety-Kleen, Inc.
<b>Waste Water Treatment Plant Facilities (WWTP)</b>	
1	Aitkin Sewage Treatment Plant
2	GRPUC Wastewater Treatment Facility
3	Crookston Wastewater Treatment Facility
4	Hibbing Waste Treatment Plant
5	Virginia Wastewater Treatment
6	WLSSD
<b>Non-Hazardous Waste Facilities</b>	
1	Pinebend Landfill (Republic Services)
2	Burnsville Sanitary Landfill (WM)
3	Spruce Ridge Landfill (WM)
4	Elk River Landfill (WM)
5	Canyon (Voyageur) (WM)
6	SKB - Rosemount
7	SKB - Environmental Landfill
8	SKB - Shamrock Landfill

\*For North Dakota and Wisconsin - see state map for facility information



Map Location



Legend

- Hazardous Waste Facility
- Waste Water Treatment Plant (WWTP)
- Non-Hazardous Waste Facility
- Enbridge Pipeline

Drawn: LBG 5/13/2016  
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Project #: Disposal

WASTE FACILITIES -  
MINNESOTA

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Appendix

## Waste Facilities – Minnesota

Facility ID	Facility (Minnesota)	Waste Type	Address	City	State	Zip	County	Contact Phone
<b>Hazardous Waste Facilities</b>								
1	Clean Harbors, Cannon Falls	Solid & Liquid - Haz	211 Holiday Avenue	Cannon Falls	MN	55009	Goodhue	(507) 263-0252
2	Safety-Kleen, Inc.	Solid & Liquid - Haz	1302 18th Street	Cloquet	MN	55720	Goodhue	(218) 879-2164
<b>Waste Water Treatment Plant Facilities (WWTP)</b>								
1	Aitkin Sewage Treatment Plant	Liquid - WWTP	120 1st Street Northwest	Aitkin	MN	56431	Aitkin	(218) 927-3406
2	GRPUC Wastewater Treatment Facility	Liquid - WWTP	1105 SE 23rd Avenue	Grand Rapids	MN	55744	Itasca	(218) 326-7024
3	Crookston Wastewater Treatment Facility	Liquid - WWTP	County Road 233	Crookston	MN	56716	Polk	(218) 281-5711
4	Hibbing Waste Treatment Plant	Liquid - WWTP	11669 Town Line Road	Hibbing	MN	55746	St. Louis	(218) 362-5999
5	Virginia Wastewater Treatment	Liquid - WWTP	1204 Southern Drive	Virginia	MN	55792	St. Louis	(218) 748-7519
6	WLSSD	Liquid - WWTP	2626 Courtland Street	Duluth	MN	55806	St. Louis	(218) 722-3336
<b>Non-Hazardous Waste Facilities</b>								
1	Pinebend Landfill (Republic Services)	Solid - NonHaz	2495 East 117th Street	Inver Grove Heights	MN	55077	Dakota	(651) 450-2155
2	Burnsville Sanitary Landfill (WM)	Solid - NonHaz	2650 West Cliff Road	Burnsville	MN	55337	Dakota	(952) 890-3248
3	Spruce Ridge Landfill (WM)	Solid - NonHaz	12755 137th Street	Glencoe	MN	55336	McLeod	(320) 864-5503
4	Elk River Landfill (WM)	Solid - NonHaz	22460 Highway 169	Elk River	MN	55330	Sherburne	(763) 441-2464
5	Canyon (Voyageur) (WM)	Solid - NonHaz	6830 Highway 53	Canyon	MN	55717	St. Louis	(218) 345-6302
6	SKB - Rosemount	Solid - NonHaz	13425 Courthouse Blvd	Rosemount	MN	55060	Dakota	(651) 438-1500
7	SKB - Environmental Landfill	Solid - NonHaz	52563 243rd Street	Austin	MN	55912	Mower	(507) 433-8131
8	SKB - Shamrock Landfill	Solid - NonHaz	761 MN Highway 45	Cloquet	MN	55720	Carlton	(218) 878-0112

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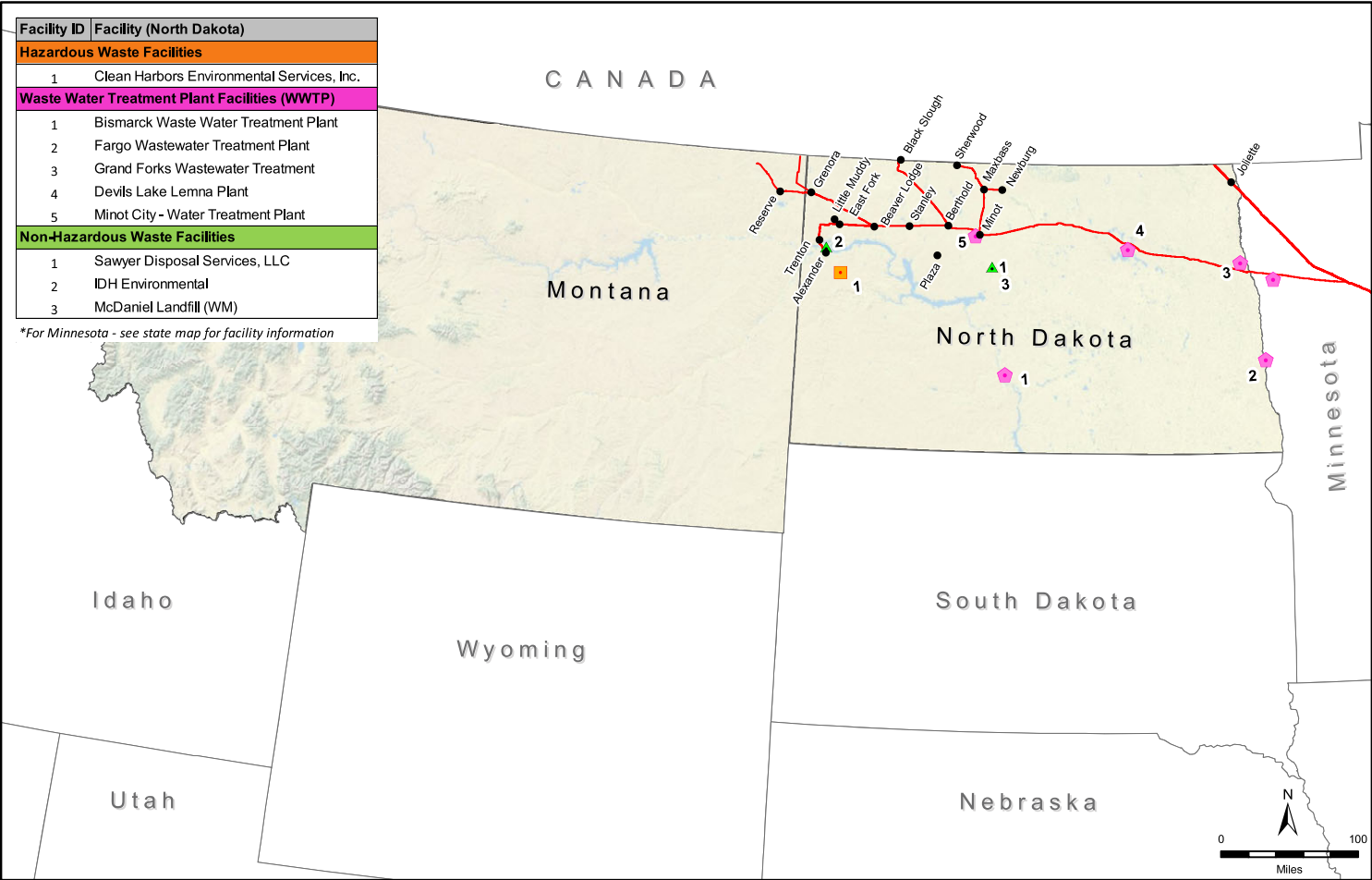
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Facility ID	Facility (North Dakota)
<b>Hazardous Waste Facilities</b>	
1	Clean Harbors Environmental Services, Inc.
<b>Waste Water Treatment Plant Facilities (WWTP)</b>	
1	Bismarck Waste Water Treatment Plant
2	Fargo Wastewater Treatment Plant
3	Grand Forks Wastewater Treatment
4	Devils Lake Lemna Plant
5	Minot City - Water Treatment Plant
<b>Non-Hazardous Waste Facilities</b>	
1	Sawyer Disposal Services, LLC
2	IDH Environmental
3	McDaniel Landfill (WM)

\*For Minnesota - see state map for facility information



Drawn: LBG 5/13/2016  
Approved: LBG 5/13/2016  
Project #: Disposal

Map Location

Legend

- Hazardous Waste Facility
- Waste Water Treatment Plant (WWTP)
- Non-Hazardous Waste Facility
- Enbridge Pipeline

**WASTE FACILITIES -**  
**NORTH DAKOTA AND MONTANA**

## Waste Facilities – North Dakota and Montana

Facility ID	Facility (North Dakota)	Waste Type	Address	City	State	Zip	County	Contact Phone
<b>Hazardous Waste Facilities</b>								
1	Clean Harbors Environmental Services, Inc.	Solid & Liquid - Haz	2541 132nd C Avenue NW	Arnegard	ND	58835	McKenzie	(701) 586-3170
<b>Waste Water Treatment Plant Facilities (WWTP)</b>								
1	Bismarck Waste Water Treatment Plant	Liquid -WWTP	601 London Avenue	Bismarck	ND	58504	Burleigh	(701) 222-6618
2	Fargo Wastewater Treatment Plant	Liquid -WWTP	3400 Broadway North	Fargo	ND	58102	Cass	(701) 241-1454
3	Grand Forks Wastewater Treatment	Liquid -WWTP	3251 North 69th Street	Grand Forks	ND	58203	Grand Forks	(701) 787-9131
4	Devils Lake Lemna Plant	Liquid -WWTP	2815 North Dakota 19	Devils Lake	ND	58301	Ramsey	(701) 662-7623
5	Minot City - Water Treatment Plant	Liquid -WWTP	900 16th Street Southwest	Minot	ND	58701	Ward	(701) 857-4760
<b>Non-Hazardous Waste Facilities</b>								
1	Sawyer Disposal Services, LLC	Solid & Liquid - NonHaz	12400 247th Ave Southeast	Sawyer	ND	58781	Ward	(701) 624-5622
2	IDH Environmental	Solid - NonHaz	14070 43rd Street Northwest	Williston	ND	58801	Williams	(701) 774-8514
3	McDaniel Landfill (WM)	Solid - NonHaz	12300 247th Avenue Southeast	Sawyer	ND	58781	Ward	(701) 624-5250

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EMERGENCY RESPONSE WASTE MANAGEMENT GUIDANCE

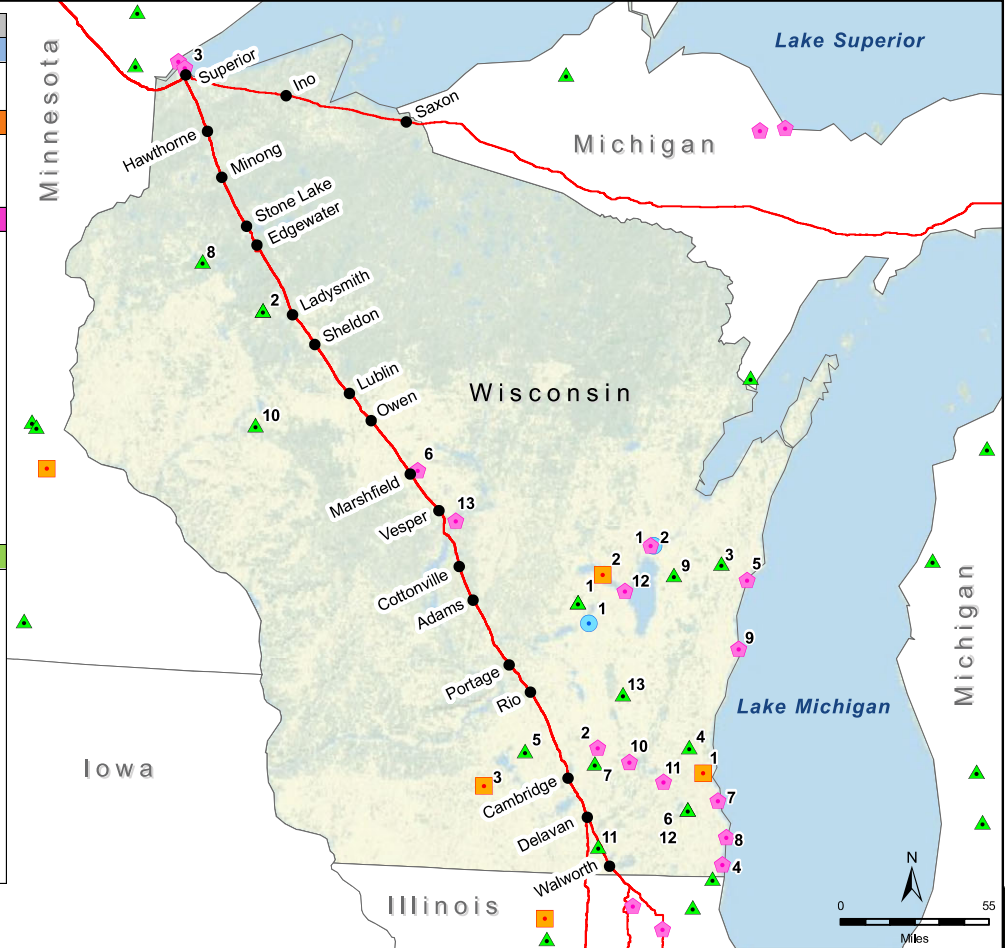
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Version Date: 05/13/2016



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Facility ID	Facility (Wisconsin)
<b>Liquid Waste Facilities</b>	
1	Covanta Environmental Solutions
2	Covanta Environmental Solutions
<b>Hazardous Waste Facilities</b>	
1	Advanced Waste Services of WI
2	Covanta Environmental Solutions
3	Safety-Kleen, Inc.
<b>Waste Water Treatment Plant Facilities (WWTP)</b>	
1	Appleton Wastewater Treatment Facility
2	Watertown Wastewater Treatment Facility
3	Superior Wastewater Division of Public Works
4	Kenosha Wastewater Treatment Plant
5	Manitowoc Wastewater Treatment Facility
6	Marshfield Wastewater Treatment Facility
7	South Milwaukee Wastewater Treatment Facility
8	Racine Utilities - Wastewater Utility
9	Sheboygan Regional Wastewater Treatment Facility
10	Oconomowoc Wastewater Treatment Facility
11	Waukesha Wastewater Treatment Plant
12	Oshkosh Wastewater Treatment Plant
13	Wisconsin Rapids Wastewater Treatment Plant
<b>Non-Hazardous Waste Facilities</b>	
1	Valley Trail Landfill (WM)
2	Timberline Trail Landfill (WM)
3	Ridgeview (WM)
4	Orchard Ridge (WM)
5	Madison Prairie (WM)
6	Metro (WM)
7	Deer Track Park (WM)
8	Lake Area Landfill (Republic Services)
9	Hickory Meadows Landfill (Advanced Disposal)
10	Seven Mile Creek Landfill (Advanced Disposal)
11	Mallard Ridge Landfill (Advanced Disposal)
12	Emerald Park Landfill (Advanced Disposal)
13	Glacier Ridge Landfill (Advanced Disposal)

\*For Minnesota, Illinois, and Michigan - see state map for facility information



Map Location



Drawn: LBG 5/13/2016  
Approved: LBG 5/13/2016  
Project #: Disposal

Legend

- Liquid Waste Facility
- Hazardous Waste Facility
- ⬠ Waste Water Treatment Plant (WWTP)
- ▲ Non-Hazardous Waste Facility
- Enbridge Pipeline

WASTE  
FACILITIES -  
  
WISCONSIN

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Appendix

## Waste Facilities – Wisconsin

Facility ID	Facility (Wisconsin)	Waste Type	Address	City	State	Zip	County	Contact Phone
<b>Liquid Waste Facilities</b>								
1	Covanta Environmental Solutions	Liquid	625 Douglas Street	Ripon	WI	54971	Fond du Lac	(920) 582-7596
2	Covanta Environmental Solutions	Liquid	552 Carter Court	Kimberly	WI	54136	Outagamie	(920) 582-7596
<b>Hazardous Waste Facilities</b>								
1	Advanced Waste Services of WI	Solid & Liquid - Haz	3801 West McKinley Avenue	Milwaukee	WI	53208	Milwaukee	(414) 397-6301
2	Covanta Environmental Solutions	Liquid - Haz	210 Tower Road	Winneconne	WI	54986	Winnebago	(920) 582-7596
3	Safety-Kleen, Inc.	Solid & Liquid - Haz	3715 Lexington Avenue	Madison	WI	53714	Dane	(608) 221-0714
<b>Waste Water Treatment Plant Facilities (WWTP)</b>								
1	Appleton Wastewater Treatment Facility	Liquid - WWTP	2006 East Newberry Street	Appleton	WI	54914	Calumet	(920) 832-5945
2	Watertown Wastewater Treatment Facility	Liquid - WWTP	800 Hoffmann Road	Watertown	WI	53094	Jefferson	(920) 262-4085
3	Superior Wastewater Div. Of Public Works	Liquid - WWTP	51 East First Street	Superior	WI	54880	Douglas	(715) 394-0392
4	Kenosha Wastewater Treatment Plant	Liquid - WWTP	7834 3rd Avenue	Kenosha	WI	53143	Kenosha	(262) 653-4335
5	Manitowoc Wastewater Treatment Facility	Liquid - WWTP	1015 South Lakeview Drive	Manitowoc	WI	54220	Manitowoc	(920) 686-3550
6	Marshfield Wastewater Treatment Facility	Liquid - WWTP	2601 East 34th Street	Marshfield	WI	54449	Marathon	(715) 486-2007
7	South Milwaukee Wastewater Treatment Facility	Liquid - WWTP	3003 5th Avenue	South Milwaukee	WI	53172	Milwaukee	(414) 768-8180
8	Racine Utilities - Wastewater Utility	Liquid - WWTP	2101 S. Wisconsin Avenue	Racine	WI	53403	Racine	(262) 636-9520
9	Sheboygan Regional Wastewater Treatment Facility	Liquid - WWTP	3333 Lakeshore Drive	Sheboygan	WI	53081	Sheboygan	(920) 459-3464
10	Oconomowoc Wastewater Treatment Facility	Liquid - WWTP	900 South Worthington Street	Oconomowoc	WI	53066	Waukesha	(262) 569-2192
11	Waukesha Wastewater Treatment Plant	Liquid - WWTP	600 Sentry Drive	Waukesha	WI	53186	Waukesha	(262) 524-3625
12	Oshkosh Wastewater Treatment Plant	Liquid - WWTP	233 North Campbell Road	Oshkosh	WI	54902	Winnebago	(920) 232-5365
13	Wisconsin Rapids Wastewater Treatment Plant	Liquid - WWTP	2540 1st Street South	Wisconsin Rapids	WI	54494	Wood	(715) 421-8287
<b>Non-Hazardous Waste Facilities</b>								
1	Valley Trail Landfill (WM)	Solid - NonHaz	N9101 Willard Road	Berlin	WI	54923	Green Lake	(920) 361-4995
2	Timberline Trail Landfill (WM)	Solid - NonHaz	N4581 Hutchinson Road	Weyerhaeuser	WI	54895	Rusk	(715) 868-7000
3	Ridgeview (WM)	Solid - NonHaz	6207 Hempton Lake Road	Whitelaw	WI	54247	Manitowoc	(920) 796-6007
4	Orchard Ridge (WM)	Solid - NonHaz	W124 N9355 Boundary Road	Menomonee Falls	WI	53051	Waukesha	(262) 509-5629
5	Madison Prairie (WM)	Solid - NonHaz	6002 Nelson Road	Sun Prairie	WI	53590	Dane	(608) 837-9031
6	Metro (WM)	Solid - NonHaz	10712 South 124th Street	Franklin	WI	53132	Milwaukee	(414) 529-6180
7	Deer Track Park (WM)	Solid - NonHaz	N6756 Waldmann Lane	Watertown	WI	53094	Jefferson	(920) 699-3475
8	Lake Area Landfill (Republic Services)	Solid - NonHaz	W5987 County Road D	Sarena	WI	54870	Washburn	(715) 469-3356
9	Hickory Meadows Landfill (Advanced Disposal)	Solid - NonHaz	W3105 Schneider Road	Hilbert	WI	54129	Calumet	(920) 853-8553
10	Seven Mile Creek Landfill (Advanced Disposal)	Solid - NonHaz	8001 Olson Drive	Eau Claire	WI	54703	Eau Claire	(715) 830-0284
11	Mallard Ridge Landfill (Advanced Disposal)	Solid - NonHaz	W8470 State Road 11	Delavan	WI	53115	Walworth	(262) 724-3257
12	Emerald Park Landfill (Advanced Disposal)	Solid - NonHaz	W124 S10629 South 124th Street	Muskego	WI	53150	Waukesha	(414) 529-1360
13	Glacier Ridge Landfill (Advanced Disposal)	Solid - NonHaz	N7296 County Road V	Horicon	WI	53032	Dodge	(920) 387-0987

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Appendix

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