# Enbridge Line 6B MP 608 Pipeline Release

# Marshall, Michigan

# Source Area Response Plan

**August 2, 2010**

**(Revised August 17, 2010 per U.S. EPA August 17, 2010 letter)**

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## List of Acronyms/Definitions

**Calhoun County Drain Commissioner (CCDC)**

**Company** – Enbridge Energy, Limited Partnership

**RPDIA** – Response Plan for Downstream Impacted Area

**DNAPL** – Dense Non-Aqueous Phase Liquid – A liquid with a Specific Gravity > 1.0

**Drain** –The word "drain" shall include the main stream or trunk and all tributaries or branches of any creek or river, any watercourse or ditch, either open or closed, any covered drain, any sanitary or any combined sanitary and storm sewer or storm sewer or conduit composed of tile, brick, concrete, or other material, any structures or mechanical devices, that will properly purify the flow of such drains, any pumping equipment necessary to assist or relieve the flow of such drains and any levee, dike, barrier, or a combination of any or all of the same constructed, or proposed to be constructed, for the purpose of drainage or for the purification of the flow of such drains, but shall not include any dam and flowage rights used in connection therewith which is used for the generation of power by a public utility subject to regulation by the public service commission.

**FOSC** – Federal On-Scene Coordinator

**LNAPL** – Light Non-Aqueous Phase Liquid – A liquid with a Specific Gravity < 1.0

**MDNRE** – Michigan Department of Natural Resources and Environment

**NREPA** – Natural Resources and Environmental Protection Act

**Oil Saturated Soil** – Soils containing free-phase product capable of flowing or migrating as an oil and/or a sheen, either of which is affecting or threatens to affect navigable waterways.

**Remediation** – Future long term corrective actions beyond those included as an initial response

**Residual Impacts** – Soils exhibiting oil staining, petroleum odor, and/or organic headspace, none of which are affecting or threaten to affect navigable waterways.

**Response** – The initial response to remove oil affected-media and/or sheen affecting and/or posing a risk to navigable water bodies

**SAP** – Sampling and Analysis Plan

**SCAT** – Shoreline Cleanup Assessment Technique also known as **SCAT Assessment or SCAT Process** – A systematic approach that uses standard terminology to collect data on impacted areas, support decision-making for cleanup; reference HAZMAT Report No. 2000-1; Office of Response and Restoration, Hazardous Materials Response Division, National Ocean Service, National Oceanic & Atmospheric Administration, Shoreline Assessment Manual – Third Edition, August 2000.

**SCAT Team** - A team of qualified individuals using SCAT, organized and reporting to the FOSC and comprised of representatives from U.S. EPA as the (FOSC), MDNRE (as the SOSC and state

NRDA trustee), NOAA or U.S. FWS (as federal NRDA trustees) and Company to assess impacted areas and recommend cleanup methods and priorities. At least one member should have sufficient expertise in wetland and aquatic ecology to evaluate the sensitivity of impacted areas.

**Source Area** - The primary locations impacted by the crude oil release, includes Division A (i.e. the wetland area impacted by the release due to overland flow of oil) referred to herein as the Spill Release Area and, Division B (i.e., the portion of Talmadge Creek impacted by the oil spill) referred to herein as the Creek

**SAR** – Source Area Response Plan - A workplan describing interim response actions designed to protect navigable waters from the crude oil release

**Spill Release Area (Division A)** – Area of primary spill release into wetland

**Talmadge Creek (Division B)** – Initial navigable water body impacted by release

**USACE** - United States Army Corps of Engineers

**U.S. EPA** – Unites States Environmental Protection Agency

**USFWS** – United States Fish and Wildlife Service

# 1.0 Introduction

## 1.1 Overview

The purpose of this Source Area Response Plan (SAR Plan) is to present initial response actions that will be taken to address the Source Area for the Enbridge Energy, Limited Partnership (Company), Marshall, Michigan, Line 6B M.P. 608 as a result of the crude oil release. The Plan is prepared in response to the United States Environmental Protection Agency (U.S. EPA) Administrative Removal Order (ARO) dated July 27, 2010.

## 1.2 Site History

On July 26, 2010, a release of heavy crude from the Company's 30-inch pipeline (referred to as "Line 6B") was discovered. The Company's pipeline release site is located just west of pipeline mile post 608 in Marshall, Calhoun County, Michigan, (North ½ Section 2, T3S, R6W, Latitude: 42.2395273 Longitude: -84.9662018) in an undeveloped area, south of town. Figure 1 shows the location of the site. The release entered Talmadge Creek and then the Kalamazoo River. These waterways are considered to be navigable waters. Currently, approximately 30 miles of the Kalamazoo River may have been impacted. To date the impacted areas are described as:

- Division A – the Spill Release Area to the constructed Flume where the release entered Talmadge Creek;
- Division B – Talmadge Creek from the Flume site to the confluence with the Kalamazoo River;
- Division C – The confluence of the Talmadge Creek and the Kalamazoo River to the Angell Street Bridge;
- Division D – The Angell Street Bridge to Kalamazoo County line; and
- Division E – Kalamazoo County Line to Morrow Lake Dam.

Figure 2 shows the site division designations A through E. This SAR Plan addresses Division A, referred to as the Spill Release Area, and Division B, referred to as the Creek.

Following the release, the U.S. EPA, issued a Removal Administrative Order (RAO) signed July 27, 2010. The RAO established actions and timeframes for responding to the release.

In conjunction with the SAR plan, the following Work Plans were requested by the RAO and are submitted as separate documents:

- Health and Safety Plan (HSP);
- Pipeline Repair Work Plan (PRWP);
- Sampling and Analysis Plan (SAP);
- Quality Assurance Project Plan (QAPP);
- Oil Recovery and Containment Plan (ORCP);
- Response Plan for Downstream Impacted Area (RPDIA) Plan; and,
- Waste Treatment, Transportation, and Disposal Plan (WTTDP).

Draft Work Plans requested in the RAO were submitted to the U.S. EPA on July 29, 2010. Comments on draft work plans were received on July 31, 2010 and are incorporated into this revision. Additional comments on this SAR Plan were received on August 10, 2010 and are addressed in this submittal. Attachment A provides a numerical tracking of the responses to the specific comments provided by the U.S. EPA in their August 10, 2010 letter.

## 1.3 Site Description and Location

The Source Area is comprised of an approximate 5-acre parcel adjacent to the pipeline release location (Spill Release Area) and the portion of the Talmadge creek extending from the release site to the confluence with the Kalamazoo river (the Creek) (Figures 3 and 4). The majority of the Spill Release Area is within a wetland between the release site and Talmadge Creek. Most of the surrounding area can be characterized as rural, including undeveloped and agricultural areas. Vegetation in the source area consists of herbaceous emergent wetland plants in low lying areas, as well as brush and trees in upland areas.

## 1.4 General Site Geology/Hydrogeology and Baseline Conditions

The surficial deposits in the area of the release site consist of glacial outwash sand and gravel and post-glacial alluvium with occasional thin clay lenses overlain by surficial peat material. The glacial deposits are generally underlain by the Mississippian Marshall Sandstone and Coldwater Shale in Calhoun County and Coldwater Shale in Kalamazoo County. The bedrock surface mapped as 50 feet

below ground surface (bgs) in much of Calhoun County and up to 200 feet in Kalamazoo County based on the State of Michigan Department of Conservation, Geological Survey Division, Drift Thickness Map, 1938. Baseline conditions within the source area will be established and will include fluvial geomorphology, baseline topographic conditions and fluid flow channel physical dimensions/survey and ecological habitats. A wetland delineation establishing jurisdictional boundaries and the type and distribution of wetland communities will also be performed within the Source Area.

It is our understanding that the Talmadge Creek is a legally established "drain"; therefore, the Company will contact and consult with the Calhoun County Drain Commissioner (CCDC) concerning work on the Creek, including interim and long-term restoration of the drain, and hydraulic capacity and drainage function.

## 1.5 Source Area Actions to Date

As of the date of this report, the following key remedial actions have occurred:

- **Security:** Access to the Source Area is restricted by fencing and twenty-four hour security. Access to surface water is being limited by security control measures at crossings, signs, and fencing at creek access points. These measures address unauthorized access to the source areas.

- **Temporary Access Road:** An access road, primarily timber mats, was constructed to the site from Division Drive. Safety turn-around areas were created and grading of the site has been completed to allow for heavy equipment traffic related to response activities and pipeline repair. Timber mat access roads are also being constructed adjacent to Talmadge Creek.

- **Site Clearing and Grubbing:** Clearing and grubbing of site trees and vegetation has been performed as necessary to allow construction of access roads and removal of soils impacted by the overland flow of oil. The trees and brush will be chipped and the material mixed with excavated soil for offsite disposal.

- **Shallow Soil Excavation:** Shallow soil in the Spill Release Area (primarily peat) impacted by the overland flow of crude oil is being excavated and staged for offsite disposal. The objective associated with shallow soil excavation is to prevent further migration of oil to surface water. Spill Release Area excavation activities involve the use of a long reach

backhoe staged on the access road to remove the top 6-inches to 1-foot of impacted soil/peat material. The material is direct loaded into off-road trucks and transported to the staging area where it is allowed to dewater prior to disposal. Creek area excavation (i.e., along the banks of the Talmadge Creek) involve removal of primarily oil impacted vegetation and shallow soil/root zone material as described in the Shoreline Cleanup Assessment Team (SCAT) Plan for Talmadge Creek (Attachment B). At the time this document was prepared, approximately 80 percent of the Spill Release Area excavation has been completed and 25 percent of Creek area has been mechanically cleaned.

- **Staging Area Construction:** An approximate 2.3 acre staging area was constructed at the boundary of the exclusion zone to the north of the Spill Release Area. The staging area was constructed using Class 5 gravel to allow heavy equipment access and minimize erosion. Silt fencing and other stormwater control measures were implemented as needed. Material from the Spill Release Area and the Creek is currently being transported to the main staging area using off-road trucks.

- **Berms:** Three temporary soil berms have been constructed to remove the migration pathway for crude oil from the Spill Release Area to Talmadge Creek. The basic design of the temporary soil berms is an elongated earthen mound used to prevent the flow of water and oil. Clean on-site soils and clean granular soils were used to construct the berms. The length and height of the berms correspond with the volume of flow and drainage area required to be controlled in the Spill Release Area. All berm heights are less than five feet from the toe of the berm to the upstream bottom elevation. This berm height will ensure that the berms are not considered "dams" under Part 315 Dam Safety, of the Natural Resources and Environment Protection Act (NREPA), 1994 PA 451, as amended. As of July 30, 2010, flow of crude oil to Talmadge Creek from the Spill Release Area has not been observed.

- **Flumes:** Numerous flumes (i.e. underflow weirs) were constructed downgradient of the Spill Release Area to minimize further migration of crude oil. The basic design of a flume is a pipe, or series of pipes, that extend through a temporary flow control structure such as a berm or dam. For a crude oil release to surface water, the pipe intakes are submerged on the upstream side of the berm to allow oil-free water to flow through the pipe. This prevents the crude oil floating on top of the water from migrating further downstream. Crude oil pools on the upstream side of the berm or dam and is captured and containerized using sorbent booms, pads and vacuum trucks.

- **Oil and Water Containment and Recovery:** Oil containment and recovery operations using flumes, berms and vacuum trucks is operating in the Source Area.

- **Initial Receptor Survey:** An initial receptor survey was implemented and will be updated during post response activities to effectively identify potential migration pathways and potential receptors within the Source Area. The receptor survey is conducted to identify the presence and location of surface waters, water wells and surface water intakes which could be impacted by the crude oil release.

- **Federal and State Approvals:** Company has coordinated efforts with all Federal and State level environmental stakeholders identified at the site including:

    - U.S. EPA, U.S. Fish and Wildlife Service (USFWS)
    - Michigan Department of Natural Resources and Environment (MDNRE)
    - U.S. Coast Guard
    - Michigan Department of Agriculture (MDA)
    - Michigan Department of Community Health (MDCH)
    - Calhoun County Public Health Department (CCPHD)
    - Kalamazoo County Health and Community Services Department (KCHCSD)

A Joint Permit Application to MDNRE and USACE for Part 303/301 and Part 31 has been submitted for activities within the Source Area (Attachment C).

## 1.6 Interim Response Scope of Work

This SAR Plan addresses the ARO requirements for the Site. The response objectives under the SAR Plan will consist of: 1) removal of free phase crude oil and heavily impacted crude oil media (oil saturated soil and vegetation) from the overall Source Area; and 2) removal and/or abate visible oil and/or sheen that is currently affecting navigable water ways and/or poses a threat of a visible oil or sheen discharge to navigable waterways. Heavily impacted soil will be excavated and staged prior to transport for off-site disposal. Free phase oil and oil/water mixtures will be recovered for beneficial re-use. The remaining contaminated water will be containerized for proper offsite disposal of in accordance with applicable rules and regulations.

Post-SAR activities will be conducted in accordance with all applicable Parts of NREPA.

# 2.0 Response Action Plan

## 2.1 Interim Response - Spill Release Area

Response actions within the Spill Release Area will include the following:

- Berming of the Spill Release Area to prevent flow of oil to the Creek;
- Installation of temporary collection trenches for the containment and recovery of crude oil ;
- Site clearing and grubbing of trees and vegetation to allow completion of free phase crude oil removal activities;
- Removal, staging, transportation and disposal of crude oil impacted soil; Stormwater management and erosion control.

On-site personnel will follow their respective Health and Safety Plans. Odors and dust generated by on-site activities will be controlled by wetting to acceptable conditions as provided by air monitoring.

### 2.1.1 Construction of Temporary Berms

Temporary berms will be constructed, as necessary, to prevent the migration of oil to and within Talmadge Creek. Figure 5 shows the location of the temporary berms.

Berms will be constructed of clean on-site and granular soil. Berms will be less than five-feet in height to satisfy MDNRE requirements. Given the shallow nature of the temporary berms, significant hydraulic head will not develop that could create subsurface water flow or channeling under the berms. Groundwater flow patterns within the wetland system will be further evaluated as part of long-term corrective remedial actions.

Berm removal will be conducted during future site restoration activities in accordance with an approved site restoration plan. Additional information pertaining to berm construction is also presented in the Oil Recovery and Containment Plan (Section 6.0) for the site.

### 2.1.2 Construction of Temporary Receptor/Collection Trenches

Temporary receptor/collection trenches will be constructed to enhance the recovery of oil within the Spill Release Area. The location of currently installed trenches is shown on Figure 5. One to two foot shallow depressions will be excavated adjacent to berm areas to allow for recovery of crude via

skimmer pumps and/or pump trucks. Trenches will be appropriately filled during final site restoration activities. Recovered crude oil will be managed in accordance with Section 6.0 of the Oil Recovery and Containment Plan.

### 2.1.3 Site Clearing and Grubbing

Site clearing and grubbing in the Spill Area will be accomplished using manual and mechanized methods to gain access for site response activities. Prior to removal of mature trees, the U.S. Fish and Wildlife Service (USFWS) will be consulted as to the potential to affect Indiana bats. Jack Dingeldine of the USFWS will be contacted to determine if the trees affected by the interim response actions would provide adequate habitat for the bats. Trees and other vegetation removed for the purpose of interim response activities will be shredded/chipped on-site and mixed with oil saturated soil in the staging area as described in 2.1.4. Shredded vegetation and woodchips will not be piled on-site to avoid adverse impacts on the local habitat.

Crude oil impacted vegetation will be cleared and handled in accordance with the Waste Treatment, Transportation and Disposal Plan (Section 2.4). Mature trees will be preserved and used for future restoration purposes if feasible and in accordance with a final restoration yet to be completed. Work within wetland areas and streams will be conducted in accordance with the Joint Permit MDNRE and USACE for Part 303/301 and Part 31. Timber matting will be used in wetlands for access and to minimize soil erosion. Additional information regarding soil erosion control is provided in Section 2.6. USFWS and MDNRE will be consulted for compliance with Threatened and Endangered (T&E) species regulation. A preliminary T&E survey has been conducted and is included as Attachment D. If additional information is collected, it will be provided at a later date.

### 2.1.4 Removal, Staging, Transportation and Disposal of Oil Saturated Soil

Soil containing free-phase product (oil saturated soil) within the Spill Release Area will be excavated based on visual field screening. If visible oil is evident in the native soils, scraping of the soil will continue until it is removed. Peat will be squeezed for any visible evidence of free-phase product (oil). If oil is present, it will be excavated. Excavation activities will be conducted within wetland areas using timber mats to allow equipment access to the area and to minimize soil erosion. The Company will balance the need to invasively remove oil while minimizing adverse impact to the natural environment and/or sensitive habitats by limiting the horizontal and vertical extent of excavation to only oil saturated material. For example, wooded habitats take longer to return to baseline conditions than emergent marshes or grasslands, therefore, consideration will be given to the use of alternate techniques, such as natural attenuation, to minimize impacts to the natural

environment. The estimated areal extent of oil saturated soil requiring excavation is shown on Figure 5.

Future remedial activities will include SCAT Team recommendations that must be approved by FOSC.

Impacted soil will be placed in a soil staging area and allowed to drain. The soil staging areas will be constructed with a series of berms preventing stormwater run-on and/or run-off. The bermed staging areas will be lined with polyethylene sheeting to prevent infiltration and/or contact with native soils. Soil staging will occur only within the constructed/lined staging areas in order to contain and recovery residual oil. Staged soil will be sampled and analyzed in accordance with Section 4.6 of the Sample and Analysis Plan (SAP) and disposed of in accordance with Section 2.2. of the Waste Treatment, Transportation and Disposal Plan (WTTDP). Soil pretreatment options may include the addition of solidification enhancing material such as kiln dust, wood chips, sawdust, native soils, etc. This will be conducted to support live loading of waste material directly to trucks for offsite disposition, or to stabilize material prior to transport to a staging pile if needed.

Wastewater generated during soil excavation activities will be managed in accordance with the Waste Treatment, Transportation and Disposal Plan (Section 2.1).

Air monitoring will be conducted during excavation activities in the Spill Release Area. Air monitoring will include, a) on-site monitoring for worker safety and b) perimeter monitoring for the protection of public health. Worker exposure is measured through real time monitoring of benzene, carbon monoxide (CO), and hydrogen sulfide ($H_2S$). On-site personnel monitoring will be conducted in accordance with the approved Health and Safety Plan (Section 2.03). Field perimeter air monitoring stations are located along Division Drive as shown on Figure 6. Additional locations may be added in consultation with FOSC as work progresses. Roving real time air monitoring occurs 24 hours per day, traveling along public roadways in and around the Spill Release Area. Air monitoring and sampling will be conducted in accordance with the approved Air Sampling and Monitoring Plan (Sections 2 and 3).

## 2.2 Interim Response – Talmadge Creek

Response action within Talmadge Creek will include:

- Installation of flumes to prevent flow of oil to Talmadge Creek

- Site Clearing and Grubbing
- Removal, Staging, Transportation and Disposal of Oil Saturated Vegetation and Soil

### 2.2.1 Flume Installation

Temporary flumes will be installed within berms and other flow prevention structures to prevent further downstream migration of crude oil in Talmadge Creek. Flumes will be constructed of steel or corrugated pipe appropriately designed for water flow and load bearing requirements. The constructed flume elevation will be designed to maintain appropriate flow of water concurrent with the collection/separation of oil. The primary flume locations will be downgradient of the Spill Release Area.

### 2.2.2 Site Clearing and Grubbing

Site clearing and grubbing in the Creek area will be accomplished using manual and mechanized methods to gain access for site response activities. Crude oil impacted vegetation will be cleared and handled in accordance with the Waste Treatment, Transportation and Disposal Plan (Section 2.4). Mature trees, if removed, will be preserved for future restoration purposes if feasible and in accordance with the final site restoration plan.

As previously described in Section 2.1.4, shredded trees and vegetation will not be piled on-site and will be incorporated into oil saturated soil for off-site disposal.

USFWS will be consulted regarding the potential to affect the Indiana bat as previously described in Section 2.1.4.

### 2.2.3 Removal, Staging, Transportation and Disposal of Oil Saturated Soil

Soil containing free-phase product (oil saturated soil) along the banks of Talmadge Creek will be excavated based on visual field screening in accordance with the cleanup plan for Talmadge Creek (Attachment B). Excavation activities will be conducted from timber mats placed parallel to the Creek to allow equipment access to the area and to minimize soil erosion and wetland disturbance. Excavation will involve primarily oil impacted vegetation and shallow soil/root zone material along the banks of the Creek. The Company will balance the need to invasively remove oil while minimizing adverse impacts to the natural environment and/or sensitive habitats by limiting the horizontal and vertical extent of excavation to only oil saturated materials. As previously described in Section 2.1.4, consideration will be given to the use of techniques other than excavation, such as

natural attenuation, to minimize impacts to the natural environment. Oil saturated soil/vegetation will be placed in a lined soil staging area as previously described in Section 2.1.4.

As described in Section 2.1.4, on-site air monitoring is performed for worker safety and for the protection of public health. Fixed air monitoring sampling stations are located on each side of the Creek and on 16-Mile Road north of the Creek (see Figure 6). Additional locations may be added in consultation with FOSC as work progresses downstream towards the Kalamazoo River.

## 2.3 Interim Methods and Confirmatory Metrics

Methods to remove oil saturated soil (i.e. posing a risk of release to navigable water) were described in Section 2.1 and 2.2 and are based on visible field screening. This does not necessarily include soil exhibiting oil staining/sheen, petroleum odor, organic headspace, etc.

**Riparian Zones and Steam Banks**

1. Shorelines no longer release sheens that affect navigable waterways.
2. Oil no longer rubs off on contact.
3. Oil removal to the point where recovery/re-colonization can occur without causing more harm than leaving the oil in place. Heavy oil generally weathers to a dry coat within weeks.

**Soil, Sand and Gravel**

1. Oil is no longer visible on surface.
2. No oil layers in test pits dug by inspection teams.

**Man-made structures**

1. Structure no longer generates liquid oil or sheen.
2. Oil no longer rubs off on contact.

The horizontal extent of the Source Area impacts will be verified following interim response actions based on collection and analysis of soil samples. As described in the SAP, samples will be field screened for the presence of petroleum impacts using odor, oil sheen test, and organic headspace. Samples will also be laboratory analyzed for total petroleum hydrocarbons (TPH), diesel range organics (DRO) (with silica gel cleanup), TPH gasoline range organics (GRO) and benzene, toluene, ethyl benzene, and xylenes (collectively as BTEX) as an indicator of clean soil conditions. A positive laboratory detection will not necessarily indicate the need for additional interim corrective action; however, these data will be evaluated as part of future assessment and remediation activities.

Sampling locations and frequency for delineation of the horizontal extent will be further discussed with FOSC prior to implementation.

The Talmadge Creek streambed consists primarily of rock and granular material. To date, no oil impacts (i.e., dense non-aqueous phase liquids (DNAPLs)) have been observed within this creek bed. Given the age and conditions associated with the release, a DNAPL component is not anticipated to exist in the streambed. However, during these Source Area interim response activities, a visual inspection of the streambed will be completed to inspect for the presence of oil/DNAPL. As outlined in the SAP, sediments will be disturbed at regular intervals (e.g., 50') from the Spill Release Area through the affected waterways of Talmadge Creek using a rod, stick, or similar implement to evaluate if a visible oil/sheen is present.

The post-response activities will be further evaluated as part of the long-term remedial actions for the site. As part of the RPDIA Plan, submitted under a separate cover, the potential for DNAPL impacts associated with the release will be evaluated with respect to product that may have sunk to the river bottom of the Kalamazoo River or Morrow Lake.

## 2.4 Interim Response Oiled Wildlife Processing Protocol

During implementation of the previously described response activities, all live oiled animals will be collected, cleaned, rehabilitated and released. Oiled wildlife carcasses identified by response staff, regulatory staff, and the public shall be called into Enbridge's Marshall Response 800 number (800.306.6837). A member of the Wildlife Response Facility (WRF) team will be dispatched to collect the carcass. The carcass will be photographed in place, and its location documented (to include either actual lat/long coordinates or coordinates from a nearby known landmark, if available). If, during the course of the response, the appropriate regulatory entity [USFWS (migratory birds) or MDNRE (other species)] has demobilized from the WRF, the collection staff shall notify them of the discovery. A record regarding the disposition of wildlife carcasses will be maintained including disposition date, dispositions status, federal band number (if applicable), and intake number.

## 2.5 Source Area Access and Security

During the removal action of the Source Area, access will be made via construction of a temporary road off of Division Drive. Efforts will be made to limit heavy trucks to minimize public disturbance. Support facilities (e.g. field trailers, etc.) will be located to the north of the Source Area and other appropriate locations near the site.

Security guards will be posted at the entrance road to the site off of Division Drive. The site is located on private property and in a rural setting. Air monitoring stations or regularly scheduled air monitoring readings for fugitive emissions will be conducted as referenced in Section 2.1.4.

## 2.6 Storm Water Management and Erosion Control

Silt fencing, flow control structures and other engineered devices will be used in the Source Area for stormwater management around construction areas consistent with Part 91 of NREPA. No erosion control will be placed near the creek prior to removal of oily soil and vegetation.

Natural fiber erosion control materials, or equivalent, will be placed and staked at the water's edge along the entire length of Talmadge Creek after the response action is implemented to protect the creek.

Other actions will be conducted in compliance with the Joint Permit MDNRE and USACE for Part 303/301 and Part 31 (application submitted) for the Source Area. As response activities are completed, site drainage will be returned to pre-existing flow patterns and/or those specified in the approved final restoration plan.

## 2.7 Source Area Interim Restoration Activities

Source Area interim restoration activities will occur within the Spill Release Area and along the shoreline and other non-aquatic areas of Talmadge Creek. Restoration activities will include backfilling and application of a vegetative cover designed to minimize erosion until long term restoration can be completed. Backfilling near the pipeline subsurface will include placement of clean granular material and then surface organic soils to match the pre-existing conditions. Backfilling in the creek, where necessary, will include placement of organic soils. Details of stream and wetland restoration will be fully determined through consultation with all appropriate regulatory agencies. The vegetative cover will include native plant species and/or non-invasive temporary cover crops, such as rye, potentially applied as a hydro-mulch material. Long term restoration will include, but not be limited to, consideration of the original controls of the site, use of the appropriate soil types, future erosion control, re-vegetation, etc. Long term monitoring plans with performance criteria including: erosion control, establishment of vegetation, absence of invasive species, etc. will be included as part of the final site restoration plan.

The Company recognizes that earth disturbance is subject to Michigan's Permit-by-Rule for construction stormwater; therefore, a detailed restoration plan will be prepared pursuant to Part 301for both the Spill Release Area and the Creek.

## 2.8 Initial Response Action Decontamination

Personnel decontamination and equipment decontamination areas will be established on-site for the duration of the initial response actions. The decontamination areas will be constructed to be strategically near work areas for personnel and equipment.

### 2.8.1 Personnel Decontamination

Entrance and egress from the hot zones will require donning and doffing personnel protective equipment. A decontamination station will be established nearby for areas where the potential for personnel contamination exists. Such stations shall be set up to accommodate individuals entering under their own power or in the event that they become disabled. Contaminated clothing will be removed from the outermost layer and turned inside out while removing. Skin surfaces will be rinsed with a mild detergent and rinsed thoroughly. Gloves will be removed last. Contaminated clothing and debris will be collected and bagged for proper disposal.

### 2.8.2 Equipment Decontamination

Decontamination units within the decontamination areas will be constructed to periodically clean equipment during response actions and upon egress from the area. Cleaning systems for skimmers, hand tools, and heavy machinery will be established for each decontamination area.

The equipment decontamination area will consist of a lined diked impoundment for cleaning equipment and a frac tank for capture of any spilled material and storage of liquids.

The decontamination process will involve using hot-water pressure washing and a citrus based soap with a water rinse. This process will be repeated until visible contamination is removed. Expendable equipment (e. g., rope mops, brushes, tarps, etc.) will not be decontaminated but will be drummed and disposed as waste.

A decontamination area and decontamination station will be established near the Source Area, along the access road prior to departing the work area. A personnel decontamination area will be setup at the boundary of the Source Area exclusion zone in accordance with Section 3.07 of the HSP.

### 2.8.3 Additional Decontamination Requirements

In addition to work personnel and equipment decontamination, additional infrastructure such as MDOT culvert Interstate 69, will be decontaminated as part of the interim response activities. The proposed decontamination method will be consulted with and approved by the appropriate regulatory agency or jurisdiction prior to implementation. Oil material resulting as part of the decontamination process will be contained and collected for proper disposal.

## 2.9 Contingency Plan

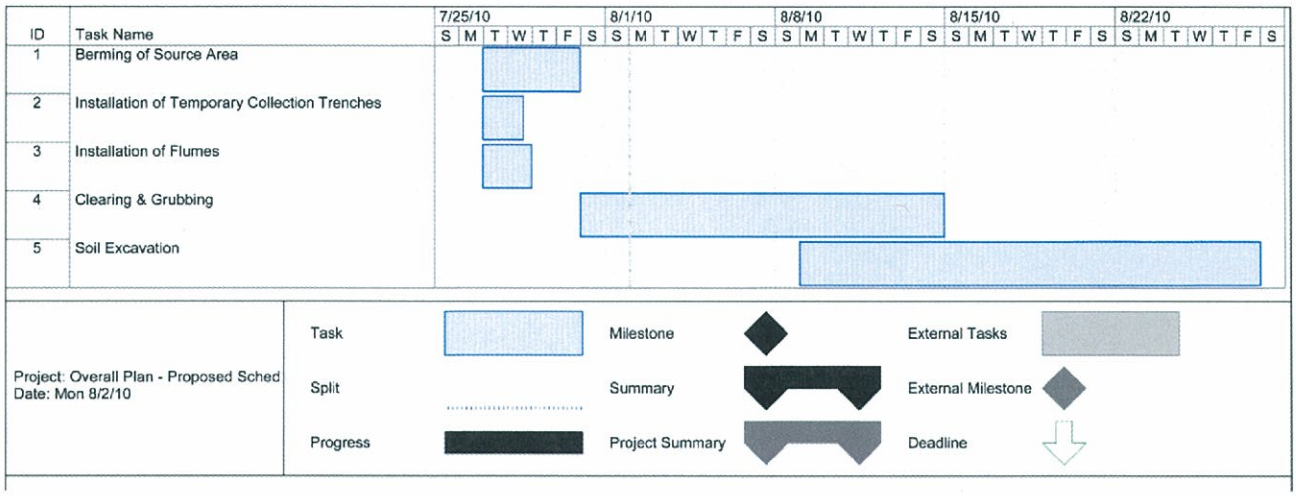
If the Company wishes to propose an action, revision or change that is not identified in this Plan, the Company shall request approval of the action, revision or change from the FOSC. To initiate the process, a written request will be submitted by Company to the FOSC outlining the proposed action, revision or change to be used and the benefits to be derived from its execution. FOSC shall then approve or disapprove in writing or discuss potential alternatives.

In addition, the Company will continue to monitor site conditions daily for the presence of visible oil on navigable water, or with the potential to threaten navigable waterways until the FOSC approves an alternate monitoring plan. Should such oil be observed, the Company will re-initiate the approved Oil Recovery and Containment Plan (Section 6.1 and 6.2) which may include the re-deployment of absorbent boom material, etc. as necessary to contain the observed oil. It is also the Company's intention to maintain the berms and flumes after initial response actions are complete to further limit the potential of future oil migration prior to final site remediation and restoration. Water discharges to the Creek during interim response actions are not anticipated to occur; however, if necessary, the SAR Plan would be re-initiated as described above.

The Company does not anticipate the need to provide a drainage contingency to adjacent landowners, due to the fact that dams will not be constructed in the Creek and the flumes put in place to allow underflow while capturing potential oil if present. In addition, no pumping or water diversion of the Creek will be performed during oil removal activities; therefore, we do not anticipate needing to meet a 50-year flood design volume.

# 3.0 Schedule And Resources

Various activities outlined in this SAR Plan have been implemented and are being implemented. Subject to the complications created by weather or other forces outside of the control of the Company, the objectives outlined above will be completed by August 27, 2010. This SAR Plan is being implemented and will be implemented in its entirety upon receiving U.S. EPA approval. A proposed schedule for SAR Plan tasks is provided below.




As of August 1, 2010 over 800 trained personnel are engaged in recovery activities. The existing complement of personnel and equipment will be adjusted to facilitate aggressive cleanup work at the release site by the approved deadlines. Cleanup activities will include removal of product and impacted material such as organics and vegetation. Any additional personnel required to facilitate this activity will be determined in part by the completion of a cleanup assessment. Variables that can impact resource loading are approval timelines, permitting and weather. The existing complement of trained personnel will be adjusted based on actual needs and assessment. Any changes, especially downsizing in resources, will be conducted only after discussions with and agreement by the FOSC. Increases in resources can be conducted as needed with notification during or subsequent to the change to the FOSC. This can be facilitated via coordination with the Operations Section Chief for U.S. EPA.

The additional personnel required to facilitate cleanup will be determined in part by the completion of shoreline assessments, specifically the completion of the SCAT and/or other assessment activity. Other variables that can impact resource loading are approval timelines, permitting and weather. The existing complement of trained personnel will be adjusted based on actual needs and assessment.

The number of crews and personnel in each crew will be dependent on many variables and is subject to areas that may impact the process, such as the final assessment process, the determination of response standards for all areas, the comments of other agencies such as the MDNRE, the number of crews that are acceptable to be on the river at one time, as examples. The plan will also require some adjustment based on the effectiveness of the technique used and the potential flushing of petroleum products into the river that will occur due to wave action and precipitation. The resourcing component of the plan will require adjustments to reflect these variables while generally requiring the appropriate number of crews and staff required to meet established deadlines.

Crews will consist of appropriately trained personnel, including supervision, clean up personnel, safety personnel, supply and waste transport and environmental monitors. The number of personnel will also be dependent on the area being remediated, level of contamination, access to the water or existing roads, denseness of vegetation, etc. and may require or limit total personnel in each area. With the appropriateness of crew structure approved, the crew size and crew numbers will determine total personnel required to complete this SAR Plan.

# Figures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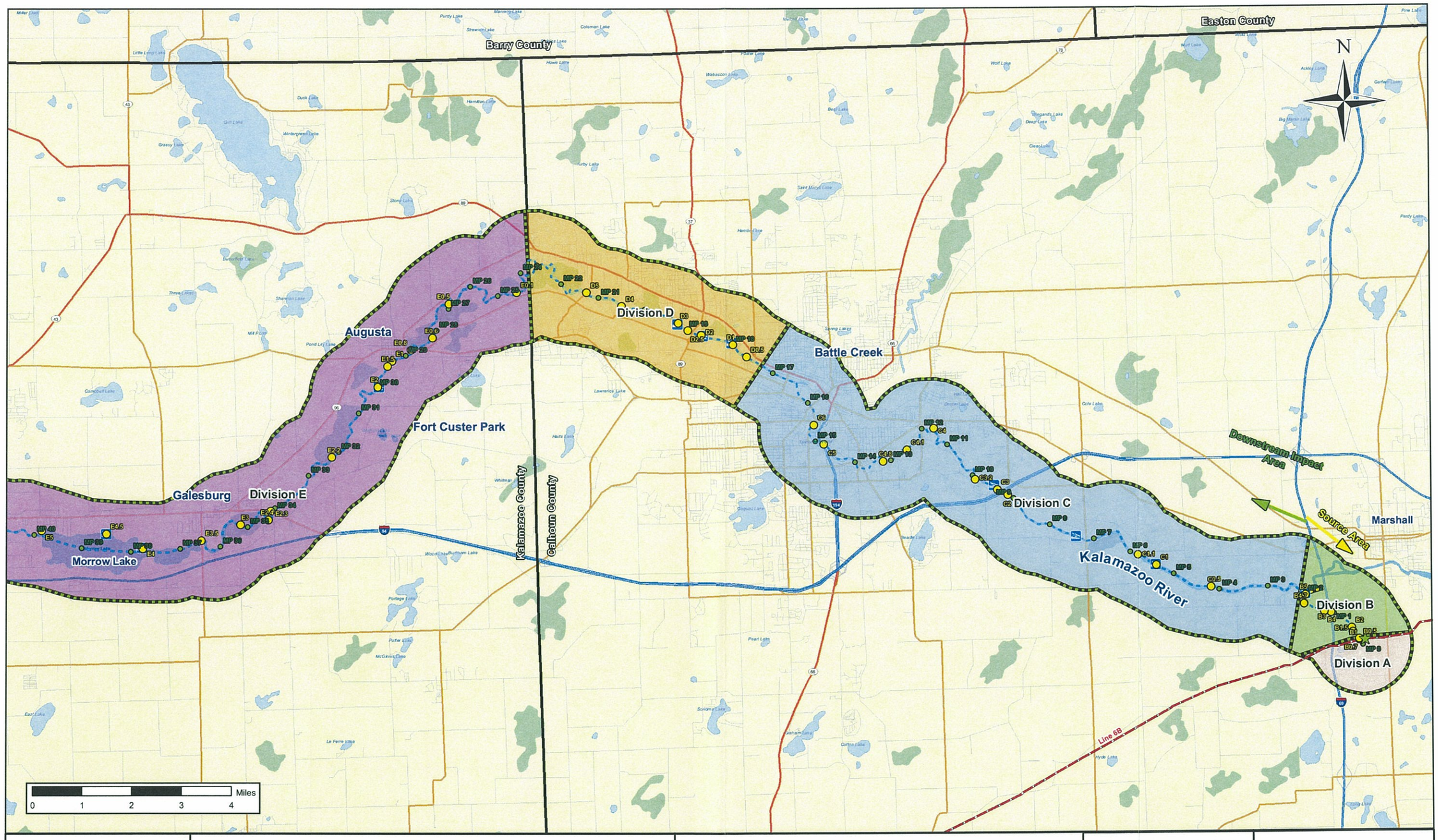
**Enbridge Energy, Limited Partnership**
**Enbridge Line 6B MP 608 - Marshall, MI**
**Source Area Response Plan**
**Figure 1: Site Location**

| | |
|---|---|
| DATE ISSUED: | Aug 11, 2010 |
| DATE REVISED: | |
| SCALE: | 1:1,500,000 |
| DRAWN BY: | NMS/JPM |
| SERIES: | 1 of 6 |

Natural Resources Engineering Co.
715-395-5680




**Legend**

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Containment Site
- Water Access
- Release Location
- Downstream Milepost

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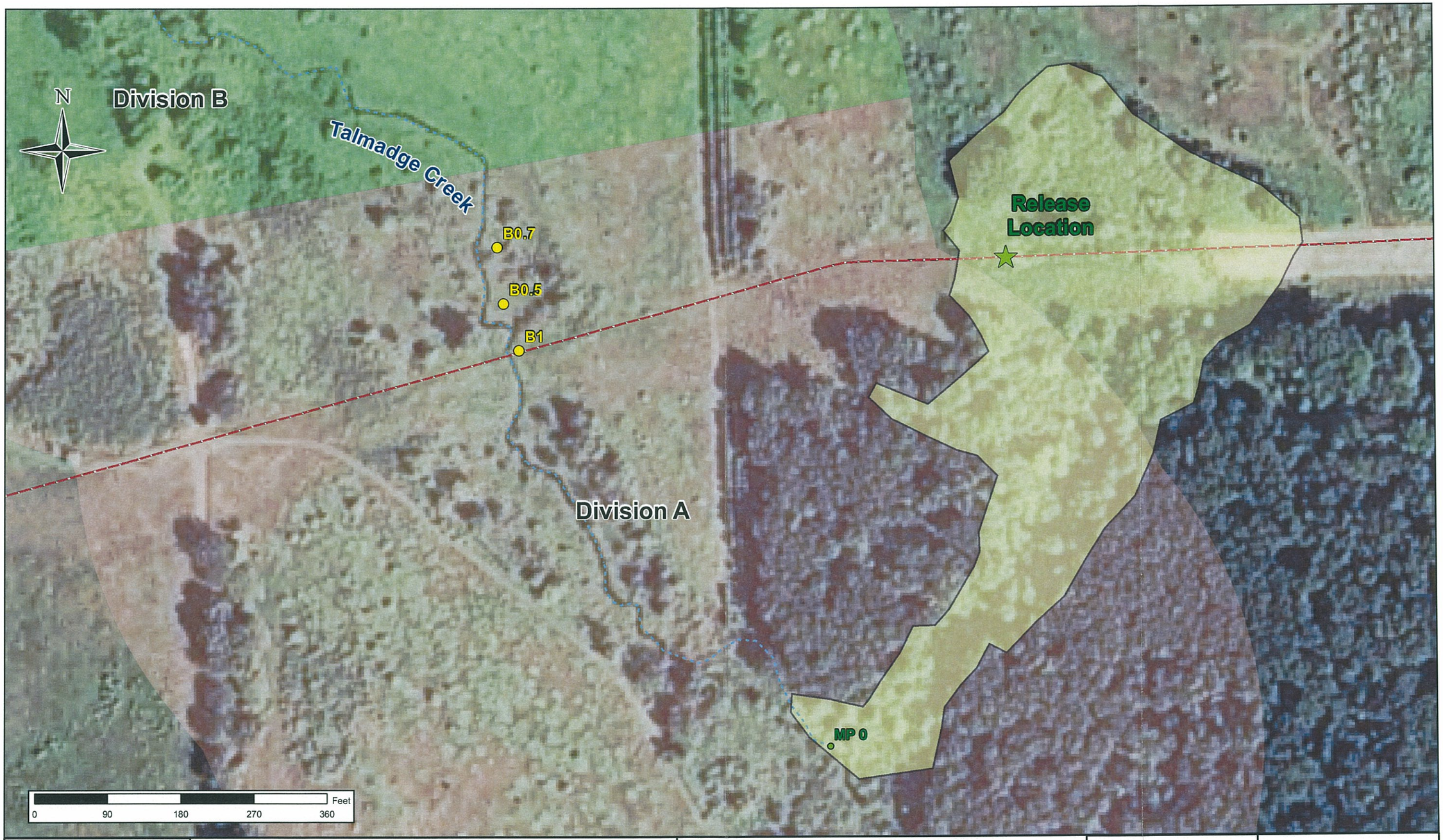
**Enbridge Energy, Limited Partnership**
**Enbridge Line 6B MP 608 - Marshall, MI**
**Source Area Response Plan**
**Figure 2: Division Designation Map**

| | |
|---|---|
| DATE ISSUED: | Aug 11, 2010 |
| DATE REVISED: | |
| SCALE: | 1:60,000 |
| DRAWN BY: | NMS/JPM |
| SERIES: | 2 of 6 |

Natural Resources Engineering Co.
715-395-5680



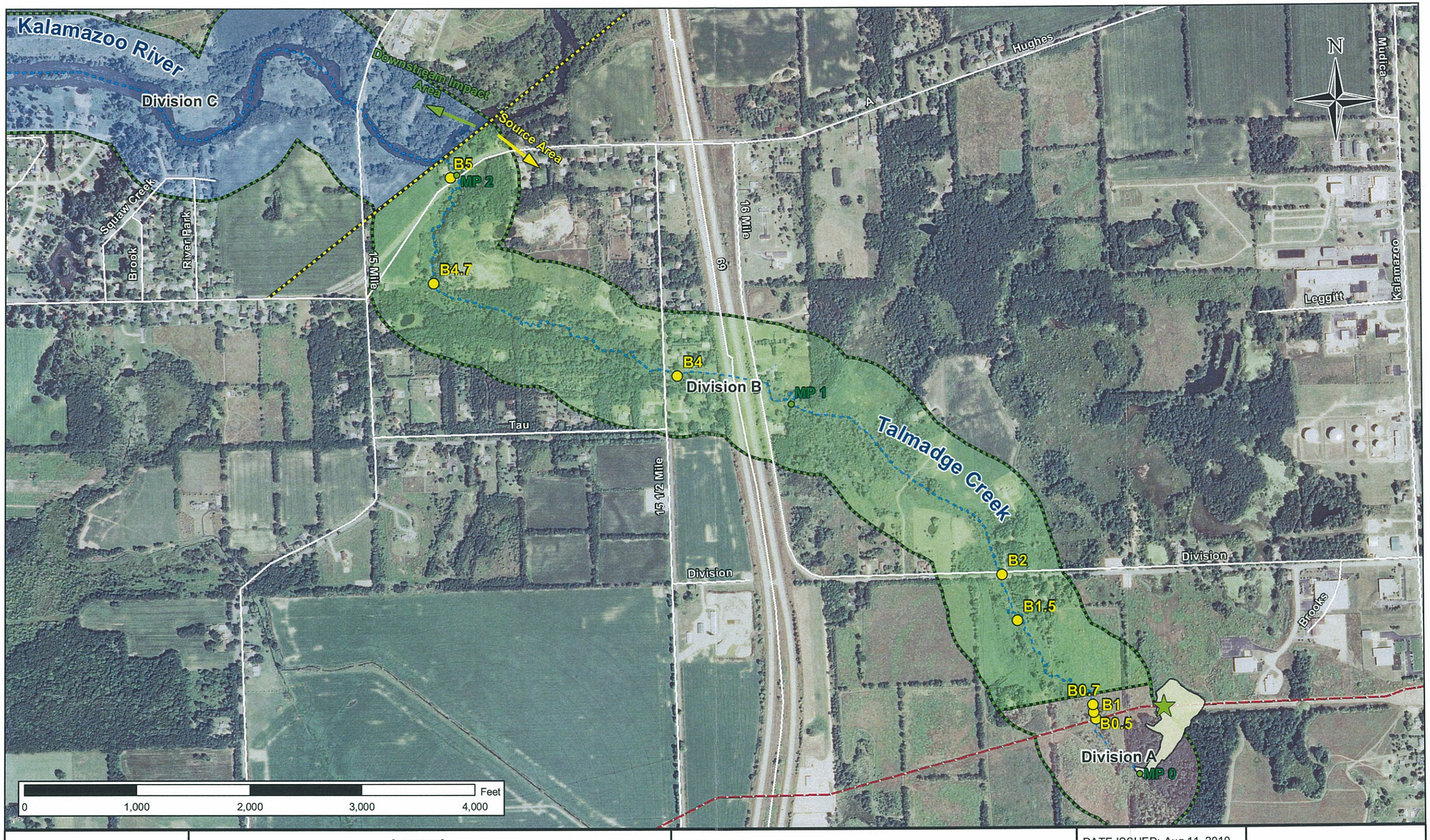

**Legend**

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Approximate Extent Of Oil
- Release Location
- Containment Site
- Downstream Milepost

**Enbridge Energy, Limited Partnership**
**Enbridge Line 6B MP 608 - Marshall, MI**
**Source Area Response Plan**
**Figure 3: Spill Release Location**

| | |
|---|---|
| DATE ISSUED: | Aug 11, 2010 |
| DATE REVISED: | |
| SCALE: | 1:700 |
| DRAWN BY: | NMS/JPM |
| SERIES: | 3 of 6 |

Natural Resources Engineering Co.
715-395-5680



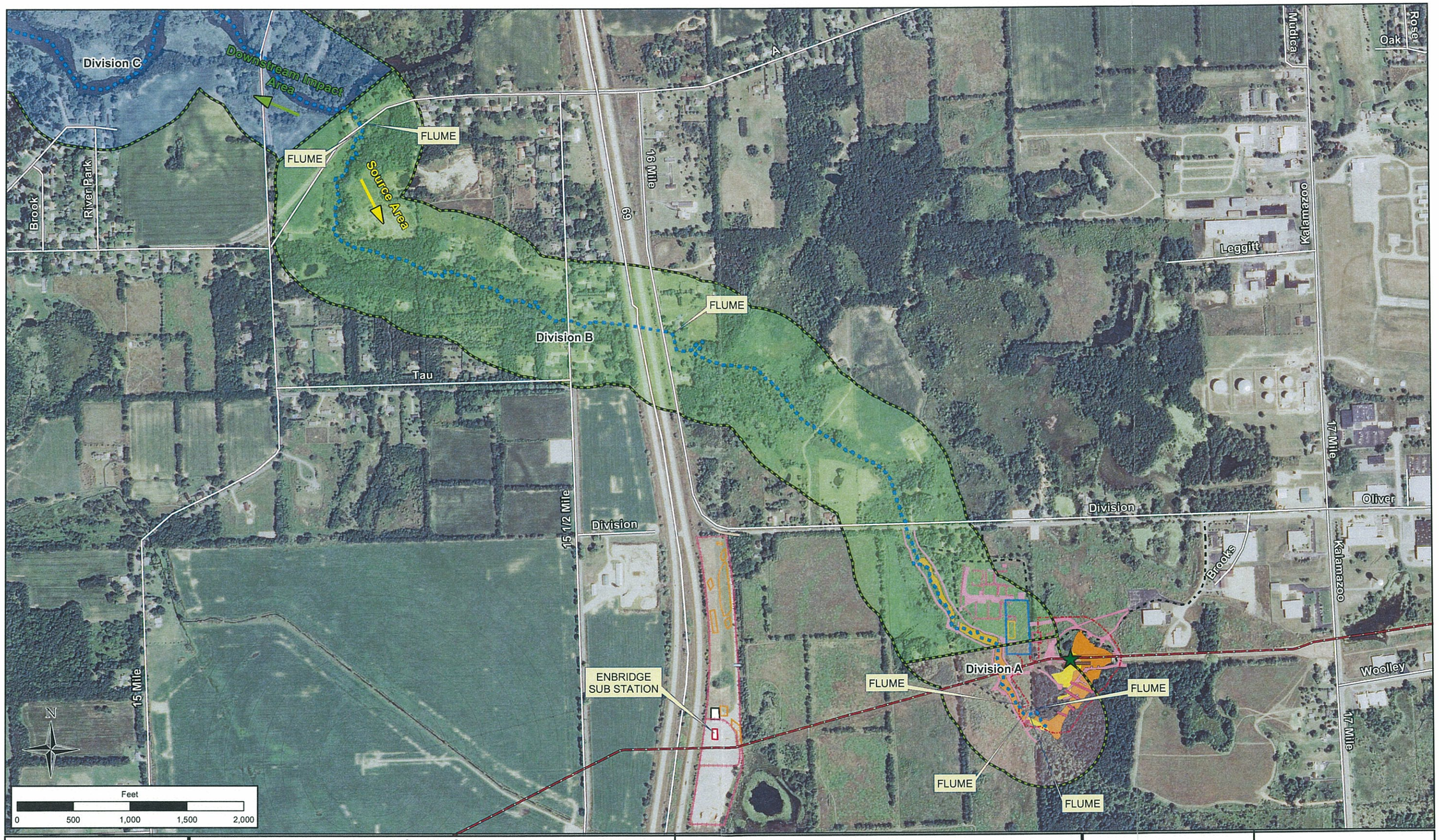

**Legend**

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Division Boundary
- Containment Site
- Release Location
- Downstream Milepost
- Approximate Extent Of Oil

**Enbridge Energy, Limited Partnership**
**Enbridge Line 6B MP 608 - Marshall, MI**
**Source Area Response Plan**
**Figure 4: Talmadge Creek**

| | |
|---|---|
| DATE ISSUED: | Aug 11, 2010 |
| DATE REVISED: | |
| SCALE: | 1:5,000 |
| DRAWN BY: | NMS/JPM |
| SERIES: | 4 of 6 |

Natural Resources Engineering Co.
715-395-5680




## Legend

- Enbridge Pipeline 6B
- River Centerline
- Access Road
- Major Road
- Fence
- Berm
- Trench
- Ditch
- Culvert
- Release Location
- Work Zone
- Contamination
- Contamination Scraped
- Staging
- Decon
- Mats
- Frac Tanks

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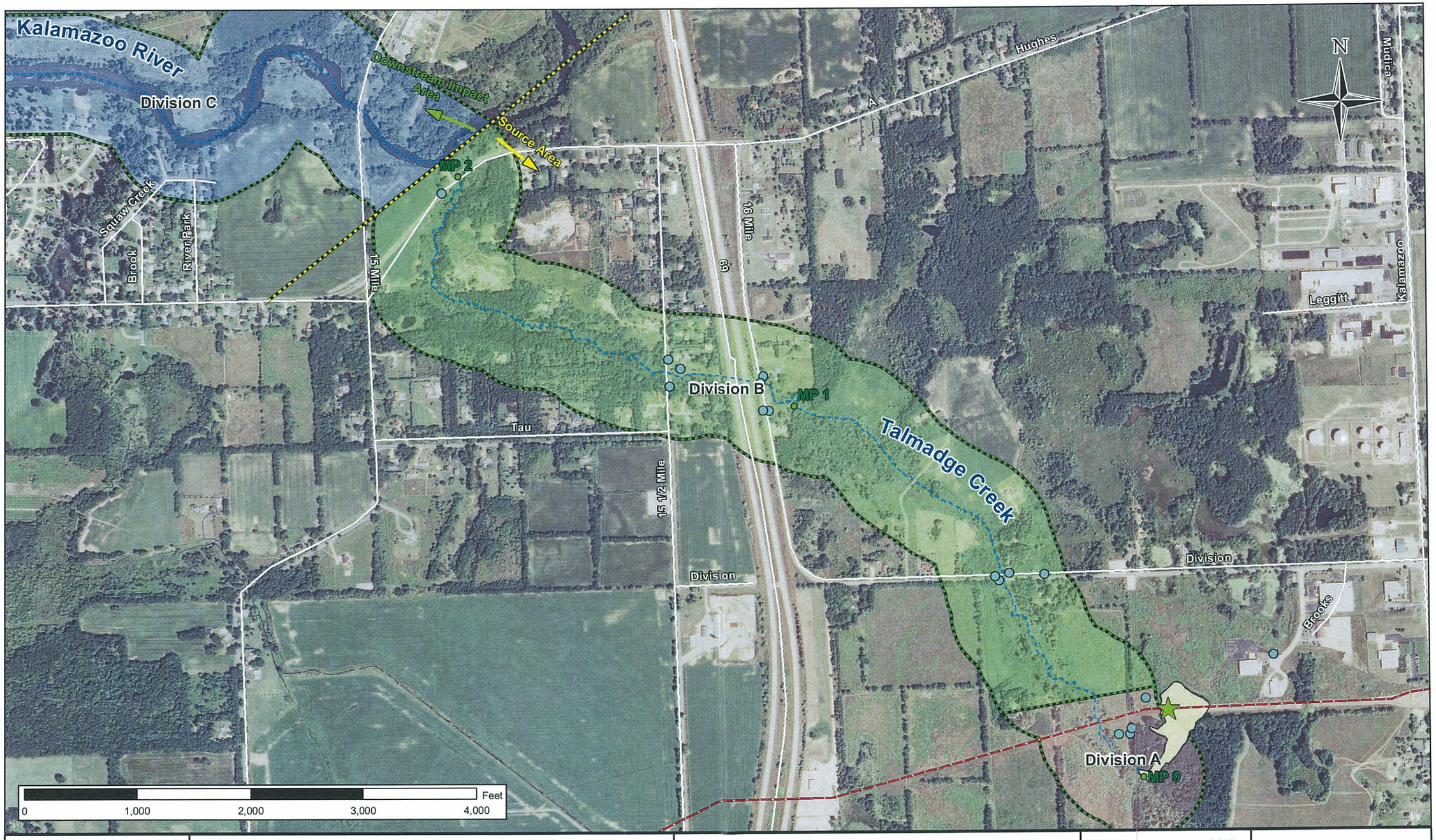
# Enbridge Energy, Limited Partnership

## Enbridge Line 6B MP 608 - Marshall, MI
## Source Area Response Plan

**Figure 5: Source Area Site Base Map**

| | |
|---|---|
| DATE ISSUED: | Aug 11, 2010 |
| DATE REVISED: | |
| SCALE: | 1:5,000 |
| DRAWN BY: | NMS/JPM |
| SERIES: | 5 of 6 |

Natural Resources Engineering Co.
715-395-5680




**Legend**

- Enbridge Pipeline 6B
- River Centerline
- Major Road
- Air Sample Location
- Downstream Impact Area
- Containment Site
- Release Location
- Downstream Milepost
- Approximate Extent Of Oil

**Enbridge Energy, Limited Partnership**
**Enbridge Line 6B MP 608 - Marshall, MI**
**Source Area Response Plan**
**Figure 6: Source Area Air Monitoring Station Locations**

| | |
|---|---|
| DATE ISSUED: | Aug 11, 2010 |
| DATE REVISED: | |
| SCALE: | 1:5,000 |
| DRAWN BY: | NMS/JPM |
| SERIES: | 6 of 6 |

Natural Resources Engineering Co.
715-395-5680

# Attachments

# Attachment A

## U.S. EPA Comment Response Verification

## Attachment A

**U.S. EPA Comment Response Verification**
Enbridge Line 6 MP 608
SAR
Marshall, Michigan
(per U.S EPA August 15, 2010 letter)

SAR Plan-Specific Comments

1. The acronym table has been revised as requested.
2. Detailed information regarding how different soil types will be evaluated has been added to Section 2.1.4.
3. The sentence has been revised as requested in Section 2.3.
4. A proposed plan to investigate Talmadge Creek bottoms/sediments has been added to Section 2.3.
5. The frequency and duration for the proposed monitoring has been added to Section 2.9.
6. Details regarding backfilling and/or regarding of impacted areas has been added to Section 2.7.
7. The SAR has been revised to state that proposed decontamination techniques of man-made structures must be approved by the regulatory agency with the appropriate jurisdiction (Section 2.8.3).
8. The reference to Section 2.1.5 has been corrected to read 2.1.4.
9. The phrase "Part 201 (Environmental Remediation) of..." has been replaced to say that the work will be conducted in accordance with all applicable parts of the NREPA.
10. Results of the preliminary Threatened and Endangered species survey have been resubmitted.
11. Language has been added to state that the SCAT Team will include recommendations for remediation that must be approved by FOSC.
12. Section 2.3 has been amended to include a reference that collection and analysis of samples will conform to the SAP.
13. Section 2.4 has been amended to include the collection, cleaning rehabilitation and release of live oiled animals.
14. In Section 2.6, the phrase "consistent with Part 91 of the NREPA" has been added to the end of the first sentence of the first paragraph. The second sentence has been clarified.
15. The SAR has been amended to include text regarding metrics from Sections 3.1, 3.1.1, 3.1.2 and 3.1.3 of the Response Plan for Downstream Impacted Areas.
16. All references from the Unified Command (UC) and/or Incident Commander (IC) in the SAR have been changed to reference the FOSC.

# Attachment B

## Cleanup Plan for Talmadge Creek

**Cleanup Plan for Talmadge Creek (Division B)**
**August 6, 2010**

Cleanup within Division B (Talmadge Creek) will be conducted per the recommendations of the shoreline cleanup assessment teams (SCAT). Initial SCAT surveys of Talmadge Creek were performed on 6 August 2010 by a team comprised of representatives of the Federal and state on-scene coordinators, Federal and state NRDA Trustees, and the Responsible Party (Enbridge). Accessible portions of the creek were surveyed on foot by walking along the banks of the affected reaches and also from bridge crossing or other vantage points.

In general, oiling conditions were found to be moderate to heavy within the areas observed. Vegetation growing on the banks and/or overhanging the channel was often heavily oiled and frequently contained varying amounts of free product (e.g., mobile oil) stranded above the water line. Bank soils were heavily coated or saturated with oil in many locations. Heavy sheen and floating free product were present on the water's surface, especially in natural accumulation areas or in association with instream deposits of woody debris.

Cleanup will utilize a variety of techniques tailored to the conditions present at specific locations with Division B. As a general rule, the least invasive cleanup methods will be applied in order to accomplish the following objectives:

- Remove free product capable of being remobilized and contaminating other areas,
- Preventing secondary oiling of wildlife, and
- Minimizing potential threats to human health or other nuisance conditions.

The benefits of cleanup actions relative to these objectives will be weighted against the potential environmental impacts. It is recognized that there is a point where the negative environmental consequences of further cleanup/more aggressive methods outweigh the incremental benefits of removing additional oil from the environment.

The following cleanup techniques will be applied as appropriate:

- **Low-pressure, high-volume ambient water flushing**. Ambient water from Talmage Creek will be pumped to mobilize oil trapped in streambank or overhanging vegetation back into the creek where it will be collected with sorbents and/or skimmers. Adequate containment in the form of hard boom or underflow (siphon) dams will be established within a reasonable distance downstream of active work zones to facilitate collection and recovery of remobilized oil and to prevent additional oiling of downstream reaches. Flushing will not be conducted where the movement of water causes erosion of unconsolidated bank sediments. Water streams shall

be directed at low angles parallel to the slope to facilitate the downgradient movement of oil, while minimizing incorporation of oil into stream channel sediments. Use of a perforated header pipe or manifold at the top of the bank to flush oil towards the creek may be used where appropriate and feasible.

- **Vegetation Cutting.** Oiled herbaceous and shrub vegetation along the streambanks and overhanging the channel will be removed by cutting. Only oiled vegetation will be targeted for removal. Removal of unoiled vegetation will be minimized. All cut oiled vegetation will be bagged immediately and segregated from other types of oily wastes (e.g., sorbents, soil, etc.). Trees with oiled bark on their trunks will not be cut. However, oil on tree bark may be removed by using sorbents and/or flushing. Only the above-ground portion of vegetation will be removed; efforts will be made to limit disturbance of the root systems of plants to help maintain bank stabilization/erosion control functions to the greatest degree possible. Removal of above-ground vegetation will also improve the chances of natural recovery from the root stock next in subsequent growing seasons.

- **Manual Removal.** Where practical, manual techniques will be used to remove oil from the streambanks and affected riparian areas. This may consist of shoveling, scraping, raking or digging oil and oil-impacted soils using hand tools. Oily material will be bagged immediately. Removal of clean underlying soils will be minimized. Efforts will be made to avoid destabilizing the streambanks, which could lead to further erosion. Manual removal also applies to removal of oily debris from the streambanks or within the stream channel. Workers will take care to avoid trampling non-oiled vegetation and walking on sift substrates, which has the potential to push oil farther down into the sediments.

- **Mechanical Removal.** In areas where bank soils are saturated with oil and manual removal is impractical or unsafe, mechanical removal will be performed using heavy equipment. Removal of clean underlying soils will be minimized. To the degree possible, channel morphology will be maintained. Impacted soils will be loaded into lined roll-off containers for proper disposal. Equipment shall be positioned in locations where it causes the least harm to surrounding environments and risk to workers. To the degree possible, equipment will not transit through oiled areas.

This plan may be adapted during the course of cleanup to use modified or alternative approaches based on conditions encountered in the field and lessons learned throughout implementation.

# Attachment C

## Joint Permit Application to MDNRE and USACE Part 303/301 and Part 31

URS

August 2, 2010

Mr. Kameron Jordan
Michigan Department of Natural Resources and Environment
Land & Water Management Division
Kalamazoo District Office
7953 Adobe Road
Kalamazoo, Mi 49009-5026

**Re: Enbridge Pipelines, Inc. Talmadge Creek Oil Spill**
**MDNRE/USACE Joint Permit Application**
**Fredonia Township, Calhoun County, Michigan**

Dear Mr. Kameron Jordan:

Please find enclosed a Joint Permit Application for wetland, stream, and floodplain impacts associated with the Enbridge Line 6B spill clean-up in Talmadge Creek in Fredonia Township, Calhoun County, Michigan. The Line 6B spill is located at T03S, S2, R06W within Calhoun County. URS, on behalf of Enbridge Pipelines, Inc. is seeking a General Permit for Minor Activities in Wetlands in the State of Michigan under Category N. Emergency Spill Cleanup.

The proposed clean up is location in wetland, stream and floodplain areas where the initial Line 6B oil spill occurred. The area of wetland impacted is an emergent and forested wetland where contaminated soil and wetland vegetation have been removed in clean up efforts. The clean up will impact approximately 2.84 acres of regulated wetland. Of the impacted wetland area 0.76 acre is emergent wetland and 2.09 acres of impact is forested wetland. Additionally, the proposed excavation will impact 2.61 acres of floodplain. Stream impacts are being cleaned up through the use of vacuum trucks and skimmers, however a complete stream assessment and survey is not possible at this time due to health and safety concerns. Further survey will be completed for the stream impacts below the OHWM.

Once the proposed clean-up is complete, the remaining wetland and floodplain in the project area will be restored to its natural condition per the enclosed restoration plan following Best Management Practices (BMP) from Enbridge's Environmental Guidelines for Construction and MDNRE's Guidebook of Best Management Practices for Michigan Watersheds. Impacts to wetlands, streams and floodplain have been minimized as much as possible.

Due to safety concerns the wetland delineation of approximately 6.61 acres conducted by URS Corporation on July 30, 2010, was limited as access to the impact area was restricted. Consequently this delineated wetland line and impacts may vary at a later date and impact quantities are approximate. A more detailed survey will be completed when conditions at the site improve.

Enclosed you will find the MDNRE joint permit application, a permit addendum, a site location map, a site plan, plan/profile drawings, a wetland/stream/floodplain restoration plan, BMPs, a photolog, an adjacent land owner reference map, table and mailing address labels, a wetland delineation report, and the credit card transaction authorization form. Please feel free to contact me, Ms. Sherry Slocum, at (616) 560-5245 with any questions or if additional information is needed.

URS Corporation
3950 Sparks Drive, SE
Grand Rapids, MI 49546
Tel: 616.574.8500
Fax: 616.574.8542

URS

Mr. Kameron Jordan
MDNRE
August 2, 2010



Sincerely,

**URS Corporation Great Lakes**

for

Sherry Slocum
Manager, Ecological Services Group

URS Corporation
3950 Sparks Drive, SE
Grand Rapids, MI 49546
Tel: 616.574.8500
Fax: 616.574.8542

US Army Corps of Engineers (USACE) | Michigan Department of Environmental Quality (MDEQ) DEQ

| AGENCY USE | | | | AGENCY USE |
|---|---|---|---|---|
| | Previous USACE Permit or File Number | Date Received | Land and Water Management Division, MDEQ File Number | |
| | USACE File Number | | Pre-application Number or Marina Operating Permit Number | |
| | District Office | | Fee received $ | |

**Read Instructions pages i - iii. All of the following boxes below must be checked and information provided for the application to be processed:**

- ☐ **All items in Sections 1 through 9 are completed**
- ☐ **Items in Sections 10 through 21 that apply to the project are completed**
- ☐ **Dimensions, volumes and calculations are provided**
- ☐ **Date project was staked**
- ☐ **Application fee is attached**
- ☐ **All requested supplementary attachments (➡) are included**
- ☐ **Reproducible location map, site plan(s), cross sections and photographs are provided, one set must be black and white on 8 ½ by 11 inch paper.**
- ☐ **List any additional attachments, tables, etc.:**

## 1 PROJECT LOCATION INFORMATION

• Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

| Site location Address (road, if no street address) | Zip Code | Township Name(s) | Township(s) | Range(s) | Section(s) |
|---|---|---|---|---|---|
| *Division and Old US 27* | *49068* | *Fredonia Township* | *03S* | *06W* | *2* |

| City/Village | County(ies) | Property Tax Identification Number(s) |
|---|---|---|
| *City of Marshall* | *Calhoun County* | |

| Name of Waterbody | Project Name or Job Number | Subdivision/Plat | Lot Number | Private Claim |
|---|---|---|---|---|
| *Talmadge Creek* | *Enbridge Pipelines, Inc. Talmadge Creek Oil Spill* | | | |

Project types (check all that apply): ☒ private ☐ public/government ☐ industrial ☐ commercial ☐ multi-family ☐ building addition ☐ new building or structure ☐ building renovation or restoration ☐ river restoration ☐ single-family ☐ project is receiving federal transportation funds ☐ other (explain)

The proposed project is on, within, or involves (check all that apply)

☐ a legally established County Drain (date established) (M/D/Y) / /

| | | | | |
|---|---|---|---|---|
| ☒ a stream | ☐ a pond (less than 5 acres) | ☐ a Great Lake or Section 10 Waters | ☐ a natural river | ☐ a new marina |
| ☐ a river | ☐ a channel/canal | ☐ a designated high risk erosion area | ☐ a dam | ☐ a structure removal |
| ☐ a ditch or drain | ☐ an inland lake (5 acres or more) | ☐ a designated critical dune area | ☒ a wetland | ☐ a utility crossing |
| ☐ floodway area | ☒ a 100-year floodplain | ☐ a designated environmental area | ☐ 500 feet of an existing waterbody | |

## 2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS (attached additional sheets)

Written Summary of All Proposed Activities. *See Addendum*

Construction Sequence and Methods. *See Addendum*

## 3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

| Owner/Applicant (individual or corporate name) | Agent/Contractor (firm name and contact person) |
|---|---|
| *Endbridge Pipelines, Inc. - Tom Fridel* | *URS Corporation - Sherry Slocum* |
| Mailing Address *1500 Main St* | Address *3950 Sparks Drive, SE* |
| City *Griffith* State *IN* Zip Code *46319-2662* | City *Grand Rapids* State *MI* Zip Code *49546* |
| Daytime Phone Number with Area Code *219-922-3133* Cell Phone Number - - | Daytime Phone Number with Area Code *616-560-5245* Cell Phone Number *616-560-5245* |
| Fax - - E-mail | Fax *616-574-8542* E-mail *Sherry_Slocum@URSCorp.com* |

☒ No ☐ Yes Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project?
➡ If no, attach letter(s) of authorization from all owners. A letter signed by each property owner authorizing the agent/contractor/other owner to act on his or her behalf or a copy of easements or right-of-ways must be provided. If multiple property owners, also attach a list of all owners along with their names, mailing addresses, and telephone numbers. If the applicant is a corporation, a corporate officer must provide written document authorizing any agent/contractor listed above to act on its behalf.
A letter of authorization must be provided from an owner receiving dredge spoils on their property, or where access through their property is required..

| Property Owner's Name (If different from applicant) | Mailing Address |
|---|---|
| *See Addendum* | |
| Daytime Phone Number with Area Code - - Cell Phone Number - - | City State Zip Code |

☒ No ☐ Yes Is there a MDEQ conservation easement or other easement, deed restriction, lease, or other encumbrance upon the property in the project area?
➡ If yes, attach a copy.

**4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED** (Attach additional sheets if necessary)

**Purpose/Intended Use:** The purpose must include any new development or expansion of an existed land use.

**Alternatives:** Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; and alternative locations. For utility crossings, include both alternative routes and alternative construction methods.

**5 LOCATING YOUR PROJECT SITE**

➡ Attach a black and white, legible copy of a map that clearly shows the site location and road from the nearest major intersection, and includes a north arrow.

Is there an access road to the project? ☐ No ☒ Yes (If Yes, type of road, check all that apply) ☐ private ☒ public ☐ improved ☐ unimproved

Name of roads at closest main intersection *Division Road* and *Old US 27 S*

Directions from main intersection *From Old US 27 S traveling north, turn west on Division Road. The site is located within the Enbridge Pipeline right-of-way to the south.*

Style of house or other building on site ☐ ranch ☐ 2-story ☐ cape cod ☐ bi-level ☐ cottage/cabin ☐ pole barn ☐ none ☐ other (describe) *N/A*

Color | Color of adjacent property house and/or buildings | House number | Street name

Fire lane number | Lot number | Address is visible on ☐ house ☐ garage ☐ mailbox ☐ sign ☐ other (describe)

How can your site be identified if there is no visible address? *Following Talmadge Creek to spill locations, area has been blocked off to prevent injury to the public.*

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody *Talmadge Creek*

Does the project cross the boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)

☐ No ☒ Yes ➡ If Yes, list jurisdictions: *Fredonia Township*

**6** List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

| Agency | Type approval | Identification number | Date applied | Date approved / denied | If denied, reason for denial |
|---|---|---|---|---|---|
| *Calhoun County Road Commission* | *SESC* | | | | |
| *MDNRE* | *T&E Clearance* | | | | |

**7 COMPLIANCE**

If a permit is issued, date activity will commence (M/D/Y) *7/27/2010*

Proposed completion date (M/D/Y) / /

Has any construction activity commenced or been completed in a regulated area? ☐ No ☒ Yes

➡ If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y) / */See Addendum*

Were the regulated activities conducted under a MDEQ permit? ☒ No ☐ Yes

If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? ☒ No ☐ Yes (If Yes, explain)

**8 ADJACENT/RIPARIAN AND IMPACTED OWNERS** (Attach additional sheets if necessary)

- Complete information for all adjacent and impacted property owners and the lake association or established lake board, including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel that is not owned by you.

Property Owner's Name | Mailing Address | City | State | Zip Code

*See Attached for Adjacent Landowner list, map, and labels*

Name of ☐ Established Lake Board ☐ or Lake Association and the Contact Person's name, phone number, and mailing address

**9 APPLICANT'S CERTIFICATION READ CAREFULLY BEFORE SIGNING**

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application; that it is true and accurate; and, to the best of my knowledge, that it is in compliance with the State Coastal Zone Management Program. I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does not release me from the requirements of obtaining the permit required herein before commencing the activity. I understand that the payment of the application fee does not guarantee the issuance of a permit.

| | Printed Name | Signature | Date (M/D/Y) |
|---|---|---|---|
| ☐ Property Owner<br>☒ Agent/Contractor<br>☐ Corporation/Public Agency – Title *URS Corporation* | *Sherry Slocum* | *Kas Bernoff for Sherry Slocum* | *8/2/2010* |

## 10 PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE

- Check boxes A through M that may be applicable to your project and provide all the requested information.
- If your project may affect wetlands, also complete Section 12. If your project may impact regulated floodplains, also complete Section 13.

To calculate volume in cubic yards (cu yd), multiply the average length in feet (ft) times the average width (ft) times the average depth (ft) and divide by 27.
Some projects on the Great Lakes require an application for conveyance prior to Joint Permit Application completeness.
➡Provide a cross-section and overall site plan showing existing lakes, streams, wetlands, and other water features; existing structures; and the location of all proposed structures, land change activities and soil erosion and sedimentation control measures. Review Appendix B and EZ Guides for completing site-specific drawings.
➡Provide tables for multiple impact areas or multiple activities and provide fill and excavation/dredge calculations.

**Water Level Elevation**
On a Great Lake use IGLD 85 ☐ surveyed ☐ converted from observed still water elevation. On inland waters, ☐ NGVD 29 ☒ NAVD 88 ☐ other
Observed water elevation (ft) date of observation (M/D/Y)

☐ **A. PROJECTS REQUIRING FILL** (See All Sample Drawings)
- Attach both overall site plan and cross-section views to scale showing maximum and average fill dimensions.

(Check all that apply) ☐ floodplain fill ☐ wetland fill ☐ riprap ☐ seawall, bulkhead, or revetment ☐ bridge or culvert
☐ boat launch ☐ off-shore swim area ☐ beach sanding ☐ boatwell ☐ crib dock ☐ other

| Fill dimensions (ft) length width maximum depth | Total fill volume (cu yd) | Maximum water depth in fill area (ft) |
|---|---|---|

Type of clean fill ☐ pea stone ☐ sand ☐ gravel ☐ wood chips ☐ other
Will filter fabric be used under proposed fill? ☐ No ☐ Yes (If Yes, type)

Source of clean fill ☐ on-site, ➡If on-site, show location on site plan. ☐ commercial ☐ other, ➡If other, attach description of location.

Fill will extend feet into the water from the shoreline and upland feet out of the water. Fill volume below OHWM (cu yd)

☒ **B. PROJECTS REQUIRING DREDGING OR EXCAVATION** (For dredging projects see Sample Drawing 7, for excavation see other applicable Sample Drawings)
- Attach both overall site plan and cross-section views to scale showing maximum and average dredge or excavation dimensions and dredge disposal location.
- Refer to www.michigan.gov/jointpermit for disposal requirements and authorization.

(Check all that apply) ☒ floodplain excavation ☒ wetland dredge or draining ☐ seawall, bulkhead, or revetment
☐ navigation ☐ boat well ☐ boat launch ☐ other

| Total dredge/excavation volume (cu yd) *See Addendum* | Dimensions length - width - depth - | Dredge/excavation volume below OHWM (cu yd) - | Method and equipment for dredging *See Addendum* |
|---|---|---|---|

Has proposed dredge material been tested for contaminants? ☒ No ☐ Yes
If Yes, provide test results with a map of sampling locations.
Dredged or excavated spoils will be placed ☐ on-site ☒ off-site.
➡Provide detailed disposal area site plan and location map.
➡Provide letter of authorization from owner, if disposing of spoils off site.

Has this same area been previously dredged? ☒ No ☐ Yes If Yes, date and permit number: / / /
If Yes, are you proposing to enlarge the previously dredged area? ☐ No ☐ Yes

Is long-term maintenance dredging planned? ☒ No ☐ Yes If Yes, when and how much?

☐ **C. PROJECTS REQUIRING RIPRAP** (See Sample Drawings 2, 3, 8, 12, 14, 17, 22, and 23. Others may apply)

| Riprap waterward of the ☐ shoreline OR ☐ ordinary high water mark | Dimensions (ft) length width depth | Volume(cu yd) |
|---|---|---|
| Riprap landward of the ☐ shoreline OR ☐ ordinary high water mark | Dimensions (ft) length width depth | Volume(cu yd) |

Type of riprap ☐ field stone ☐ angular rock ☐ other
Will filter fabric be used under proposed riprap? ☐ No ☐ Yes (If Yes, type)

☐ **D. SHORE PROTECTION PROJECTS** (See Sample Drawings 2, 3, and 17) Complete Sections 10A, B, and/or C above, as applicable.
(check all that apply) ☐ riprap – length (ft) ☐ seawall/bulkhead – length (ft) ☐ revetment – length (ft)
Distances of project from both property lines (ft)

☐ **E. DOCK - PIER – MOORING PILINGS – ROOFS** (See Sample Drawing 10)

| Dock Type ☐ open pile ☐ filled ☐ crib Seasonal support structure? ☐ No ☐ Yes | Permanent Roof? ☐ No ☐ Yes Mounted on Maximum Dimensions: length width height |
|---|---|
| Proposed structure dimensions (ft) length width | Dimensions of nearest adjacent structures (ft) length width |

☐ **F. BOAT WELL** (See EZ Guides)
Type of sidewall stabilization ☐ wood ☐ steel ☐ concrete ☐ vinyl ☐ riprap ☐ other

| Boat well dimensions (ft) length width depth | Number of boats |
|---|---|
| Volume of backfill behind sidewall stabilization (cu yd) | Distances of boat well from adjacent property lines (ft) |

☐ **G. BOAT LAUNCH** (See EZ Guide) (check all that apply) ☐ new ☐ existing ☐ public ☐ private ☐ commercial ☐ replacement

| Proposed overall boat launch dimensions (ft) length width depth | Type of material ☐ concrete ☐ wood ☐ stone ☐ other |
|---|---|
| Existing overall boat launch dimensions (ft) length width depth | Boat launch dimensions (ft) below ordinary high water mark length width depth |
| Distances of launch from both property lines (ft) | Number of adjacent Skid piers / Skid pier dimensions (ft) length width |

☐ **H. BOAT HOIST** (See EZ Guide)
(Check all that apply) ☐ *seasonal* ☐ permanent ☐ cradle ☐ side lifter ☐ other
located on ☐ *seawall* ☐ *dock* ☐ bottomlands

**10 Continued - PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE**

☐ **I. BOARDWALKS AND DECKS IN** ☐ **WETLANDS - OR -** ☐ **FLOODPLAINS** (See Sample Drawings 5 and 6. Provide table if necessary)

| Boardwalk ☐ on pilings ☐ on fill | Dimensions (ft) length width | Deck ☐ on pilings ☐ on fill | Dimensions (ft) length width |
|---|---|---|---|
| | | | |

☐ **J. INTAKE PIPES** (See Sample Drawing 16) ☐ **OUTLET PIPES** (See Sample Drawing 22)

| Type ☐ headwall ☐ end section ☐ pipe ☐ other | If outlet pipe, discharge is to ☐ wetland ☐ inland lake ☐ stream, drain, or river ☐ Great Lake ☐ other | | |
|---|---|---|---|
| Dimensions of headwall OR end section (ft) length width depth | | Number of pipes | Pipe diameters and invert elevations |

☐ **K. MOORING AND NAVIGATION BUOYS** (See EZ Guide for Sample Drawing)

➡ Provide an overall site plan showing the distances between each buoy, distances from the shore to each buoy, and depth of water at each buoy in feet.

➡ Provide cross-section drawing(s) showing anchoring system(s) and dimensions.

| Number of buoys | Boat Lengths | Type of anchor system | Purpose of buoy ☐ mooring ☐ navigation ☐ swimming |
|---|---|---|---|
| | | | |

| Dimensions of buoys (ft) width height swing radius chain length | Do you own the property along the shoreline? ☐ No ☐ Yes ➡ Attach Authorization Letter from the property owner(s), if No above. |
|---|---|
| | |

☐ **L. FENCES IN WETLANDS, STREAMS, OR FLOODPLAINS** (No Sample Drawing available)

- Provide an overall site plan showing the proposed fencing through wetlands, streams, or floodplains.
- Provide drawing of fence profile showing the design, dimension, post spacing, board spacing, and distance from ground to bottom of fence.

| (check all that apply) ☐ wetlands ☐ streams ☐ floodplains | Total length (ft) of fence through wetlands streams floodplains | Fence height (ft) | Fence type and material |
|---|---|---|---|
| | | | |

☐ **M. OTHER** - e.g., structure removal or construction, breakwater, aerator, fish shelter, and structural foundations in wetlands or floodplains

**11 EXPANSION OF AN EXISTING OR CONSTRUCTION OF A NEW LAKE OR POND** (See Sample Drawings 4 and 15)

Which best describes your proposed waterbody use (check all that apply)

☐ wildlife ☐ stormwater retention basin ☐ recreation ☐ wastewater basin ☐ other

Water source for lake/pond

☐ groundwater ☐ natural springs ☐ Inland Lake or Stream ☐ stormwater runoff ☐ pump ☐ sewage ☐ other

Location of the lake/basin/pond ☐ floodplain ☐ wetland ☐ upland

| Maximum dimensions (ft) length width depth<br>Maximum Area: ☐ acres ☐ sq ft | Spoils will be placed ☐ onsite ☐ offsite outside of wetland and floodplain ☐ other<br>➡ Provide a Detailed Disposal Area Site Plan with location map, address and disposal dimensions<br>➡ Provide a Letter of Authorization from off site disposal site owner<br>➡ Provide elevations and cross sections for outlets and/or emergency. Complete Section 10J, |
|---|---|

Will project involve construction of a dam, dike, outlet control structure, or spillway? ☐ No ☐ Yes (If Yes, complete Section 17)

**12 ACTIVITIES THAT MAY IMPACT WETLANDS** (See Sample Drawings 8 & 9, and complete sections 10 A and 10 B for dredge or excavation as applicable)

- For information on the MDEQ's Wetland Identification Program (WIP) visit www.michigan.gov/deqwetlands or call 517-373-1170.
- Complete the wetland dredge and wetland fill dimension information below for each impacted wetland area. ➡ Attach tables for multiple impact areas or activities
- Label the impacted wetland areas on a site plan, drawn to scale or with dimensions. ➡ Attach at least one cross-section for each wetland dredge and/or fill area.
- If dredge/excavation material will be disposed of on site, show the location on site plan and include soil erosion and sedimentation control measures.

(check all that apply) ☐ fill (Section 10A) ☒ dredge or excavation (Section 10B) ☐ boardwalk or deck (Section 10I) ☐ dewatering ☐ fences (Section 10L) ☐ bridges and culverts (Section 14) ☐ draining surface water ☐ stormwater discharge ☐ restoration ☐ other

| | | | | | |
|---|---|---|---|---|---|
| wetland dredge/excavation dimensions | maximum length (ft) *156.0* | maximum width (ft) *794.0* | dredge/excavation area ☒ acres ☐ sq ft *2.84* | average depth (ft) *2.0* | dredge volume (cu yd) *9173.17* |
| wetland fill dimensions *N/A* | maximum length (ft) *N/A* | maximum width (ft) *N/A* | fill area ☐ acres ☐ sq ft *N/A* | average depth (ft) *N/A* | fill volume (cu yd) *N/A* |

| Total wetland dredge/excavation area ☒ acres ☐ sq ft *2.84* | Total wetland dredge/excavation volume (cu yd) *9173.17* | Total wetland fill area ☐ acres ☐ sq ft *N/A* | Total wetland fill volume (cu yd) *N/A* |
|---|---|---|---|
| | | | |

| The proposed project will be serviced by: ☐ public sewer ☐ private septic system ➡ Show system on plans | If septic system, has an application for a permit been made to the County Health Department? ☐ No ☐ Yes | If Yes, has a permit been issued? ☐ No ☐ Yes ➡ Provide a copy. |
|---|---|---|
| | | |

| Has a professional wetland delineation been conducted for this parcel? ☐ No ☒ Yes ➡ Provide a copy of the delineation. ➡ Supply data sheets. | Applicant purchased property ☐ before OR ☐ after October 1, 1980. |
|---|---|
| | |

Is there a recorded MDEQ easement on the property? ☒ No ☐ Yes If Yes, provide the easement number)

Has the MDEQ conducted a wetland assessment for this parcel? ☒ No ☐ Yes ➡ If Yes, provide a copy of assessment or WIP number:

Describe the wetland impacts, the proposed use or development, and any alternatives considered: *See Addendum*

Does the project impact more than 1/3 acre of wetland? ☐ No ☐ Yes

➡ If Yes, submit a Mitigation Plan that includes the type and amount of mitigation proposed. For more information go to www.michigan.gov/deqwetlands

Describe how impacts to waters of the United States will be avoided and minimized: *See Addensum*

Describe how impact to waters of the United States will be compensated. OR Explain why compensatory mitigation should not be required for the proposed impacts.

*See Addendum*

| Is any grading or mechanized land clearing proposed? ☐ No ☒ Yes ➡ Show locations on submitted site plan. | Has any of the proposed grading or mechanized land clearing been completed? ☐ No ☒ Yes ➡ Show labeled locations on site plan. |
|---|---|
| | |

**13 FLOODPLAIN ACTIVITIES** (See Sample Drawing 5. Others may apply.) For more information go to www.michigan.gov/deqfloodplainmanagement

- Complete Sections 10 A and 10 B and other Sections, as applicable.
- A hydraulic analysis or hydrologic analysis may be required to fully assess floodplain impacts. ➡ Attach hydraulic calculations.

➡ Attach additional sheets or tables with the requested information when multiple floodplain activities are included in this application.

(check all that apply) ☐ fill ☒ excavation ☐ other

Site is 1.0 feet above ☐ ordinary high water mark (OHWM) OR ☒ observed water level. Date of observation (M/D/Y) 7/30/2010

| Fill volume below the 100-year floodplain elevation (cu yd) 0 | Compensating cut volume below the 100-year floodplain elevation (cu yd) 8,428.78 |
|---|---|

**14 BRIDGES AND CULVERTS** (Including Foot and Cart Bridges) (See Sample Drawings 5, 14A, 14B, 14C, 14D, and EZ Guides)

- Provide detailed site-specific drawings of existing and proposed Plan and Elevation View, (Sample Drawing 14A), Elevation View (Sample Drawing 14B), Stream and Floodplain Cross-Section (Sample Drawing 14C), Stream Profile (Sample Drawing 14D) and Floodplain Fill (Sample Drawing 5) at a scale adequate for detailed review.
- Provide the requested information that applies to your project. If there is not an existing structure, leave the "Existing" column blank.
- If you choose to have a Licensed Professional Engineer "certify" that your project will not cause a "harmful interference" for a range of flood discharges up to and including the 100-year flood discharge, then you must use the "Required Certification Language." You may request a copy by phone, email, or mail. A hydraulic report supporting this certification may also be required. Is Certification Language attached? ☐ No ☐ Yes

➡ Attach additional sheets and table with the requested information for multiple crossings. Include hydraulic calculations.

| | | Existing | Proposed | | | Existing | Proposed |
|---|---|---|---|---|---|---|---|
| Culvert type (box, circular, arch) and material (corrugated metal, timber, concrete, etc.) | | | | Bridge span (length perpendicular to stream) OR culvert ☐ width ☐ diameter (ft) | | | |
| Bridge type (concrete box beam, timber, concrete I-beam, etc.) | | | | Bridge width (parallel to stream) OR culvert length (ft) | | | |
| Entrance design (projecting, mitered, wingwalls, etc.) | | | | Bridge rise (from bottom of beam to streambed) OR Culvert rise (fill from top of culvert to streambed) (ft) | | | |
| Total structure waterway opening above streambed (sq ft) | | | | Approach slope fill from existing grade to culvert or bridge | | | |
| ☐ elevation of culvert crown | Upstream | | | Higher elevation of ☐ culvert invert OR | Upstream | | |
| ☐ bottom of bridge beam (ft) | Downstream | | | ☐ streambed within culvert (ft) | Downstream | | |
| Elevation of road grade at structure (ft) | | | | Distance from low point of road to mid-point of bridge crossing (ft) | | | |
| ation of low point in road (ft) | | | | | | | |

| Cross-sectional area of primary channel (sq ft) (See Sample Drawing 14C) | Average stream width at OHWM outside the influence of the structure (ft) | Upstream Downstream |
|---|---|---|

Reference datum used (show on plans with description) ☐ NGVD 29 ☐ NAVD 88 ☐ IGLD 85 (Great Lakes coastal areas) ☐ other

High water elevation – describe reference point and highest known water level above or below reference point and date of observation.

**15 STREAM, RIVER, OR DRAIN CONSTRUCTION ACTIVITIES** (No sample drawing available)

- Complete Section 10A for fill, Section 10B for dredge or excavation, and Section10C for riprap activities.
- If side casting or other proposed activities will impact wetlands or floodplains, complete Sections 12 and 13, respectively.

➡ Provide an overall site plan showing existing lakes, streams, wetlands, and other water features; existing structures; and the location of all proposed structures and land change activities.

➡ Provide cross-section (elevation) drawings necessary to clearly show existing and proposed conditions. Be sure to indicate drawing scales.

➡ For activities on legally established county drains, provide original design and proposed dimensions and elevations.

(check all that apply) ☐ maintenance ☐ improvement ☐ relocation ☐ enclosure ☐ new drain ☐ wetlands ☐ other

Dimensions (ft) of existing stream/drain channel to be worked on. length width depth

| Dimensions (ft) of new, relocated, or enclosed stream/drain channel. length width depth | Volume of dredge/ excavation (cu yds) |
|---|---|
| Existing channel average water depth in a normal year (ft) | Proposed side slopes (vertical / horizontal) |

How will slopes and bottom be stabilized?

| Will old/enclosed stream channel be backfilled to top of bank grade? ☐ No ☐ Yes | Length of channel to be abandoned (ft) | Volume of fill (cu yds) |
|---|---|---|

If an enclosed structure is proposed, check type ☐ concrete ☐ corrugated metal ☐ plastic ☐ other

nsions of the structure: diameter length volume of fill

Will spoils be disposed of on site? ☐ No ☐ Yes ➡ Show location of spoils on site plan if spoils disposed of on an upland area.)

Water elevation Reference datum used ☐ NGVD 29 ☐ NAVD 88 ☐ IGLD 85 (Great Lakes coastal areas) ☐ other

➡ Show elevation on plans with description.

**Addendum to Joint Permit Application**
**Enbridge Pipelines, Inc. – Applicant**
**URS Corporation – Agent**
**Emergency Spill Clean Up**
**August 2010**

**2. Describe Proposed Project and Associated Activities, and the Construction Sequence and Methods**

Written Summary of All proposed Activities – Project activities occurred within wetland and floodplain areas where Enbridge Line 6B oil spill occurred. Excavators and vacuum trucks were used within the impact area. Additionally stream, wetland, and floodplain surveys will be conducted at a later date once health and safety issues are improved. This will allow for a more accurate wetland line and impacts to stream.

Construction Sequence and Methods – 1. Excavation and vaccuuming of contaminated soils within wetland and floodplain areas, 2. Skimming and vaccuum trucks removing contamanents within stream, 3.Removal of soils and contaminated vegetation off-site, 4. Regrade and remediate wetland, and floodplain areas

**3. Applicant, Agent/Contactor, and Property Owner Information**

Property owner information other than adjacent landowners is not provided here. Property owners in the area of the spill have been evacuated and have not been contacted to date by URS Corporation in association with this submittal due to the nature of this permit as an emergency clean up general permit.

**7. Compliance** – Emergency clean up commenced soon after the initial spill on July 27, 2010. The impact area of the spill is detailed on attached site plans.

**10B. Projects Requiring Dredging or Excavation -** Excavation for this project will be occurring within the 100 year floodplain and wetland area.

**Total dredge/excavation volume:**
Floodplain - 8,428.78 cu yd
Wetland – 9,173.17

**Dimensions:**
Floodplain Excavation Dimensions
**Length** 162.0 ft **Width** 702.0 ft **Depth** 2.0 ft

Wetland Dredging Dimensions
**Length** 156.0 ft **Width** 794.0 ft **Depth** 2.0 ft

**Dredge/excavation volume below OHWM (cu yd):**
Due to safety concerns a stream survey was not possible. The volume of dredging within the floodplain is approximately 8,428.78 and the volume of dredging within the wetland

is approximately 9,173.17. A complete survey of the impact area will be conducted at a later date. To date vacuum trucks and skimmers have been working to clean and contain stream contamination further survey will be needed to determine any stream impacts below the OHWM.

**Method and Equipment for dredging** – Excavators, vacuum trucks, and skimmers were used in wetland, stream, and floodplain areas to remove contaminated soils, oil sheen, and vegetation.

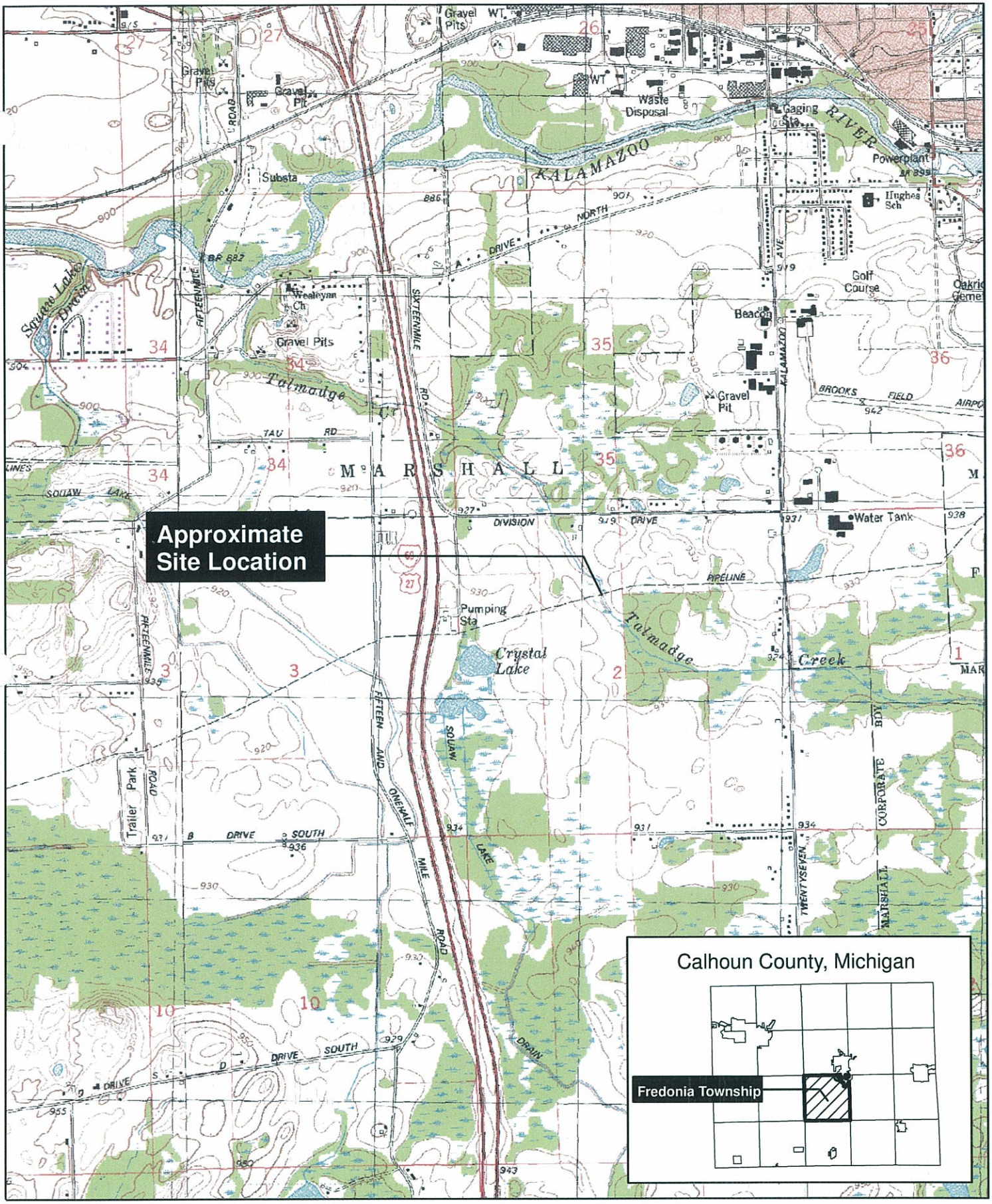
**12. Activities that may impact wetlands**

**Describe the wetland impacts, the proposed use or development, and any alternatives considered:** Wetland was impacted in order to conduct emergency spill clean up from the Enbridge Line 6B oil spill. The impacted wetland was excavated to remove contaminated soil and vegetation that was effected by the spill. The wetland excavation impacted approximately 2.84 acres of wetland. The impact to emergent wetland is 0.76 acre and 2.09 acres impact to forested wetland.

Due to safety concerns the wetland delineation conducted by URS Corporation was limited as access to the impact area was restricted. Consequently, the delineated wetland line and impacts may vary at a later date. Additionally, a detailed plant list was difficult to compile do to the amount of oil covering much of the vegetation in the impact area. At the point of pipe failure excavation accured to respond to the emergency situation, at this location there is not an existing plan and profile drawing of the ditch where the actual pipe failure happened, therefore that depth of impact to the wetland area for the pipe has not been taken into account. Due to the nature of this emergency situation this general permit is limited to the initial spill location and remediation.

**Describe how impacts to waters of the United States will be avoided and minimized:** Wetland impacts have been minimized as much as possible by placing control structures along the wetland boundaries as well as damming structures within the stream to prevent further impacts.

**Explain why compensatory mitigation should not be required for the proposed impacts:** The wetland impacts associated with the clean up are approximately 2.84 acres. The wetland impacts to emergent wetland (PEM) are approximately 0.76 acre and impacts to forested wetland (PFO) are approximately 2.09 acres. Due to safety concerns the wetland delineation of 6.61 acres conducted by URS Corporation on July 30, 2010, was limited as access to the impact area was restricted. Consequently, this delineated wetland line and impacts may vary at a later date and impact quantities are approximate. A more detailed survey will be completed when conditions at the site improve. Once the clean up is complete, Enbridge Pipelines, Inc. will restore the wetland area to its original condition according to the included wetland restoration plan. Wetland mitigation may be required by the MDNRE and a wetland mitigation plan will be provided by URS Corporation at a later date to mitigate for wetland impacts.




**Site Location Map**

# Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

**Township 03S Range 06W Section 2**

N

0 1,000 2,000 4,000 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

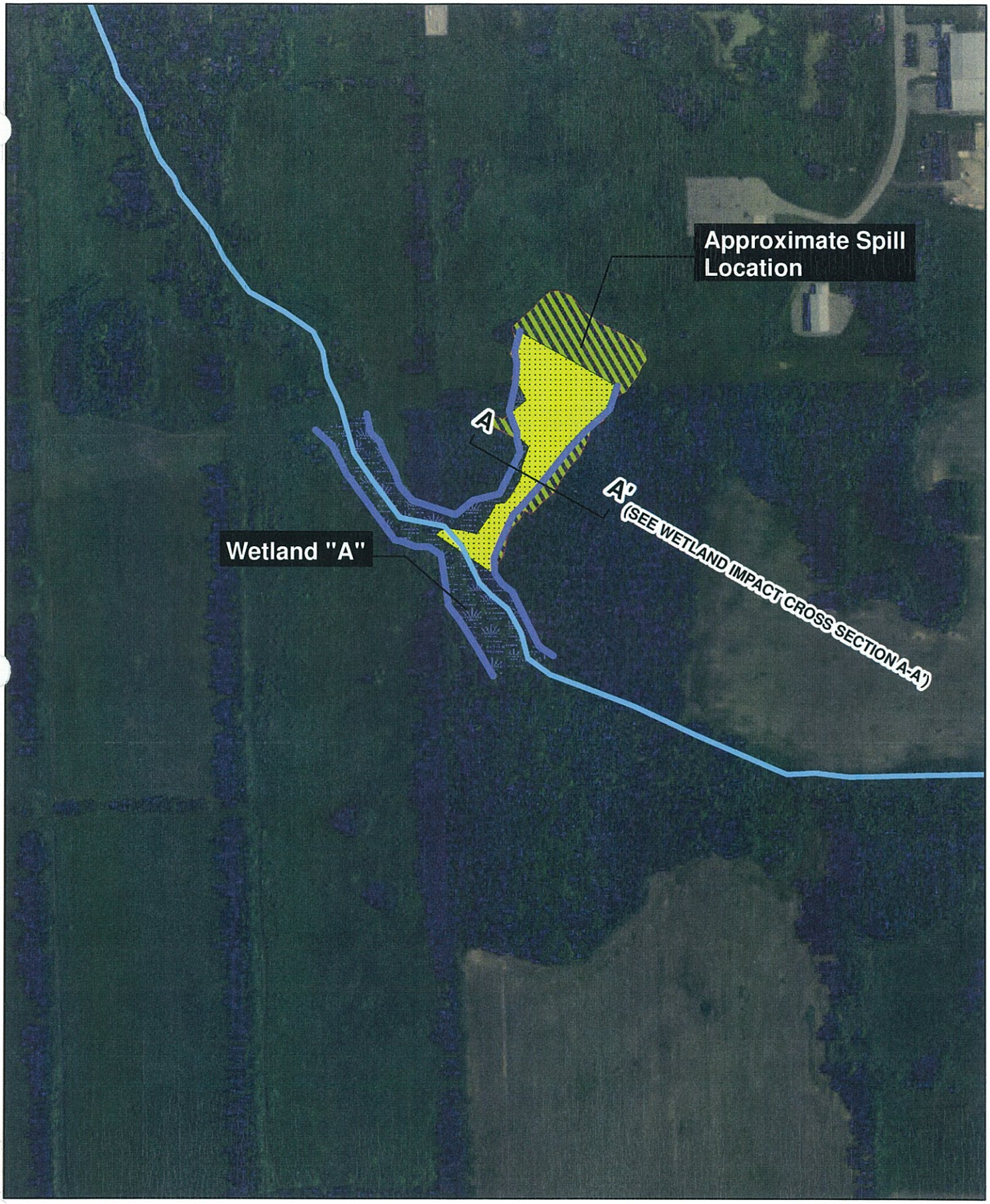

ENBRIDGE

0 0.03 0.06 0.09 0.12 Miles

**Enbridge Energy, Limited Partnership**
**MP 608 - Marshall, MI**

**Release Area Site Base Map**

| |
|---|
| DATE ISSUED: July 31, 2010 |
| DATE REVISED: |
| SCALE: 1:1,000 |
| DRAWN BY: NMS/JPM |
| SERIES: |




Wetland "A" Impact Plan — Talmadge Creek — URS Wetland Delineation — Wetland Impact — Spill Area

N

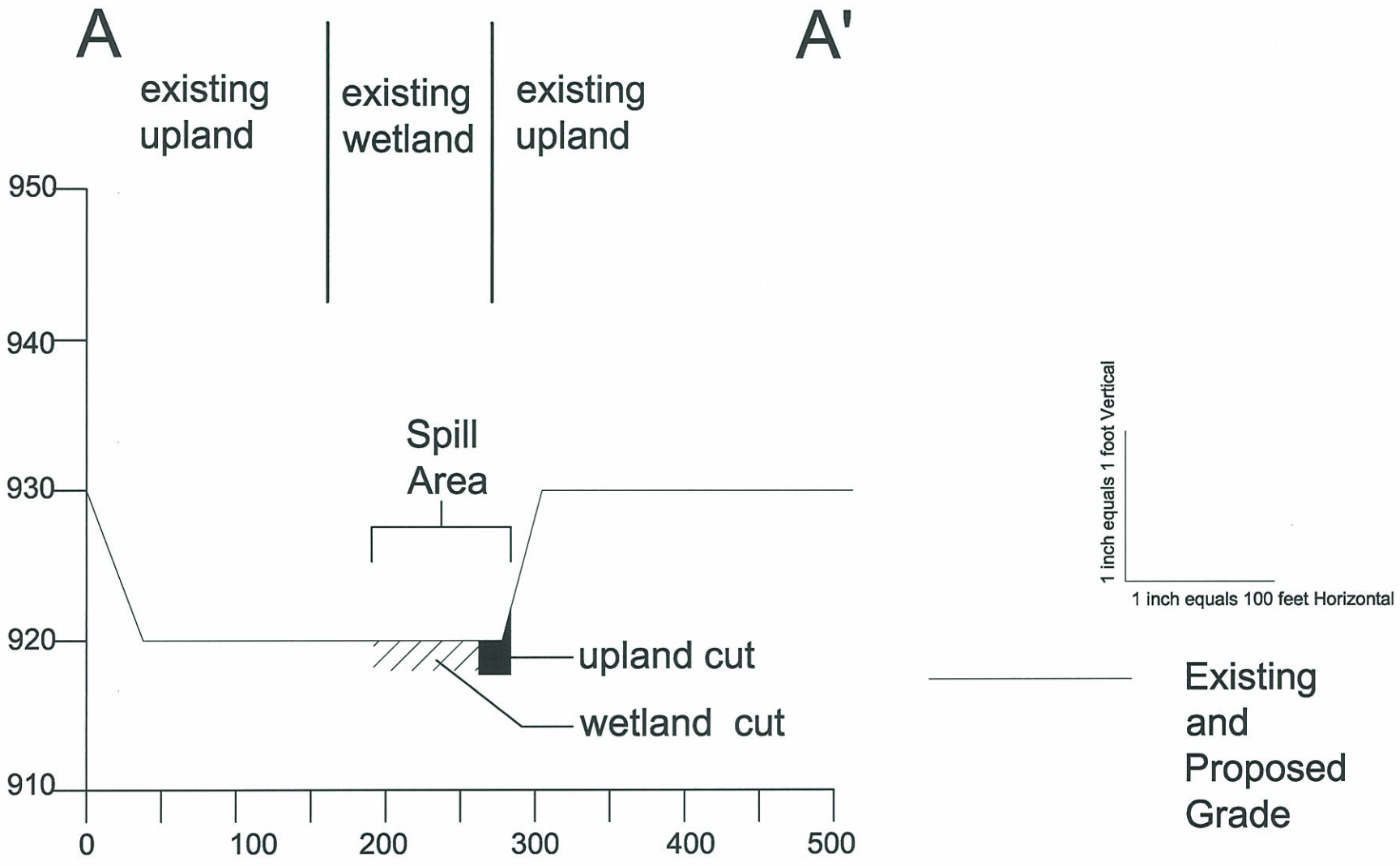
# Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

**Township 03S**
**Range 06W Section 2**

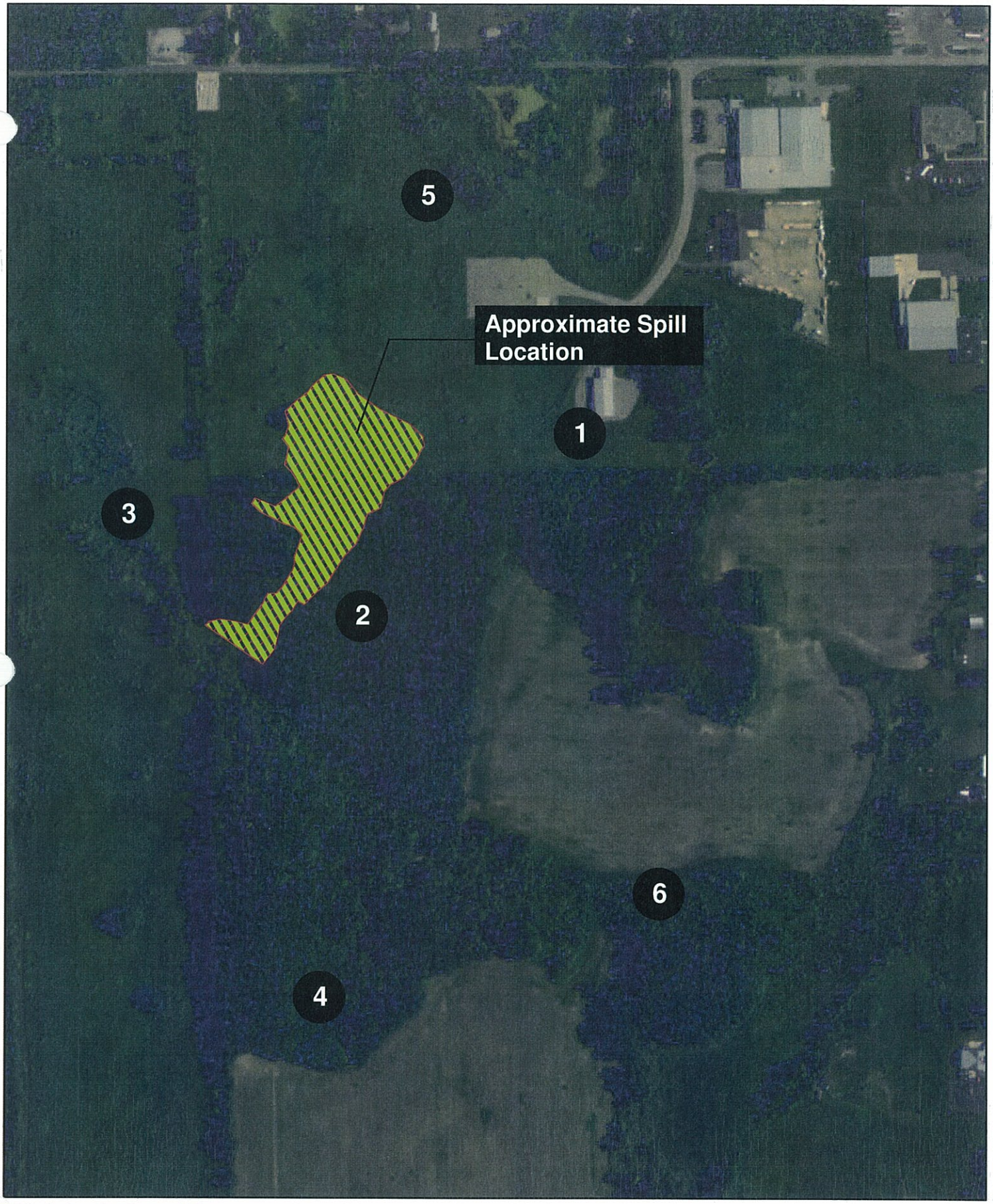
0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/




Wetland Impact Cross Section A-A'
ENBRIDGE, INC. Talmadge Creek Oil Spill, Fredonia Township, Michigan
Created by: JPB, URS Project , August 2, 2010




Adjoining Property Map

Spill Area

N

# Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

**Township 03S**
**Range 06W Section 2**

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

Adjacent Landowners to Enbridge Line 6B Spill

| Map Id | Parcel Number | Contact | Street Address | City | State | Zip |
|---|---|---|---|---|---|---|
| 1 | 53-003-053-00 | Qualtek Inc | 1611 Brooks Dr | Marshall | MI | 49068 |
| 2 | 11-102-003-00 | Haman, Joyce Ruth | 11661 Old Us 27 South | Marshall | MI | 49068 |
| 3 | 11-102-039-00 | Zinn, D & Schaffer, B | 16240 Division Dr | Marshall | MI | 49068-9565 |
| 4 | 11-102-045-00 | Simmons, Martin D. Living Trust | 1621 Monroe Bch | Battle Creek | MI | 49014-7544 |
| 5 | 53-003-025-00 | City of Marshall | 323 W. Michigan Ave. | Marshall | MI | 49068 |
| 6 | 53-003-150-00 | City of Marshall-Lafferty Prop | 11301 Old US 27 S | Marshall | MI | 49068 |

Joyce Ruth Haman
11661 Old Us 27 South
Marshall, MI 49068

Qualtek Inc.
1611 Brooks Drive
Marshall, MI 49068

Martin D. Simmons Living Trust
1621 Monroe Beach
Battle Creek, MI 49014-7544

Zinn, D & Schaffer B
16240 Division Dr
Marshall, MI 49068

City of Marshall
323 W. Michigan Ave
Marshall, MI 49068

City of Marshall – Lafferty Property
11301 Old US 27 S
Marshall, MI 49068

# Enbridge Pipelines, Inc. Talmadge Creek Oil Spill
# Line 6B Spill Clean Up, Fredonia Township, Calhoun County, Michigan
# WETLAND RESTORATION PLANTING PLANS

## INTRODUCTION

The following table presents proposed restoration plans for wetland impacts due to the safety area expansion.

## RESTORATION OBJECTIVES

The goal of this plan is to restore the wetland, stream, and floodplain area to a condition as good as what previously existed, with a similar plant community and similar hydrologic regime, at the same finished grade as pre-existing conditions. Planting will incorporate species existing prior to disturbance. Due to the nature of the clean up effort topsoil will not be segregated; instead topsoil will be removed and hauled off site. New topsoil will be placed and spread prior to planting. Use straw mulch in level areas and mulch blankets for slopes.

## PROPOSED MONITORING

The MDNRE may require monitoring of the restored wetland, stream and floodplain areas annually in the fall of each year for three years after the project is complete (2010 to 2013). For each monitoring visit, we will document the establishing plant community, compare to seeding treatments, and assess the results. Observe and report any wildlife use of the area. Observe and report on hydrology, and provide photos of each area. Submit by Dec. 31 of each year.

## SEED MIX, TREE AND SHRUB RECOMMENDATIONS

Seed mix and shrub recommendations are based on plant inventories of pre-existing communities created during the site assessment phase. The wetland area is emergent and forested wetland. The suggested seed mix for the emergent area is an Emergent Wetland Seed Mix with additional shrub plugs. The Emergent mix is suitable for saturated soils and shallow standing water. It includes a mix of rushes, sedges, bulrushes, and wetland grasses, as well as oats for rapid temporary stabilization. Similar seed mixes are available from local or regional producers and may be used if species mix is substantially the same as outlined. Preference is for seed grown in or near Michigan for regional genotype. Recommended shrub species are silky dogwood - *Cornus*

*amomum,* red osier dogwood – *Cornus stolonifera* and sandbar willow - *Salix exigua* because they are suitable for seasonal shallow standing water and saturated soils.

The suggested seed mix for the forested wetland area is a Wooded Wetland Establishment Seed mix. This mix is suitable in saturated, newly reforested areas to reduce weed competition and provide soil stabilization. As the reforested land becomes more shaded, some of the species in this seed mix will establish a permanent herbaceous understory layer and help fill out the maturing wooded wetland. This mix includes grass and sedge species as well as native tree, forb and shrub species. Similar seed mixes are available from local or regional producers and may be used if species mix is substantially the same as outlined. Preference is for seed grown in or near Michigan for regional genotype.

## SEED/SHRUB PLANTING INSTALLATION RECOMMENDATIONS

Optimum seeding time is October 1 to June 15. It can be done outside of this window but establishment may take longer. Mid-summer seeding is not recommended. With regards to planting plugs, detailed instructions should be obtained with the nursery where the plants are purchased. However, important points to remember in planting in wetland areas include the following:

- Plant emergent plants in the spring after water levels have lowered in order to establish a root system strong enough to overwinter.
- Summer planting of live plants will be successful if regularly watered.
- Label a few plants to prevent accidental weeding and assist in monitoring.
- Gently pry apart from roots in the bottom half of the root ball to stimulate root growth.
- Avoid burying plants either too deep or too shallow. Plant so that the surface of the root ball exactly matches the existing soil surface.
- Mulch the top surface of the root ball with lightly covered mulch layer.

Other erosion controls (silt fences, mulch blankets, straws etc.) should be installed prior to seeding.

Scarify soil surface by raking or shallow tilling. Press seed into soil using a roller or similar equipment. Light raking may also be used, but do not cover seed more than ¼" deep.

| Summary of Wetland Restoration Planting Plans | | | |
|---|---|---|---|
| **Wetland ID and Type Impacted** | **Pre-Disturbance Dominant Plant Species** | **Planting Recommendations and Notes** | **Soil Treatment** |
| A<br><br>Emergent Wetland | *Typha angstifolia,* narrow leaved cattail<br>*Cornus foemina,* gray dogwood<br>*Phalaris arundinacea,* reed canary grass<br>*Onoclea sensibilis,* senstitive fern<br>*Eupatoriadelphus maculates,* spotted joe-pye-weed<br>*Thelypteris thelypteroides* , Marsh fern<br>*Cicuta maculate*, Water hemlock<br>*Parthenocissus quinquefolia*, Virginia creeper<br>*Eupatorium perfoliatum*, boneset | Emergent Wetland Seed Mix | New topsoil |
| A<br><br>Forested Wetland | *Onoclea sensibilis,* senstitive fern<br>*Phalaris arundinacea,* reed canary grass<br>*Cornus foemina,* gray dogwood<br>*Cornus amomum*, silky dogwood<br>*Fraxinus pennsylvanica* , Green ash<br>*Parthenocissus quinquefolia* , Virginia Creeper<br>*Ulmus Americana,* American Elm<br>*Populus deltoids,* Eastern Cottonwood | Wooded Wetland Establishment Seed Mix<br><br>Wetland Shrubs – Planted just above waterline. Recommend: silky dogwood (*Cornus amomum),* red osier dogwood (*Cornus stolonifera),* sandbar willow (*Salix exigua),* American Elm (*Ulmus Americana),* Eastern Cottonwood (*Populus deltoids)* | New topsoil |

- Detailed Seed Mixes on Following Pages -

# Enbridge Pipelines, Inc. Talmadge Creek Oil Spill
# Line 6B Spill Clean Up, Fredonia Township, Calhoun County, Michigan

## Suggested Plant list for Wetland Restoration
## For the emergent wetland areas the following plants will be used:

| Scientific Name | Common Name | Oz/Acre |
|---|---|---|
| **Permanent Grasses/Sedges/Rushes** | | |
| *Carex comosa* | bristly sedge | 2.50 |
| *Carex lacustris* | common lake sedge | 0.25 |
| *Carex lurida* | bottlebush sedge | 4.00 |
| *Carex vulpinoidea* | brown fox sedge | 6.00 |
| *Eleocharis ovata* | blunt spike rush | 1.00 |
| *Juncus effuses* | common rush | 1.00 |
| *Leersia oryzoides* | rice cut grass | 3.00 |
| *Scirpus acutus* | hard-stemmed bulrush | 2.50 |
| *Scirpus pungens* | chairmaker's rush | 4.00 |
| *Scirpus validus* | great bulrush | 6.00 |
| **Temporary Cover** | | |
| *Avena sativa* | common oat | 360.00 |
| *Lolium multiflorum* | annual rye | 104.00 |
| **Forbs** | | |
| *Acorus calamus* | sweet flag | 1.00 |
| *Alisima sp.* | water plantain | 2.00 |
| *Asclepias incarnata* | swamp milkweed | 1.50 |
| *Cephalanthus occidentalis* | buttonbush | 1.00 |
| *Decodon verticillatus* | swamp loosestrife | 1.25 |
| *Eupatorium maculatum* | spotted Joe-pye weed | 0.50 |
| *Hibiscus sp.* | rose mallow | 3.00 |
| *Iris virginica* | blue flag | 6.00 |
| *Lobelia cardinalis* | cardinal flower | 0.25 |
| *Lobelia siphilitica* | great blue lobelia | 1.50 |
| *Ludwigia alternifolia* | seedbox | 0.25 |
| *Mimulus ringens* | monkey flower | 1.00 |
| *Peltandra virginica* | arrow arum | 16.00 |
| *Pontederia cordata* | pickerel weed | 10.00 |
| *Sagittaria latifolia* | common arrowhead | 2.00 |
| *Sparganium americanum* | American bur reed | 2.00 |
| *Sparganium eurycarpum* | common bur reed | 4.00 |
| *Verbena hastata* | blue vervain | 1.00 |

**For the wetland edge areas that will not be inundated the following seed mix should be used:**

| Scientific Name | Common Name | Oz/Acre |
|---|---|---|
| **Permanent Grasses/Sedges/Rushes** | | |
| *Carex comosa* | bristly sedge | 1.00 |
| *Carex cristatella* | crested oval sedge | 2.00 |
| *Carex frankii* | bristly cattail sedge | 4.00 |
| *Carex lurida* | bottlebush sedge | 4.00 |
| *Carex vulpinoidea* | brown fox sedge | 3.00 |
| *Eleocharis palustris* | great spike rush | 0.50 |
| *Elymus virginicus* | Virginia wild rye | 12.00 |
| *Glyceria striata* | fowl manna grass | 1.00 |
| *Leersia oryzoides* | rice cut grass | 1.50 |
| *Scirpus atrovirens* | dark green rush | 1.00 |
| *Scirpus cypernius* | wool grass | 0.75 |
| *Scirpus pungens* | chairmaker's rush | 1.00 |
| *Scirpus validus* | great bulrush | 6.00 |
| *Sparganium eurycarpum* | common bur reed | 4.00 |
| **Temporary Cover** | | |
| *Avena sativa* | common oat | 360.00 |
| *Lolium multiflorum* | annual rye | 100.00 |
| **Forbs** | | |
| *Acorus calamus* | sweet flag | 1.00 |
| *Alisima sp.* | water plantain | 2.00 |
| *Asclepias incarnata* | swamp milkweed | 1.00 |
| *Aster puniceus* | bristly aster | 1.00 |
| *Bidens sp.* | Bidens | 2.00 |
| *Decodon verticillatus* | swamp loosestrife | 1.00 |
| *Eupatorium perfoliatum* | common boneset | 1.00 |
| *Helenium autumnale* | sneezeweed | 2.00 |
| *Hibiscus sp.* | rose mallow | 3.00 |
| *Iris virginica* | blue flag | 2.50 |
| *Lobelia siphilitica* | great blue lobelia | 1.00 |
| *Ludwigia alternifolia* | seedbox | 0.25 |
| *Mimulus ringens* | monkey flower | 1.50 |
| *Peltandra virginica* | arrow arum | 4.00 |
| *Rudbeckia laciniata* | wild golden glow | 0.75 |
| *Sagittaria latifolia* | common arrowhead | 2.00 |
| *Senna hebecarpa* | wild senna | 2.00 |
| *Thalictrum dasycarpum* | purple meadow rue | 1.50 |
| *Verbena hastata* | blue vervain | 1.20 |
| *Verbesina alternifolia* | wingstem | 0.75 |
| *Vernonia sp.* | ironweed | 2.00 |

**For the forested wetland areas the following seed mix should be used:**

| Scientific Name | Common Name | Oz/Acre |
|---|---|---|
| **Permanent Grasses/Sedges/Rushes** | | |
| *Calamagrostis canadensis* Grass | Bluejoint | 1.00 |
| *Carex crinita* | Fringed Sedge | 2.00 |
| *Carex lupulina* | Common Hop Sedge | 4.00 |
| *Carex lurida* | Bottlebrush Sedge | 1.50 |
| *Carex frankii* | Bristly Cattail Sedge | 3.00 |
| *Carex squarrosa* | Narrow-leaved Cattail Sedge | 1.00 |
| *Carex typhina* | Common Cattail Sedge | 1.00 |
| *Carex vulpinoidea* | Brown Fox Sedge | 4.00 |
| *Elymus virginicus* | Virginia Wild Rye | 20.00 |
| *Glyceria striata* | Fowl Manna Grass | 2.00 |
| *Leersia oryzoides* | Rice Cut Grass | 2.00 |
| *Scirpus atrovirens* | Dark Green Rush | 2.00 |
| *Spartina pectinata* | Prairie Cord Grass | 1.00 |
| **Temporary Cover** | | |
| *Avena sativa* | common oat | 360.00 |
| *Lolium multiflorum* | annual rye | 100.00 |
| **Forbs / Shrubs** | | |
| *Alisma* spp | Water Plantain Mix | 3.00 |
| *Angelica atropurpurea* | Great angelica | 1.00 |
| *Aster puniceus* | Bristly aster | 0.75 |
| *Aster umbellatus* | Flat-Top aster | 0.25 |
| *Bidens cernua* | Nodding Bur Marigold | 2.50 |
| *Campanula americana* | Tall Bellflower | 0.25 |
| *Cephalanthus occidentalis* | Buttonbush | 0.50 |
| *Helenium autumnale* | Sneezeweed | 2.00 |
| *Heracleum lanatum* | Cow Parsnip | 0.75 |
| *Hibiscus moscheutos* | Swamp Rose Mallow | 2.00 |
| *Lobelia siphilitica* | Great Blue lobelia | 1.50 |
| *Lycopus americanus* | Common Water Horehound | 0.25 |
| *Mimulus ringens* | Monkey Flower | 1.25 |
| *Penthorum sedoides* | Ditch Stonecrop | 0.50 |
| *Polygonum* spp. | Smartweed Mix | 0.50 |
| *Rudbeckia laciniata* | Wild Golden Glow | 0.75 |
| *Verbesina alternifolia* | Wingstem | 2.00 |

**Plugs planting: Planted just above the water line.**

| Plugs / Trees | | |
|---|---|---|
| Scientific Name | Common Name | Price Per Plant |
| *Cornus amomum* | Silky dogwood | $0.90 |
| *Cornus stolonifera* | Red Osier dogwood | $0.90 |
| *Salix exigua* | Sandbar Willow | $1.35 |
| *Ulmus Americana* | American Elm | $1.45 |
| *Populus deltoides* | Eastern Cottonwood | $0.90 |

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# Environmental Guidelines for Construction

December 2003

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# WATERCOURSES and WETLANDS 02–11

## Purpose

Watercourses are a major environmental concern associated with pipeline construction. Poor construction schedules or inadequate environmental mitigation measures can damage fish habitat, harm aquatic life and interfere with downstream water users. Pipeline construction also may alter stream substrates, cause physical or chemical changes in water quality or block fish movement. Although many environmental impacts are relatively short-term (i.e., the impact stops soon after the crossing is completed), long-term impacts may result if the watercourse is not properly restored.

Due to the unstable nature of some wetland soils, construction activities may differ from typical pipeline construction. As such, construction activities may be minimized in wetlands and/or special construction techniques required to minimize disturbance to plants and soils, and to protect wetland hydrology.

## Requirements

### Project Scheduling

Carry out instream activities during periods of low flow unless government agencies request an alternate schedule.

Postpone construction in watercourses if excessive flows or flood conditions exist or are anticipated, and construction methods cannot be modified to cope with the increased flow.

To minimize the duration and severity of disturbance, complete all instream activity within 48 hrs, unless site-specific conditions make this impractical.

**NOTE:** For more information on scheduling construction activities, see 01-3, Project Scheduling.

### Permits/Licenses/Approvals

Where instream activities are required, obtain approval from fish and wildlife authorities, including federal authorities if required.

Any alternatives or modifications to the wetland crossing requirements specified in permits must be approved by the company before construction begins.

Before starting work, the contractor must provide the company with a tentative watercourse construction plan and schedule, and confirm the schedule (a) 14 days before and (b) 2 days before starting crossing construction.

**NOTE:** For more information on activities that require environmental permits and/or regulatory approvals, see 01-2, Planning and Preparation.

### Clearing and Grading

Restrict clearing and grading to the minimum necessary to safely complete the job (see 02-4, Clearing and Grubbing, and 02-7, Grading).

### Trenching

When practical, salvage upper stream bed material and replace last during stream bed restoration.

For information on trenching in watercourses and wetlands, see 02-8, Trenching.

### Fish Habitats

When sport fish are concentrated in a watercourse area that requires blasting, use blast reflectors or absorbers, time delay charges and the smallest charges practical. If practical, remove fish and block their access to the area.

### Erosion Control

Install temporary erosion control measures within 24 hrs of backfilling the crossing (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers. For information on backfilling, see 03-2, Backfilling).

## Guidelines

### Construction Methods

Select an appropriate watercourse construction method based on geotechnical, biological and hydraulic considerations, and discussions with government agencies. Use Table 1, Watercourse Construction Methods as a guide to selecting an appropriate watercourse crossing construction method.

**NOTE:** If contaminated stream substrate is suspected, e.g., by industrial pollution, use a construction method that minimizes disturbance of the substrate (e.g., drill, bore).

**Table 1**
**Watercourse Construction Methods**

| Construction Method | Small Watercourse less than 10 m (33 ft) | | | Medium Watercourse 10 to 20 m (33 to 65 ft) | | | Large Watercourse greater than 20 m (65 ft) | | |
|---|---|---|---|---|---|---|---|---|---|
| | L | M | H | L | M | H | L | M | H |
| **Wet Trench** | | | | | | | | | |
| • hoe | 4 | 4 | 7 | 4 | 4 | 7 | 4 | 4 | 7 |
| • dragline | $ | 7 | 7 | $ | 7 | 7 | 4 | 7 | 7 |
| • dredging | $ | $ | $ | $ | $ | $ | 4 | 4 | 4 |
| **Dry Trench** | | | | | | | | | |
| • flume | 4 | 4 | 4 | 4 | 4 | 4 | — | — | — |
| • dam and pump | 4 | 4 | 4 | 4 | 4 | 4 | — | — | — |
| • high volume pump | 4 | 4 | 4 | 4 | 4 | 4 | — | — | — |
| **Trenchless** | | | | | | | | | |
| • boring | $ | 4 | 4 | $ | 4 | 4 | — | — | — |
| • directional drilling | $ | $ | $ | $ | $ | $ | $ | 4 | 4 |
| **Aerial** | | | | | | | | | |
| • bridge attachment | $ | $ | 4 | $ | 4 | 4 | $ | 4 | 4 |

**NOTES**

**L** = Low sensitivity
- no downstream water users
- no fish habitat impacted by construction
- no flow

**M** = Medium sensitivity
- downstream water users
- no significant impact on fish habitat by construction
- low probability of downstream habitat impacted by sediment

**H** = High sensitivity
- downstream water users cannot tolerate sediment load
- fish habitat directly impacted by sedimentation

4 = environmentally acceptable
$ = environmentally acceptable, however, may not be practical due to high construction cost
7 = not environmentally acceptable
— = not usually possible from an engineering or construction standpoint

## Wet Trench

Use a wet trench construction method on narrow and/or warm water streams and rivers that will not be flumed, dammed and pumped, or directionally drilled (see Figure 1, Typical Waterbody Crossing Wet Trench Method)

**NOTE:** For dry intermittent streams and agricultural drainage ditches, use standard construction procedures (i.e., involving stringing, welding, excavating the trench with backhoes, installing the pipe in the trench and backfilling the trench with native material).

Where sedimentation is not a major concern, use the wet open cut method (see Figure 2, Water Crossing-Wet Open Cut of Large Rivers and Figure 3, Wet Open Cut of Small Rivers).

## Dry Trench

Use a dry instream construction method where sedimentation is a concern, and where required by permits.

### *Dam and Pump/High Volume Pump*

Use the dam and pump method on narrow watercourses with low stream flow (see Figure 4, Typical Waterbody Crossing Dam and Pump). On watercourses with moderate stream flow, use the high volume pump method (see Figure 5, Water Crossing-High Volume Pump).

**NOTE:** Have two pumps on hand, each sized with the pumping capacity of the anticipated stream flow, to ensure standby function.

If fish passage is a concern, do not use either the dam and pump or high volume pump construction method.

The dam and pump method involves damming the stream before excavating:

- Construct upstream and downstream dams of sandbags, steel plates, Aquadams™ or clean gravel with a plastic liner.
- Prevent interrupting downstream flow by pumping the water simultaneously with dam construction.
- Pump water across the construction area through a hose and onto an energy dissipation device back into the dry stream bed downstream (see Figure 4, Typical Waterbody Crossing, Dam and Pump Method).
- Continuously monitor dams for proper seal.
- Adjust the dams as necessary to prevent large volumes of water from seeping around the dams and into the construction work area.

**NOTE:** For more information on dewatering, see 02-17, Dewatering.

Place the pump in an impermeable, bermed area on the upstream side of the construction site to prevent any spilled fuel from entering the watercourse.

**NOTE:** Electric submersible pumps are the best option and should eliminate concerns with fuel spills.

Monitor the pumping operation at all times, and adjust the pump as necessary to maintain an even flow of water across the work

area and near-normal water levels upstream and downstream from the crossing.

A backup pump of equal or greater capacity must be onsite at all times in case the primary pump fails.

Pump standing water that is isolated in the construction area by the dams, or any stream water that leaks around the dams or seeps from the ground into the trench into a filter bag or a dewatering structure (see 02-17, Dewatering).

***Flume***

Use the flume method to cross sensitive, relatively narrow streams that have straight channels and that are relatively free of large rocks and bedrock at the point of crossing.

**NOTE:** The diameter of conduit (flume) must be large enough to accommodate the maximum stream flow.

The flume method involves placing a conduit in the stream bed to direct stream flow across the construction area without introducing sediment into the water (see Figure 6, Typical Waterbody Crossing, Flume Method):

- Install the flume(s), typically at least 12–18 m (40–60 ft) long, before trenching.
- Align the flumes such that water is not impounded upstream of the flume(s).
- Construct dams of sandbags, metal plate, water dam, plastic sheeting or clean rock (or equivalent) around the upstream and downstream ends of the flume(s).

**NOTE:** Construct the upstream dam first, to funnel stream flow into the flume(s). The downstream dam prevents backwash of water into the trench and construction work area, and keeps water in the excavation from moving downstream if flooding occurs.

Continuously monitor dams to ensure a watertight seal.

Adjust the dams as necessary to prevent large volumes of water from seeping around the dams and into the trench and construction work area.

Pump standing water that is isolated in the construction area by the dams, or any stream water that leaks around the dams or seeps from the ground into the trench:

- if clean, into the watercourse downstream of the crossing

- if dirty, into a filter bag or a dewatering structure (see 02-17, Dewatering)

**NOTE:** Salvage any stranded fish and relocate upstream

After backfilling a high sensitivity watercourse with a gravel bed, consider washing the gravel before removing the flume to minimize sediment washing downstream from the construction zone.

Remove the flume(s) after the pipeline is installed and stream banks have been restored.

## Directional Drilling

Use directional drilling for large watercourses that are environmentally sensitive to instream or streambank activity, or where conventional methods are not feasible due to engineering or navigational constraints (see Figure 7, Typical Waterbody Crossing Directional Drill Method).

Directional drilling may be economically feasible for large deep rivers that require considerable extra cover, expensive reclamation work, or where slope stability is a concern or bank disturbance must be avoided.

**NOTE:** Obtain geotechnical data before drilling. Drilling may not be feasible in streambed materials such as unconsolidated gravel.

Set up drilling equipment a minimum of 16 m (50 ft) from the edge of the watercourse. Do not clear or grade this 16 m buffer area.

Use water from an approved source (typically the river) in accordance with applicable permits to mix drilling mud. The mud mix must be appropriate for aquatic life in the stream, e.g., pure bentonite clay with no unapproved additives.

During drilling operations, prevent mud and slurry from flowing into the stream or adjacent wetlands by storing it well back from the river bank, contained by an earthen berm sediment control structure, tanks or other methods.

Minimize mud pump pressure during entry and exit of the bore to prevent frac-out, i.e., borehole fracture and escape of mud.

**NOTE:** For more information on temporary erosion and sedimentation control, see 02-14, Temporary Sedimentation Control.

After the pipe is in place, spread excess drilling mud and slurry over an upland area if approved by the company, or haul excess offsite to an approved location.

## Boring

Use the boring (or punching) method to cross irrigation canals and where practical, to cross natural watercourses (see Figure 8, Water Crossing Bored or Punched). This method may not be possible if there is excessive groundwater, sand or gravel, cobbles, large boulders or bedrock.

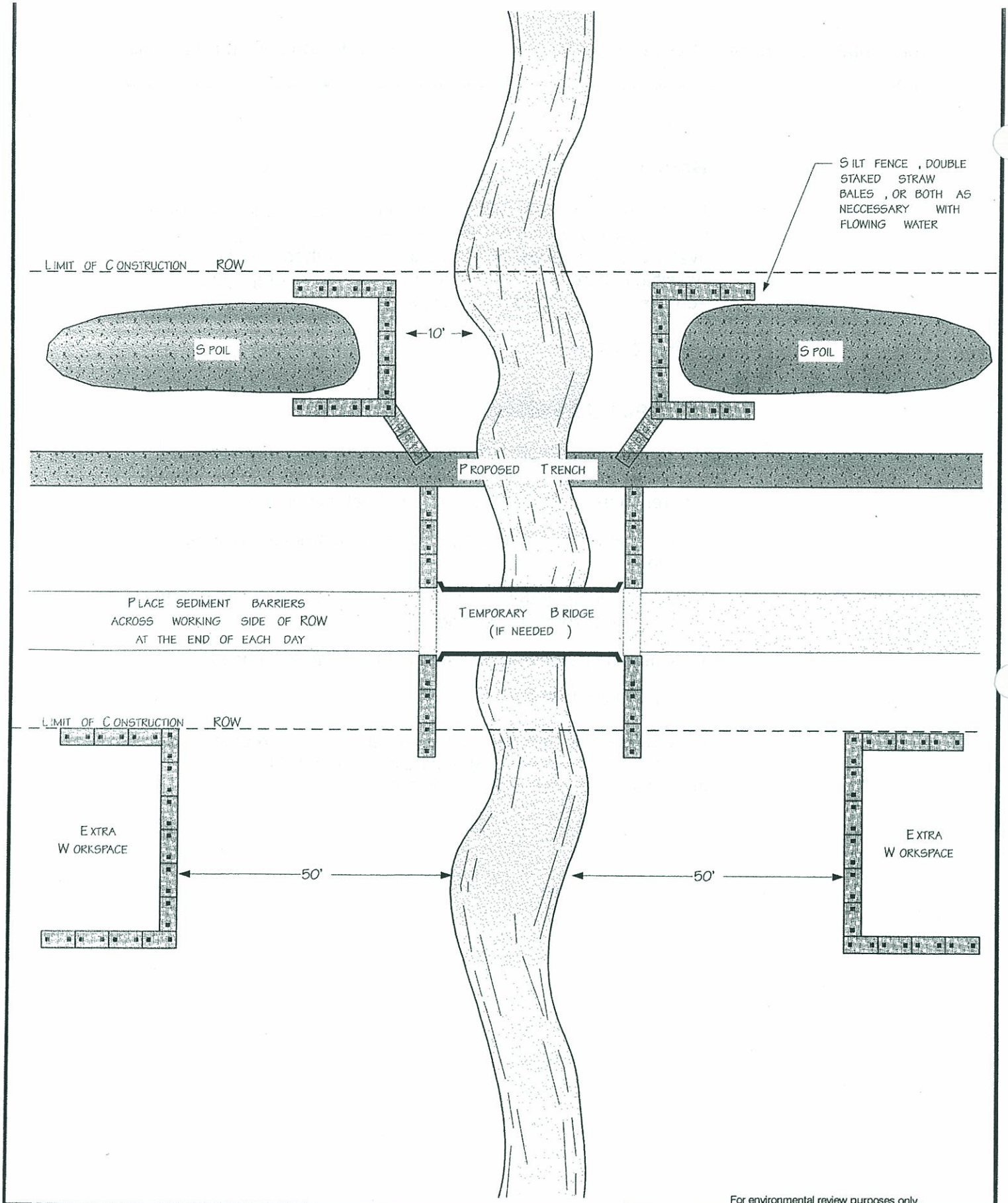
Obtain geotechnical data before boring or punching.

## Push/Pull Method

For large wetlands with standing water and saturated soils, assemble the pipeline in an upland area, and position the pipe in the trench using the push-pull and/or float techniques:

- excavate the trench using a backhoe supported on timber mats
- push-pull the prefabricated section of pipe into position or float the pipe across the wetland
- when the pipeline is in position, remove floats, if used
- backfill the trench

**NOTE:** The push-pull and float techniques usually requires additional temporary workspace next to the ROW (for more information, see 01-6, Determining Workspace.

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# Figure 1

Typical Waterbody Crossing
Wet Trench Method

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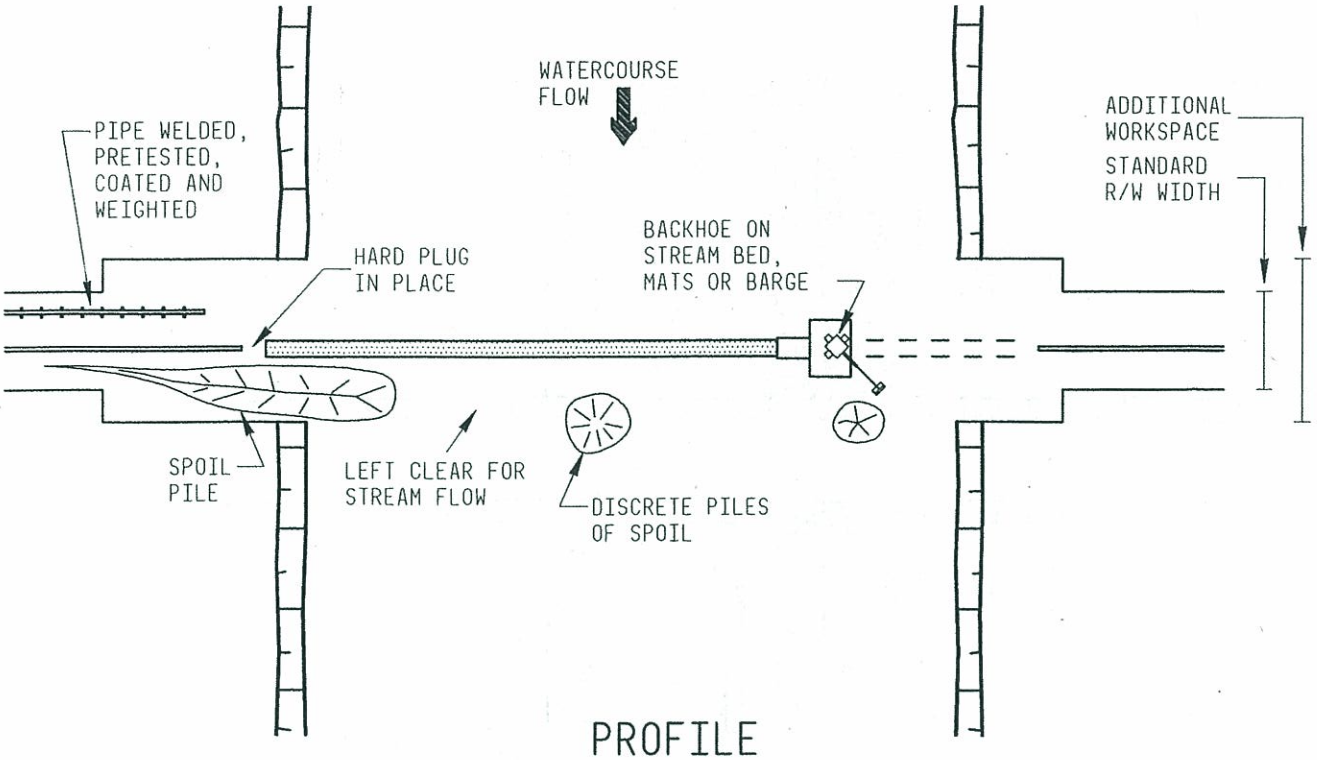


PROFILE

NOTES:

1. USE THIS TECHNIQUE ON LARGE WATERCOURSES WHEN A BACKHOE CANNOT REACH AT LEAST HALFWAY INTO THE CHANNEL.
2. SCHEDULE INSTREAM ACTIVITY FOR LOW FLOW PERIODS AND FOR THE APPROPRIATE TIMING WINDOW. OBTAIN ALL GOVERNMENT APPROVALS PRIOR TO INSTREAM CONSTRUCTION.
3. OBTAIN ADDITIONAL TEMPORARY WORK SPACE TO ALLOW INSTREAM SPOIL TO BE STORED ON BANKS WHERE POSSIBLE.
4. RESTRICT ROOT GRUBBING. DO NOT GRUB WITHIN 10m OF WATERCOURSE EXCEPT ALONG TRENCH LINE AND SPOIL PILE AREA WHEN ABSOLUTELY NECESSARY.
5. LEAVE HARD PLUGS AT BANK.
6. WELD, COAT, PRETEST AND WEIGHT PIPE PRIOR TO COMMENCEMENT OF INSTREAM CONSTRUCTION.
7. SERVICE OR REFUEL MOBILE CONSTRUCTION EQUIPMENT A MINIMUM OF 100m AWAY FROM WATERCOURSE.
8. TRENCH THROUGH WATERCOURSE RETAINING HARD PLUGS AT EACH BANK UNTIL JUST PRIOR TO PIPE INSTALLATION. STOCKPILE AS MUCH SPOIL ON BANKS AS POSSIBLE. PLACE INSTREAM STORAGE IN DISCRETE PILES AVOIDING AREAS OF HIGHEST WATER VELOCITY. DO NOT WINDROW SPOIL ACROSS THE CHANNEL OR BLOCK MORE THAN 2/3 OF THE CHANNEL. IF NECESSARY TO CONTROL WATER FLOW AND TRENCH SLOUGHING, INSTALL TEMPORARY SOFT PLUGS AND DEWATER TRENCH ON TO STABLE VEGETATED LAND, NOT DIRECTLY TO WATERCOURSE. MAINTAIN STREAMFLOW, IF PRESENT, THROUGHOUT CROSSING CONSTRUCTION. LOWER IN AND BACKFILL IMMEDIATELY. RESTORE STREAM CHANNEL TO APPROXIMATE PRECONSTRUCTION PROFILE AND SUBSTRATE. ATTEMPT TO COMPLETE ALL STREAM ACTIVITY WITHIN 24 HOURS.
9. RESTORE AND STABILIZE WATERCOURSE BANKS AND APPROACHES TO AS CLOSE TO ORIGINAL GRADES AS POSSIBLE (TO A MAXIMUM 3:1). INSTALL BANK PROTECTION WHERE APPROPRIATE.
10. SEED AND FERTILIZE BANKS IMMEDIATELY.



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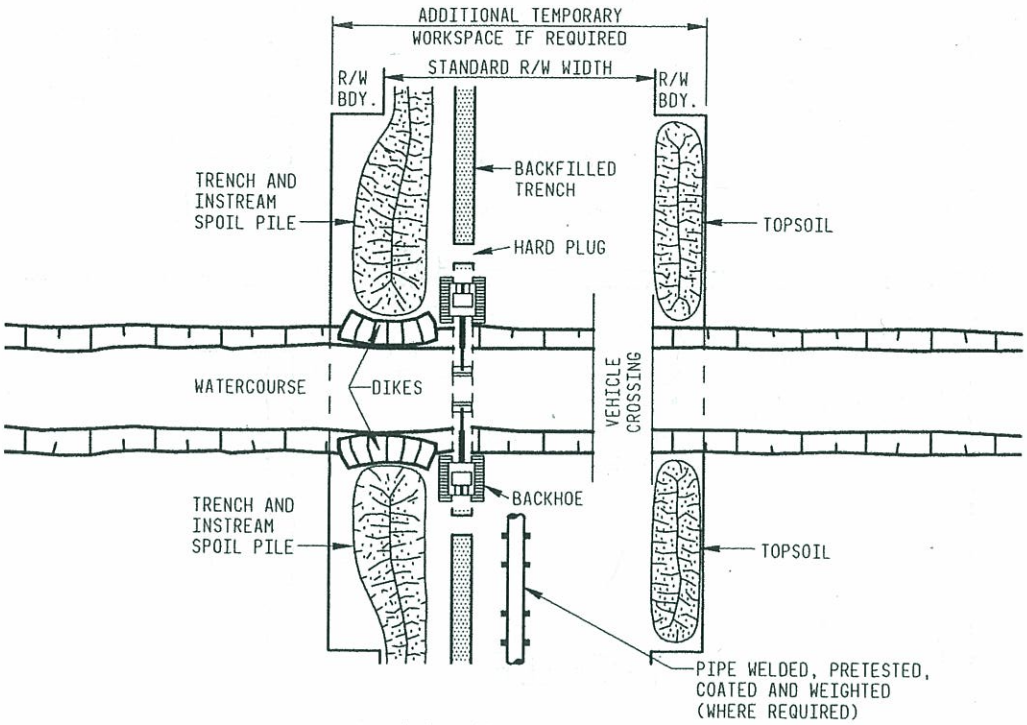
**Figure 2**

Water Crossing -
Wet Open Cut of Large Rivers




# PLAN VIEW

NOTES:

1. USE THE WET CROSSING METHOD WHEN CONTROL OF SEDIMENTATION IS NOT A MAJOR CONCERN.
2. SCHEDULE INSTREAM ACTIVITY FOR LOW FLOW PERIODS AND FOR THE APPROPRIATE TIMING WINDOW. OBTAIN ALL GOVERNMENT APPROVALS PRIOR TO INSTREAM CONSTRUCTION.
3. OBTAIN ADDITIONAL TEMPORARY WORK SPACE TO ALLOW INSTREAM SPOIL TO BE STORED ON BANKS. ALL SPOIL SHOULD BE STORED ON BANKS OF ANY WATERCOURSES LESS THAN 20m WIDE.
4. INSTALL VEHICLE CROSSING IF REQUIRED.
5. RESTRICT ROOT GRUBBING. DO NOT GRUB WITHIN 10m OF WATERCOURSE EXCEPT ALONG TRENCH LINE AND SPOIL PILE AREA WHEN ABSOLUTELY NECESSARY.
6. WELD, COAT, PRETEST IFREGUIRED AND WEIGHT PIPE PROIR TO COMMENCEMENT OF INSTREAM CONSTRUCTION.
7. SERVICE OR REFUEL MOBILE CONSTRUCTION EQUIPMENT A MIN. OF 100m AWAY FROM WATERCOURSE.
8. TRENCH THROUGH WATERCOURSE RETAINING HARD PLUGS AT EACH BANK UNTIL JUST PRIOR TO PIPE INSTALLATION. STOCKPILE ALL INSTREAM SPOIL ON BANKS IF POSSIBLE. ON LARGER WATERCOURSES STOCKPILE AS MUCH SPOIL ON BANKS AS POSSIBLE. IF INSTREAM STORAGE IS REQUIRED; PLACE IN DISCRETE PILES AVOIDING AREAS OF HIGHEST WATER VELOCITY. DO NOT WINDROW SPOIL ACROSS THE CHANNEL OR BLOCK MORE THAN 2/3 OF CHANNEL. IF NECESSARY TO CONTROL WATER FLOW AND TRENCH SLOUGHING, INSTALL TEMPORARY SOFT PLUGS AND DEWATER TRENCH ON TO STABLE VEGETATED LAND, NOT DIRECTLY TO WATERCOURSE. MAINTAIN STREAMFLOW, IF PRESENT, THROUGHOUT CROSSING CONSTRUCTION. INSPECT, REPAIR OR REPLACE PIPE AND BACKFILL IMMEDIATELY. RESTORE STREAM CHANNEL TO APPROXIMATE PRECONSTRUCTION PROFILE AND SUBSTRATE. ATTEMPT TO COMPLETE ALL STREAM ACTIVITY WITHIN 24 HOURS.
9. RESTORE AND STABILIZE WATERCOURSE BANKS AND APPROACHES TO AS CLOSE TO ORIGINAL GRADE AS POSSIBLE (TO A MAXIMUM 3:1). INSTALL BANK PROTECTION WHERE APPROPRIATE.
10. SEED AND FERTILIZE BANKS IMMEDIATELY.



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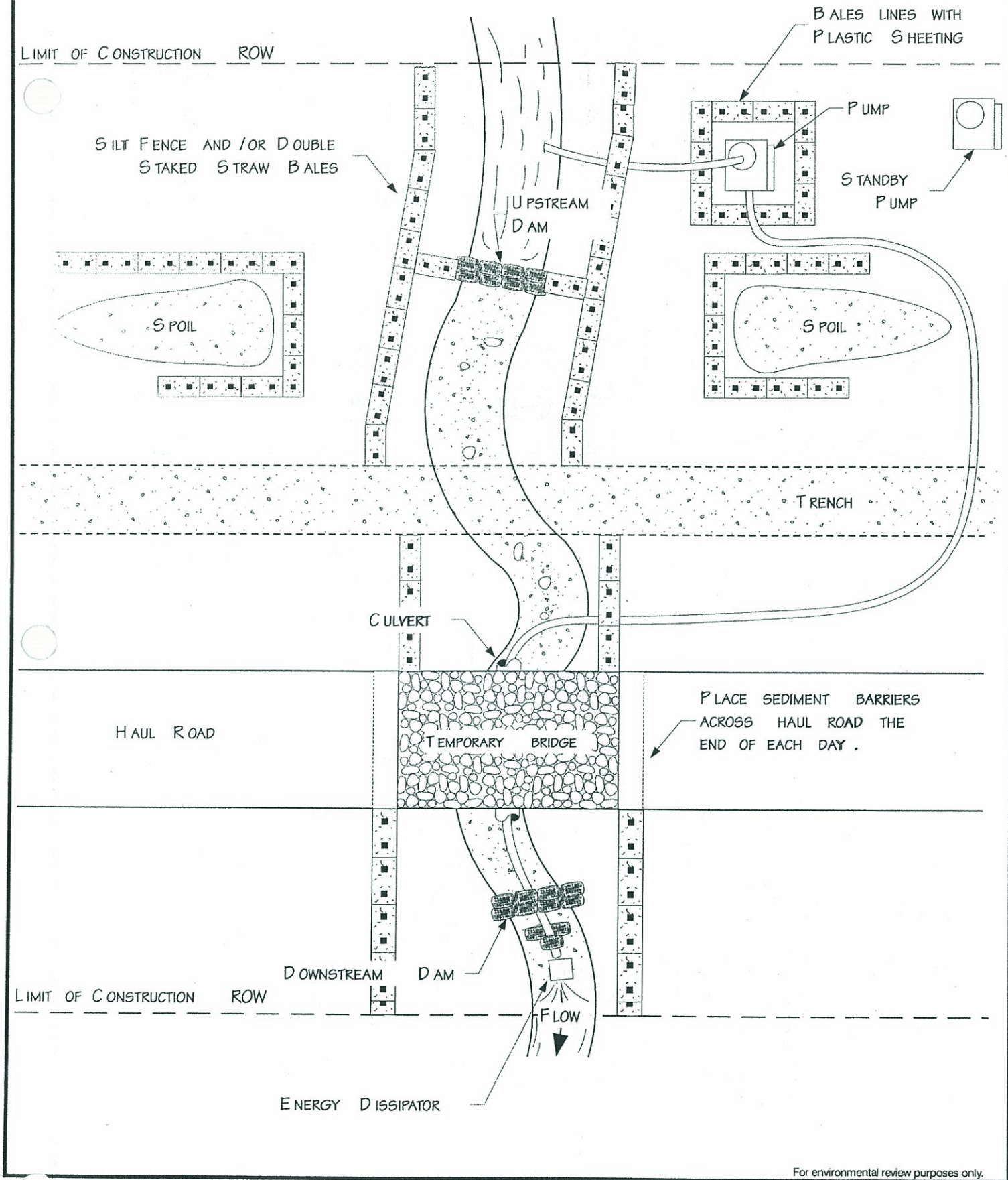
**Figure 3**

Water Crossing -
Wet Open Cut of Small Rivers

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# Figure 4

Typical Waterbody Crossing
Dam and Pump Method

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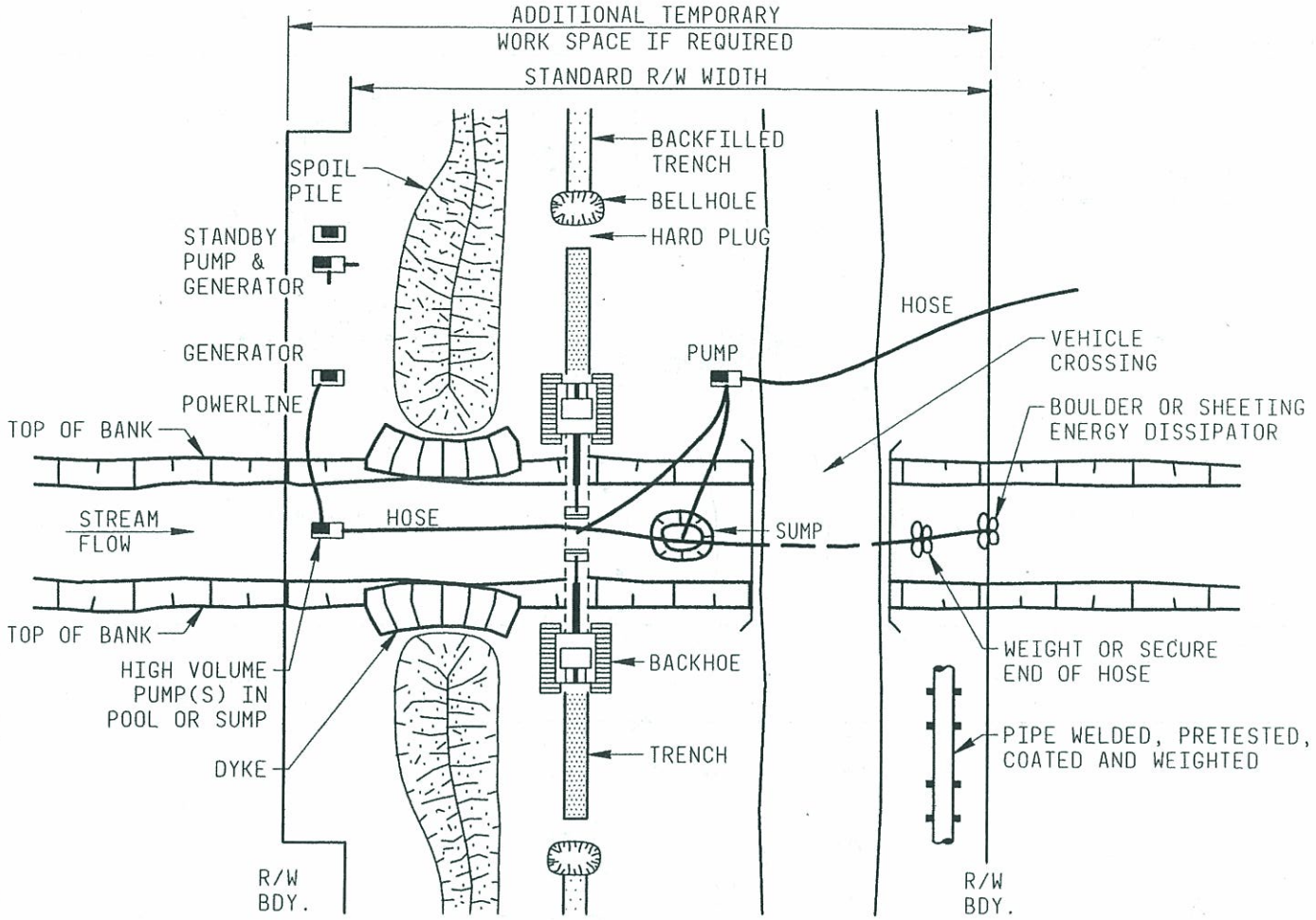


PLAN VIEW

NOTES:

1. USE HIGH VOLUME PUMP METHOD ON WATERCOURSES WITH MODERATE STREAMFLOW TO PREVENT SEDIMENTATION AND INTERRUPTION OF STREAMFLOW DURING INSTREAM WORK. THIS METHOD IS NOT APPROPRIATE IF FISH PASSAGE IS A CONCERN.
2. SCHEDULE CONSTRUCTION DURING LOW FLOW ON LARGE WATERCOURSES.
3. INSTALL TEMPORARY VEHICLE CROSSING
4. ENSURE ADEQUATE ELECTRIC POWER SUPPLY AND ADEQUATELY SIZED PUMPS. HAVE STANDBY PUMP(S) ON SITE.
5. INSTALL PUMP IN POOL LOCATED UPSTREAM OF THE EXCAVATION. DIG TEMPORARY SUMP UPSTREAM IF NO NATURAL POOL EXISTS. ADD ADDITIONAL PUMPING CAPACITY IF REQUIRED. DISCHARGE WATER THROUGH OR INTO AN ENERGY DISSIPATOR INTO THE RIVER CHANNEL SUFFICIENTLY DOWNSTREAM OF THE TRENCH TO PREVENT WATER FLOWING BACK INTO THE EXCAVATION.
6. IMMEDIATELY INITIATE FISH SALVAGE FROM ISOLATED POOLS. ENSURE FISH SALVAGE PERMIT(S) ARE ACQUIRED PRIOR TO INSTALLING PUMP.
7. DIG A SMALL SUMP DOWNSTREAM OF CROSSING TO COLLECT SILT LADEN WATERS. INSTALL SMALL PUMPS IN SUMP AND TRENCH TO DISCHARGE SILT-LADEN WATER ON TO WELL VEGETATED SOILS AWAY FROM THE WATERCOURSE.
8. EXCAVATE TRENCH, COMPLETE REPAIR WORK AND BACKFILL TRENCH. MOVE HOSE AS REQUIRED TO MAINTAIN STREAMFLOW.
9. WASH BACKFILLED TRENCH AREA INTO SUMP. PUMP SILT-LADEN WATER FROM TRENCH ONTO A WELL VEGETATED AREA OFF RIGHT OF WAY. ALSO COMPLETE THIS STEP IN THE EVENING PRIOR TO SHUTTING OFF UPSTREAM PUMP IF INSTREAM WORK IS TO OCCUR ON SUCCESSIVE DAYS.



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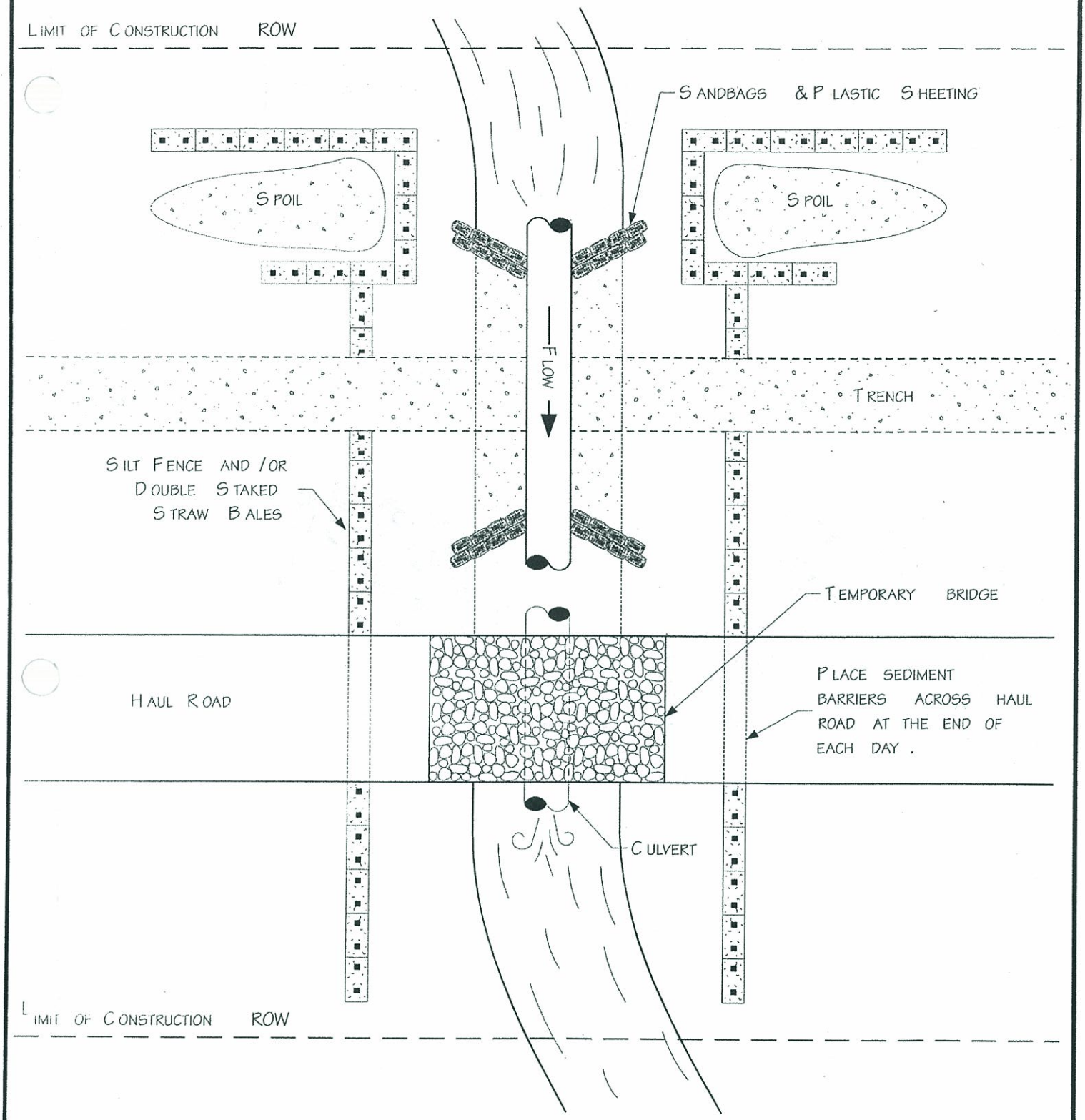
**Figure 5**

Water Crossing -
High Volume Pump

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# Figure 6

Typical Waterbody Crossing
Flume Method

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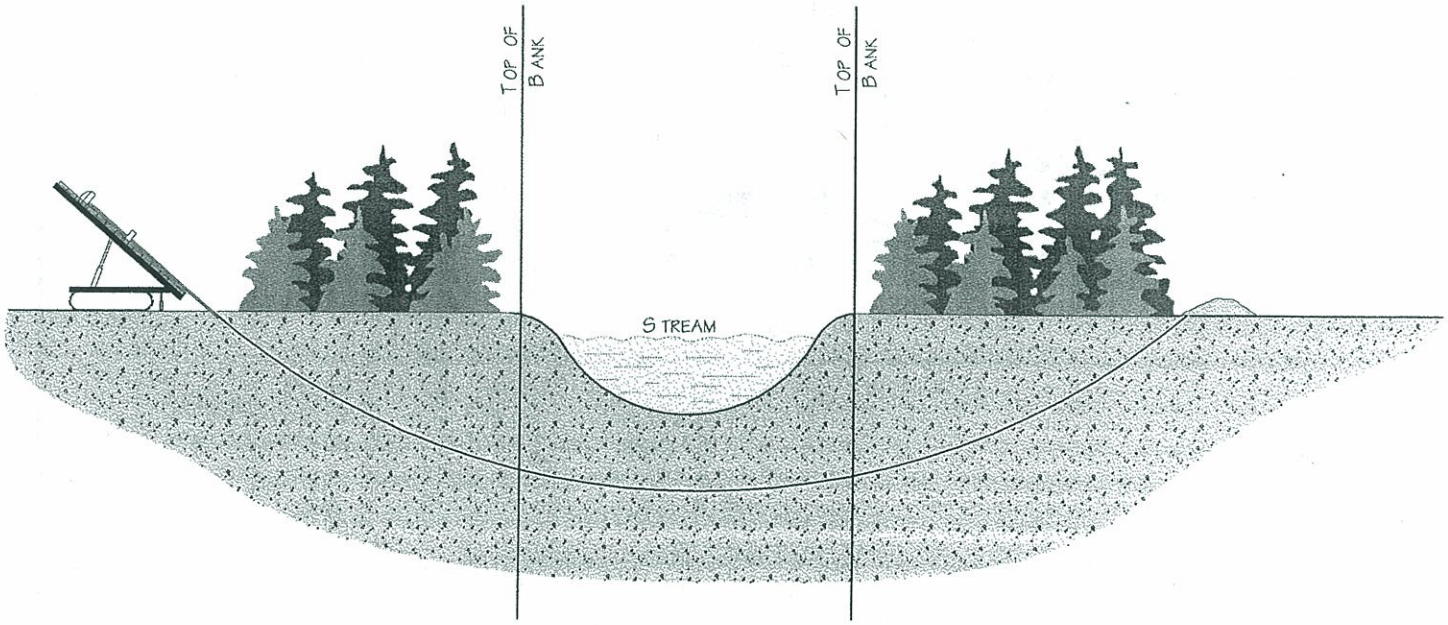


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# Figure 7

Typical Waterbody Crossing
Directional Drill Method

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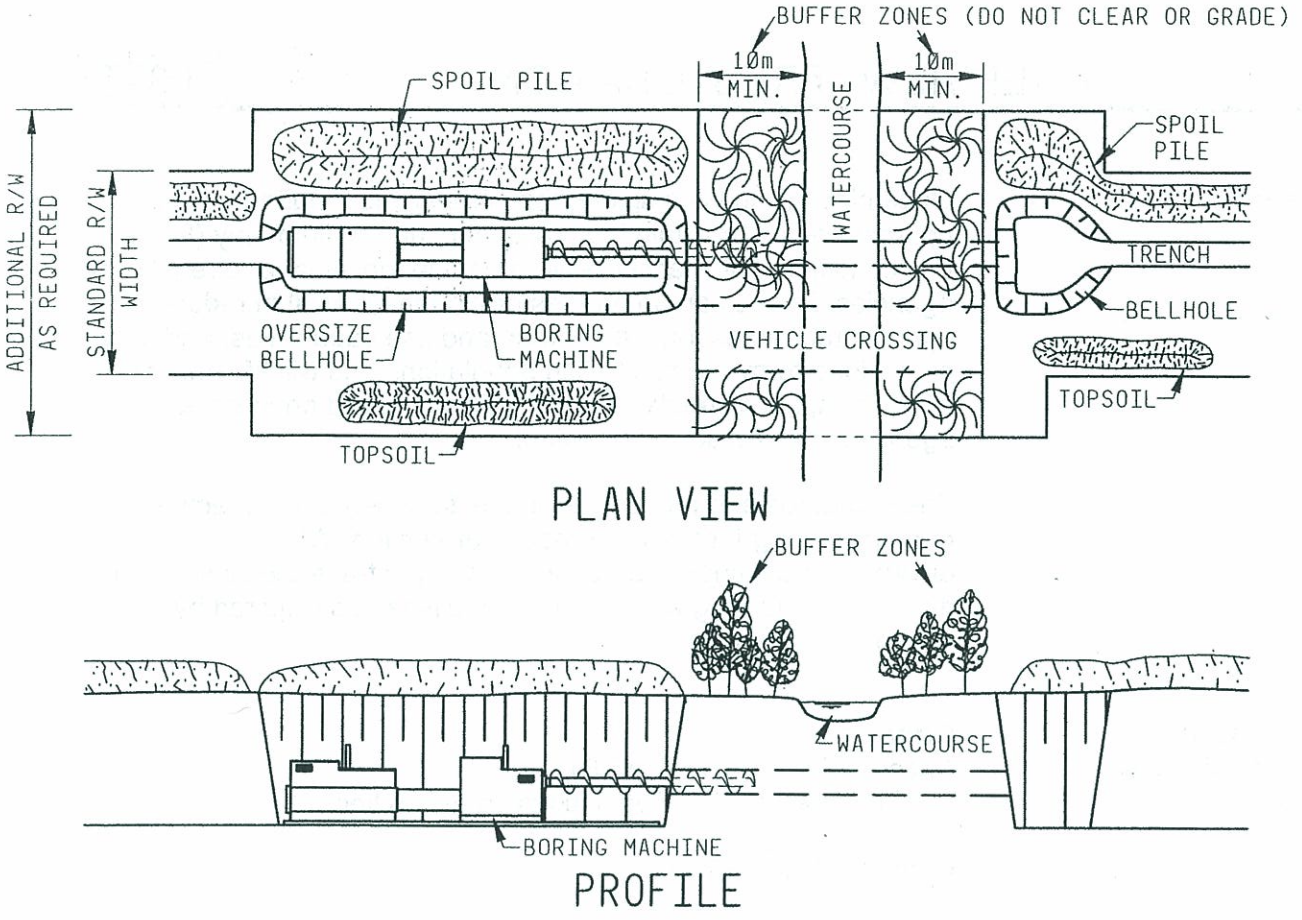


NOTES:

1. BORE (OR PUNCH) WATERCOURSE CROSSING TO PREVENT SEDIMENTATION OF WATERCOURSE, INTERRUPTION OF STREAM FLOW, AND ALTERATION OF STREAM SUBSTRATE. THIS METHOD IS APPROPRIATE FOR CROSSING IRRIGATION CANALS AND OCCASIONALLY, FOR CROSSING NATURAL WATERCOURSES. HOWEVER, IT MAY NOT BE POSSIBLE IF THERE IS EXCESSIVE GROUNDWATER, OR A PERMEABLE OR ROCKY SUBSTRATE OF GRAVEL, COBBLES, LARGE BOULDERS OR BEDROCK. OBTAIN GEOTECHNICAL DATA PRIOR TO COMMENCING BORING (OR PUNCHING).
2. AQUIRE AND MARK ADDITIONAL TEMPORARY WORK SPACE.
3. INSTALL VEHICLE CROSSING.
4. EXCAVATE BELLHOLE. STORE SPOIL ON OPPOSITE SIDE OF RIGHT OF WAY.
5. COMPLETE BORING AND TIE-IN TO MAINLINE.
6. PUMP BELLHOLE DRY IF SEEPAGE BECOMES A PROBLEM.
7. BACKFILL AND COMPACT. LEAVE A CROWN TO ALLOW FOR SUBSIDENCE.
8. RESEED AND FERTILIZE AS APPROPRIATE.



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**Figure 8**

Water Crossing -
Bored or Punched

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# OVERVIEW of RESTORATION 03-1

**Purpose**

Once pipe laying is complete, the company is required to clean up, restore and maintain the project site and right-of-way (ROW) in a condition that is acceptable to both landowners and regulatory agencies. Poor clean up and restoration may result in reduced agricultural, recreational and other land use capabilities, and may cause long-term impacts to fish populations and wildlife habitats. In addition, public relations with landowners and government agencies may be adversely affected.

The standards and procedures in this tab ensure the effectiveness of ongoing long-term environmental protection. Where environmental impacts are suspected, a post-activities inspection and monitoring program must be established as required by government agencies.

**Legislation**

CAN

**Canada**

National Energy Board (NEB):

- Onshore Pipeline Regulations, latest edition

Land Use Regulations

USA

**United States**

Department of Transportation (DOT), Pipeline Safety Regulations:

- Part 195, Transportation of Hazardous Liquids by Pipeline

Area contingency plan/regional contingency plan
Clean Air Act
Clean Water Act
Comprehensive Environmental Response Cleanup and Liability Act (CERCLA)
Emergency Planning and Community Right to Know Act (EPCRA)
Federal, state and local environmental agency regulations
National Environmental Policy Act (NEPA)
Oil Pollution Act (OPA)
Safe Drinking Water Act

# BACKFILLING



## Purpose

Backfilling generally involves replacing the material excavated from the trench and is the first stage in restoring the right-of-way (ROW). In areas where topsoil has been segregated, the subsoil is replaced and the topsoil spread uniformly over the area where it was removed. An earth crown is left over the trench line (except in wetlands) to allow backfill material to settle.

Improper backfilling can affect the quality of final restoration on the project. Poorly compacted backfill material or an excessive crown can cause drainage problems and inconvenience to landowners, livestock and wildlife. In addition, mixing topsoil with subsoil during backfilling may reduce soil capability.

## Guidelines

Before backfilling, inspect the trench for small mammals and reptiles, skids, refuse, welding rods and other debris, and remove if present. Inspect the backfill material to ensure it is free of debris or other material that could damage the pipeline.

Backfill as soon as practicable after lowering-in the pipe to the desired depth. During winter construction, ensure backfill is completed by nightfall.

Confine backfill activities to the ROW. To prevent damage off the ROW, use a Mormon board, backhoe or specialized excavator (e.g., Gradall) where there is insufficient working space for bulldozers.

Use a backfill auger (e.g., Brown Bear), power dozer or suitable equipment to break up clods or frozen soils if required.

Avoid mixing snow with spoil.

Pad the pipe if backfill is frozen or stony, or if bedrock must be replaced. Dispose of surplus rocks at sites approved by the landowner or government agency.

On cultivated lands, leave the top 0.5 m (20 in.) of trench free from rocks to prevent interference with farm equipment. The average spacing and size of rocks left on the ROW should be no more than on adjacent lands.

On pasture lands and woodlands, avoid scalping the sod layer when replacing the topsoil and spoil. To prevent scalping, mount a urethane "prairie protector" attachment to backfill equipment, or use modified street sweepers to protect the sod layer.

On sandy soils and dunes, replaced graded fill to less than the natural angle of repose so that continual sloughing does not become a problem.

## Trench Breakers

Before backfilling on steep slopes, install any necessary trench breakers to force groundwater along the pipe to the surface (see 02-15, Trench Breakers).

## Subdrains

Before backfilling, install any necessary subdrains to divert shallow groundwater flow from the ROW and to improve slope stability (see Figure 1, Subdrains).

## Drain Tiles

Before backfilling, determine whether any drain tiles crossed during trenching were damaged during construction. Use a sewer rod or pipe snake to probe open ends of tiles (see Figure 2, Drainage Tile Restoration).

Repair any damaged tiles by inserting a competent support (e.g., length of solid pipe) around the tile to prevent settling. If damage is extensive, remove broken tile and replace with new tile.

Drain tiles damaged during construction must be repaired to their preconstruction condition or better.

Backfill around drain tiles in lifts. Compact each lift.

## Compaction

Backfill the trench with soil to a height approximately 300 mm (1 ft) above the level of the surrounding ground, except at potential drainage courses.

To compact backfilled spoil, run a grader along the trench once it has been filled just below the level of the surrounding ground.

**NOTE:** Compaction with a grader is essential to avoid ditch subsidence. Although the degree of compaction is limited by factors such as soil type, frost and moisture content, depth of cover, pipe strength and insulation, compaction is typically achieved by a few passes with a grader.

**CAUTION**: Do not run a grader over foreign lines. To compact backfill near foreign lines, use manually operated compaction equipment or another approved method.

On irrigated fields and open cut road crossings, 100% percent compaction is desirable. Use appropriate-sized compaction equipment and compact in multiple lifts.

To minimize subsidence on irrigated fields, compact backfill in a series of 15 cm (6 in.) lifts, or as indicated in project specifications. Avoid the formation of a trench crown or other obstacles that may impede the movement of sprinkler systems.

Compact the trench crown where pivot irrigation wheels pass. If compaction is not adequate at pivot wheel crossings, install a steel plate until compaction is achieved.

**NOTE:** Inspect and monitor the trench before and during the first irrigation season to determine the success of the trenchline compaction and leveling.

Take extra care to avoid using saturated, wet spoil when compacting the trench at the banks of watercourses.

If trench spoil is frozen, postpone compaction until cleanup in mid to late spring.

## Watercourses

Backfill stream beds to their original contour with original stream bed material unless permits specify otherwise.

When backfilling stream banks, pump the ditch dry, then use dry soil in compacted lifts to prevent stream bank sloughing.

At watercourses where sport fish spawn, replace the upper layer of streambed material with previously salvaged materials (see 02-11, Watercourses and Wetlands), or backfill the upper layer of the trench with material equal to, or better than, original stream bed material.

## Wetlands

When backfilling wetlands, replace subsoil material removed from the trench during construction so that no crown remains, unless soils are frozen. If a crown is left over the trench in wetlands to account for settling of frozen backfill, leave periodic breaks to prevent damming, and restore the original contours during cleanup the following spring or summer.

Do not use segregated topsoil as padding. Return segregated topsoil to its original horizon over the backfilled trench.

## Crowning

Crown the trench with remaining spoil to allow for settlement. The height of the crown depends on:

- land use
- degree of compaction desired
- swell coefficient of backfill (see Table, Swell Coefficient of Backfill)
- soil temperature

Ensure the crown is centered over the ditchline.

On forested lands, a higher crown is acceptable provided drainage and wildlife are unaffected.

Frozen soils require higher crowns than unfrozen soils.

On agricultural lands with unfrozen soils, the crown should be low and wide to facilitate replacing topsoil.

Feather excess spoil over the stripped portions of the ROW to create a smooth mound. If more room is needed for excess spoil, strip one blade width (approximately 3–4 m [10–13 ft]) of topsoil from the spoil or work areas of the crown to facilitate feathering out excess trench spoil without mixing subsoil with topsoil.

Leave breaks in the trench crown:

- in obvious drainage runs
- whenever seepage occurs
- at regular intervals where sidehill is encountered

Compact backfill where breaks in the trench crown are left.

**NOTE:** The breaks may require maintenance the following year to fill in settled areas.

Table 1 shows the swell coefficient of various soil types. To calculate the height of a crown, use the formula:

$R = s \times D$

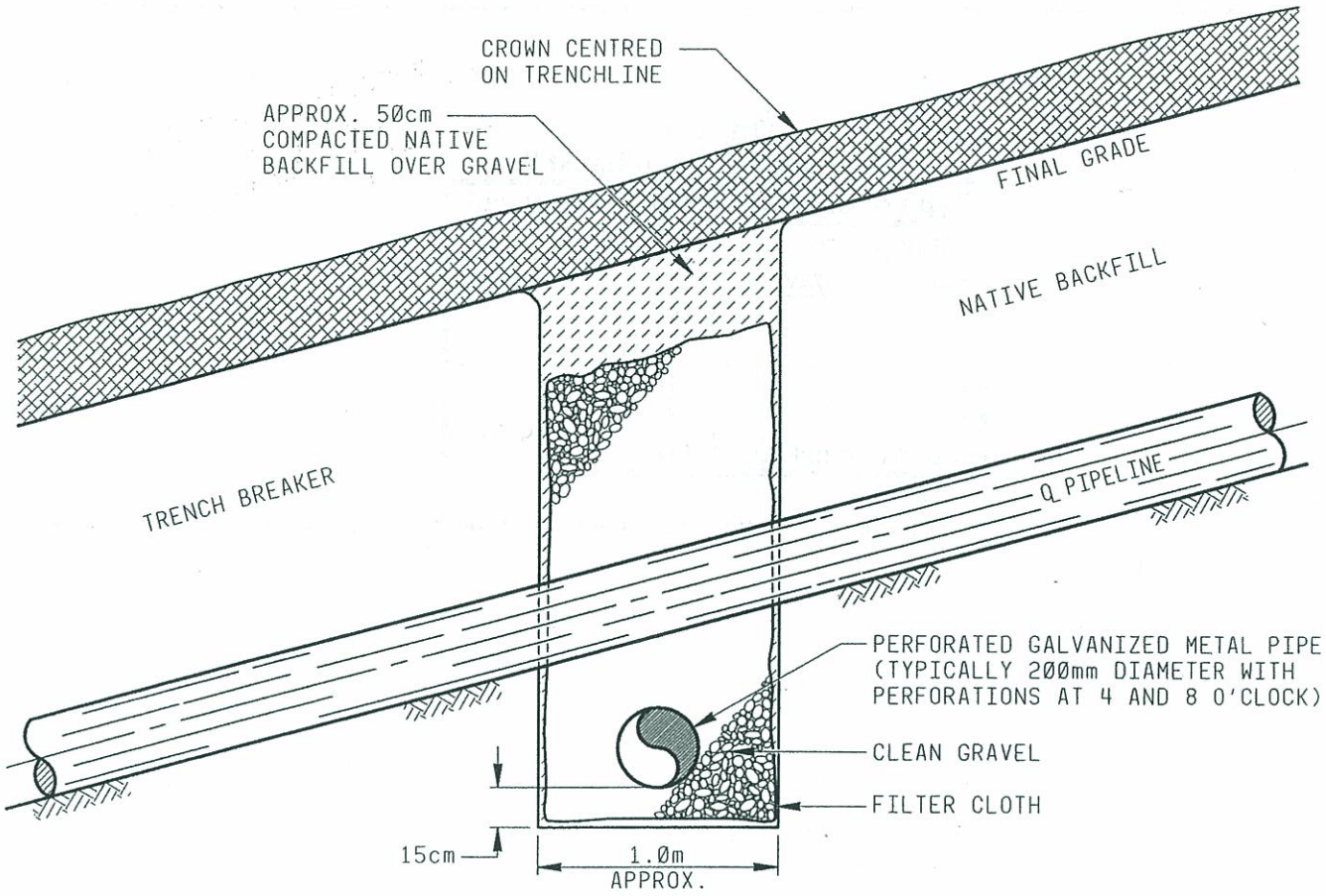
**Where:**

R = height of crown
s = swell coefficient
D = depth of trench

**Table 1**
**Swell Coefficient of Backfill**

| Type of Backfill | Swell Coefficient |
|---|---|
| blasted rock | .00–.05 |
| sand and gravel | .05–.10 |
| sand | .08–.15 |
| silty sand | .10–.15 |
| silt | .10–.20 |
| clay | .10–.25 |
| organic (muskeg) | .50–1.00 |

**NOTE:** The higher numbers in the range represent the worst case (i.e., frozen or clods).




PROFILE

NOTES:

1. INSTALL A SUBDRAIN TO DIVERT SHALLOW GROUNDWATER FLOW AWAY FROM THE PIPELINE, TO IMPROVE SLOPE STABILITY. CLEAN GRAVEL, WRAPPED IN FILTER CLOTH, PERMITS DRAINAGE AIDING IN RETENTION OF BACKFILL. IN CERTAIN CIRCUMSTANCES, A PARALLEL DRAIN MAY BE INSTALLED LENGTHWISE DOWN THE SLOPE UNDERNEATH THE PIPELINE. A GEOTECHNICAL ENGINEER CAN ADVISE IN WHICH METHOD IS MOST APPROPRIATE.

2. DETERMINE THE LOCATION OF DRAIN BY ON-SITE INVESTIGATION CONSIDERING SUCH FACTORS AS GROUNDWATER CONDITIONS IN TRENCH, SOIL TYPES, LOCAL TOPOGRAPHY, AND DRAINAGE PATTERNS.

3. SKEW CROSS DRAIN WITH DOWNHILL GRADING AT 5° TO ENSURE SUFFICIENT DRAINAGE.

4. INSTALL TRENCH BREAKER DOWNSLOPE OF DRAIN, WHERE DRAINS CROSS PIPELINE TRENCH, TO PREVENT DRAIN WATER FLOWING DOWN PIPE TRENCH



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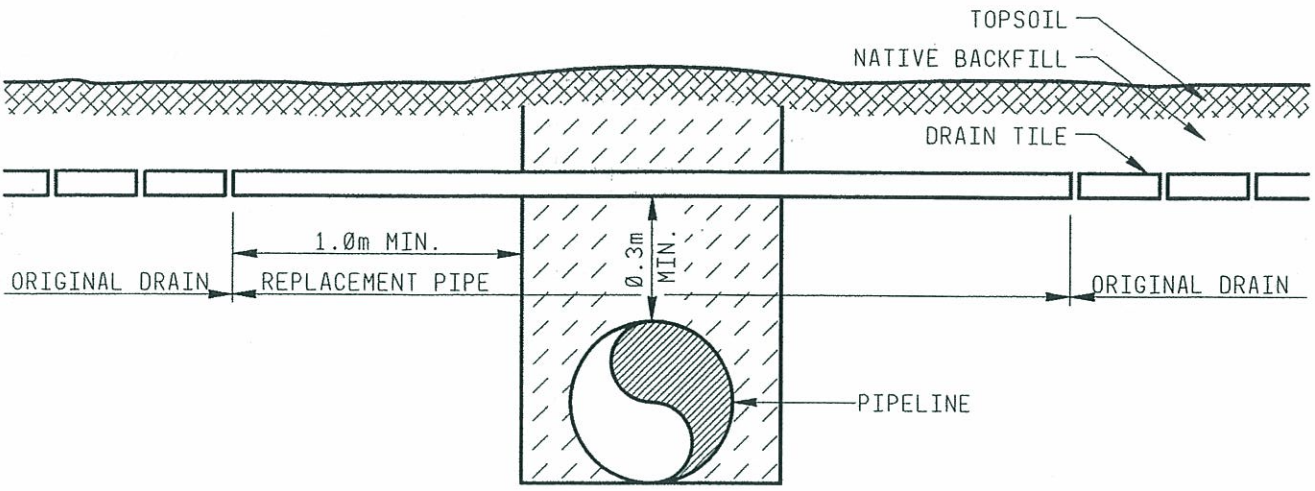
**Figure 1**

Subdrain




# PROFILE
(CROSS-SECTION OF TRENCH)

NOTES:

1. IF TILE OR TUBE DRAINS ARE CUT DURING TRENCHING, MARK LOCATIONS, CAP DRAINS TO PREVENT CLOGGING WITH DIRT OR DEBRIS, AND INSTALL A TEMPORARY FLUME TO MAINTAIN DRAINAGE.

2. PROIR TO TOPSOIL REPLACEMENT, REPLACE DRAINS WITH A LENGTH OF SOLID PIPE TO PREVENT SETTLING. IF DISTURBANCE IS EXTENSIVE, REPLACE WITH NEW DRAIN TUBING, OR PERFORATION SOLID PIPE ON A COMPACTED BED.

3. INSERT A SEWER ROD OR PIPE SNAKE INTO OPEN DRAIN ENDS FAR ENOUGH TO ENSURE THAT RIGHT OF WAY TRAFFIC HAS NOT DAMAGED OR DISPLACED DRAINS

4. REPAIR ANY DAMAGED TILES BY INSERTING A COMPETENT SUPPORT (E.G. LENGTH OF SOLID PIPE) AROUND THE TILE TO PREVENT SETTLING.

5. IF DAMAGE IS EXTENSIVE, REMOVE BROKEN TILE AND REPLACE WITH NEW TILE.

6. REPLACE DRAIN TO ITS FORMER GRADIENT AND ALIGNMENT.

7. BACKFILL AND COMPACT SUBSOIL IN LIFTS BENEATH AND AROUND PIPE.



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**Figure 2**

Drainage Tile Restoration

# CLEANUP 03–3

## Purpose

Cleanup typically involves removing construction refuse and debris from the right-of-way (ROW), grading to restore disturbed areas to original contours, installing or repairing erosion control structures, and replacing topsoil and fences removed during construction. The quality of work done during cleanup often directly affects future relations with landowners and government agencies.

## Guidelines

### Scheduling

***Summer/Fall***

Clean up summer/fall projects as soon as possible after backfilling, and before freezeup, if possible.

Postpone cleanup on wet ground until soils dry out.

***Winter/Spring (Rough)***

Begin rough cleanup of winter projects as soon as possible after backfilling (frozen conditions) and before spring breakup.

***Winter/Spring (Final)***

Begin final cleanup of projects not completed before freezeup and cleanup of winter projects as soon as possible after spring breakup.

Schedule cleanup to minimize interference with agricultural operations, migratory birds and fish spawning as much as possible.

For damaged soils, postpone cleanup until soils dry out.

Before final cleanup, consult with the landowner to ensure any special concerns can be addressed before completing restoration.

### Waste

Collect and dispose of all construction-related garbage, debris, wastes and hazardous materials from the ROW in designated containers or at approved facilities.

**NOTE:** For appropriate waste management practices, see the Waste Management Plan.

Do not leave waste on or along the ROW, or buried in an excavation.

Remove stones to achieve equivalence with the surrounding subsoil/topsoil, as well as stones from the upper 30 cm (1 ft) of soil that will interfere with topsoil replacement or cultivation, i.e., stones larger than 10 cm (4 in.) in diameter. Dispose of stones at locations approved by landowners or government agencies.

Dispose of excess rock displaced from the trench or ROW by blasting as directed by landowners or government agencies.

## Topsoil Replacement

Replace topsoil as evenly as possible over stripped areas of the ROW.

Postpone replacing topsoil during wet weather or high winds to prevent damaging soil structure or erosion of topsoil.

Immediately before replacing topsoil, cut a clean edge with a grader. Distribute edge cut material evenly over the prepared subsoil surface.

## Regrading

Regrade areas with vehicle ruts, erosion gullies, settled trenches or where the trench crown is misaligned.

Regrade stream banks and approaches to a maximum of 1:3 (rise over run), unless otherwise directed by a geotechnical engineer.

## Recontouring

Recontour the right-of-way (ROW) to restore surface drainage and the approximate preconstruction profile. When replacing sidehills or other graded areas is not practical due to the risk of slope failure or ovalling the pipe, recontour slopes to grades not exceeding 1:3 (rise over run) or as advised by a geotechnical engineer.

If fill is frozen, postpone recontouring until spring.

On flood irrigated lands, recontour the ROW to preconstruction profile.

### *Wetlands*

Restore the original contours of wetlands, and remove any excess backfill to an upland area approved by the environmental department.

## Damaged Soils

Rip compacted subsoils, temporary access trails and soils damaged during wet weather with a multishank ripper to a depth of 30 cm (12 in).

Use a disk plow or cultivator on ripped subsoils to break up lumps and to smooth the surface.

**NOTE:** To minimize further compaction, limit disking to what is necessary to break up clods.

Till or cultivate fields and any severely compacted or rutted areas with a deep tillage device or chisel plow to loosen compacted soils.

## Corduroy

Remove corduroy from locations where drainage disruptions are likely, where requested by landowners or government agencies, and from mineral soils.

Remove and return clay or sand caps overlying corduroy to the original location, unless otherwise requested by landowners or government agencies.

Ensure adequate culverts or other cross drainage is provided in any capped corduroy that is left in place.

Dispose of corduroy, slash and any remaining leaning trees in the same manner as the original clearing (see 02-4, Clearing).

## Cultivation

Cultivate the ROW where it crosses fields, bush or woodlands to a depth adequate to alleviate surface compaction and in a manner acceptable to the landowner. Do not pulverize soil.

If seeding immediately after topsoil is replaced, harrow the ROW.

Cultivate hay and pasture land if the sod layer is broken or badly compacted.

With the approval of the landowner at problem sites, add manure or plant legumes to increase organic matter.

## Equipment Crossings

Where possible, remove equipment crossing structures before freezeup (summer/fall projects) or before spring breakup (winter projects).

If equipment crossings are needed for access during final seeding, they can be replaced after spring breakup.

## Temporary Erosion Control

Use temporary erosion control measures, e.g., sandbags, logs or straw bales, during rough cleanup on undisturbed pasture or well-sodded right-of-way (ROW).

Install temporary stream bank protection during rough cleanup if erosion is evident at water crossings (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers).

To minimize drifting soils and loss of topsoil in areas prone to wind erosion:

- spread wood chips or straw crimping
- sow a fast growing ground cover
- walk down tree and shrub debris over exposed soils

If winter conditions preclude final cleanup, stabilize the area (e.g., flatten topsoil piles, partially fill grade cuts) and keep temporary erosion control measures in place until permanent erosion control measures can be installed.

### *Temporary Slope Breakers/Sediment Barriers*

During frozen conditions, install temporary slope breakers and sediment barriers during rough cleanup if final cleanup is not completed until the following spring (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers).

### *Mulch*

Mulch slopes greater than 5%. Apply mulch after the last grading operation of winter construction.

**NOTE:** Mulch can be applied to snow-covered ground.

Do not apply mulch by hand or apply more than 2 tons per acre, as it may be removed the following spring before seeding.

### *Wetlands*

Restore the original contours of wetlands, and remove any excess backfill to an upland area approved by the environmental department.

## Damaged Soils

Rip compacted subsoils, temporary access trails and soils damaged during wet weather with a multishank ripper to a depth of 30 cm (12 in).

Use a disk plow or cultivator on ripped subsoils to break up lumps and to smooth the surface.

**NOTE:** To minimize further compaction, limit disking to what is necessary to break up clods.

Till or cultivate fields and any severely compacted or rutted areas with a deep tillage device or chisel plow to loosen compacted soils.

## Corduroy

Remove corduroy from locations where drainage disruptions are likely, where requested by landowners or government agencies, and from mineral soils.

Remove and return clay or sand caps overlying corduroy to the original location, unless otherwise requested by landowners or government agencies.

Ensure adequate culverts or other cross drainage is provided in any capped corduroy that is left in place.

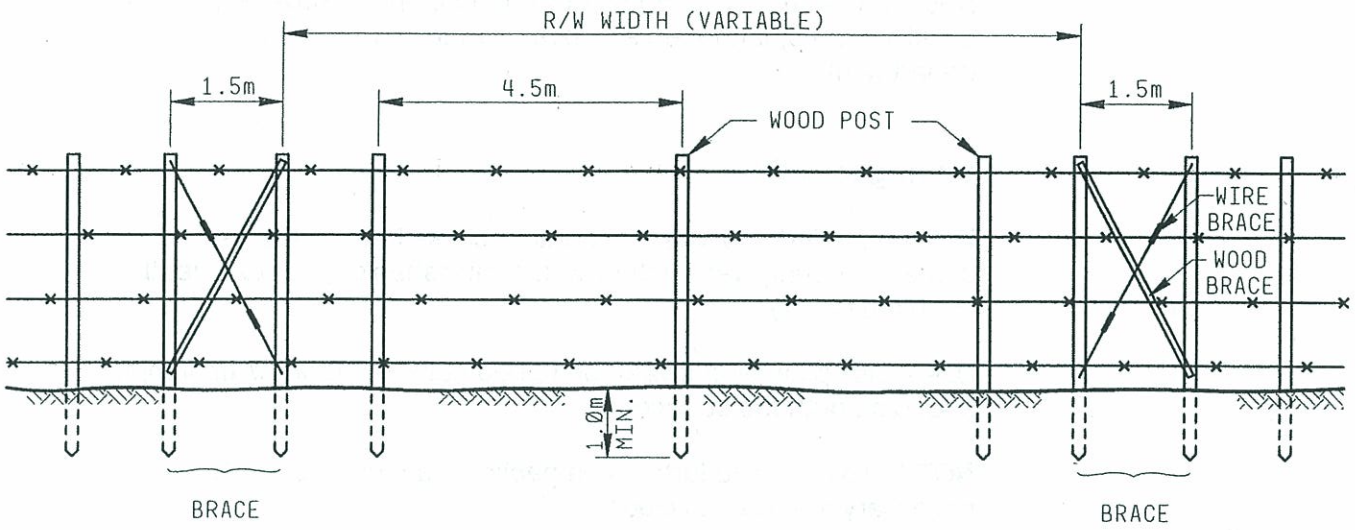
Dispose of corduroy, slash and any remaining leaning trees in the same manner as the original clearing (see 02-4, Clearing).

## Cultivation

Cultivate the ROW where it crosses fields, bush or woodlands to a depth adequate to alleviate surface compaction and in a manner acceptable to the landowner. Do not pulverize soil.

If seeding immediately after topsoil is replaced, harrow the ROW.

Cultivate hay and pasture land if the sod layer is broken or badly compacted.




PROFILE

NOTES:

1. INSTALL POST AND WIRE FENCES TO REPLACE TEMPORARY GATES INSTALLED FOR PIPELINE CONSTRUCTION.

2. FOLLOWING PIPELINE CONSTRUCTION, REMOVE TEMPORARY GATE AND REPLACE WITH NEW FENCE USING MATERIAL OF EQUAL OR BETTER QUALITY THAN THE ORIGINAL FENCE. RETAIN BRACES AS PERMANENT PART OF FENCE STRUCTURE. IF GROUND IS FROZEN, USE METAL POSTS AND REPLACE WITH WOOD POSTS WHEN SOIL HAS THAWED. WHERE APPROPRIATE, MAINTAIN A MINIMUM BOTTOM WIRE ELEVATION OF Ø.4m TO ACCOMMODATE SMALL WILDLIFE SPECIES.

3. INSPECT FENCE FOR 1ØØm IN BOTH DIRECTIONS FOR SLACK WHEN TENSIONING THE WIRES.

4. REMOVE ALL EXCESS WOOD, WIRE, STAPLES, AND OTHER WASTE.



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**Figure 1**

Post and Wire Fence

# REVEGETATION 03–4

**Purpose**

Permanent revegetation involves preparing the seed bed and seeding disturbed areas to establish a permanent groundcover.

**Guidelines**

Seed and fertilize disturbed areas of the right-of-way (ROW) as requested by landowners or government agencies as soon as possible after final cleanup, weather and soil conditions permitting.

When re-establishing cover, consider seasonal factors including:

- seed dormancy
- hot, dry conditions
- access during spring breakup

Mix and sow specific seed mixes as recommended in the project specifications or in consultation with the environment department for the following:

- steep slopes
- stream banks
- native pasture/prairie
- critical wildlife areas
- sandy soils or sand dunes
- highly erodible soils and locations
- areas with high visual impact
- contaminated soils
- wetland, muskeg, slough and marsh areas
- urban areas, lawns, etc. (sod as required)

Where problems may be expected in establishing vegetation (e.g., on sandy soils and dunes) consider using any or a combination of the following:

- install wind barriers such as slat fences, straw bales, brush grid, cover crops or straw crimping
- apply manure, green feed, peat or material rich in organic content to amend the soil
- prepare the surface to enhance seed germination by tilling or by creating gouges, furrows or impressions with specialized equipment, such as chisel plows or land imprinters

- install diversion berms and ditches on slopes
- apply slash rollback or mulches. Import slash as required
- seed drought resistant grasses and legumes, and a cover crop of annual rye or barley
- transplant container-grown native shrubs and herbaceous species
- apply fertilizer as per soil analysis and as identified in the construction specifications

Ensure straw mulch and seed mix used to revegetate the ROW are free of noxious weed seed. Use certified seed and retain the analysis certificate in case a dispute arises concerning weeds.

Restrict public vehicle access over newly grassed areas.

## Agricultural Land

Seed and fertilize cultivated land on the ROW as part of normal farming operations where possible.

On those portions of the ROW where the landowner is not planting a crop during the next growing season:

- Purchase seed in accordance with Pure Live Seed (PLS) analysis for the seed mix, i.e., compare seed cost based on purity percentage multiplied by germination percentage (PLS).
- Use seed within 12 months of germination testing.
- Treat legume seed with an inoculant specific to the species. When hydroseeding, use four times the manufacturer's recommended rate of inoculant. Do not hold inoculated seed in a slurry without fertilizer for more than 1 hr.
- Fence the ROW if practical until seedlings are well established and to prevent damage from livestock.

## Wetlands

Wetlands generally revegetate naturally. Revegetate disturbed wetland areas with annual ryegrass planted at a rate of 40 lb/acre, unless there is standing water or unless permanent planting or seeding with native wetland vegetation is required.

Do not apply fertilizer, lime or mulch in wetlands.

During frozen conditions, apply annual ryegrass as a dormant seeding. If dormant seeding is not feasible, seed annual ryegrass during the next growing season in wetlands that are sufficiently dry to support appropriate equipment.

### Watercourses

On steep approaches to watercourses where the slope was extensively graded, transplant native shrubs, willow cuttings or use other bioengineering techniques, e.g., vegetative geogrid (see Figure 1, Vegetated Geogrid, and 03-7, Installing Willow Cuttings).

Revegetate watercourse banks and approach slopes with a standard mix plus an annual cover crop, i.e., barley or annual rye, applied at twice the standard rate. After seeding, apply erosion control blanket, e.g., high velocity curlex, or mulch.

### Swales

Seed and mulch swales with straw for the width of the ROW.

### Mulch

Mulch stabilizes the soil surface and limits soil movement and the availability of soil to enter runoff. Typical mulch materials include straw or hay, or erosion control fabrics, such as high and low velocity curlex or jute blanket.

Do not apply mulch to cropland unless specifically requested by the landowner.

After seeding, mulch slopes greater than 5% or sandy areas with 2 tons of straw or hay per acre, or as specified by the company (see Figure 2, Typical Low Relief Drainage Way Stabilization-Seed & Straw Mulch).

Mulch all areas of dormant seeding with 2 tons per acre of hay or straw, or as specified by the company to cover >75% of the ground surface.

Anchor mulch to minimize loss by wind and water. If soil conditions allow, use a mulch anchoring tool or farm disc set in the straight position to crimp the mulch 2–3 in. deep.

**NOTE:** Liquid tackifiers may be used after obtaining written approval from the company.

If final cleanup is delayed longer than 10 days, or if construction is interrupted for extended periods, apply mulch before seeding. To provide temporary vegetative cover for extended periods, seed upland areas with annual rye.

Do not apply mulch in wetlands.

## Seed and Fertilizing Methods

To promote seed germination on dry or wind exposed sites:

- use straw crimping
- apply manure (with landowner approval)
- use or import small diameter slash (uncultivated areas)
- thinly spread wood chips (uncultivated areas)

Where terrain and soil conditions allow, apply seed using a seed drill equipped with packing wheels.

**NOTE:** Ensure the depth control on the drill is set correctly.

Broadcast or aerial seed and fertilize wet soils to minimize surface disturbance.

Broadcast seed and fertilizer on berms and other erosion control structures to ensure immediate revegetation or soil stability.

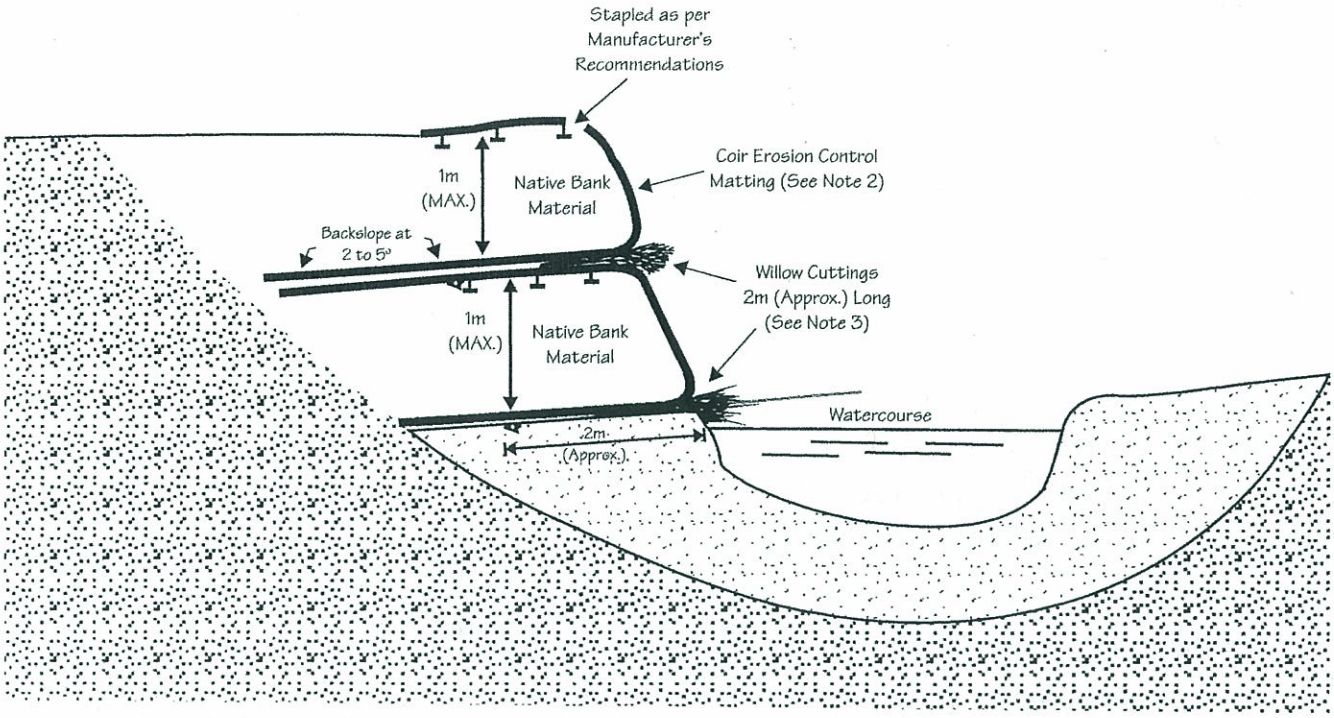
Use hydroseeders, mulches, tackifiers, seed impregnated netting or other suitable methods on steep or erosion-prone slopes.

Broadcast seed but do not fertilize next to watercourses. Harrow or hand rake to incorporate seed.

When broadcast seeding, firm the seed bed with a harrow-packer or roller after seeding.

Apply fertilizer and pH modifying agents, e.g., lime, as specified by the company and in consultation with landowners and government agencies.

**NOTE:** If spring cleanup extends to many weeks, a weed control program may be required.




PROFILE
(Not To Scale)

NOTES:

1. Install vegetated geogrid on steep approach slopes to watercourses where extensive grading of the slope was required.
2. Install coir erosion control matting shown above during nonfrozen conditions. Only matting that meets or exceeds the requirements noted in the construction specifications or is approved by the environmental department shall be installed. All materials used in the coir matting shall be biodegradable.
3. Ensure willow cuttings are fresh with a minimum 1cm (Min.) diameter at their base. Install willow cuttings at frequency of 25 (Approx.) per linear metre.
4. Compact, to the extent practical, each lift of backfill separately.
5. Hand broadcast seed prior to installation of the coir matting, if practical, or on the surface of the coir matting.



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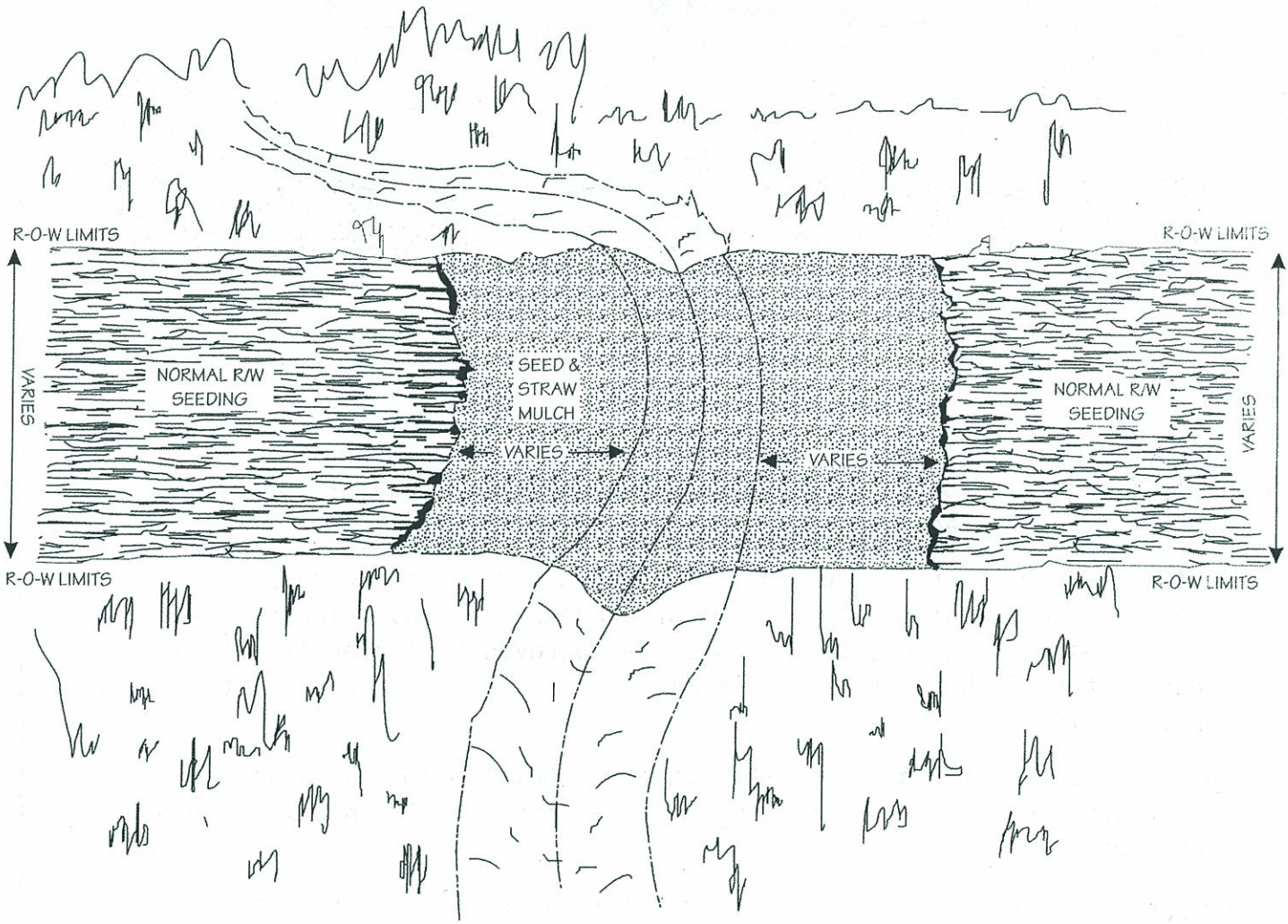
**Figure 1**

Vegetated Geogrid

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# Figure 2

Typical Low Relief Drainage Way Stabilization
Seed and Straw Mulch

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# PERMANENT EROSION and SEDIMENTATION CONTROL 03–5

## Purpose

Permanent soil erosion and sedimentation control begins as soon as possible upon completion of backfilling. Erosion control is necessary to prevent pipe exposure and the subsequent cost to restore the site to previous conditions. Erosion control is also required to minimize siltation in watercourses.

## Guidelines

### Slopes

After final grading, stabilize disturbed steep slopes in areas other than cropland with permanent erosion control structures (see Figure 1, Permanent Slope Breakers-Perspective View), especially if heavy runoff, spring breakup or heavy storms are likely and there is a risk of significant soil erosion. Consider any of the following:

- install cross ditches and diversion berms
- walk down tree and shrub debris over exposed soils
- armor berms and ditches with logs, polyethylene or sandbags
- install netting or filter cloth
- apply tackifier
- install and stake sod
- hydromulch
- hydroseed, spread straw and crimp
- seed an annual crop of barley, fall rye or oats
- plant native shrubs or willow cuttings

Install permanent slope breakers according to the same design and spacing used for temporary slope breakers (see 02-13, Slope Breakers).

On slopes over 30%, install erosion control blanket, e.g., curlex, jute, or equivalent (see Figure 2, Erosion Control Blanket-Steep Slopes > 30%).

### *Stream Banks*

Since most water crossings have individually designed crossing plans, obtain the special instructions from a company representative before working next to watercourses. If there are no special conditions, use a company standard design to ensure appropriate erosion control measures are in place.

**NOTE:** For information on installing stream bank protection, see the procedures in this tab.

Install berms or other sediment filter devices at the base of sloped approaches to streams greater than 50% (for information on berms, see 02-13, Slope Breakers).

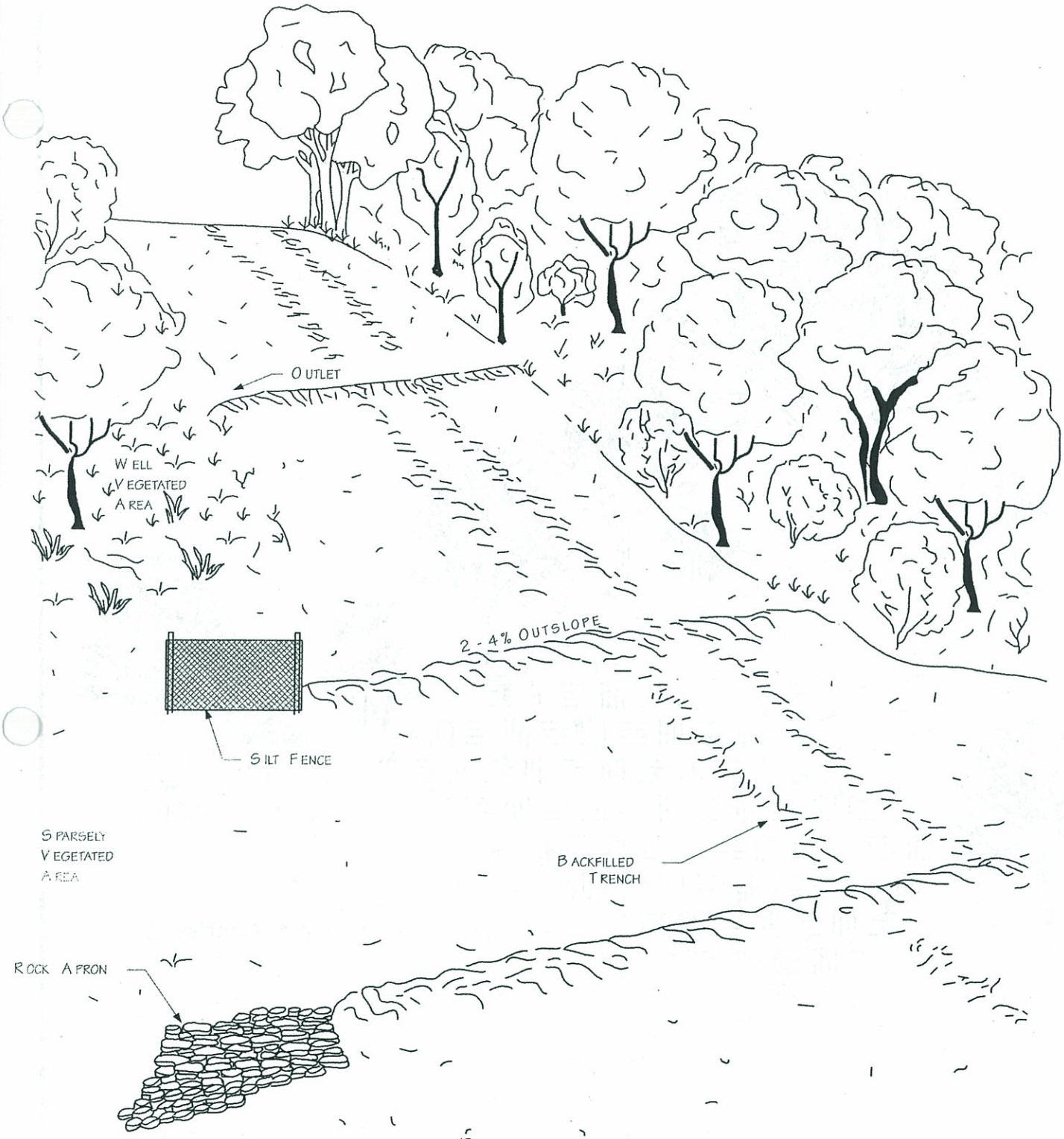
Immediately after stream banks are restored to their original contours, or to a 3:1 slope, whichever is less steep, install bank protection according to site and permit requirements:

- place riprap and geotextile fabric (see Figure 3, Typical Stream Bank Stabilization Riprap & Erosion Control Blanket) and prepare soil for seeding upslope
- if not riprapped with rock, seed with the specified seed mix and cover with an erosion control blanket (see Figure 4, Typical Streambank Stabilization Erosion Control Blanket - Seed and Straw Mulch).

**NOTE:** For more information, see 03-6, Installing Riprap.

### Watercourses

Permanently restore and stabilize drainage ditches and intermittent streams with erosion control blanket, permanent seeding or other appropriate measures.




PERSPECTIVE VIEW
(NOT TO SCALE)

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# Figure 1

Permanent Slope Breakers - Perspective View

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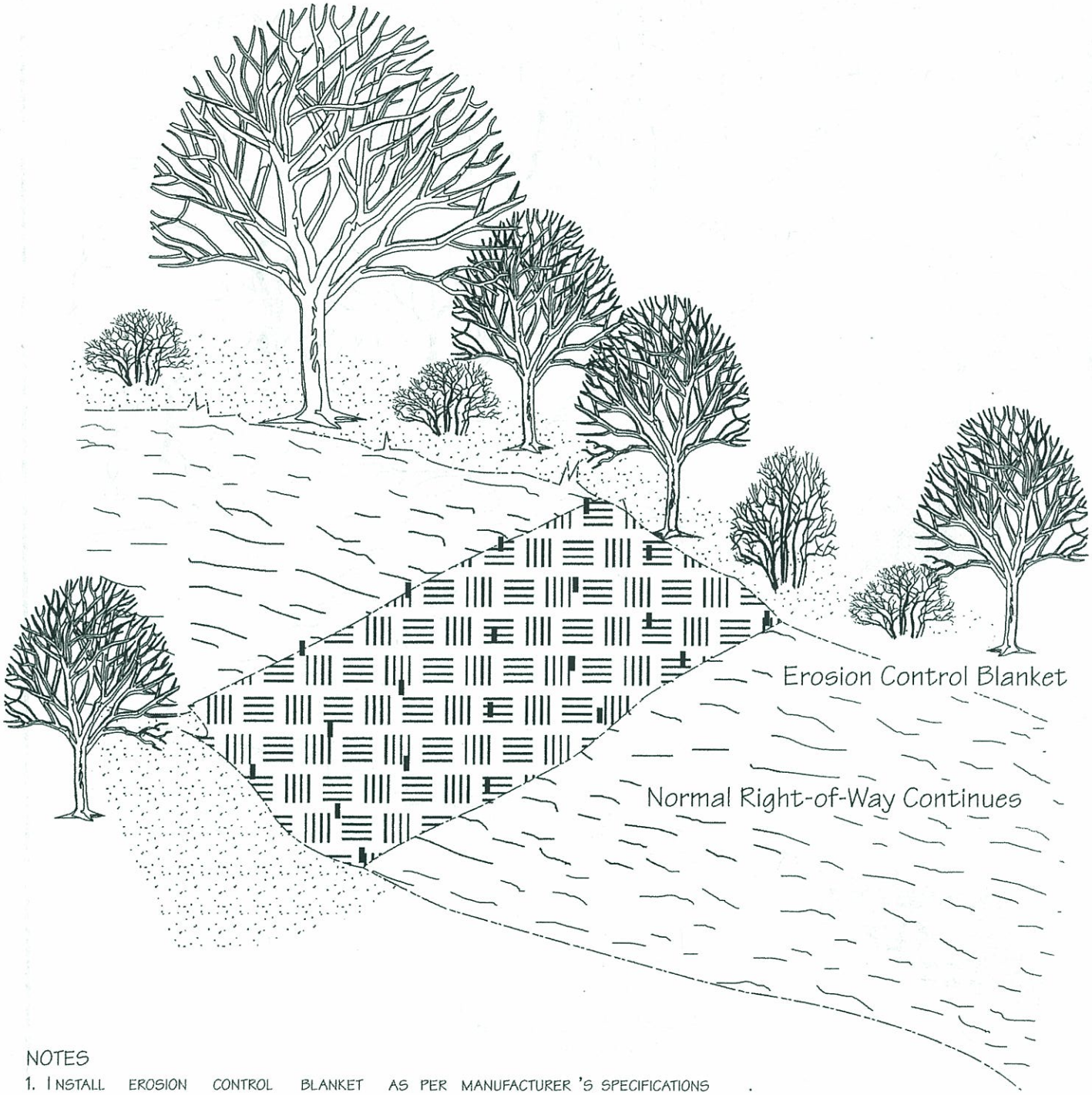


NOTES

1. INSTALL EROSION CONTROL BLANKET AS PER MANUFACTURER'S SPECIFICATIONS .



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**Figure 2**

Erosion Control Blanket - Steep Slopes (≥30%)

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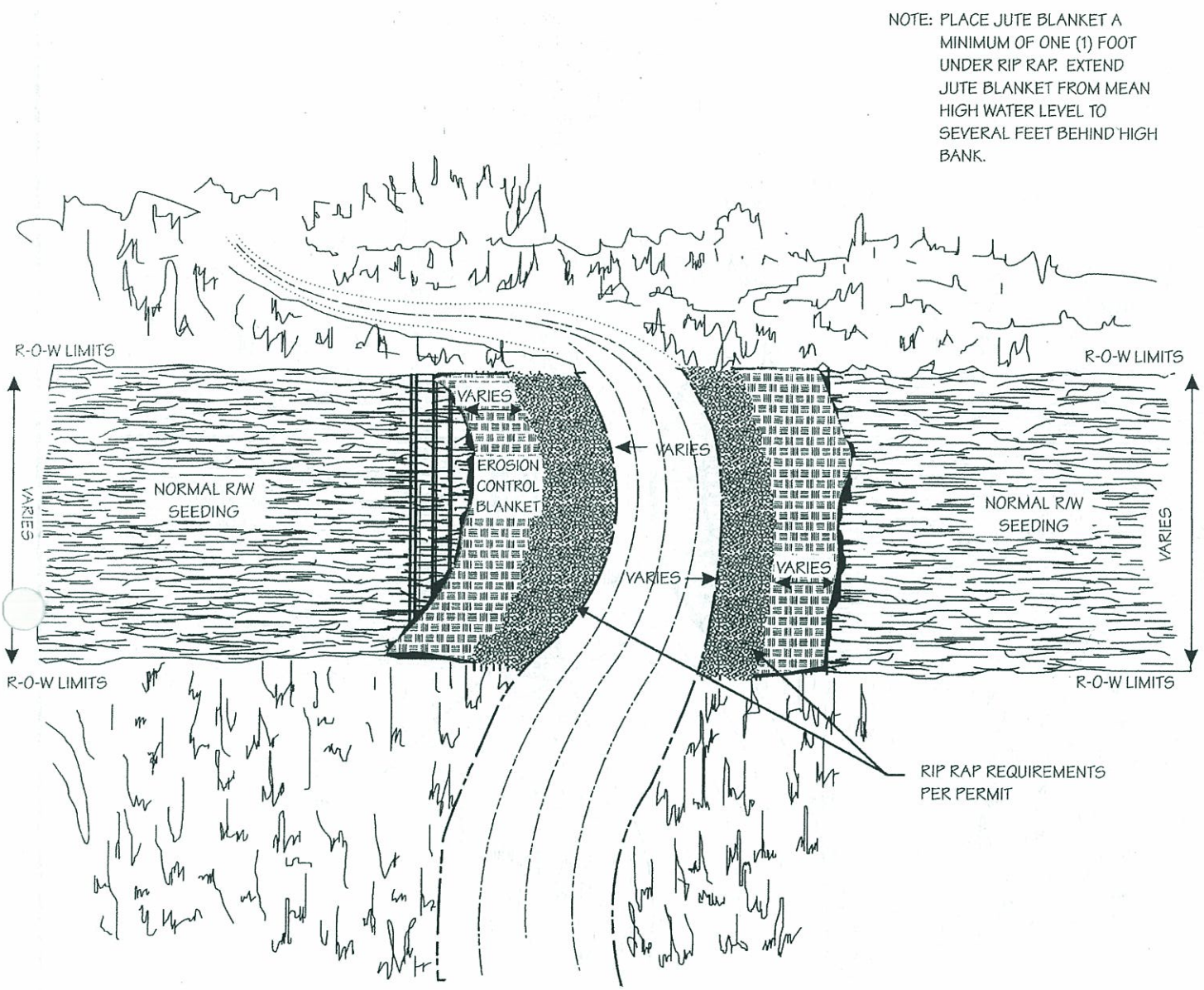


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# Figure 3

Typical Stream Bank Stabilization
Riprap & Erosion Control Blanket

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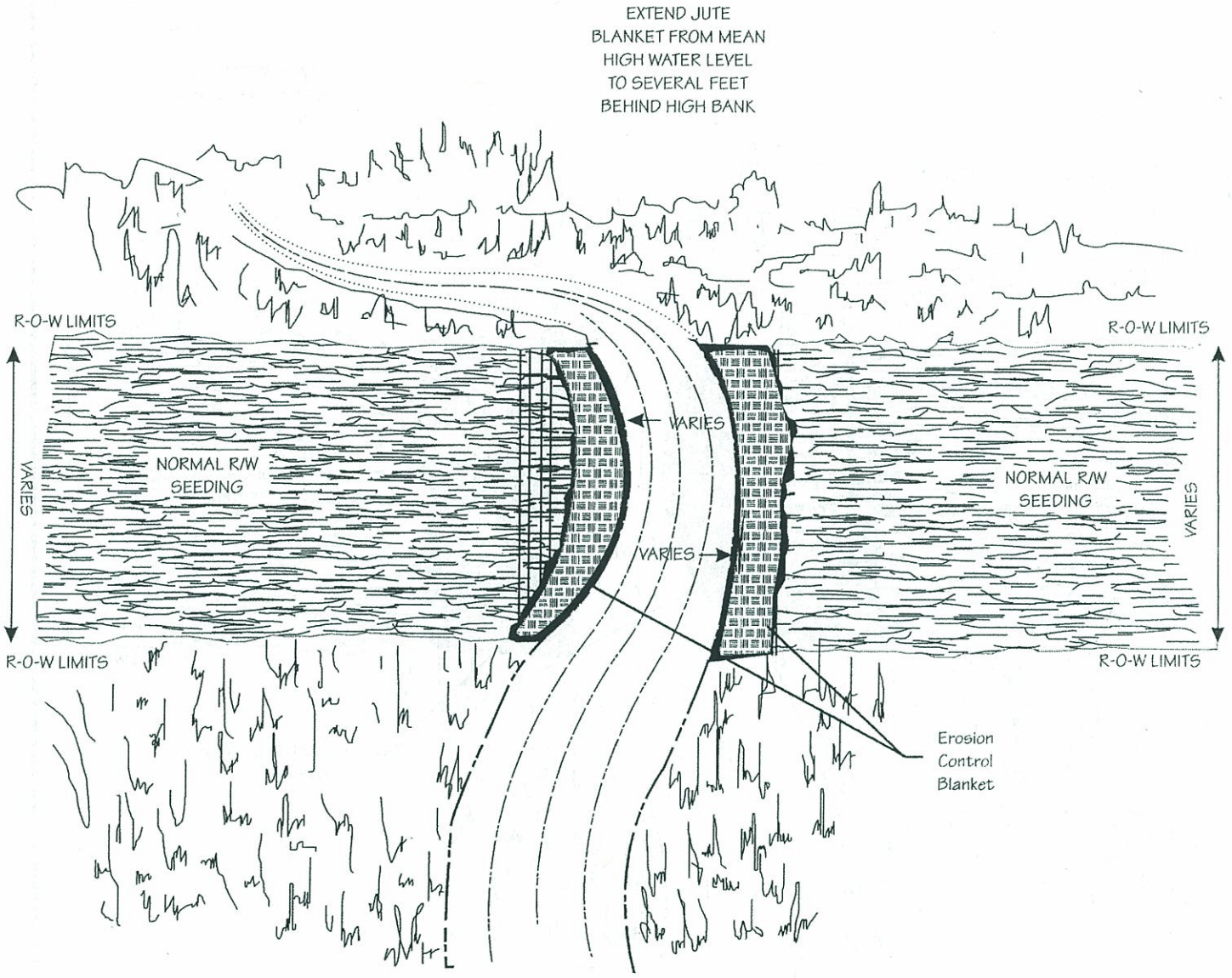


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**Figure 4**

Typical Stream Bank Stabilization
Erosion Control Blanket, Seed and Straw Mulch

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# INSTALLING ROCK RIPRAP

03–6

## Purpose

Rock riprap is installed immediately after streambank restoration or as required to stabilize erosion-sensitive watercourse banks at locations where pre-construction banks did not overhang or provide shade to provide significant fish habitat.

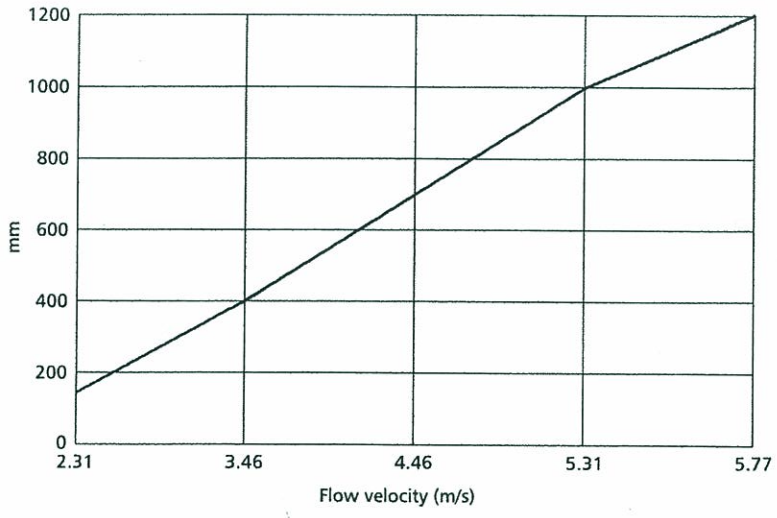
## Guidelines

Use rock riprap on watercourse banks where flow conditions are likely to preclude vegetative stabilization.

Rock riprap should be dense, durable, roughly equal in dimension (not flat and thin), angular and clean.

Size of riprap depends on stream bank slope and water velocity. Recommended rock sizes for various flow rates are shown below. The size distribution of the riprap should ensure 50% of the mixture is larger than the median specified.

Geotextile is usually unnecessary under riprap and may inhibit vegetative growth.



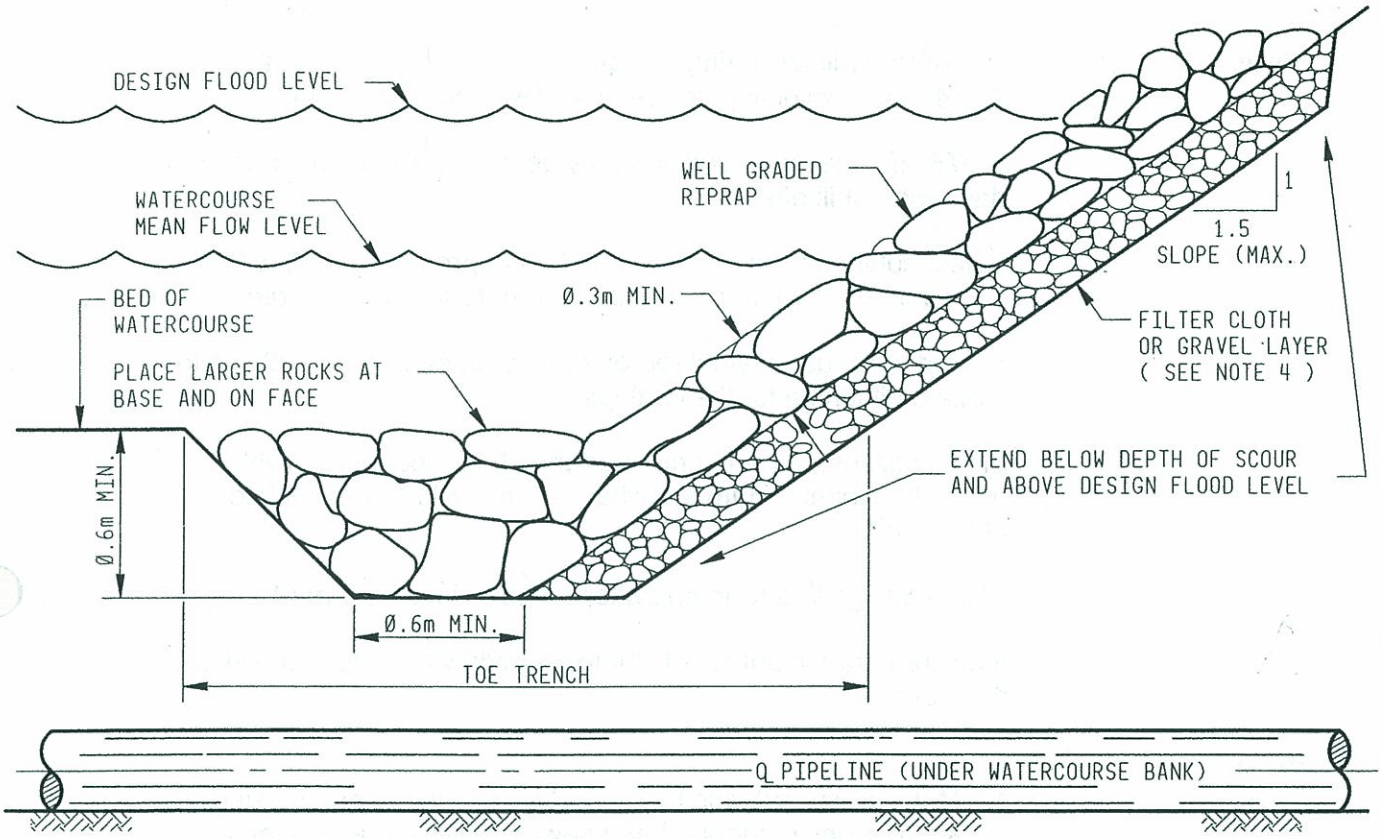

**Median Size of Riprap for Maximum Flow Rates**

## Procedure

**NOTE:** Refer to Figure 1, Streambank Protection – Riprap Armour.

1. Remove all stumps, organic matter and work material.
2. Regrade watercourse banks to a 1.5:1 maximum slope.

3. Construct a toe trench to tie in the bottom of armor protection.
4. Install filter cloth if watercourse bank erosion could result between large rocks.
5. Place riprap on the slope to be protected.
6. Install riprap to a depth approximately two times the diameter of the riprap.
7. Construct riprap boundaries in a manner that riprap will not be undermined from the side.
8. Place riprap with flat surface up to resist movement by ice and water, minimize void space and ensure no rocks protrude more than 30 cm (1 ft) above design lines and grades.




PROFILE

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**Figure 1**

Streambank Protection -
RIPRAP Armour

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# INSTALLING WILLOW CUTTINGS 03–7

## Purpose

Live willow cuttings are installed when reconstructing watercourse banks to improve stability and to re-establish cover and habitat for fish-bearing streams.

## Guidelines

Transplant willow cuttings as quickly as possible, preferably within 2 to 4 hrs of collecting, to prevent them from drying out.

**NOTE:** If necessary, cuttings may be stored instream for several days without ill effects.

Select cuttings from bottom branches approximately 12 to 25 mm ($^1/_2$ to 1 in.) in diameter and 0.3 to 0.6 m (1 to 2 ft) in length.

In hard soils, use a steel rod of equal diameter to the cuttings to make a pilot hole for the cuttings.

In soft soil, use a neoprene-lined post hole pounder or rubber mallet to minimize damage when driving willow cuttings into streambanks.

Plant cuttings in a random pattern, approximately 1 m (3 ft) apart.

If desired, transplant small clumps of willow bushes to the stream bank area.

## Procedure

1. Make willow cuttings from nearby indigenous brush using sharp pruning shears, hand saw or knife to make clean cuts.
2. Mark the basal ends to ensure correct installation, i.e., cut top ends at 90° and bottom ends at 45° to form a point.
3. Ensure there are two lateral buds above the surface.
4. Trim side shoots close to the main stock.
5. Insert the cuttings into the soil at an angle by hand, approximately 1.5 m (5 ft) back from watercourse banks for the entire right-of-way (ROW) width.
6. If soil is compacted or extremely dry, use a frost pin to make a pilot hole.
7. Once installed, firm soil around cuttings and place mulch ≈1 in. deep around the cuttings to preserve moisture.

# INSTALLING CRIBWALL 03–8

**Purpose**

Cribwalls are installed during restoration to provide erosion control and fish habitat.

**NOTE:** To avoid sedimentation of the stream, cribwalls should be installed as part of crossing activities—otherwise, it may be necessary to isolate the crossing a second time.

**Guidelines**

Install an overhanging cribwall where the original contour of stream banks was an overhang.

Install a vertical cribwall where the original contour of stream banks was vertical.

Constructing cribwall is a permit-specific activity; review permits before proceeding.

**Procedure**

## Overhanging Cribwall

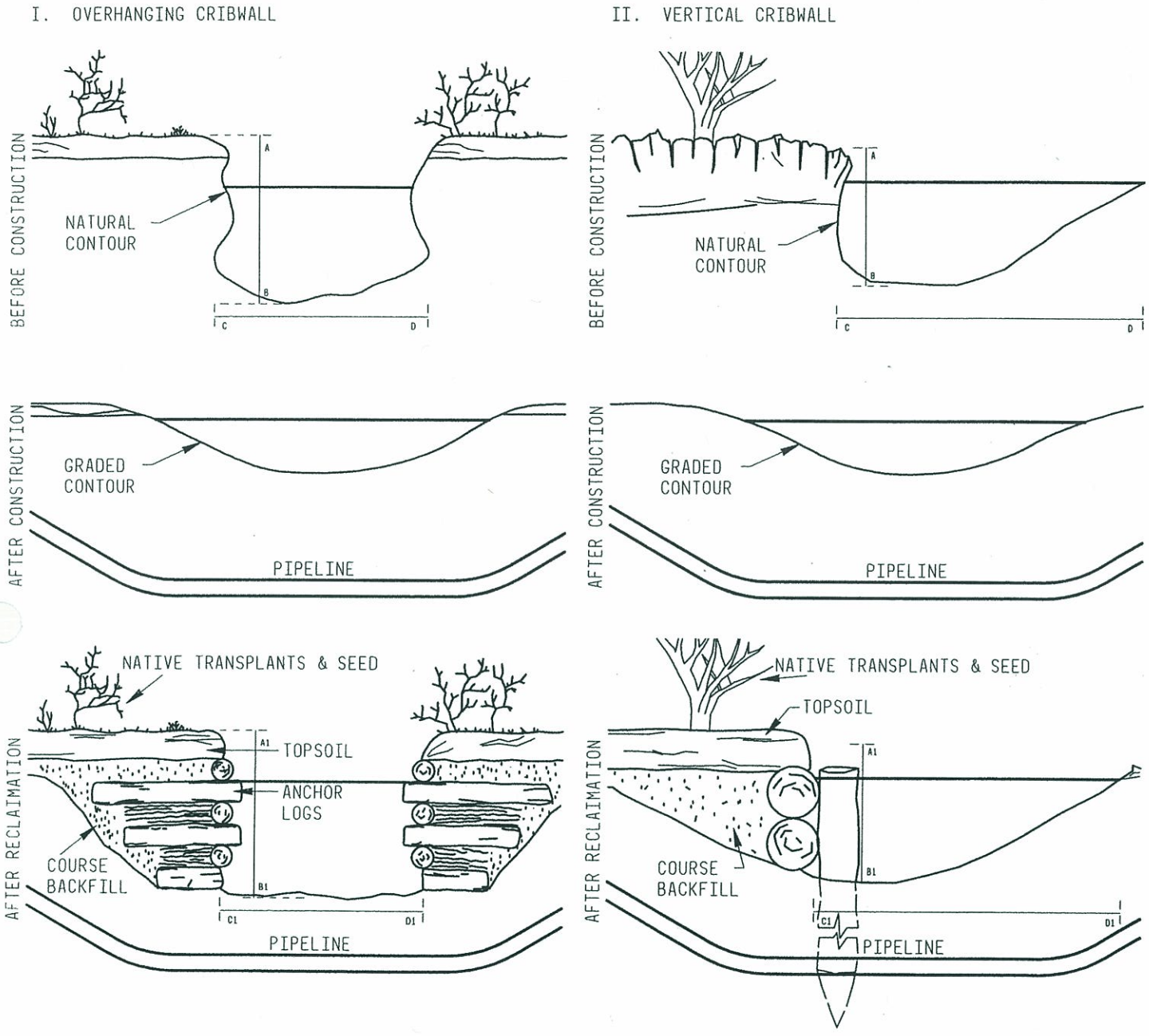
**NOTE:** Refer to Figure 1, Streambank Protection - Cribwall.

1. Install a log overhang if the vertical distance (A–B) is greater than 30 cm (1 ft).
2. Use native timber to build the structure (coniferous where possible).
3. Ensure the maximum distance (depth) from the streambed to ground level (A1–B1) is not less than the original distance (A–B).
4. Ensure the width of the stream channel (C1–D1) is not greater than the original width (C–D).
5. Backfill with coarse, nonerodible material.
6. Replace subsoil and topsoil.
7. Transplant native vegetation.
8. Sow an appropriate seed mix.

## Vertical Cribwall

NOTE: Refer to Figure 1, Streambank Protection - Cribwall

1. Install pressure-treated (if allowed) vertical posts three times the length of the exposed height.
2. Use native timber or lumber for the horizontal structure.
3. Ensure the maximum distance (depth) from the streambed to ground level (A1–B1) is not less than the original distance (A–B).
4. Ensure the width of the stream channel (C1–D1) is not greater than the original width (C–D).
5. Anchor posts to a horizontal structure as required.
6. Backfill with coarse, nonerodible material.
7. Replace subsoil and topsoil.
8. Transplant native vegetation.
9. Sow an appropriate seed mix.

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# Figure 1

Streambank Protection - Crib Wall

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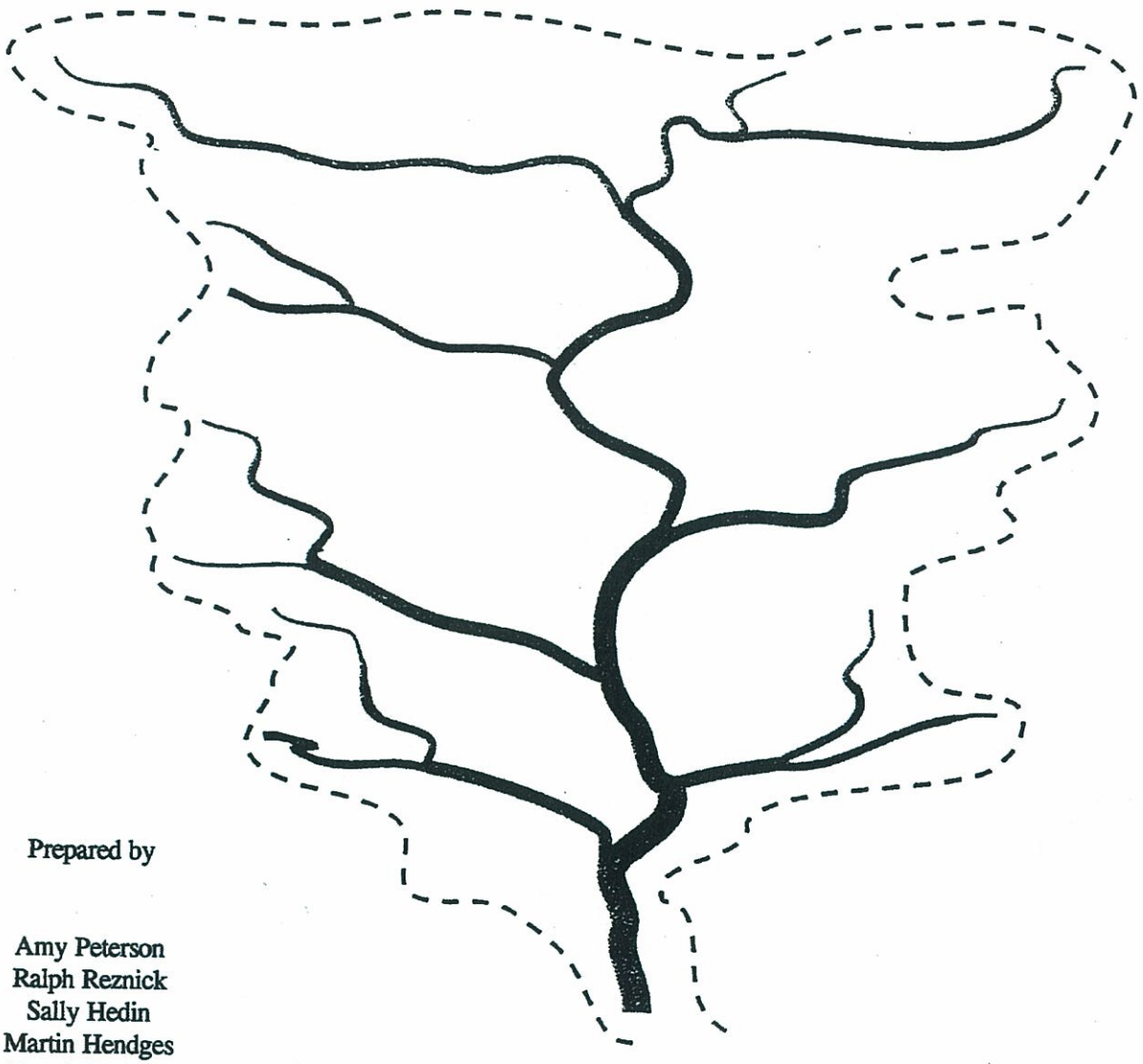
# Guidebook of Best Management Practices for Michigan Watersheds

**Reprinted October, 1998**




Prepared by

Amy Peterson
Ralph Reznick
Sally Hedin
Martin Hendges
Dennis Dunlap



Michigan Department of Environmental Quality,
Surface Water Quality Division

Russell J. Harding, Director
John Engler, Governor

# Riprap

Updated September, 1997

## Definition

Riprap is a permanent cover of rock used to stabilize streambanks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows.

This BMP addresses using riprap to stabilize streambanks, line channels and provide stable outlets. For purposes of this BMP, "rock" can be used interchangeably with "stone". For information on designing various types of stream liners (including vegetation and riprap), see the Stormwater Conveyance Channel BMP.

All work conducted below the ordinary high water mark of a lake or stream, or in a floodplain or wetland will require permits from the Michigan Department of Environmental Quality, Land and Water Management Division. This includes the placement of riprap. (See Exhibit 1 for a definition of ordinary high water mark).

## Other Terms Used to Describe

Armoring
Energy Dissipator

## Pollutants Controlled and Impacts

The use of riprap in channels and below concentrated flows protects stream banks and discharge channels from higher erosive flow velocities. This reduces downcutting and lateral cutting, which in turn decreases sediment input to a watercourse.

## Application

Land Use
All land uses.

Soil/Topography/Climate
The rock to be used as riprap must be capable of withstanding freezing and thawing and the flow or wave action of the water where it is used. The soil texture on the site and whether seepage is occurring are factors in determining the need and thickness of filters beneath the riprap.

When to Apply
Riprap used at outlets should be in place before the outlet is discharging. Streambank grading should be done when it is most feasible to bring stone to the site. Riprap should be placed as soon after grading as possible.

Where to Apply
Riprap is most often used in streambanks, on slopes, and at outlets.

## Relationship With Other BMPs

Riprap is often used in making Stabilized Outlets, in Streambank Stabilization (including bioengineering techniques), and Slope/Shoreline Protection. Filters should be used underneath riprap to

help stabilize the soils.

## Specifications

**General Considerations:**

Riprap structures should be designed by licensed professional engineers or other persons qualified in the design of such structures.

Stone Type

The material used for riprap should be fieldstone or rough unhewn quarry stone. Stone should be hard, angular, and of such quality that it will not disintegrate on exposure to water or weathering. It should also be chemically stable, capable of withstanding freezing and thawing, and suitable in all other respects for the intended use.

Because it is not as aesthetically pleasing as rock, broken concrete is a less favorable riprap alternative. If concrete is used, it should be clean and otherwise meet design criteria. Asphalt should *not* be used as riprap.

Riprap Size

Riprap comes in a variety of sizes. The appropriate size to use primarily depends on the intended use of the structure. For example, the size of riprap used to stabilize streambanks depends on the velocity of the water.

Structural design is usually based on the diameter of stone in the mixture for which a percentage, by weight, will be smaller. For example, $D_{50}$ indicates a mixture of stones in which 50 percent of the stone by size would be larger than the diameter specified, and 50% would be smaller than the stone size specified. In other words, the design is based on the average size of stone in the mixture.

Table 1 lists some typical riprap by weight, spherical diameter and corresponding rectangular dimensions. These stone sizes are based on an assumed specific weight of 165 lbs./ft$^3$.

Table 1

Size of Typical Riprap Stones

| Weight (lbs) | Mean Spherical Diameter (in) | Typical Rectangular Shape Length (in) | Width, Height (in) |
|---|---|---|---|
| 50 | 10 | 18 | 6 |
| 100 | 13 | 21 | 7 |
| 150 | 14 | 24 | 8 |
| 300 | 18 | 30 | 10 |
| 500 | 22 | 36 | 12 |
| 1000 | 27 | 45 | 15 |
| 1500 | 31 | 52 | 17 |
| 2000 | 34 | 57 | 19 |
| 4000 | 43 | 72 | 24 |
| 6000 | 49 | 83 | 28 |
| 8000 | 54 | 90 | 30 |

Source: USDA Soil Conservation Service

Gradation

Riprap should be composed of a well-graded mixture down to the one-inch size particle such that 50 percent of the mixture by weight is larger than the $D_{50}$ size as determined from the design procedure. For the purposes of this BMP, a well-graded mixture is defined as a mixture composed primarily of the larger stone sizes but with a sufficient mixture of other sizes to fill the progressively smaller voids between the stones. The diameter of the largest stone size in such a mixture should not be more than 1.5 times the $D_{50}$ stone size.

After determining the riprap size that will be stable under the flow conditions, the designer should consider that size to be a minimum size and then, based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size.

Riprap structures for **streambank stabilization** should be designed to be stable for bank-full flows in the reach of the channel being stabilized.

Thickness

For both streambank stabilization and outlets, the minimum thickness of the riprap layer should be 1.5 times the $D_{50}$ diameter, or 6 inches, whichever is greater. **A geotextile or stone filter must be placed under the riprap to prevent water from removing the underlying soil material through the voids in the riprap.** (Removal of the soil material leaves cavities behind the riprap and failure of the riprap may result). The filter may consist of smaller sized stone (usually 2"), a geotextile material, or a combination of both. Stone filters should be a minimum of 6 inches thick, and greater if the area has high seepage pressures. Follow the specifications below.

*Granular (Stone) Filter Blanket.* For dumped riprap, a filter ratio of 5 or less between successive layers will result in a stable condition. The filter ratio is defined as the ratio of $D_{15}$ size of the coarser layer to the $D_{85}$ size of the finer layer. An additional requirement for stability is that the ratio of the $D_{15}$ size of the coarse material to the $D_{15}$ size of the fine material should exceed 5 and be less than 40. A further requirement is that the ratio of the $D_{50}$ size of the coarse material to the $D_{50}$ size of the fine material not exceed 40. These requirements can be stated as follows:

$$\frac{D_{15}\text{ (coarser layer)}}{D_{85}\text{ (finer layer)}} < 5 < \frac{D_{15}\text{ (coarser layer)}}{D_{15}\text{ (finer layer)}} < 40$$

$$\frac{D_{50}\text{ (coarser layer)}}{D_{50}\text{ (finer layer)}} < 40$$

The filter requirements apply between the bank material and the filter blanket, between successive layers of filter blanket material if more than one layer is used, and between the filter blanket and the stone cover.

If a single layer of filter material will not satisfy the filter requirements, one or more additional layers of filter material must be used. In addition to the filter requirements, the grain size curves for the various layers should be approximately parallel to minimize the infiltration of the fine material into the coarser material. Not more than 5 percent of the filter material should pass the No. 200 sieve.

The minimum thickness of each layer of granular filter material shall be 6 inches, or 3 times the $D_{50}$ size of the filter, whichever is greater.

*Synthetic (Geotextile) Filter Fabric.* The Filters BMP includes information on geotextile materials which may be used may be used in place of or in conjunction with granular filters. Always check manufacturer's specifications to ensure that the filter fabric selected meets the tensile strength and

durability requirements for the determined rock size. Some guidance in selecting filter fabric is given below.
The following particle size relationships must exist:

For filter fabric adjacent to granular materials containing 50 percent or less (by weight) of fine particles (less than 0.075 mm):

a) $\frac{D_{85} \text{ base (mm)}}{\text{EOS* filter fabric (mm)}} > 1$

b) Total open area of filter fabric is less than 36 percent.

For filter fabric adjacent to all other soils:

a) EOS less than U.S. Standard Sieve No. 70.

b) Total open area of filter is less than 10 percent.

*Equivalent Opening Size to a US Standard Sieve Size

No filter fabric should be used with less than 4 percent open area or an EOS smaller than U.S. Standard Sieve No. 100.

## Stream Bank Protection and Channel Lining

See Exhibit 1 for applications.

**General Planning Considerations:**

1. Slopes on which riprap is used to stabilize streambanks should be no steeper than 1.5:1.

2. All bare soil on the slope above the riprap should be stabilized with seed and mulch, or sod. See the Vegetative BMPs.

3. When riprap is used in conjunction with other vegetative practices or bioengineering, the riprap should extend 1 foot above the ordinary high water mark. When only riprap is being used for bank stabilization, the top of the riprap should extend 3 feet above the ordinary high water mark. See Exhibit 1 for an explanation of the ordinary high water mark.

4. Determine a means of accessing the site before designing any riprap structure.

5. Determine how the riprap will be placed on the site. If the rock is to be dumped, it must be done in a manner which will not cause separation of the small and large stones. If rock is to be dumped over a bank and placed by hand, it must be done so that it does not create more erosion. Consider using aluminum or wooden shutes to roll rock down a bank to the waters' edge.

6. If riprap placement requires re-configuring banks or slopes, the filter should be placed as soon after the banks are prepared as possible. Placement of riprap should follow immediately after the placement of the filter.

7. The finished surface should not have pockets of finer materials which would flush out and

weaken the structure. Some hand placing should be done to provide a stable surface.

8. Riprap used both at the outlet of storm sewers and to protect an eroding bank, should be designed to accommodate both uses. Riprap used as outlet protection should be constructed before the pipe or channel begins to operate.

**Design:**

Stone Size Selection for Streambank Stabilization:

The design method described below is adapted from *Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15* of the Federal Highway Administration. It is applicable to both straight and curved sections of channel where the flow is not perpendicular to the bank of the channel.

A. Straight Sections of Channel.

This design method determines a stable rock size for straight and curved sections of channels. It is assumed that the shape, depth of flow, and slope of the channel are known. A stone size is chosen for the maximum depth of flow. If the sides of the channel are steeper than 3:1, the stone size must be increased accordingly. The final design size will be stable on both sides of the channel and the bottom.

1. Enter Exhibit 3 with the maximum depth of flow (feet) and channel slope (feet/foot). Where the two lines intersect, choose the $d_{50}$ size of stone.

2. If channel side slopes (z) are steeper than 3:1, continue with step 3, if not, the procedure is complete.

3. Enter Exhibit 4, with the side slope and the base width to maximum depth ratio (B/d). Where the two lines intersect, move horizontally left to K1. Record K1.

4. Determine from Exhibit 5, the angle of repose (Ar) for the $d_{50}$ size of stone. The angle of repose is the angle in which the rocks will lay in relation to the bank. Banks should be designed so that the natural angle of repose of the stone mixture is greater than the slope of the bank being stabilized. (Use Ar=42° for $d_{50}$ greater than 1.0 ft. Do not use riprap on slopes steeper than the angle of repose for the size of stone.)

5. Enter Exhibit 6, with the side slope (z) of the channel and the angle of repose (Ar) for the $d_{50}$ size of stone. Where the two lines intersect, move vertically down to read K2. Record K2.

6. Compute $d'_{50} = d_{50} \times K1/K2$, where $d'_{50}$ is to determine the correct size stone for the bottom and side slopes of straight sections of channel.

B. Curved Sections of Channel

1. Compute the radius of the curve (Ro), measured at the outside edge of the bottom.

2. Compute the ratio of the top width of the water surface (Bs) to the radius of the curve (Ro), Bs/Ro.

3. Enter Exhibit 7, with the ratio Bs/Ro. Move vertically until the curve is intersected.

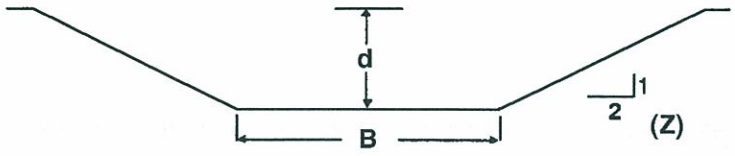
Move horizontally left to read K3.

4. Compute $d_{50c} = d'_{50} \times K3$, where $d_{50c}$ is the correct size stone for bottom and side slopes of curved sections of channel.

C. Design Example Problems:

**Problem #1**

**Given**: A trapezoidal channel 3 feet deep (d), with an 8-foot bottom (B), 2:1 side slopes (z), and a 2 percent slope. **Calculate**: A stable riprap size for the bottom (B) and side slopes (z) of the channel.




**Solution**:

1. From Exhibit 3, for a 3-foot deep channel on a 2 percent grade: $d_{50} = 0.75$ feet or 9 inches.

2. Since the side slopes (z) are steeper than 3:1, continue with Step 3.

3. From Exhibit 4 for B/d = 2.67 and z = 2; K1 = 0.8

4. From Exhibit 5 for $d_{50}$ = 9 inches; Ar = 41°

5. From Exhibit 6 for z = 2 and Ar = 41°; K2 = 0.75

6. $d'_{50} = d_{50} \times K1/K2 = 0.75 \times 0.8/0.75 = 0.8$ feet

   0.8 ft x 12 inches = 9.6 inches

   Use $d'_{50}$ = 10 inches

**Problem #2**

**Given**: The preceding channel in Problem #1 has a curved section with a radius of 50 feet at the outside edge of the bottom. **Calculate**: A stable riprap size for the bottom and side slopes of the curved section of channel.

**Solution**:

1. Radius of curvature, Ro = 50 feet

2. Top width at water surface,

   Bs = 8 +(2 x 3 x 2) = 20 feet

   Bs/Ro = 20/50=0.40

3. From Exhibit 7 for Bs/Ro = 0.40; K3 = 1.1

4. $d_{50c} = d'_{50} \times K3 = 0.84 \times 1.1 = 0.92$ feet

   Use $d_{50c}$ = 1.0 ft = 12 inches

Length/Thickness/Height of Streambank Area to be Riprapped
Refer back to page RIP-3 for specifications on the proper thickness.

Length: The appropriate length of channel in which rock should be placed should be at least the entire eroded section that is being protected, plus a minimum of 10 feet upstream and downstream of the eroded area. Be sure that the stone on the upstream and downstream ends are trenched in to prevent dislodging.

Where riprap is used only for slope or bank protection and does not extend across the bottom at the channel, riprap should be "keyed in" as shown in Exhibit 2.

Height: Install riprap to a height of three feet above the ordinary high water mark, or 1 foot above the ordinary high water mark if used in conjunction with bioegineering techniques. All exposed soil above the riprap should be stabilized according to the vegetative BMPs.

Design Example Problem:
A streambank has an ordinary high water mark of 3 feet, an 8 foot bottom width, 2:1 side slopes and a two percent slope. There is a 75 foot long curved bank that is eroding. Determine the proper rock size, appropriate stone gradation, and dimensions of the riprap.

1. Refer to example Problems #2 to solve for the proper stone size. Use a $D_{50}$ stone size of 12 inches.

2. This riprap will be placed to a height of 6 feet (3 feet above the ordinary high water mark). The depth will be 24 inches: [1.5 x (stone size of 12 inches) = 18 inches + 0.5 foot granular stone = total of 24 inches].

3. The length of area covered with riprap will be the eroded area (75 feet) + 10 feet upstream and downstream = 95 feet.

4. A geotextile fabric will be installed beneath the riprap.

**Construction:**

1. Where grading is required, grade the site according to the grading plan. Grade only when stone is ready to be placed.

2. Compact gravel subgrades according to design. Any fill that is used should be compacted to a density approximating that of the surrounding undisturbed area.

3. Install geotextile filter fabrics according to the manufacturer's specification. Always bury both the upper-most and toe of the geotextile fabric to prevent unravelling. (Basic installa-

tion techniques are discussed in the Filters BMP. Spread granular filters in uniform layers according to the design.

4. Install riprap. If riprap is dumped, hand place any rocks that need to be moved to fit the design.

### Maintenance of Riprap on Stream Banks

Inspections should be made of all sites immediately after the first rainfall following installation of riprap. This is particularly important in areas where riprap that is displaced during the storm would impact culverts. Thereafter, riprapped sites should be checked following large storms, especially those which are near or exceed the storm frequency used in the design. Displaced riprap should be removed from its downstream location and new riprap placed according to the specifications above.

## Outlets

### General Considerations for Outlets

1. How and when to use a riprapped outlet should be made based on criteria given in the Stabilized Outlets BMP.

2. The outlet structure should be designed in conjunction with the conveyance system (i.e. pipe, outlet of a Sediment Basin, etc.) from which the water is outletted. There should be no overfall from the end of the pipe/outlet to the outlet structure (i.e. the pipe/outlet should not be suspended above the outlet structure).

overfall

no overfall

3. The outlet structure should be in place before water is released from the conveyance system.

4. Additional protection may be required on the opposite bank or downstream to prevent in-stream erosion.

5. There should be no overfall from the end of the apron to the receiving channel streambed.

Stone Size Selection for Outlets

1. The median stone diameter, $d_{50}$, in feet, shall be determined from the formula:

$$d_{50} = \frac{0.02}{TW} \frac{Q}{D_o}^{4/3}$$

Where TW is tailwater depth above the invert of the culvert in feet,

Q is the pipe discharge in cfs for the conduit design storm, or the 25-year storm, whichever is greater, and

$D_o$ is the maximum inside culvert width in feet.

2. Fifty percent by size of the riprap mixture should be larger than the median size stone designated as $d_{50}$ and 50% should be smaller. The largest stone size in the mixture should be 1.5 times the $d_{50}$ size. The riprap should be reasonably well-graded.

Outlet Dimensions
Refer to Exhibit 8.

1. **Length**: The length of the apron, L, should be determined using the following formula:

$$L_a = \frac{1.7\,Q}{D_o^{3/2}} + 8D_o \quad \text{for culverts flowing up to 1/2 full.}$$

$$L_a = \frac{3.0\,Q}{D_o^{3/2}} \quad \text{for culverts flowing at or above 1/2 full}$$

Where Q and $D_o$ are as described above.

2. **Width**: Where there is a well-defined channel downstream of the apron, the bottom width of the apron should be at least equal to the bottom width of the channel. The structural lining should extend at least one foot above the tailwater elevation, but no lower than two-thirds of the vertical conduit dimension above the conduit invert.

Where there is *no* well-defined channel immediately downstream of the apron (i.e. as may apply to Sediment Basins) width, W, of the outlet end of the apron should be as follows:

For tailwater elevation greater than or equal to the elevation of the center of the pipe:

$$W = 3D_o + 0.4L_a$$

For tailwater elevation less than the elevation of the center of the pipe:

$$W = 3D_o + L_a$$

Where $L_a$ is the length of the apron determined from the formula above and $D_o$ is the culvert width.

The width of the apron at the culvert outlet should be at least three times the culvert width.

3. The side slopes should be 2:1 or flatter.

4. The bottom grade should be level (0.0%).

5. There should be no overfall from the end of the apron to the receiving channel streambed.

6. There should be no overfall at the end of the apron or at the end of the culvert.

7. There should be no bends or curves at the intersection of the conduit and apron.

Stone Size and Gradation

1. The median stone diameter, $D_{50}$, in feet shall be determined from the formula,

$$D_{50} = \frac{0.02}{TW}\left(\frac{Q}{D_o}\right)^{4/3}$$

Where Q and $D_o$ are as defined under apron dimensions and TW is tailwater depth above the invert of culvert in feet.

2. The largest stone size in the mixture shall be 1.5 times the $D_{50}$ size. The riprap shall be reasonably well graded.

3. Gabions or precast cellular blocks may be substituted for riprap if the $D_{50}$ size calculated above is less than or equal to the thickness of the gabions or concrete revetment blocks. See the Shoreline/Slope Stabilization BMP.

Design Example Problem:

Given: a maximum inside culvert width, $D_o$ of 1.5 ft., a flow (Q) of 14/5 cfs, and a tailwater elevation, TW, of 0.7 feet, determine the appropriate design dimensions of the apron ($h_a$ and W), and the $D_{50}$ stone size.

Solution:

Using $L_a = \frac{1.7Q}{D_o^{3/2}} + 8D_o$

$$= \frac{1.7\,(14.5)}{(1.5)^{3/2}} + 8(1.5)$$

$L_a$ = 25.4 feet, rounded up = 26 feet

Since TW < 0.5 $D_o$, use $W = 3D_o + L_a$

$$= 3(1.5) + 26$$

W = 30.5 feet, rounded up = 31 feet

Using $D_{50} = \frac{0.02}{TW}\left(\frac{Q}{D_o}\right)^{4/3}$

$$= \frac{0.02}{0.7}\left(\frac{14.5}{1.5}\right)^{4/3}$$

$D_{50}$ = 0.58 feet, converted and rounded = 7 inches

## Maintenance

Inspections should be made of all sites immediately after the first rainfall following installation of riprap. This is particularly important in areas where riprap that is displaced during the storm would impact culverts. Thereafter, riprapped sites should be checked following large storms, especially those which are near or exceed the storm frequency used in the design. Displaced riprap should be removed from its downstream location and new riprap placed according to the specifications above.

## Exhibits

Formulas included in this BMP were taken from the Rhode Island Soil Erosion and Sediment Control Handbook, Rhode Island Dept. of Env. Mgt., 1989.

Exhibit 1: Streambank stabilization using Riprap. MDNR Construction Project Evaluation Manual, 1987, and Rhode Island Soil Erosion and Sediment Control Handbook, as adopted from Connecticut Guidelines for Soil Erosion and Sediment Control, Connecticut Council on Soil and Water Conservation, 1985.

Exhibit 2: Length and Height of Riprap. MDEQ, Surface Water Quality Division.

Exhibit 3: Maximum depth of Flow for Riprap-lined Channels. "Design of Stable Channels with Flexible Linings", Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975.

Exhibit 4: Distribution of Boundary Shear Around Wetted Perimeter of Trapezoid Channels. "Design of Stable Channels with Flexible Linings", Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975.

Exhibit 5: Angle of Repose for Riprap Stone. Virginia Erosion and Sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980.

Exhibit 6: Ratio of Critical Shear on Sides to Critical Shears on Bottom. "Design of Stable Channels with Flexible Linings", Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975.

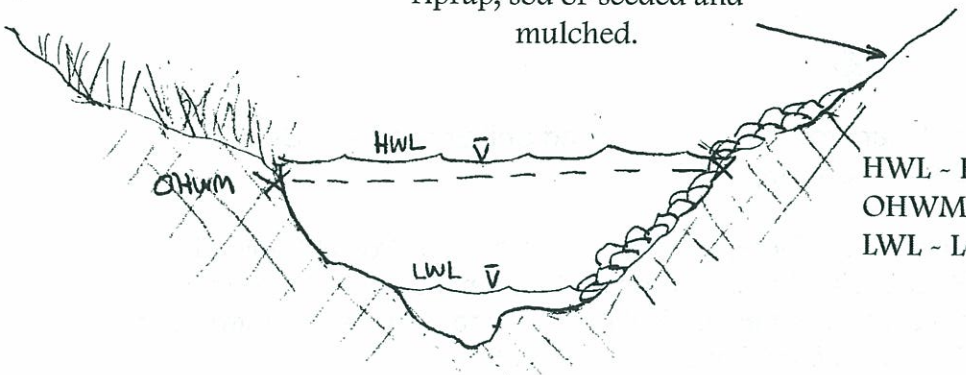
Exhibit 7: Ratio of Maximum Boundary Shear in Bends to Maximum Bottom Shear in Straight Reaches. Virginia Erosion and sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980.

Exhibit 8: Configuration of Conduit Outlet Protection where there is no well defined channel downstream. Standards for Soil Erosion and Sediment Control in New Jersey, New Jersey Soil Conservation Committee, 1980.

Exhibit 1

# Ordinary High Water Mark

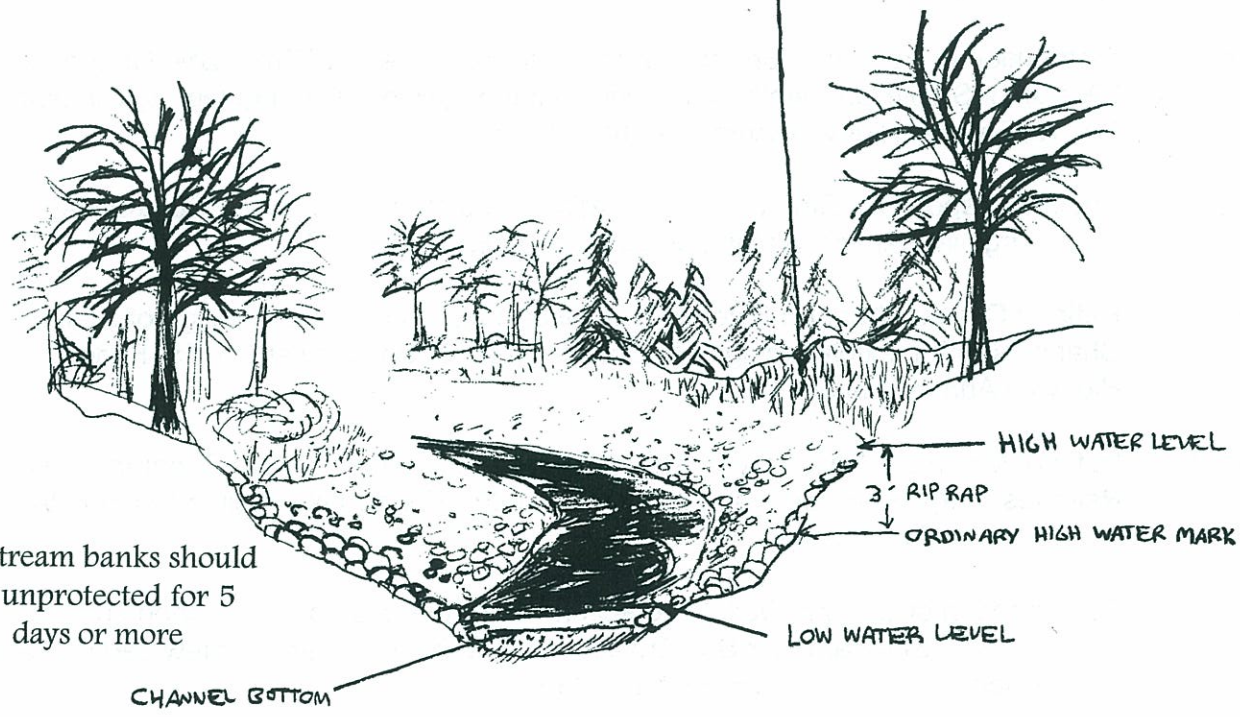
All raw soil above permanent riprap should be covered with riprap, sod or seeded and mulched.




HWL - High Water Level
OHWM - Ordinary High Water Mark
LWL - Low Water Mark

The ordinary high water mark is the normal water level, which on a river is where the grass stops and the bare soil starts.

All raw soil above permanent riprap should be covered with riprap, sod or seeded and mulched.

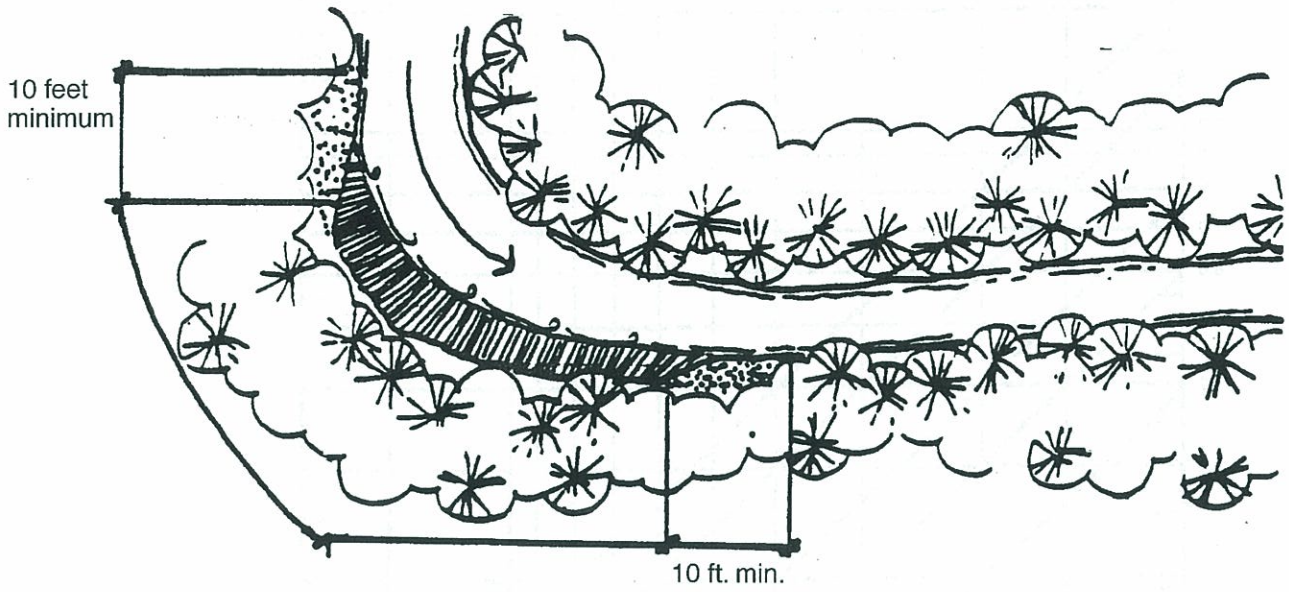



No stream banks should be unprotected for 5 days or more

Source: Michigan Department of Environmental Quality, Land and Water Management Division, 1997.

Exhibit 2

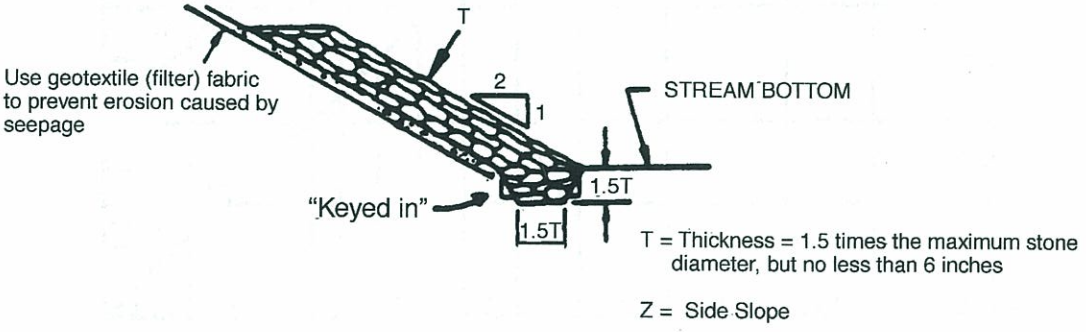
# Riprap Placement: Length, Thickness, Height




Length to stabilize: cut bank, plus a minimum of 10 feet on both sides.

Height to stabilize: usually three feet above the Ordinary High Water Mark; can be less on hydrologically stable streams.

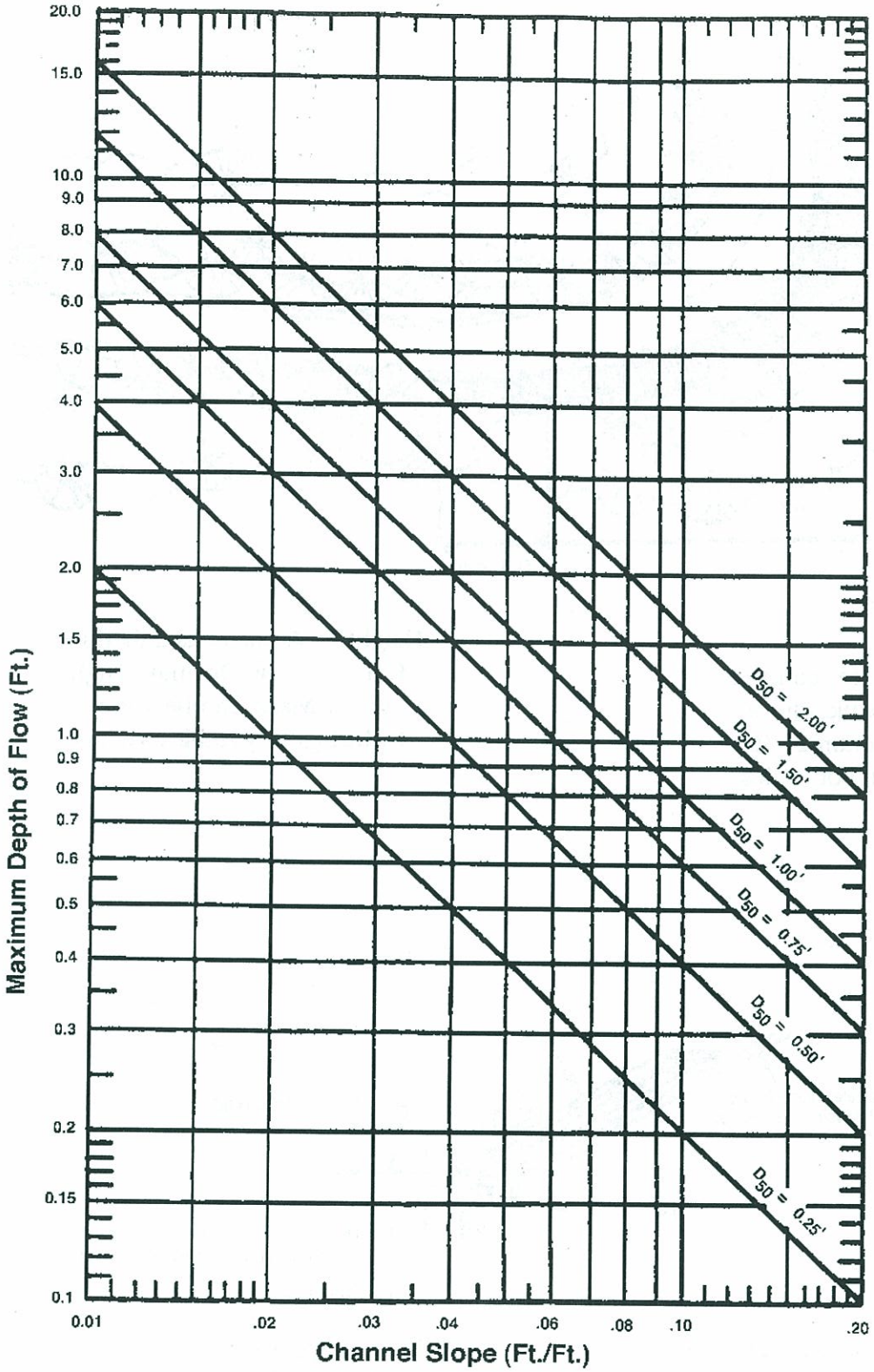
## "Keying in"




Sources: Top: Construction Project Evaluation Manual. Michigan Department of Environmental Quality, Land and Water Mangement Division. Redrawn 1997. Bottom: Rhode Island Soil Erosion and Sediment Control Handbook, as adopted from the Connecticut Guidelines for Soil Erosion and Sediment Control, Connecticut Council of Soil and Water Conservation, 1985. Redrawn 1997 by MDEQ.

Exhibit 3

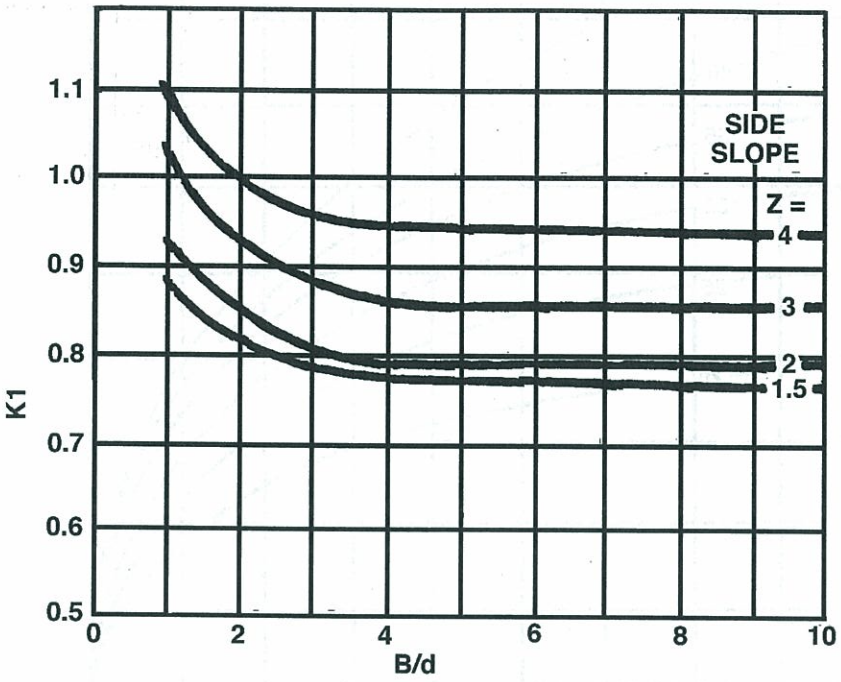
# Maximum Depth of Flow for Riprap-Lined Channels




Source: Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 4

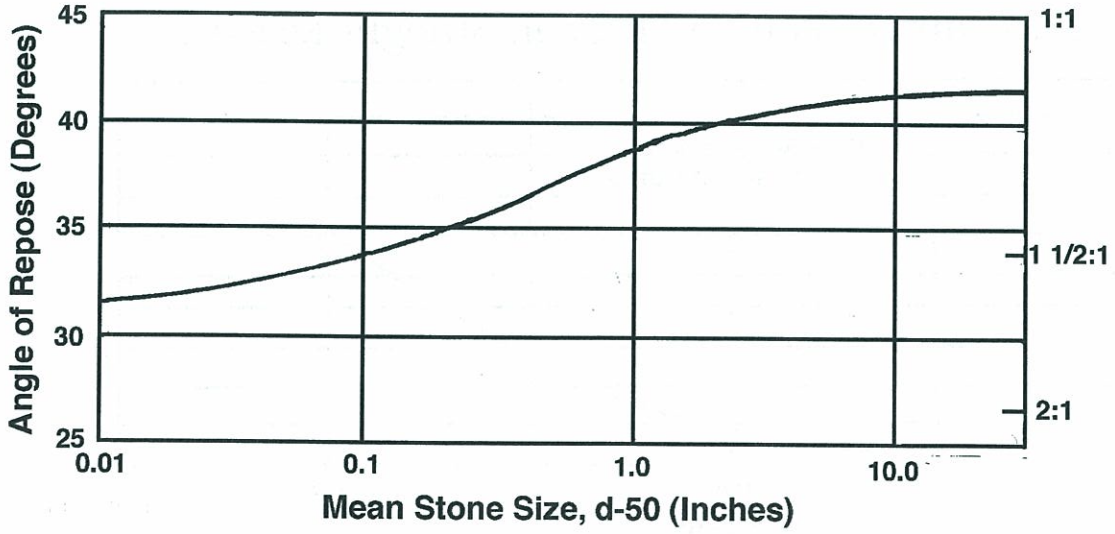
# Distribution of Boundary Sheer Around Wetted Perimeter of Trapezoidal Channels




Source: Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 5

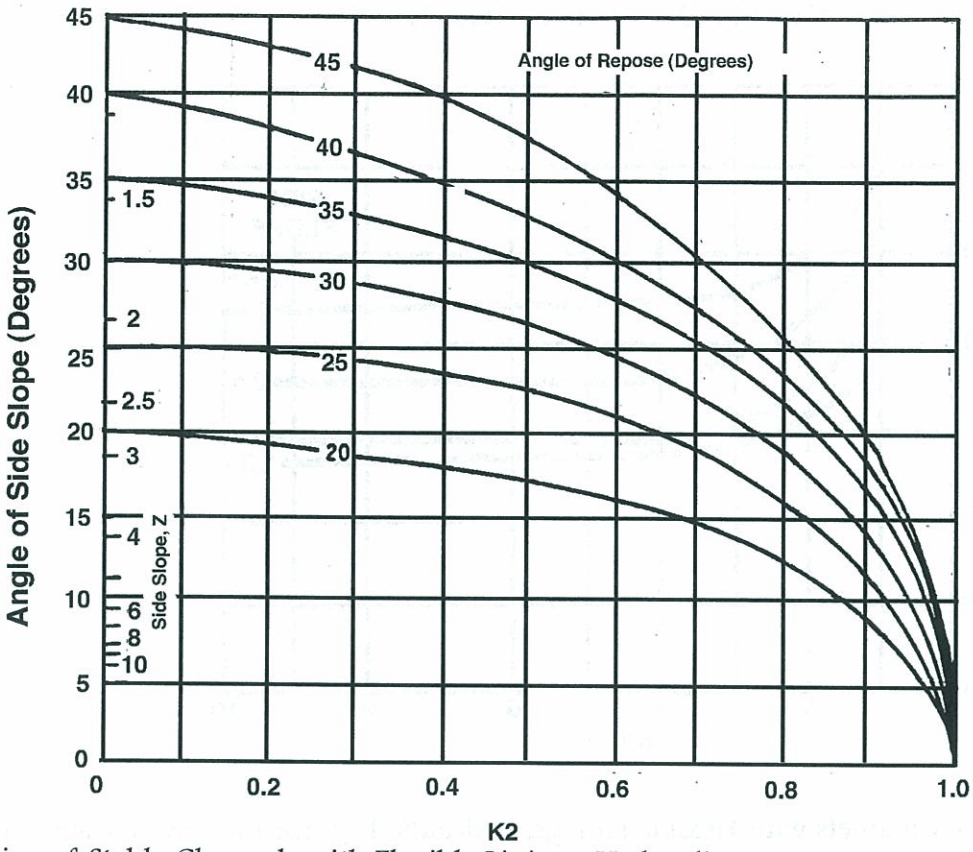
# Angle of Repose for Riprap Stones




Source: Virginia Erosion and Sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 6

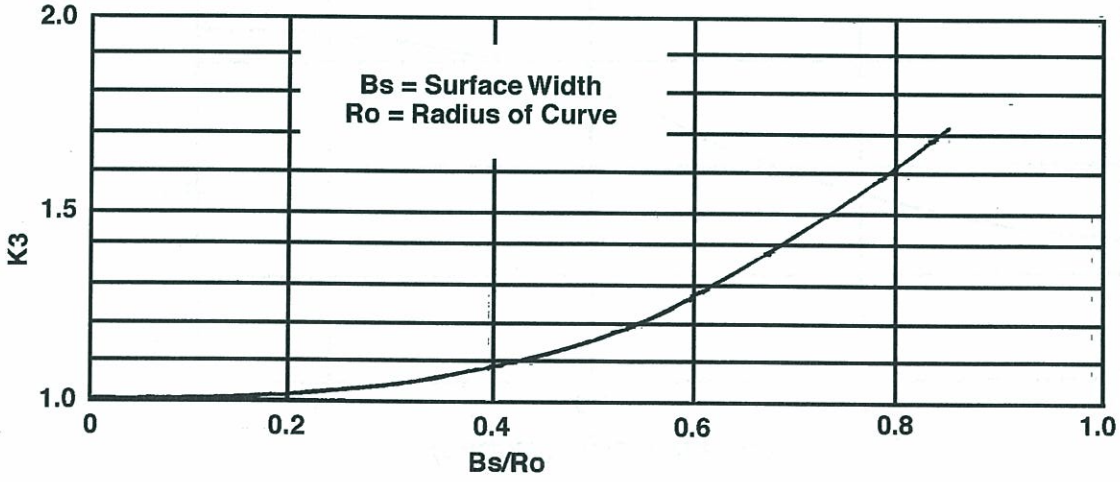
## Ratio of Critical Shear on Sides to Critical Shear on Bottom




Source: Design of Stable Channels with Flexible Linings, Hydraulic Engineering Circular No. 15, Federal Highway Administration, 1975, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 7

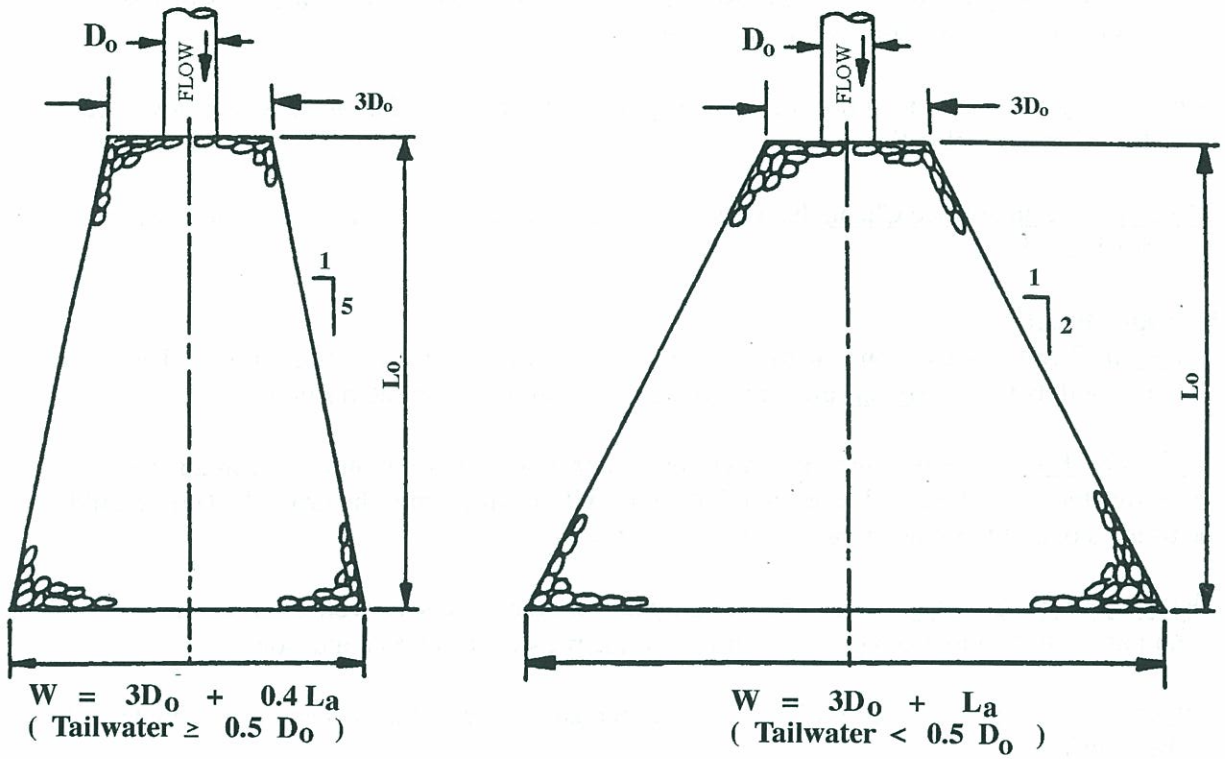
## Ratio of Maximum Boundary Shear in Bends to Maximum Bottom Shear in Straight Reaches




Source: Virginia Erosion and Sediment Control Handbook, Virginia Soil and Water Conservation Commission, 1980, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

Exhibit 8

# Configuration of Conduit Outlet Protection Where There is no Well-Defined Channel Downstream




Source: Standards for Soil Erosion and Sediment Control in New Jersey, New Jersey Soil Conservation Committee, 1980, as copied from the Rhode Island Soil Erosion and Sediment Control Handbook.

**Design Considerations:**
**Stabilized outlets should be designed by registered professional engineers.**

The specific type of outlet needed depends on the velocity of the water being discharged, the pollutants in the water and the type of soil. The following is a brief discussion of several types of outlets, most of which are BMPs.

**Conveyance Outlets:**

1. Grassed Waterway or swale. Used most often in rural areas where flows are 6 cfs or less and water is not laden with sediment or other pollutants.

2. Stone Filters. Used at the outlets of small Sediment Basins and other areas where flows are maintained at low velocities.

3. Stormwater Conveyance Channels. Used in both urban and rural areas to contain flows at non-erosive velocities.

**Water Storage Outlets:**

1. Sediment Basins are used on construction sites where water is laden with sediment. They can serve as outlets for Diversions and areas of bare soils and concentrated runoff.

2. Infiltration Basins are used in areas where the water is such that it would not contaminate groundwater, and where soils are such that water will infiltrate into the ground. They should be used as one of the final stops in a "treatment train."

3. Detention/Retention Basins are used on many development sites, as well as in-stream, to obtain an in-stream hydrology that is similar to the pre-construction conditions.

4. Oil/Grit Separators are used in urban areas and industrial sites where oil and grit is contained in the runoff.

5. Wet ponds and wetlands. Like infiltration basins, these are used as the "final treatment" in a series of BMPs, where water up-slope/up-stream has been treated with other BMPs.

**Conduits:**
Outlets from stormwater basins, sediment basins and any other conduit structures which release water to watercourses, should be designed as part of the structural BMP. Conduits which release water into watercourses should be stablilized with riprap to three feet above the ordinary high water mark. Follow specifications in the Riprap BMP.

**Outlet Protection:**
The maximum allowable velocity at the outlet should be determined using Table 1, below. When the velocity at the outlet exceeds the allowable velocity given in Table 1, riprap outlet protection should be used to dissipate energy. Follow specifications in the Riprap BMP.

## Maintenance

All of the BMPs cited in the section above require regular maintenance. Follow the maintenance

# Buffer/Filter Strips

Updated September, 1997

## Description

A buffer/filter strip is a vegetated area adjacent to a waterbody (i.e. river, stream, wetland, lake). The buffer/filter area may be natural, undeveloped land where the existing vegetation is left intact, or it may be land planted with vegetation. Its purpose is to protect streams and lakes from pollutants such as sediment, nutrients and organic matter, prevent erosion, provide shade, leaf litter, and woody debris. Buffer/filter strips often provide several benefits to wildlife, such as travel corridors, nesting sites and food sources.

For the purposes of this BMP, a buffer/filter strip is a combination of 1) a *buffer* of vegetation between human land use and a stream, and 2) a *filter*, to trap sediment and absorb sheet flow. The buffer is usually comprised of trees, the buffer provides shade, leaf litter, woody debris, erosion protection, and often serves as wildlife habitat. The filter strip is an area of dense grass at least 20 feet wide designed specifically to remove pollutants from stormwater runoff from sheet flow off adjacent land, through filtering and infiltration. Although vegetative filters designed as specified in this BMP can be expected to provide significant pollutant removal, overall water quality will not be protected if a filter stirp is not used in conjunciton with a buffer along the stream corridor.

To protect water quality, a buffer/filter at least 100 feet wide should be preserved or created around all waterbodies and wetlands, with strip widths increasing with increasing slope. Research shows that when the buffer is less than 100 feet, stream quality begins to diminish. If a 100-foot buffer/filter strip is not feasible, or if wildlife habitat is of interest, refer to the specifications section of this BMP for additional information.

Special Considerations: Natural or Wild and Scenic Rivers may have special buffer/filter strip restrictions, depending on their designation (see Exhibit 1). Contact the MDNR, Forest Management Division, Natural Rivers Program staff for further information.

## Other Terms Used to Describe

Vegetative Filter

## Pollutants Controlled and Impacts

Several researchers have measured >90% reductions in sediment and nitrate concentrations; buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).

## Application

Land Use

Applicable to all land uses adjacent to waterbodies.

Soil/Topography/Climate

This practice is especially important on and adjacent to steep slopes. Natural buffer strips are essential in maintaining the shade and stream temperatures of coldwater streams.

When to Apply

Natural buffer/filter strips should be identified and protected before any development occurs on a site. At the watershed level, buffer/filter strips could be identified during community land use planning (i.e. during master plan development, development of parks, or greenways, etc.) or as part of efforts to identify and protect specific land uses, such as prime farm land. At the site level, buffer/filter strips should be incorporated into the overall plan for the site, and protected during construction.

Where to Apply

Adjacent to all watercourses and wetlands.

## Relationship With Other BMPs

Natural buffer/filter strips should be identified prior to any Land Clearing operations.

BMPs may be needed upslope of a buffer/filter strip if: 1) runoff directed to the buffer/filter cannot enter as sheet flow, or 2) protection of the buffer from excess sediment is needed to maintain the integrity of the buffer.

## Specifications

**Planning Considerations to Preserve Buffer/Filter Strips:**

Buffer/filter strips which are able to remain as undisturbed native vegetation should be delineated on preliminary and final site plans. *To protect water quality*, preserve natural buffer areas a total *minimum width of 100 feet* along all water courses and wetlands, with widths increasing with increasing slope. This is recommended to maintain shade, uptake pollutants and absorb sheet flow (i.e. stormwater that is not concentrated at a single point and causes erosion). While the 100-foot width is consistent with stream research studies (see Exhibit 6) and is the policy of most forest managers as a means to protect water quality, if wildlife habitat is of particular interest, see the Exhibit 1 for information on buffer/filters which protect water quality and wildlife habitat.

**Management of the Buffer: The Three-Buffer Zone System**

Scheuler (1995) promotes the use of a buffer/filter system made up of three zones, each of which has a different width, function and management scheme. The total minimum width of the three zones is 100 feet and includes the floodplain.

- The *streamside zone* is usually made up of mature trees which provide shade, leaf litter, and woody debris to the stream, as well as erosion protection. The minimum width of this zone is 25 feet. Land uses allowed in this zone are limited to footpaths, and well-designed watercourse crossings (for utilities, roads, etc.). See the Watercourse Crossings BMP to help in designing sound watercourse crossings.
- The *middle zone* extends from the outer edge of the streamside zone and protects the stream's ecosystem by providing a larger protective area between the stream and upland development. Ideally, this zone will also be made of mature trees and will be a minimum of 50 feet, with widths increasing to ensure the 100-year floodplain, adjacent steep slopes and protected wetlands are included. The width of this zone may also increase as the stream order increases. Uses allowed in this zone include bike paths and other low-impact recreational uses and stormwater BMPs.
- The *outer zone* is the zone between the middle zone and the nearest permanent structure (e.g. house or building). This is the filter part of the buffer/filter system. In residential areas, this

zone is usually a grassy backyard. The zone is a minimum of 20 feet in width, with widths increasing with increasing slopes and with the amount of sediment and/or nutrients the filter is expected to treat. Septic systems and permanent structures are restricted in this zone. In urban areas or areas directly adjacent to pavement, this area should be a managed filter strip to maximize pollutant removal.

**Incorporating Stormwater BMPs in the Buffer/Filter:**
Buffer/filter strips are not capable of treating all stormwater generated in a watershed. (Schueler states that a buffer/filter system can treat runoff from less than 10% of the contributing watershed). Therefore, stormwater BMPs must be used to protect the streamside buffer zone and the stream itself.

*The designer should evaluate all the possible paths of flow into the buffer/filter strip.* If any flow paths are expected to exceed sheetflow or otherwise cause erosion, then BMPs are needed upslope. If land is limited, the BMPs may need to be installed in the upper or middle zones.

Example problem: A designer determined that stormwater would enter the buffer/filter strip from a new development at three points: 1) a parking lot curb cut draining half of a parking lot, 2) parking lot overland flow draining the other half of a parking lot; and 3) building roof drains. The designer determined that the water leaving the parking lot would do so as sheet flow and cause no erosion in the buffer/filter strip.

Example Solution: Since the parking lot curb cut would cause concentrated flow into the buffer/filter strip, the designer added two more curb cuts to the design to break up the flow. He designed the parking lot so that the buffer/filter would be located 3 to 6 inches lower than the pavement to prevent sediment deposits from blocking inflow to the filter strip. He also included installing a layer of stone at the outlets of the curb cuts to slow the water. To address the concentrated flow from the building roof drains, he included a rock-lined splash apron below the drains, and below it, some dense vegetation. Due to limitations in the land available, these BMPs were installed in the outer zone of the buffer/filter strip.

**Planning Considerations for Creating Buffer/Filter Strips:**
Re-establishment of buffer/filter strips is possible if urban land is being reclaimed, if sites of environmental contamination are being cleaned up, or if greenways are being established as part of a greenways program or recreation enhancement program. Under these and other re-establishment conditions:

1. Conduct a site evaluation to determine:
   - the drainage characteristics. Depending on drainage, it may be necessary to use other BMPs. Note that concentrated flows can be minimized by limiting the drainage area to less than 5 acres.
   - percentage slope and length of slope.
   - type of soil and soil stability. Sloughing soils, will require additional BMPs to ensure stability of the slope.

2. Determine all of the possible uses of the newly developed buffer strip and incorporate those uses into the design. For wildlife considerations, see Exhibit 1.

3. Select vegetation based on the site characteristics determined uses and the three-zone

concept. For vegetative mixtures for the outer zone, see Exhibit 2.

4. **Buffer/filter strips are not effective methods for treating concentrated flow.** Determine flow patterns onto the buffer/filter strip and incorporate BMPs to ensure stormwater enters the buffer/filter strip as **sheet flow**.

**Installing Buffer/Filter Strips:**

1. Install any BMPs needed upland.

2. Prepare the site. If it is necessary to clear and grade land, follow specifications in the Land Clearing and Grading Practices BMPs. *Never grade to the edge of a watercourse without using filter fencing or other BMPs to protect the watercourse.* Any use of soil amendments such as fertilizer should be based on soil tests and follow the Soil Management specifications.

3. Refer to the Seeding, Sodding, Mulching and Trees, Shrubs and Ground Covers BMPs, as appropriate to the vegetation selected.

4. Maintain any temporary upland BMPs until vegetation "takes." Grass should be a minimum height of 4 inches and 90 percent ground cover before temporary upland BMPs are removed (i.e. the site should be stable).

5. Consider using mulch between trees and shrubs to keep soil on site.

6. Avoid spraying the buffer strip with pesticides; consider alternatives in the Integrated Pest Management BMP.

7. Protect the buffer/filter from damage by equipment and traffic. Do not use the buffer/filter strip as a roadway.

## Maintenance

**All Zones:**

Periodic inspections should be done to ensure that concentrated flows have not developed, and to make sure the vegetative cover is maintaining its effectiveness. If the integrity of the buffer/filter strip is jeopardized by upland erosion, or if concentrated flows are creating rills or gullies up-slope of the strip, additional BMPs may need to be installed. If the buffer strip is being jeopardized by stream bank erosion, then the cause of the bank erosion needs to be investigated and actions taken to address the causes. Damaged strips should be repaired as soon as possible. Strips damaged due to construction upslope of the buffer/filter should be replanted, as necessary, after the cause of the damage is assessed and any other BMPs needed are implemented.

In buffer/filter strips used by wildlife—but especially in the streamside zone—avoid using herbicides to control weeds. Refer to the Pesticide Management BMP for other options.

**Streamside Zone and Middle Zone:**

Natural woody buffer/filter strips should be left undisturbed, except for the uses listed in the management section of this BMP (pages 2 and 3). Do not use heavy equipment in this area.

To replace or repair damaged trees, refer to the Tree Protection and Trees, Shrubs and Ground Covers BMP.

**The Outer Zone:**

- If sediment enters the filter strip in amounts which cannot be removed by hand, or in amounts which damage the filter strip, additional upland BMPs will likely need to be installed.
- Remove sediment in this zone when sediment begins to build up. Reseed if necessary.
- If the filter was designed for nutrient removal, remove any harvested vegetation (grass clippings, leaves, etc.) and dispose of outside the buffer/filter strip.
- If grass fails to grow in newly established filter strips, determine the reasons for failure before reseeding. The Lawn Maintenance BMP includes information on unhealthy turf. Spot seed applications when only small areas are affected. If insects are damaging the filter strip, explore integrated pest management techniques in the Pesticide Management BMP to protect any wildlife using the filter strip.
- Mowing should be done to help control weed growth, prevent the growth of woody plants, and help the filter maintain its effectiveness. Mow no lower than six inches to allow vegetation to provide filtering of sediment, organic matter, nutrients, and pesticides. If the strips are used by nesting birds, do not mow until after July 15. To maintain winter cover for wildlife, do not mow after September 1.
- *During the establishment year,* clip to control undesirable plants such as Canadian thistle and milkweed. Clip high (6 inches) to prevent damage to the permanent seeding. Clip between July 15 and August 15. If needed, clip twice during the summer. Use chemical controls only after all non-chemical methods have been considered.
- *After the establishment year*, only spot clipping (or spot chemical treatment, if necessary) should be done, rather than clipping or otherwise treating the entire strip. If noxious weeds develop, clip in the spring to prevent weed seeds from dispersing. Otherwise, clip between July 15 and August 15 to protect any nesting wildlife.

## Exhibits

Exhibit 1: 1997 Literature Review of Buffer/Filter Strips for Wildlife and Water Quality. MDEQ, Surface Water Quality Division.

Exhibit 2: Vegetative Widths for the Outer Zone. USDA Soil Conservation Service Technical Guide.

Exhibit 3: Vegetative Mixtures for the Outer Zone. USDA Soil Conservation Service Technical Guide.

Exhibit 4: 1993 Literature Review on Buffer/Filter Strip Widths. MDEQ, Surface Water Quality Division.

Exhibit 5: References used in developing the BMP.

Exhibit 6: Michigan's Natural Rivers System. List of rivers designated or proposed under the Natural Rivers program.

Exhibit 1

# For Wildlife Corridors That Also Protect Water Quality

For wildlife corridors that also protect water quality, consider the following:

- Rudolf and Dickenson (1990) found that reptiles and amphibians were more abundant in buffers 99-313 feet than 0-82 feet.

- Dicken and Huntly (1987) found abundant signs of squirrels in buffers greater than 165 feet, but virtually none in zones narrow than 99 feet.

- Dicken and William (1988) found small mammals to be more abundant in narrower streamside areas with well developed herbaceous vegetation compared to wider zones with sparse vegetation.

- Burk et al (1990) found that turkeys were significantly less when buffers were less than 150 feet.

- Premo (1995) found that a 50-foot zone of intact vegetation is too narrow to support most breeding species of birds. He also found that in hardwood riparian buffers/filters, mammal use was heaviest closest to the river and decreased out to 400 feet and leveled off; in conifer riparian buffer/filters, mammal use was fairly high near the river but peaked at 400 feet, and therefore, sections of 400-foot buffer/filter may be needed in coniferous riparian zones to optimize use by mammals.

Exhibit 2

# The Outer Zone: Grass/Sod Filter Widths

| Length of Slope | Percent Slope | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.2 | 0.3 | 0.4 | 0.5 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 8.0 | 10.0 | 12.0 | 14.0 | 16.0 | 18.0 |
| | Width - Feet | | | | | | | | | | | | | | | |
| 100 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 50 | 60 | 60 | 60 |
| 200 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 40 | 50 | 50 | 60 | 60 | 60 | 60 |
| 300 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 |
| 400 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 50 | 60 | 60 | 60 | 60 | 60 |
| 500 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 |
| 600 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 |
| 700 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 |
| 800 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 |
| 900 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1000 | 20 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1100 | 20 | 20 | 20 | 20 | 20 | 30 | 30 | 40 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1200 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 40 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1300 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1400 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1500 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1600 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 1700 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 2000 | 20 | 20 | 20 | 20 | 20 | 30 | 40 | 50 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |

Source: USDA Soil Conservation Service Technical Guide, #326.

Exhibit 3

# Vegetative Mixtures for the Outer Zone

**Soils:** Well and moderately well drained sand and loamy sand (coarse textured soils)

| Seeding Mixtures | Rates Lbs./Acre | Suitability Sediment Filter Wind | Water |
|---|---|---|---|
| Red Fescue<br>Ryegrass | 20<br>5 | | X |
| Smooth Brome | 15 | | X |
| Switchgrass | 8 | X | |
| Switchgrass<br>Tall or Intermediate Wheatgrass | 4<br>8 | X | |
| Tall or Intermediate Wheatgrass | 15 | X | |

**Soils:** Well and moderately well drained, moderately coarse to moderately fine textured soils (sandy loam, loam, silt loam, and clay loam)

| Seeding Mixtures | Rates Lbs./Acre | Suitability Sediment Filter Wind | Water |
|---|---|---|---|
| Reed Canarygrass | 6 | | |
| Reed Canarygrass<br>Tall Fescue | 4<br>8 | | X |
| Smooth Brome | 15 | X | X |
| Smooth Brome<br>Tall Fescue | 8<br>12 | X | X |
| Switchgrass | 8 | X | |
| Switchgrass<br>Tall or Intermediate Wheatgrass | 4<br>8 | X | |
| Tall Fescue | 20 | X | X |
| Tall or Intermediate Wheatgrass | 15 | X | |

1/ Double seeding rates.



(continued)

Exhibit 3 (Continued)

# Vegetative Mixtures for the Outer Zone

**Soils** - Well and moderately well drained clay and silty clay (fine textured soils)

| Seeding Mixtures | Rates Lbs./Acre | Suitability Sediment Filter Wind | Water |
|---|---|---|---|
| Reed Canarygrass | 6 | X | X |
| Reed Canarygrass<br>Tall Fescue | 4<br>8 | X | X |
| Smooth Brome | 15 | X | X |
| Smooth Brome<br>Tall Fescue | 8<br>12 | X | X |
| Switch Grass | 8 | X | |
| Tall Fescue | 20 | X | X |
| Tall or Intermediate Wheatgrass | 15 | X | X |

**Soils** - Somewhat poorly drained or poorly drained soils without artificial drainage.

| Seeding Mixtures | Rates Lbs./Acre | Suitability Sediment Filter Wind | Water |
|---|---|---|---|
| Reed Canarygrass | 6 | X | X |
| Switchgrass 2/ | 8 | X | |
| Tall Fescue | 20 | X | X |

* The following legumes may be added to the grass mixtures: 6#-8# alfalfa or 3#-4# of birdsfoot trefoil and/or 2# of sweet cover.

1/ Double seeding rates.

2/ Use species tolerant of wetter soils.

Source: USDA Soil Conservation Service Technical Guide #393

Exhibit 4

# 1993 Literature Review of Buffer/Filter Widths

| SOURCE | FACTORS REVIEWED | FINDINGS/RECOMMENDATIONS |
|---|---|---|
| Aubertin<br>West Virginia | turbidity, nutrients | Used 10-20M (32.8 feet - 65.6 feet) buffers in study.<br>Both turbidity & nutrients increased during and after logging. |
| Brazier<br>Oregon | temperature | 80' Buffer was necessary to maintain temperature and 55' was necessary for 90% of that temperature or angular canopy density |
| Erman<br>California | stream invertebrates | Streams with a buffer strip less than 30M (98.4') showed same response as stream logged without buffers. Changes were caused by decreased canopy density, increased primary production, increased stream flows, increased temperature and increased sediment. |
| Graynoth<br>New Zealand | stream invertebrates | Streams with buffer strip less than 30M showed same response as stream logged without buffers. Changes were caused by decreased canopy density, increased primary production, increased stream flows, increased temperature and increased sediment. |
| Corbett<br>Pennsylvania | turbidity, sedimentation | 1978 Report recommended 23-30M (75.4'-98.4') Buffers<br>1981 Report recommended 30M (98.4') Buffers<br>1990 Report recommended 100 feet or 1 1/2 times the average tree length |
| Farrish<br>Louisiana | soil erosion | **Buffers did not stop gully erosion** that was initiated upslope of buffer.<br>All 1,584 sites reviewed had developed gullies. |
| Verry 1986<br>Minnesota | stream flow | Clearcutting hardwoods increased annual stream flow 9 to 20 cm (a 30 to 80 percent increase). It took 12 to 15 years to return to preharvest levels |
| Verry 1992<br>Minnesota | large woody debris, temperature, water depth, cover, stream flow | Recommend 2 tree lengths, typically 150 feet, as a leave zone beginning at the top of the bank. Cut only 25% of basal area in second tree length. |
| Oklahoma<br>State University | Habitat | |
| -Rudolph & Dickenson, 1990 | reptiles/amphibians | More abundant in buffer 99 - 313' than 0-82 feet. |
| -Dicken & William 1988 | small mammals | More abundant in narrower streamside areas with well developed herbaceous vegetation compared to wider zones with spare vegetation |
| -Dicken & Huntly 1987 | squirrels | Abundant signs of squirrel in buffers wider than 165' but virtually none in zone narrower than 99' |
| -Burk et. al. 1990 | turkeys | Turkeys were significantly less when buffers were less than 150' |
| Hesser<br>Pennsylvania | trout production, sedimentation, temperature | A recommendation of one and one-half chains (100') on both sides of river was made from a literature review. Increased zones may be necessary for sensitive areas. |

Exhibit 5

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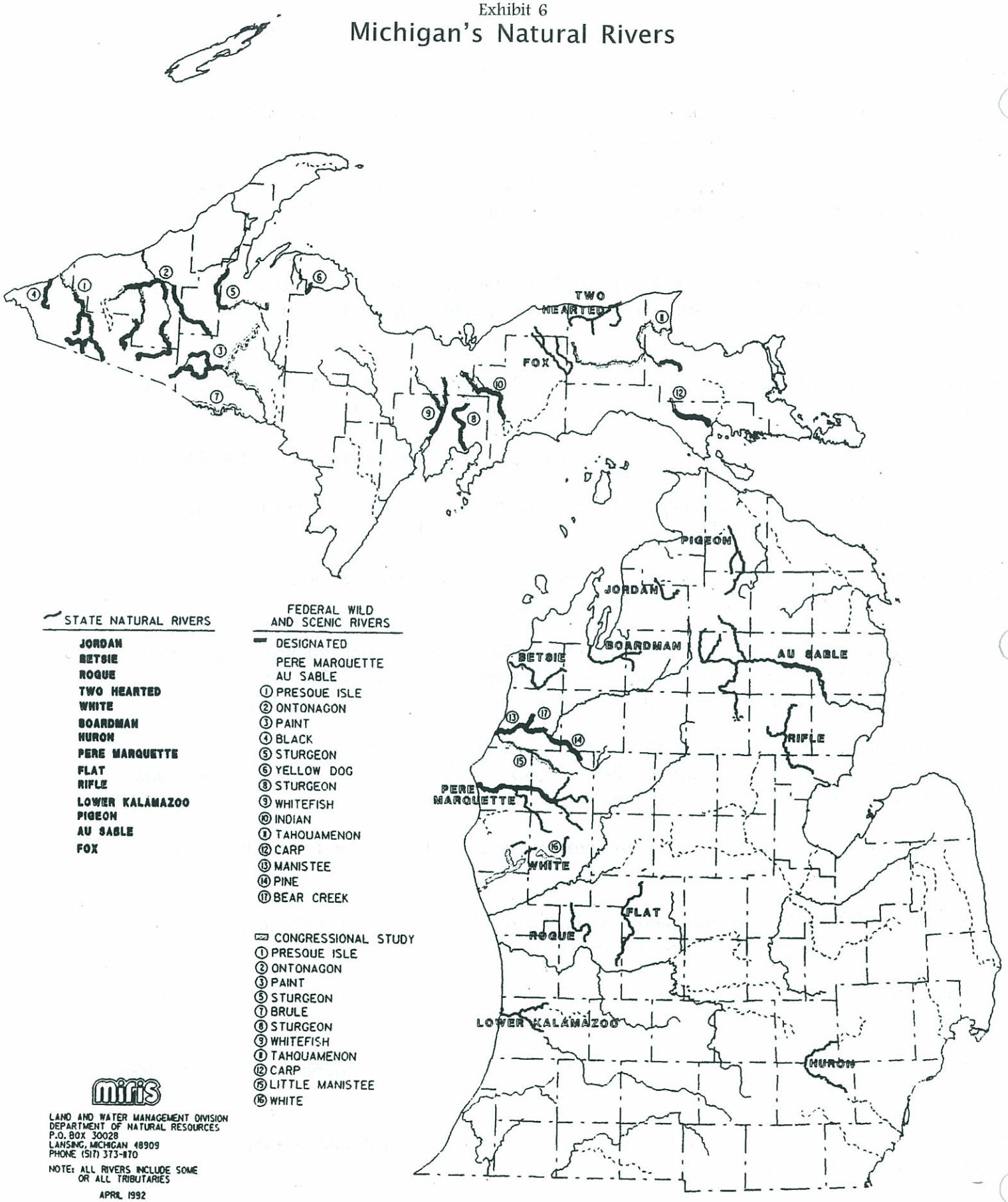
Exhibit 6

# Michigan's Natural Rivers




STATE NATURAL RIVERS

- JORDAN
- BETSIE
- ROGUE
- TWO HEARTED
- WHITE
- BOARDMAN
- HURON
- PERE MARQUETTE
- FLAT
- RIFLE
- LOWER KALAMAZOO
- PIGEON
- AU SABLE
- FOX

FEDERAL WILD AND SCENIC RIVERS

DESIGNATED

PERE MARQUETTE
AU SABLE
① PRESQUE ISLE
② ONTONAGON
③ PAINT
④ BLACK
⑤ STURGEON
⑥ YELLOW DOG
⑧ STURGEON
⑨ WHITEFISH
⑩ INDIAN
⑪ TAHQUAMENON
⑫ CARP
⑬ MANISTEE
⑭ PINE
⑰ BEAR CREEK

CONGRESSIONAL STUDY
① PRESQUE ISLE
② ONTONAGON
③ PAINT
⑤ STURGEON
⑦ BRULE
⑧ STURGEON
⑨ WHITEFISH
⑪ TAHQUAMENON
⑫ CARP
⑮ LITTLE MANISTEE
⑯ WHITE

miris

LAND AND WATER MANAGEMENT DIVISION
DEPARTMENT OF NATURAL RESOURCES
P.O. BOX 30028
LANSING, MICHIGAN 48909
PHONE (517) 373-870

NOTE: ALL RIVERS INCLUDE SOME OR ALL TRIBUTARIES

APRIL 1992



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# Construction Barriers

## Description

Construction barriers are fences, signs and other means used on a construction site to:

-confine equipment and personnel to the immediate construction area, thus minimizing the destruction of vegetation and reducing the potential for erosion and compaction.

-protect trees and their root zones against abrasion and soil compaction. It takes 20-30 years for newly planted trees to provide the benefits of mature trees.

-prevent unnecessary access to structural BMPs

-protect sensitive areas, such as water bodies and newly seeded areas

-restrict access of unauthorized persons and vehicles.

## Other Terms Used to Describe

Fencing

## Pollutants Controlled and Impacts

Confining construction activities to a specific site will limit the amount of soil exposed to wind and rain. Effective confinement may also eliminate unnecessary or excessive regrading or revegetation of slopes or raw areas.

## Application

Land Use
Use at all construction areas where earth changes are taking place. Land uses include transportation (highway work), urban (drain work, private, commercial and industrial developments), and golf courses.

Soil/Topography/Climate
This practice can be used anywhere, but is particularly important on erodible soils and steep slopes.

When to Apply
Apply this practice prior to the start of construction and as needed throughout the duration of the project. Some barriers, such as vehicle deterrent barriers, may remain in place after project completion.

Where to Apply
Apply anywhere confinement or protection of persons, property or natural resources is needed.

## Relationship With Other BMPs

Construction barriers are used to protect critical erosion areas (see Critical Area Stabilization) and to prevent unwanted access by vehicles, equipment and people. It is a component BMP used with many other soil erosion control practices.

## Specifications

**Planning Considerations:**

1. Barriers used to separate the construction area from pedestrian thoroughfares, or used to alert personnel about the existence of hazardous conditions, should be stable and easily discernible.

2. Keep barriers outside the drip line of any trees which will remain intact during and after the construction project. (The drip line is the area from the trunk outward to the a point at which there is no longer any overhanging vegetation). Pounding barriers into the ground within the drip line of trees may cause root damage and weaken the tree. Follow specifications in the Tree Protection BMP.

3. Signs should *not* be nailed or otherwise posted on trees.

4. In large open areas susceptible to wind, consider protecting sprigged or seeded areas with fencing.

5. Barriers are particularly important around detention, retention, and Sediment Basins, and dams (including cofferdams). At a minimum, barriers in these areas should include signs which warn people of potential dangers. Fencing may also be needed, depending upon the slope steepness, outlet flows, depth of water, etc.

   Select appropriate structures for the intended use:

   **Temporary structures:**
   Temporary fences can be made out of snow fence or the orange plastic fencing which is commonly used in construction areas. Silt fences can also be used as temporary barriers where safety is not a consideration. (See the Filters BMP).

   **Permanent structures:**
   Permanent fences may be constructed of wood, plastic, synthetic fabric, plastic or any other appropriate material.

   Cyclone-type fences with secure gates and locks should be used around dangerous areas such deep basins.

   Snow fences can be used to prevent pedestrian access and to control wind erosion.

**Construction Considerations:**

1. Signs should be constructed out of durable materials and printed legibly.

2. Construct the fence following specifications for the type of fence being installed. Be sure all posts are sturdy, and all material is suitable for the intended use. One source of specifications for standard wire, suspension, electric and permanent power fences is the Soil Conservation Service Technical Guide, specifications for Fencing (#382).

3. All fences used as filters should be implemented following specifications in the Filters BMP.

**After Construction:**

1. Remove all temporary construction barriers. Before leaving the site, inspect all permanent barriers to ensure they are in good working order, and repair where necessary.

2. When removing tree protection barriers, check to make sure the tree is still in good health. Trees which are severely damaged should be removed and replaced. See the Tree Protection BMP for information on replacing trees, and techniques on how to properly repair damaged roots and limbs.

## Maintenance

Barriers should be inspected and maintained on a regular basis. Damaged signs and fences should be repaired or replaced immediately.

# Grading Practices

## Description

Grading is reshaping the ground surface to planned grades determined by engineering survey evaluation and layout. This BMP includes basic grading concepts, as well as specific types of grading practices that can be used to reduce erosion. Grading plans are discussed in the BMP Guidebook.

## Other Terms Used to Describe

Rough Grading
Contour Grading
Special Grading Practices
Land Smoothing

## Pollutants Controlled and Impacts

Proper grading practices help to improve surface drainage and reduce the amount of soil which erodes from a site.

## Application

Land Use
Construction sites

Soil/Topography/Climate
Grading should compliment the natural configuration of the landscape. Where possible, the depth of grading should be controlled to prevent exposing extensive amounts of subsoil. Topsoil should be removed, stockpiled and re-spread over the graded area.

When to Apply
Apply whenever earth moving or construction activities produce grades which may increase erosive velocities or off-site sedimentation.

Where to Apply
This practice applies on any areas which require grading.

## Relationship With Other BMPs

Diversions should be considered to prevent runoff from causing erosion on the exposed soil. To prevent off-site sedimentation, control measures such as Filters (filter fences), Grade Stabilization Structures and Sediment Basins may need to be installed at the lower perimeter of the site. Staging should be done to reduce the size of the area being exposed. (See the Staging and Scheduling BMP).

## Specifications

The following is modified from the "North Carolina Erosion and Sediment Control Planning and Design Manual."

**Planning Considerations:**

1. Develop a **grading plan** to help establish drainage areas, direct drainage patterns, and decrease runoff velocities. The grading plan should follow the guidance in the BMP Guidebook, including coordinating the grading plan with the soil erosion/sedimentation control plan and the stormwater plan.

2. Slopes which will be mowed should not be steeper than 3:1.

3. Grading should be done in stages according to the implementation schedule. See the Staging and Scheduling BMP.

4. Protect spoil piles following specifications in the Spoil Piles BMP.

5. To ensure even settling, any fill to be used should be free of objectionable material such as logs, rocks and stumps. Do not use frozen or mucky material for fill.

6. Do not place fill adjacent to a channel bank where it can create bank failure or result in deposition of sediment downstream.

7. The exposed area should be stabilized with vegetation, crushed stone, riprap or other ground cover as soon as grading is completed or when work is interrupted for 30 working days or more. Use mulch (see Mulching BMP) to stabilize areas temporarily where final grading must be delayed. Slopes in excess of 2:1 should be stabilized following the specifications in the Critical Area Stabilization BMP.

**During Grading:**

1. Following the grading plan, construct all erosion and sedimentation control practices.

2. Remove vegetative matter in accordance with Land Clearing specifications. Remove topsoil and store in temporary Spoil Piles until final grading. Temporary spoil piles adjacent to wetlands or streams should be protected to prevent erosion.

3. Do not grade to the edge of watercourses. If a natural Buffer/Filter Strip cannot be left, construct a berm or place filter fencing adjacent to the watercourse/wetland. (See Filters BMP).

4. Divert runoff to stabilized areas, according to the grading plan.

5. Where possible, contour the grade to follow the natural contour of the land.

6. Finish grade and compact according to the intended use of the area. See the appropriate BMP for additional information on the finish grading procedures and the degree of compaction needed.

7. Except on roadway side slopes, use one of the surface roughening techniques described below to retain water, increase infiltration and facilitate vegetative growth. See Exhibit 1.

**Stair-step grading.** This method should be done on slopes steeper than 3:1 which have material soft enough to be bulldozed and which will not be mowed. The vertical cut should be less than the horizontal distance and should not exceed 2 feet in soft material and 3 feet in rocky material. The horizontal position of the "step" should be sloped toward the vertical up-hill wall.

**Grooving.** This method can be done on any area which can safely accommodate disks, tillers, spring harrow, or the teeth of a front-end loader bucker. In areas which will not be mowed, use equipment to create grooves perpendicular to the slope. Grooves should not be less than 3 inches deep, nor more than 15 inches apart. In cuts, fills, and areas that will be mowed, grooves should be less than 10 inches apart and not less than 1 inch deep.

**Tracking.** This method is done by running tracked machinery (such as bulldozers) up and down slopes to leave horizontal depressions in the soil. To avoid undue compaction of the soil, this method should only be done on sandy soils. Back-blading should not be done during the final grading operation.

8. Use proper Tree Protection techniques to maintain the health and integrity of the trees. Excavate as far away from the drip line as possible.

When **raising the grade** around an existing tree:

1. A well can be created around the tree(s) just outside the drip line to retain the natural soil in the area of the feeder roots

2. A dry well can be constructed around the trunk with space to allow the trunk to grow. The well should be designed to allow drainage within the well and around the root system inside the drip line. See exhibit 2.

When **lowering the grade:**

Protect trees by constructing a tree wall made of large stones, brick, building tile, or concrete block or cinder block. The wall should be designed to provide for drainage through the wall. See exhibit 3.

See the Tree Protection BMP for specifications on how to repair damaged tree roots and limbs.

**After Construction:**

Stabilize all areas with vegetation (See vegetative BMPs) or Slope/Shoreline Stabilization structures, where appropriate.

## Maintenance

Desired gradients will have to be maintained until the proposed land use is established with a structure, pavement, or vegetation. In addition, maintenance should be done on any BMPs installed in association with the grading.

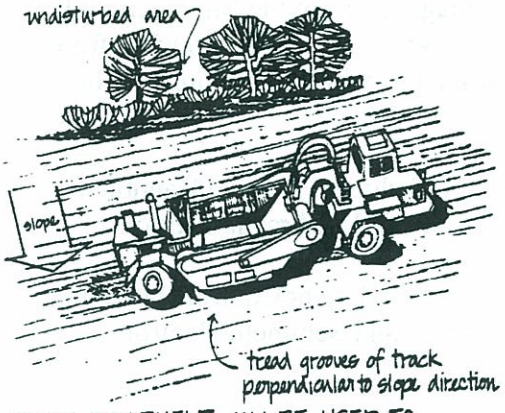
## Exhibits

Exhibit 1: Surface Roughening Techniques. Includes two diagrams from the Michigan Soil Erosion and Sedimentation Control Guidebook. Also, grooving, as modified from the Virginia SWCC (copied from the North Carolina Erosion and Sedimentation Control Planning and Design Manual).

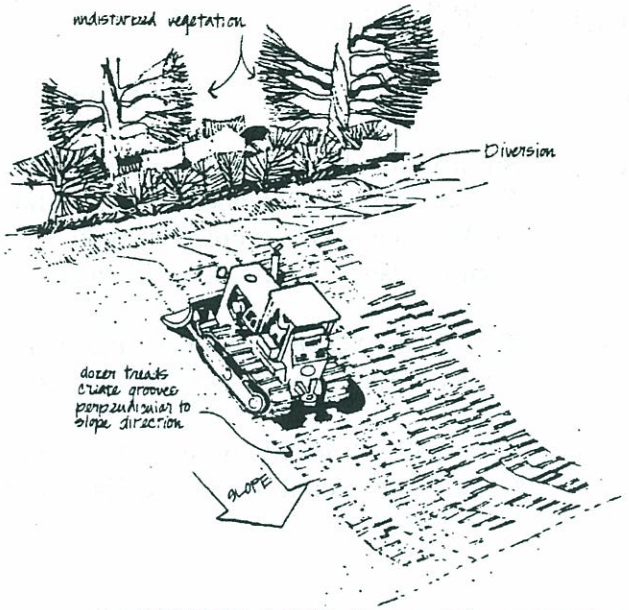
Exhibit 2: Tree Well. Adapted from the Virginia Erosion and Sediment Control Handbook. Copied from Connecticut Guidelines for Soil Erosion and Sediment Control.

Exhibit 3: Tree Wall. Originally from the Virginia Erosion and Sediment Control Handbook. Copied from Connecticut Guidelines for Soil Erosion and Sediment Control.

## Exhibit 1
## Surface Roughening Techniques

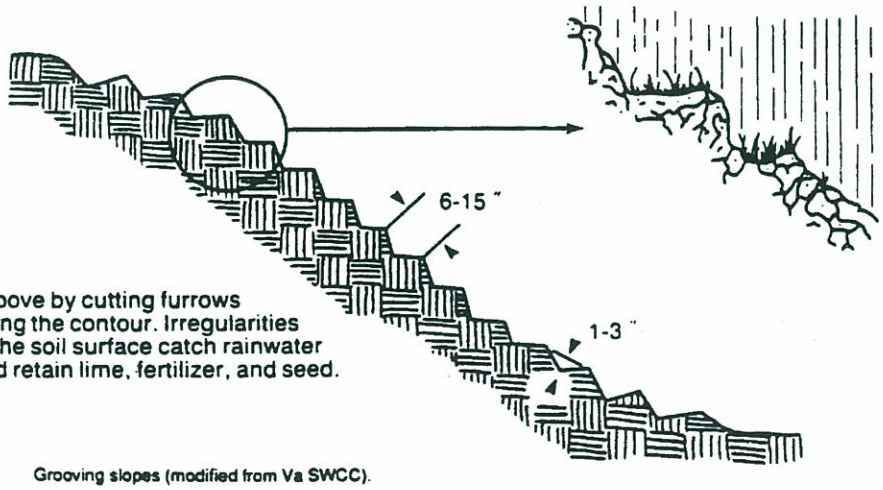



HEAVY EQUIPMENT CAN BE USED TO MECHANICALLY SCARIFY SLOPES




UNVEGETATED SLOPES SHOULD BE TEMPORARILY SCARIFIED TO MINIMIZE RUNOFF VELOCITIES

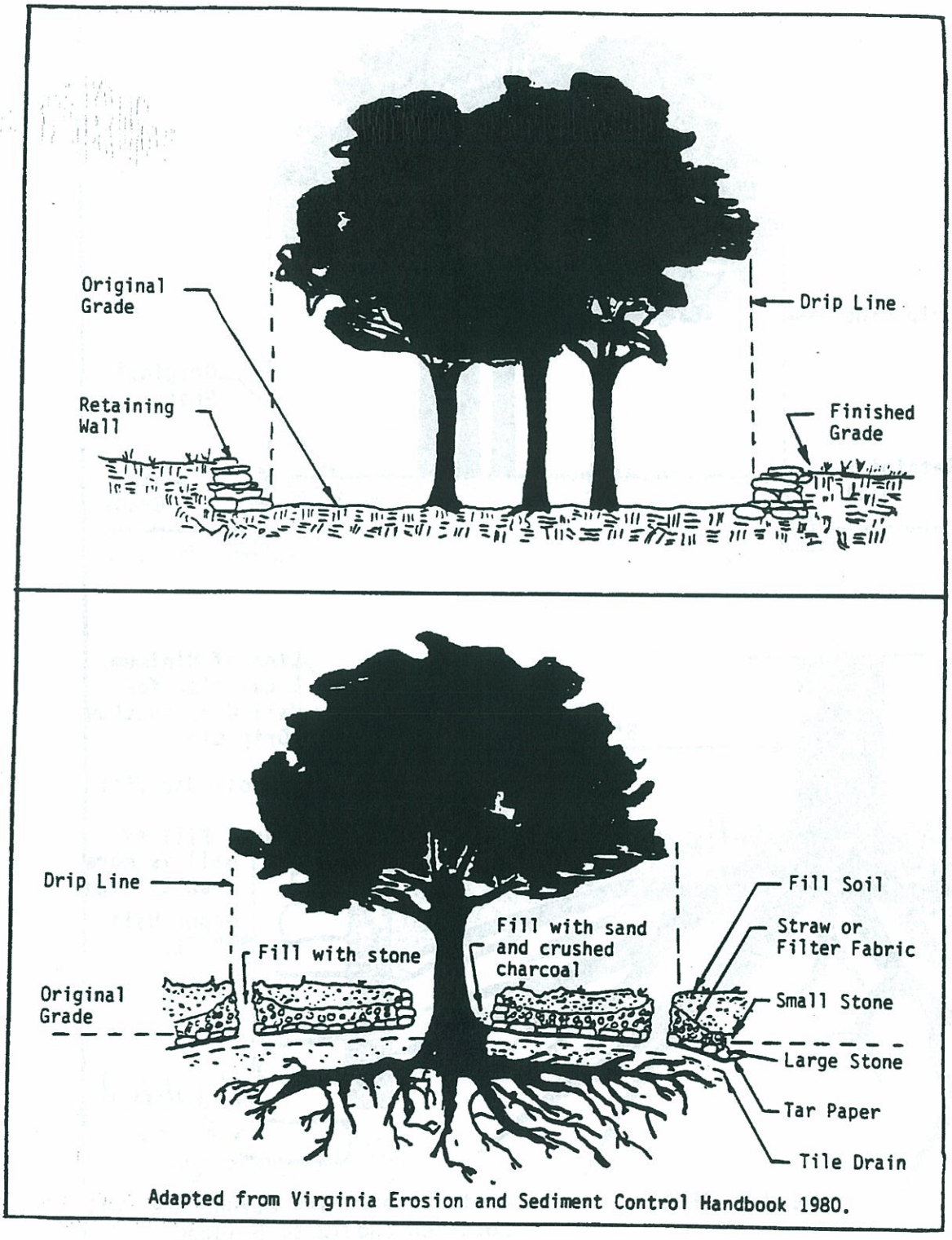
Source: Michigan Soil Erosion and Sedimentation Control Guidebook




Grooving slopes (modified from Va SWCC).

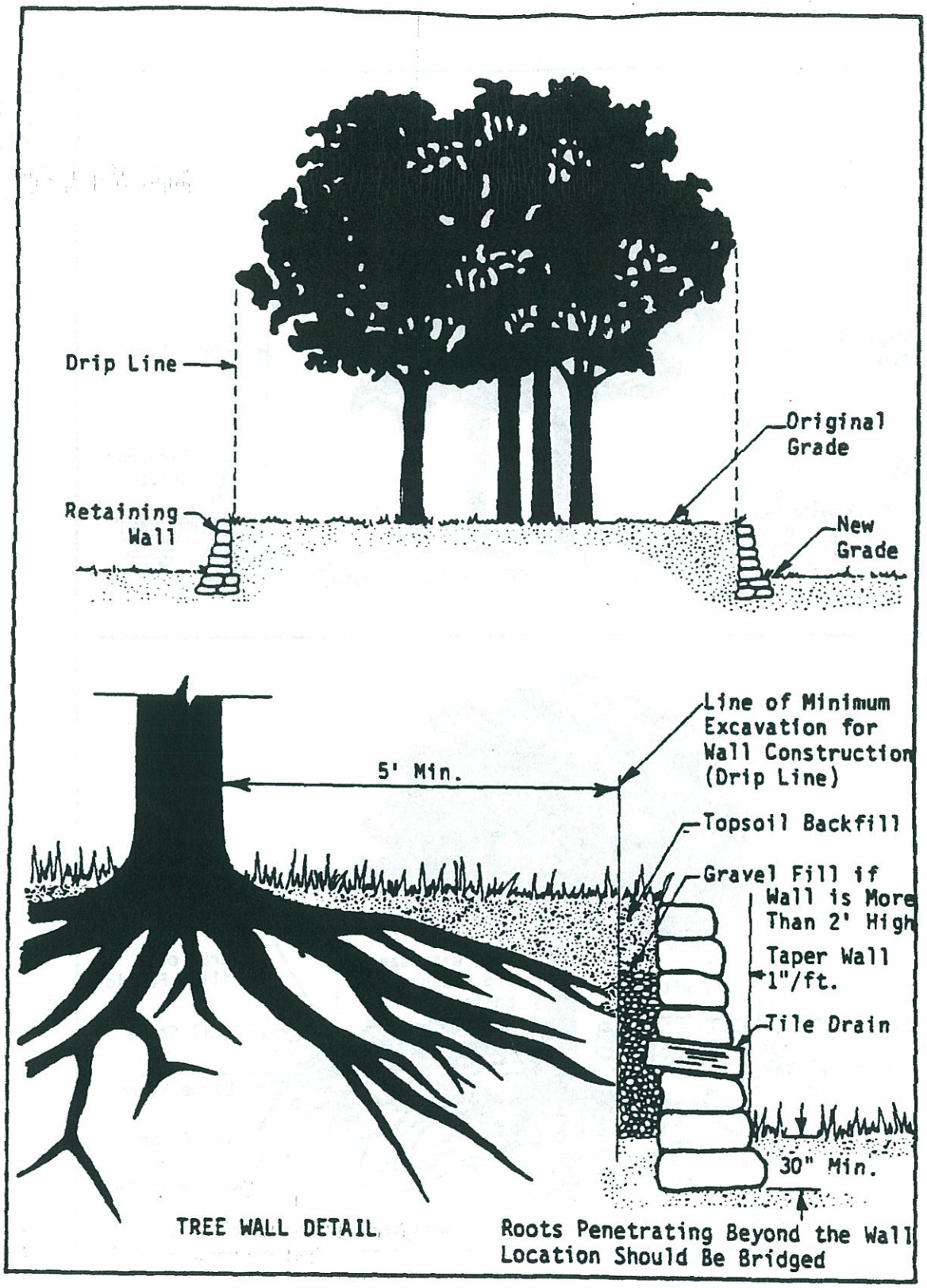
Source: North Carolina Erosion & Sediment Control Planning & Design Manual

**Exhibit 2**
**Tree Well**




Source: Connecticut Guidelines for Soil Erosion and Sediment Control

**Exhibit 3**
**Tree Wall**




Source: Virginia Erosion and Sediment Control Handbook, as copied from Connecticut Guidelines for Soil Erosion & Sediment Control.

# Tree Protection

## Description

Protecting trees during construction activities is done to preserve their health and ensure their vitality after construction.

## Other Terms Used to Describe

Tree Preservation

## Pollutants Controlled and Impacts

Trees should be considered for preservation because:

-They stabilize the soil and prevent erosion
-They reduce stormwater runoff by intercepting rainfall and promoting infiltration
-They moderate temperature changes, promote shade, and reduce the force of wind
-They provide buffers and screens against noise and visual disturbance, and provide some privacy
-They filter pollutants from the air and produce oxygen
-They provide a habitat for animals and birds
-They increase property values and improve site aesthetics

## Application

Land Use
This practice is used most often on construction sites.

Soil/Topography/Climate
This practice is especially important in areas subject to windthrow, where trees removed in the upland area may cause a domino effect in the lower area. It is also important on highly erodible soils, where tree roots help stabilize soils and prevent erosion.

When to Apply
Apply during site evaluation before any construction is done on the site. During site evaluation, note where valuable trees are located and incorporate them into the overall construction design.

Where to Apply
Apply anywhere trees are in need of protection.

## Relationship With Other BMPs

Tree protection should be done before any Land Clearing or Grading Practices are done. Construction Barriers are often used in conjunction with tree protection.

## Specifications

Note that much of the information below was derived from the North Carolina Erosion and Sediment Control Planning and Design Manual.

**Planning Considerations:**
When selecting trees to be protected, consider:

1. Tree vigor. Preserve healthy trees. Sick trees or those damaged beyond repair can be left for wildlife, or removed. Trees lacking vigor include those with dead branches, small annual twig growth, stunted leaf size, sparse foliage, and pale foliage color. Trees with hollow or rotten trunks also should be removed.

2. Tree age. Older trees are usually more aesthetically pleasing, but often require more maintenance than younger trees.

3. Tree species. Protect trees which are most suitable for the site development.

4. Tree aesthetics. Protect trees which are aesthetically pleasing.

5. Wildlife benefits. Protect trees which are preferred by wildlife for food, cover or nesting. Evergreens are important for cover during the winter months. Hardwoods are more valued for food. A mix of evergreens and hardwoods is usually most beneficial.

**Design Considerations:**
When designing a construction site in wooded areas, consider:

1. Leaving critical areas (such as floodplains, steep slopes and wetlands) with as many desirable trees as possible in their natural condition.

2. Locating roadways, storage areas and parking areas away from valuable trees.

3. Selecting trees to be preserved before siting roads, buildings, or other structures.

4. Minimizing trenching in areas with trees. Multiple utilities should be placed in the same trench.

5. Equipment, structural materials, topsoil and fill dirt should never be stored in the drip line of the tree.

6. When the construction plan calls for lowering or raising the grade around trees, see the specifications for tree wells and tree walls in the Grading Practices BMP.

**Implementation:**
See Exhibit 1 for examples of several types of tree protection methods.

1. Never excavate, traverse, or fill closer than the drip line of trees to be saved.

2. Trees which will be preserved should be marked with a bright color paint or surveyor's ribbon applied in a band circling the tree at a height visible to equipment operators.

3. (Construction) Barriers for tree protection should never be placed within the drip line of the tree.

4. Don't cut roots in the drip line.

5. Never nail boards or wire to the trees, as this will make them more susceptible to disease, insect damage and decay. As a last resort, a tree trunk can be armored with burlap wrapping and 2-inch studs wired vertically no more than two inches apart to a height of five feet encircling the trunk.

**After Construction:**

Once construction is complete, you can remove all temporary tree protection devices. Inspect all trees to ensure they are in good health. Repair all damaged roots and branches:

1. Repair roots by cutting off the damaged areas and painting them with tree paint. Spread peat moss or moist topsoil over exposed roots.

2. Repair damaged bark by trimming around the damaged area (as shown in Exhibit 2). Taper the cut to provide drainage. Paint with tree paint.

3. Cut off all damaged tree limbs above the tree collar at the trunk or main branch. Use three separate cuts to prevent bark from peeling off healthy areas of the tree. (See Exhibit 2).

4. Trees which are severely damaged should be removed and replaced with similar species, with trunk diameters at least 2 inches.

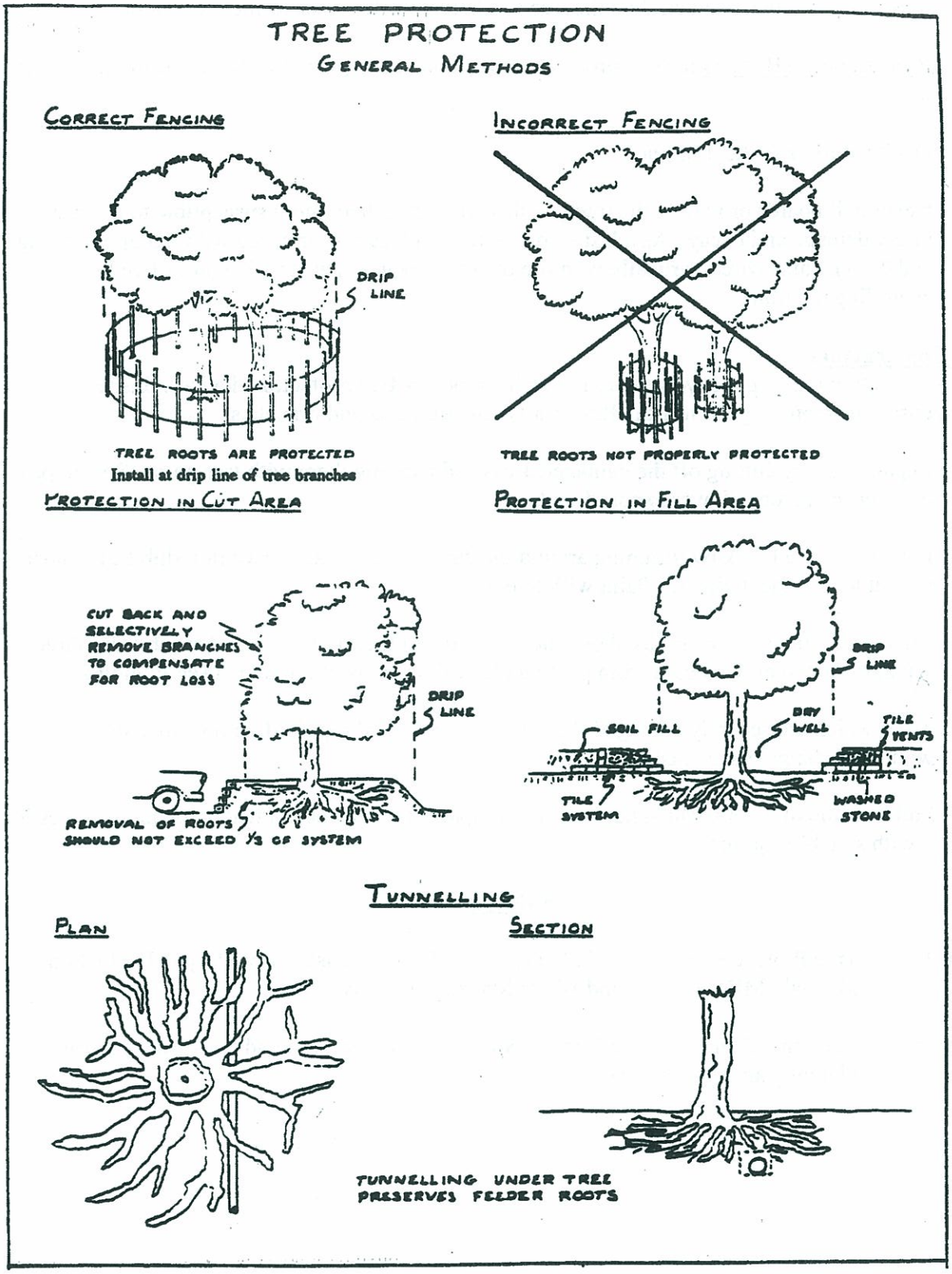
5. Soil over the root zone which has become compacted should be aerated by punching holes in it with suitable equipment.

## Exhibits

Exhibit 1: Tree Protection, General Methods, Detail TP-1. Construction Project Evaluation Manual. MDNR, Land and Water Management Division.

Exhibit 2: Repairing Damaged Tree Limbs. North Carolina Erosion and Sediment Control Planning and Design Manual.

**Exhibit 1**




Source: Construction Project Evaluation Manual. Michigan Department of Natural Resources, Land and Water Management Division.

# Critical Area Stabilization

## Description

Critical area stabilization is stabilizing areas which are highly susceptible to erosion by implementing one or more vegetative or structural BMPs. For the purposes of this BMP, critical areas include areas with highly erodible soils, long or steep slopes, droughty soils, excessively wet soils, soils that are very acidic or alkaline, slopes immediately adjacent to waterbodies or wetlands, fill areas and areas subject to concentrated flows.

## Other Terms Used to Describe

High-Risk Erosion Areas
Critical Area Seeding

## Pollutants Controlled and Impacts

Protecting critical areas is one of the most effective means of preventing sediment from entering surface waters. Properly established vegetation used to protect critical areas will also help absorb nutrients and reduce flows from steep slopes.

## Application

Land Use
Applicable to all land uses.

Soil/Topography/Climate
This practice is particularly important on soils that are excessively wet, droughty, or which are subject to erosion even during a light to moderate rainfall.

When to Apply
Critical erosion areas should be identified during the planning stages of the project or proposed earth change activity. All possible measures should be taken not to disturb these areas. If it is necessary to disturb these areas, attention should be given to protecting them immediately.

Where to Apply
Apply on any area which is difficult to stabilize.

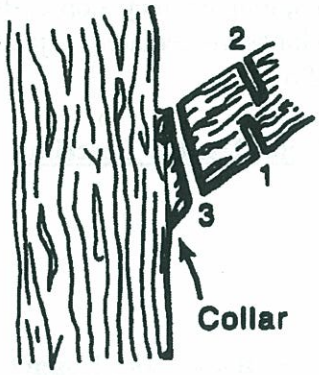
## Relationship With Other BMPs

See the "Specifications" section, below.

**Exhibit 2**

**Repairing Damaged Tree Limbs**

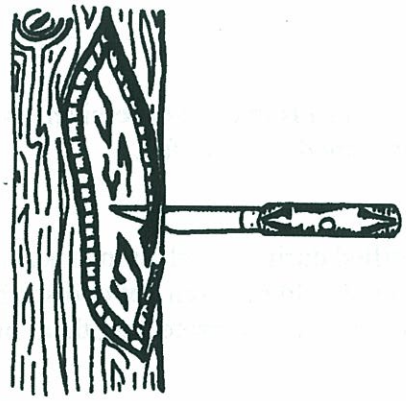
Incorrect




Correct

**Trim bark wounds with a tapered cut, then apply tree paint.**

Tree wound



Trim and taper

**Prune damaged branches with three cuts to avoid peeling bark from the tree trunk when limb falls.**

Source: North Carolina Erosion and Sediment Control Planning and Design Manual

**For structural practices:**
Follow the procedures in the selected BMP.

**Design and Implementation:**
The proper design and implementation of all BMPs used to stabilize critical areas should be done according to the specifications in the selected BMPs.

## Maintenance

**For vegetative practices:**
Periodic inspections should be scheduled to ensure the vegetation is maturing correctly and staying in place.

Once the vegetation is well established:

1. Consideration should be given to removing Construction Barriers. In some areas, it may be beneficial to leave the barriers in place.

2. Vegetation should continue to be watered, when appropriate, to a depth of 1 inch into the sod bed. Water uniformly. See the Lawn Maintenance BMP.

3. Vegetation should be mowed according to its intended use. Follow the mowing specifications in the Lawn Maintenance BMP.

4. Soil testing should be done periodically to determine if the soil requires additional fertilizer or lime. Follow specifications in the Soil Management BMP.

5. Pesticides should only be used following specifications in the Pesticide Management BMP.

6. Spot Seeding should be done as needed on small damaged areas.

**For structural practices:**
Follow maintenance procedures in the "Maintenance" section of each structural BMP.

## Specifications

**Planning Considerations:**

**For vegetative practices:**

1. All critical areas should be protected from pedestrian access using Construction Barriers.

2. If possible, divert concentrated flows away from critical areas, at least until the vegetation is established. Follow specifications in the Diversions BMP.

3. Select and apply seed and legumes according to specifications in the Seeding BMP. Be sure to select plant species which are tolerant to the site condition.

4. Mulching should be done on seeded areas according to specifications in the Mulching BMP.

5. Sodding should be done according to the Sodding BMP to stabilize areas quickly. Rows of sod can be alternated with rows of seeded areas to stabilize the area more quickly.

6. Dune/sand areas should be stabilized following specifications in the Dune/Sand Stabilization BMP.

7. Trees, shrubs and ground covers should be selected and planted based on the Trees, Shrubs and Ground Covers BMP. Note that Soil Conservation Service soil surveys include species of trees, shrubs and ground covers that work well in each soil texture.

**For structural practices:**

1. Consider using Grade Stabilization Structures to take concentrated flows from one elevation to the other.

2. Consider using Riprap on slopes adjacent to watercourses and wetlands, and Slope/Shoreline Stabilization on steep slopes and slopes adjacent to cut and fill slopes. The Slope/Shoreline Stabilization BMP includes information on seawalls/retaining walls, revetments, and gabions.

3. Consider using terraces or benches to slow runoff velocities.

4. Consider using Buffer/Filter Strips to control erosion resulting from sheet flow.

5. Subsurface Drains may be needed where water movement may cause seeps or soil slippage. Grassed Waterways may need to be tiled to ensure the vegetation is established.

**Site Preparation:**

**For vegetative practices:**

1. Soil tests should be done to determine the nutrient and pH content of the soil. Depending on the results of soil tests, Soil Management may be necessary to adjust the soil pH to between 6.5 and 7.0 (for most conditions). All soil deficiencies should be addressed following the Soil Management specifications.

2. Follow the site preparation sections in the BMPs being used for vegetative establishment.

# Stream Bank Stabilization

updated September, 1997

## Description

This BMP discusses the thought process that should be used when eroding stream banks are deemed in need of stabilization. Emphasis is placed on stabilization at the watershed level first, then individual sites. Several systems of BMPs are discussed, with reference to specific BMPs. Emphasis is given to "softer", less rigid structures.

In all aspects of stream bank erosion—from source and cause identification to design and implementation of BMPs—people are encouraged to work with Department of Environmental Quality (DEQ) Nonpoint Source staff in Surface Water Quality Division, or with other stream bank experts.

Note that all stream bank stabilization activities will require permits from the Department of Environmental Quality, Land and Water Management Division. For a discussion on the use of gabions, seawalls and retaining walls, groins, shoreline revetments, and breakwalls, see the Slope/Shoreline Stabilization BMP.

## Other Terms Used to Describe

Armoring
Revetments
Riprapping (Note that Riprap is a separate BMP)
Soil Bioengineering/Bioengineering
Stream Bank Protection

## Pollutants Controlled and Impacts

Stabilizing stream banks can:

* Prevent the loss of land or damage to utilities, roads, buildings or other facilities adjacent to a watercourse, and prevent the loss of stream bank vegetation,
* Reduce sediment loads to streams,
* Maintain the capacity of the stream channel,
* Improve the stream for recreational use or as habitat for fish and wildlife, and
* Control unwanted meander of a river or stream.

## Application

Land Use
This practice is applicable to all land uses.

Soil/Topography/Climate
The site-specific stream bank practices used will be partially dependent upon the types of soils present, the slope of the bank, gradient of the river, flow, and uses of the watercourse.

When to Apply
The appropriate time to apply stream bank erosion controls is dependent upon the method used. Some seasonal limitations are included in the specifications of referenced BMPs.

Where to Apply
Apply this practice in areas where stream banks are eroding.

## Relationship With Other BMPs

Geotextile materials (Filters) are often used underneath Riprap.

## Specifications

Since each reach of a watercourse is unique, stream bank protection techniques must be selected on a site-by-site basis; the specifications for each technique differ. The following is guidance which can be used to determine appropriate stream bank erosion control practices.

**Planning Considerations:**
It is important to remember that streams are dynamic. Even without human influence streams may meander, and in the process, cause banks to erode. Therefore, not all eroding banks are "bad" and in need of repair. In fact, the wrong system of BMPs installed in the wrong place may cause more damage downstream (and therefore to the entire stream system) than leaving the stream in its natural state. For example, "hard structures" like large riprap or gabions, placed on one eroding bank, can displace the stream's energy downstream to a previously stable bank, causing the downstream bank to erode. If this downstream bank is also stabilized with a hard structure, the stream's energy may be moved further downstream to another previously stable bank, and so on.

So before stabilizing stream banks, consider the cause of the stream bank erosion. If the banks are eroding due to a natural meander, then it may be best to leave the bank alone. If the banks are eroding due to fluctuations in hydrology, the hydrologic fluctuations should be addressed before the banks are stabilized.

Once the cause of erosion is addressed, determine the goal in stabilizing the stream banks. Some banks are stabilized to protect buildings and land. Others are stabilized to keep soil from entering the stream and to allow angler access to the stream. The purpose for stabilizing the banks and the users of the stream will help determine the type of structures needed.

Once the above concerns have been addressed, then it is important to work with agencies with expertise in stream bank erosion techniques to address stream bank erosion at the watershed level. Looking at the entire watershed will help prioritize bank stabilization efforts. If you are only interested in site-specific alternatives, please turn to "Methods" on page 5.

**1) compile land use data on the watershed** to determine if there is a direct link between land use and soil erosion. For example, land in livestock production can be a source of sediment if the livestock have direct access to the stream. If land uses are being converted from agriculture to urban, the increased impervious areas may cause increased flows to the stream, which may scour stream banks and cause erosion. Put simply, land uses can help pinpoint potential sources of erosion.

The DEQ, Land and Water Management Division's Michigan Resource Information System (MIRIS) database contains information on the soils, land uses, streams, roads and other features in watersheds throughout the state. Keep in mind that as of the date of this printing, MIRIS data was based mostly on 1978 land use data. Many Soil Conservation District offices also have land use data (often based in part on the MIRIS). Several universities have sophisticated land use decision-making ca-

pabilities (which may include MIRIS data), as well as the capabilities to determine future land uses based on current trends.

Other important sources of land use information include topographic maps of the area, soil maps (if available), and aerial photos. These will show the pattern of the river as it meanders through the watershed. Comparing recent aerial photos to historic photos will also help determine if the river is widening, meandering or otherwise in a state of change.

**2) Field verify the data.** Because land uses change, it is important to field verify land use data in order to ensure decisions are made based on current and accurate information. This is particularly important in rapidly developing areas. Field verify data by walking or canoeing the entire river, or, if granted permission by property owners, by walking the stream banks. If you're not familiar with the river or stream, contact the DEQ, Surface Water Quality Division or Land and Water Management Division, or DNR, Fisheries Division to find out if the stream is wadable. In National Forest Service lands, contact the US Forest Service. These and other agencies will likely have some information on the stream you're interested in.

When you go out in the field, take a measuring tape, clipboard, pencil or waterproof pen, and multiple copies of the attached worksheet (Exhibit 1). A camera is also important when discussing site-specific conditions with other people. On wadable streams, take hip boots or waders. Use the attached worksheet while noting the specific areas of stream bank erosion. Note soil type and any log jams, construction activities, eroding road crossings, and improper stream access (e.g. cows in the water, areas where people have accessed the river for recreational opportunities, etc.). Where possible, measure the length and height of the eroded stream banks.

Back in the office, incorporate your visual observations with the land use data. Ideally, this will be done by incorporating your notes into the land use database.

**3) Estimate the magnitude of the erosion and all potential sources of erosion**. Sources of sediment to the stream may include angler access, livestock access, or poorly maintained or improperly designed road crossings. The magnitude of the erosion can be determined by ranking each site as severe, moderate or minor, using the attached field sheet (Exhibit 1). Use of the Universal Soil Loss Equation is discussed in an appendix of the Guidebook of BMPs.

**4) Rank the sites.** At its simplest, ranking sites can be based on addressing the most severe sites first and working from upstream to downstream, including tributaries. Another alternative is to rank sites based on four criteria: 1) degree of impact (severe, moderate, minor); 2) the cost of installing the system of BMPs needed; 3) landowner willingness to cooperate; and 4) "demonstration-ability." (i.e. amount of public visibility). "Demonstration-ability" is important if you plan to solicit volunteers or funding for stabilization efforts. This site ranking method was used in the Bear Creek watershed, Kent County.

**5) Determine appropriate options for the high priority sites.** Use the information gathered on land use and from visual observations (including photos) to evaluate stream bank stabilization alternatives. The BMPs selected should also help to achieve the overall goals for the watershed (such as improving fish habitat or providing greater recreational access). Review the scenarios below, the various Methods on page 5, and then contact stream bank experts to discuss site-specific options.

**Stream Bank Stabilization Scenarios:**
The following hypothetical scenarios illustrate various alternatives for stream bank stabilization:

Scenario 1: Visual observations show several minor stream bank erosion sites. Erosion was determined to be caused by stream flow. The amount of human influence on flow is low (i.e. it is naturally "flashy" versus flashiness caused by increased flow from urbanization). The decision in this case is to leave the eroding banks alone.

Scenario 2: Comparing aerial photos from 1938 and 1990 shows that the stream hasn't meandered much, yet there are hundreds of banks along the stream that are bare, mostly due to angler and canoeist access. The stream is a high quality trout stream and local people hold the river in high esteem. Since sediment is detrimental to trout habitat, the decision was made to stabilize stream banks in this watershed, providing access via stairways and canoe landings, and restricting access via practices such as fencing and brush mulch. Since the greatest reduction in sediment load will be gained by stabilizing severe sites, the most severe banks will be stabilized first, going from upstream areas, downstream. If more money becomes available, then moderate sites would be stabilized, again, starting upstream.

Scenario 3: The predominant land use is urban. Severe erosion is observed downstream of the urban area. In this hydrologically unstable area a stormwater management plan will be developed in conjunction with or prior to stream bank stabilization to reduce extreme hydrologic fluctuation and velocities. In this example, the decision was also made to work on an ordinance which would address stormwater practices to prevent additional flows to the stream.

Scenario 4: The predominant land use is agricultural. Moderate and severe bank erosion is occurring at several livestock access areas. In this example, cattle exclusion systems, including fencing and alternative watering areas, were designed and implemented in conjunction with stream bank stabilization techniques.

Scenario 5: Visual observations and historical aerial photographs show the stream to be relatively stable. Most of the adjoining land is rural/agricultural but is expected to experience 35% growth in the next 15 years: therefore, additional flows to the stream are expected. Two new road crossings are causing severe erosion downstream of the crossings. The decision was made to stabilize the banks downstream of the new crossings with structures which help absorb some of the energy from stream flow (see soil bioengineering structures, below). The decision was also made to work with the road commission so that future road designs would be done such that downstream areas are not impacted. An ordinance to provide on-site detention/retention of stormwater from the newly constructed area was also proposed.

**Other Things to Consider**
In selecting site-specific options to stabilize eroding stream banks, consult the Michigan Department of Environmental Quality (Surface Water Quality Division or Land and Water Management Division), local Conservation District, or other agencies or consultants experienced in stream bank erosion control. Also, be sure to check Exhibit 2 to see if your river is included on the list of Natural or Wild and Scenic Rivers. These rivers have special restrictions, depending on their designation. Contact the MDEQ, Natural Rivers Program staff for further information on the types of stream bank practices that can be used in Natural Rivers.

It is also important to get input from the people who may use the watercourse at the specific site in need of stabilization, (i.e. river boat guides, anglers, canoeists, etc.). Consider working through a local watershed steering committee, if available. These committees include representatives from a variety of backgrounds and interests.

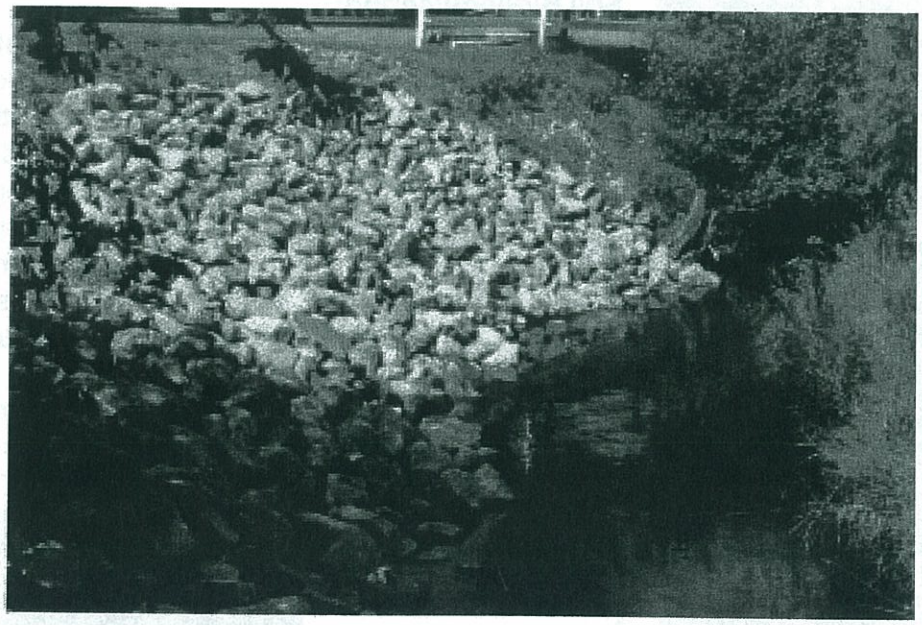
**NOTE: While considering BMP options, remember that no removal of sediment bars, snags, stumps, debris drifts, trees, brush or similar material should be done unless absolutely necessary, and upon approval by the MDEQ, Land and Water Management Division.** This in-stream cover is necessary for channel diversity and aquatic habitat.

**Methods:**

There are numerous methods available to stabilize stream banks. Rather than discuss all of them or any of them in detail, below is a discussion of the most common practices.

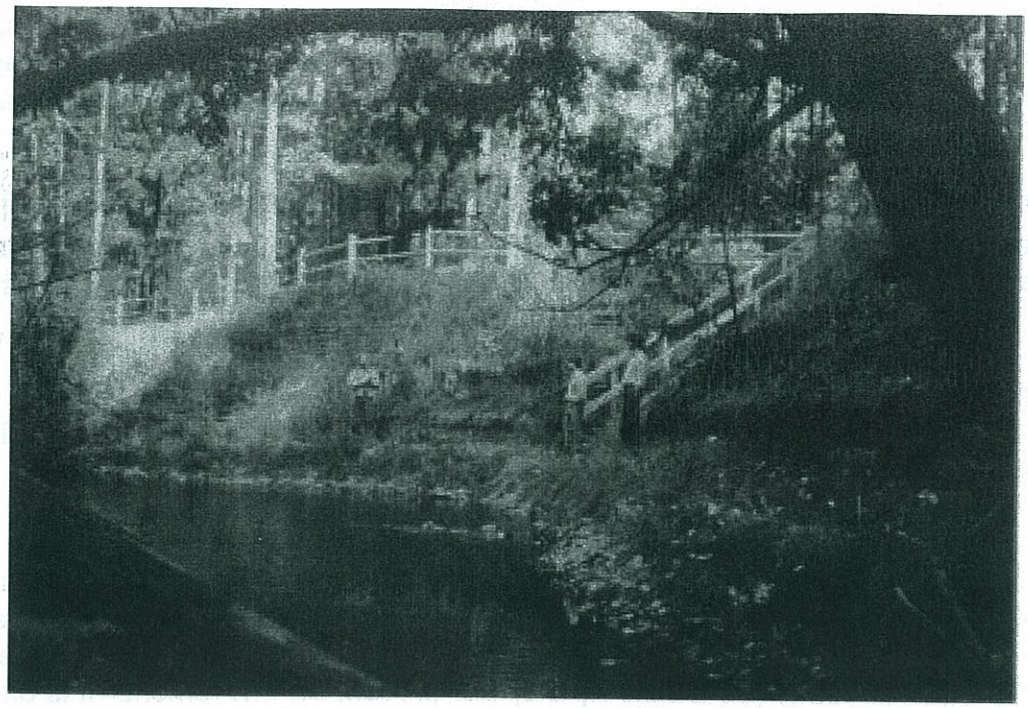
**Riprap:**

Riprap is one of the more commonly used stream bank stabilization techniques. It is a permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. It is generally used on stream banks at the toe (bottom) of the slope, with other structures placed up-slope to prevent soil movement. It is often a component of many soil bioengineering techniques. Specifications for riprap used in stream bank stabilization is discussed in the Riprap BMP.

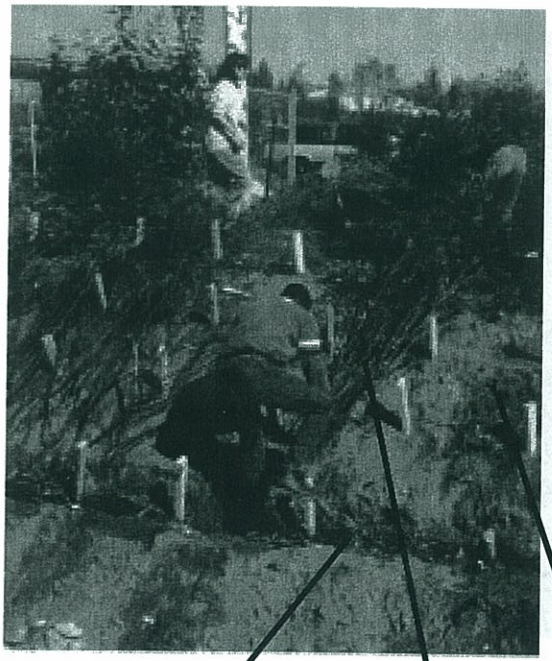


**Picture 1, above:** The bank was stabilized with rock riprap from the toe (bottom) of the bank to the top of bank. This may be needed on streams with unstable hydrology (i.e. "flashy" streams), and where banks have groundwater seeps. Source: North Branch Chippewa River Nonpoint Source Project.

The Department supports the use of natural fieldstone for riprap; only natural fieldstone is allowed in rivers designated under the Natural Rivers program. The use of vegetation in conjunction with riprap is encouraged to "soften" stream bank structures.



**Picture 2, right:** Riprap was placed to 3 feet above the ordinary high water mark and a portion back-filled with soil. Log terraces were placed on the bank and the bank was seeded. This approach can be used on top of fish lunker structures and on banks where stream flows are relatively stable. Also note the fence and stairway to direct recreationist access. Source: Boardman River Nonpoint Source Project.



fascine

brush layering

live stake

**Soil Bioengineering:**

Soil bioengineering is a method of using vegetation to stabilize a site with or without structural controls. Some refer to bioengineering as softening the traditional rock-the-bank approach because non-invasive vegetation is used to blend the site into its surrounding landscape. Bioengineering techniques may be as simple as using stop-logs to form terraces, then seeding exposed soil to help prevent soil movement. Techniques also include using fascines (long bundles of willow or dogwood), with layers of brush, along with individual plantings.

**Picture 3, left**, shows a fascine, brush layering and live stakes. **Picture 4, below,** shows new growth from a live stake. Source: Whetstone Creek Nonpoint Source Watershed Project.

Chapter 18 of the USDA Soil Conservation Service (now Natural Resource Conservation Service (NRCS)) Engineering Field Handbook is one of the most comprehensive sources of information on soil bioengineering. Chapter 18 describes soil bioengineering as a combination of biological and ecological concepts to arrest and prevent shallow slope failures and erosion. Rather than duplicate NRCS' efforts to describe soil bioengineering techniques here, people interested in exploring soil bioengineering are encouraged to work with the NRCS, MDEQ, and other agency staff familiar with bioengineering practices.

As another example of a system of practices used to stabilize a bank, refer to Picture 2. In addition to riprap, seed and log terraces, the system of BMPs on the bank in Picture 2 included fencing to direct foot traffict, and a set of stairs.

## Maintenance

A maintenance plan should be included with all site plans. The maintenance plan should indicate when inspections of the site will be made and who will be responsible for needed maintenance. Site inspections, conducted to ensure the stream bank structures are staying in place, are particularly important within the first few months of installation, and following storm events which result in bankfull streams. More specific maintenance procedures can be found in the referenced BMPs.

## Exhibits

Exhibit 1: Field Data-Entry Form which can be used in the stream bank erosion inventory, Northwest RC&D Council. (This type of approach has been used to identify and rank eroding sites on the Muskegon, Au Sable, Pine and Betsie Rivers).

Exhibit 2: Michigan's Natural Rivers System. List of rivers designated or proposed under the Natural Rivers program.

# Field Data-Entry Form for Stream Bank Erosion Inventory

This form is intended to be used to compare the severity of eroding stream banks within a watershed. Results can be used to help prioritize stream bank stabilization efforts. Fill in all known information. Where provided, fill in the appropriate number per each category, then total the "points" on the last page.

Date: _____
County: _____
Stream: _____
Observer: _____

SITE LOCATION:
Township Name: _____ No. _____ Range ____ Sec. ____
Bank (right or left, looking downstream): _____
Property Owners: _____
Other info re: location: _____
Accessibility for machinery/materials (good/bad)
Access Problems:_____

SITE NUMBER: _____

MEAN WIDTH OF RIVER: _____
(no points)

CONDITION OF BANK:

| | | |
|---|---|---|
| | 5 | Toe and upper bank eroding |
| | 3 | Toe undercutting |
| _____ | 1 | Toe stable, upper bank eroding |

| | | |
|---|---|---|
| | 5 | Length of eroding bank > 50 ft. |
| | 3 | Length of eroding bank 20-50 ft. |
| _____ | 1 | Length of eroding bank < 20 ft. |

| | | |
|---|---|---|
| | 5 | Side slope vertical 1:1 |
| | 3 | Side slope 2:1, 3:1 |
| _____ | 1 | Side slope 4:1 or flatter |

PROBLEM TREND

| | | |
|---|---|---|
| | 5 | Increasing |
| _____ | 1 | Decreasing or stable |

(continued, next page)

DEPTH OF RIVER

| | | |
|---|---|---|
| | 1 | > 3 feet |
| _____ | 2 | < 3 feet |

VEGETATIVE COVER

| | | |
|---|---|---|
| | 5 | Vegetative cover 0-50% |
| | 3 | Vegetative cover 50-80% |
| _____ | 1 | Vegetative cover 80-100% |

MEAN HEIGHT OF BANK

| | | |
|---|---|---|
| | 5 | Mean height of bank > 20 ft. |
| | 3 | Mean height of bank 10-20 ft. |
| _____ | 1 | Mean height of bank < 10 ft. |

SOIL TYPE OR TEXTURE

| | | |
|---|---|---|
| | 3 | Sand |
| | 2 | Gravel |
| | 2 | Stratified |
| _____ | 1 | Clay or loam |

APPARENT CAUSE OF EROSION

| | |
|---|---|
| | 1-Light access traffic |
| | 1-Obstruction in river |
| | 1-Bank seepage |
| | 1-Gullying by side channels |
| | 2-Bend in river |
| | 3-Road-stream crossing, grade/shoulder runoff |
| | 3-Moderate access traffic |
| | 5-Heavy access (foot, horse, etc.) traffic |
| _____ | 5-Construction site erosion |

_____ TOTAL POINTS:

more than 36 — severe
30-36 — moderate
less than 30 — minor

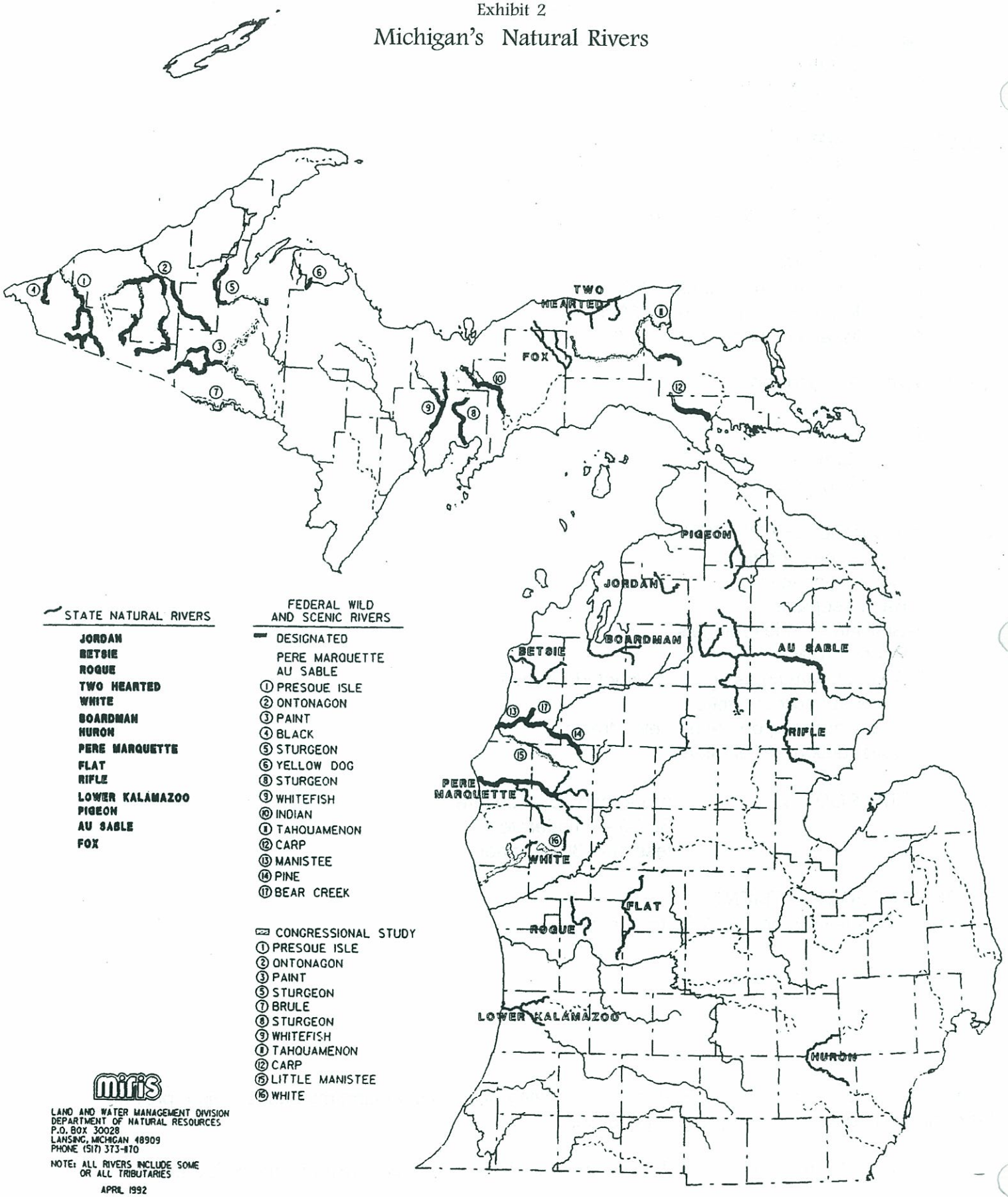
RECOMMENDED TREATMENT
Describe a potential system of BMPs for the site:

NOTE: Sketch location on a separate sheet, showing any unusual circumstances. Also, provide black-and-white or color photograph, if possible.

Source: Modified from the inventory sheet used in the Upper Manistee Stream Bank Erosion Inventory.

Exhibit 2

# Michigan's Natural Rivers




STATE NATURAL RIVERS

- JORDAN
- BETSIE
- ROGUE
- TWO HEARTED
- WHITE
- BOARDMAN
- HURON
- PERE MARQUETTE
- FLAT
- RIFLE
- LOWER KALAMAZOO
- PIGEON
- AU SABLE
- FOX

FEDERAL WILD AND SCENIC RIVERS

DESIGNATED
PERE MARQUETTE
AU SABLE

1. PRESQUE ISLE
2. ONTONAGON
3. PAINT
4. BLACK
5. STURGEON
6. YELLOW DOG
8. STURGEON
9. WHITEFISH
10. INDIAN
11. TAHQUAMENON
12. CARP
13. MANISTEE
14. PINE
17. BEAR CREEK

CONGRESSIONAL STUDY

1. PRESQUE ISLE
2. ONTONAGON
3. PAINT
5. STURGEON
7. BRULE
8. STURGEON
9. WHITEFISH
11. TAHQUAMENON
12. CARP
15. LITTLE MANISTEE
16. WHITE

miris

LAND AND WATER MANAGEMENT DIVISION
DEPARTMENT OF NATURAL RESOURCES
P.O. BOX 30028
LANSING, MICHIGAN 48909
PHONE (517) 373-870

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# WETLAND ASSESSMENT REPORT

# ENBRIDGE PIPELINES, INC. TALMADGE CREEK OIL SPILL PROJECT

## FREDONIA TOWNSHIP

## CALHOUN COUNTY, MICHIGAN

*Prepared for:*

Enbridge Pipelines, Inc.

August 2010

URS

URS Corporation
3950 Sparks Drive SE
Grand Rapids, Michigan 49546

**URS Project No. 12942585**

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# SECTIONONE Introduction

A wetland delineation was performed by URS Corporation staff on behalf of Enbridge, Inc in support of the excavation of contaminated soils associated with the Talmadge Creek oil spill. Approximately 2.84 acres of proposed excavation area located in Fredonia Township, Calhoun County, Michigan was delineated for the proposed excavation of contaminated soils. The proposed excavation area is located in Fredonia Township within Calhoun County, Michigan. See **Figure 1** for a Site Location Map.

On July 30, 2010, Mr. Brendan Earl, Environmental Scientist for URS Corporation, conducted a wetland delineation of approximately 6.61 acres of proposed excavation area. The wetlands were overlaid onto available maps of the proposed project area. **Figure 3** is included as the Wetland Delineation Map.

The wetland delineation was completed using guidance manuals and procedures set forth by the Michigan Department of Natural Resources and Environment (MDNRE) and the United States Army Corps of Engineers (USACE). Methods and procedures used for this delineation are in accordance with Part 303, Wetlands Protection, of Act 451 Natural Resources and Environmental Protection Act (NREPA), as amended (1994). A permit is required for any dredging, draining, filling, or maintained use or development activities within regulated wetlands as defined by Part 303.

# SECTION TWO Methodology

## 2.1 MAP RESOURCE INVESTIGATION

Soil surveys, aerial photographs, topographic maps, MDNRE's Wetland Inventory maps, and National Wetlands Inventory (NWI) maps were reviewed prior to conducting the field work for indications of surface water, wetlands, physical features, and hydric soils within the study areas.

## 2.2 CRITERIA FOR WETLAND INVESTIGATION

The wetland investigation was performed in accordance with the USACE *Wetlands Delineation Manual* (1987), the USACE *Draft Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region* (2008), and the MDNRE *Michigan Wetland Identification Manual* (2001). The USACE Manual follows a three-parameter approach to making wetland determinations and generally requires that one positive wetland indicator from each parameter (vegetation, soil, and hydrology) be found on the site to make a wetland determination. The MDNRE Manual generally requires positive indicators for hydrophytic vegetation and wetland hydrology. Evidence of wetland hydrology can be supported by observed hydric soils in the wetland. A summary of the vegetation, soils, and hydrology within the study area are discussed in the following paragraphs.

Methods and procedures used for this delineation are in accordance with Part 303, Wetlands Protection, of Act 451 the Natural Resources and Environmental Protection Act (NREPA), as amended (1994). Wetlands were classified in accordance with the U.S. Fish and Wildlife Service based on Cowardin et al.'s *Classification of Wetlands and Deepwater Habitats of the United States* (1979). Although procedures for making wetland determinations in the field are standardized, wetlands are often transitional areas between aquatic and upland habitats. Wetland delineations were made using the parameters as defined in the USACE Manual and MDNRE Manual and the best professional judgment of the field personnel at the time of the delineation. The wetland boundaries may be subject to final field delineation and verification by the MDNRE.

### 2.2.1 Hydrophytic Vegetation

Dominant plant species observed in the wetlands within the study area were identified and the wetland indicator status for each species was determined from the *National List of Plant Species that Occur in Wetlands: North Central-Region 3* (USFWS, 1988). The indicator status

designates the probability of a given plant species to occur in regional wetlands. According to the USACE Manual, an area has hydrophytic vegetation when more than 50 percent of the dominant plant species present have a wetland indicator status of OBL, FACW+, FACW, FACW-, FAC+, or FAC.

### 2.2.2 Hydric Soils

A hydric soil is a soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. A hydric soil may either be drained or undrained, although a drained hydric soil may not continue to support hydrophytic vegetation. According to the MDNRE Manual, when a hydric soil supports hydrophytic vegetation and the area has indicators of wetland hydrology, the soil is referred to as a wetland soil. Hydric soils are typically determined by soil colors at diagnostic depths. Soil pits are excavated to a depth of approximately 16 inches with a sharpshooter shovel. Soils are then visually analyzed using the Munsell® Soil Color Charts (2000). Munsell chroma values of two or less with mottles or inclusions and/or gleyed colors commonly indicate the presence of hydric soils. Other field indicators of hydric soils are aquic moisture regime, organic streaking in sand, histic epipedons, reducing soil conditions, and iron and manganese concretions.

### 2.2.3 Hydrologic Indicators

Indicators of wetland hydrology are usually present in areas that are periodically inundated or have soils saturated to the surface at some time during the growing season. Areas that are inundated or saturated for sufficient duration tend to develop hydric soils and support vegetation typically adapted for life in anaerobic conditions. These indicators of wetland hydrology include drainage patterns, drift lines, sediment deposits, water marks, and visual observation of saturated soils, surface water, or inundation. Water supply to the wetlands in the study area depends on precipitation, runoff, and groundwater recharge. Hydrologic indicators observed in the study area were noted during the field investigation.

# SECTION THREE Results and Conclusions

On July 30, 2010, Mr. Brendan Earl, Environmental Scientist for URS Corporation, conducted a wetland delineation of approximately 6.61 acres of the proposed excavation area. One regulated wetland was identified within the project area. Approximately 2.84 acres of Wetland A will be impacted by the excavation activities. **Figure 1** is a Site Location Map and **Figure 3** is a map of the Wetland Delineation boundaries. Photographs of the wetlands are included in **Appendix A**. Additional details of the vegetation, hydrology, and soils within the study area are available in the attached Field Data Sheets **Appendix B**.

## 3.1 MAP RESOURCE INVESTIGATION

According to the *Calhoun, Michigan* 7.5-minute United States Geological Survey (USGS) quadrangle (1985), elevations in the proposed excavation are, as identified on U.S. Geological Survey (USGS) topographic maps, range from 920 to 930 feet above sea level. Topography in the excavation area ranges from mostly flat to slightly sloping. The slope ranges from 0 to 6 percent. The topographic map is included as **Figure 1.**

NWI maps were reviewed for the presence of wetlands within the proposed project area. The NWI map includes four wetland complexes of which one is composed of bottomland forest (PFO), one is a scrub/shrub habitat (PSS), and two are emergent wetlands (PEM). However, the wetland complexes located on the NWI map that were field verified were the emergent and forested wetland habitats within the project area. The NWI map is included as **Figure 4.**

Floodplains within the project area are located along Talmadge Creek. The Floodplain map is included as **Figure 5**.

Soil survey data, as described in the *Web Soil Survey of Calhoun County, Michigan* (USDA, 2009), was reviewed for the presence of hydric soils within the study areas. A summary of the soil types located within the proposed project area is included in **Table 1**. There are ten soil types mapped to the project area and three of those soils are listed on the Hydric Soils List from *the Soil Survey Geographic (SSURGO) database for Calhoun County, Michigan.*

## 3.2 FIELD INVESTIGATION

One wetland was delineated within the project area. Wetland A is an emergent and forested wetland along Talmadge Creek. Wetland A will be impacted with approximately 2.84 acre of

impact by excavation activities. The delineated wetland area and its associated positive wetland indicators are described in the following paragraphs. Additional details regarding the wetland are available in the Field Data Sheet (**Appendix B**). The location, area and type of wetland are depicted in **Figure 2**.

### 3.2.1 Description of Wetlands

Wetland A is located along the north bank of Talmadge Creek and into the forest upstream of the spill area. Wetland A includes a marginal emergent (PEM) wetland complex located along the north bank of Talmadge Creek downstream of the spill area and a forested wetland fringe (PFO) located upstream of the spill area.

Vegetation within the PEM area includes reed canary grass (*Phalaris arundinacea*, FACW+), narrow leaf cattail (*Typha angustifolia*, OBL ), spotted joe-pye-weed (*Eupatoriadelphus maculatus*, OBL), sensitive fern (*Onoclea sensibilis*, FACW), marsh fern (*Thelypteris thelypteroides,* FACW+), water hemlock (*Cicuta maculata*, OBL), gray dogwood (*Cornus racemosa*, FAC), Virginia creeper (*Parthenocissus quinquefolia*, FAC-), and boneset (Eupatorium perfoliatum, FACW+). Hydrology indicators include drainage patterns and saturated soils. Soils in the PEM wetland were highly contaminated due to the oil spill, therefore, no samples were collected however, soil appeared to be a clay loam from 0-16 inches.

Vegetation within the PFO area includes sensitive fern (*Onoclea sensibilis*, FACW), reed canary grass (*Phalaris arundinacea*, FACW+), gray dogwood (*Cornus racemosa*, FAC), silky dogwood (*Cornus amomum* FACW+), green ash (*Fraxinus pennsylvanica*, FACW), and Virginia creeper (*Parthenocissus quinquefolia*, FAC-). Hydrology indicators include approximately 4-inches of inundation, saturated soils, and drainage patterns. Soils in the PFO wetland area were highly contaminated due to the oil spill, therefore no samples were collected, however, soil appeared to be a loam from 0 to 16 inches.

## 3.3 CONCLUSIONS

On July 30, 2010, Mr. Brendan Earl, Environmental Scientist for URS Corporation, conducted a wetland delineation of approximately 6.61 acres of the proposed excavation area. One regulated wetland was delineated within the project area.

# SECTION THREE Results and Conclusions

Approximately 2.84 acres of Wetland A will be impacted by the excavation activities. This wetland was an emergent and forested wetland associated with Talmadge Creek. Please be advised that the physical characteristics of the project area can change and are dependent on factors such as weather, drainage alterations, and the time of the year the wetland delineation was performed. Additionally, due to health and safety concerns and site accessibility issues present at the time of the delineation the extent of the wetland impacts may change.

# SECTIONFOUR References

Barnes, Burton V., and Wagner, Warren H. Jr., *Michigan Trees – A Guide to the Trees of the Great Lakes Region*, The University of Michigan Press, Ann Arbor, MI, 2004.

Chadde, Steve W., *A Great Lakes Wetland Flora*, Second Edition, PocketFlora Press, Laurium, MI, 2002.

Cowardin, L., V. Carter, F.Golet, and E. La Roe., *Classification of Wetlands and Deepwater Habitats of the United States*. United States Fish and Wildlife Service, Washington, DC. 1979.

Environmental Laboratory, 1987 *Corps of Engineers Wetlands Delineation Manual.* Technical Report Y-87-1, United States Army Engineer Waterways Experiment Station, Vicksburg, MS, 1987.

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Newcomb, Lawrence, *Newcomb's Wildflower Guide*, Little, Brown, & Company, Canada, 1977.

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US Fish and Wildlife Service (USFWS), *National List of Plant Species that Occur in Wetlands: North Central (Region 3)*, Biological Report 88(23.6), May 1988.

US National Fish and Wildlife Service (USFWS), *National Wetlands Inventory Map,* 2006.

US Department of Agriculture, *Soil Survey of Calhoun, Michigan*, Issued 1992.

US Department of Agriculture, *Munsell® Soil Color Charts*, Revised 2000.

US Geological Survey (USGS), 7.5-minute quadrangle *Calhoun County, Michigan,* 1985.

# SECTIONFIVE Corporate and Professional Qualifications

URS has been a worldwide provider of comprehensive environmental and other specialized consulting and engineering services for more than 100 years. The Corporate Headquarters for URS is in San Francisco, California. The company has more than 200 offices in 20 countries, and is staffed by over 30,000 professional and support personnel.

Mr. Brendan Earl, Environmental Scientist for URS performed the wetland delineation, data acquisition and reporting. Mr. Brendan Earl is a qualified environmental professional with extensive environmental experience and training from the URS office located in Grand Rapids, Michigan.

Sincerely,

**URS Corporation Great Lakes**

Kas Permaff for

Sherry Slocum
Manager, Ecological Services Group

Brendan Earl
Environmental Scientist

# Figures


**Figure 1. Site Location and USGS Topographic Map**

**Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan**

**Township 03S Range 06W Section 2**

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/


ENBRIDGE

0 0.03 0.06 0.09 0.12 Miles

**Enbridge Energy, Limited Partnership**
**MP 608 - Marshall, MI**

**Release Area Site Base Map**

| | |
|---|---|
| DATE ISSUED: | July 31, 2010 |
| DATE REVISED: | |
| SCALE: | 1:1,000 |
| DRAWN BY: | NMS/JPM |
| SERIES: | |

**FIGURE 2**

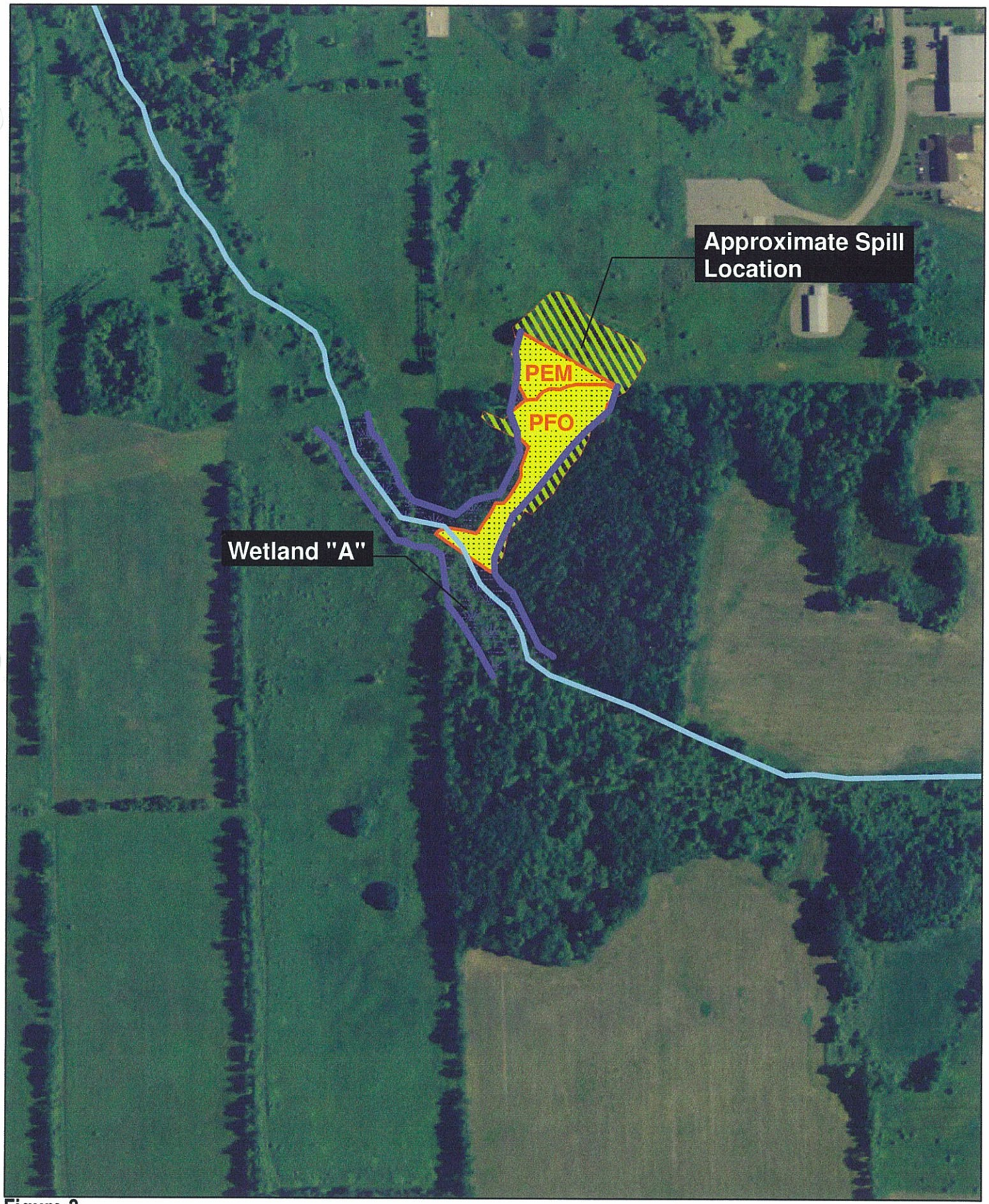


**Figure 3.**
**Wetland Delineation Map**
**Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan**

Talmadge Creek | URS Wetland Delineation | Wetland Impact | Spill Area

N

**Township 03S**
**Range 06W Section 2**

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

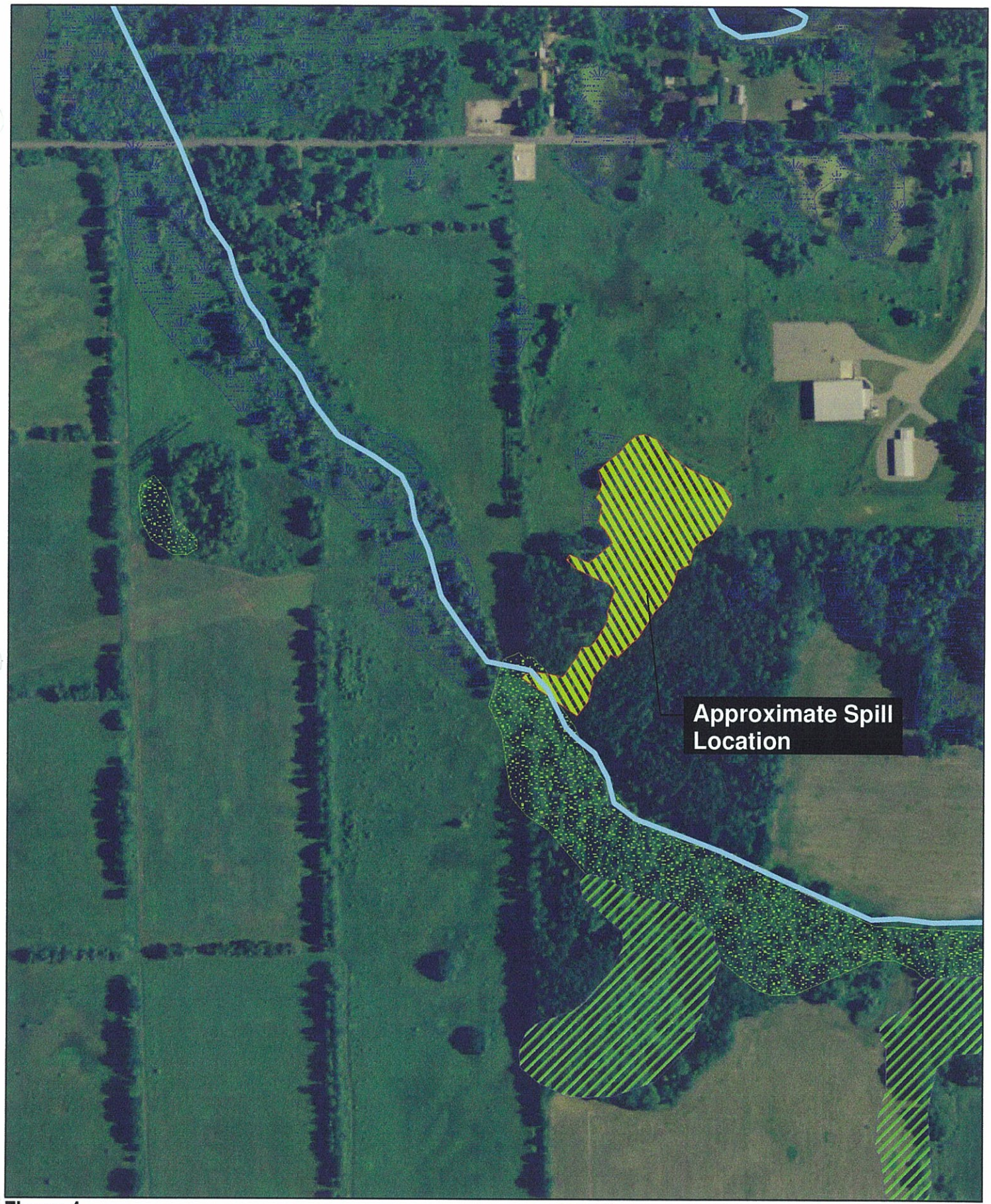


**Figure 4.**
**National Wetland Inventory (NWI) Map**
**Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan**
**Township 03S**
**Range 06W Section 2**

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

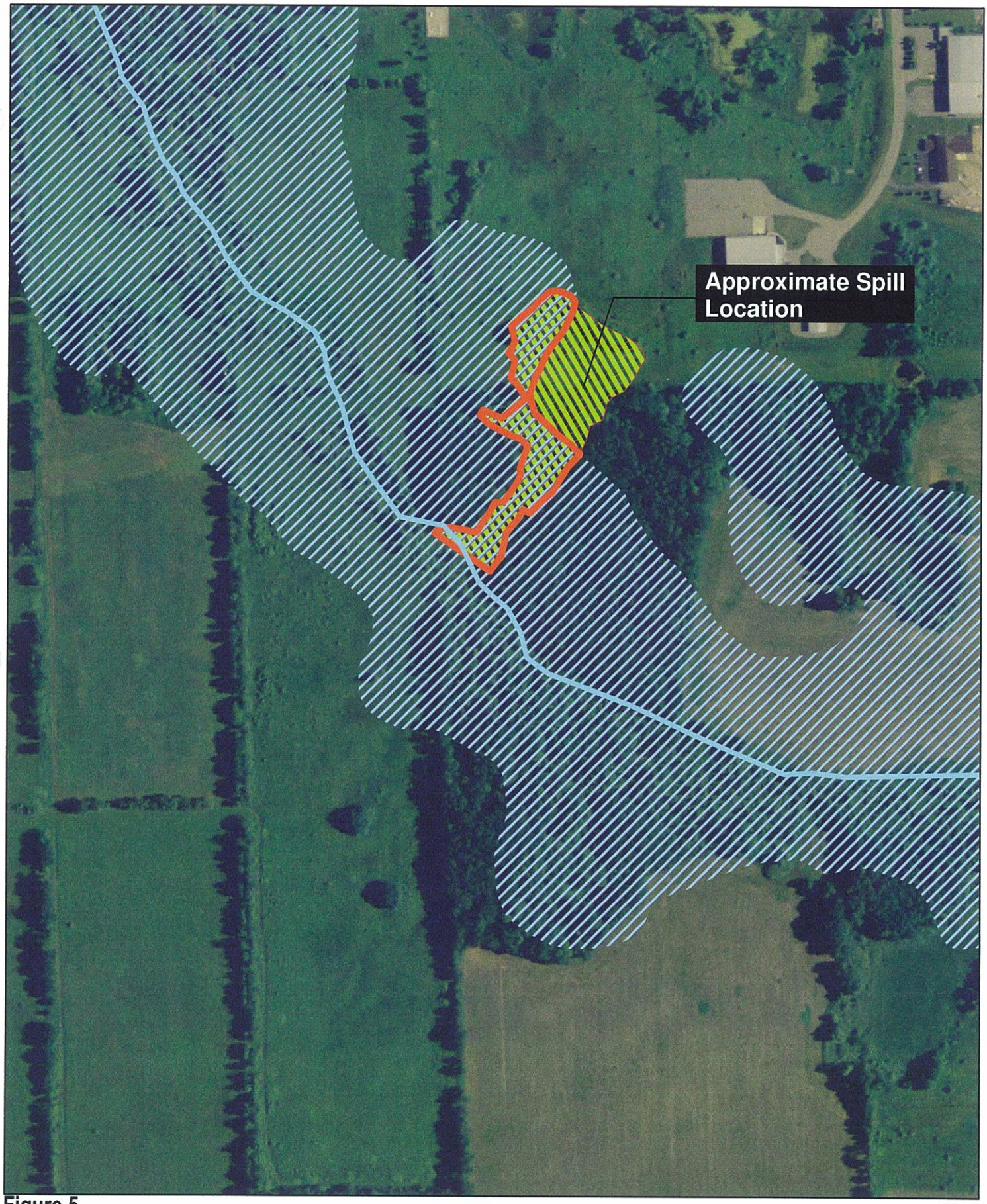


**Figure 5.**
**FEMA FIRM Floodplain Map**
**Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan**
**Township 03S**
**Range 06W Section 2**

Talmadge Creek | 100 Yr Floodplain Impact | Spill Area | 100 Yr. Floodplain

N

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/


**Figure 6. Soil Survey Map**

Talmadge Creek | Hydric Soils | Spill Area

N

## Enbridge Inc., Talmadge Creek Oil Spill, Fredonia Township, Michigan

**Township 03S**
**Range 06W Section 2**

0 200 400 800 Feet

URS

Created for: Enbridge Created by: JPB, URS Corp. Project , August 1, 2010
Data Source: http://www.mcgi.state.mi.us/mgdl/, http://datagateway.nrcs.usda.gov/

# Tables

TABLE 1

**SOILS MAPPED TO THE PROPOSED PROJECT AREA**
**Enbridge Pipelines, Inc. Talmadge Creek Oil Spill**

| Soil Symbol | Soil Unit | Brief Description of Soil Unit | Hydric? (Y/N) |
|---|---|---|---|
| **2** | **Houghton Muck** | **This soil has 0 to 2 percent slopes. This soil is very poorly drained and has no frequency of flooding and frequent ponding.** | **Y** |
| **4** | **Adrian Muck** | **This soil has 0 to 2 percent slopes and is very poorly drained. There is no frequency of flooding and frequent ponding and moderately high water capacity.** | **Y** |
| 13B | Spinks loamy sand | This soil has 0 to 6 percent slopes and is well drained. The soil is not flooded or ponded and has high available water capacity. | N |
| 14B | Bronson sandy loam | This soil has 0 to 6 percent slopes and is moderately well drained. This soil has no frequency of flooding or ponding and high available water capacity. | N |
| 16B | Oshtemo sandy loam | This soil has 0 to 6 percent slopes and well drained. This soils is not flooded or ponded, and has high available water capacity. | N |
| 16C | Oshtemo sandy loam | This soil has 6 to 12 percent slopes and is well drained. The soils is not flooded or ponded and has high available water capacity. | N |
| 25A | Kalamazoo loam | This soil has 0 to 2 percent slopes. This soil is well drained, is not flooded or ponded, and has high available water capacity. | N |
| 25B | Kalamazoo loam | This soil has 2 to 6 percent slopes. This soil is well drained, is not flooded or ponded, and has high available water capacity. | N |
| 43B | Brandy sandy loam | This soil has 1 to 4 percent slopes and is somewhat poorly drained. This soil has high available water capacity and no frequency for flooding or ponding. | N |
| **44A** | **Matheron loam** | **This soil has 0 to 3 percent slopes and is somewhat poorly drained. This soil is not flooded or ponded, and has high available water capacity.** | **Y** |

Notes:
1. Soil Symbol, Soil Unit, and Soil Description as obtained from the *Web Soil Survey of Calhoun County, Michigan*
2. Hydric soils as listed on Hydric Soils list from *the Soil Survey Geographic (SSURGO) database for Bureau County, Illinois.*

# APPENDIX A Photographs

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 1 | 7/30/10 |

**Direction Photo Taken:**

North

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

| Photo No. | Date: |
|---|---|
| 2 | 7/30/10 |

**Direction Photo Taken:**

Northwest

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 3 | 7/30/10 |

**Direction Photo Taken:**

East

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

| Photo No. | Date: |
|---|---|
| 4 | 7/30/10 |

**Direction Photo Taken:**

West

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 5 | 7/30/10 |

**Direction Photo Taken:**

Northwest

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

Emergent Wetland vegetation.

| Photo No. | Date: |
|---|---|
| 6 | 7/30/10 |

**Direction Photo Taken:**

Southwest

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 7 | 7/30/10 |

**Direction Photo Taken:**

West

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

| Photo No. | Date: |
|---|---|
| 8 | 7/30/10 |

**Direction Photo Taken:**

South

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 9 | 7/30/10 |

**Direction Photo Taken:**

Northeast

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

| Photo No. | Date: |
|---|---|
| 10 | 7/30/10 |

**Direction Photo Taken:**

East

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 11 | 7/30/10 |

**Direction Photo Taken:**

West

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

| Photo No. | Date: |
|---|---|
| 12 | 7/30/10 |

**Direction Photo Taken:**

Northeast

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 13 | 7/30/10 |

**Direction Photo Taken:**

North

**Description:**

Wetland A – PEM wetland associated with Talmadge Creek

| Photo No. | Date: |
|---|---|
| 14 | 7/30/10 |

**Direction Photo Taken:**

South

**Description:**

Wetland A – PFO wetland

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 15 | 7/30/10 |

**Direction Photo Taken:**

West

**Description:**

Wetland A – PFO wetland

| Photo No. | Date: |
|---|---|
| 16 | 7/30/10 |

**Direction Photo Taken:**

Southwest

**Description:**

Wetland A – PFO wetland

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 17 | 7/30/10 |

**Direction Photo Taken:**

East

**Description:**

Wetland A – PFO wetland

| Photo No. | Date: |
|---|---|
| 18 | 7/30/10 |

**Direction Photo Taken:**

Southeast

**Description:**

Wetland A – PFO wetland

URS

# PHOTOGRAPHIC LOG

| Client Name: | Site Location: | URS Project No. |
|---|---|---|
| Enbridge, Inc. | Talmadge Creek Oil Spill, Fredonia Township, Michigan | 12942585 |

| Photo No. | Date: |
|---|---|
| 19 | 7/30/10 |

**Direction Photo Taken:**

East

**Description:**

Wetland A – PFO wetland

| Photo No. | Date: |
|---|---|
| 20 | 7/30/10 |

**Direction Photo Taken:**

Southeast

**Description:**

Wetland A – PFO wetland

## WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Enbridge Line 6B City/County: Marshall/Calhoun Sampling Date: 7/30/10

Applicant/Owner: Enbridge Pipelines, Inc. State: Mi Sampling Point: A

Investigator(s): B.Earl Section, Township, Range: S2, T03S, R06W

Landform (hillslope, terrace, etc.): floodplain Local relief (concave, convex, none): concave

Slope (%): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: disturbed soils NWI classification: PEM/PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology Y significantly disturbed? Are "Normal Circumstances" present? Yes _____ No X

Are Vegetation _____, Soil _____, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

### SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

| | | | |
|---|---|---|---|
| Hydrophytic Vegetation Present? | Yes X | No _____ | **Is the Sampled Area within a Wetland?** Yes X No _____ |
| Hydric Soil Present? | Yes X | No _____ | |
| Wetland Hydrology Present? | Yes X | No _____ | If yes, optional Wetland Site ID: Wetland A |

Remarks: (Explain alternative procedures here or in a separate report.)

Wetland A is located within the Enbridge Line 6B oil spill impact area and has been disturbed greatly with oil contaminants- soils within the wetland were disturbed and a sample was not readable.

### HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one is required; check all that apply)

- X Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- X Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes X | No _____ | Depth (inches): 4 |
| Water Table Present? | Yes _____ | No _____ | Depth (inches): _____ |
| Saturation Present? (includes capillary fringe) | Yes X | No _____ | Depth (inches): _____ |

**Wetland Hydrology Present?** Yes X No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

**VEGETATION –** Use scientific names of plants.

Sampling Point: A

| Tree Stratum (Plot size: 30 ft) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. Fraxinus pennsylvanica | 60 | Y | FACW |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| | 60% | = Total Cover | |

| Sapling/Shrub Stratum (Plot size: 15ft) | | | |
|---|---|---|---|
| 1. Cornus racemosa | 25 | N | FAC |
| 2. Cornus amomum | 40 | Y | FACW+ |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| | 65 | = Total Cover | |

| Herb Stratum (Plot size: 5ft) | | | |
|---|---|---|---|
| 1. Eupatorium perfoliatum | 5 | N | FACW+ |
| 2. Typha angustifolia | 15 | Y | OBL |
| 3. Eupatoriadelphus maculatus | 10 | N | OBL |
| 4. Onoclea sensibilis | 20 | Y | FACW |
| 5. Thelypteris thelypteroides | 10 | N | FACW+ |
| 6. Cicuta maculata | 20 | Y | OBL |
| 7. Phalaxis arundinacea | 20 | Y | FACW+ |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| | 100 | = Total Cover | |

| Woody Vine Stratum (Plot size: 30ft) | | | |
|---|---|---|---|
| 1. Parthenocissus quinquefolia | 30 | Y | FAC- |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| | 30% | = Total Cover | |

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 45 | x 1 = | 45 |
| FACW species | 155 | x 2 = | 310 |
| FAC species | 25 | x 3 = | 75 |
| FACU species | 0 | x 4 = | |
| UPL species | 0 | x 5 = | |
| Column Totals: | 225 (A) | | 430 (B) |

Prevalence Index = B/A = 1.91

**Hydrophytic Vegetation Indicators:**

- ___ Rapid Test for Hydrophytic Vegetation
- X Dominance Test is >50%
- X Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

**Definitions of Vegetation Strata:**

**Tree** – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

**Sapling/shrub** – Woody plants less than 3 in. DBH and greater than 3.28 ft (1 m) tall.

**Herb** – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

**Woody vines** – All woody vines greater than 3.28 ft in height.

**Hydrophytic Vegetation Present?** Yes X No ___

Remarks: (Include photo numbers here or on a separate sheet.)

## SOIL

Sampling Point: A

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | % | Redox Features Color (moist) | % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-16 | — | | — | | | | clay-loam | Soils disturbed by oil spill - saturated with oil, no sample was readable |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators:**

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR R, MLRA 149B)**
- ___ Polyvalue Below Surface (S8) **(LRR R, MLRA 149B)**
- ___ Thin Dark Surface (S9) **(LRR R, MLRA 149B)**
- ___ Loamy Mucky Mineral (F1) **(LRR K, L)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

**Indicators for Problematic Hydric Soils[3]:**

- ___ 2 cm Muck (A10) **(LRR K, L, MLRA 149B)**
- ___ Coast Prairie Redox (A16) **(LRR K, L, R)**
- ___ 5 cm Mucky Peat or Peat (S3) **(LRR K, L, R)**
- ___ Dark Surface (S7) **(LRR K, L)**
- ___ Polyvalue Below Surface (S8) **(LRR K, L)**
- ___ Thin Dark Surface (S9) **(LRR K, L)**
- ___ Iron-Manganese Masses (F12) **(LRR K, L, R)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149B)**
- ___ Mesic Spodic (TA6) **(MLRA 144A, 145, 149B)**
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

**Restrictive Layer (if observed):**

Type: _____

Depth (inches): _____

**Hydric Soil Present?** Yes X No ____

Remarks:

# Attachment D

## Preliminary Threatened and Endangered Species Survey

# United States Department of the Interior

FISH AND WILDLIFE SERVICE
East Lansing Field Office (ES)
2651 Coolidge Road, Suite 101
East Lansing, Michigan 48823-6316

IN REPLY REFER TO:

July 30, 2010

Mr. Steven Wolf
U.S. Environmental Protection Agency
Region 5
25089 Center Ridge Road
Westlake, Ohio 44145

Re: Request for Emergency Consultation for the Response to the Kalamazoo River Oil Spill, Calhoun and Kalamazoo Counties, Michigan

Dear Mr. Wolf:

We are responding to your request for an emergency consultation pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended. 50 CFR §402.05 provides Federal agencies the ability to consult in an expedited manner in situations involving an act of God, disaster, casualties, etc., and includes response activities that must be taken to prevent imminent loss of human life or property.

We understand that new road construction through forested riparian areas may be necessary to provide access for oil spill clean up. Forested riparian areas within southern Michigan may provide habitat for the federally endangered Indiana Bat (*Myotis sodalis*). Although there are no documented records of Indiana bats in the vicinity of the action, complete survey information is lacking, and maternity colonies may be present. As a result, efforts should be made to protect habitat, if possible.

The summer range of Indiana bats in Michigan includes the southern half and most of the western coastal counties of the Lower Peninsula. Suitable habitat typically consists of highly variable forested landscapes in riparian, bottomland and upland areas composed of roosting trees. In Michigan, Indiana bats area often found in palustrine forested wetlands with an open understory. Roost trees generally are large (greater than 9 inches in diameter), dead, dying, or live trees with peeling or exfoliating bark, which allows the bat to roost between the bark and bole of the tree. Favored roost trees are usually exposed to the sun. Female Indiana bats typically form colonies that use several alternate roost trees in addition to primary roost trees. Individual bats are known to travel up to 7.8 kilometers (4.8 miles) between roosts in a single night and at least 2 to 4 kilometers from roost trees while foraging. We have enclosed additional information concerning the distribution, life history, and habitat requirements of the Indiana bat.

The following recommendations are provided to help minimize adverse effects of the proposed action and document any actions taken:

- Modify road locations, as feasible, to avoid areas of suitable habitat,

- Within areas of suitable habitat, avoid removal of dead, dying, or live trees with peeling or exfoliating bark that are larger than 9 inches in diameter,

- Determine the approximate location, total size, and configuration of forested areas cut for access road construction and provide that information to the Service once the response action is completed,

- Report to the East Lansing Field Office (517 351-2555) any observations of bat mortalities, or bats exiting cut trees.

We conclude that the process of oil spill containment and clean up may affect Indiana bat, but should not jeopardize the species. Once the oil spill is under control, we request that you initiate consultation with our office. In addition, we request that you provide our office a description of the emergency, a justification for the expedited consultation, and an evaluation of the response to and the impact of the emergency on Indiana bat and its habitat.

We appreciate the opportunity to cooperate with the U.S. Environmental Protection Agency. If you have any questions regarding these comments, please contact Jack Dingledine of this office, at (517) 351-6320 or jack_dingledine@fws.gov.

Sincerely,

Jack Dingledine
Acting Field Supervisor

cc: Chris Hoving, MDNRE, Wildlife Division, Lansing, MI

# Bat Life History

Since listing as endangered in 1967, the range-wide Indiana bat population has declined by nearly 60%. Several factors have contributed to its decline including the loss and degradation of suitable hibernacula, human disturbance during hibernation, pesticides, fragmentation of forest habitat, and loss and degradation of forested habitat, particularly stands of large, mature trees.

In Michigan, summering Indiana bats roost in trees in riparian, bottomland, and upland forests from approximately April 15 to September 15. Indiana bats may summer in a wide range of habitats, from highly altered landscapes to intact forests. Roost trees are typically found in patches of forests of varying size and shape, but have also been found in pastures, hog lots, fence rows, and residential yards.

Male Indiana bats are dispersed throughout the range in the summer, roosting individually or in small groups, but may favor areas near hibernaculum. In contrast, reproductive females form larger groups, referred to as maternity colonies. Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas, tending to return to the same summer range annually to bear their young. These traditional summer sites are essential to the reproductive success and persistence of local populations.

Indiana bats are known to use a wide variety of tree species for roosting, but structure (i.e., crevices or exfoliating bark) is probably most important in determining if a tree is a suitable roost site. Roost trees generally are dead, dying or live trees (e.g. shagbark hickory and oaks) with peeling or exfoliating bark which allows the bat to roost between the bark and bole of the tree, but Indiana bats will also use narrow cracks, split tree trunks and/or branches as roosting sites. Southern Michigan maternity roost trees are typically in open areas exposed to solar radiation. Roost trees vary considerably in size, but those used by Indiana bat maternity colonies usually are large relative to other trees nearby, typically greater than 9 inches dbh. Male Indiana bats have been observed roosting in trees as small as 3 inches dbh.

Maternity roosts of the Indiana bat can be described as "primary" or "alternate" based upon the proportion of bats in a colony consistently occupying the roost site. Maternity colonies typically use 10–20 different trees each year, but only 1–3 of these are primary roosts used by the majority of bats for some or all of the summer. It is not known how many alternate roosts must be available to assure retention of a colony within a particular area, but large, nearby forest tracts appear important. Although the Indiana bat appears to be adaptable to changes in its roosting habitat, it is essential that a variety of suitable roosting trees exist within a colony's summer area to assure the persistence of the colony.