ENBRIDGE

Environmental Guidelines
for
Construction

December 2003

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INTRODUCTION

Scope

This manual provides environmental guidelines and mitigation measures when planning and constructing new pipelines and facilities. It was developed based on the company's experience implementing best management practices during construction. In addition to the guidelines in this manual, site-specific project circumstances must be considered.

Who Should Use this Manual

This manual is primarily intended for Engineering and Operations employees and their contractors during planning and construction of new pipelines and facilities in Canada and the United States.

Locating Information

To locate information quickly, refer to the table of contents, which provides a cover-to-cover overview of the manual contents.

Manual Custodian

Safety & Environment, Enbridge Pipelines Inc., is the custodian of *Environmental Guidelines for Construction*.

Relationship to Other Manuals

This manual is maintained independent from the series of O&MP manuals. For a copy of this manual, contact Enbridge Pipelines Inc., Safety & Environment, at [780] 420-8436.

Review and Revision

This manual is reviewed and revised as necessary by new or different operating conditions and regulatory requirements.

GLOSSARY

aquifer	A natural underground geological formation, structure or layer (rock, sand or gravel) containing water. Are sources of groundwater for wells and springs.
aquifer recharge area	An area that allows water to enter an acquitter.
bentonite	A colloidal clay, expansible when moist, commonly used to provide a tight seal around a well casing.
clearing	The removal of all trees, brush, underbrush, vegetative growth, logs, deadwood, debris, rubbish and other objectionable matter.
construction ROW	A temporary right-of-way (ROW) acquired to accommodate construction, usually adjacent to and including a part of the permanent ROW.
control point	A location downstream of a spill site on a stream or river where containment and recovery operations can occur.
emergency	An unforeseen combination of circumstances or a disruption of normal operating conditions that poses a potential threat to human life, health, property and/or the environment if not contained, controlled or eliminated immediately.
environmental sensitivity maps	Maps that identify sensitive wildlife areas, waterfowl nesting areas, important fishing areas, irrigated lands, parks and water users along the pipeline system.
erosion	The wearing away of land surface by wind or water.
extra work space	Rectangular area adjacent to the right-of-way that, through an agreement with the landowner, is available for use during the construction period.
grubbing	The mechanical removal and disposal of surface organic debris, including stumps, roots and partially embedded rocks or boulders.
hazardous material	A material that, because of its quantity, concentration and physical or chemical characteristics, either individually or in combination with other substances is, or poses a threat to, the environment, humans or other living organisms.
heavy silt-laden	In general terms, when settling of sediment can be seen after a few minutes in a glass jar.
incident	An event affecting company operations that may be defined as an emergency or crisis.

mulch	A layer of material (e.g., wood chips, straw, leaves) placed around plants to hold moisture, prevent weed growth, and enrich or sterilize the soil.
riparian habitat	Areas adjacent to a water supply such as a rivers, lakes or ponds with a different density, diversity, and productivity of plant and animal species relative to nearby uplands
sedimentation	The settling out of soil particles which are transported by water. Sedimentation occurs when water carrying soil particles slows for a sufficient amount of time to allow the particles to settle out.
soil erosion	The removal and loss of soil by the action of wind and water.
stumping	The mechanical removal and disposal of subsurface organic debris, including stumps, roots, rocks or boulders
topography	The size and slope of a site.
watercourse	The bed and shore of a river, stream, lake, creek, lagoon, swamp, marsh or other natural body of water, or a canal, ditch, or other man-made surface feature, whether it contains or conveys water continuously or intermittently.
well point	A hollow vertical tube, rod or pipe terminating in a perforated pointed shoe and fitted with a fine- mesh screen.
wetlands	An area that is saturated by surface or ground water with vegetation adapted for life under those soil conditions, as swamps, bogs, fens, marshes, and estuaries.

Abbreviations

COSH	Canadian Occupational Safety and Health
CSA	Canadian Standards Association
DOL	Department of Labor
EPA	Environmental Protection Agency
MSDS	Material Safety Data Sheet
NEB	National Energy Board
NERC	National Emergency Response Center
NGL	natural gas liquids
OPA	Oil Pollution Act
OSHA	Occupational Safety and Health Administration
PLM	pipeline maintenance
WHMIS	Workplace Hazardous Materials Information System

OVERVIEW of PRECONSTRUCTION 01–1

Purpose

Protecting the environment, compliance with regulatory requirements and maintaining good landowner relations is of primary importance to the company. Careful and effective planning ensures compliance with environmental regulations, public and landowner concerns are addressed and potential long-range impacts are identified.

Responsibilities

The project manager is responsible for ensuring workers clearly understand and follow the company policies and procedures in this manual throughout all phases of construction.

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

PLANNING and PREPARATION 01–2

Purpose

Project planning is an essential part of pipeline construction. Work activities are assessed to determine associated environmental issues and restrictions (e.g., wastes, water management). In addition, construction within environmentally sensitive areas must be planned on a site specific basis and special mitigative measures taken to minimize potential impacts.

Requirements

Permits/Licenses/Approvals

Apply for necessary licenses, permits and approvals well in advance of construction activities. Consult with the environment department to determine lead times for permits.

Typical situations that require environmental permits and/or regulatory approvals include:

- crossing environmentally sensitive areas, (e.g., watercourses, wetlands, cultural resources, endangered species, parks, nesting/denning areas)
- disturbing soil or vegetation
- hazardous waste generation, storage and disposal
- intrusive work in or adjacent to environmentally sensitive areas
- water appropriation (withdrawals) for hydrotests/dewatering
- discharging stormwater, hydrotest water or other waste water
- air emissions

NOTE: If permit requirements are more stringent than the requirements in this manual, the more restrictive requirements apply.

ENB (NW) Before entering any land with regional land claims, obtain any necessary quarry and access permits.

Notifications

Government Agencies

Notify government agencies of pipeline work as specified in the conditions of approval, or as required by legislation, e.g., fish and wildlife authorities, downstream water users.

NOTE: Contact the environment department for a complete list of government agencies.

Notify public agencies before using public access routes, especially ditches and vegetated access-ways or dirt bed roadways that are subject to rutting. Take photos before construction begins to document the as-found condition of all access routes.

Landowners

A company representative must contact landowners in advance to advise them of the scope of work and to discuss any special concerns. Determine lead time for notifications based on the nature and scope of the job and previous experience. Larger projects require longer lead time as landowner concerns and special approvals may need to be addressed.

Trappers

Before entering their trapping areas, notify registered trappers of the right-of-way (ROW) location and planned activities.

Forestry and Logging

Before clearing timber or beginning salvage operations, notify forestry or logging companies holding agreements, licenses or quotas.

Before construction, coordinate with local operators to haul merchantable timber.

Fish and Wildlife

Notify fish and wildlife authorities:

- if construction activities will damage beaver ponds, dams and lodges, muskrat pushups, raptor nests, mineral licks, etc.
- before implementing habitat enhancement techniques

Water Users

Notify downstream water users within the potential impact zone before instream activity at watercourse crossings, or before water withdrawal or discharge of hydrostatic test water.

Crossings

Notify road, rail, utility and other pipeline owners to obtain crossing and road use agreements.

Pre-Job Meeting

Before beginning construction, the project manager, or designate, must hold a pre-job meeting with engineering, safety and environment employees; inspectors; contractors; and government personnel to review:

- environmental concerns, mitigation measures, methods and regulations specific to the work
- the company's Environmental Policy
- contingency plans
- specific conditions on associated permits and regulatory approvals (e.g., public lands such as nation forest lands, wildlife areas, etc., and Indian lands)

Records

Line List

Before construction begins, contractors must be provided with a Construction Line List that describes special requirements requested by landowners, e.g., timber salvage, topsoil segregation, restoration measures, fencing requirements.

Permits

Permits typically require the company to submit compliance reports at specified intervals during the project and upon project completion, to submit permit termination notices. These records should be retained with other appropriate project documentation in Engineering files.

PROJECT SCHEDULING 01–3

Purpose

The project schedule identifies the start and finish of construction, including the timing of individual activities. Poor scheduling can impact soil, fish and wildlife resources, and land uses such as agriculture, forestry and outdoor recreation.

Guidelines

Spring Breakup

Avoid construction during spring breakups to minimize surface disturbance and impacts on aquatic habitats and agricultural land. The cost of moving equipment also may be prohibitive, since most jurisdictions severely restrict loads allowed on roadways.

Schedule Changes

When projects are large or have serious impacts on stakeholders, notify environmental inspectors, landowners and government agencies if field conditions or work progress requires a change in the project schedule.

Wet Areas

For wet areas, consider scheduling work activities during frozen conditions (see Table 1).

Table 1
Frost Depths for Wet Areas

Terrain	Minimum Frost Depth	
	cm	in.
loam soils	15	6
saturated silts or clays	30	12
muskeg	45	18
swamp, sloughs and shallow water	90	35

Weather

Where possible, schedule work during periods of low precipitation and runoff.

Fish and Wildlife Resources

Cross wildlife habitats during periods of low sensitivity, or as defined by government agencies.

Investigate the potential for the presence of endangered species

Contact the environment department to establish timing constraints for construction activities. Schedule activities before or after periods of concern, within reason. For example, when planning clearing operations consider timing restraints, e.g., migratory bird nesting from May 15–Aug 15.

Agricultural Activities

Coordinate work to minimize interference with agricultural operations and other activities such as spraying and fertilizing. Avoid construction during the irrigation season.

Burning

Burn tree and shrub debris during low fire hazard season. This applies in forested areas, native prairies or other areas prone to wild fire, or as directed by government agencies.

Recreational Areas

In recreational areas, schedule work during periods of low use if practical.

Near parks or campsites, schedule noisy activities between 0700–2000 hours, or as dictated by municipal bylaws.

Urban Areas

In urban areas, coordinate activities that might affect the public with:

- landowners
- community associations
- municipal governments

Schedule noisy activities between 0700–2000 hours, or as dictated by municipal bylaws.

SELECTING FACILITY SITES 01–4

Purpose

Selecting the site for a new facility is primarily determined by existing company facilities. Where practical, new facilities are located within existing facility sites; however, where no company facilities exist, a new site must be selected. Poor site selection may result in regulatory constraints, construction difficulties, geotechnical concerns and landowner disturbance. Use these guidelines to evaluate new sites for facilities and sites on existing undisturbed company property.

Guidelines

Alternative Sites

When evaluating alternative facility site locations, consider the following factors:

- Ensure sites are adjacent to the proposed or existing company right-of-way (ROW), in a high and dry location.
- Minimize the requirements for access road and infrastructure (e.g., power) development.
- Minimize disrupting agricultural practices. Avoid locating sites near sensitive agriculture operations (e.g., in the middle of agricultural lands or near feedlots, dairy operations and chicken/turkey farms).
- Minimize disrupting wildlife habitat and avoid locations with site-specific critical wildlife habitat.
- Avoid sites where groundwater can become contaminated.
- Avoid wetlands and other areas where drainage could be a problem.

NOTE: In the USA, government agencies will authorize filling wetlands only in extreme cases.

- Avoid sites on native prairie where practical.
- Avoid sites near surface drainage channels (e.g., watercourses, ravines).
- Avoid sites that would require significant grading.
- Ensure subsurface soil conditions will provide adequate support for facility foundations.
- Minimize tree clearing.
- Ensure noise levels from the facility are below the maximum acceptable limits at the nearest residence.

- Maximize the distance of the facility from existing and proposed residences.
- Minimize the number of residences with unobstructed and partially obstructed lines of sight to the facility.
- Avoid locations where air emissions could become an issue.

Procedure

1. Identify optimum and alternative facility site locations based on acceptable engineering and operational criteria (e.g., hydraulics, power considerations).
2. Gather and review environmental information for the potential facility sites from, for example:

- existing public data (e.g., wetland inventory maps, topographic maps)
- company records
- previous environmental assessments
- monitoring programs
- commissioned studies

3. Contact government agencies, local authorities, company representatives and landowners to identify concerns in the area of the potential facility sites.
4. Identify environmental concerns near the potential facility sites (see Table 1, Environmental Concerns, in 01-5, Selecting Routes).
5. Evaluate potential facility site locations.

SELECTING ROUTES 01–5

Purpose

Minimizing the adverse environmental effects of pipeline construction requires careful route selection. Poor route selection may result in regulatory constraints, construction difficulties, geotechnical concerns and potential land use conflicts. The preferred routing for a new pipeline is to utilize an existing right-of-way (ROW). However, where projects are not near an existing pipeline or where environmental sensitivities or land use prevent parallel routing, a new route must be selected. Use these guidelines to help select preferred and alternative routes for a new ROW and for routes that parallel an existing ROW.

Guidelines

Environmentally Sensitive Areas

Plant Species

Assess any plant or community identified in supporting studies (e.g., rare plant species survey) and/or regulatory agency consultations as having special conservation status using the following criteria:

- position of the plant or community on the ROW
- relative rarity and local abundance of the plant or community
- growth habit, propagation strategy and habitat preferences of the plant or community

Wildlife

Identify species, preferred types of cover and boundaries of significant wildlife habitat(s).

Assess any wildlife species identified as having special conservation status or site-specific habitat using the following criteria:

- location of wildlife or habitat features on or near the ROW
- presence of topography features or vegetation to effectively separate the wildlife or habitat features from construction activities, e.g., assess nesting setbacks
- timing of construction versus the timing constraints for the species, e.g., nesting season
- potential to alter construction activities to minimize or avoid sensory disturbances

Fish Habitats

Assess any sensitive fish habitat identified in supporting studies using the following criteria:

- position of the fish habitat features with respect to a proposed crossing
- timing of construction versus the timing constraints for the fish species, e.g., spawning season
- potential to alter construction activities to minimize habitat disturbance

Cultural Resources

Assess archaeological, historical or paleontological resources identified in supporting studies using the following criteria:

- significance and depth of the resource site
- location of the resources with respect to the proposed route
- feasibility of alternate routes or sites that avoid the resource

Evaluating Routes

When identifying and evaluating routes within a corridor, consider the following factors:

- Minimize pipeline length in order to minimize potential disturbance and cost.
- Minimize the amount of steep terrain, sidehill and unstable terrain.
- Parallel existing pipelines, use existing rights-of-way or other linear developments, e.g., roads, cutlines, abandoned railroad.
- Avoid country residential subdivisions, industrial subdivisions and urban areas where practical.
- Minimize the number of watercourse crossings.
- Minimize crossings of native prairie.
- Minimize crossing high-quality woodlots.
- Cross watercourses as close as possible to right angles and where approach slopes are stable.
- Avoid, where possible, environmentally sensitive areas such as critical wildlife areas, natural areas, parks, archaeological or historical sites.

- Avoid, where practical, special land use areas, e.g., golf courses, research farms.
- Minimize crossings of muskegs, wetlands, lakes and sloughs.
- Avoid, where practical, farm buildings, farmsteads, well sites, aquifer recharge areas and shelterbelts.
- As much as possible, cross windbreaks and shelterbelts at right angles to minimize the width of the ROW to that necessary for the trench line and vehicle traffic.
- Cross roads and rail lines at or near right angles.
- Contact all affected government agencies, landowners and other concerned parties. Where appropriate, hold an open house(s) to inform these groups of the proposed project, route alternatives and associated environmental mitigation.
- When practical, modify the route to accommodate input from landowners, the public and regulatory agencies.

Procedure

1. Identify the approximate corridor within which a number of possible routing alternatives for the proposed project may fall.
2. Gather and review environmental information for the proposed corridor from, for example:

- existing public data
- company records
- report and monitoring programs
- commissioned studies

3. Contact government agencies, local authorities, company representatives and landowners to identify general concerns within the corridor.
4. Identify environmental concerns within the corridor (see Table 1).
5. Identify and evaluate alternative routes within the corridor.
6. Select a preferred route from the alternatives.
7. Perform environmental assessment of preferred route.
8. Prepare formal applications and permits to jurisdictional/regulatory agencies for approval.

Table 1
Environmental Concerns

Environmental Components	Considerations
geology	• depth of bedrock • stability of bedrock • stability of surficial deposits
topography	• landform (e.g., dunes, wetlands, hills and hummocks). • slope stability • topographic features (e.g., slopes, ravines, slides, slumps, fault zones)
soils	• classification • texture • previous chemical contamination and physical damage • agricultural capability • erodibility • suitability for reclamation • profile characteristics
hydrology	• water table • surface and subsurface drainage • groundwater resources
vegetation	• dominant species • rare and endangered species • weeds • specialty crops • native prairie or other native vegetation • relative crop productivity • extent of vegetation cover • timber merchantability
wildlife	• dominant species • species with special conservation status • critical habitats • sensitive periods
watercourses	• named, unnamed and intermittent drainage courses • irrigation and drainage canals • bank and substrate composition • bank height and stability • riparian habitat • previous stream bed disturbance and construction • fish spawning, incubation, migration periods • navigable use • presence of contaminated substrate • location of municipal water intakes • licensed water uses • commercial or native fishing areas

Table 1—*continued*
Environmental Concerns

Environmental Components	Considerations
land uses/socio-economic	• urban area • rural areas • country residential • industrial development • existing ROW • compensation and land value • drainage tile • irrigated areas, equipment needs • ecological, wildlife or preservation parks, designated natural areas and reserves • landfills, quarries or mines • specialized farming operations • designated campgrounds and recreation sites • First Nations • aesthetics • historical, archaeological, paleontological or other unique site designations

DETERMINING WORK SPACE 01–6

Purpose

Right-of-way (ROW) width is a factor in the size of the pipeline installed and the appropriate equipment and construction methods used. An undersized ROW width can result in topsoil mixing with subsoils, slow work activities, and lead to damage off the ROW. Excessive ROW width results in unnecessary surface disturbance and greater restoration requirements.

Responsibilities

The project manager is responsible for defining appropriate widths for the construction right-of-way and extra work space, to ensure there is sufficient space for project activities and to confine disturbance to defined areas.

Requirements

All work must be carried out within the company's ROW and acquired extra work space. Any work beyond these limits requires landowner approval, work space agreements and/or special easements or permits.

Guidelines

Construction ROW Width

ROW width for construction activities involving large-diameter pipe (≥20 NPS) generally ranges from 26 m (85 ft) to 38 m (125 ft), depending on pipe size and construction environment (see Figure 1,Typical Construction of ROW).

Where a new pipeline will share an existing ROW with an operating pipeline, temporary ROW may be required to accommodate construction.

Environmentally Sensitive Areas

In environmentally sensitive areas, restrict ROW width to the minimum required and design the project activity to conform to this width.

Extra Work Space

Extra work space outside the boundary of the construction ROW may be necessary for:

- bends and line crossings
- steep slopes and staging areas
- watercourses, wetlands and road crossings

- safety reasons
- assembling sections of pipe
- storing spoil material, topsoil or equipment

Extra work space must be acquired from the landowner under an agreement negotiated by the company or designate.

NOTE: Use of unauthorized work space is prohibited without written approval from the company and landowner.

In all cases, the size of extra work space must be kept to the minimum necessary to safely conduct work.

Watercourses

Locate extra work spaces a minimum of 16 m (50 ft) away from the water's edge if practical, depending on topographic or other physical conditions such as stream channel meanders (see Figure 2, Typical Extra Workspace Waterbody or Wetland Crossing <50 ft Wide). Any deviations in size or location required by the contractor's crossing plan is subject to site-specific approval from the environment department or its field representative.

Vegetation between an extra work space and a watercourse must remain undisturbed.

Wetlands

USA

Locate extra work spaces a minimum of 16 m (50 ft) away from wetland boundaries if possible, depending on topographic conditions (see Figure 3, Typical Extra Workspace Waterbody or Wetland Crossing >50 ft Wide). If conditions do not allow for a 16 m (50-ft) setback, locate extra work spaces as far away from the wetland as practicable with approval from the environment department.

CAN

Establish wetland boundaries, buffer areas or setbacks in consultation with the environment department and regulatory agencies.

Road and Rail Crossings

Additional extra work spaces similar to watercourses and wetlands are often necessary adjacent to road and railway crossings (see Figures 4, Typical Extra Workspace Bored Road or Railroad Crossing and Figure 5, Typical Extra Workspace Open-Cut Road Crossing).

Procedure

1. Determine the area required for spoil piles and topsoil piles considering the following factors:

- ground cover
- topsoil depth and stripping width
- bulking factor
- trench shape
- trench wall stability
- trenching method
- trench depth and width (spoil)
- storage pile separation
- equipment track width

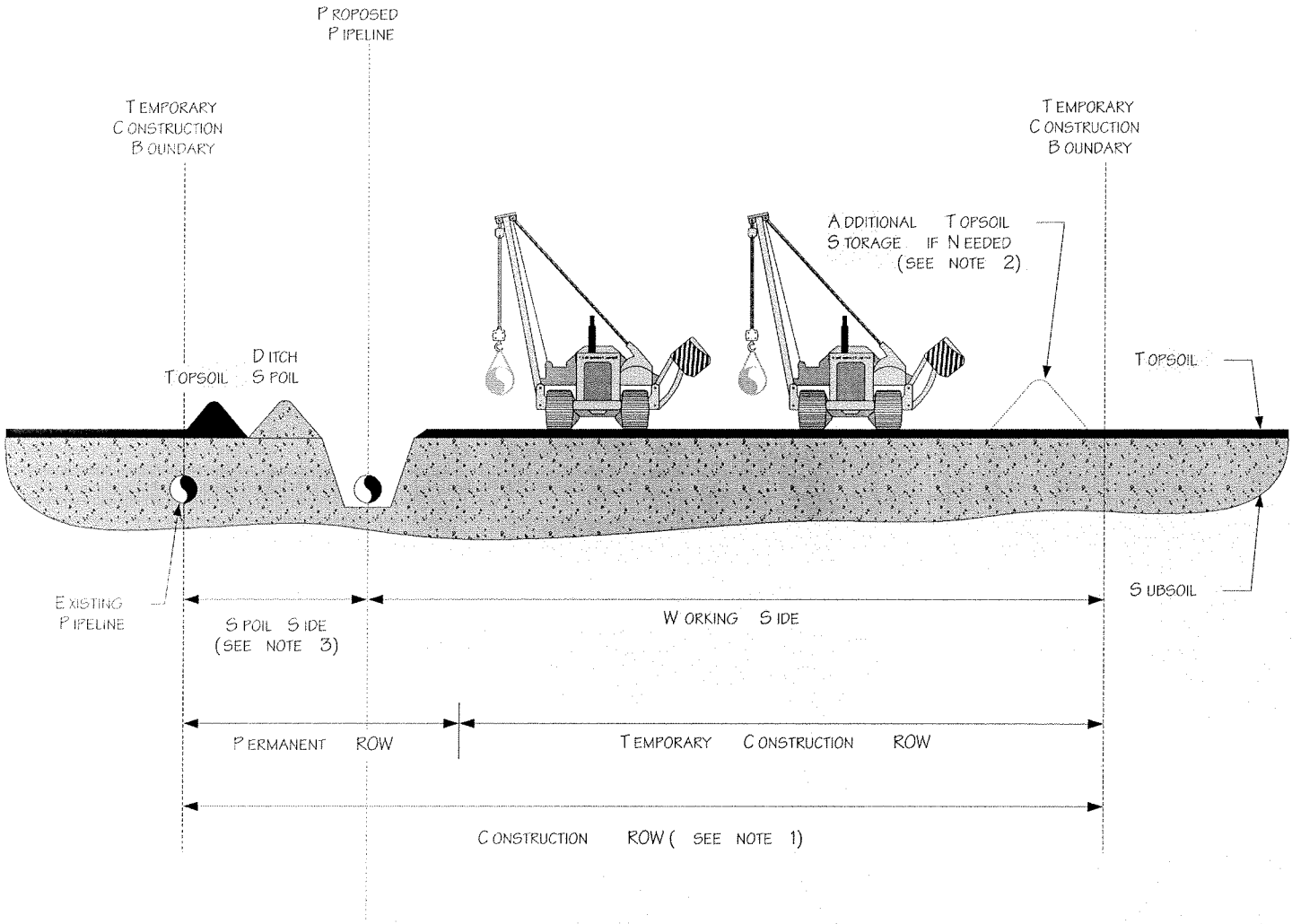
2. Determine space requirements for setup areas, working lane and passing lane (see Figure 6, Right of Way Widths).

3. Determine the standard construction ROW width and any locations requiring extra work space or where special work activities require extra storage space for the use of larger equipment.

NOTE: Table 1 shows the factors to consider when determining ROW width.

Table 1
Right-Of-Way Width Factors

ROW Factors	Less ROW	More ROW
number of pipelines • multiple		X
pipe diameter • small • large	X	 X
working space • crossings • expansion loops • passing land		 X X X
slash disposal • burning • rollback, mulch, chip	X	 X
topsoil stripping • depth 10 cm (4 in.) min 30 cm (12 in.) max • lift 2 lift 3 lift	 X X	 X X
grading • none • extensive	X	 X
trench material • clay • sand	X	 X
depth of cover • 1 m (3 ft) • 3 m (10 ft)	X	 X
water table • low • high	X	 X



PROFILE

NOTES :

1. THIS DRAWING REFLECTS "DITCH PLUS SPOIL SIDE" TOPSOIL STRIPPING PROCEDURE .
2. STOCKPILE TOPSOIL SEPARATELY FROM DITCH SPOIL AS SHOWN OR IN OTHER CONFIGURATIONS APPROVED BY THE COMPANY .
3. THE OFFSET FROM NORTHERNMOST OR SOUTHERNMOST EXISTING PIPELINE , WHERE APPLICABLE , WILL BE 20' FOR MOST LOCATIONS BUT MAY BE INCREASED OR DECREASED DEPENDING ON THE SITE SPECIFIC CONSTRUCTION REQUIREMENTS .

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Figure 1

Typical Construction Right-of-Way

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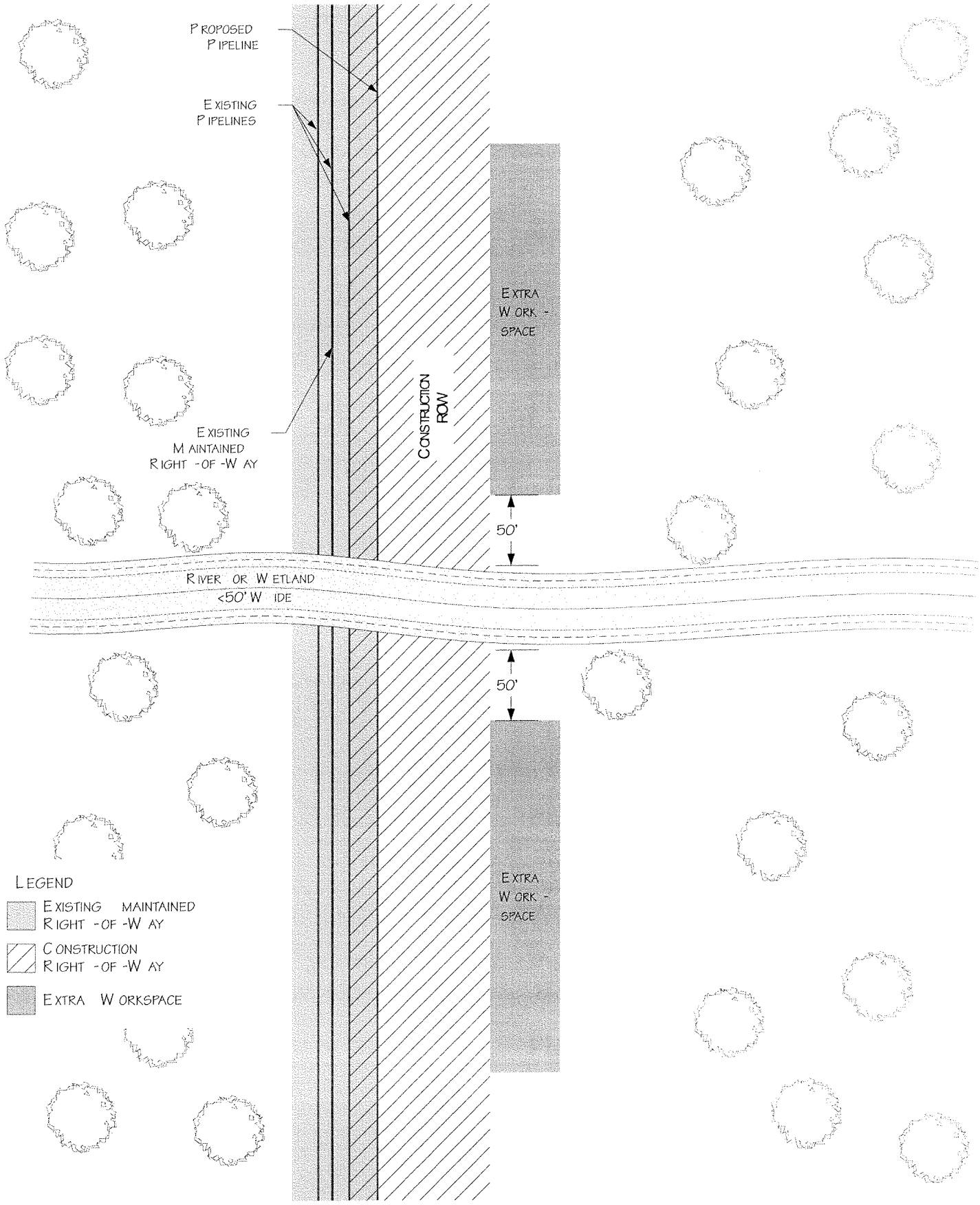

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Figure 2

Typical Extra Workspace Waterbody or Wetland Crossing < 50 Feet Wide

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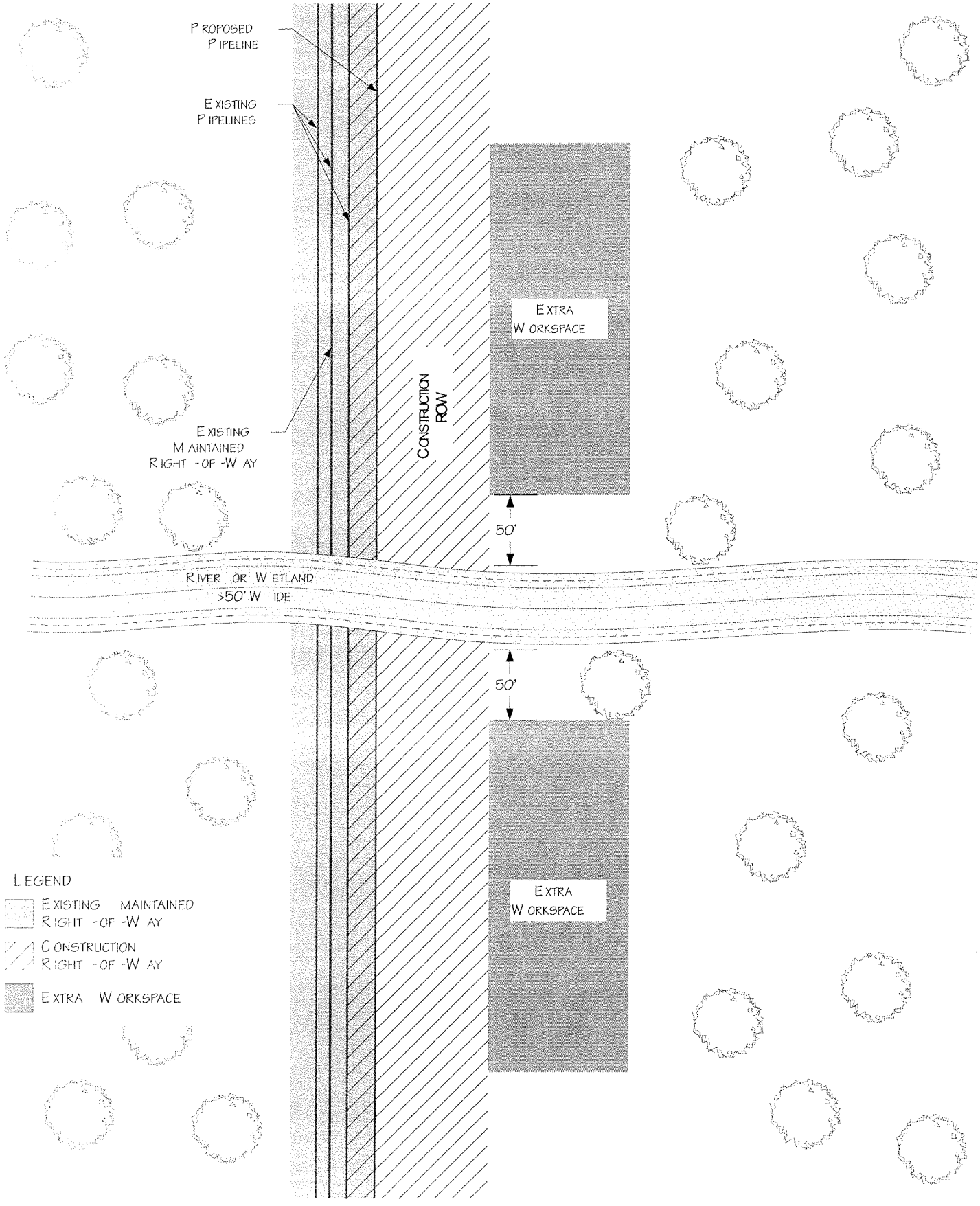

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Figure 3

Typical Extra Workspace Waterbody or Wetland Crossing >50 Feet Wide

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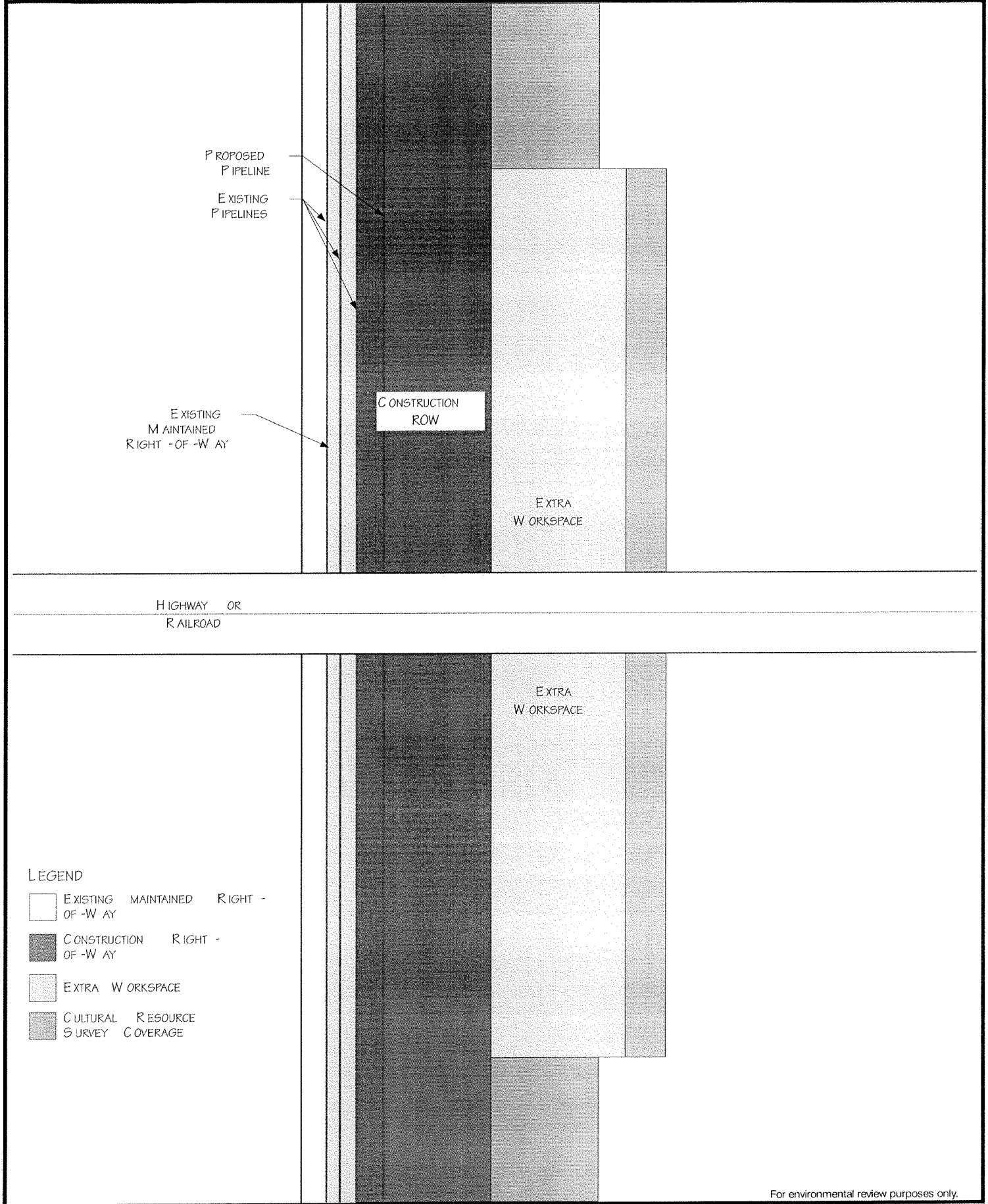

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Figure 4

Typical Extra Workspace
Bored Road or Railroad Crossing

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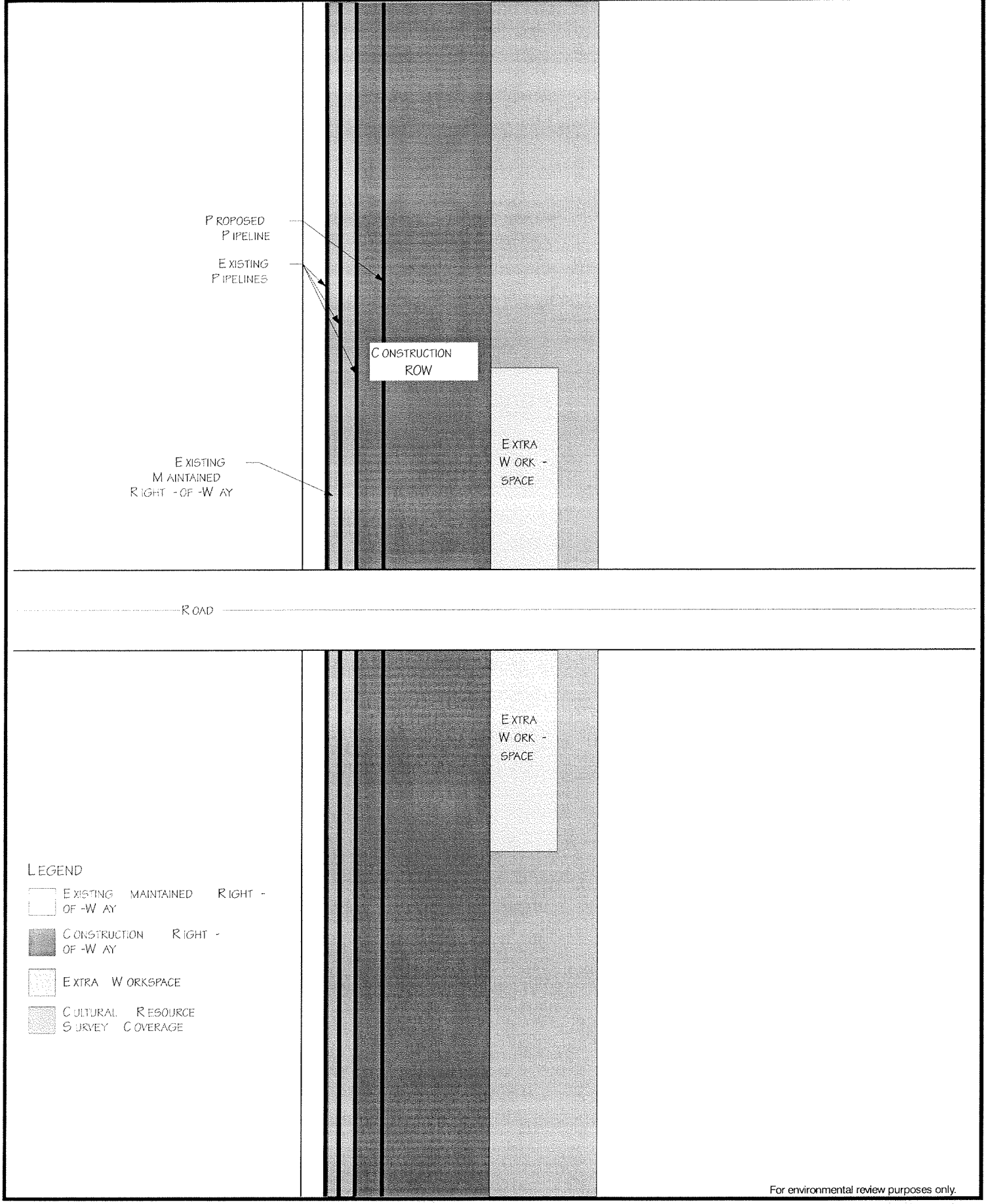

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Figure 5

Typical Extra Workspace
Open-Cut Road Crossing

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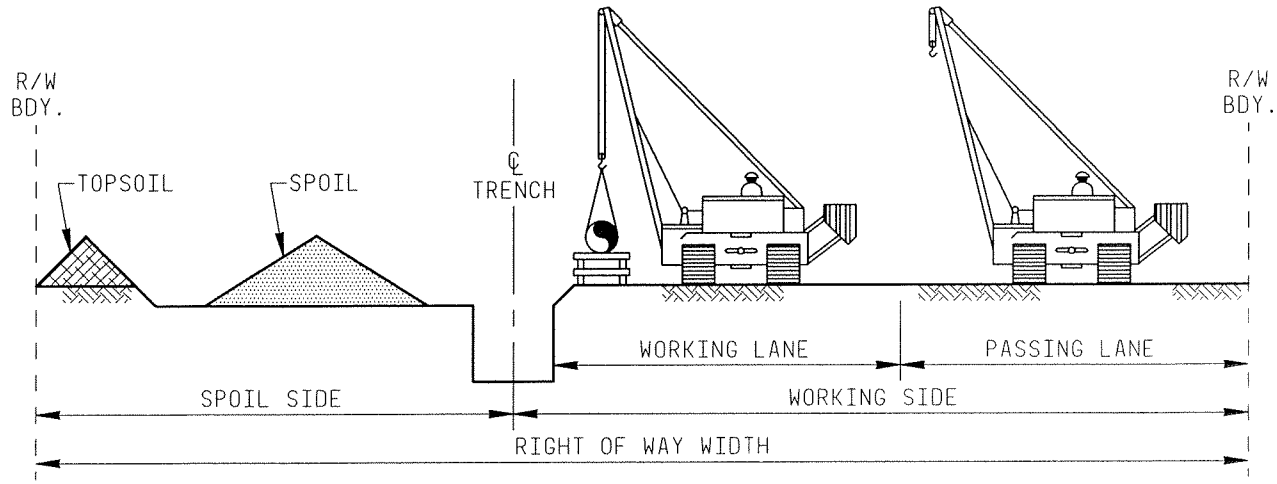

PROFILE

NOTES:

1. DETERMINE STANDARD RIGHT OF WAY WIDTH AND LOCATIONS REQUIRING ADDITIONAL TEMPORARY WORK SPACE PRIOR TO CONSTRUCTION. MERCHANTABLE TIMBER CAN THEN BE CLEARED AND SALVAGED, AND TOPSOIL CAN BE STRIPPED AND STOCKPILED SEPARATELY FROM SPOIL.

2. TWO LIFT SOIL HANDLING REFERS TO TOPSOIL SALVAGE FOLLOWED BY TRENCHING TO THE FULL DEPTH OF THE TRENCH.

3. THREE LIFT SOIL HANDLING REFERS TO TOPSOIL SALVAGE, FOLLOWED BY THE SALVAGE OF AN UPPER DESIRABLE LIFT OF SUBSOIL AND THEN THE LOWER UNDESIRABLE SUBSOIL. THE THREE LIFTS ARE PILED SEPERATELY AND ARE RETURNED TO THE TRENCH SEQUENTIALLY.

RIGHT OF WAY CONSIDERATIONS

	LESS R/W	MORE R/W
A) NO OF PIPELINES		
- SINGLE	X	
- MULTIPLE		X
B) PIPE DIAMETER		
- SMALL	X	
- LARGE		X
C) WORKING SPACE		
- CROSSINGS		X
- EXPANSION LOOPS		X
- PASSING LANE		X
D) SLASH DISPOSAL		
- BURNING	X	
- ROLLBACKS, MULCH, CHIP		X
E) TOPSOIL STRIPPING		
- WIDTH - NONE	X	
- FULL R/W		X
- DEPTH - 10cm (MIN)	X	
- 30cm (MAX)		X
- LIFT - 2 LIFT	X	
- 3 LIFT		X
F) GRADING		
- NONE	X	
- EXTENSIVE		X
G) TRENCH MATERIAL		
- CLAY	X	
- SAND		X
- ROCK (BLASTING)		X
H) DEPTH OF COVER		
- 1m	X	
- 3m		X
I) WATER TABLE		
- LOW	X	
- HIGH		X

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Figure 6

Right-of-Way Widths

DETERMINING AREA for SOIL STORAGE 01–7

Purpose

Depths and widths of ditch and topsoil stripping must be established during the planning stage of construction to ensure adequate workspace is acquired for soil storage.

Requirements

Soil Survey

Base the depths of topsoil to be stripped on a soil survey (CAN), or soils maps (USA), since segregating soils solely by field observation could result in soil mixing and loss of agricultural capability.

NOTE: Lack of technical information related to stripping depths and widths, and consequently volumes, may result in the insufficient acquisition of right-of-way (ROW) or temporary working space.

Procedure

CAN

1. Commission a soil survey to establish topsoil depths, agricultural capability and locations with problem soils that require special handling.

NOTE: In Canada, for assistance in obtaining this information, contact Safety & Environment.

2. Identify all land uses along the proposed route by reviewing, for example, route sheets, topographical maps or aerial surveys.

3. Determine the amount of grading required.

4. Identify the preferred width of topsoil stripping based on:

- soil survey
- agricultural capability
- land uses
- season of construction
- regulatory requirements

5. Calculate the width of the spoil pile using the formula:

$$\text{Width of spoil pile base (W)} = \sqrt{6A}$$

Where:

A	=	(x-t) yb (cross-sectional area of spoil pile)
x	=	depth of trench
t	=	depth of topsoil
y	=	width of trench
b	=	bulking factor (1.2 for trenchers, 1.3 for backhoes)

e.g.,

Where:

x	=	*1.2 m (3.9 ft) depth of trench*
t	=	*15 cm (6 in) depth of topsoil*
y	=	*.91 m (3 ft) width of trench*
b	=	*1.3 (backhoe)*
A	=	*(1.2-.15) (.91) (1.3)*
	=	*1.24 m^2*

Then:

$$\textit{Width of spoil pile base (W)} = \sqrt{6A}$$

$$= \sqrt{6(1.24)}$$

$$= \sqrt{7.45}$$

$$= 2.73\ m$$

6. Determine the width of topsoil stripping (see 02-5,Topsoil Stripping and Segregation).

7. Calculate the width of the topsoil pile, using the formula:

$$\text{Width of topsoil pile base (W)} = 1.4\sqrt{6A}$$

Where:

A	=	ztb (cross-sectional area of topsoil pile)
z	=	width stripped of topsoil
t	=	depth of topsoil
b	=	bulking factor (1.1 for cultivated land, 1.2 for pasture)

NOTE: The width of a topsoil pile pushed by a dozer is 1.4 times the width of the same pile if deposited by a conveyor
e.g.,

Where:

z	=	*7 m (22.97 ft) width stripped of topsoil*
t	=	*15 cm (6 in) depth of topsoil*
b	=	*1.1 (cultivated land)*
A	=	*(7) (.15) (1.1)*
	=	*1.16 m^2*

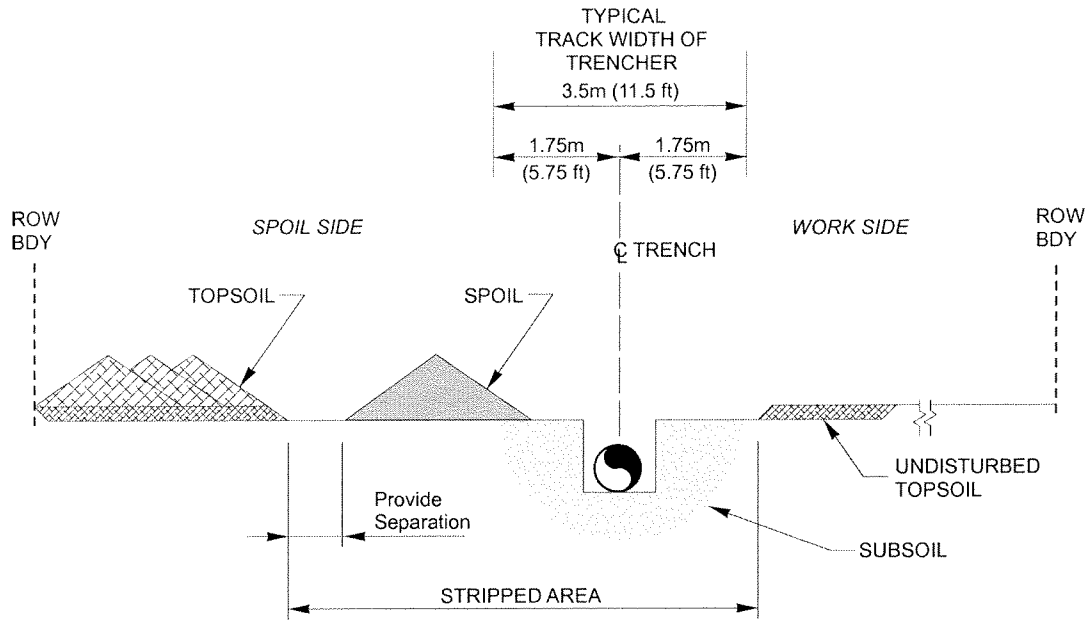
Then:

$$\text{Width of topspoil pile base } (W) = 1.4\sqrt{(6)1.6}$$
$$= 1.4\sqrt{6.93}$$
$$= (1.4)(2.64)$$
$$= 3.69 \text{ m}$$

8. Calculate the ROW and temporary workspace requirements (see 01-6, Determining Workspace).

9. Adjust calculations if:

- any of the assumptions cannot be made (see Figure 1)
- a stripping technique other than trench and spoil is used
- special subsoil handling procedures are required



PROFILE

NOTES

This drawing is based on trench and topsoil stripping and assumes:

- topsoil is stripped with a blade
- trench wall is excavated and spoil is stored with a wheel trencher
- trench walls are stable and can be cut vertically

Figure 1
Stripping and Storage Requirements

OVERVIEW of CONSTRUCTION 02–1

Purpose

This tab includes guidelines to ensure environmental protection and regulatory compliance during pipeline construction activities. In addition to the guidelines in this tab, site-specific project circumstances that necessitate alternate procedures must be considered.

Legislation

CAN

Canada

National Energy Board (NEB):

- Onshore Pipeline Regulations, latest edition

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

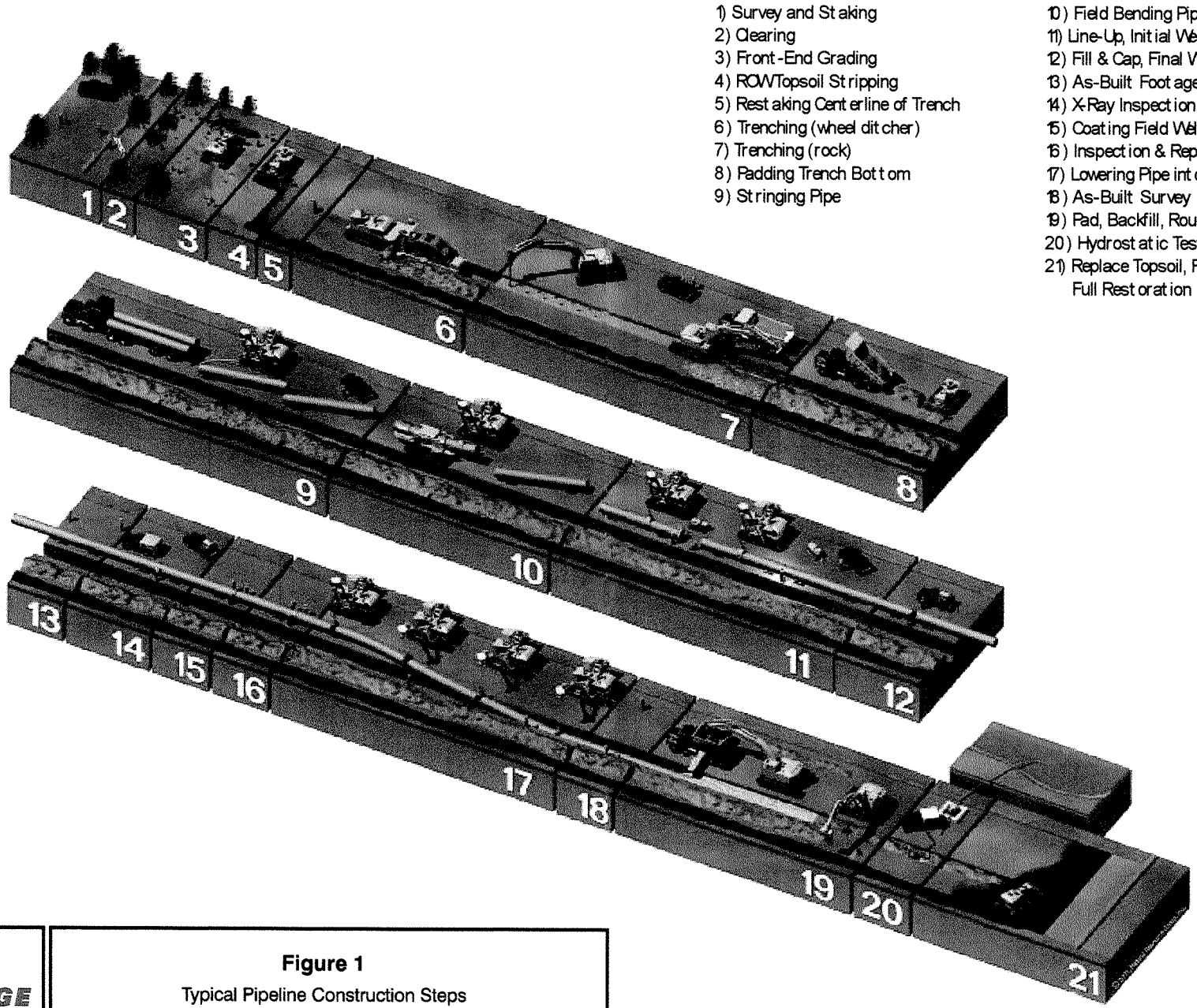


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Figure 1

Typical Pipeline Construction Steps

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For environmental review purposes only.

GENERAL MITIGATION MEASURES 02–2

Purpose

Poor construction practices could result in short- or long-term environmental impacts. Further, these impacts could slow down construction, increase project costs, irritate landowners, or result in government agencies halting working or imposing fines that may jeopardize future approvals in the region.

This subject outlines general environmental mitigation measures that apply at all times throughout the construction project.

NOTE: For information on safety-related standards and procedures required throughout construction:

- for company employees, see Book 2: Safety
- for contractors, see the Contractor Safety Manual (CAN) or the Construction Safety Program (USA)

Guidelines

Planning and Preparation

Before beginning construction activities, the project manager, or designate, must ensure:

- workers clearly understand the environmental concerns, regulations and conditions specific to the work
- conditions on various permits are consistent
- applicable permits, licenses and approvals are filed or posted at the construction site

NOTE: For more information on project planning, see 01-2, Planning and Preparation.

Worksite Access

Confine all construction equipment and vehicles to the designated right-of-way (ROW), extra work space, existing public roads and approved temporary access roads.

Wetlands

Install a shoofly around wetlands or, in consultation with government agencies, construct a temporary access road along the working side of the construction ROW. Restrict access through wetlands to the shoofly or access road to the extent practical.

Watercourses

Locate temporary access roads as far from the watercourse as practical to minimize clearing and grading near the watercourse.

Traffic and Roads

Place appropriate protective materials (e.g., tires) when crossing roads, sidewalks and railways to minimize damage by tracked equipment. Install asphalt ramps on sidewalk curbs if required.

Noise and Dust Control

Ensure that noise abatement equipment on machinery is in good working order. If excessive noise becomes a nuisance to nearby residents, implement measures such as equipment alterations, erect noise barriers, or change the work schedule.

Take reasonable measures to control construction-related noise and dust near residential areas and other areas as directed by the company. Control measures for dust may include watering down the ROW, and suspending topsoil stripping and replacement during strong winds.

Highway and Road Crossings

Avoid open-cutting roads where other practical options exist. If an open cut is the best option, take photos before construction begins to document the as-found condition of the road.

NOTE: When weighing alternatives, consideration must be given to log hauling in forested areas and harvest operations in agricultural areas.

Install appropriately sized culverts where needed under access ramps in bar ditches.

Prevent tracking mud onto roadway crossings. After equipment crosses, shovel or sweep off any mud tracked onto a roadway and place within a sediment barrier as soon as possible, but no longer than 24 hrs after discovery.

NOTE: For more information on sediment barriers, see 02-14, Temporary Sediment Barriers.

Noxious Weeds

To minimize the risk of spreading undesirable weeds within the construction ROW:

- provide contractors and inspectors with information to help identify noxious weeds
- provide environmental inspectors with training to identify and prevent the spread of undesirable species
- flag areas containing noxious weeds during preconstruction walkovers
- before starting clearing/grading, use weed burners or herbicides to destroy infestations
- minimize the construction equipment used, and limit the number of passes the equipment makes through the infested areas
- place mats (i.e. construction mats, swamp mats) over infested areas to minimize construction equipment transporting weed or plant material. Ensure mats are free of soil, vegetation and debris prior to removing from site.
- ensure equipment is free of soil, vegetation and debris before arriving and leaving the site. If necessary set up cleaning stations to wash equipment.
- do not allow soil and water from cleaning the equipment to flow to uninfested areas
- during grading operations, strip the full ROW width and contain the spoil pile containing noxious weeds to prevent mixing with the surrounding soil during regrading and cleanup

Hazardous Materials

The project manager, in consultation with the Safety and Environment department, must consider the need for the contractor to develop response plans, e.g., spill response, emergency response, fire response.

NOTE: For more information on handling hazardous materials:

- for company employees, see Book 2: Safety, Tab 08, Hazardous Materials
- for contractors, see the Contractor Safety Manual (CAN) or the Construction Safety Program (USA)

Material Safety Data Sheets (MSDS) for all hazardous materials onsite must be readily available.

All hazardous materials onsite must be properly stored and labeled with, as a minimum, the:

- product contents
- hazard warning

Workers must be trained in the identification and safe handling of hazardous materials onsite.

If a fuel or hazardous material spill occurs, immediately notify the project manager (CAN) or implement the Spill Prevention, Containment and Control Plan (USA).

Transportation

Fuel trucks must not access any sections of the ROW where the risk of a fuel truck accident is high, e.g., steep slopes and difficult watercourse crossing approaches.

Vehicles transporting more than 200 L (CAN) or 119 gal (USA) of fuel or hazardous materials to unmanned pipeline locations and/or ROW work sites should be equipped with spill kits containing at a minimum:

- a shovel
- 30 m^2 (36 sq yd) of 6-ml polyethylene sheeting
- 25 kg (55 lb) of absorbent

Watercourses and Wetlands

Do not store hazardous materials, chemicals, fuels or lubricating oils or perform concrete coating activities within 30 m (100 ft) of watercourses or wetlands.

Cure concrete coating on the pipe for a minimum of 3 days before installation in a wetland, due to potential toxic effects on wildlife.

Refueling/Equipment Care

To minimize the risk of fuel spills:

- ensure containers for fuel or hazardous materials and any attached hoses and nozzles are free of leaks
- station equipment/fuel truck operators at both ends of a hose during fueling of equipment, unless the ends are visible and are readily accessible by one operator
- drain any fuel remaining in a hose into the storage container
- ensure the hose nozzle has an automatic shutoff

Watercourses and Wetlands

Do not wash equipment or machinery in or within 30 m (CAN) or 100 ft (USA) of watercourses or wetlands. Where this is not possible, adequate spill response equipment must be available.

Before using equipment near a watercourse, inspect hydraulic, fuel and lubrication systems to ensure they are in good condition and free of leaks.

Service and refuel mobile construction equipment on road allowances or on company property, maintaining a minimum of 30 m (CAN) or 100 ft (USA) from watercourses or wetlands. Stationary equipment within this zone must have an impervious means of secondary containment in place.

Fire Prevention

Maintain vehicle exhaust and engine systems in good repair, and park vehicles in a manner that minimizes the risk of igniting dried grass or other combustible material.

Immediately report accidental fires to the appropriate government authorities or landowners. All equipment and workers must be made available to control a fire.

When the fire hazard is rated high or extreme, the following are prohibited on the ROW:

- vehicles parking on tall grass or stubble
- fires
- dropping cigarette butts and used welding rods on the ground

Maintain water trucks on the ROW when the fire hazard is rated high or extreme.

NOTE: The stripping, welding, and coating operations may each need a water truck and delivery system.

Waste

Collect and dispose of all general waste and construction refuse daily at an approved facility. Waste containers must accompany each working unit. Do not dispose of waste in the trench.

Locate temporary toilets at convenient locations on/along the construction site.

At the end of each day, leave the construction site in a tidy and organized condition.

Environmentally Sensitive Areas

NOTE: The following environmental protection measures are guidelines only. The environment department will plan and prepare site-specific and detailed mitigative measures.

Watercourses and Wetlands

Where grading or spoil could block natural drainage and lead to ponding, install culverts at appropriate locations.

Wildlife

Do not harass or feed wildlife or livestock.

Do not allow pets on the ROW.

Report encounters or collisions with wildlife to Fish and Wildlife authorities or the local police department.

Where habitat degradation cannot be avoided, salvage and transplant vegetation or native seed of critical importance to the species.

Cultural Resources

If potential artifacts or fossils are discovered anytime during construction work activities:

- suspend the work activity
- immediately contact the project manager
- fence or flag off the area

Do not remove artifacts from the site.

Plant Species

If rare plant species with special conservation status is identified, consider implementing the following mitigative measures:

- fence or flag off the area
- temporarily cover the site with geotextile pads, fluxnet or swamp mats
- propagate plants or portions of the plant community via vegetative or reproductive means (e.g., harvesting seeds, collecting cuttings or transplanting plants)

Fish Habitats

If sensitive fish habitat is identified, consider implementing the following mitigative measure:

- alter the construction method to use isolated crossing techniques, e.g., partial bypass or trenchless crossing technique
- implement temporary and/or permanent erosion control measures to prevent increased sediment loading
- alter the equipment crossing to minimize disturbance, e.g., use existing bridges, or install temporary bridge

RIGHT-OF-WAY SURVEY 02–3

Purpose

Before construction activities begin, the right-of-way (ROW) boundaries are surveyed and clearly marked. In certain circumstances, surveyors make minor routing adjustments to avoid small problem areas. Extra work space to accommodate specific construction activities is also surveyed and marked.

Although surveyors generally cause minimal environmental impact, the primary concern is that they are given appropriate direction regarding standard ROW width, location of extra work space, and adjustments to navigate around environmentally sensitive areas. Potential impacts related to slopes and side hills, road and watercourse crossings, special areas of concern, and aesthetics can be overcome by route modifications and minor field adjustments.

Guidelines

Notification

Notify landowners and government authorities of intent to conduct a survey.

NOTE: For more information on requirements before surveying, see 01-2, Planning and Preparation.

Staking and Flagging

Surveyors are responsible to mark ROW boundaries and extra work spaces with stakes and flags. Increase the use of stakes, if appropriate, in environmentally sensitive areas.

Maintain stakes and flagging throughout construction activities.

Ensure the size and shape of the area surveyed is appropriate for construction, see 01-6, Determining Work Space. Advise the project manager of areas that are inadequate and that require additional temporary work space.

Wetlands

Stake, flag and/or fence limits of the ROW through all wetlands in a manner that (a) identifies start and end points and (b) prevents encroachment on the surrounding area.

Environmentally Sensitive Areas

Before beginning construction, identify, survey and fence, or flag off:

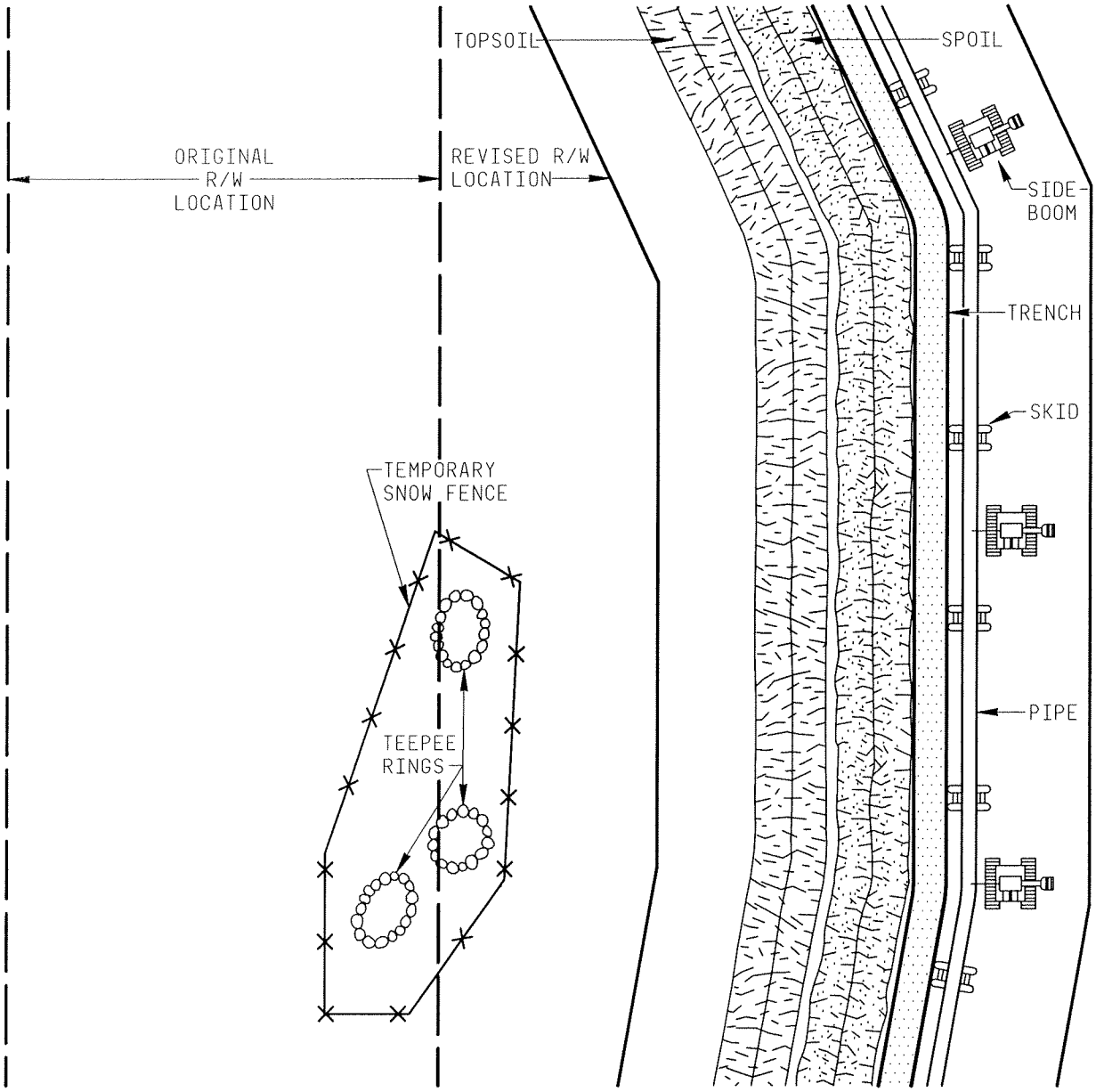
- archaeological, paleontological or historical sites (see Figure 1, Realignment for Environmentally Sensitive Areas)
- rare plant species and important wildlife habitat

Use short stakes to reduce cattle's attention where appropriate.

Route Adjustments

Surveyors should adjust the ROW survey to avoid sidehills, environmentally sensitive areas, poor watercourse crossing approaches, shelterbelts, buildings or other structures and significant features.

Verify any route adjustments with the project manager before leaving the field to ensure all company concerns are addressed.



PLAN VIEW

NOTES:

1. REALIGN RIGHT OF WAY OR TEMPORARY WORK SPACE TO AVOID SIGNIFICANT FEATURES.
2. OBTAIN PERMISSION FROM LANDOWNER AND/OR GOVERNMENT AUTHORITY TO RE-ROUTE AROUND SITE.
3. FENCE KNOWN ARCHAEOLOGICAL OR HISTORICAL SITES, SHELTERBELTS, SHADE TREES, DUGOUTS OR OTHER ENVIRONMENTALLY SENSITIVE AREAS TO BE PRESERVED.
4. SURVEY REALIGNMENT.

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Figure 1

Realignment for
Environmentally Sensitive Areas

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CLEARING and GRUBBING 02–4

Purpose

Clearing is the first major surface disturbance associated with pipeline construction. Clearing and grubbing involve removing trees, roots and stumps, brush and other vegetation from the right-of-way (ROW) ground surface. Poor clearing practices can damage the ROW, slow construction progress and complicate ROW restoration.

Guidelines

Clearance Width

Clear only the width needed for construction. Do not clear beyond marked ROW boundaries.

NOTE: For information on defining space required and acquiring temporary workspace, see 01-6, Determining Workspace.

Equipment

Clearing may be accomplished by:

- hand cutting
- bulldozers
- harvesting machinery

Use clearing equipment that minimizes surface disturbance, soil compaction and topsoil loss, e.g., equipment with low ground pressure tracks or tires, blade shoes and brush attachments.

To grub tree roots, use bulldozers equipped with brush rakes.

NOTE: Do not grub trees growing over an existing pipeline.

Winter Conditions

In winter, consider using bulldozers equipped with shearing blades to cut nonmerchantable timber flush to the ground.

NOTE: This minimizes the need for grubbing in areas other than the trench line if the root balls are frozen into the ground.

Fences and Gates

Before clearing the ROW, dismantle existing fences and livestock barriers in accordance with landowner agreements to allow access for construction equipment (see 02-9, Fences and Temporary Gates).

Install temporary gates and/or fences where necessary to maintain access restrictions.

Noxious Weeds

To prevent spreading undesirable plant species to the project area, construction equipment must be clean when it arrives at the site (see 02-2, General Mitigation Measures).

Trees and Shelterbelts

Fall trees parallel to the ROW. Fall bordering trees onto the cleared ROW to prevent damaging existing property, pipelines, adjacent trees and brush.

Save ornamental trees, wind breaks and shelterbelts on the ROW as much as possible or as per landowner agreements by boring underneath or transplanting.

Protect ornamental or other significant trees adjacent to the ROW from damage with flags, fencing or signs, or, if appropriate, by placing a minimum of 750 mm (30 in.) of topsoil over the roots within the dripline.

Slopes

On erosion-prone or steep slopes, consider:

- postponing clearing until immediately before pipe stringing
- leaving a temporary uncleared buffer zone extending back from the crest
- hand clearing or using slope harvesters, which leaves stumps and roots in place

Hand clear slopes leading to watercourses, going no closer than 16 m (50 ft) from the watercourse, except for timber salvage and if an equipment crossing is installed, an access trail. Leave this buffer strip of vegetation in place until crossing activities begin.

Watercourses and Wetlands

Minimize clearing next to watercourses and wetlands. Except for trees and brush hand cut close to the ground, leave a 16 m (50 ft) buffer of otherwise undisturbed vegetation between the area of disturbance and the watercourse or wetland.

If trees/shrubs must be preserved and fencing off is not practical, salvage live trees or shrubs from streambanks. Store salvaged trees and shrubs on the side of the ROW in a manner such that they don't dry out before replanting during restoration.

To minimize the potential for sedimentation in watercourses, cut vegetation and trees off at ground level, leaving root systems and organic matter undisturbed in areas that drain to the watercourse.

Fall trees away from watercourses to prevent damaging adjacent trees and aquatic habitat.

Immediately remove trees, debris or soil inadvertently deposited below the high watermark of watercourses to minimize disturbance to the streambed and banks.

Do not skid logs across watercourses or push logs into watercourses.

When clearing, limit the working space to the surveyed areas as much as possible.

If timber is needed for riprap or equipment mats, do not cut trees outside of the surveyed area within a wetland.

Merchantable Timber

Before construction on public lands, ensure salvage requirements are specified and agreed to by the company, clearing contractors, government agencies and commercial logging operator.

On private lands, salvage timber as specified by landowners; on public lands, salvage timber as specified by the government agency.

Do not bulldoze merchantable timber. If not needed by the owner of the timber rights, offer merchantable timber to the landowner. If the landowner does not want the timber, offer the timber to a commercial buyer. If a willing commercial buyer cannot be found, consider the timber nonmerchantable and dispose of it accordingly.

In upland areas, stack merchantable timber at a landing near the edge of the ROW in a manner that is accessible to hauling trucks (see Figure 1, Salvage of Merchantable Timber).

Nonmerchantable Timber

Consider saving nonmerchantable timber near watercourses for use in equipment crossing structures, slope stabilization or instream bank restoration.

In winter, cut nonmerchantable timber flush to the ground.

Disposal

Dispose of nonmerchantable timber and slash not needed for equipment crossing structures or bank restoration to the satisfaction of the landowner or regulatory authority. Disposal methods include:

- transportation to commercial disposal facilities
- burning
- chipping/grinding
- stockpiling (for firewood)

Do not dispose of nonmerchantable timber by placing it off the ROW, unless previously approved in writing by the landowner and the company.

NOTE: In forested areas, stumps and roots may be buried under 2 m of cover in natural clearings or low spots off the ROW, if the company can obtain permission in writing from the landowner or responsible forestry official.

Do not dispose of nonmerchantable timber, chips or any fill material in wetlands unless specifically approved by government agencies.

Rollback/Chip/ Mulch

Retain nonmerchantable timber and slash for use as chipping, rollback or corduroy.

ENB (NW)

Appropriate trees for chipping include spruce, alder and poplar.

If sufficient space is available, push slash into a windrow on the edge of the work side and store until cleanup; if space is limited, obtain temporary workspace in natural clearings adjacent to the ROW (see Figure 2, Slash Disposal-Rollback/Mulch/Chip).

Spread chips/mulch from clearing operations no thicker than 75 mm (3 in.). If practical, distribute clips/mulch across the ditch line and spoil area to encourage mixing during grading, backfill and cleanup, which eliminates a layer that can slow revegetation.

Burning

Burn nonmerchantable timber and slash if there is an excessive amount that may impede access for future maintenance activities.

Burning must be done under constant surveillance and in compliance with applicable permit requirements.

Before burning nonmerchantable timber and slash:

- develop a fire control plan
- obtain a burning permit
- designate a fire watch
- ensure adequate firefighting equipment is onsite

ENB (NW)

For minimum firefighting equipment requirements, refer to the applicable Land Use Permit or forestry regulation.

Push timber and slash into the center of the ROW, making windrows or piles no more than 60 m (196 ft) long. Separate the piles with firebreaks at least 8 m (25 ft) wide (see Figure 3, Slash Disposal-Burning).

Do not locate burn piles within 100 m (330 ft) of a watercourse or on organic soils.

Avoid locating burn piles on organic soil or on topsoil within agricultural lands. Burn piles on mineral soils or in a burning sloop.

Before leaving the site:

- extinguish burning embers
- spread ashes over the ROW
- dispose of all partially burnt stumps and logs to the satisfaction of landowners or government authorities

Equipment Crossings

A mat setting crew should install equipment crossings as a part of clearing operations, so that equipment does not ford any watercourse. (see 02-12, Equipment Crossings).

Grubbing

NOTE: Removing stumps and tree roots can cause topsoil and subsoil mixing, soil erosion, damage to standing trees and excessive surface disturbance.

Restrict grubbing to:

- the trench line
- areas requiring grading
- workside areas only where necessary to ensure safe equipment passage
- no closer than 2 m (6 ft) from standing trees to prevent damaging roots and to avoid creating bog holes in wetlands
- no closer than 10 m (CAN) or 50 ft (USA) from watercourses, except when absolutely necessary along the trench line and spoil pile area

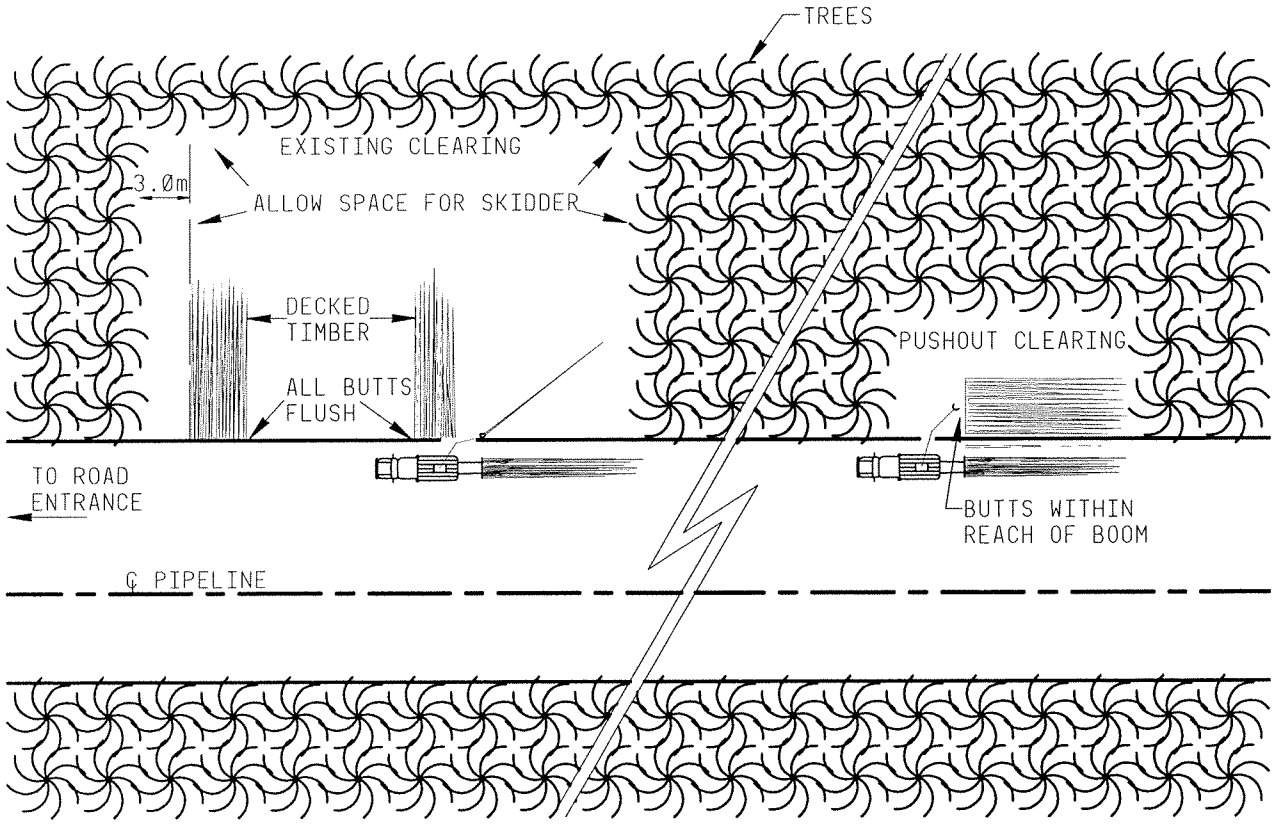
Grub spoil pile areas only if necessary.

Wildlife

If a tree to be cleared contains any large bird nests, or if any large ground nest, burrow or den is discovered during clearing:

- suspend the work activity
- immediately contact the project manager
- fence or flag off the area

NOTE: For more information on protecting wildlife, see 02-2, General Mitigation Measures.



PLAN VIEW

NOTES:

1. SALVAGE MERCHANTABLE TIMBER AS SPECIFIED BY LANDOWNER OR GOVERNMENT AUTHORITY AND COMPANY.

2. CUT TREES CLEAN; DO NOT BULLDOZE MERCHANTABLE TIMBER. REMOVE LIMBS AND TOPS. LOGS SHOULD NOT BE SKIDDED ACROSS OR DRIVEN INTO WATERCOURSES.

3. IN UPLAND AREAS, STACK MERCHANTABLE TIMBER AT A LANDING NEAR THE EDGE OF THE ROW IN A MANNER THAT IS ACCESSIBLE TO HAULING TRUCKS.

4. REQUEST LOGGING OPERATORS TO BEGIN HAULING TIMBER, PREFERABLY AFTER GRADING BUT BEFORE TRENCHING AND PIPE STRINGING.

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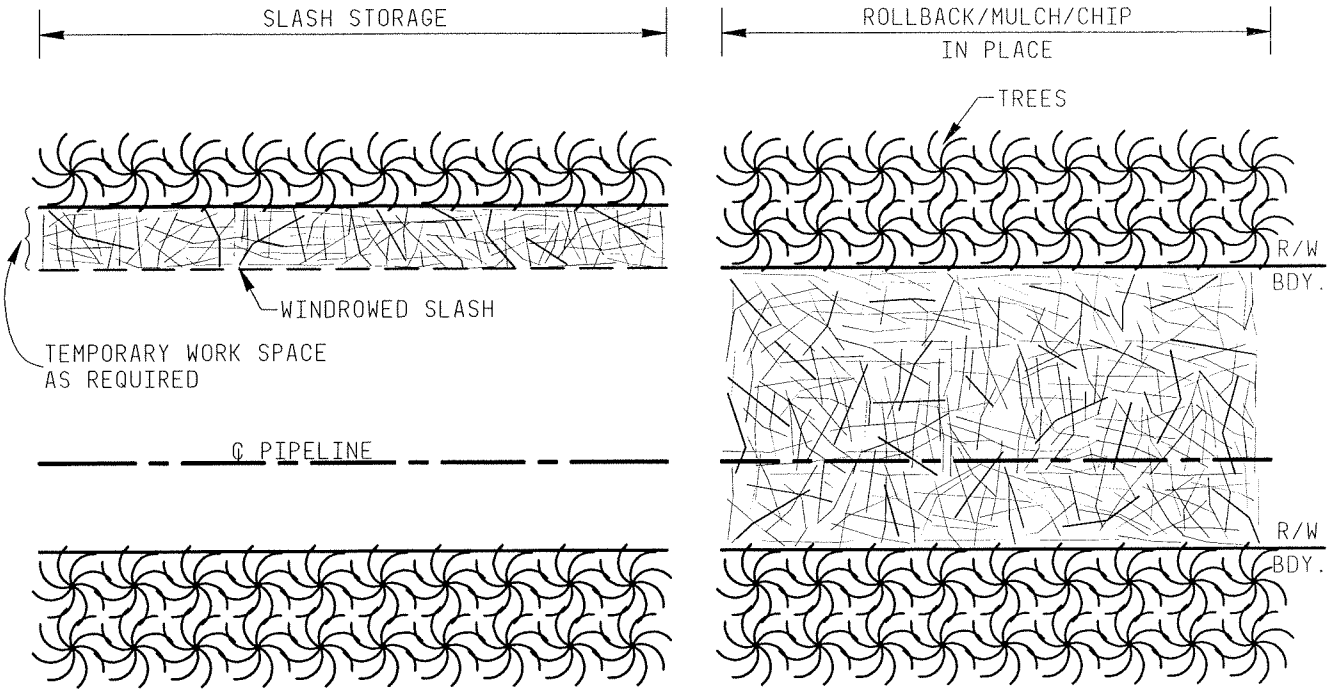
Figure 1

Salvage of Merchantable Timber



PLAN VIEW

NOTES:

1. RETAIN SLASH AND NON MERCHANTABLE TIMBER FOR USE AS CHIPPING, ROLLBACK OR CORDUROY.
2. WINDROW SLASH ON EDGE OF WORK SIDE AND STORE UNTIL CLEANUP. IF SPACE IS LIMITED, OBTAIN TEMPORARY WORKSPACE IN A NATURAL CLEARING ADJACENT TO ROW.
3. SPREAD CHIPS/MULCH FROM CLEARING OPERATIONS NO THICKER THAN 75MM (3IN.). IF PRACTICAL, DISTRIBUTE CHIPS/MULCH ACROSS THE DITCH LINE ON SPOIL AREA TO ENCOURAGE MIXING DURING GRADING, BACKFILL AND CLEANUP, WHICH ELIMINATES A LAYER THAT CAN SLOW VEGETATION.
4. WALK DOWN SLASH WITH BULLDOZER.
5. LEAVE AN ACCESS TRAIL CLEAR, IF REQUIRED.

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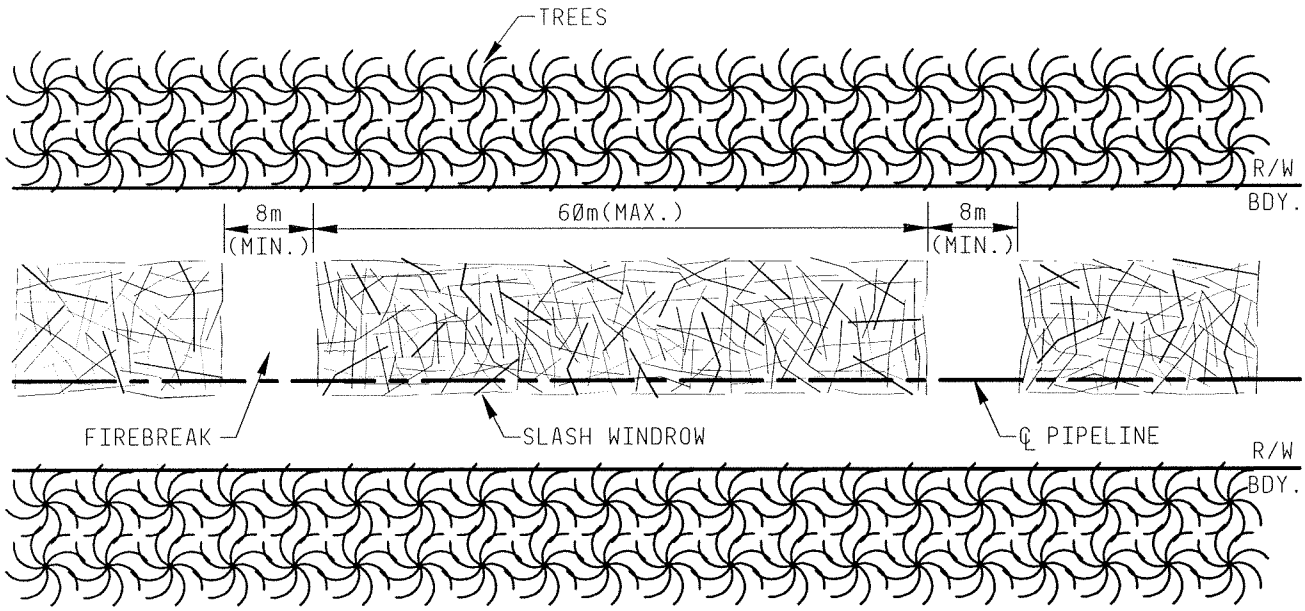
Figure 2

Slash Disposal -
Rollback/Mulch/Chip



PLAN VIEW

NOTES:

1. BURN NONMERCHANTABLE TIMBER AND SLASH IF THERE IS AN EXCESSIVE AMOUNT THAT MAY IMPEDE ACCESS FOR FUTURE MAINTENANCE ACTIVITIES.
2. BURNING MUST BE DONE UNDER CONSTANT SURVEILLANCE AND IN COMPLIANCE WITH APPLICABLE PERMIT REQUIREMENTS.
3. MAINTAIN FIRE FIGHTING EQUIPMENT ON SITE.
4. PUSH SLASH INTO WINDROWS OR PILES ALONG CENTRE OF RIGHT OF WAY AND SEPARATE BY FIREBREAKS. LOCATE BURN AREAS MORE THAN 100m FROM BODIES OF WATER AND AVOID LOCATING BURN SITES ON ORGANIC SOILS.
5. ATTEND FIRES AND PREVENT FROM SPREADING OFF RIGHT OF WAY. EXTINGUISH BURNING EMBERS BEFORE LEAVING SITE.
6. SPREAD ASHES OVER RIGHT OF WAY. DISPOSE OF ALL PARTIALLY BURNT STUMPS AND LOGS TO SATISFACTION OF LANDOWNERS OR GOVERNMENT AUTHORITIES.

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Figure 3

Slash Disposal - Burning

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TOPSOIL STRIPPING and SEGREGATION 02–5

Purpose

Topsoil is a valuable natural resource that is critical to agricultural capability and successful revegetation. Because subsoil properties are usually less favorable, mixing topsoil and subsoil can lower the overall productivity of soils. To prevent mixing soil during construction, every effort must be made to salvage topsoil in areas where soil productivity is an important consideration, e.g., cropland, pasture, golf courses, residential areas.

NOTE: For information on replacing topsoil, see 03-3, Cleanup.

Responsibilities

A company representative or an environmental inspector must oversee topsoil stripping in areas where:

- there is poor color change between topsoil and subsoil
- there are erodible soils
- the three-lift soils handling method is used
- there is uncertainty about the depth of stripping

Requirements

Stripping Depth

NOTE: In a typical soil profile, there is generally a visible change in color between topsoil and subsoil. Where color change is not evident, determine topsoil depth by texture and structure.

Maximum Depth

Where there is deep topsoil, such as on cultivated lands, strip topsoil to a maximum depth of 30 cm (12 in.) unless otherwise requested by the landowner

NOTE: If more than 30 cm (12 in.) of topsoil is stripped, additional space may be needed for spoil storage (see 01-7, Determining Area for Soil Storage).

Minimum Depth

Where there is less than 30 cm (12 in.) of topsoil, strip topsoil to color change, 15 cm (6 in.), or plough layer, whichever is deepest.

Variable Depth Topsoil

Strip topsoil so that the exposed surface has a mottled pattern composed of 50% topsoil and 50% subsoil where possible.

Use equipment with fine depth control, e.g., a grader or dozer, to strip variable depth topsoil.

Sandy Soils and Dunes

For sandy soils and dunes, strip the upper 5–10 cm (2–4 in.) of material where topsoil has not developed or is not apparent.

Stripping Width

Determine stripping width before beginning construction activities

NOTE: Strip topsoil from all areas that require grading.

Trench and Spoil Area

Strip topsoil from the trench and spoil area during dry and unfrozen conditions where there is greater than 10 cm (4 in.) of topsoil on (see Figure 1, Typical Storage Segregation Ditch Plus Spoil Side):

- cultivated land
- pasture and hay land with poorly established sod layer
- bush or woodland with agricultural potential
- deeply furrowed or rough-cultivated land

Store topsoil from the trench and spoil area on the spoil side of the trench, next to the stripped area and on adjacent undisturbed surface (see Figure 1, Typical Storage Segregation Ditch Plus Spoil Side).

Full Right-Of-Way

Strip topsoil from the full ROW during dry and unfrozen conditions on (see Figure 2, Typical Topsoil Segregation Full ROW):

- agricultural lands with localized weed infestations
- cultivated lands and lands with agricultural potential that are subject to compaction or soil mixing on the work side, e.g., where there is less than 10 cm (4 in.) of topsoil
- areas that will be graded or filled

Strip topsoil from the full ROW in wet or thawing soil conditions when project activities cannot be postponed.

NOTE: If soils are wet or thawed, use appropriate contingency measures or postpone work activities until soils dry out or freeze (see 02-16, Wet/Thawing Soils).

Trench Line Only

Strip topsoil from over the trench line only (see Figure 3, Typical Topsoil Segregation Trench Line Only):

- where topsoil is frozen solid
- in wetlands without standing water or saturated soils
- in areas with a fairly thick sod layer, e.g., golf courses, mature pastures, residential areas

Crossings

Strip topsoil from the full ROW width to allow for a wider and deeper trench, storage of larger volumes of spoil, and additional grading and temporary workspace.

Sandy Soils and Dunes

For sandy subsoils and dunes, strip an extra width of topsoil to allow for slumping of trench walls, or where trench walls are sloped.

NOTE: Minimize disturbance to surface vegetation on sandy soils or dunes wherever possible.

Stony Topsoil

For stony topsoil, minimize stripping the full width of the ROW to avoid bringing stones to the surface.

Use a backhoe to strip stony topsoil only if conventional methods, i.e., dozers and graders, are ineffective.

Unstable Trench Walls, Sidebends

Increase the width of stripped topsoil if (a) trench walls do not stand up and (b) a wider or deeper trench is otherwise needed, e.g., sidebend and tie-in locations (see Figure 4, Unstable Trench with Trench and Spoil Area Topsoil Stripping).

If possible, salvage topsoil from under the new spoil pile on the spoil side and relocate to the edge of the extra working space.

Storage

Always maintain separation between the base of a topsoil and the base of an adjacent subsoil pile.

When the three-lift soils handling method is used, maintain separation between topsoil and subsoil piles, and also between subsoil piles.

Urban Areas

In urban areas where storage space is limited, remove and store soils separately at a remote location; or alternately, flatten the topsoil pile, cover the pile with tarps, plywood or straw, and store the subsoil on top.

Winter Conditions

Maintain snow cover over the area to be stripped as long as possible. Remove snow just before stripping and windrow to the edges of the ROW.

Grade topsoil in the spoil area smooth to minimize mixing during backfilling.

To break up frozen topsoil, strip topsoil 1 m wider than the trench using a modified bucket wheel trencher, step blade or conventional equipment preceded by a ripper (see Figure 5, Topsoil Stripping and Trench Area Winter Construction).

Store topsoil on the working side of the trench, set back to allow the tracks of the trencher to operate on level ground. Leave breaks in topsoil at drainage courses.

Wooded Areas

In wooded areas where little or no topsoil has developed, stripping is not required unless requested by the authorities having jurisdiction.

Wetlands

Strip topsoil in unsaturated wetlands, giving extra attention to maintaining root stocks for replacement. Keep wetland soils separate from upland soils.

Organic Soils

Do not strip organic soils (peat).

Hay and Pasture Land

For mature sod layers on hay and pasture land, disc the area to be stripped.

Three-Lift Soils Handling

Strip topsoil using the three-lift soils handling technique during dry and unfrozen conditions where:

- a soil survey has indicated that lower subsoils are of significantly lower quality than upper subsoils
- conventional trenching could raise the undesirable lower subsoils within the soil profile.

Store topsoil on the spoil side of the trench next to the stripped area (see Figure 6, Three Lift Soil Handling Non-Frozen Conditions).

Store the first lift of trench subsoil on the spoil side, either next to the trench (Profile A), or back far enough to store the second lift (Profile B). Maintain a separation between the topsoil pile and the excavated spoil (see Figure 6, Three Lift Soil Handling).

Store the second lift of trench subsoil next to the trench, either on the work side (Profile A), or the spoil side (Profile B). Maintain a separation between the two excavated spoil piles, or between the second lift spoil pile and the undisturbed topsoil on the work side.

Erosion Control

High Winds

If drifting soils or topsoil loss is evident in areas prone to wind erosion, postpone topsoil stripping until 3 days before trenching. If this is not practical:

- limit the time between topsoil stripping and final cleanup
- suspend topsoil stripping and backfill operations during high winds
- apply a tackifier to the topsoil pile
- install wind barriers, e.g., slat fences, snow fences

Tackifier

Apply tackifier solution to topsoil piles at a minimum rate of 1.4 L/m^2. The solution should contain at least 0.5 L/m^2 of concentrated tackifier (ER-2000 or company approved alternative).

If directed, also apply tackifier solution to the unstripped work side at a minimum rate of 2.25 L/m^2 for the initial application. This solution should contain at least 1.1 L/m^2 of concentrated tackifier.

For subsequent applications to the work side, reduce the solution concentration to 0.5 L/m^2 of concentrated tackifier.

Adjacent Hot Lines

When stripping topsoil over adjacent hot lines, use (a) a grader with a basic operating weight not exceeding 40,500 lbs and a maximum axle loading of 18,000 lbs per axle, or (b) a company approved equivalent.

CAUTION: Do not strip topsoil over hot lines within a swamp or slough, or within 6 m of a protective sleeve.

Maintain a minimum of 0.76 m of cover over hot lines, reducing the depth of topsoil stripping if necessary. Where there is 0.83 m or less of cover over the existing pipeline before stripping, suspend stripping. Instead, place a protective covering over the topsoil in the spoil area to prevent mixing topsoil and subsoil (e.g., matting, sheeting).

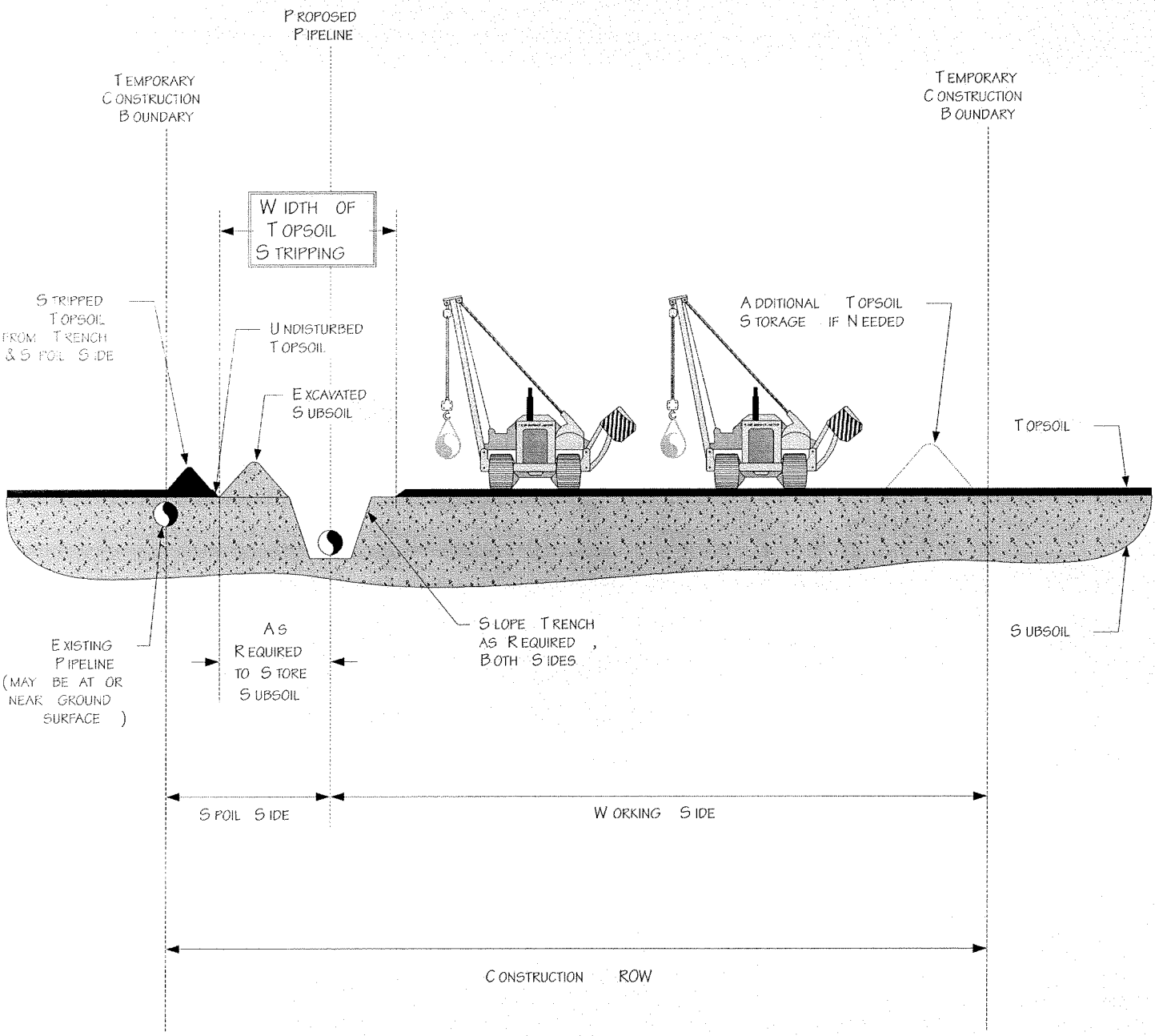

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Figure 1

Typical Topsoil Segregation
Ditch Plus Spoil Side

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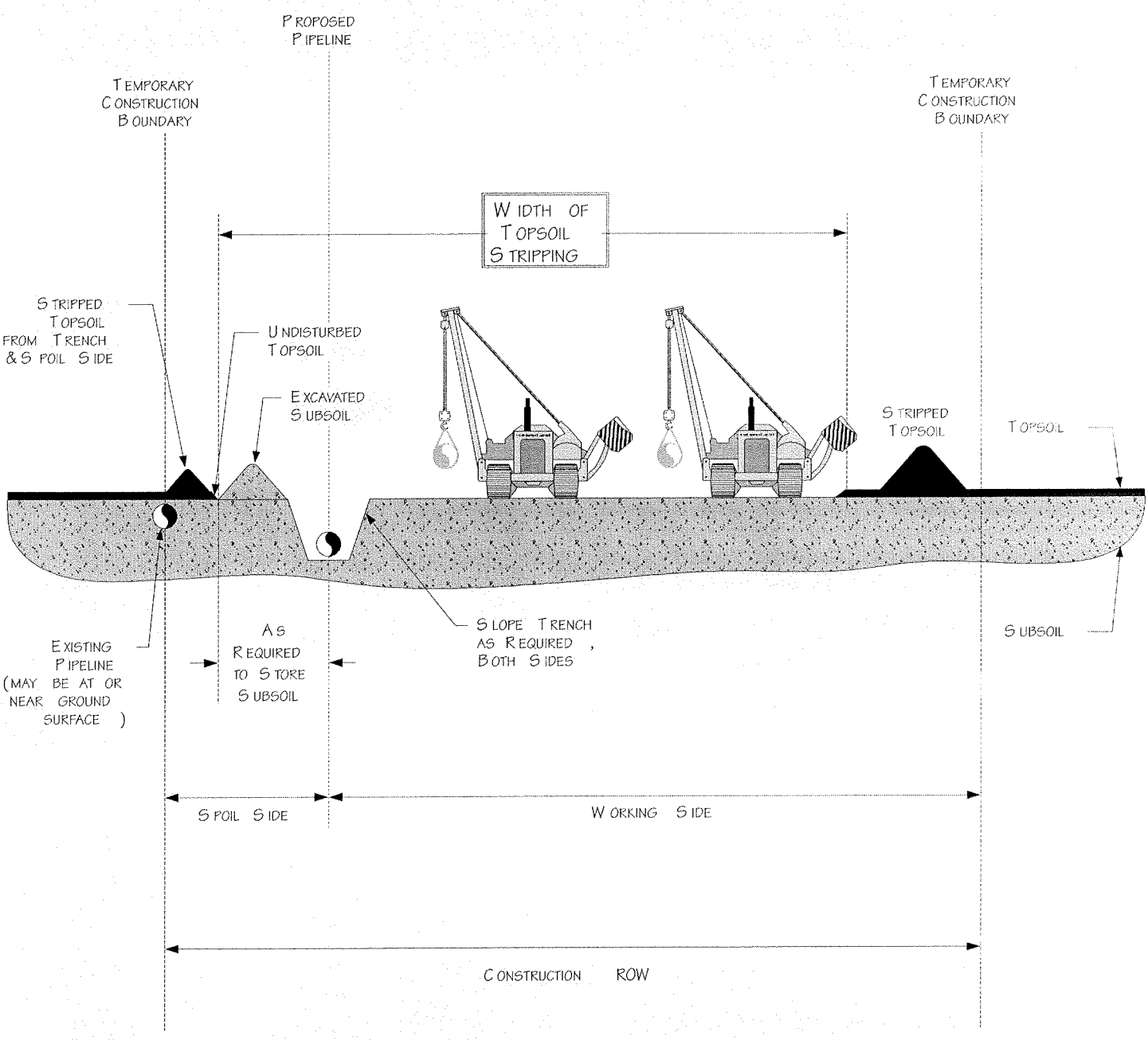

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Figure 2

Typical Topsoil Segregation
Full Right-of-Way

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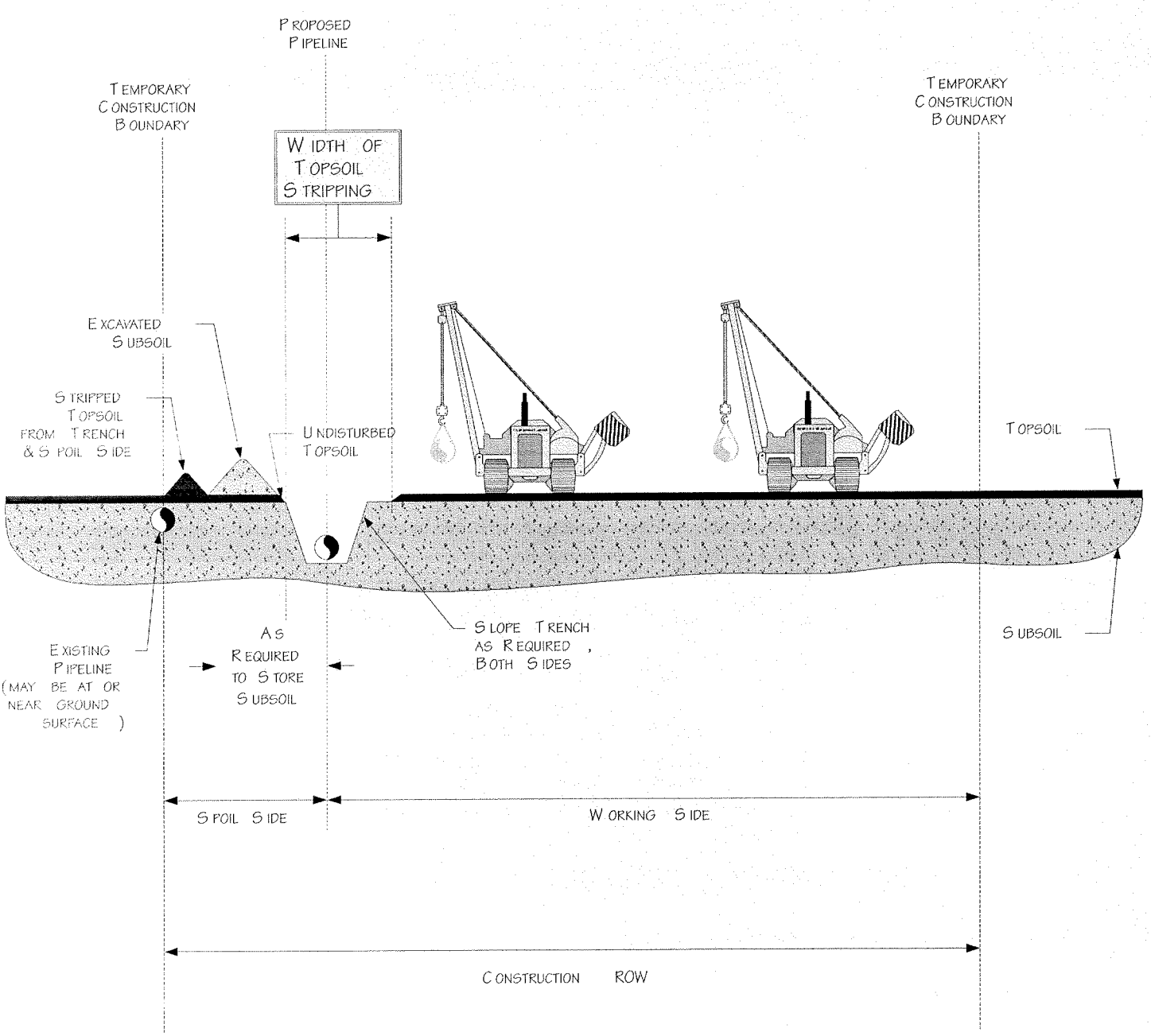

NOTES :

1. TRENCH LINE ONLY TOPSOIL SEGREGATION TYPICALLY EMPLOYED IN UNSATURATED WETLANDS, HAYLAND, PASTURES, AND RESIDENTIAL AREAS UNLESS OTHERWISE SPECIFIED BY THE LANDOWNER.

ENBRIDGE

Figure 3

Typical Topsoil Segregation
Trench Line Only

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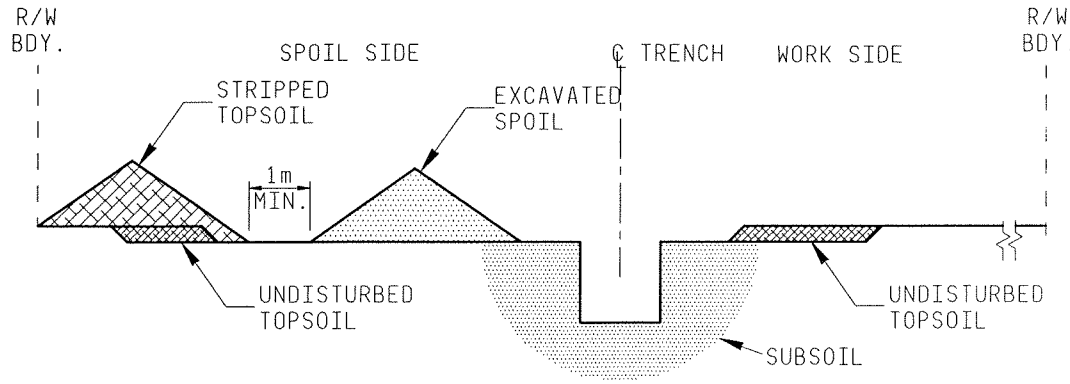
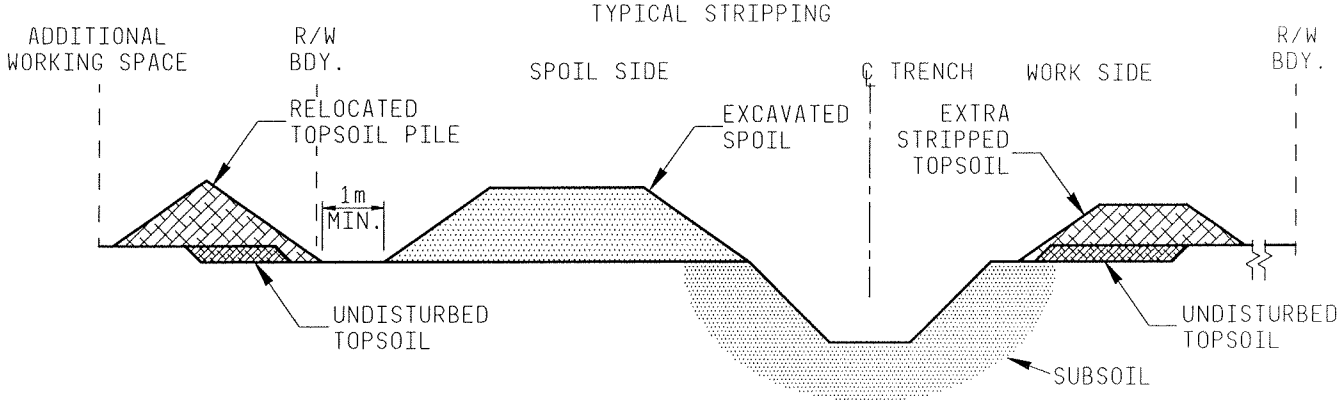


PROFILE
TYPICAL STRIPPING



PROFILE
EXTRA STRIPPING

NOTES:

1. SUSPEND TRENCHING IF UNSTABLE TRENCH IS ENCOUNTERED. WELD-UP PIPE PRIOR TO CONTINUING TRENCHING TO MINIMIZE TIME OF AN OPEN TRENCH.
2. STRIP EXTRA WIDTH IF TRENCH WALLS DO NOT STAND UP AND TOPSOIL AND SUBSOIL SLOUGH INTO TRENCH OR A WIDER OR DEEPER TRENCH IS OTHERWISE NEEDED.
3. OBTAIN EXTRA WORKING SPACE ON SPOIL SIDE.
4. SALVAGE TOPSOIL PILE ON THE SPOIL SIDE AND RELOCATE TO THE EDGE OF EXTRA WORKING SPACE.
5. STRIP EXTRA TOPSOIL ON WORK SIDE AND FLATTEN AS REQUIRED FOR PIPE SET-UP AREA.
6. EXCAVATE TRENCH TO ANGLE OF REPOSE OF SUBSOIL. STORE ON SPOIL SIDE.
7. MAINTAIN 1.0m SEPARATION BETWEEN SPOIL PILE AND TOPSOIL PILE.

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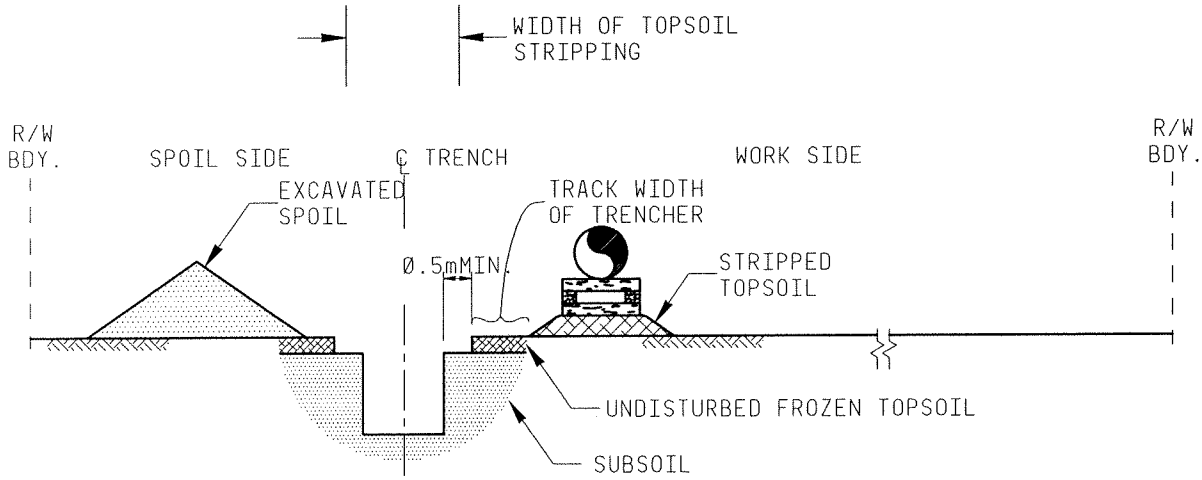
Figure 4

Unstable Trench with Trench and Spoil Area Topsoil Stripping



PROFILE

NOTES:

1. UTILIZE WINTER WIDTH STRIPPING ON SOLID FROZEN GROUND WHERE A SOD LAYER, A SNOW BARRIER OR GROUND SURFACE WILL PREVENT MIXING OF TOPSOIL AND SPOIL.
2. STRIP TOPSOIL WIDER THAN THE TRENCH USING A MODIFIED BUCKET WHEEL TRENCHER OR A STEP BLADE PRECEEDED BY A RIPPER. MULTIPLE PASSES WITH THE RIPPER ARE PREFERRED TO A SINGLE PASS TO THE FULL STRIPPING DEPTH.
3. STRIPPING WIDTH SHOULD BE 1m WIDER THAN AND CENTERED OVER THE TRENCH. STRIPPING DEPTH SHOULD BE 10cm MIN. TO THE COLOR CHANGE OR AS INDICATED ON THE AIRPHOTO MOSAIC OR LINE LIST.
4. STORE TOPSOIL ON WORKING SIDE OF THE TRENCH SET BACK TO ALLOW THE TRACKS OF THE TRENCHER TO OPERATE ON LEVEL GROUND. LEAVE BREAKS IN TOPSOIL AT DRAINAGE COURSES.
5. EXCAVATE TRENCH CENTERED WITHIN STRIPPED AREA AND STORE ON SPOIL SIDE.
6. COMPLETE STRINGING, WELDING AND LOWERING-IN ACTIVITIES
7. RETURN EXCAVATED SPOIL TO TRENCH AND LEAVE A HIGH CROWN CENTERED OVER THE TRENCH LINE. ALLOW BACKFILL MATERIAL TO THAW IN THE SPRING. COMPACT NONFROZEN MATERIAL IN PLACE. NO CROWN SHOULD BE EVIDENT.
8. RETURN TOPSOIL EVENLY OVER THE TRENCH LINE.
9. ALLEVIATE COMPACTION OF TOPSOIL OVER ENTIRE RIGHT OF WAY ON CULTIVATED LANDS. SEED DISTURBED AREA WITH A COMPATIBLE SEED MIX AND FERTILIZE ON PASTURE , HAY AND NONCULTIVATED LANDS.

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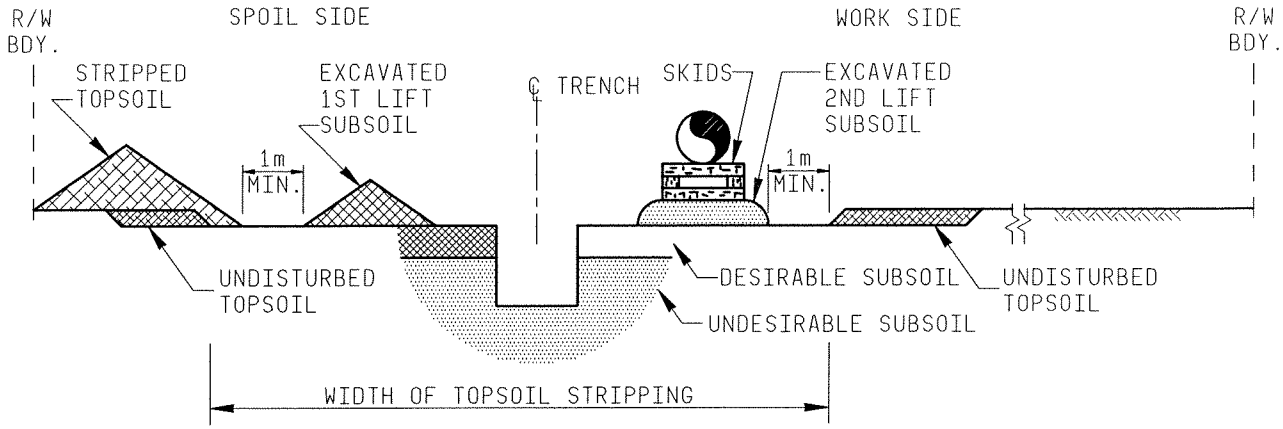
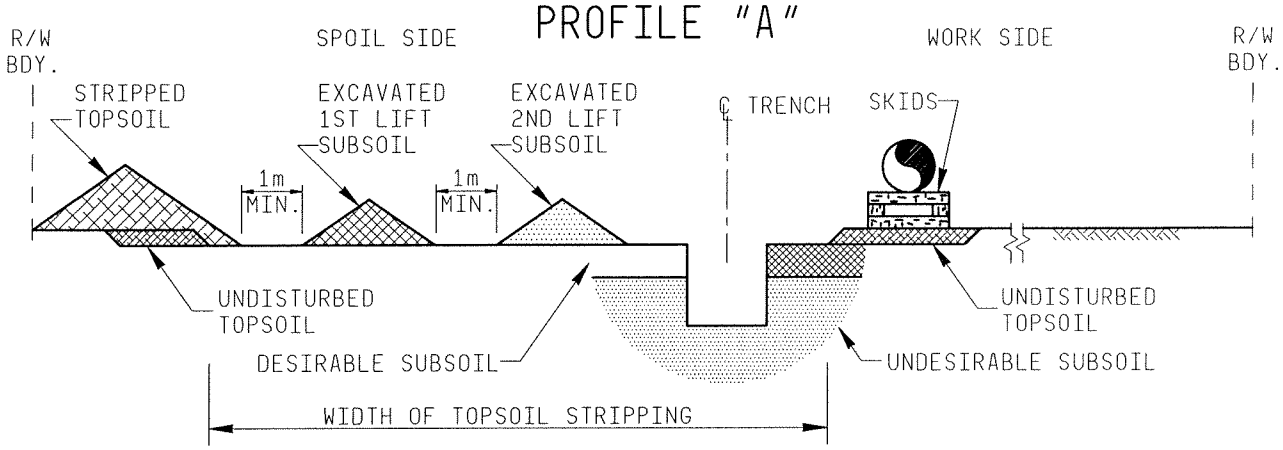
Figure 5

Topsoil Stripping - Trench Area
Winter Construction



PROFILE "A"



PROFILE "B"

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Figure 6

Three Lift Soil Handling
Non-Frozen Conditions

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TEMPORARY EROSION and SEDIMENTATION CONTROL 02–6

Purpose

Temporary erosion and sedimentation control measures include slope breakers, sediment barriers, trench breakers and mulch. The purpose of erosion and sedimentation control is to (a) contain excavated soils onsite and to (b) prevent construction-related sediment from entering streams, wetlands, lakes, drainage ditches (dry or flowing) or other watercourses.

NOTE: For information on specific temporary control measures, see the procedures in this tab.

Guidelines

Soil erosion is determined by four main factors:

- soil characteristics
- vegetative cover
- topography
- climate

Soil Characteristics

Analyze soil conditions at the site to help determine erosion control measures. The most erodible soils have a high content of silt and very fine sand. The least erodible soils have little or no silt, e.g., well-drained gravel and sand.

Although soils with a high content of clay are more resistant to erosion, these soils have poor infiltration and therefore runoff tends to increase resulting in erosion. In addition, clay soils are easily transported and do not settle out very quickly.

Vegetative Cover

Maintain existing vegetation on areas with high erosion potential whenever possible, e.g., slopes, drainage ways or next to streams and wetlands. Vegetative cover (e.g., grass, weeds, shrubs, crops) is important in controlling erosion because it:

- shields the soil surface
- slows runoff
- maintains the capacity of the soil to absorb water
- holds soil in place

Topography

Protect disturbed slopes from runoff and revegetate quickly. Where possible, leave steep slopes undisturbed. Topography is important in controlling erosion because as the slope length and gradient increases, the volume and velocity of runoff increases and the potential for erosion increases.

Climate

Climate affects the frequency, intensity and duration of rainfall. Where possible, schedule work during periods of low precipitation and runoff.

NOTE: For more information on scheduling projects, see 01-3, Project Scheduling.

Principles of Erosion and Sedimentation Control

Keep disturbed areas small and minimize the length of time they are disturbed.

Stabilize and protect disturbed areas as soon as possible.

Keep storm water runoff velocities low.

Protect disturbed areas from storm water runoff.

Retain sediment within the corridor or site area.

Temporary Control Measures

All temporary control measures must be:

- properly installed
- installed immediately after initial disturbance
- reinstalled where required, e.g., after backfill
- inspected and properly maintained (i.e., repaired, replaced or supplemented with functional materials) throughout construction until permanent erosion control is established or restoration is complete

GRADING 02–7

Purpose

Grading generally follows clearing and involves leveling and smoothing the construction right-of-way (ROW) to create an even working surface for equipment and vehicles. Grading can disturb the surface more than any pipeline activity. Cutting and replacing steep slopes may lead to long term instability and erosion, which may threaten integrity of the pipeline. In addition, grading and erosion near streams may damage riparian habitats and result in siltation of aquatic habitats. Finally, berming snow or organic matter over the trench line during winter construction can temporarily block the movement of wildlife and livestock.

Guidelines

Before grading, ensure erosion control measures are in place at watercourses.

Minimize grading and grade changes that require excessive cuts and fills. Grade only as necessary to provide an adequate surface for construction equipment, and to allow overbends and sag bends to be made within permissible bending limits.

Do not store or push graded materials into treed areas. Store graded spoil in discrete piles or windrows for replacement during cleanup (see Figure 1, Cut and Fill Grading).

Minimize grading on hay or improved pasture and native prairie to minimize disturbance to the sod.

Slopes

Minimize grading on steep slopes. Limit grading to allow access for tracked vehicles only. Rubber-tired traffic must use temporary access trails.

Do not place graded material on steep slopes or closer than 20 m (60 ft) from the crests of slopes. Cuts and fills should not exceed 1:3 slope (rise over run). Do not store graded spoil in low areas.

Ensure graded material does not spread off the ROW.

Do not mix topsoil and subsoil disturbed during grading with foreign material, e.g., stumps and brush.

Two-tone the ROW to limit the need for deep cuts and additional temporary work space on sidehills (see Figure 2, Two Toning Grading).

Watercourses and Wetlands

Minimize disturbance to natural drainage channels during grading; avoid blocking channels with graded material—install a culvert.

Restrict grading to the trench line and work area where possible. Minimize grading when constructing temporary bridges or fill crossings. Ice bridges and fords may require additional grading.

Direct grading away from watercourses to reduce the risk of material entering the watercourse. Do not place fill material in a watercourse during grading.

Grading equipment must not be operated directly in watercourses or must not directly cross watercourses.

Minimize grading within the 16 m (50 ft) buffer of undisturbed vegetation on each stream bank. If grading within the buffer, install temporary sediment barriers to prevent sediment from disturbed areas from flowing into the stream (see 02-14, Temporary Sediment Barriers).

Immediately after grading, install temporary slope breakers or silt fences at the base of slopes leading to streams or wetlands (see 02-13, Slope Breakers and 02-14, Temporary Sediment Barriers).

Snow

As soon as wetlands or muskegs are sufficiently frozen to support light construction equipment, remove snow from the working side of the proposed line to increase frost penetration.

Windrow snow over the trench line to prevent deep frost penetration along the trench line.

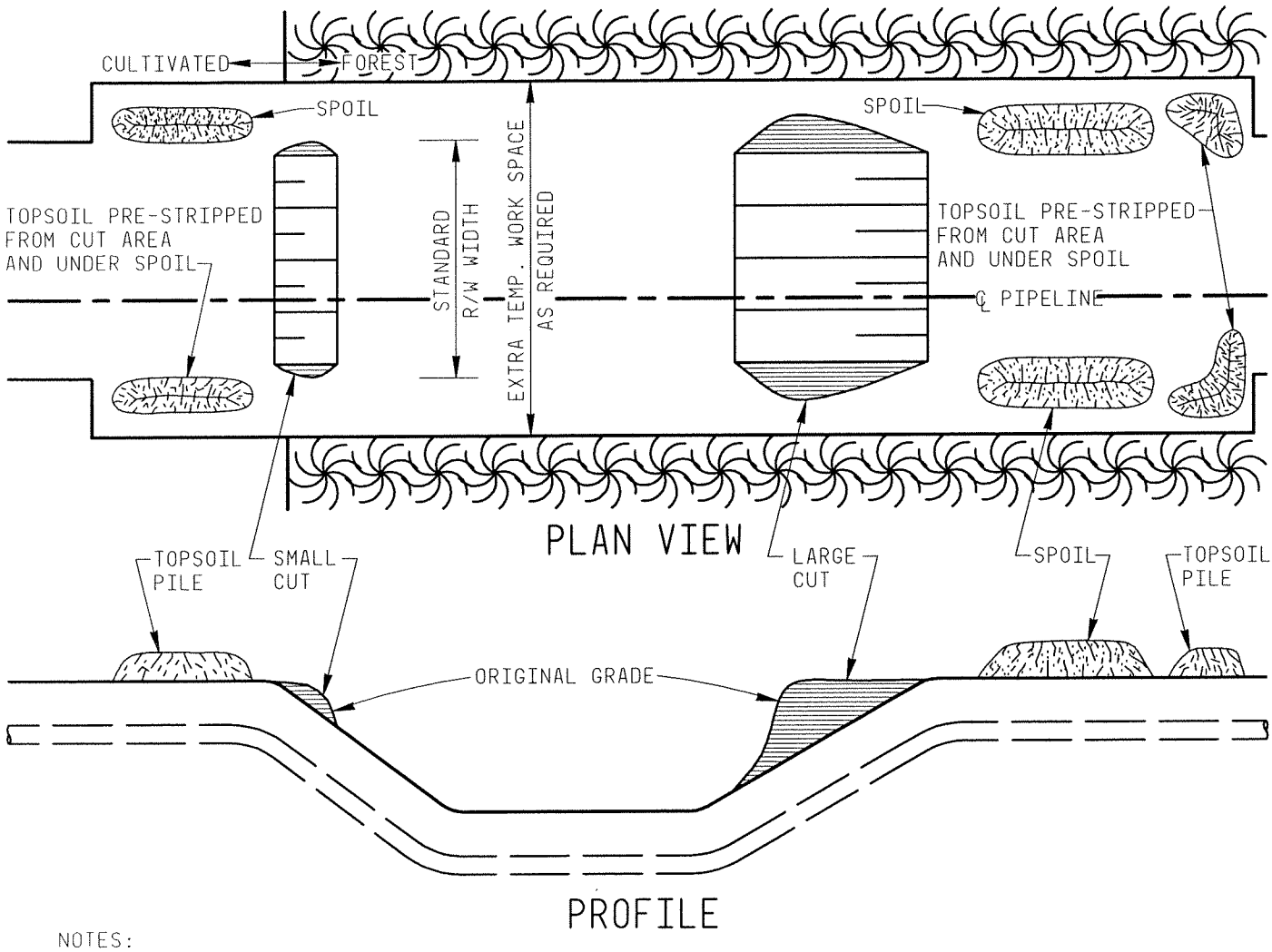
Remove large amounts of snow from the spoil storage area to facilitate removing spoil during backfilling and to avoid mixing snow with the backfill.

NOTE: With landowner permission, windrow snow off the ROW.

Immediately before ditching, windrow surplus snow and any snow bermed over the trench line to the closest side of the ROW.

If necessary to contain spoil during construction, use snow berms at the edge of the ROW. If snow berms are not feasible or could lead to mixing snow in the backfill material, install silt fence or hay bales.

Leave 3 m (10 ft) wide gaps at regular intervals (every 400 m or ¼ mi) in snow windrows greater than 0.75 m (30 in.) in height, to allow movement of wildlife and livestock.



NOTES:

1. GRADE EXCESSIVELY STEEP SLOPES TO PROVIDE A SUITABLE SURFACE FOR MOVEMENT OF CONSTRUCTION EQUIPMENT AND TO ALLOW OVERBENDS AND SAGBENDS TO BE MADE WITHIN PERMISSIBLE BENDING LIMITS. ON WINTER PROJECTS, USE SNOW TO SMOOTH OUT THE WORKING SIDE IF POSSIBLE.

2. IDENTIFY AREAS WHERE ADDITIONAL RIGHT OF WAY IS REQUIRED TO ACCOMMODATE CUTS AND FILLS. SALVAGE MERCHANTABLE TIMBER AND TOPSOIL. MAINTAIN A MINIMUM 1m SEPARATION BETWEEN TOPSOIL AND SPOIL PILES.

3. GRADE SLOPES SUFFICIENTLY TO MINIMIZE INSTABILITY AND RESULTANT EROSION AND PIPE INTEGRITY PROBLEMS.

4. STORE FILL UPHILL OF CUT WHERE IT CAN BE EASILY RECOVERED AND WHERE NATURAL DRAINAGE IS NOT BLOCKED.

5. STORE FILL ON LEVEL GROUND BACK FROM UPPER BREAK OF SLOPE TO AVOID OVERLOAD AND POTENTIAL FAILURE. OBTAIN ADVICE FROM A GEOTECHNICAL ENGINEER.

6. REPLACE CUTS AND RECONTOUR SLOPES DURING CLEAN-UP TO MAXIMUM 3:1 GRADE UNLESS OTHERWISE DIRECTED BY GEOTECHNICAL ENGINEER.

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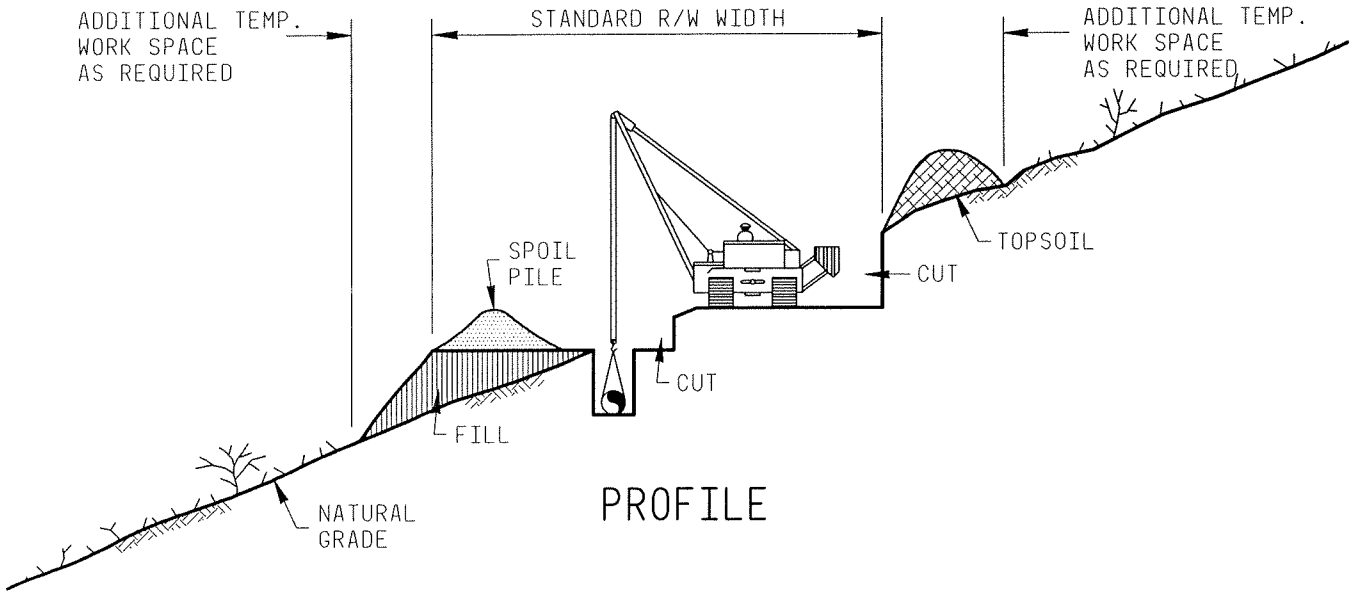
Figure 1

Cut and Fill Grading



PROFILE

NOTES:

1. TWO-TONE THE RIGHT OF WAY TO LIMIT THE NEED FOR EXCESSIVELY DEEP CUTS AND FILLS AND TO MINIMIZE THE NEED FOR ADDITIONAL TEMPORARY WORK SPACE ON SIDEHILLS.
2. CLEAR AND STAKE ADDITIONAL TEMPORARY WORK SPACE TO ALLOW FOR EXTRA SPOIL.
3. ENSURE SIDE BOOM TRACTORS ARE EQUIPPED WITH BOOM EXTENDERS AND COUNTERWEIGHTS IF REQUIRED.
4. USE BACKHOE TO ASSIST BULLDOZERS WITH REPLACING CUTS. RECONTOUR TO MAXIMUM 3:1 GRADE UNLESS OTHERWISE DIRECTED BY GEOTECHNICAL ENGINEER.
5. EXCESS FILL MAY BE PUSHED FORWARDS OR BACKWARDS TO RAMP APPROACH SLOPES OR DRAWS IN THE SIDE SLOPE.

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Figure 2

Two-Toning Grading

TRENCHING 02–8

Purpose

Trenching (pipe installation) involves stringing pipe, welding, ditching and lowering the pipe into the excavation. Excavating the trench for the pipeline is typically done using backhoes or a wheel ditching machine. Spoil (subsoil) from the trench is piled near the trench opposite the working side.

Pipe stringing involves unloading pipe from heavy trucks onto skids in preparation for welding. After pipe stringing is complete, the pipe is bent as necessary to conform to changes in ground contour and pipeline alignment. Pipe joints are then welded together and the welds are nondestructively tested. After the welds are coated with a material as protection from corrosion, pipe sections are lowered into the trench.

These activities have the potential to cause soil mixing and compaction, and can interfere with farming activities and wildlife.

Guidelines

Scheduling

During winter construction, ensure the frost is deep enough to proceed without causing excessive rutting and soil compaction.

If excessive rutting and compaction are expected, postpone heavy traffic until soils freeze or dry.

Coordinate with landowners to minimize disruption of access caused by trenching or pipe stringing.

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

Minimize the length of time a trench is open to limit trench sloughing or frost penetration, and disruption to wildlife, agricultural activities and other land uses.

Pipe Stringing

Confine stringing trucks to the stripped portion of the ROW as much as practical.

Limit heavy equipment to machinery and vehicles equipped with low-ground pressure tires or wide tracks. If ground conditions are too soft to support stringing trucks, consider using specialized equipment such as tracked flat beds or Rolligons.

If low-ground pressure equipment is not used and ground conditions on the ROW are unstable, use geotextile or corduroy to improve the bearing capacity of soft ground.

NOTE: Do not use tree stumps, bush riprap, imported dirt or rock fill to stabilize the ROW for vehicle traffic.

Welding

Do not leave spent welding rods, filings/shavings from end preparation, or cut off pipe rings on the ground or in the trench.

Provide receptacles (e.g., garbage cans, steel drums) for disposal of welding rods and other refuse at strategic locations.

Shut down welding during high winds in high fire hazard areas.

If requested by the landowner or the regulatory agency, leave gaps in continuous welded sections every 500 m (1/3 mi) to allow passage of livestock, farm equipment and wildlife.

Ditching Equipment

To minimize spoil storage requirements:

- match the trench width to the pipe size and soil conditions during trenching
- maximize the use of wheel ditchers
- minimize the amount of backhoe work

Unstable Trench Walls

If trench walls or topsoil slough into the trench or there is a potential for mixing topsoil with subsoil, suspend trenching and increase the width of stripped topsoil.

NOTE: For more information, 02-5, Topsoil Stripping and Segregation

Delay trenching in areas with a high water table or where there is a risk of sloughing until just before lowering in the pipe.

NOTE: Before trenching, consider installing well points around the site to intercept groundwater before it enters the trench.

Gaps and Plugs

Leave gaps in the spoil pile at natural drainage channels to accommodate surface runoff.

If requested by the landowner, leave gaps in strung pipe and in topsoil and spoil piles, with corresponding plugs in the ditch to allow vehicle access or movement of livestock and wildlife across the ROW. Consult with landowner regarding the location of gaps (recommended minimum width of the plug and gap is 3 m (10 ft) (see Figure 1, Two-Toning Grading and Topsoil and Spoil Piles).

Ripping

Rip bedrock where encountered and where adequate equipment is available. Ripping is preferred over blasting.

Blasting

Follow explosive laws and regulations where blasting is necessary.

Use blasting mats to prevent damage from rock fragments. Immediately collect any displaced rock from the vicinity of residences, highways, utilities, structures, and cultivated or improved lands. Dispose of excess rock by windrowing, scattering, placing in discrete piles or as directed by landowners or regulatory agencies.

Collect and dispose of shot cord, caps, cones and other debris associated with blasting in accordance with the Waste Management Plan.

If blasting is required within 50 m of a fish-bearing watercourse, contact the environment department.

Drain Tiles

Excavate the trench so that the pipeline may be laid over or under the tile with a minimum clearance of 30 cm (12 in.).

If drain tiles are cut during trenching:

- identify the location of the damaged tile at the trench and at both sides of the construction ROW
- install a temporary flume if needed to maintain drainage
- cap the ends to prevent clogging drains with dirt or debris

NOTE: Keep plugs in place until the damaged tile is repaired (see 03-2, Backfilling).

Road and Rail Crossings

Where soil and topographic conditions permit, bore public road and rail crossings to prevent disturbing the crossing and disrupting service (see Figure 2, Road Crossing-Boring). As circumstances dictate, also consider boring for irrigation canals, selected watercourses, shelterbelts, roadside trees and foreign lines.

If boring a road is impeded by topography, rock, gravel or organic material, and if rerouting is impractical, obtain the consent of local authorities to open cut the road.

Minimize the time crossings are left open.

Notify road owners and users, and construct detours as necessary. Install safety barricades, fences, signs and flashers around open road crossings and bellholes adjacent to the road.

Watercourses and Wetlands

Since water crossings are usually handled by a separate crossing or tie-in-crew, stop trenching crew activities before the buffer zone at the watercourse banks.

Use backhoes or draglines operated from one or both stream banks or from bridges to excavate the trench. As much as possible, store instream spoil on the stream bank within a straw bale/silt fence containment area (see 02-6, Temporary Erosion and Sedimentation Control).

Locate crossing pipe tie-ins and any bends requiring tie-ins at least 10 m (35 ft) from stream banks to minimize disturbance from bell holes.

If excavating equipment must encroach into the stream, it must operate on a sled or clean construction mats.

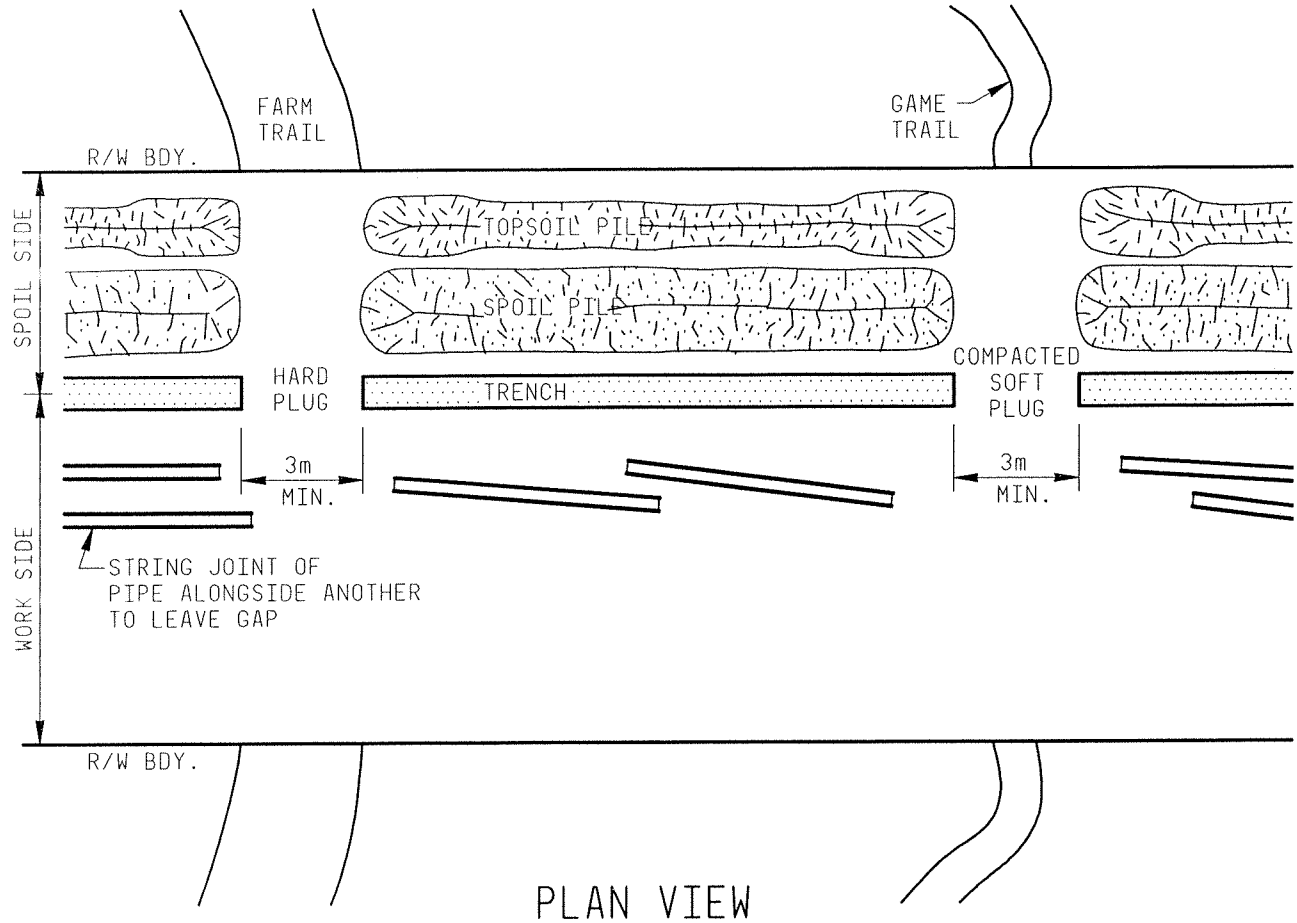
To facilitate trench excavation in saturated soils, timber mats may be placed over the ditch line to support the backhoe.

If the watercourse is wider than what can be trenched with a hoe entering the water, place insert spoil in discrete piles away from the areas of highest water velocity. Do not windrow soil across the stream channel or block more than two-thirds of the channel.

Install 3 m (10 ft) hard plugs in the ditchline to separate the crossing trench from the open trench on the stream banks. Before removing hard plugs, install soft plugs where necessary to prevent silty trench water from entering the watercourse. Dewater the trench onto stable, well-vegetated uplands (see 02-17, Dewatering).

Trench Breakers

Where the pipeline trench has the potential to partially drain a wetland, install trench breakers as necessary to maintain the original wetland hydrology (see 02-15, Trench Breakers).



PLAN VIEW

NOTES:

1. LEAVE GAPS IN STRUNG PIPE, TOPSOIL AND SPOIL PILES TO PERMIT VEHICULAR ACCESS OR MOVEMENT OF LIVESTOCK AND WILDLIFE ACROSS THE RIGHT OF WAY. CONSULT WITH LANDOWNER REGARDING LOCATION OF GAPS.

2. LEAVE GAPS AT DRAINAGE COURSES, WILDLIFE TRAILS AND IF REQUESTED, LIVESTOCK TRAILS.

3. GAPS IN STRUNG PIPE SHOULD COINCIDE WITH GAPS LEFT IN TOPSOIL, SPOIL PILES, AND WITH HARD PLUGS IN TRENCH.

4. INSTALL A COMPACTED SOFT PLUG WHERE TRENCHING HAS ALREADY BEEN COMPLETED.

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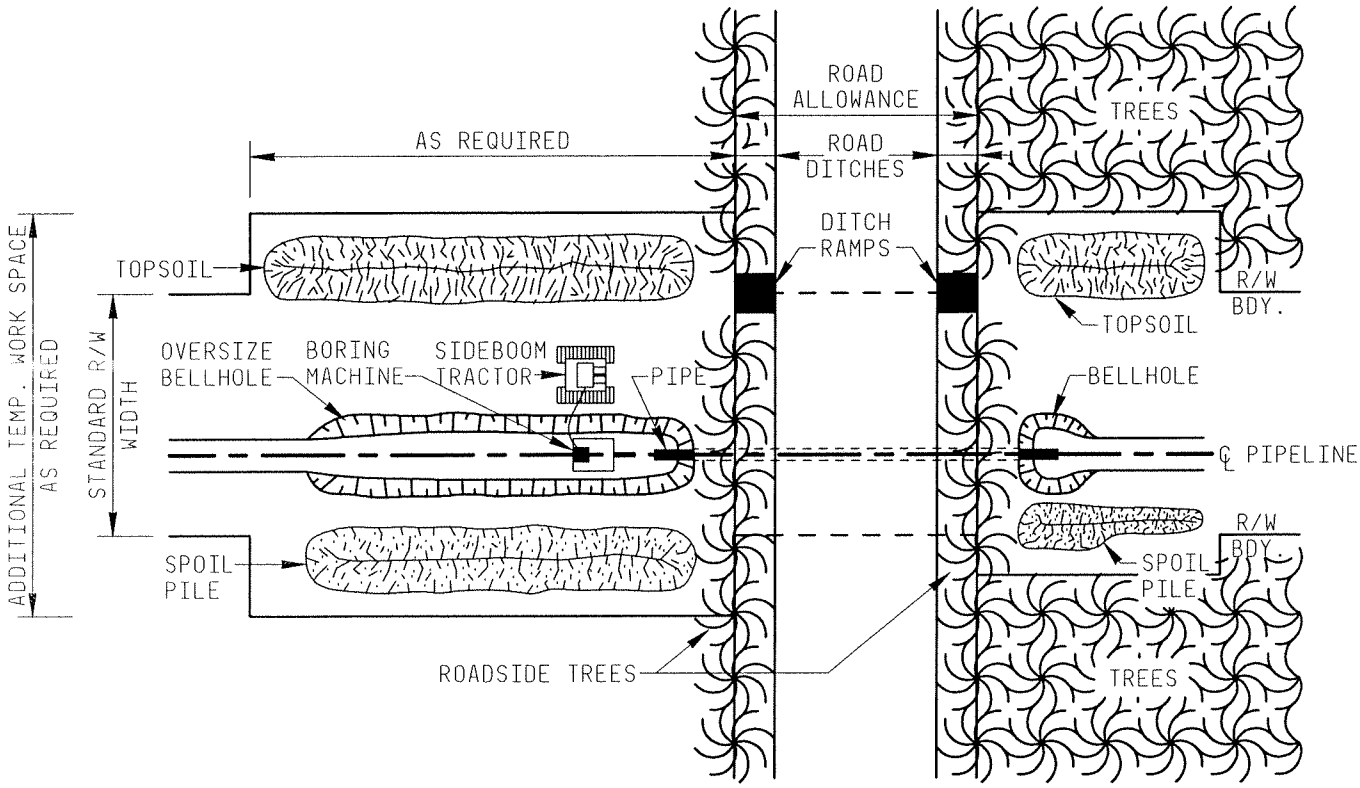
Figure 1

Two-Toning Grading
and Topsoil and Spoil Piles



PLAN VIEW

NOTES:

1. BORE PUBLIC ROAD CROSSINGS AND RAIL LINES TO PREVENT DISTURBANCE TO THE ROAD OR RAIL BED AND DISRUPTION OF SERVICES. BORING SHOULD ONLY BE PERFORMED WHERE SUBSOILS PERMIT. CONSIDER BORING IRRIGATION CANALS, SELECTED WATERCOURSES AND SHELTER-BELTS. CONTINUE BORING BEYOND ROADSIDE SHELTER WHERE POSSIBLE.
2. ACQUIRE AND MARK ADDITIONAL TEMPORARY WORK SPACE.
3. EXCAVATE BELLHOLE. STORE ON OPPOSITE SIDE OF RIGHT OF WAY, USE GRADED MATERIAL FOR DITCH RAMPS.
4. COMPLETE BORING AND TIE-IN TO MAINLINE.
5. BACKFILL AND COMPACT. LEAVE A CROWN TO ALLOW FOR SUBSIDENCE.
6. RESEED AND FERTILIZE AS APPROPRIATE.

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Figure 2

Road Crossing - Boring

FENCES and TEMPORARY GATES 02–9

Purpose

Before or during clearing of the right-of-way (ROW), existing fences and livestock barriers are cut or dismantled as necessary to allow access for construction equipment. In addition, temporary gates and/or fences are installed where required to restrict access to the right-of-way (ROW) and to control livestock movements. Temporary gates and fences remain in place until construction is complete, when permanent repairs or new fencing can be installed.

Improper cutting or replacement of wire fences can cause wires to slacken along the fence, possibly leading to livestock escaping and inconvenience to landowners. Similar problems may occur if gates are left open or if temporary fencing is not supplied where required.

Requirements

Bracing

Before cutting a wire fence, brace and secure the fence on each side of the new opening to maintain tension in the rest of the fence.

NOTE: Double end braces are especially necessary for high tension suspension fences in order to resist the fence tension.

Guidelines

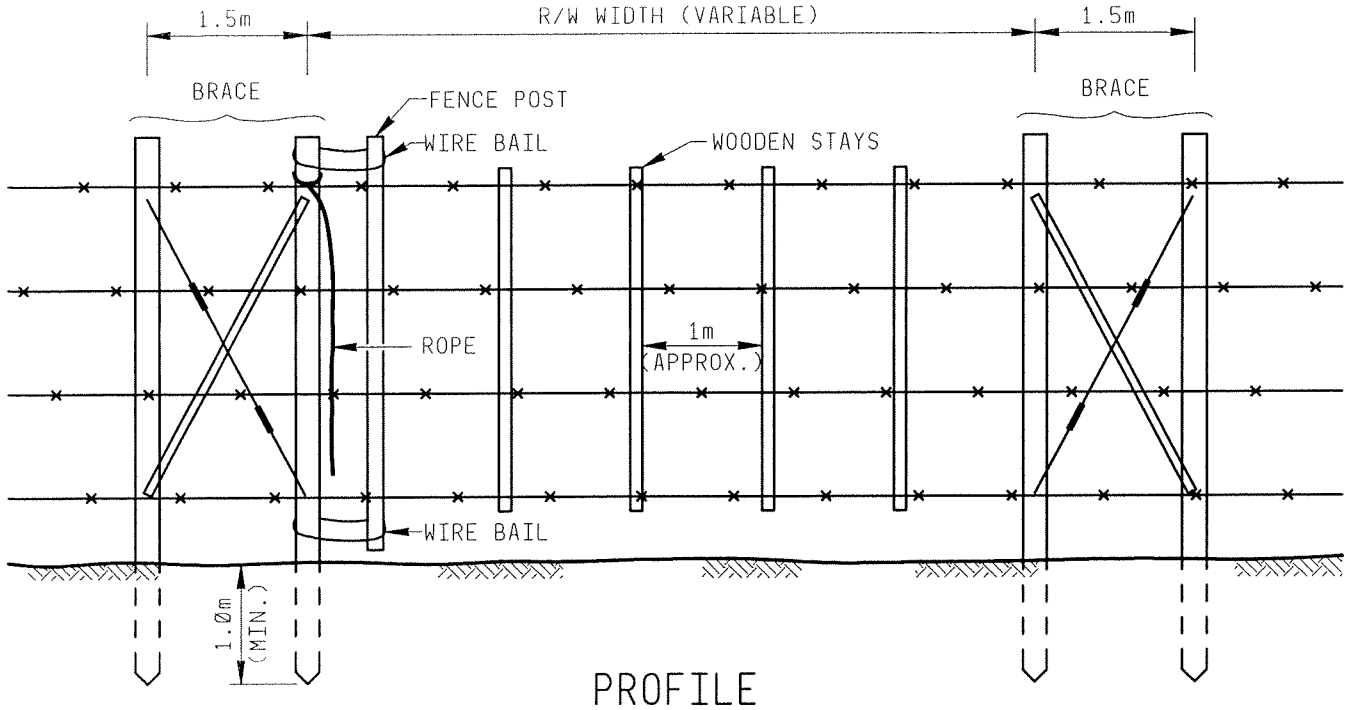
Make arrangements with landowners to keep livestock in fields not traversed by the ROW, if practical.

Carefully dismantle and store all unique fences (e.g., stump, stone or rail) for later reassembly.

Before dismantling or cutting fences, obtain consent from landowners, tenants or regulatory authorities, if practical.

Equip gates with facilities or construct them in a manner such that one worker can open and close the gates (see Figure 1, Temporary Wire Gate).

Install temporary fencing and gates of equal or better quality material as the original, where practical or as directed by the landowner.



PROFILE

NOTES:

1. INSTALL TEMPORARY GATES WITHIN ALL EXISTING FENCES CROSSING THE RIGHT OF WAY.
2. OBTAIN CONSENT OF LANDOWNER, TENANT OR GOVERNMENT AUTHORITY PRIOR TO CUTTING THE FENCE. CUT FENCE PRIOR TO ANY SUBSEQUENT CONSTRUCTION ACTIVITY.
3. BEFORE CUTTING THE FENCE, BRACE AND SECURE THE FENCE ON EACH SIDE OF THE NEW OPENING TO MAINTAIN TENSION IN THE REST OF THE FENCE. USE MATERIAL OF EQUAL OR BETTER QUALITY FOR THE BRACE. SALVAGE POSTS AND WIRE IF IN GOOD CONDITION.
4. INSTALL TEMPORARY GATE AS REQUIRED.
5. EQUIP GATES WITH FACILITIES OR CONSTRUCT THEM IN SUCH A MANNER THAT ONE WORKER CAN OPEN AND CLOSE THE GATE.
6. KEEP GATE CLOSED AT ALL TIMES EXCEPT DURING PASSAGE OF PEOPLE AND EQUIPMENT TO PREVENT LIVESTOCK FROM ENTERING OR LEAVING THE PROPERTY. IF NECESSARY, ASSIGN A WATCHMAN TO ENSURE GATE CLOSURE.
7. REMOVE TEMPORARY GATE AND REPLACE FENCE WITH MATERIAL OF EQUAL OR BETTER QUALITY FOLLOWING CONSTRUCTION UNLESS OTHERWISE REQUESTED BY LANDOWNER.

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Figure 1

Temporary Wire Gate

INSPECTION and MONITORING 02–10

Purpose

Environmental inspections during construction ensure compliance with applicable legislation and the terms and conditions of project approval by regulators. The company may be subject to fines or lawsuits if agreements with landowners or regulatory requirements are not fulfilled.

Requirements

Environmental Inspector

The company determines whether to appoint an environmental inspector for the entire project or for sensitive phases of the project (e.g., topsoil stripping, watercourse construction, cleanup), depending on:

- environmental sensitivity of the terrain
- complexity of environmental protection measures
- regulatory requirements

The company must employ qualified environmental inspectors to oversee construction activities. The environmental inspector must have:

- sufficient environmental knowledge to make appropriate field decisions
- sufficient pipelining experience to understand the constraints of construction

If an environmental inspector is not appointed, a company representative or supervisor must assume the responsibilities of the environmental inspector.

Specialists

Specialists, such as geotechnical engineers, archaeologists or drainage tile engineers, may be assigned or made available as required to inspect or monitor project activities.

Prejob Information

Before project activities begin, environmental inspectors must be briefed on the project and made aware of any special situations or areas of concern.

Before beginning project activities, environmental inspectors and contractors must have all relevant documents, including the most recent updates, revisions, amendments, conditions and requirements.

NOTE: For more information on prejob meetings, see 01-2, Planning and Preparation.

Communications

Establish a chain of command in the field so that environmental inspectors always communicate with the same workers.

Responsibilities

Environmental Inspector

Environmental inspectors:

- oversee contractors to ensure compliance with environmental requirements and permits

NOTE: When the environmental inspector is not onsite, the supervisor is responsible for implementing environmental protection measures.

- provide options and guidance to supervisors on environmental matters, and address unforeseen environmental concerns responsibly
- brief workers on the environment requirements of the project at the prejob meeting
- are present for all phases of project activities involving environmentally sensitive areas
- stop work activities and implement mitigative measures that are not in compliance with this document
- make daily written inspection reports and encourage frequent telephone contact with the environment department
- maintain regular liaison with government representatives
- obtain approval from the environment department before authorizing any major changes or decisions
- maintain appropriate records to ensure contractor compliance with environmental specifications and permits (i.e., take appropriate samples, photos and measurements at various stages of project activities)
- shut down project activity if significant environmental damage is occurring

Workers

Workers must:

- fully cooperate with environmental inspectors in the course of their duties

NOTE: Substantial fines and imprisonment may be imposed on workers and the company for noncompliance with legislation.

- understand the requirements regarding environmental rules and regulations
- report perceived environmental infractions to their supervisors

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.

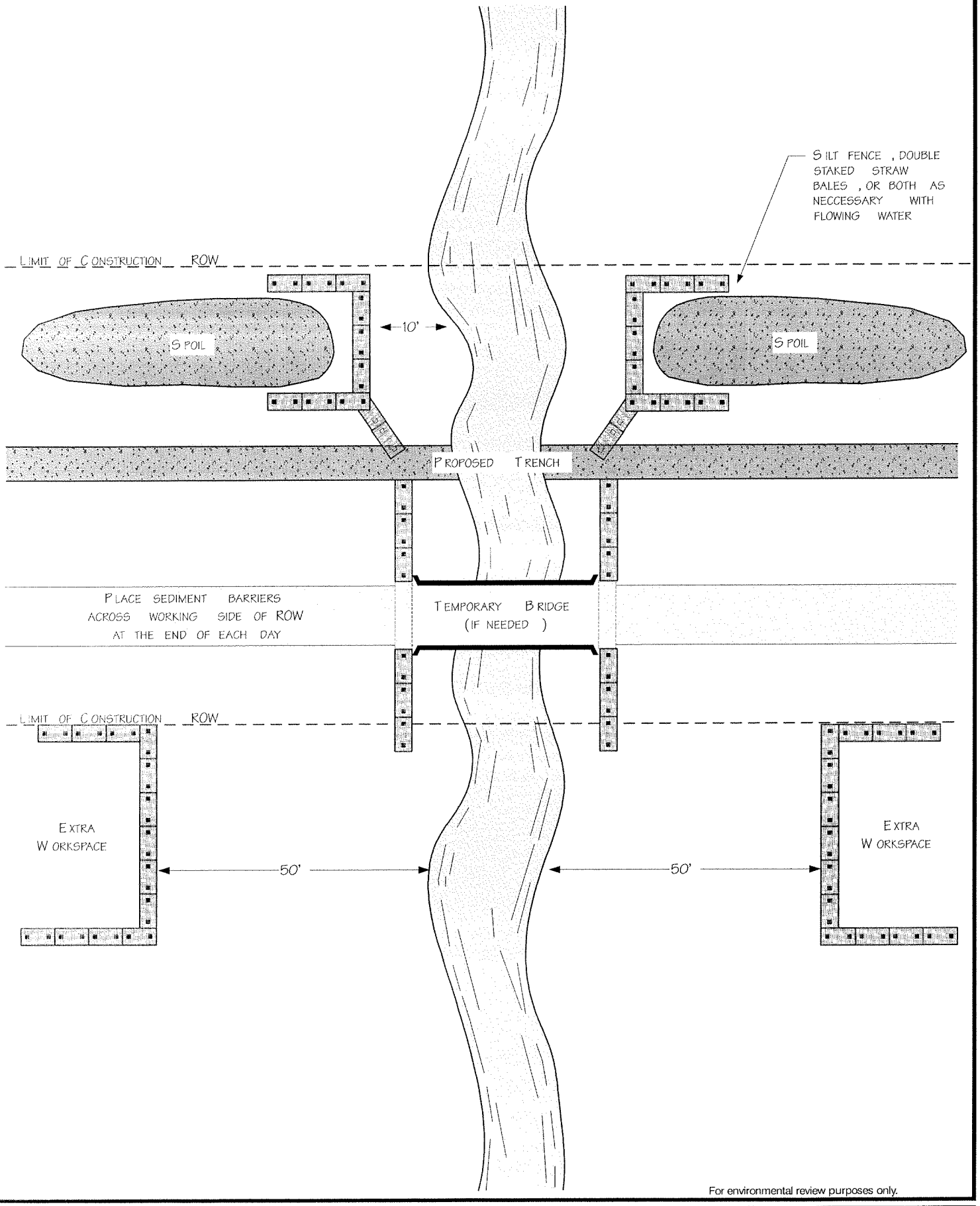

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Figure 1

Typical Waterbody Crossing
Wet Trench Method

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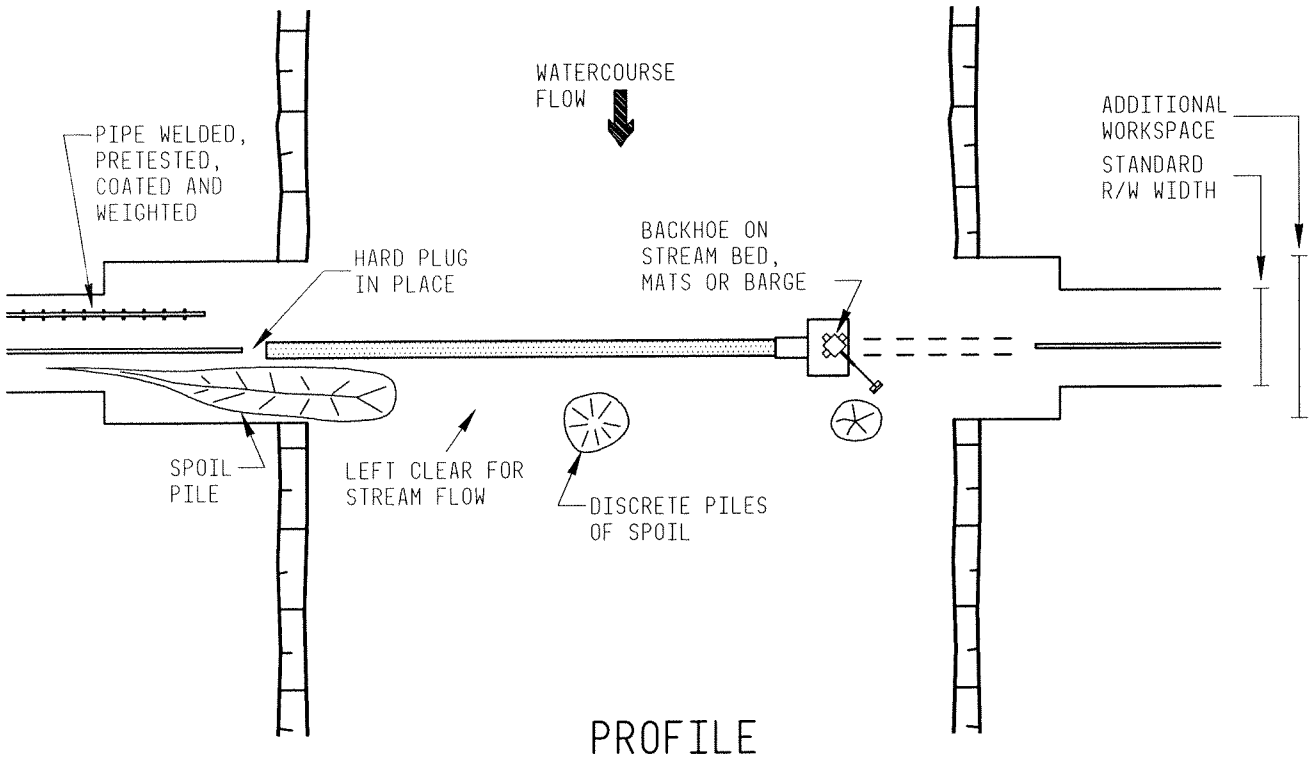

PROFILE

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

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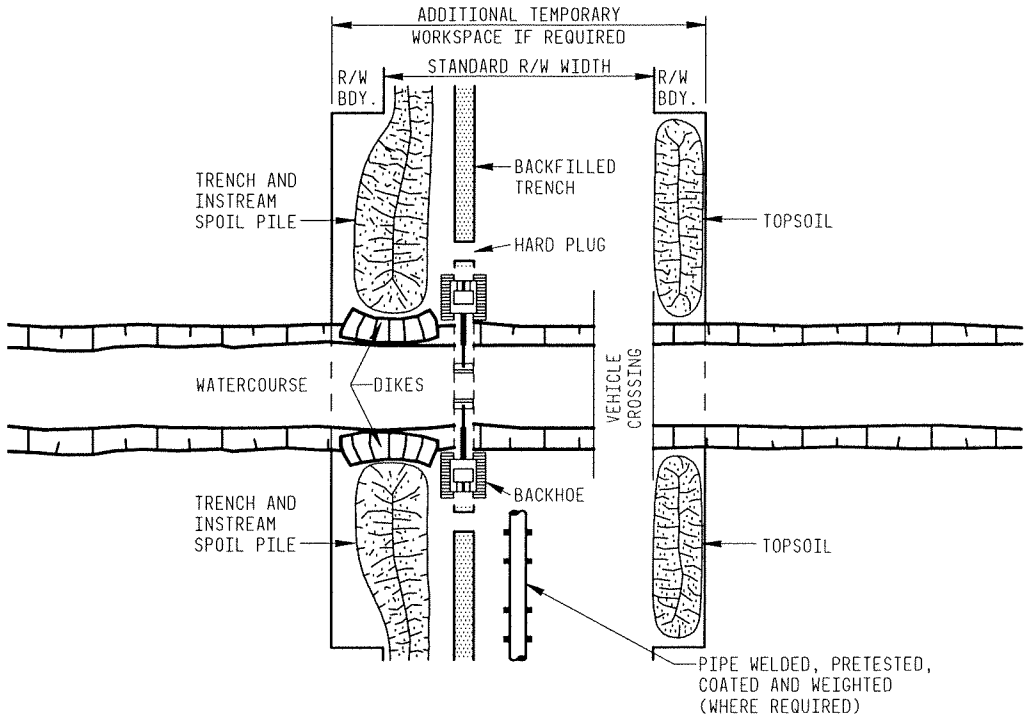

PLAN VIEW

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

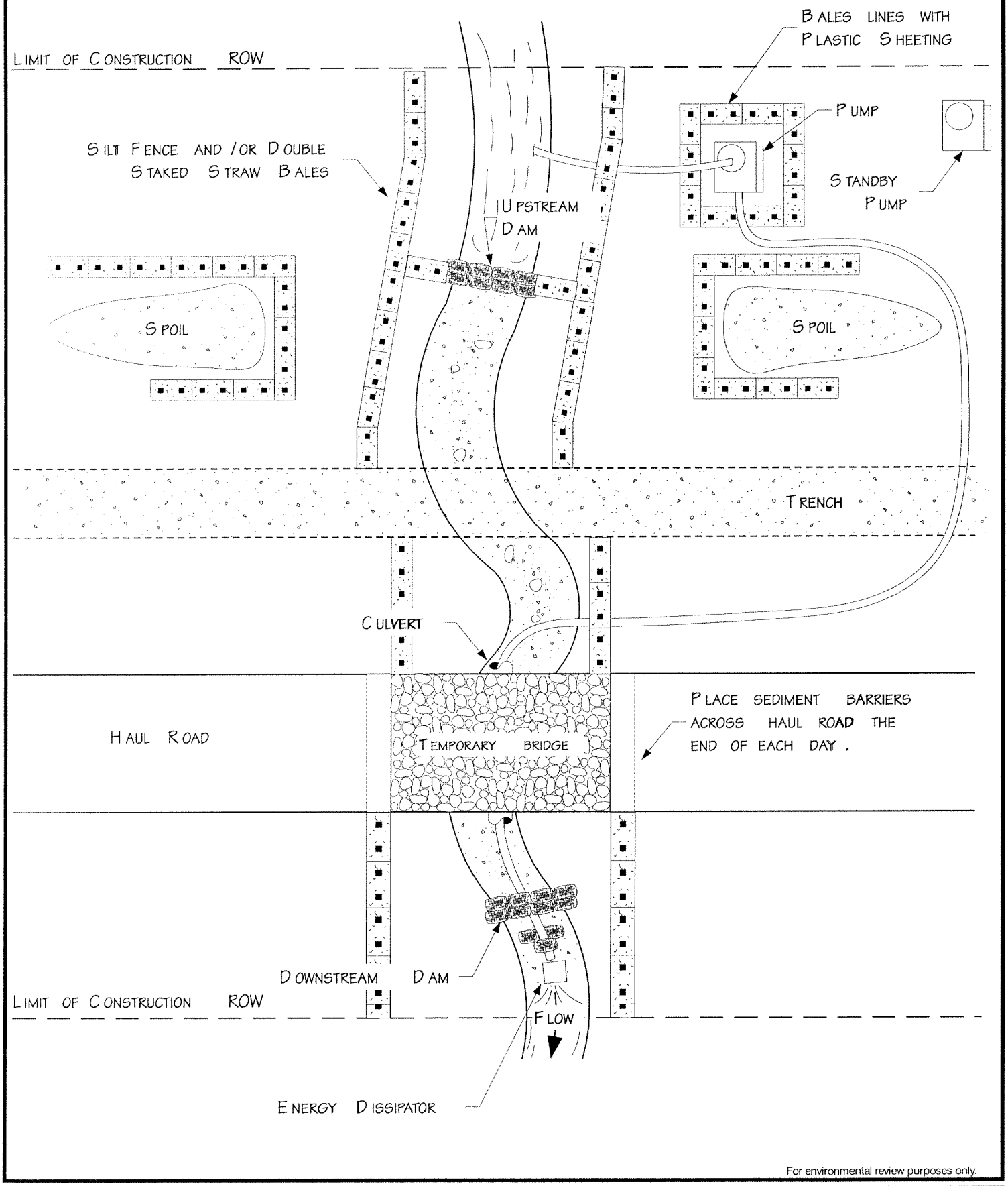

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Figure 4

Typical Waterbody Crossing
Dam and Pump Method

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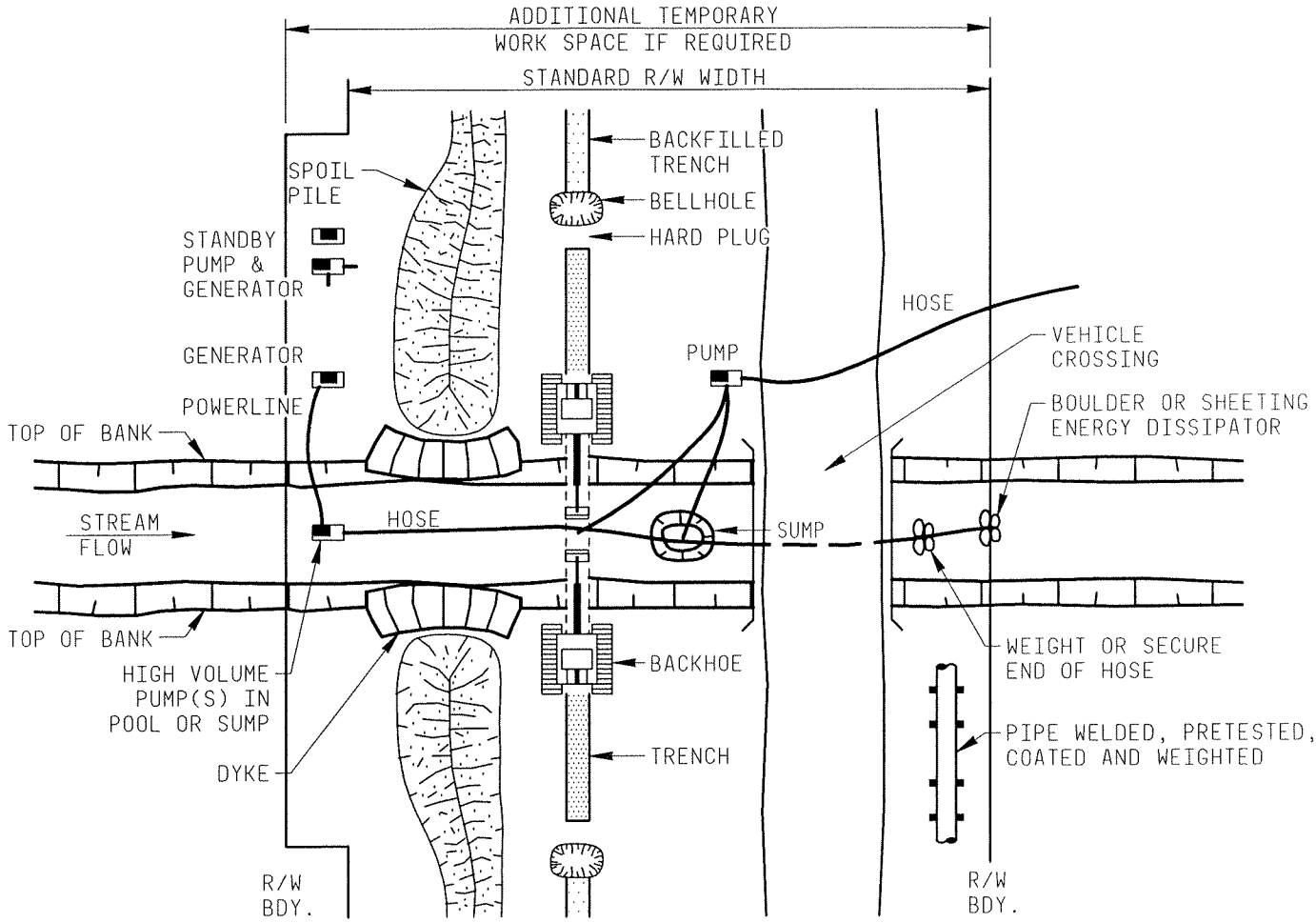

PLAN VIEW

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

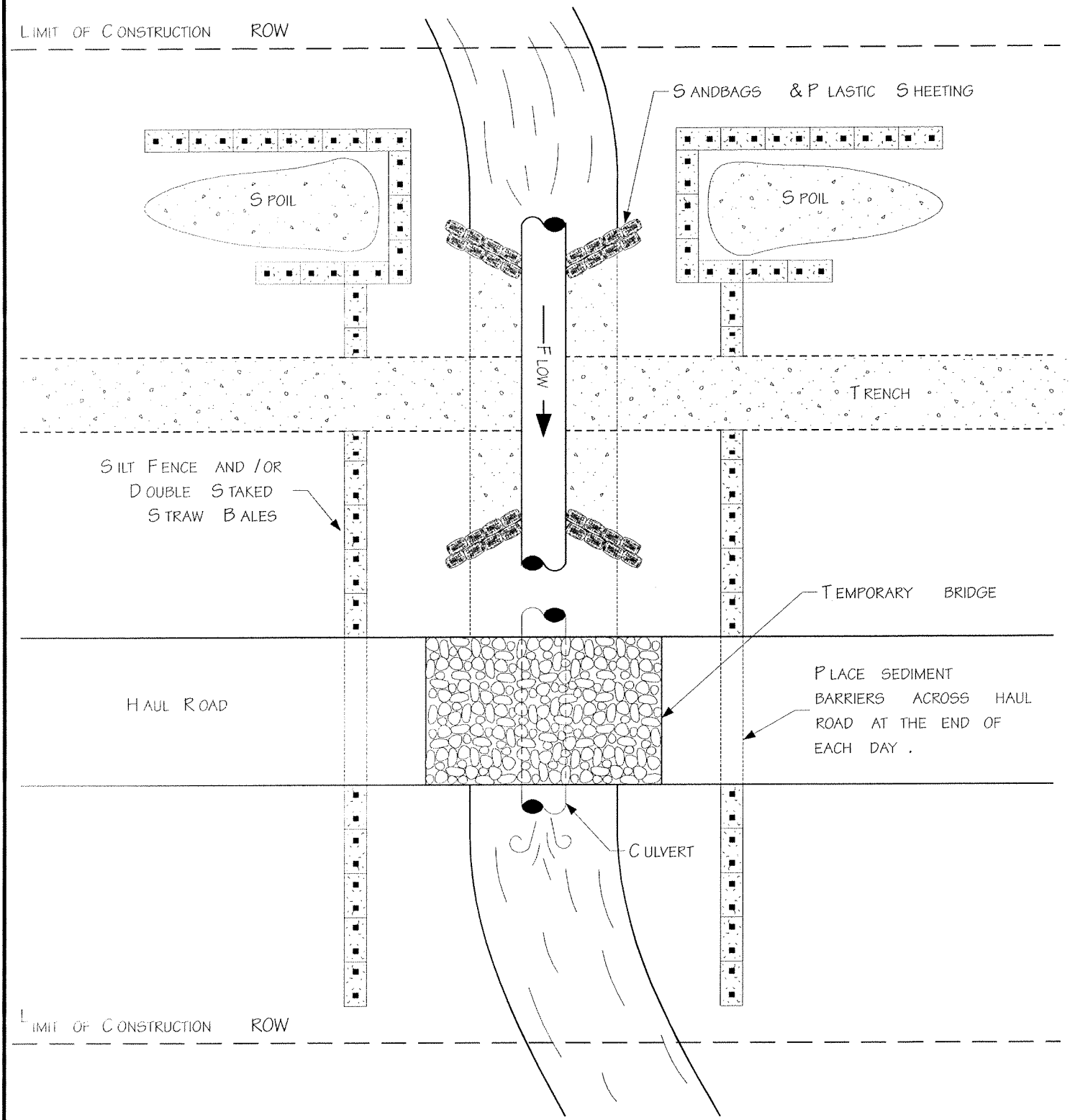

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Figure 6

Typical Waterbody Crossing
Flume Method

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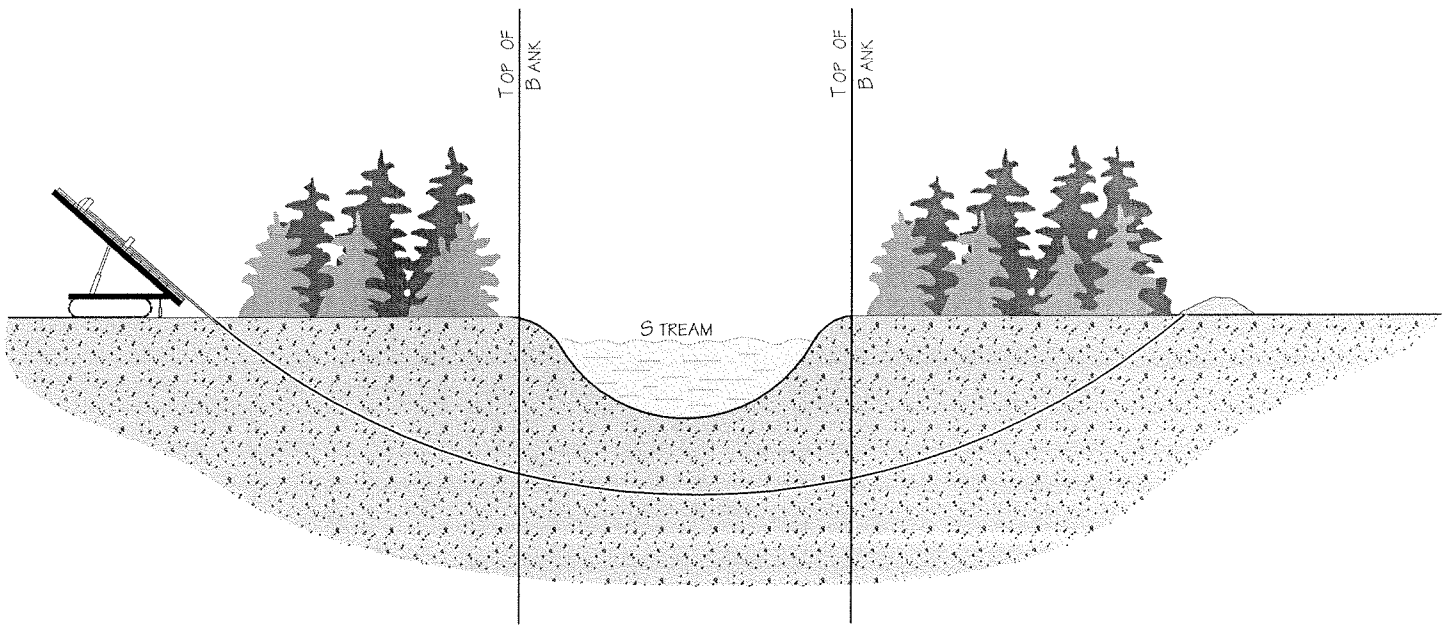

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Figure 7

Typical Waterbody Crossing
Directional Drill Method

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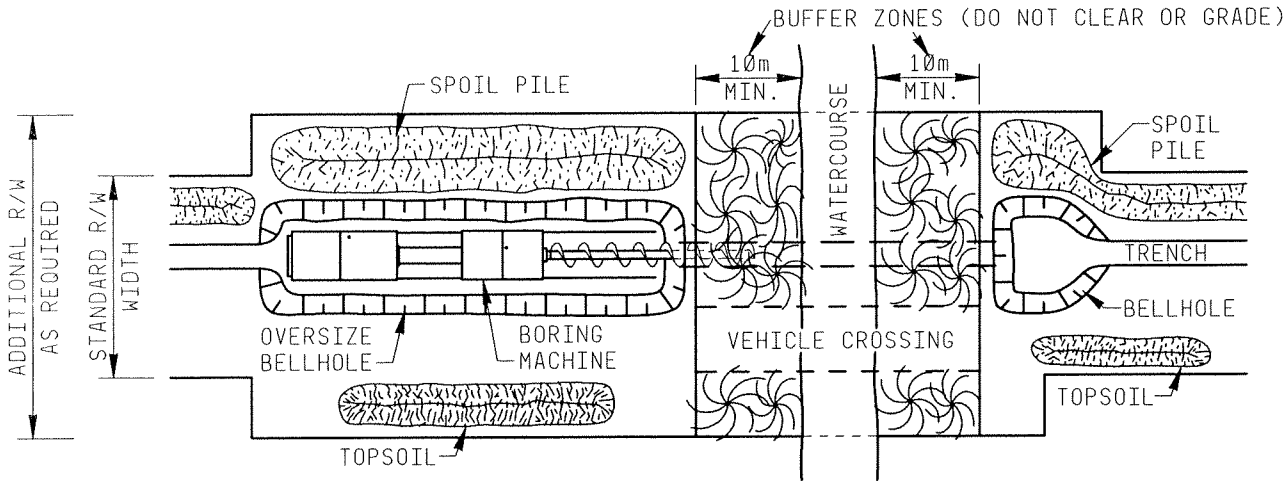
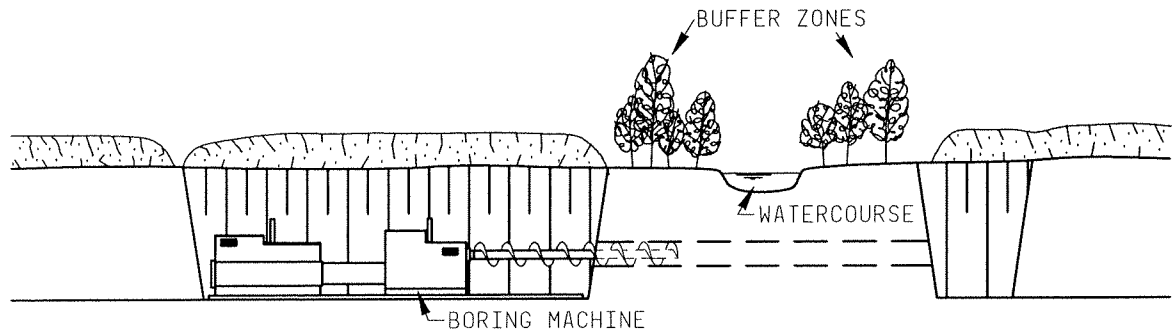


PLAN VIEW



PROFILE

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.

ENBRIDGE

Figure 8

Water Crossing -
Bored or Punched

EQUIPMENT CROSSINGS 02–12

Purpose

Temporary equipment crossings are constructed at watercourses (except for drainage ditches and intermittent streams) to allow machinery and vehicles to travel along the right-of-way (ROW). Stream beds and banks can be excessively damaged if inappropriate crossings are used or if heavy equipment travels before crossings are installed.

NOTE: Equipment crossings are usually installed in conjunction with clearing activities.

Guidelines

Planning and Preparation

Obtain permission from appropriate government agencies before constructing an equipment crossing. Contact the environment department for assistance.

NOTE: Bridge construction or installation is usually specified in the regulatory permits required for water crossings; review permits before proceeding.

NOTE: For more information on project planning, see Tab 01, Pre-Construction.

Installation

Install equipment crossings in locations that will not interfere with pipeline work activities, typically close to the workside ROW boundary.

Install equipment crossings on adjacent previously disturbed ROW, if available and practical, to minimize clearing and grading at the proposed crossing.

Crossing Methods

Select an appropriate equipment crossing method (see Table 1, Equipment Crossing Methods) based on geotechnical, biological and hydraulic considerations, and on discussions with government agencies

Table 1
Equipment Crossing Methods—CAN

Crossing Method	Small Watercourse less than 6 m (20 ft)			Medium Watercourse 6 to 15 m (20 to 50 ft)			Large Watercourse greater than 15 m (50 ft)		
	L	M	H	L	M	H	L	M	H
Bridge									
• existing bridge	4	4	4	4	4	4	4	4	4
• permanent bridge	$	$	$	$	$	$	$	$	$
• temporary bridge	$	$	4	$	4	4	4	4	4
• ice bridge	$	$	4	$	4	4	4	4	4
Fill									
• swamp mat	4	4	41	—	—	—	—	—	—
• log/pipe fill	4	4	41	—	—	—	—	—	—
• snow fill	4	4	41	—	—	—	—	—	—
• clean rock ramp &culvert/flume	4	4	41	—	—	—	—	—	—
Ford									
• travel pad	$	7	7	4	7	7	4	7	7
• ford	4	7	7	7	7	7	7	—	—
Barge									
• barge	—	—	—	$	$	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

1 Environmentally acceptable only when constructed within a dry crossing or nonflowing water.

Bridges

Design and Maintenance

Equipment bridges must be designed to withstand the maximum expected flow of the stream, and maintained to prevent flow restriction while the bridge is in place, e.g., remove any debris that restricts flow.

Bridges must be constructed with clean materials, and maintained to minimize soil from equipment falling into the water, e.g., built with a solid deck and remove any mud or soil that builds up, or geotextile covered with wooden treads.

Existing Bridges

Use existing bridges where the ROW is accessible from both sides of the watercourse (see Figure 1, Vehicle Crossing-Existing Bridge).

Temporary Bridges

Install temporary bridges (e.g., flexi-floats, railway flat car) to allow equipment to cross streams that:

- are sensitive
- have unstable bed and banks (see Figure 2, Vehicle Crossing-Temporary Bridge).
- are too deep, wide or fast for an alternate crossing structure.

NOTE: Temporary bridges are not required for drainage ditches or intermittent and other waters that are not fish bearing, unless required by permit.

Do not typically install temporary bridges at directionally drilled streams.

Limit temporary bridges to watercourses less than 30 m (100 ft) wide.

Use approach fills made of clean granular material rather than cuts in stream banks. Do not constrict flow with approach fill or support structures.

Ensure there is adequate distance between the bridge and the water level to handle anticipated stream flow and boaters.

Install an apron of logs or plywood to ensure fill material does not spill into the watercourse, where required.

Ice Bridges

Locate ice bridges at sites with gently sloping banks to minimize cuts in watercourse banks. Use snow and ice to slope approaches, rather than cutting stream banks (see Figure 3, Vehicle Crossing-Ice Bridge).

Flood the ice surface with water to increase load-bearing capacity.

Install logs to strengthen the bridge, if necessary.

NOTE: The ice bridge should not impede stream flow.

Fill

Culverts

Design culverts to handle 150% of maximum anticipated flows. Where fish passage is required, consult with local fisheries officers to develop design guidelines.

Contact government agencies for maximum water depth specifications and maximum water velocities; then choose an appropriate culvert(s).

Place ends of culverts below the natural grade of stream at an angle that does not exceed normal stream gradient.

NOTE: Depth of placement depends upon streambed type, culvert size and expected flow conditions—lower is better.

Log/Pipe Fill

Install log/pipe fill to cross small watercourses with square, U- or V-shaped channels. Log/pipe fill is not appropriate where fish passage is required.

Log/pipe fill should not impede flow or cause flooding.

Install a cable under the logs, or cable the logs together to facilitate removal.

Add compacted snow if necessary to bring up to grade.

If soil is used, first install filter fabric or equivalent to prevent soil from entering the watercourse.

Timber Riprap and Mats

Where a wetland cannot support vehicle traffic and low-ground pressure equipment is not used, carry out construction activities from a temporary platform of timber riprap or, preferably, from timber mats (see Figure 4, Typical Wetland Crossing).

Obtain approval from the company before using timber riprap.

For additional stabilization, place subsoil from the pipeline trench within the immediate wetland on top of the timber riprap then level for access.

Logs and timber mats are the only materials that can be brought into a wetland and placed on the working side.

CAN

Ford

Do not use fords during fish spawning, incubation or migration periods.

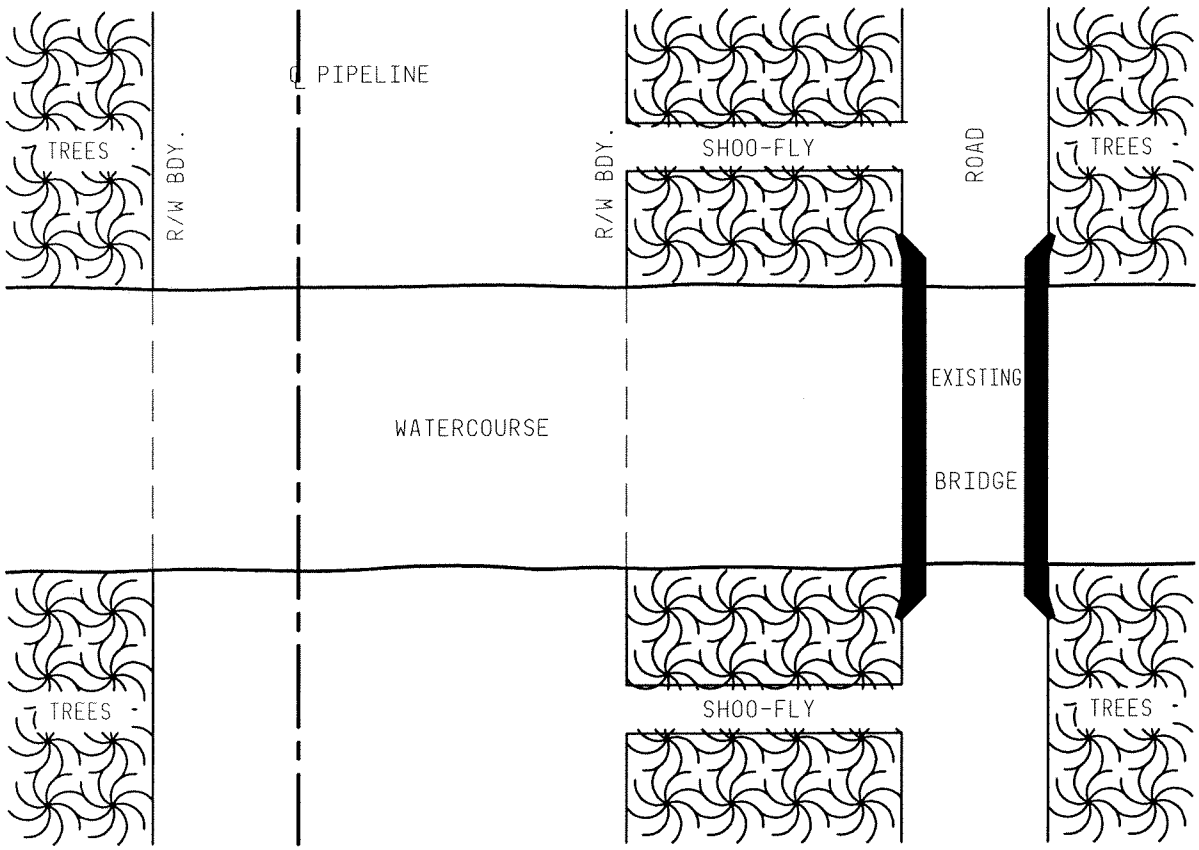
Stabilize banks and approaches with granular material underlain with a geotextile, if required.

Mark the ford boundaries on both sides of the crossing to help confine all equipment traffic to the ford.

When the ford is no longer required, restore and stabilize stream beds and bank to their original contour. Do not remove the granular material unless it is a barrier to fish during low flow conditions.

Cleanup

Remove equipment crossing structures as part of cleanup and restoration (for more information, see 03-3, Cleanup).



PLAN VIEW

NOTES:

1. USE EXISTING BRIDGE WHENEVER POSSIBLE TO PREVENT SEDIMENTATION OF WATERCOURSE, BANK DISTURBANCE, AND ALTERATION OF STREAM BEDS CAUSED BY VEHICLES CROSSING THE WATERCOURSE.

ENBRIDGE

Figure 1

Vehicle Crossing - Existing Bridge

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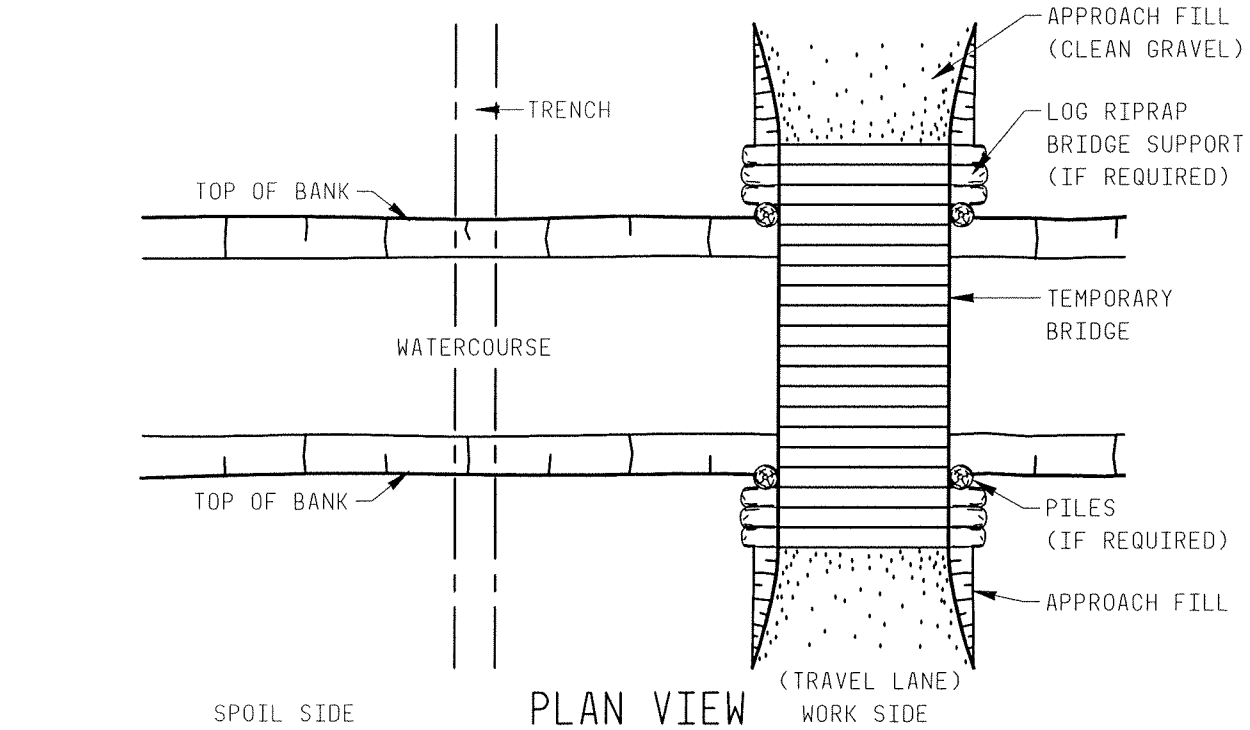
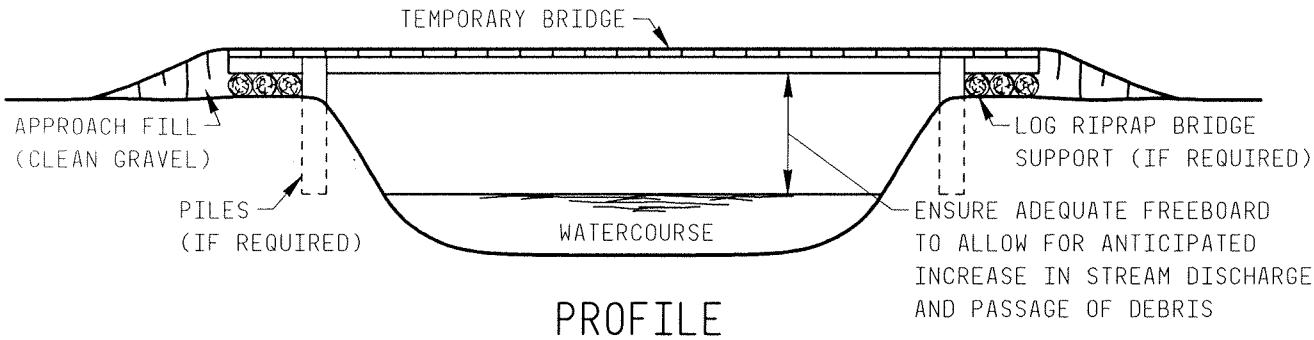




PROFILE

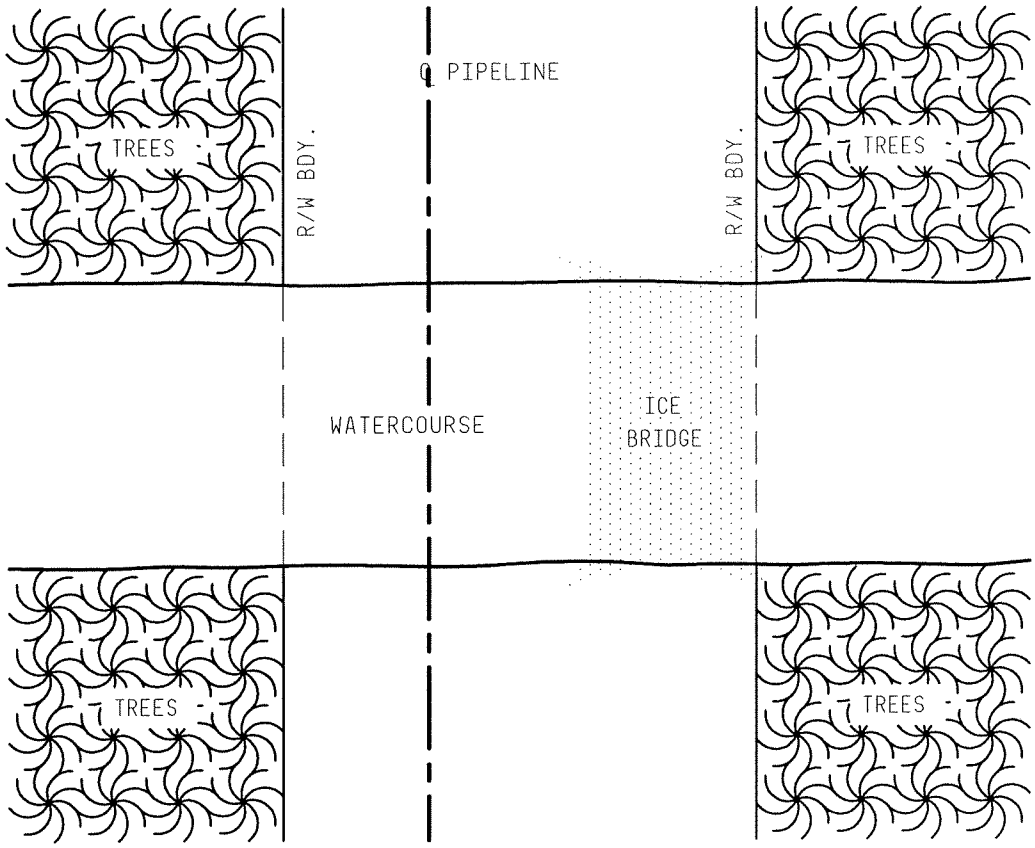
NOTES:

1. INSTALL A TEMPORARY BRIDGE TO ALLOW VEHICLES TO CROSS A WATERCOURSE THAT IS HIGHLY SENSITIVE OR THAT HAS UNSTABLE BED AND BANKS. BRIDGES ARE ALSO USED WHERE WATERCOURSES ARE TOO DEEP, WIDE OR FAST TO PERMIT AN ALTERNATE CROSSING STRUCTURE. THIS METHOD MINIMIZES SEDIMENTATION OF THE WATERCOURSE, AND STREAM BANK AND BED RESTORATION WORK. IT IS GENERALLY LIMITED TO WATERCOURSES LESS THAN 30m IN WIDTH.
2. UTILIZE APPROACH FILLS OF CLEAN GRANULAR MATERIAL RATHER THAN CUTS IN STREAM BANKS TO MINIMIZE EROISION POTENTIAL. DO NOT CONSTRICT FLOW WITH APPROACH FILL OR SUPPORT STRUCTURES. ENSURE ADEQUATE DISTANCE BETWEEN THE BRIDGE AND THE WATER WELL (FREE-BOARD) TO HANDLE ANTICIPATED STREAM FLOWS AND BOATERS.
3. INSTALL APRON OF LOGS OR PLYWOOD TO ENSURE THAT FILL MATERIAL DOES NOT SPILL INTO THE WATERCOURSE. WHERE REQUIRED.

ENBRIDGE

Figure 2

Vehicle Crossing - Temporary Bridge



PLAN VIEW

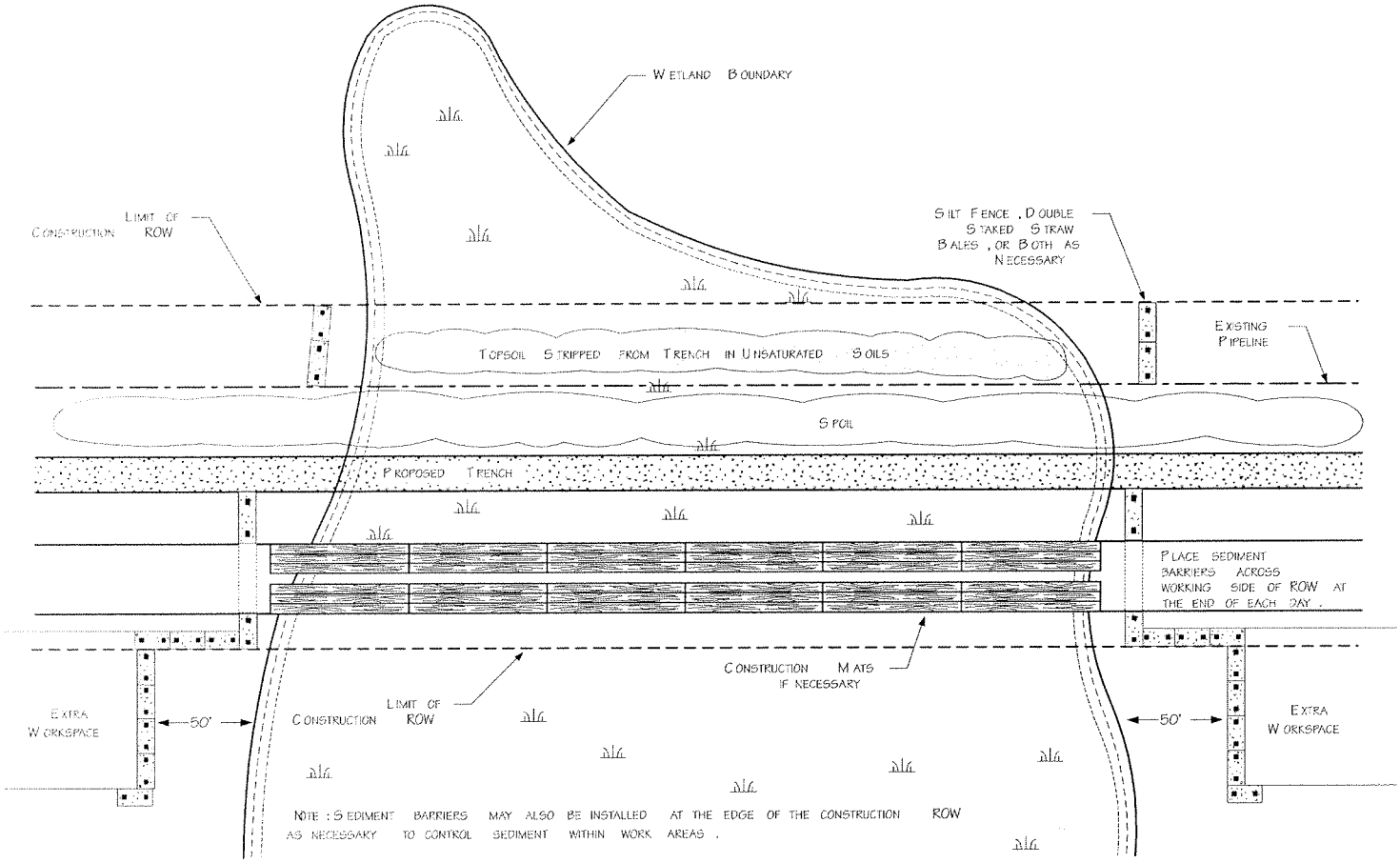
NOTES:

1. INSTALL ICE BRIDGES ON WINTER PROJECTS WHEN A SAFE ICE THICKNESS CAN BE MAINTAINED.
2. LOCATE ICE BRIDGES AT SITES WITH GENTLY SLOPING BANKS TO MINIMIZE CUTS IN WATERCOURSE BANKS. USE SNOW AND ICE TO SLOPE APPROACHES, RATHER THAN CUT BANKS.
3. FLOOD ICE SURFACE WITH WATER AND COVER WITH SNOW TO INCREASE LOAD BEARING CAPACITY. LOGS MAY BE USED AS A BASE TO STRENGTHEN THE BRIDGE.
4. ICE BRIDGE SHOULD NOT IMPEDE FLOW.

ENBRIDGE

Figure 3

Vehicle Crossing - Ice Bridge



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ENBRIDGE

Figure 4

Typical Wetland Crossing

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SLOPE BREAKERS 02–13

Purpose

Slope breakers, also called berms or diversion berms, may be temporary or permanent. Slope breakers are installed to divert water away from disturbed areas and to reduce erosion from runoff.

Guidelines

Determine the location and direction of slope breakers based on local topography and drainage patterns.

Construction

Ensure the backfill is well compacted uphill of and underneath the slope breaker. If the backfill cannot be compacted, line the uphill side of the breaker with geotextile over the ditchline.

Construct slope breakers using compacted native materials, i.e., earthen material, with a 4-ft base and a height of 0.45 m (1.5 ft), or 1 m (3 ft) high for winter [frozen] construction) (see Figure 1, Slope Breaker – Elevation View). Silt fence or hay bales also may be used to construct temporary slope breakers.

If groundwater flow is a concern in the construction area, install the slope breaker berm with a trench breaker to direct subsurface flow out of the trench and to the surface.

Where trench breakers are installed, install berms immediately downslope of the gravel drain and overlying the trench breaker.

NOTE: For more information, see 02-15, Trench Breakers.

Where native material is erodible, protect the upslope of the berm and the base of the cross ditch with riprap.

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

Install soil berms with a downhill gradient of 5°–10° [95°–100° of fall line]) to prevent water from ponding behind berms and to allow for drainage away from the trench line (see Figure 2, Typical Temporary or Permanent Berms – Perspective View).

Terminate slope breakers toward appropriate energy dissipating devices (e.g., in a well-vegetated area, silt fence, rock apron), and staggered a minimum of 2 m (6 ½ ft) off the right-of-way (ROW) if possible.

Tie new berms into existing berms where possible.

Ensure there is no crown in the diversion ditch.

Installation

Temporary Breakers

Install temporary slope breakers:

- at the base of slopes leading to streams or wetlands
- immediately uphill from disturbed areas
- spaced according to Table 1, Typical Spacing for Slope Breakers

Do not install temporary slope breakers during frozen conditions unless snow melt and runoff are likely during construction.

Inspect temporary slope breakers daily and repair as necessary to maintain operational integrity and to prevent erosion.

Remove temporary slope breakers as necessary during working days and replace before leaving the area.

Where a temporary slope breaker crosses an open trench, leave a hard plug in place.

Permanent Breakers

Install permanent slope breakers according to the spacing in Table 1, Typical Spacing for Slope Breakers.

If the length of the slope is less than the distance of the required spacing in Table 1, no slope breakers are required unless the slope is to a watercourse, where one large breaker should be installed at the toe of the slope.

Do not install permanent slope breakers on agricultural land unless specifically requested by the landowner

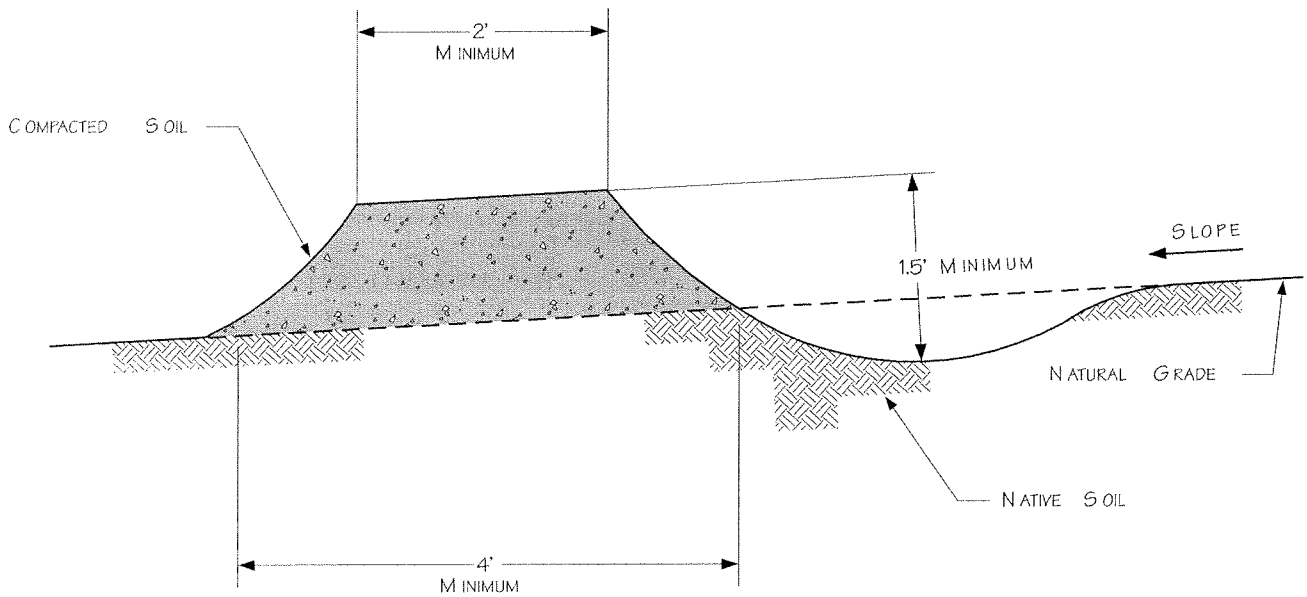
Table 1—CAN
Typical Spacing for Slope Breakers

Slope		Spacing[1]	
(°)	(%)	(m)	(ft)
<8	<15	as required	
8–14	15–25	45	148
14–17	30–35	35	115
17–20	30–35	20	65
>20	>35	10–15	32–50

NOTES
1 Rely on field judgment to determine appropriate spacing.

Table 1—USA
Typical Spacing for Slope Breakers

Slope	Spacing	
(%)	(m)	(ft)
>5–15	92	300
>15–30	61	200
>30	31	100



NOTES

1. BERMS SHALL BE CONSTRUCTED WITH 2 TO 8 PERCENT OUTSLOPE .
2. BERMS SHALL BE OUTLETED TO WELL VEGETATED STABLE AREAS , SILT FENCES , STRAW /HAY BALES OR ROCK APRONS .
3. BERMS SHALL BE SPACED AS DESCRIBED IN CONSTRUCTION SPECIFICATIONS .

ENBRIDGE

Figure 1

Slope Breaker - Elevation View

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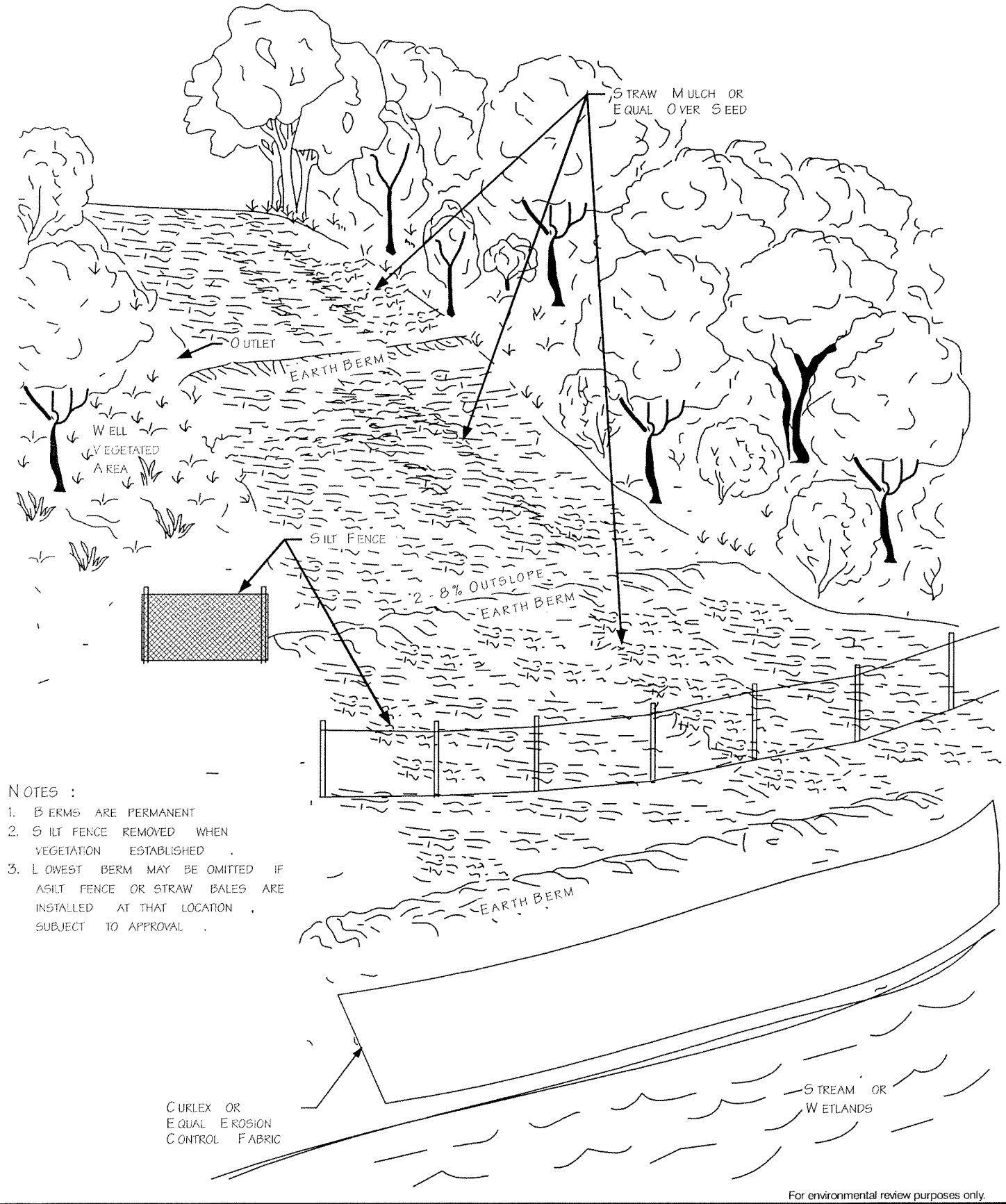

NOTES :

1. BERMS ARE PERMANENT
2. SILT FENCE REMOVED WHEN VEGETATION ESTABLISHED .
3. LOWEST BERM MAY BE OMITTED IF ASILT FENCE OR STRAW BALES ARE INSTALLED AT THAT LOCATION , SUBJECT TO APPROVAL .

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ENBRIDGE

Figure 2

Typical Temporary or Permanent Berms
Perspective View

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TEMPORARY SEDIMENT BARRIERS 02–14

Purpose

Temporary sediment barriers (e.g., silt fence, straw bales) are installed to stop the flow of sediment from spoil piles and disturbed areas into watercourses/wetlands or from sloped approaches leading to watercourses/wetlands.

Guidelines

Where possible, leave a buffer of undisturbed vegetation between disturbed areas and potential receivers of off-site sediment, e.g., watercourses, wetlands, roads.

NOTE: For more information, see 02-4, Clearing and Grubbing.

Construction

Construct temporary sediment barriers with silt fence or staked straw bales (see Figures 1, Typical Silt Fence Installation & Figure 2, Typical Strawbale Intstallation). If large amounts of silt are expected, consider reinforcing the installation by installing snow fence behind the silt fence and tying them together.

Use steel reinforcing rods to stake straw bales if frozen conditions make wooden stakes impractical.

Silt fence must be a minimum of 36 in. high.

Installation

Install temporary sediment barriers:

- before or immediately after the ground is disturbed
- at the base of slopes leading to watercourses and wetlands
- between the edges of the disturbed area and watercourses
- at other sloped areas with watercourses downslope
- at the base of slopes leading to road crossings where vegetation has been disturbed (see Figure 3, in Section 02-13, Typical Temporary or Permanent Berms-Perspective View.).
- at the edge of the right-of-way (ROW) as needed to prevent siltation of watercourses downslope of the ROW

During frozen conditions, do not install temporary sediment barriers until final grading and cleanup, unless snow melt and runoff are likely during construction.

Maintenance

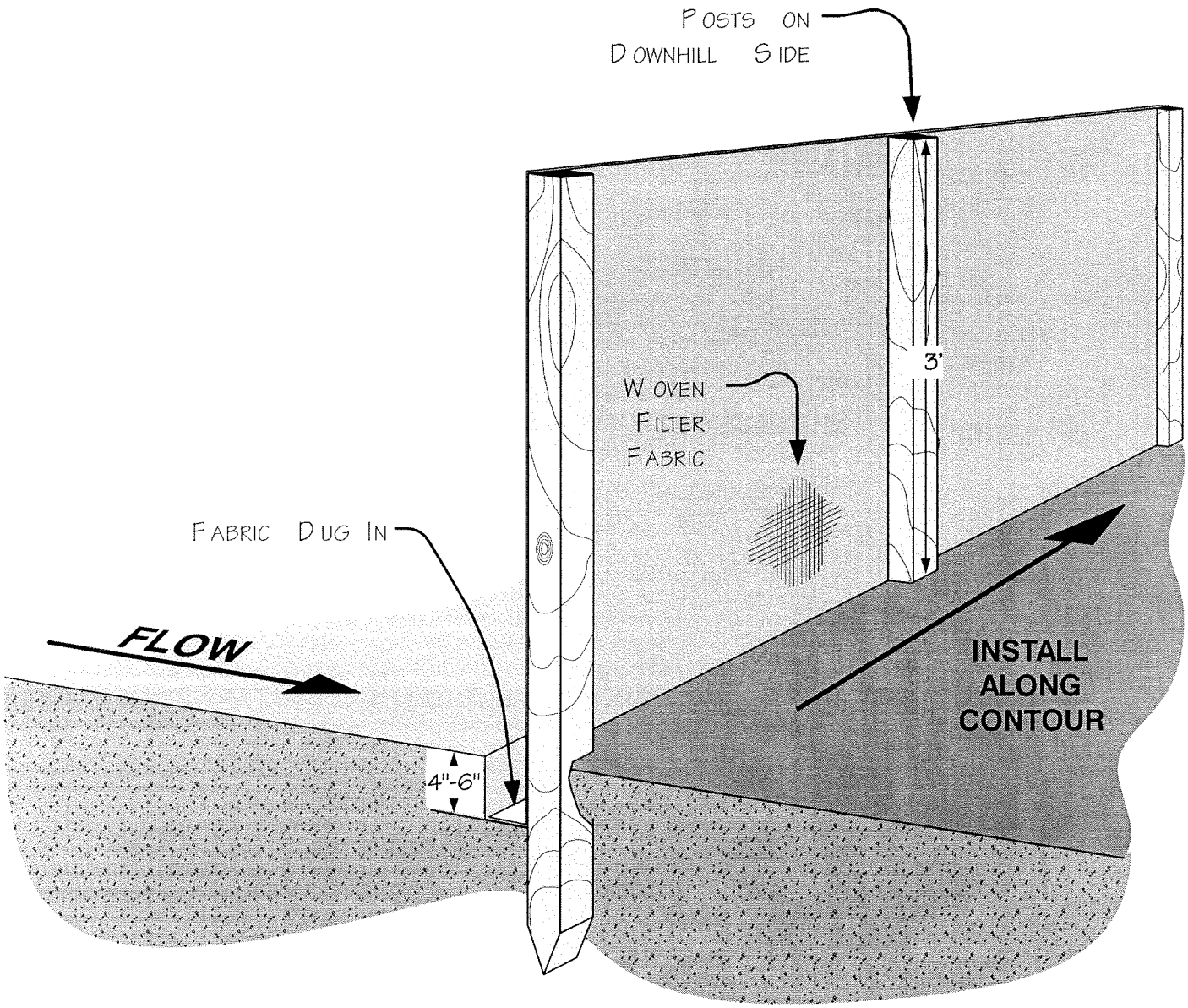
Inspect sediment barriers regularly, typically weekly and within 24 hrs of significant rainfall.

When the depth of sediment reaches one-third the height of a sediment barrier, replace the barrier and/or remove the sediment.

Repair or replace nonfunctional sediment barriers within 24 hrs of discovery.

Cleanup

Remove temporary sediment barriers after the disturbed area is restored/revegetated to pre-excavation condition and the area is stable.



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ENBRIDGE

Figure 1

Typical Silt Fence Installation

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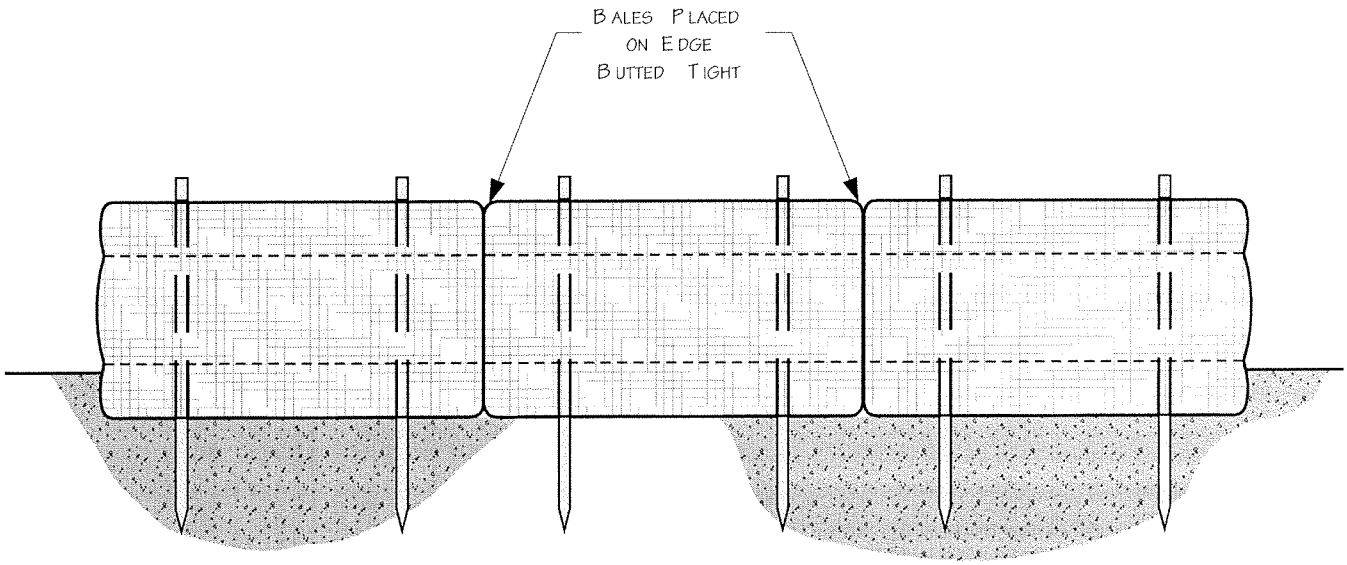
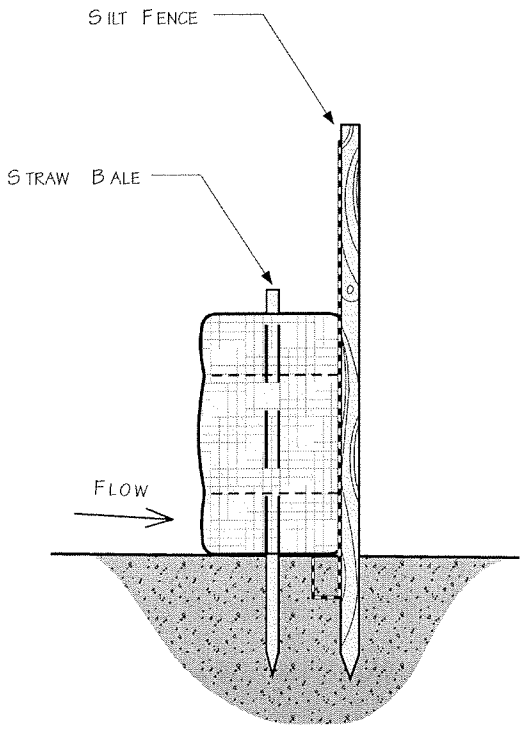
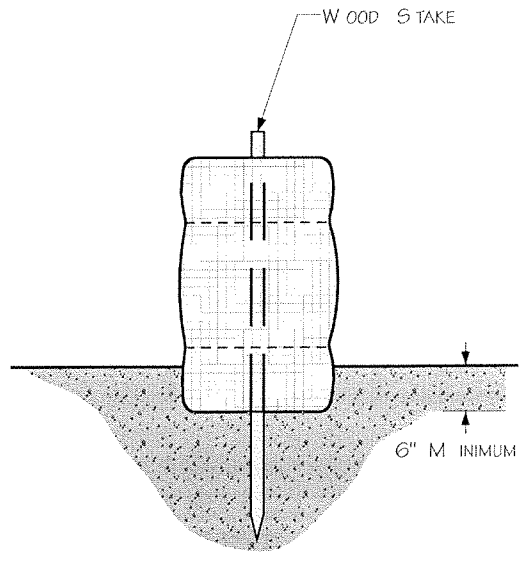




STRAW /HAY BALES &
SILT FENCE



STRAW /HAY BALES ONLY

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ENBRIDGE

Figure 2

Typical Straw Bale Installation

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TRENCH BREAKERS 02–15

Purpose

Trench breakers are installed around the pipe after it has been lowered in the trench to prevent water from channeling down the pipe and subsequently prevent subsurface erosion from occurring along the pipe once the trench is backfilled.

Guidelines

Installation

Determine the location of trench breakers by onsite investigation, considering the potential for subsurface flow and degree of slope. Typically, install trench breakers:

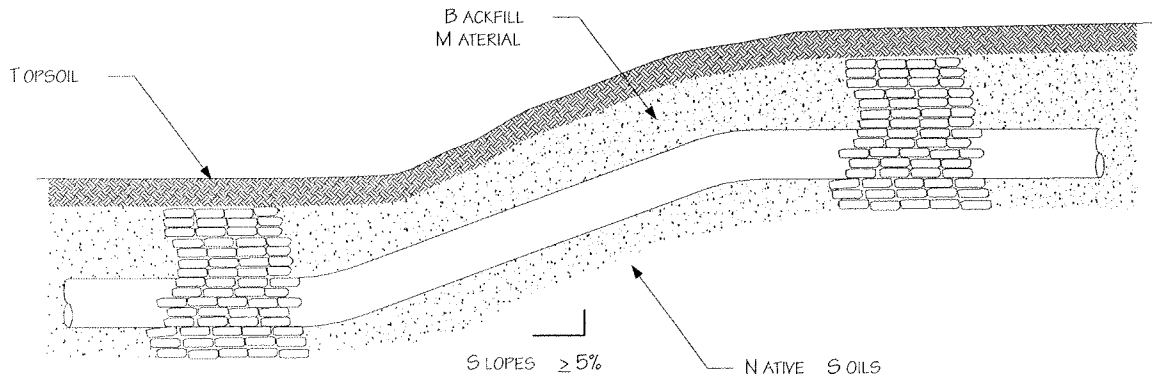
- on slopes leading to wetlands, watercourses where a trench is longer than 30 m (100 ft)
- on slopes greater than 5% next to watercourses and edges of wetlands
- where springs are evident in the ditch walls

Construction

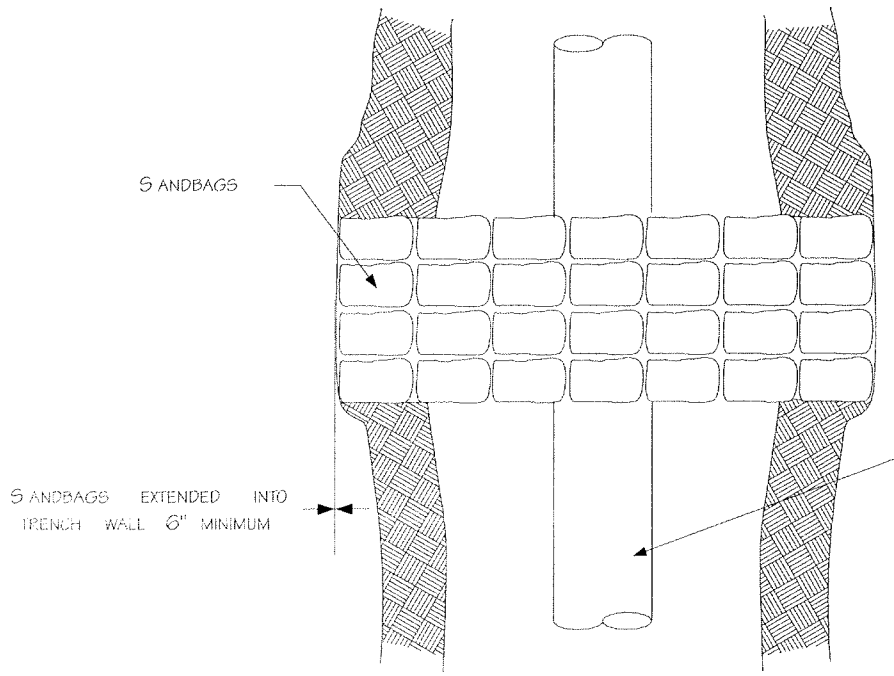
Construct trench breakers using sacks filled with subsoil or sand that is free of rock, bentonite, urethane foam or other compacted impervious materials. Do not fill bags with topsoil.

Place trench breakers from the bottom of the trench to near the top of the trench, completely surrounding the pipe (see Figures 1, Typical Trench Breakers Plan and Profile View & Figure 2, Typical Trench Breakers Perspective View). Ensure the upslope surface is level to slightly sloping downhill to allow drainage into the cross ditch.

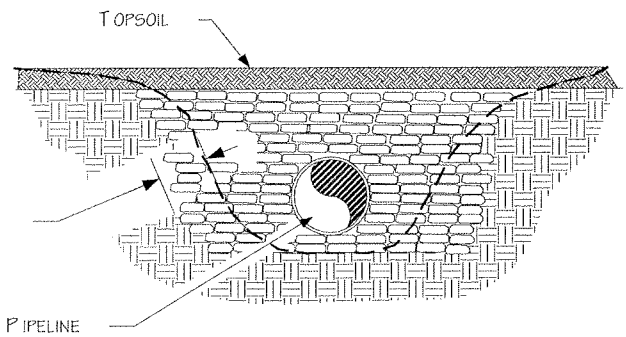
Space trench breakers the same as berms (see Table 1 in 02-13, Slope Breakers), or as otherwise specified by the company.



PROFILE VIEW
(NOT TO SCALE)



PLAN VIEW
(NOT TO SCALE)



FACE VIEW
(NOT TO SCALE)

NOTES

1. BAGS WILL NOT BE FILLED WITH TOPSOIL

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ENBRIDGE

Figure 1

Typical Trench Breakers - Plan & Profile Views

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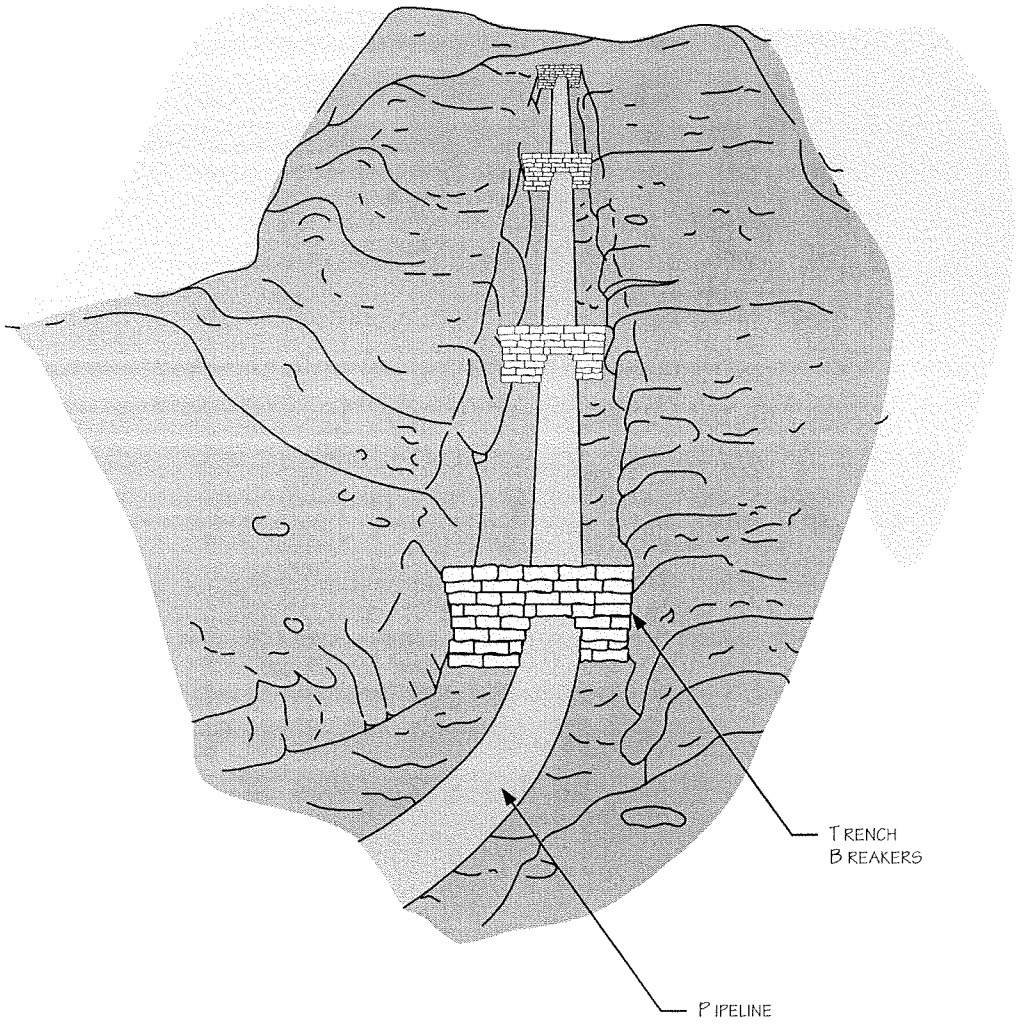

NOTES

1. BAGS WILL NOT BE FILLED WITH TOPSOIL .

ENBRIDGE

Figure 2

Typical Trench Breakers - Perspective View

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WET/THAWING SOILS 02–16

Purpose

Wet or thawing soil in agricultural land may require delaying certain construction activities in order to avoid topsoil and subsoil compaction, or to avoid mixing, rutting and loss of soil structure.

Indications of wet or thawed soils include:

- wheelslip
- mud buildup on tires and cleats
- formation of ruts
- water ponding

Guidelines

To determine whether to shut down construction activities in wet conditions, consider the following factors in consultation with the environmental inspector:

- plasticity of the surface soil to a depth of 10–20 cm (4–8 in.)
- location and depth of the wetting front in relation to the A and B horizons
- extent of surface ponding
- extent and depth of rutting
- whether traffic can be rerouted around a wet area
- type of equipment and nature of the construction operations proposed for that day

Upon indication of wet or thawing soils, stop all affected construction activity immediately. Resume construction activities only after soils have dried or frozen.

If heavy runoff, spring breakup or heavy storms are imminent and there is a risk of significant soil erosion, use temporary erosion control measures such as silt fences, straw bales or temporary sand bag berms (for more information, see 02-6, Temporary Erosion and Sedimentation Control).

Respect road bans posted on private and public roads.

Shutdown Alternatives

As an alternative to shutting down all construction in wet weather:

- suspend construction activities only along affected portions of the right-of-way (ROW)
- continue selected activities along the ROW, or along a portion of the ROW, that will not damage soils, e.g., bored crossings, welding

Mitigation

If construction during wet or thawing soils is absolutely necessary, implement one or more of the following:

- restrict construction activity to the narrowest possible area
- use ground surface protection such as swamp mats, corduroy ramps or geotextiles
- limit traffic to equipment with wide tracks or low ground pressure tires
- operate equipment at night or early morning when the ground is frozen
- strip topsoil from the full ROW if soil conditions permit (see 02-5, Topsoil Stripping and Segregation)
- pump standing water to a vegetated area of the ROW
- backblade ruts to disperse water and allow faster drying

DEWATERING 02–17

Purpose

Before lowering the pipe into the trench, it may be necessary to dewater the ditch to visually inspect the trench bottom for rocks or adequate depth. Trench dewatering also may be necessary:

- where tie-in welds are required
- at road-boring sites
- at locations where set-on weights are placed over the pipe
- in other areas where increased visibility or physical access to the trench is needed

Guidelines

Before commencing dewatering activities, ensure appropriate discharge permits and approvals are in place. Contact the environment department for further information. Before dewatering, any oil (free product) on the water must be completely removed or contained in the excavation as follows:

- Use sorbent booms or other means to hold the sheen to a portion of the excavation well away from the pump intake hose.
- Keep the pump intake hose submerged throughout dewatering to prevent the sheen from entering the hose.
- Direct discharge to a filter bag or hay bale structure.

If excavating in significantly contaminated soil, petroleum compounds may be dissolved in excavation water in amounts that require treatment or special dewatering approaches (e.g., tank truck). Before discharging potentially contaminated water, contact the district/regional manager and the environment department.

Siltation

Secure the pump intake hose at least 30 cm (1 ft) above the bottom of the trench.

Dispose of used filter bags in an approved landfill.

Watercourses and Wetlands

To prevent silt-laden water from flowing into wetlands and watercourses, direct dewatering discharge onto an appropriate energy dissipation device, e.g., sheet of plywood located in a well vegetated upland area (see Figure 1, Typical Dewatering Measures).

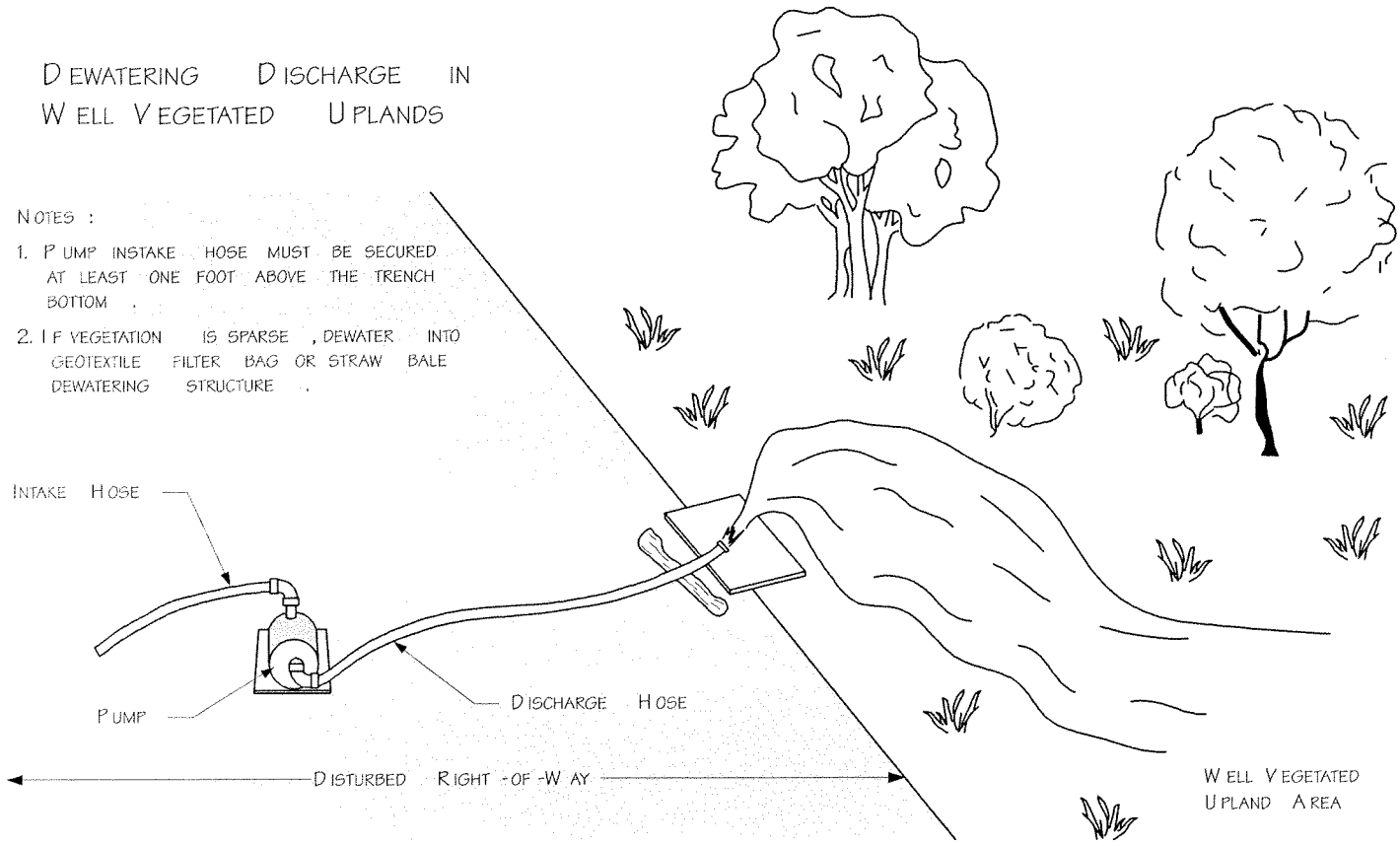
If vegetation is sparse and/or discharge is near a stream or wetland, direct dewatering discharge into a geotextile filter bag or a straw bale/silt fence dewatering structure (see Figure 2, Typical Straw Bale Dewatering Structure) then onto an upland area well away from watercourses, wetlands or drainage ditches.

NOTE: Use only nonwoven fabric filter bags for dewatering.

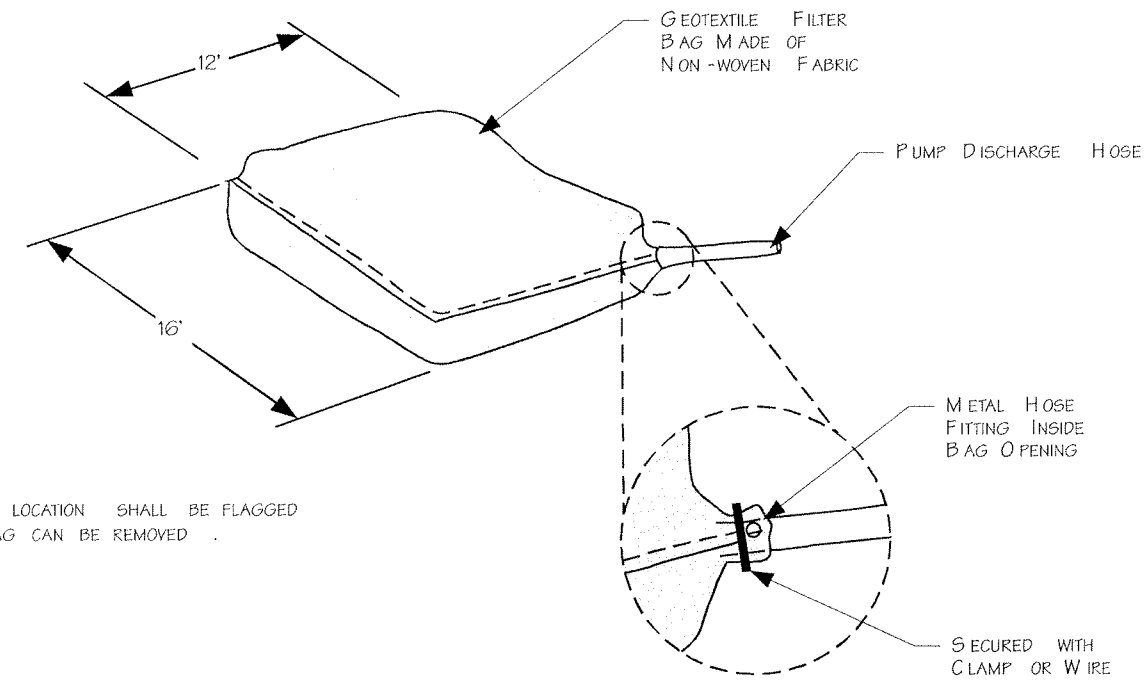
DEWATERING DISCHARGE IN WELL VEGETATED UPLANDS

NOTES :

1. PUMP INSTAKE HOSE MUST BE SECURED AT LEAST ONE FOOT ABOVE THE TRENCH BOTTOM .
2. IF VEGETATION IS SPARSE , DEWATER INTO GEOTEXTILE FILTER BAG OR STRAW BALE DEWATERING STRUCTURE .



GEOTEXTILE FILTER BAG



NOTE :

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

For environmental review purposes only.

ENBRIDGE

Figure 1

Typical Dewatering Measures

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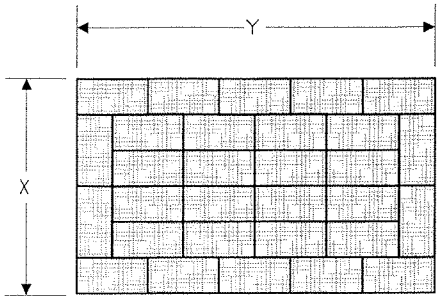
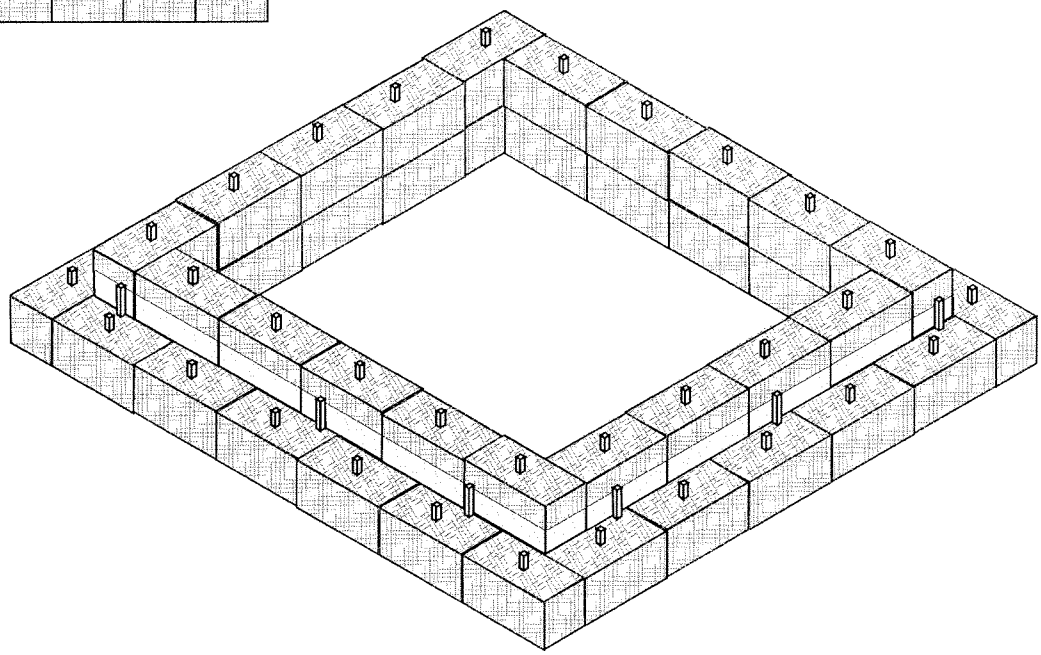
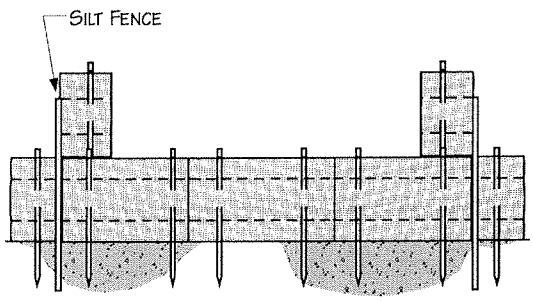


NOTES

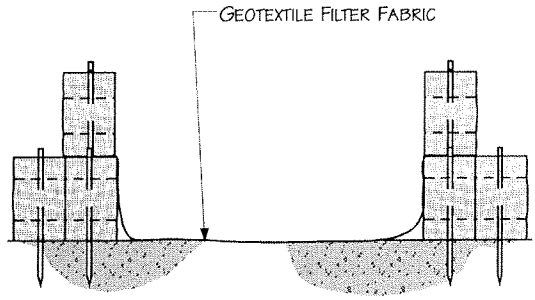
1. ARRANGE THE STRAW BALES TO THE X AND Y DIMENSIONS AS SPECIFICIED BELOW .
2. IF BOTTOM OF STRUCTURE IS NOT LINED WITH STRAW BALES (OPTION 1), LINE ENTIRE STRUCTURE WITH GEOTEXTILE FILTER FABRIC .



PERSPECTIVE VIEW



OPTION 1



OPTION 2

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

ENBRIDGE

Figure 2

Typical Straw-Bale Dewatering Structure

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HYDROSTATIC TESTING 02–18

Purpose

Industry standards and government regulations require that pipelines and other facilities are tested before commissioning for integrity purposes. The withdrawal and discharge (dewatering) of test water must be properly managed to ensure adverse impacts on the surrounding environment are prevented. Therefore, it is very important to ensure that each test is planned well in advance to allow for water source and discharge management, proper regulatory notification and time to obtain the necessary permits.

Responsibilities

The Project Manager is responsible for:

- completing the Hydrostatic Permit Request form and submitting it to Safety & Environment
- ensuring the requirements of the environmental plan have been fulfilled

Safety & Environment is responsible for:

- acquiring the necessary water withdrawal and discharge permits or approvals for the pressure test
- notifying the test supervisor, either by copy of the approvals or verbally as appropriate at least 3 weeks before the date of the pressure test.

Guidelines

Hydrotest Permit Request Form

The objective of the Hydrotest Permit Request form is to inform Safety and Environment of upcoming hydrotests, as well as provide them with necessary information so applicable permits can be obtained.

Required information includes (see attached form):

- description of facility (i.e. tank, mainline, station piping, etc.)
- water source/withdrawal (i.e. water source, rate of withdrawal, dates, etc.)
- water discharge (i.e. discharge location, rate of discharge, dates, etc.)

Permits/Licenses/Approvals

Because in most cases regulatory approvals for hydrostatic testing can take 10 weeks (CAN) 26 weeks (USA), complete the Hydrostatic Permit Request form in the planning phases of the project, and submit it to Safety & Environment at least 10 weeks (CAN) or 26 weeks (USA) prior to the scheduled date of the pressure test.

NOTE: A Hydrotest Permit Request is not required for new facilities if the test medium will be (a) less than 10 m^3 (2600 [US] gal) of clean water obtained and returned to company property or (b) from a municipal water supply that will be clean at disposal.

Immediately notify Safety & Environment of any changes or additions after the Hydrotest Permit Request is submitted, or to accommodate an expedited schedule for permit requests.

Notification

The Project Manager is responsible for ensuring that appropriate notification(s) to landowners and other potentially affected local agencies are made prior to a mainline pressure test. Typical local agencies include:

- city, town, village, or municipal offices
- police and fire departments
- hospitals
- Emergency Measures Organization (EMO)
- railways that cross or follow the pipeline
- other pipeline companies and utility companies that cross the pipeline

Source/Withdrawal

Follow all conditions outlined in the withdrawal permit.

When planning the test, consider utilizing alternatives to natural bodies of water as a source of hydrostatic test water, municipal water supplies, such as industrial water supplies at plants or refineries, where possible.

Avoid using water bodies with known environmental sensitivities.

Ensure withdrawal sources have sufficient quantity and quality of water required for testing purposes. Avoid use of highly saline sources of water if practical.

Do no exceed permitted withdrawal rates, nor 10% of the flow or volume of the water source unless otherwise approved by authorities having jurisdiction.

Only withdraw from approved locations.

Screen intakes in order to minimize intake of debris and organisms (this may be regulated within the withdrawal permit).

If necessary, test source water quality and provide the environmental department with lab results well in advance of water withdrawal.

Location

Avoid locating water withdrawal/discharge sites on steep slopes, muskegs or other sensitive areas.

Discharge

Follow all conditions outlined in the discharge permit.

During pressure testing, discharge water only at approved locations.

Locate dewatering sites:

- downstream of municipal water intakes, or
- upstream of municipal water intakes at a distance approved by regulatory authorities

If possible, discharge the source water within the same watershed from where it was withdrawn.

Discharge water must not be more than 2°C (4°F) warmer or cooler than a receiving body of water if the receiving body of water supports sport fish. If the potential exists for a temperature change that exceeds these limits, contact Safety & Environment.

Dewater the pipe/tank in such a manner that prevents soil erosion and damage to the beds and banks of water bodies. Use low velocities, dissipate water energy and utilize protective riprap, sheeting, tarpaulins or equivalent to prevent washouts, flooding or erosion (see 02-17, Dewatering, Figures 1 & 2).

Undertake representative sampling and obtain a laboratory analysis of discharge test water and obtain soil chemistry analysis, if required, prior to discharging on land.

NOTE: Other requirements for water discharge are handled on a project specific basis. For more information, contact Safety & Environment.

Water Additives/Saline Test Water

Safety & Environment must approveany additives to test water before use. Avoid or minimize the use of additives, although non-toxic, biodegradable, or photodegradable additives at minimum dosages may be permitted with regulatory approval.

Recover all methanol, ethylene glycol and water contaminated by freezing depressants in tanks. Do not allow contaminants to enter natural bodies of water or soils.

Dispose of contaminated test water at approved sites/facilities.

When using additives or saline test water, the test supervisor must develop a contingency plan for handling spills and leaks.

Hydrotest Permit Request Form

Project/AFE: _____ Request Date: _____
Test Report No: _____ Page __of ____ Proposed Test Date: _____
Pipeline Contractor:_____
Testing Contractor: _____

Description of Facility

☐ Mainline Line - No. _____ From MP _____ To MP _____
☐ Station Piping - Station _____
☐ Tank Hydrotest - Tank No. _____ Volume _____
☐ Emergency Stock Pipe - Pipe ID _____
☐ Drawing Attached - No. _____

Pipe Data: OD _____ Length_____

Test Medium _____ Fill Volume _____ Squeeze Volume _____

Water Source/Withdrawal

Water Withdrawal Date: Start _____ Finish _____Duration _____
Analine Dye: ☐ No ☐ Yes
Water Additives/ Others ☐ No ☐ Yes (Describe) _____

Primary Water Source/Location: _____
Secondary Water Source/Location: _____

Rate of Water Draw: _____ Screen Size on Intake: _____
Method of Transporting Water to Site, if applicable ☐ Temporary Piping ☐ Tank Truck
(If temporary pipe is required, attach maps/drawings and description.)

Water Discharge

Water Discharge Date: Start _____ Finish _____ Duration _____
Primary Discharge Location: _____
Secondary Discharge Location: _____

Rate of Discharging Water: _____
Method of Water Treatment: _____
_____
Discharge Control Measures (e.g., baffles, straw filters, rip rap, tarpaulins): _____
_____
_____

Requested By: _____ Phone: _____

Signature : _____

Fax this form to Safety and Environment (780) 420-8253 (CAN) (715) 394-1570 (US)

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 03–2

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:

$R = s \times D$

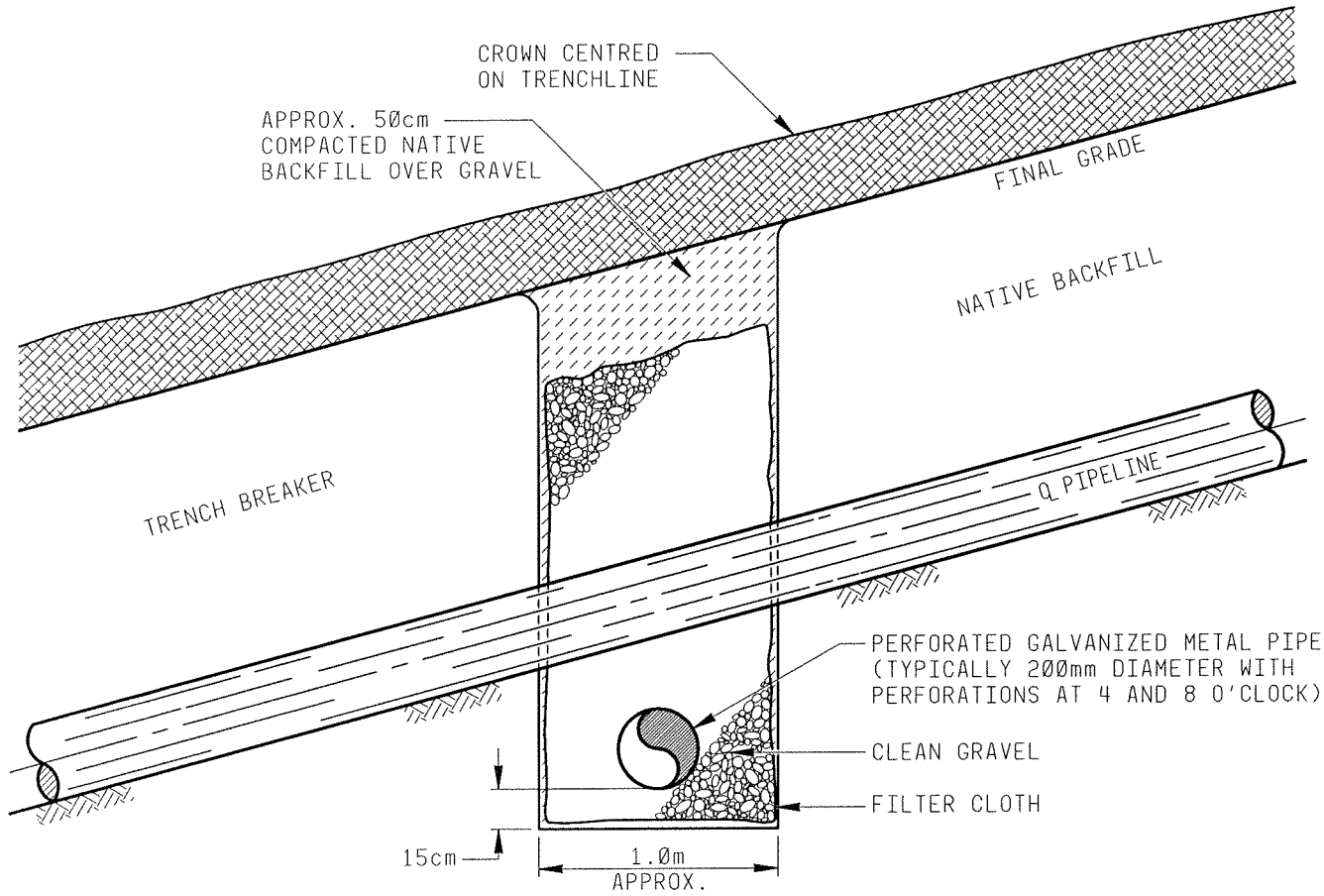
Where:

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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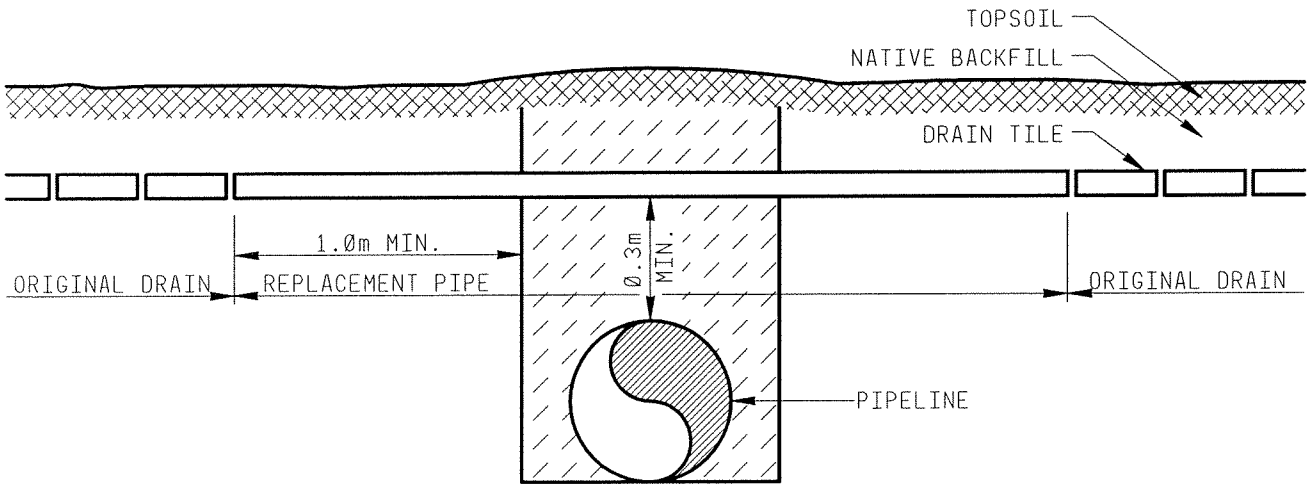
Figure 1

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.

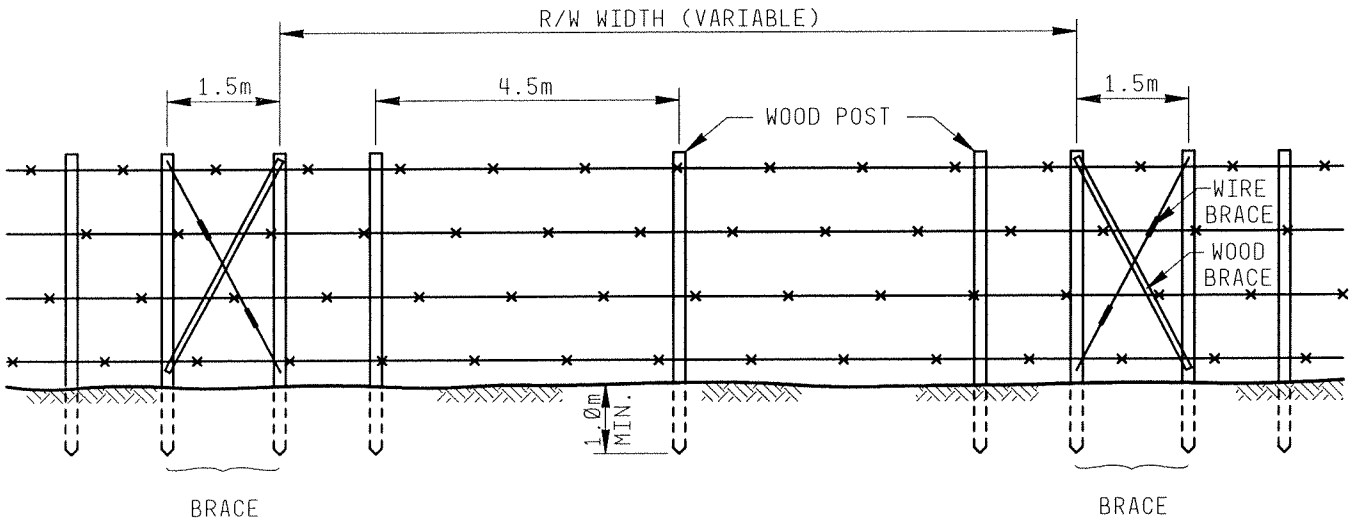
Dispose of corduroy, slash and any remaining leaning trees in the same manner as the original clearing (see 02-4, Clearing).

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.

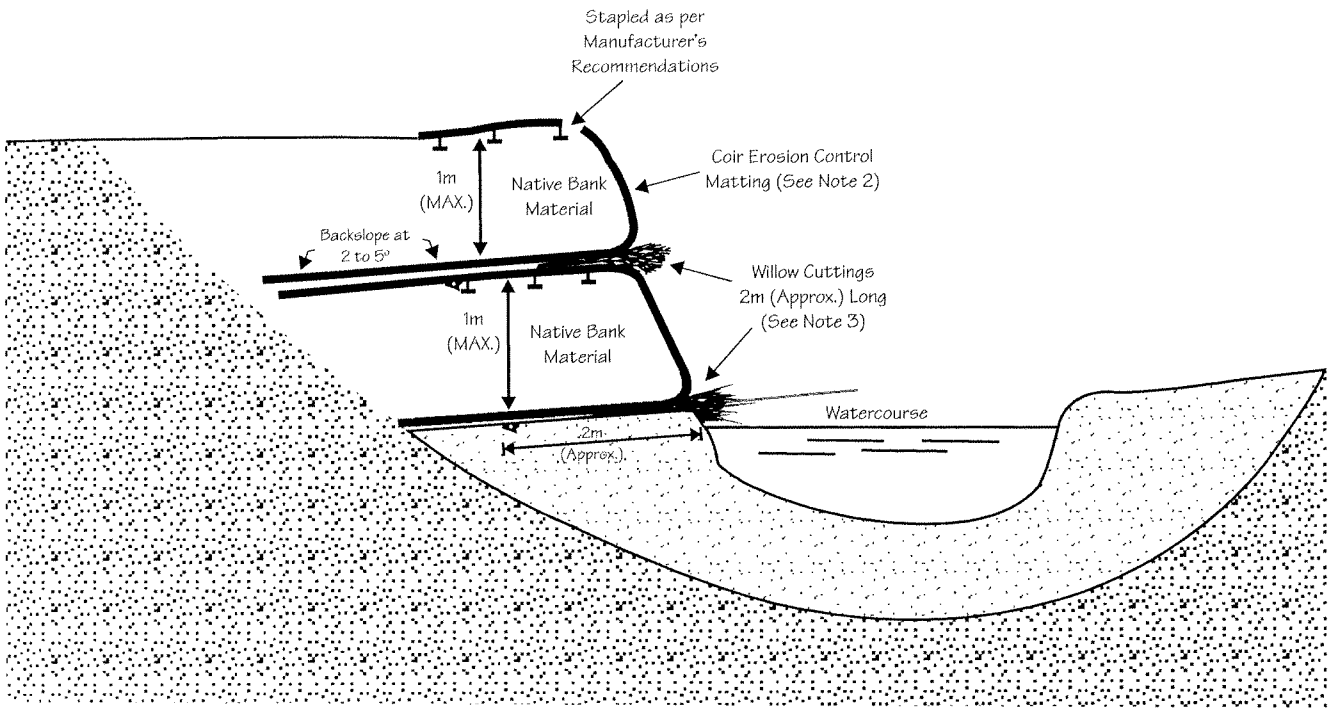
Use hydroseeders, mulches, tackifiers, seed impregnated netting or other suitable methods on steep or erosion-prone slopes.

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

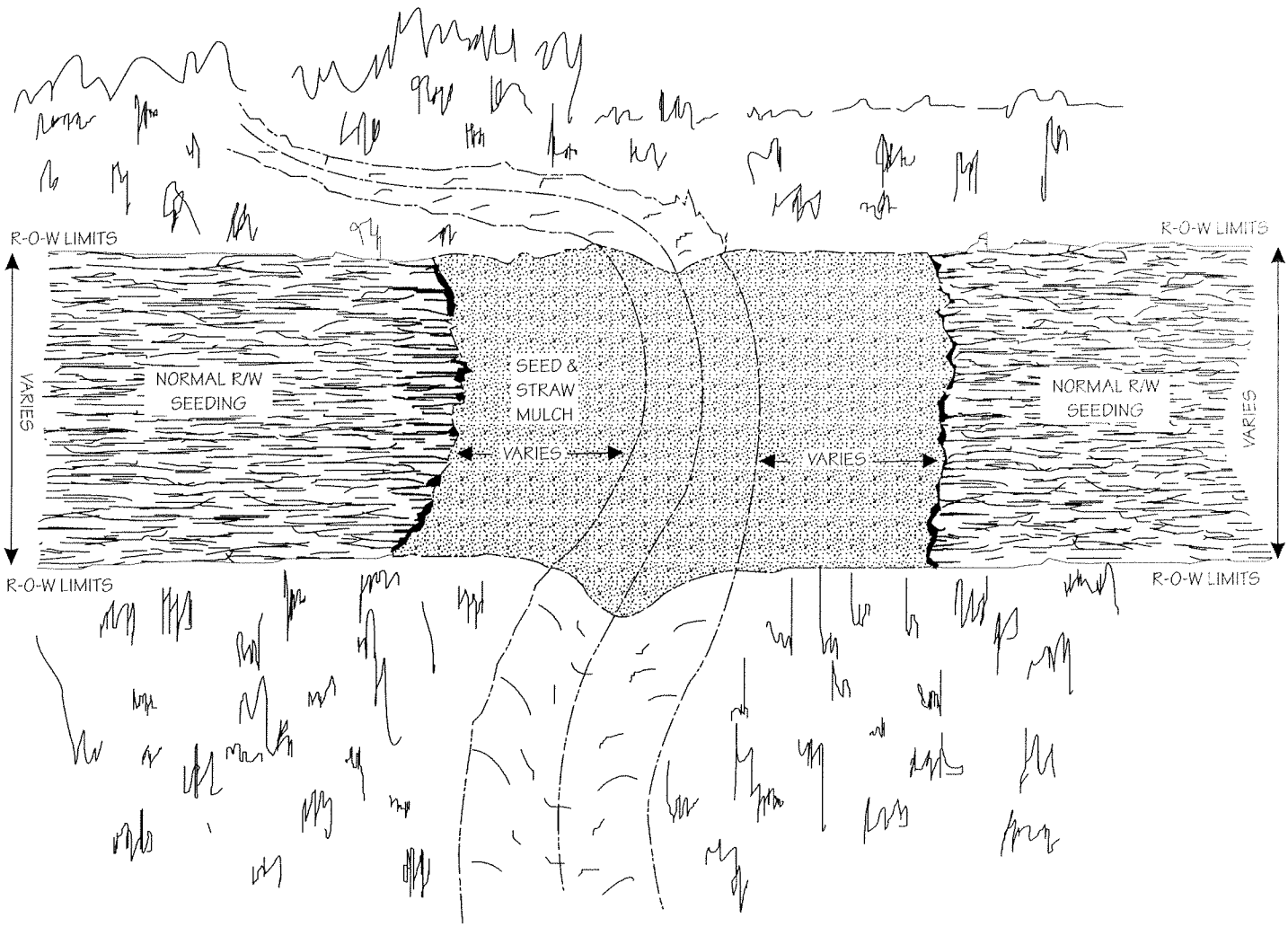

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Figure 2

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).

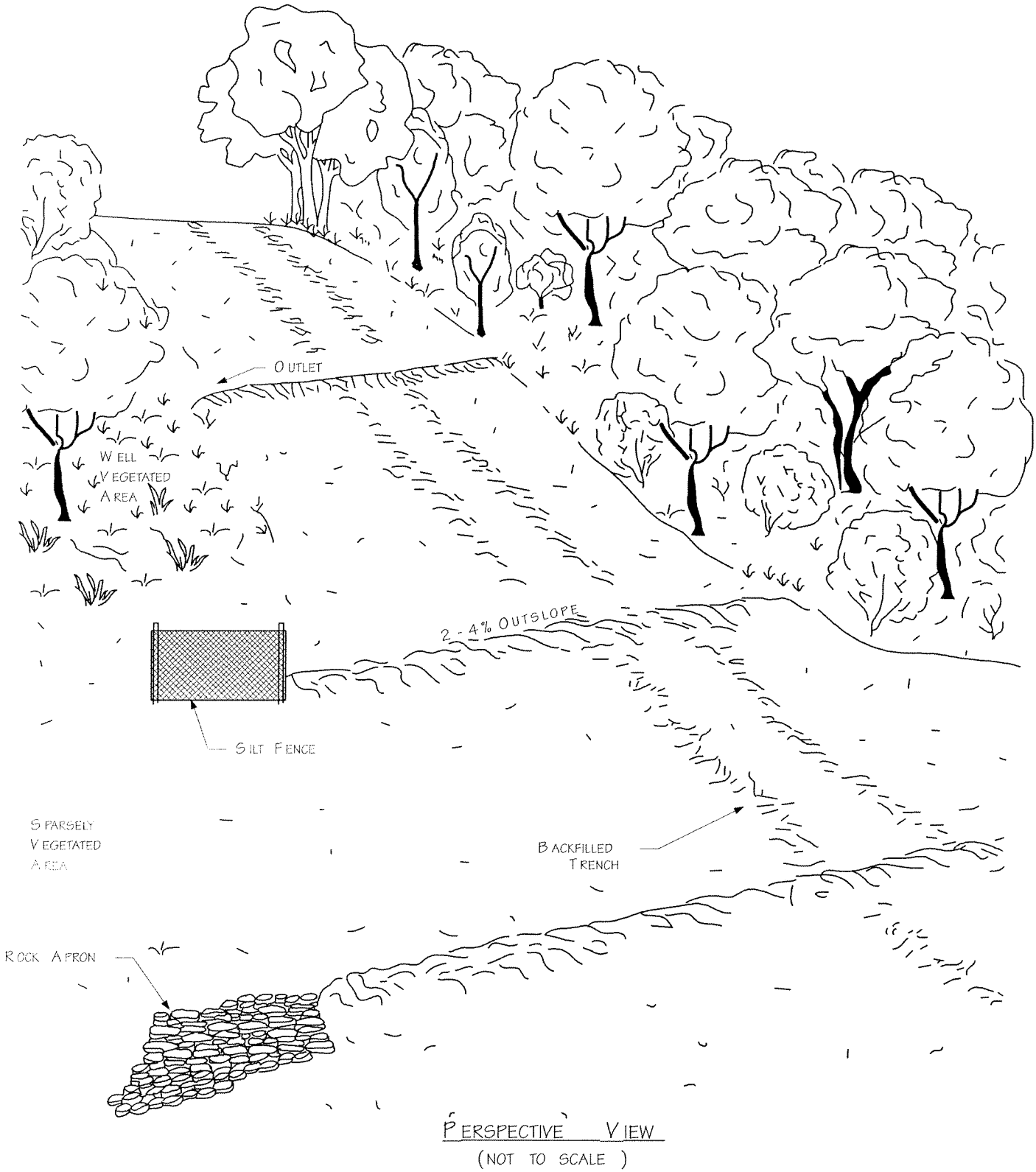
Immediately after stream banks are restored to their original contours, or to a 3:1 slope, whichever is less steep, install bank protection according to site and permit requirements:

- 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
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Figure 1

Permanent Slope Breakers - Perspective View

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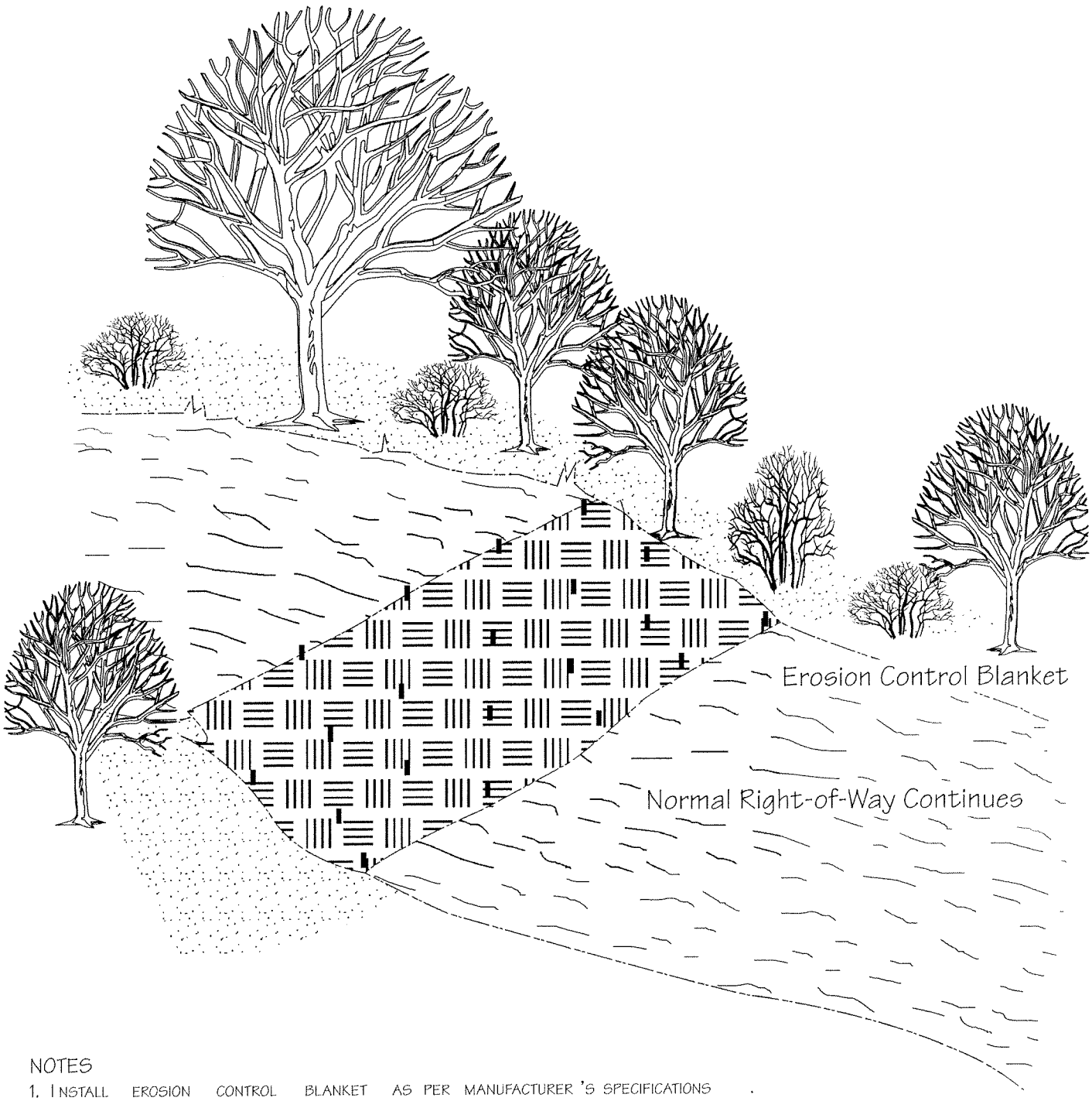

NOTES

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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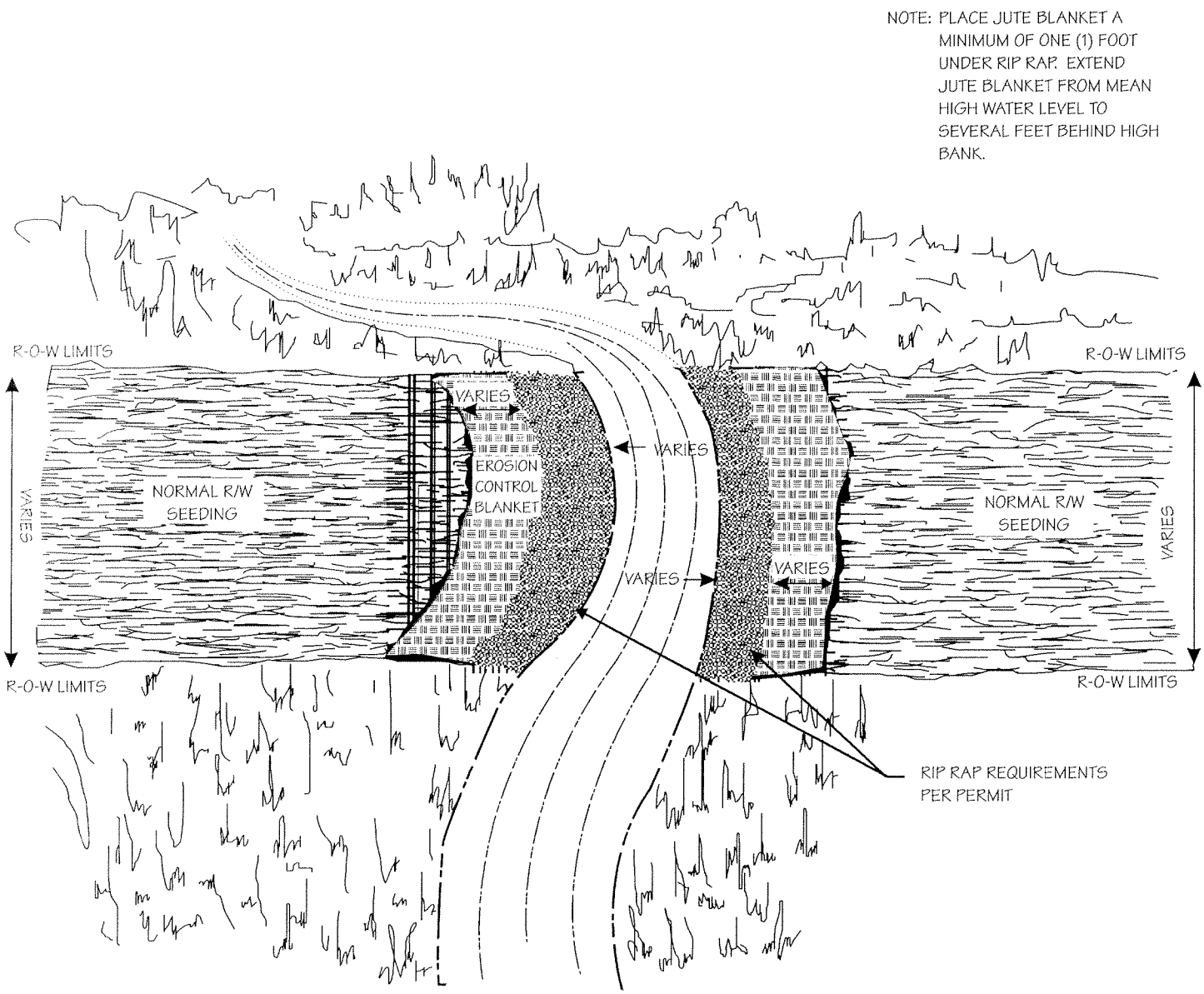

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Figure 3

Typical Stream Bank Stabilization
Riprap & Erosion Control Blanket

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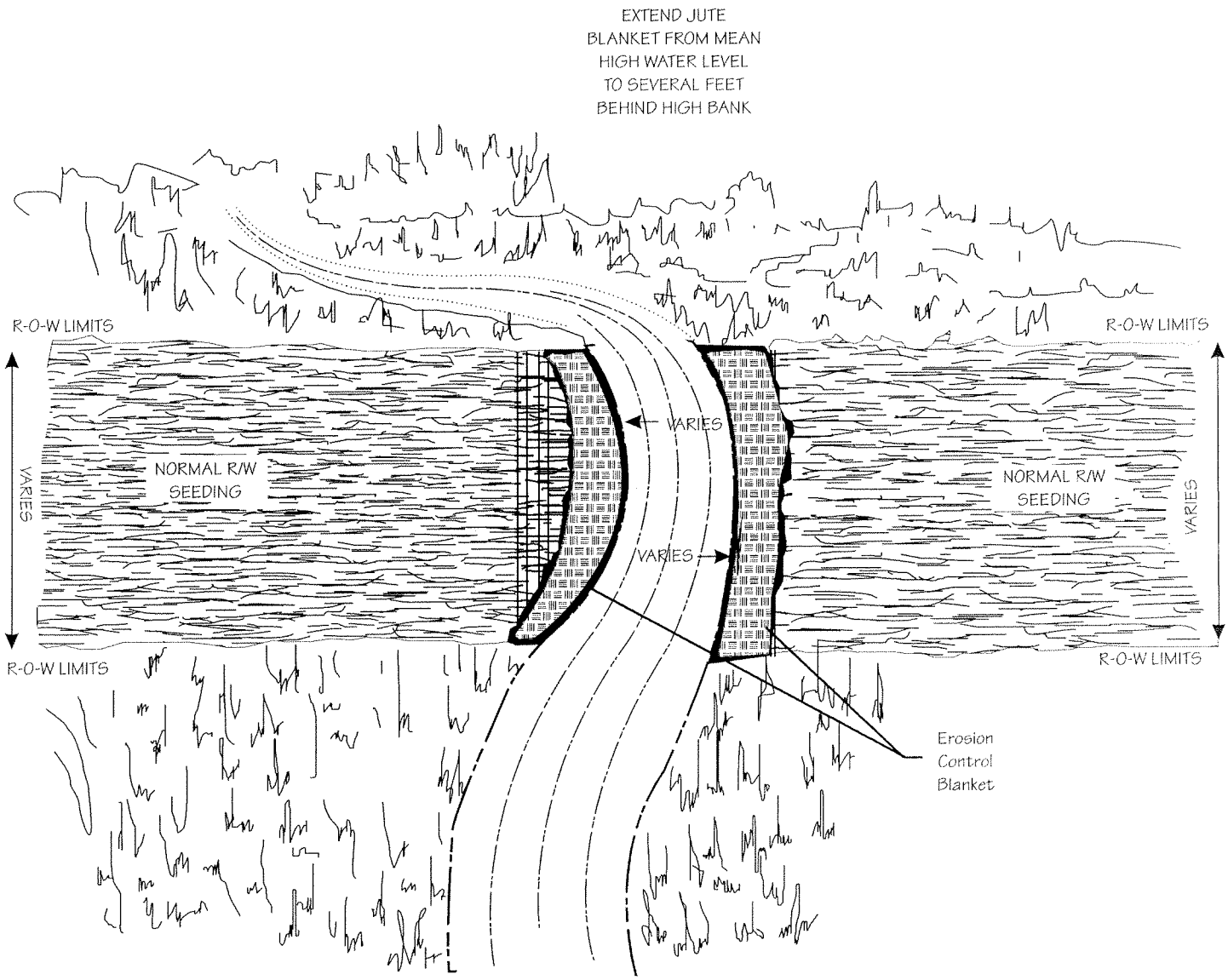

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Figure 4

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.

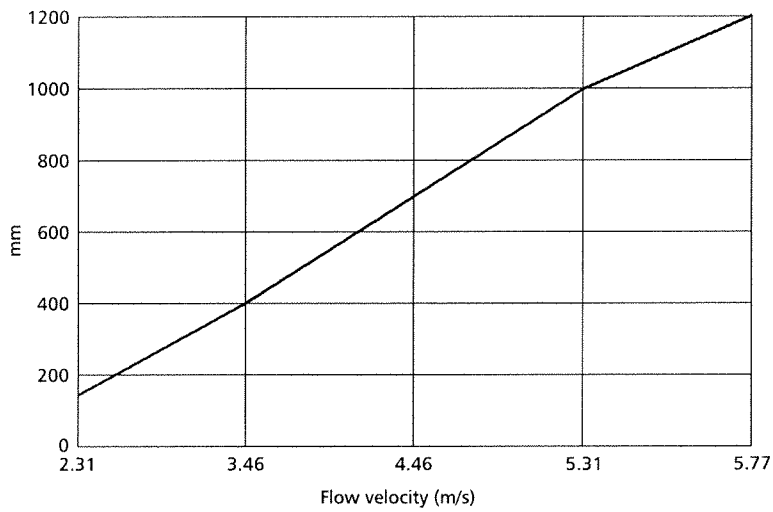
Guidelines

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.



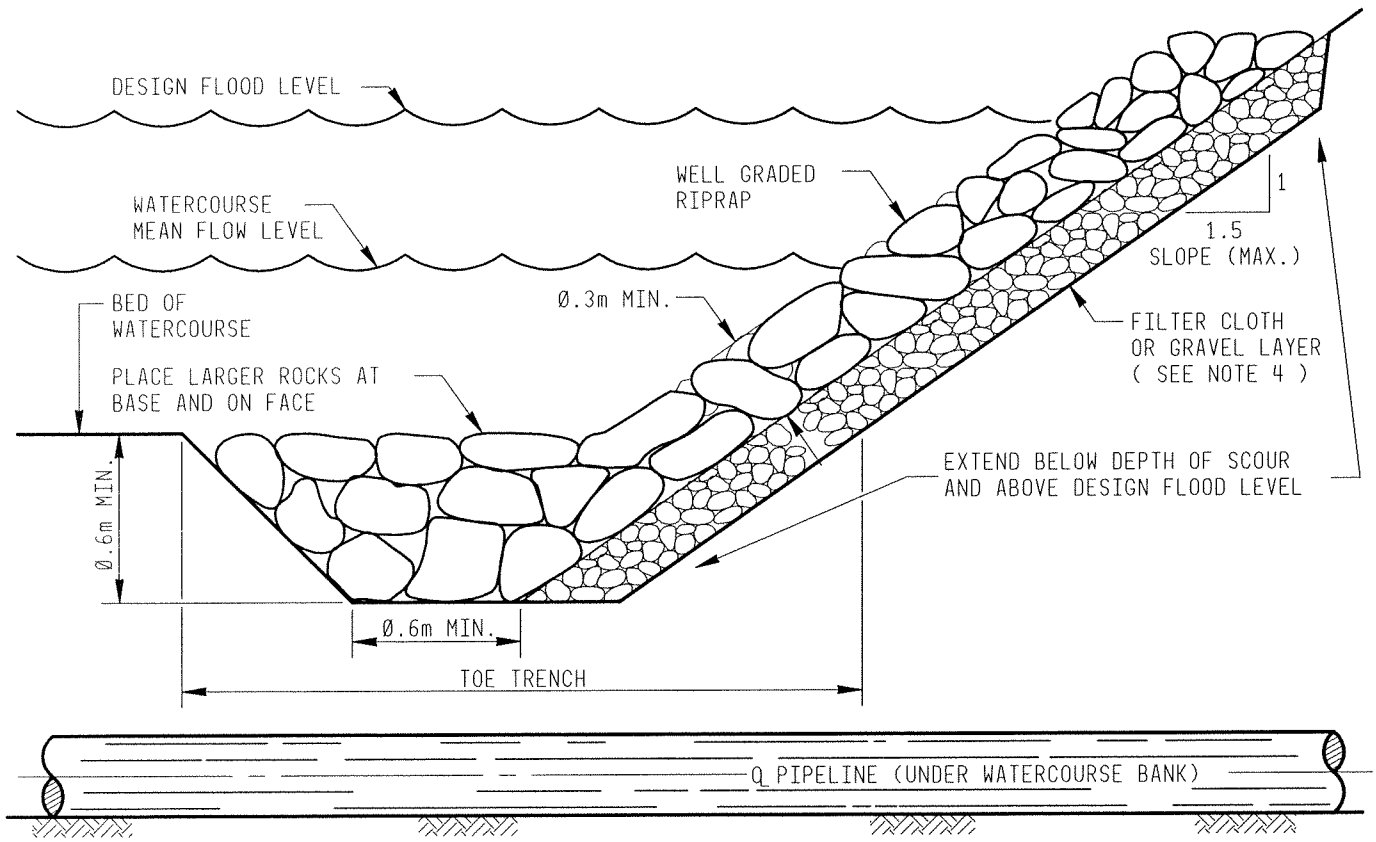
Median Size of Riprap for Maximum Flow Rates

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.

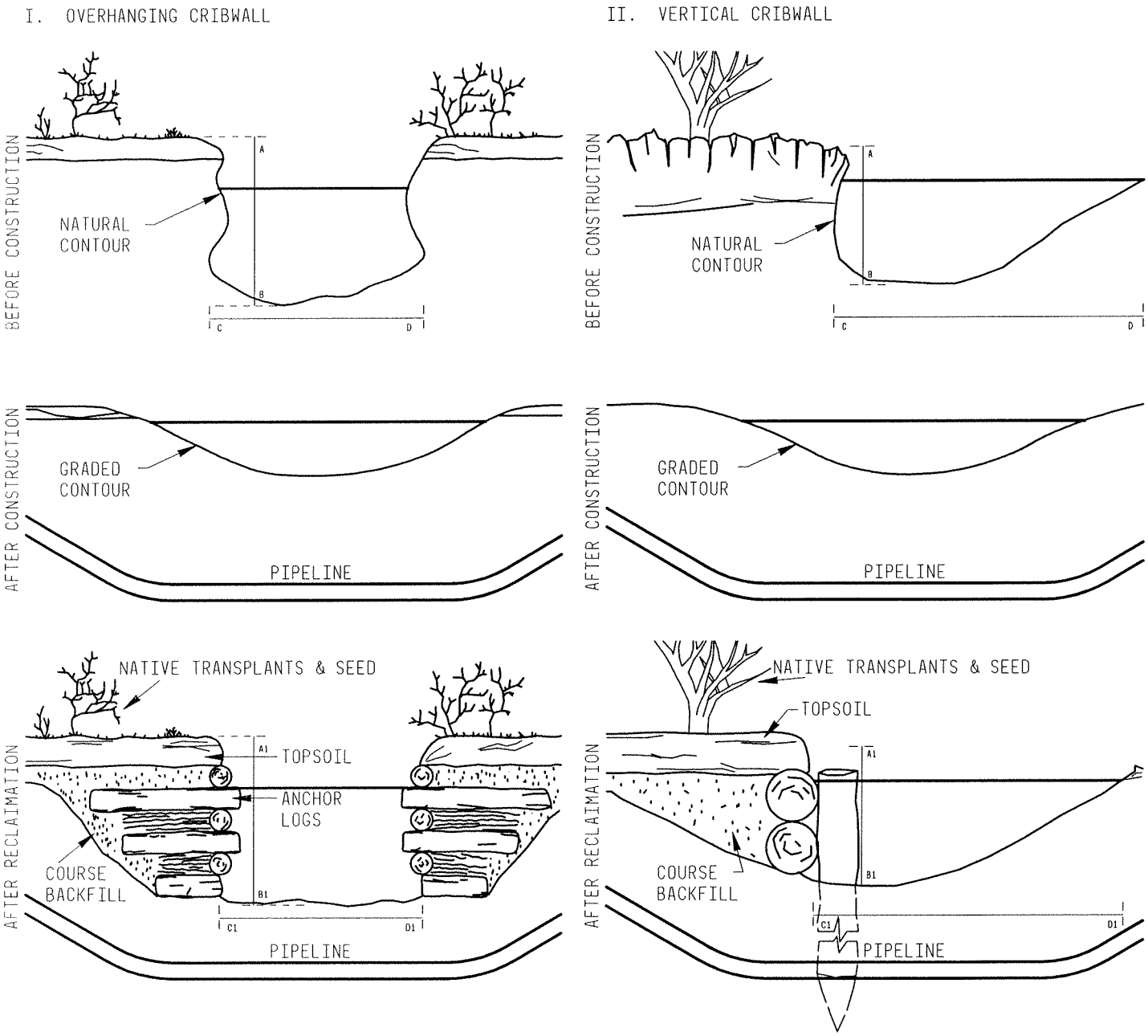

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Figure 1

Streambank Protection -
Crib Wall

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INSTALLING BERMS and DITCHES 03–9

Purpose

Diversion berms and cross ditches are installed on disturbed steep slopes as a permanent erosion control measure to direct surface water away from the trench line and off the right-of-way (ROW).

NOTE: For more information on stream bank erosion see 03-5, Permanent Erosion and Sedimentation Control.

Guidelines

Ensure there is no crown in the diversion ditch.

Tie new berms into existing berms where feasible.

Procedure

1. Determine the location and direction of diversion berms based on local topography and drainage patterns.

2. Construct diversion berms of compacted native materials, approximately 1 m (3 ft) for winter (frozen) construction and 0.6 m (2 ft) for summer construction. (see Figure 1, Configuration with Trench Breakers & Figure 2, Configuration without Trench Breakers).

   - If groundwater flow is a concern in the construction area, install the diversion berm with a trench breaker to direct subsurface flow out of the trench and to the surface.

   - Where native material is erodible, protect the upslope of the berm and base of the cross ditch with riprap (see 03-6, Installing Rock Riprap).

3. Skew berms with a downhill gradient of 5° - 10° (95° - 100° of the fall line) to prevent water from ponding behind berms and to allow for drainage away from the trench line (see Figure 3, Diversion Berm and Cross Ditch with Trench Breaker & Figure 4, Diversion Berm and Cross Ditch without Trench Breaker)

4. Where trench breakers are installed, install berms immediately downslope of the gravel drain and overlying the trench breaker.

5. Space berms as shown in Table 1.

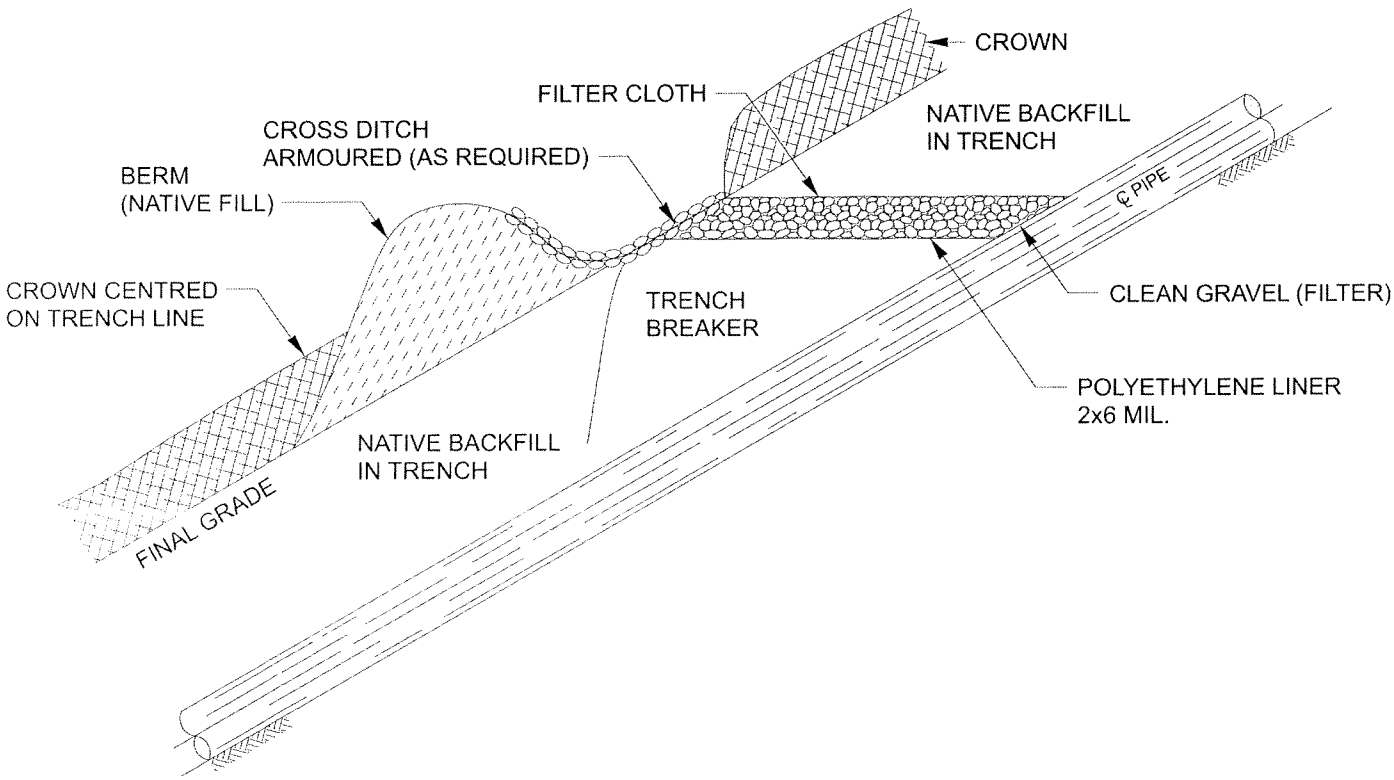
Table 1
Typical Diversion Berm Spacing

SLOPE GRADIENT		TYPICAL SPACING*	
(degrees)	(percent)	(m)	(ft)
<8	<15	as required	
8 – 14	15 – 25	45	148
14 – 17	30 – 35	35	115
17 – 20	30 – 35	20	65
> 20	> 35	10 – 15	32 – 50

NOTES
* Rely on field judgment to determine appropriate spacing.

6. Terminate berms in natural vegetation and staggered a minimum of 2 m (6 ½ ft) off the ROW.

7. Tie new berms into existing berms where possible.



PROFILE

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Figure 1

Configuration with Trench Breakers

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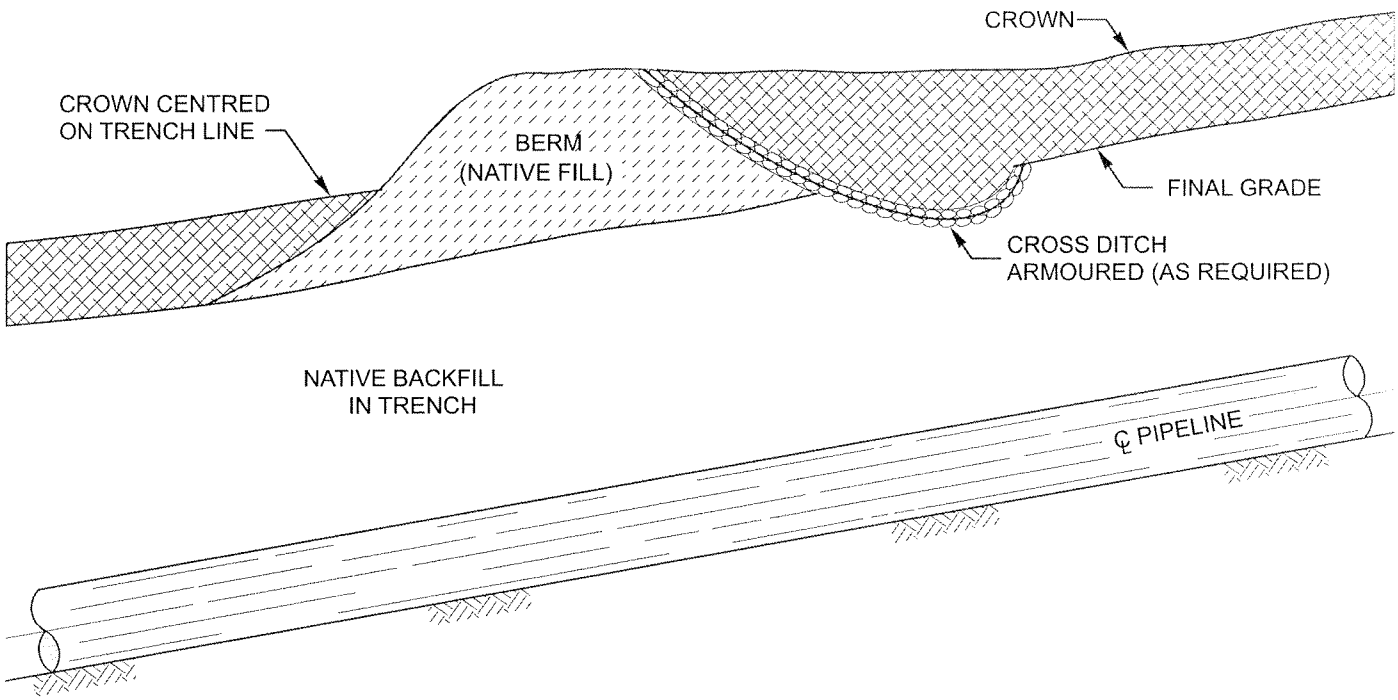

PROFILE

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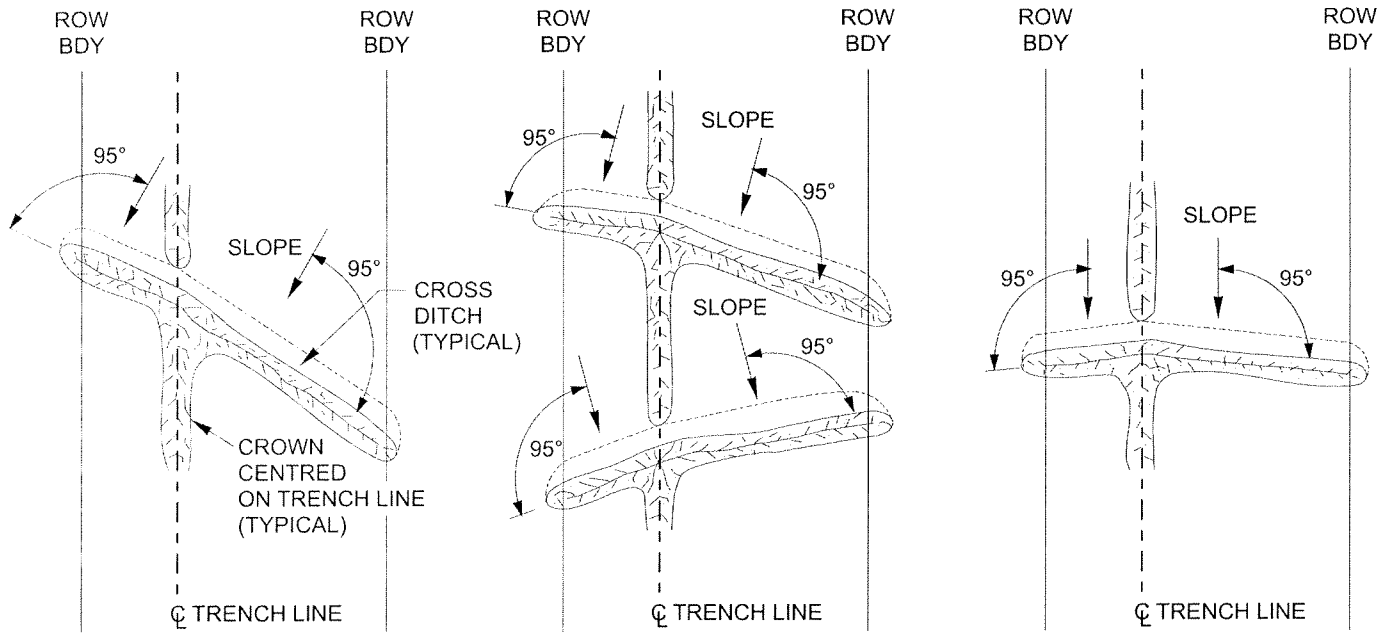
Figure 2

Configuration without Trench Breakers

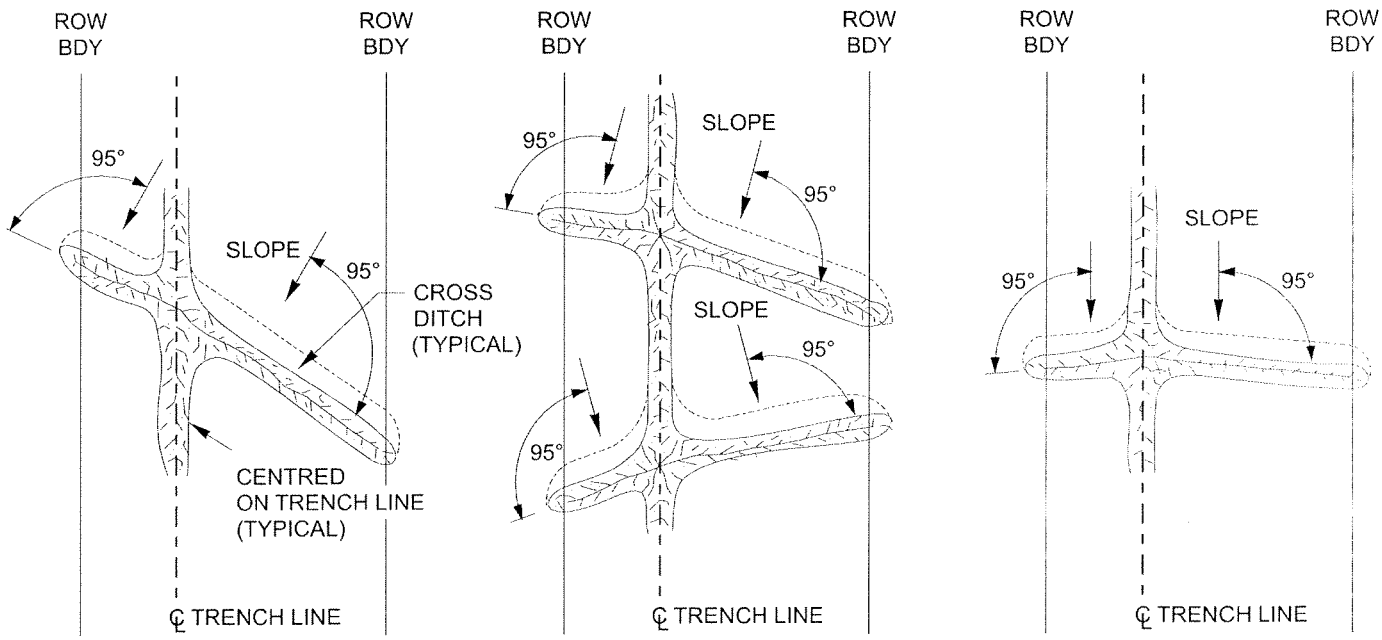


PLAN VIEW

ENBRIDGE

Figure 3

Diversion Berm and Cross Ditch with Trench Breaker



PLAN VIEW

ENBRIDGE

Figure 4

Diversion Berm and Cross Ditch without Trench Breaker