

BCTS
BC Timber Sales

SEDIMENT AND
EROSION CONTROL
FIELD GUIDE

PREFACE

While it is impossible to prevent sediment from leaving disturbed forest lands due to rainfall and snow melt, significant reductions can be realized. This field manual had been developed to assist those in the forestry field who install, maintain, monitor and inspect sediment and erosion measures associated with roads and stream crossings. This document does not address all mitigation measures that are available to implement; however, information has been incorporated to increase the effectiveness of the most common Best Management Practices (BMPs) found in BC Timber Sales forestry applications.

Techniques presented in this manual have been developed from personal experience, research, Erosion Draw 4.0, and teaching about sediment and erosion control. While none of the BMPs will achieve 'Zero Sediment Discharge', correct application, implementation and maintenance can result in significant reductions of sediment in runoff waters. It is expected that the use of this manual will result in practical and effective control of sediment that may be generated during forestry operations.

Methods outlined in this manual have been designed for uses prescribed in various environmental plans based on variables triggered through the BCTS Risk Matrix. Depending on key variables present at each site location, the risk of activities can be assessed and the corresponding Environmental Management Plan (EMP) or Sediment and Erosion Control Plan (SECP) will be prepared.

This manual is to be used as a guide, and is in no way designed to replace contract/license design specifications if applicable. If specified design parameters have been prescribed, these specifications/prescriptions take precedence over the methods and techniques presented in this manual. For additional information refer to the Be Timber Sales Environmental Management System, Emergency Response Manual and site specific Emergence Response Plans.

BC Timber Sales would like to acknowledge FP Innovations for several pages within this document that were extracted from the "Erosion and Sediment Guide Control Practices for Forest Roads and Stream Crossings" handbook, A Practical Operations Guide Advantage Vol. 9 No. 5 dated December 2007. Page 1, Sediment and Erosion Control Plan for Low Risk Stream Culvert Construction, Page 3, Sediment and Erosion Control Plan for Low Risk Stream Culvert Construction, Page 9, Soils Identification Guide, Page 10, Soil Erosion Hazard Guide have been utilized as part of this guide. BC Timber Sales is a member of the FP Innovations.

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STANDARD SEDIMENT AND EROSION CONTROL PLAN (SECP) FOR LOW RISK ROAD CONSTRUCTION

TABLE 1 – SECP BMPs for low risk crossings

CONSTRUCTION						
TECHNIQUE	LEGEND	REF.	OBJECTIVES	BMP	LOCATION	TIMING OF INSTALLATION
LIMIT SITE DISTURBANCE		1	Protect soil from unnecessary disturbance which creates potential for erosion processes.	No grubbing outside of the road prism. When clearing vegetation within the road right-of-way, cut off (prune back) vegetation leaving root mass intact in soil. Vegetation promotes rainfall interception and infiltration. Store equipment and building materials away from existing vegetation where possible.	Along the entire right-of-way.	During road construction.
		2	Where possible, avoid working in areas of ponded water or saturated soils.	These seasonally wet areas require extra precautions to protect soils and vegetation. If road construction is required in these locations, overland fill/log corduroy may be required to protect the native soils and vegetation.	Any wet ground encountered within the right-of-way.	Ground protection measures should be implemented prior to accessing beyond the saturated area.
DRAINAGE MANAGEMENT		3	Avoid generating greater erosive force and down-cutting of the ditch.	Maintain natural drainage paths and avoid concentrating ditch flows by installing adequate cross drains. Ensure cross drain invert on overland low relief areas, are installed at ground elevation.	Where road intersects drainages and seeps. Install additional cross drains when road cuts bring groundwater to the surface and drainage can be diverted away from the road.	As water is encountered during road construction, establish adequate drainage to ensure flows are controlled and water quality is maintained.
		4	Avoid blocking the inlet and outlet of drains which may be caused by encroachment of eroding road embankment fill.	Ensure cross drains are sufficient length to protrude past end fills and scour protection measures.	Both the inlet and outlet of the cross drain.	During initial planning and also ground truthing during installation.
		5	Divert ditch flows out of ditches and through cross drains or through wing ditches to a location where it can be discharged away from any watercourse.	Construct non-erodible ditch blocks.	At all cross drains and wing ditches on the side with the higher elevation.	As soon as ditches are constructed.
		6	Divert ditch water out of ditches and across vegetated forest floor to allow natural filtration.	Construct wing ditches to prevent ditch water from becoming concentrated.	Wherever terrain allows.	As water is encountered during road construction, establish adequate drainage to ensure flows are controlled and water quality is maintained.
		7	Avoid excavating ditch lines in low relief areas which concentrates ditch flow and does not allow drainage to flow away from the site.	Avoid excavating ditch lines where not necessary and where overland road construction occurs along fill slopes.	Overland road construction.	N/A
		8	Prevent rill/gully formation on the road running surface.	Slope road so that surface flow drains off the running surface.	Any road with significant slope and on side slopes.	During road construction.
		9	Increase the slope length to decrease the erosion potential.	Construct stable cut and fill slopes at designed angles. Consider terracing steep cut slopes. Slopes should be constructed based on soils, aspect, moisture content and climatic conditions.	Any cut or fill slope created during construction.	Throughout road construction.
EROSION CONTROL		10	Protect unstable or erodible fill at cross drain outlets with rock, flumes or other erosion-resistant material.	Install erosion-resistant measures at the outlet of cross drains with highly erodible material.	At the outlet of the cross drain. If water is discharged down an erodible slope, additional armouring may be required down to the toe of the slope.	In conjunction with the installation of the cross drain.
		11	Slow water velocity and limit down-cutting within the ditch lines.	Armour steep, erodible ditch lines with gravel and cobble to minimize erosive potential due to water velocity and volume.	Any erodible ditch line with high gradient should be armoured with hard materials.	Upon completion of ditch construction.
		12	Temporarily prevent rain splash erosion while the site is exposed during construction.	Temporarily cover exposed soils if heavy rainfall is encountered. Tarps, geotextile, hay or logging slash may be utilized.	Any exposed soils that may erode and be carried towards a watercourse.	If heavy rainfall is expected or long construction delays are anticipated.
		13	Provide seeding catchment areas to aid in germination/infiltration.	Surface roughening on all cut slopes and fill slopes. Do not backblade when finishing slopes. Seed all exposed soils.	All exposed soils in ditches and cut/fill slopes.	During final site contouring and after slopes are finished to grade.
		14	Prevent road rutting and road surface degradation which leads to erosion and sedimentation into the ditch lines.	When the road is constructed of fine textured soils, cap road surfaces with non-erodible materials.	Fine textured road surfaces which will be utilized year-round.	At completion of the project.
		15	Reduce ditch water velocity to aid in sediment deposition and stop down-cutting.	Rock check dams. Constructed of non-erodible material tightly packed together with ends higher than the center.	Install in highly erodible ditch lines with high gradient where water cannot be discharged from the ditch line (i.e. large through cut).	After ditch construction is complete.
SEDIMENT CONTROL		16	Provide areas for sediment deposition by temporarily slowing water velocity.	Construct settling basins as required.	Install at the bottom of slopes and prior to any watercourse where there is a direct connection with the ditch line.	As soon as ditch lines are constructed.
		17	Slow the flow of runoff water and aid in sediment deposition by temporarily slowing water velocity.	Install silt fences as required.	At the discretion of the contractor as deemed necessary. Install along contours of grade. Do not install in locations where heavy flows are anticipated.	At completion of the project.

1.0 Objectives

The primary objective of this SECP is to provide a generic plan for **low risk** road construction projects. Erosion, which causes sediment delivery into the aquatic environment, will be minimized during road construction and operation by; (1) minimizing site disturbance, (2) drainage management, (3) erosion control, and (4) sediment control (in descending priority). Low risk road construction typically includes: **stable soils, gentle grades and moderate cuts/fills.**

2.0 Critical Areas

Critical areas relating to erosion control with respect to road construction include; cut slopes, natural seeps, right-of-way clearing, ditch lines and terrain which drains toward any stream crossing.

3.0 Timing

All road construction should proceed in appropriate dry weather conditions. Mitigation measures and construction techniques must be implemented as the road is constructed (i.e. not waiting until construction is completed before going back to install erosion control measures), or as soon as soil conditions allow. Drainage systems should also be constructed, as much as practicable, concurrently with subgrade construction. Once commenced, all road works will proceed to completion as soon as practicable. Additional timing windows apply to working around all fish bearing waters. Refer to the *Reduced Risk Timing Windows and Measures for the Conservation of Fish and Fish Habitat for the Omineca Region.*

4.0 Accountability

It is the responsibility of the contractor to ensure that this SECP is followed in conjunction with the *BC Timber Sales Prince George Business Area Environmental Management System.*

Should an emergency occur (i.e. significant erosion event due to forestry road construction activities), the event must be dealt with in accordance with the *BC Timber Sales Environmental Management System*, including site specific *Emergency Response Plans* and the *Emergency Response Manual*. Contact numbers and instruction for documentation of the incident are available in these plans.

5.0 Best Management Practices (BMPs)

While it is impossible to prevent sediment from leaving recently constructed roads due to rainfall and snow melt, significant reductions can be realized. This plan does not address all possible mitigation measures that are available to implement; however, information has been incorporated to increase the effectiveness of the most common BMPs found in forestry road construction. Refer to Table 1 for recommended BMPs. For additional information, refer to *BC Timber Sales Environmental Field Procedures* and the *Forest Road Engineering Guidebook*. All BMPs will be installed as per specifications in the *BC Timber Sales Field Guide to Effective Sediment and Erosion Control Practices for Forestry Applications.*

6.0 Contingency Plans

Contingency plans are additional mitigation measures that will be employed if unforeseen environmental concerns are encountered during road construction. These plans include having extra sediment/erosion control materials on-site and halting operations if heavy or persistent rainfall is encountered.

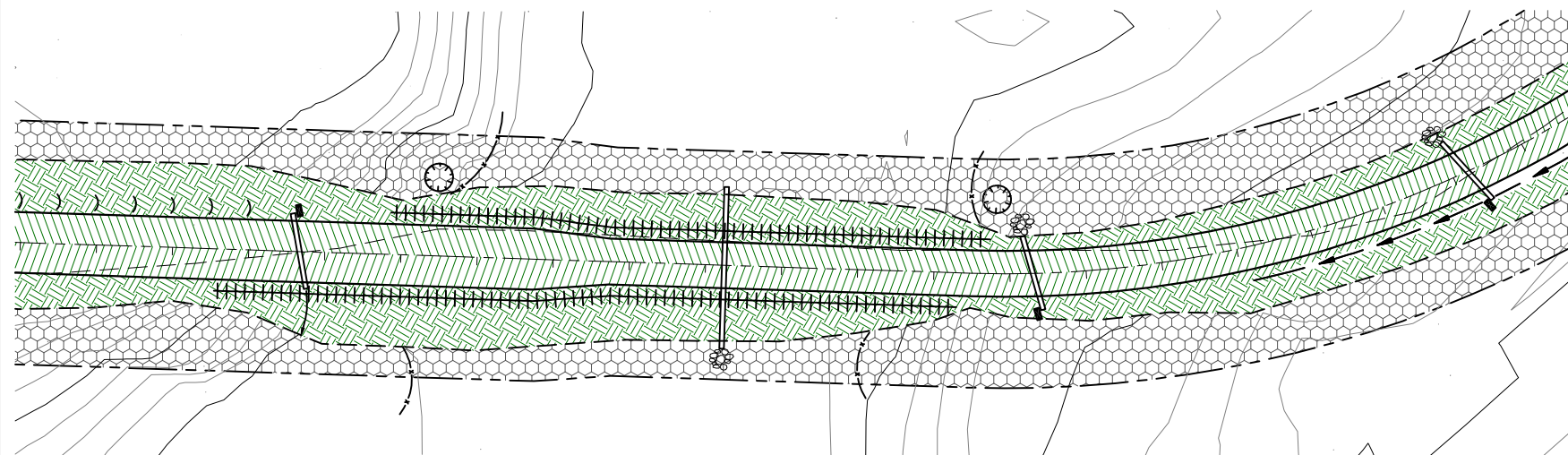
An emergency supply of sediment control materials will be available on-site which may include; silt fencing, tarps, sand bags, seed and straw bales. In addition, stockpile an adequate supply of culverts, riprap and geotextile on-site for immediate and future use, should the need arise.

If works are temporarily suspended due to heavy precipitation, the site will be monitored during the shutdown period to ensure environmental concerns are adequately addressed.

Should unanticipated site conditions (i.e. significant seeps flowing out of cut slopes or hidden layers of highly erodible, fine textured soils) or extreme weather be encountered during construction, the BC Timber Sales representative will be immediately contacted to reassess the project. If increased environmental risk is perceived, site specific plans/measures may be required.

7.0 Inspection and Maintenance

During construction, inspections of the BMPs will be made, especially after heavy precipitation events. If any measure is not functioning as intended, it will be immediately repaired/replaced. All inspections and actions shall be documented.



PROJECT TITLE	BCTS-SECP-R		DESIGNED BY:	BAA, RPBio
PROJECT LOCATION(S)	DRAWING NAME:	REV.:	CHECKED BY:	RT, BCTS E.O.
DATE	02/05/06		DRAWN BY:	WG
NAME	SIGNATURE		DATE ISSUED:	
BCTS REPRESENTATIVE			DWB Forestry Services Ltd. 1A, 1750 Quinn Street Prince George, B.C. V2N 1X3 Phone: (250) 562-5541 Fax: (250) 562-5561	
CONTRACTOR				

CROSS DRAINS & DITCH BLOCKS

Instructions For Installation:

Cross drains should be installed to facilitate natural drainage patterns, such as at the top of steep gradients, at seepage zones, at zones with localized overland flow, at low points, immediately prior to cut slopes and through cuts and at any location where accelerated ditch erosion could potentially begin. Refer to the BCTS SECP plans and contract specifications to determine installation location.

To encourage smooth entry of ditch flows, skew cross drain culverts perpendicular to the road centerline, by 3° for each 1% that the road grade exceeds 3% to a maximum of 45°.

Should be installed in conjunction with Ditch Blocks to direct flows into CMP inlet.

Should be installed at appropriate depth within road fills/ditch line to facilitate complete drainage.

Install cross drain culverts at a gradient of 1–2.5%

Ditch blocks should consist of non-erodable materials such as boulders, cobbles, and riprap.

Do not install cross drains below natural ground elevation in overland section of road as this promotes pooling. Do not install ditch blocks above the running surface of the road.

In erodable soils or steep slopes the cross drain spacing should be reduced.

Installation of cross drains will have an effect on the drainage patterns and must be considered along with the ground stability when armouring drain outlets. Refer to page 8 on Cross Drain Outlet Armouring.

Inspection/Maintenance

Inspect structures after heavy precipitation events to ensure they are functioning properly.

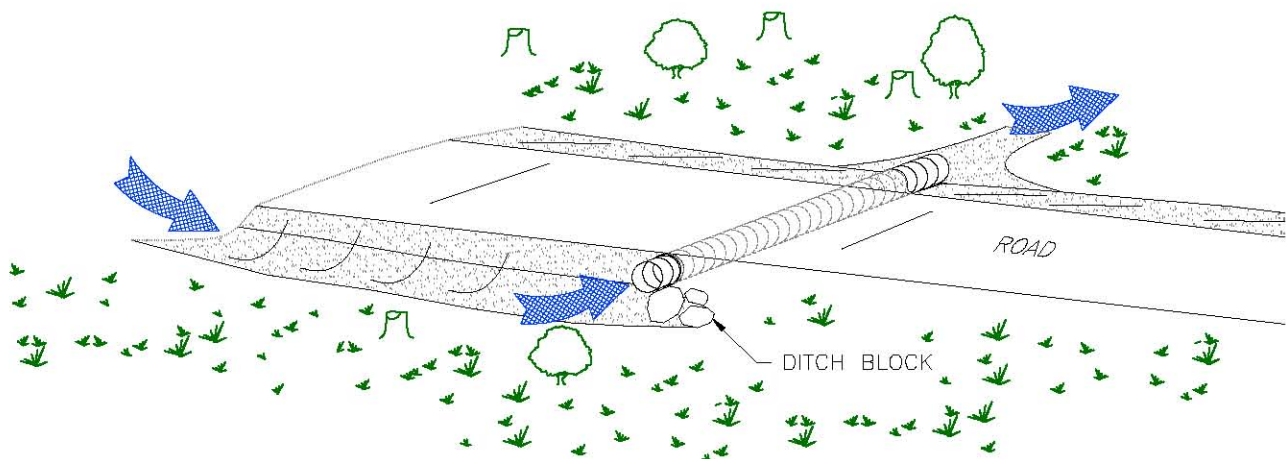


TABLE 1 – SECP BMPs for low risk crossings

CONSTRUCTION						
TECHNIQUE	LEGEND	REF.	OBJECTIVES	BMP	LOCATION	TIMING OF INSTALLATION
LIMIT SITE DISTURBANCE		1	Protect soil from unnecessary disturbance which creates potential for erosion processes.	No grubbing outside of the road prism. When clearing within the road right-of-way adjacent to the watercourse, cut off (prune back) vegetation leaving root mass intact in soil. Vegetation promotes rainfall interception and infiltration. It also provides watercourse shading and nutrients to the aquatic environment. Store equipment and building materials away from existing vegetation where possible.	Within the Riparian Management Area of the watercourse.	During road construction and culvert installation procedures.
		2	As much as possible, avoid working in areas of ponded water or saturated soils.	These seasonally wet areas require extra pre-cautions to protect soils and vegetation. If CMPs are required in these locations, overland fill/log corduroy may be required to access the crossing in order to complete the installation.	Any wet ground encountered immediately adjacent to the watercourse.	Ground protection measures must be in place prior to accessing the construction site.
CMP INSTALLATION		3	Minimize construction footprint and disturbance to existing watercourse.	Only excavate in the immediate area of the CMP installation. A smaller footprint requires less sediment and erosion control measures after installation. No unprotected fording of the watercourse is permitted.	The CMP will be installed centred on the existing watercourse and should not substantially change the natural flow pattern.	During planning and site preparation for the CMP installation.
		4	Allow installation to proceed under isolated conditions.	Isolate construction site by installation of temporary sediment sumps/active pumping of sediment-laden waters. Should significant flows be encountered, water may have to be diverted around the site. Temporary sediment sumps function to collect and settle mobilized sediments. Water from these sumps can be temporarily diverted down existing ditch lines or actively pumped from the construction site into adjacent upland areas for natural filtration.	Ideally, the sump location would be directly upstream of crossing location. Should this not be feasible, a secondary sump location would be immediately below the crossing.	The sumps must be installed prior to excavation in preparation for installation of the CMP. Pumping should occur whilst installation is occurring.
		5	Prevent detrimental impacts associated with increased sediment loads on downstream waters.	Install in-stream silt curtains (if site isolation stated above cannot be implemented). In-stream silt curtains only function in low volume, slow moving waters. They may be constructed using non-woven geotextile draped over logs and weighted with boulders to the channel bottom. Silt curtains are used in series (typically 2-3) to filter suspended sediments.	Install immediately downstream of work site where suspended sediment loads are greatest.	Prior to CMP bed preparation.
		6	Protect against future scour and erosion of the structure which leads to piping, undermining and eventual road failure.	Excavate unsuitable materials beneath the CMP and replace with suitably compacted fill to provide erosion resistant foundation. Also, install collar seepage barriers where necessary.	Beneath location where CMP will be installed.	Prior to placement of the CMP.
		7	Avoid blocking the inlet and outlet of CMPs which may be caused by encroachment of eroding road embankment fill.	Ensure CMP length is of sufficient length to protrude past end fills and scour protection measures.	Both the inlet and outlet of the CMP.	During initial planning and also ground truthing during installation.
		8	Protect unstable or erodible fill at CMP outlet and inlet with rock aprons to prevent scour and erosion.	Install erosion-resistant materials at the inlet and outlet of the CMP.	Immediately adjacent to the inlet and outlet of the CMP.	Immediately upon completing the installation of the CMP.
DRAINAGE MANAGEMENT		9	Divert ditch flow to a location where it can be discharged away from the watercourse.	If possible, install cross drain culverts or trenches to divert ditch water to the side of the approach with the most intact vegetation buffer between the watercourse and the ditch termination. Protect erodible fill slopes from cross drain discharges with flumes or other erosion-resistant material.	Where terrain allows, and as close to the watercourse as possible, while still diverting flows away from the watercourse.	As soon as ditches are constructed.
		10	Divert ditch flow to a location where it can be discharged away from the watercourse.	Construct non-erodible ditch blocks at cross drains and wing ditches as required.	At all cross drain and wing ditch inlets.	As soon as ditches are constructed.
		11	Divert ditch water out of ditches, away from the watercourse and across vegetated forest floor to allow natural filtration.	Construct wing ditches to disconnect all ditch lines from the watercourse.	Both approaches to the crossing as terrain allows.	As soon as ditches are constructed.
		12	Prevent rill/gully formation and prevent direct flow into the watercourse.	Crown road approaches so that surface flow drains off to the side of the road and not directly into the watercourse.	Road grade immediately adjacent to the watercourse.	At project completion.
EROSION CONTROL		13	Increase the slope length to decrease the erosion potential.	Construct stable cut and fill slopes, at designed angles. Consider terracing steep cut slopes. Slopes should be constructed based on soils, aspect, moisture content and climatic conditions.	Any cut or fill slope immediately adjacent to the CMP crossing which has the potential to deliver sediment-laden runoff to the watercourse.	Throughout road approach construction.
		14	Temporarily reduce rain splash erosion while the site is exposed during construction.	Temporarily cover exposed soils if heavy rainfall is encountered. Tarps, geotextile, hay or logging slash may be utilized.	Any exposed soils that may erode and be carried towards the watercourse.	If heavy rainfall is encountered during construction or anticipated overnight.
		15	Provide seeding catchment areas to aid in germination/infiltration.	Surface roughening on all cutslopes and fill slopes. Do not backblade when finishing slopes. Seed and mulch all exposed soils.	All exposed soils in ditches and slopes immediately adjacent to the site.	During final site contouring and after slopes are finished to grade.
		16	Move waste to a stable location where it cannot erode and enter the watercourse.	Endhaul debris/waste immediately adjacent to the site. Seed and mulch all waste sites.	All spoil materials within the riparian management zone.	Prior to completion of the project.
SEDIMENT CONTROL		17	Provide areas for sediment deposition prior to flowing into the watercourse.	Construct settling basins as required. (note: these structures require periodic maintenance).	Install 5-10m back from the watercourse edge in any ditch that directly flows into the watercourse.	As soon as ditch lines are constructed.
		18	Slow the flow of runoff water and aid in sediment deposition prior to entering the watercourse.	Install silt fences as required. (note: these structures require periodic maintenance).	At the discretion of the contractor on all disturbed soils within close proximity to the watercourse.	Throughout project as soils are exposed and at project completion.

STANDARD SEDIMENT AND EROSION CONTROL PLAN (SECP) FOR LOW RISK STREAM CROSSING CULVERT CONSTRUCTION

1.0 Objectives

The primary objective of this SECP is to provide a generic plan for **low risk** watercourse crossing culvert construction projects. Sediment delivery into the aquatic environment and associated downstream reaches will be minimized during culvert installation and operation by; (1) minimizing site disturbance, (2) drainage management, (3) erosion control, and (4) sediment control (in descending priority). Low risk culvert installations are typically **crossings of non-fish bearing streams and substantial Non-Classifiable Drainages (NCDs) which are not directly connected to fish-bearing waters.**

2.0 Critical Areas

Critical areas relating to the project include; all ditch lines which drain towards the watercourse, areas of excavation, existing riparian vegetation, and the reach immediately downstream of the crossing location.

3.0 Timing

All construction will proceed in appropriate weather conditions. Although no specified timing window exists for culvert installations on non-fish bearing watercourses, it is recommended that works be carried out during low flows. Culverts must be installed as each crossing is encountered during road construction. Once commenced, all works will proceed to completion as soon as practicable.

4.0 Accountability

It is the responsibility of the contractor to ensure that this SECP, in conjunction with the *BC Timber Sales Prince George Business Area Environmental Management System*, are followed in their entirety.

Should an emergency occur (i.e. significant sediment release into the aquatic environment due to construction of forestry related activities), the event must be dealt with in accordance with the *BC Timber Sales Environmental Management System*, including site specific *Emergency Response Plans* and the *Emergency Response Manual*. Contact numbers and instruction for documentation of the incident are available in these plans.

5.0 Best Management Practices (BMPs)

While it is impossible to prevent sediment from leaving disturbed construction sites due to rainfall and snow melt, significant reductions can be realized. This plan does not address all possible mitigation measures that are available to implement; however, information has been incorporated to increase the effectiveness of the most common BMPs found in forestry watercourse crossing culvert installations. Refer to Table 1 for recommended BMPs. For additional information, refer to *BC Timber Sales Environmental Field Procedures* and the *Forest Road Engineering Guidebook*. All BMPs will be installed as per specifications in the *BC Timber Sales Field Guide to Effective Sediment and Erosion Control Practices for Forestry Applications*.

6.0 Contingency Plans

Contingency plans are additional mitigation measures that will be employed if unforeseen environmental concerns are encountered during construction. These plans include having extra sediment/erosion control materials on-site and halting operations if heavy or persistent rainfall is encountered.

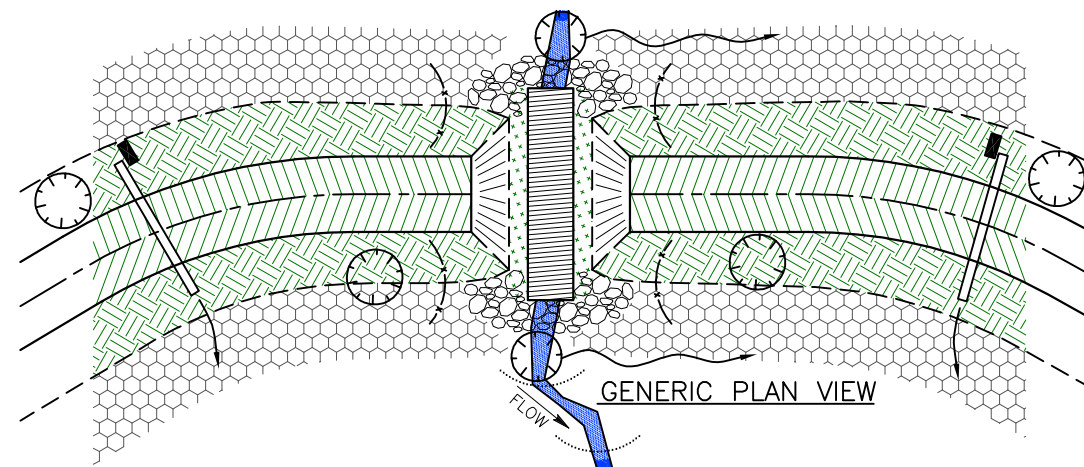
An emergency supply of sediment control materials will be available on-site which may include; silt fencing, geotextile, tarps, sand bags, seed, straw bales and volume pumps with discharge hose.

If works are temporarily suspended due to heavy precipitation, the site will be monitored during the shutdown period to ensure environmental concerns are adequately addressed.

Should unanticipated site conditions or unseasonably wet weather be encountered during construction, the BC Timber Sales representative will be immediately contacted to reassess the project. If increased environmental risk is perceived, site specific plans/measures may be required.

7.0 Inspection and Maintenance

During construction, regular inspections of the BMPs will be made, especially after heavy precipitation events. If any measure is not functioning as intended, it will be immediately repaired/replaced. All inspections and actions shall be documented.



PROJECT TITLE		BCTS-SECP-C		DESIGNED BY: BAA, RPBio	
PROJECT LOCATION(S)				CHECKED BY: RT, BCTS E.O.	
DATE		DRAWING NAME:		REV.:	
		02/05/06		WG	
NAME		SIGNATURE		DATE ISSUED:	
BCTS REPRESENTATIVE				DWB Forestry Services Ltd. 1A, 1750 Quinn Street Prince George, B.C. V2N 1X3 Phone: (250) 562-5541 Fax: (250) 562-5561	
CONTRACTOR					

WING DITCHES

Instructions for installation

Excavate wing ditches to direct flow out of ditch lines to avoid accumulation of water/velocity causing sediment mobilization.

Construct below ditch grade as wing ditches are gravity fed.

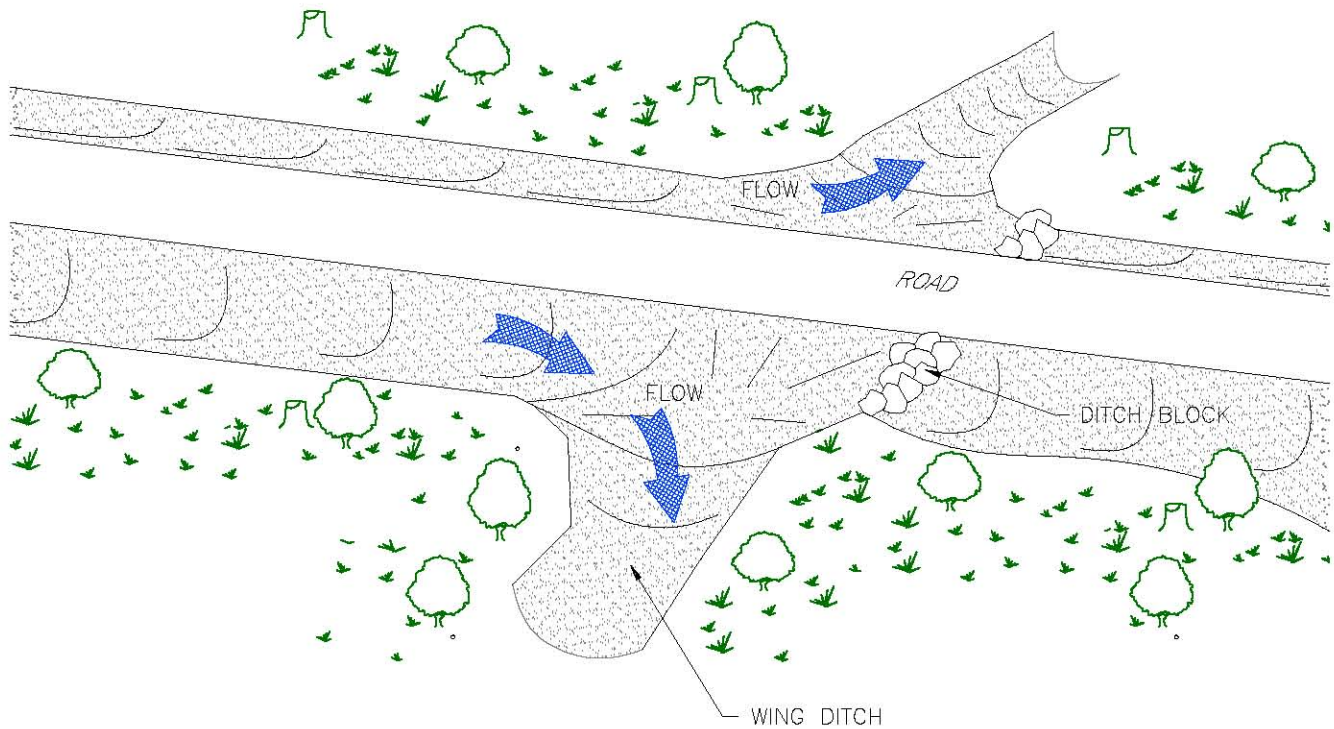
Install as many as terrain allows.

Measures must be taken to ensure that the slopes are capable of withstanding the drainage directed at them. This can be done by lining the ditch (page 2), installing check dams to slow flows (page 3), or armouring outlets where heavy flows are anticipated (page 8).

May be associated with cross drains in some cases to get rid of water from both ditch lines.

Inspection/Maintenance

Ensure wing ditch is functioning properly during periods of heavy flow within ditch lines. Excavate/remove debris as necessary.



SEEDING/MULCHING

Instructions For Installation

Select approved seed mixture (BCTS standard forestry reclamation mixture) for the geographic location as specific grass species have higher success of germination rates than others. Apply grass seed after surface roughening using a broadcast seeder, which will distribute seeds evenly over the entire area. Apply seed to manufacturers specifications to a minimum of 80% pure live seed [PLS] (usually displayed on seed bag). Seed all disturbed soils.

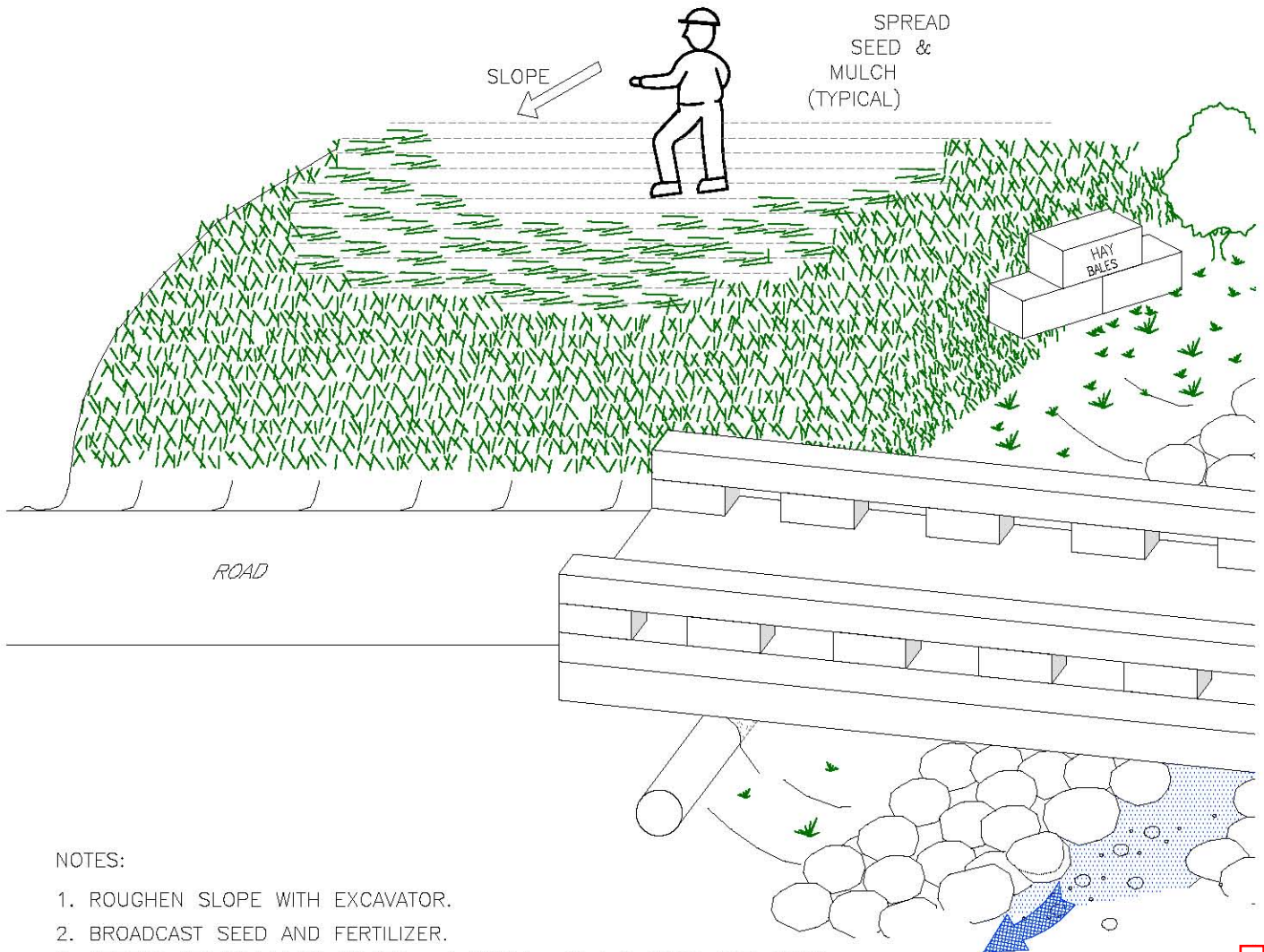
Do not over-seed, as competition for nutrients will occur decreasing the overall health of all established grasses.

Fertilize exposed soils with 18-18-18 at 300kg/hr. Do not fertilize in the riparian management area of any stream or any direct conveyance to a stream.

After seeding and fertilization, hand mulch all exposed soils. Break bales and scatter over soils to prevent seed from washing away prior to germination. Hay mulch should not be applied more than 5cm deep on seeded sites and should cover at least 80% of the soil surface.

Inspection/Maintenance

Inspect seeded sites during the growing season to ensure germination success of applied seed. Any areas where grass failed to establish should be re-seeded.



NOTES:

1. ROUGHEN SLOPE WITH EXCAVATOR.
2. BROADCAST SEED AND FERTILIZER.
3. SPREAD STRAW MULCH 3" (76mm) THICK. (2 1/2 TONS PER ACRE)

ARMOR INLET & OUTLET OF CMP (NON-FISH BEARING STREAM)

Instructions For Installation

Inlets and Outlets of CMPs should be armored accordingly based on the size and flow regime of the drainage. Drainages that exhibit heavy flows should be heavily armored with assorted rip rap, boulders and cobbles.

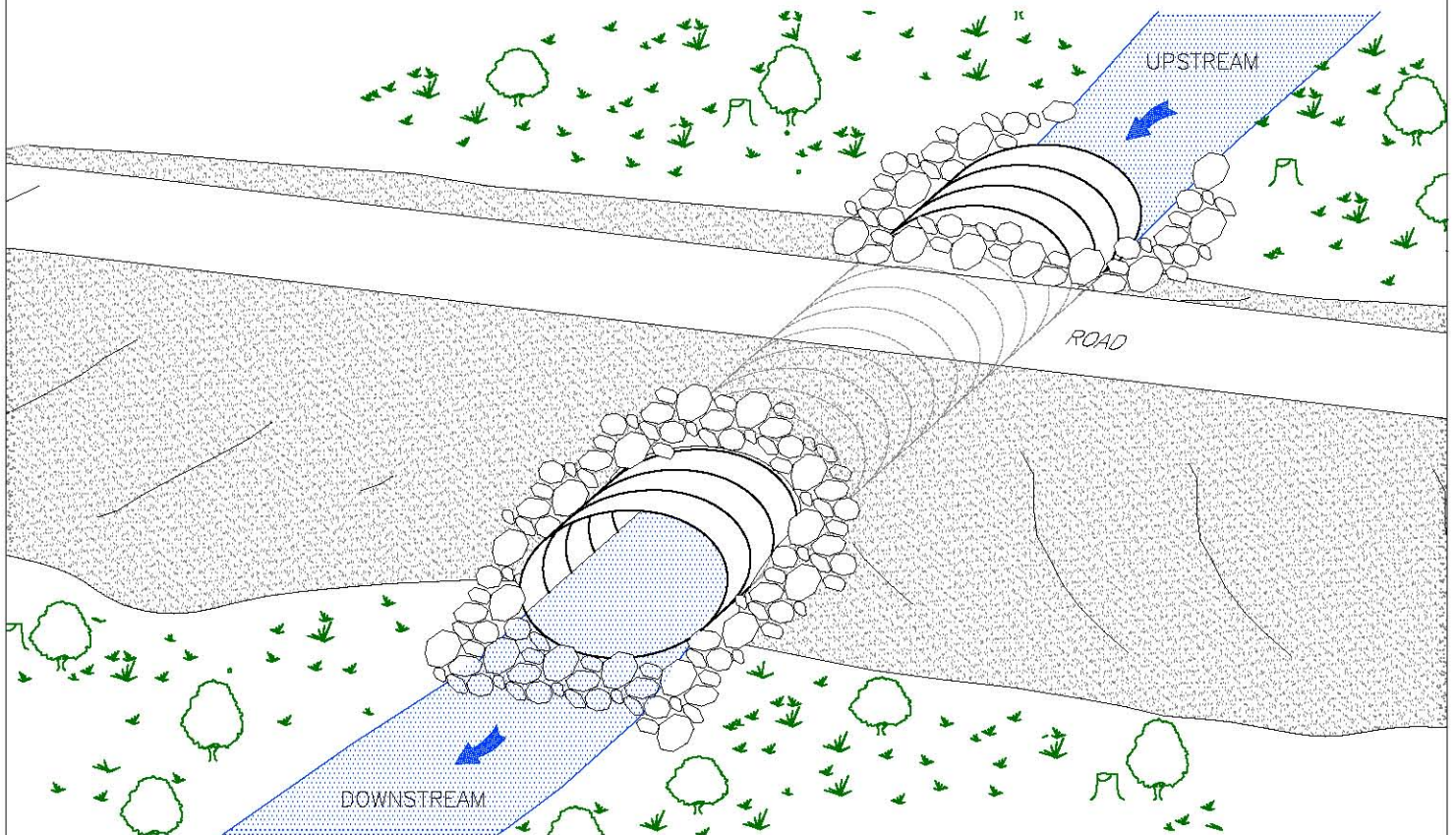
Place large angular substrates (if available) around inlet and outlet of CMP tight to stream bed. Fill holes with smaller materials once leading edge has been installed. Ensure armor is tight to CMP around inlet and outlet to prevent erosion (inlet) and undermining during high flows.

Place smaller substrates within stream channel at outlet of CMP to provide additional armoring.

Ensure geotextile collar is installed at inlet of CMP to prevent piping and undermining.

Inspection/Maintenance

Inspect armor after significant rain events and make necessary repairs. Ensure woody debris does not block inlet flow, clean as necessary.



SURFACE ROUGHENING

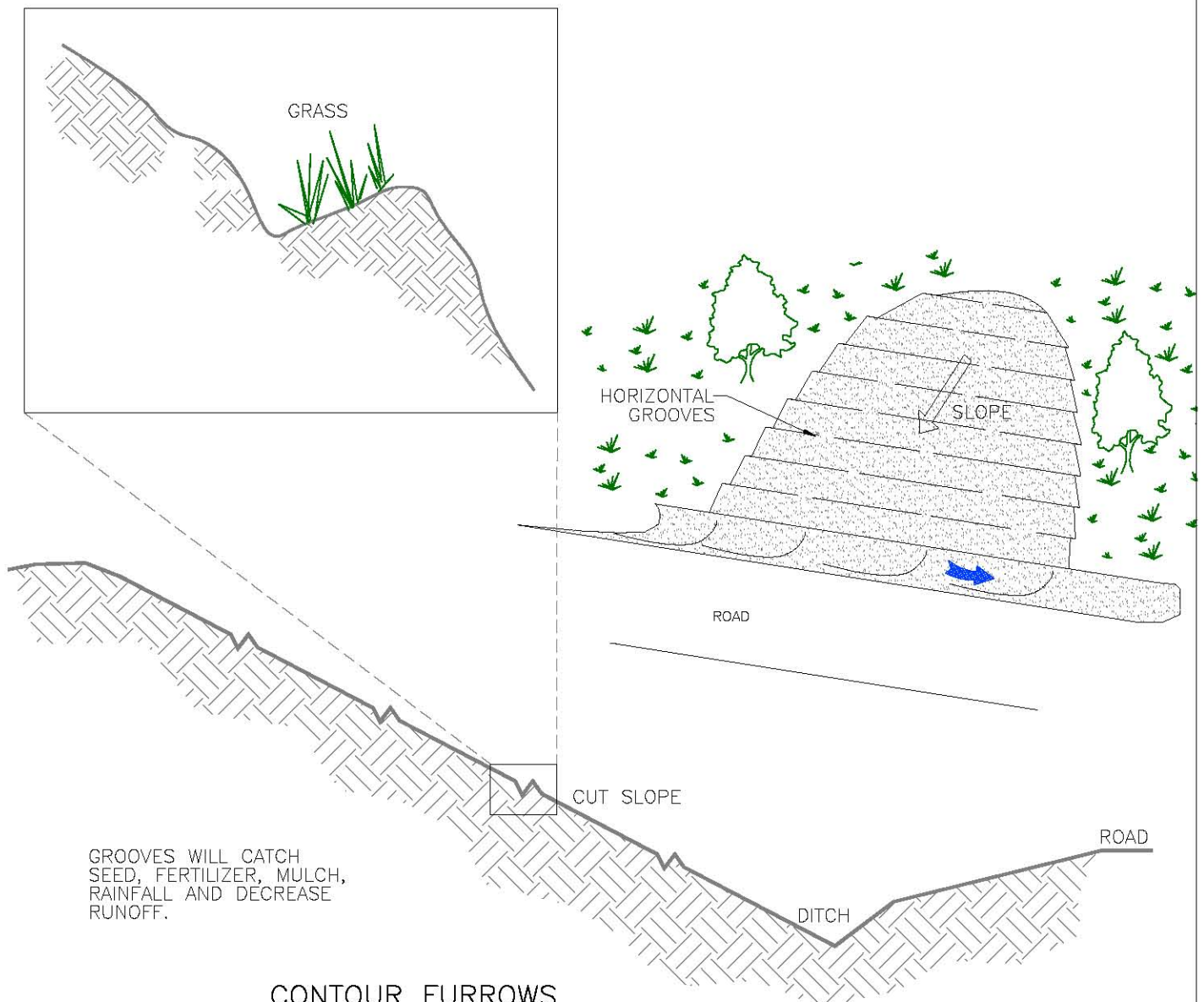
Instructions for installation

Roughen disturbed slopes creating deep grooves to catch the seed/fertilizer. Allows vegetation to establish on steep slopes. Prevents rainfall/runoff from washing seeds (prior to germination) off slopes.

Roughening can be achieved using the bucket of an excavator by swinging the bucket horizontal along the slope gently creating grooves with the leading edge of the bucket (surface roughen serrate slope between furrows).

Inspection/Maintenance

Inspect roughened slopes to ensure large scale slumping is not evident (after large rain events). If slumping is evident remove slumped materials from the toe of the slope and re-seed as necessary.



CONTOUR FURROWS

Know your soils

Table 1. Size range of coarse fragment and fine earth particles

Soil category	Common name	Example of size ^a
Coarse fragment	Boulders	Larger than bowling ball
	Cobbles	Grapefruit
	Gravels - coarse	Orange or lemon
	- medium	Grape or pea
	- fine	Rock salt
	Sands - coarse	Sugar
	- medium	Table salt
	- fine	Icing sugar
Fine earth	Silts	Not visible. Use “feel” test to distinguish between silts and clays.
	Clays	

^a Examples taken from B.C. Ministry of Forests (2002).

- Fine earth portion:
 - harder to identify
 - has higher erosion potential

- Coarse fragments:
 - are easily identified
 - not many erosion issues

Table 2. Relative soil erodibility for fine earth portion of soil^a

Surface soil texture	Risk of water-caused erosion
Very fine sand	
Loamy very fine sand	
Silt loam	
Very fine sandy loam	
Silty clay loam	
Clay loam	
Loam	
Silty clay	
Clay	
Sandy clay loam	
Heavy clay	
Sandy loam	
Loamy fine sand	
Fine sand	
Coarse sandy loam	
Loamy sand	
Sand	

^a Adapted from Wall et al. (2002).

Know your erosion hazard

Table 5. Detailed erosion hazards (low, moderate, severe) by soil type and slope^a

Texture	Material	Slope (%)														
		0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75
Coarse	Sandy gravels	L	L	L	L	L	L	L	M	M	M	M	M	S	S	S
	Gravelly sands	L	L	L	L	L	L	L	M	M	M	M	M	S	S	S
	Gravels	L	L	L	L	L	L	L	M	M	M	M	M	S	S	S
Moderately coarse	Sand	L	L	L	L	L	L	M	M	M	S	S	S	S	S	S
	Loamy sand	L	L	L	L	L	L	M	M	M	S	S	S	S	S	S
	Sandy loam	L	L	L	L	L	L	M	M	M	S	S	S	S	S	S
	Fine sandy loam	L	L	L	L	L	L	M	M	M	S	S	S	S	S	S
	Gravelly sandy loam	L	L	L	L	L	L	M	M	M	S	S	S	S	S	S
	Gravelly loamy sand	L	L	L	L	L	L	M	M	M	S	S	S	S	S	S
Moderately fine	Loam	L	M	M	M	S	S	S	S	S	S	S	S	S	S	S
	Silt loam	L	M	M	M	S	S	S	S	S	S	S	S	S	S	S
	Silt	L	M	M	M	S	S	S	S	S	S	S	S	S	S	S
	Sandy clay loam	L	M	M	M	S	S	S	S	S	S	S	S	S	S	S
	Clay loam	L	M	M	M	S	S	S	S	S	S	S	S	S	S	S
	Silty clay loam	L	M	M	M	S	S	S	S	S	S	S	S	S	S	S
Fine	Sandy clay	L	L	M	M	M	S	S	S	S	S	S	S	S	S	S
	Clay	L	L	M	M	M	S	S	S	S	S	S	S	S	S	S
	Silty clay	L	L	M	M	M	S	S	S	S	S	S	S	S	S	S
	Heavy clay	L	L	M	M	M	S	S	S	S	S	S	S	S	S	S

Table 5 shows:

- By soil type
- By slope

Layout and field notes:

- Terrain or field indicators - i.e. long continuous slopes vs. benches and breaks

^a From Carr (1982).

CROSS DITCH

Instructions For Installation

Cross ditches should be installed back from the stream channel across the road prior to the riparian zone of the stream. Ensure sufficient length to prevent passage of surface flow down road grade to deactivated crossing.

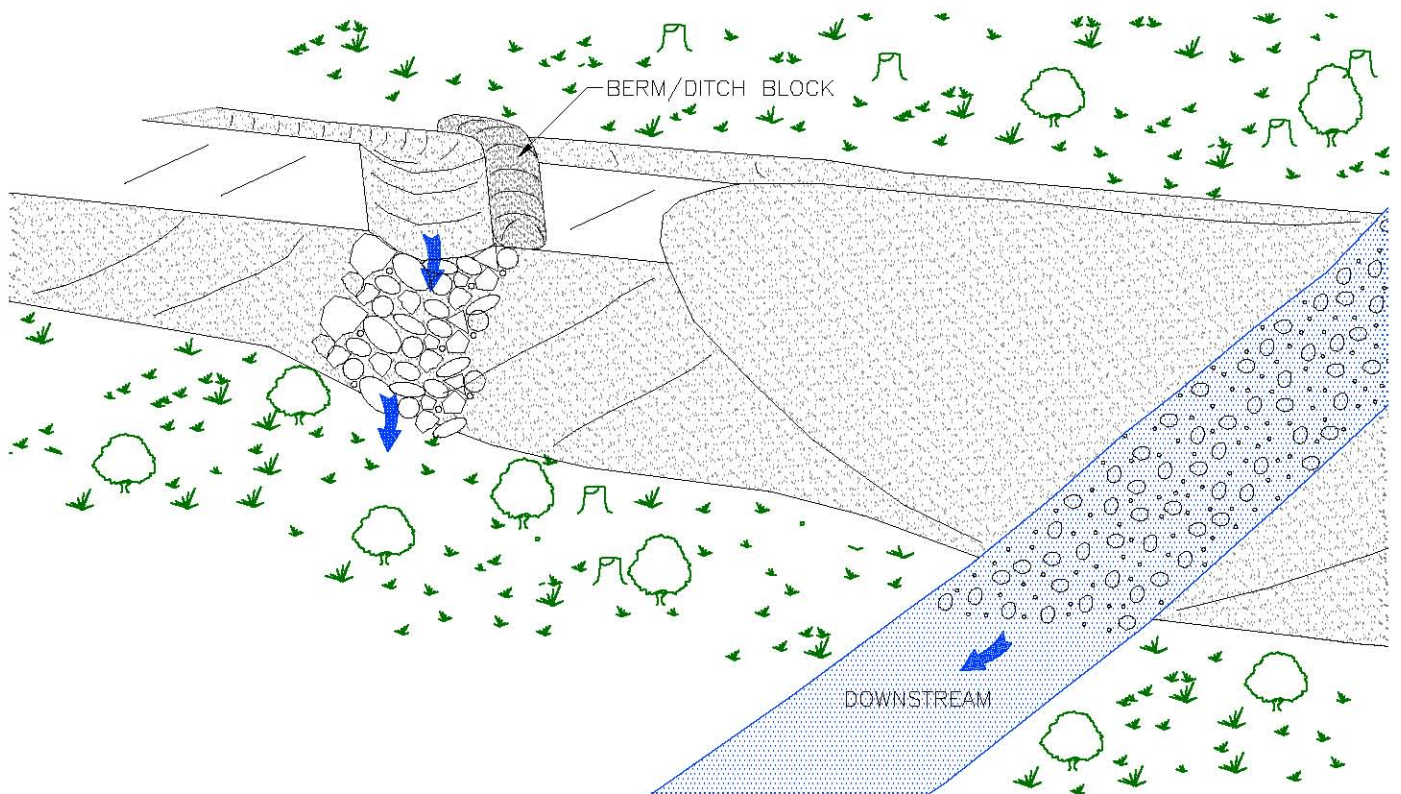
Should be installed in areas where road grade slopes towards crossing. Ensure that the slope below the outlet of the drainage structure is stable, and armour where necessary.

Cross ditch should be excavated to well below the original grade. It should be skewed so that water flowing through it is not slowed down or made to abruptly change direction, therefore steeper roads require more skew. Ditch gradient should be installed at a minimum of 2%. For ditch lining specifications refer to page 2 and for outlet armouring refer to page 8.

Maintenance/Inspection

Should be inspected periodically to ensure measure is functioning properly and not contributing sediment to the stream crossing.

Fix or replace any damaged sections with suitable materials.



WATERBAR

Instructions for installation

Excavate road fill materials across entire road surface to facilitate drainage of flows on the surface of the road. Ensure vehicular access is maintained as well as slope stability below the waterbar.

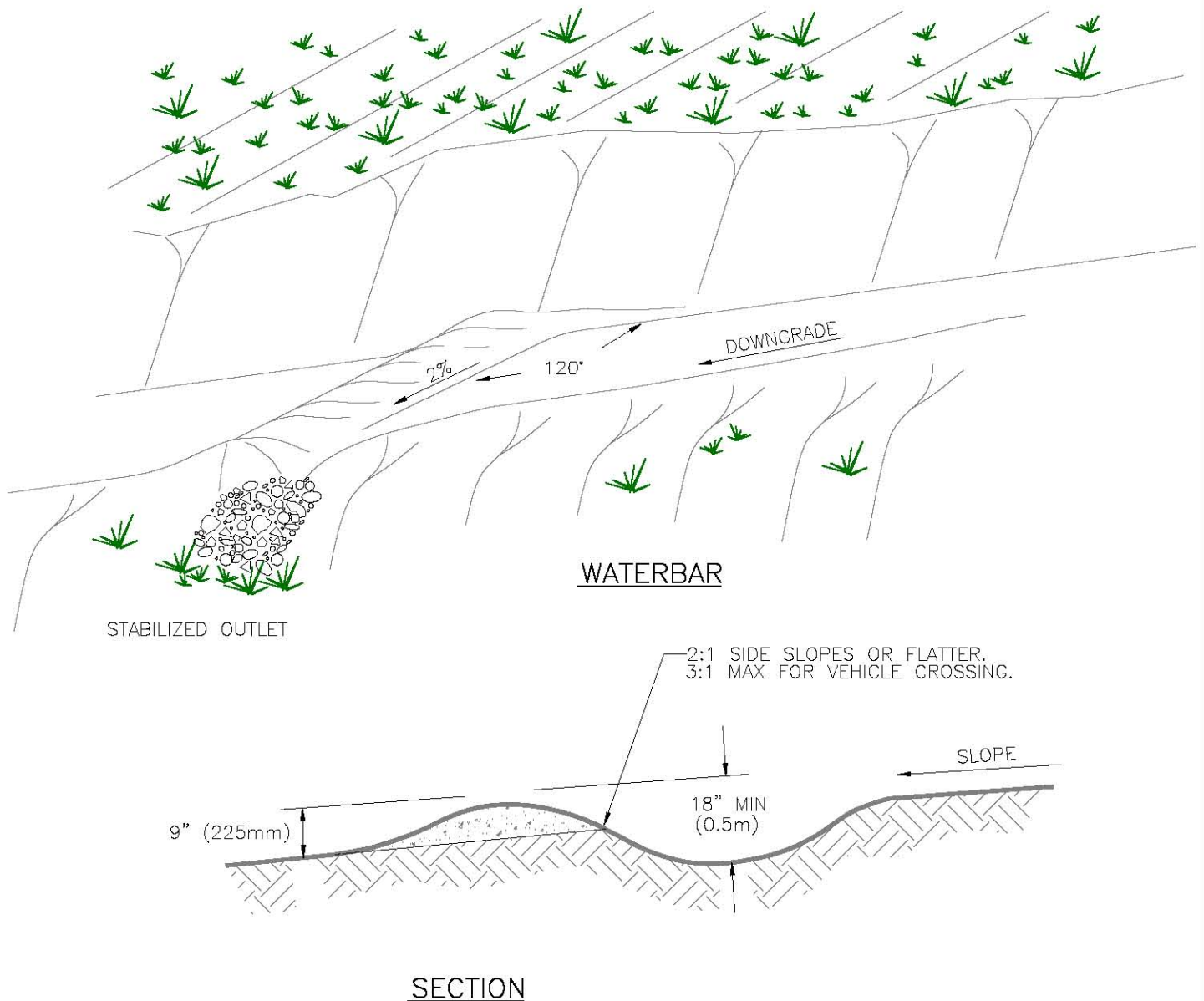
Fills from waterbar are deposited immediately down grade forming a berm.

Armour as necessary after considering the materials present and the slope stability below the waterbar.

Ensure the waterbar does not transfer water out of the ditch line, just off of the roadway.

Inspection/Maintenance

Inspect during heavy precipitation events to ensure dimensions of structure are sufficient to remove all flows off road grade.



DE-COMPACT ROAD SURFACE

Instructions For Installation

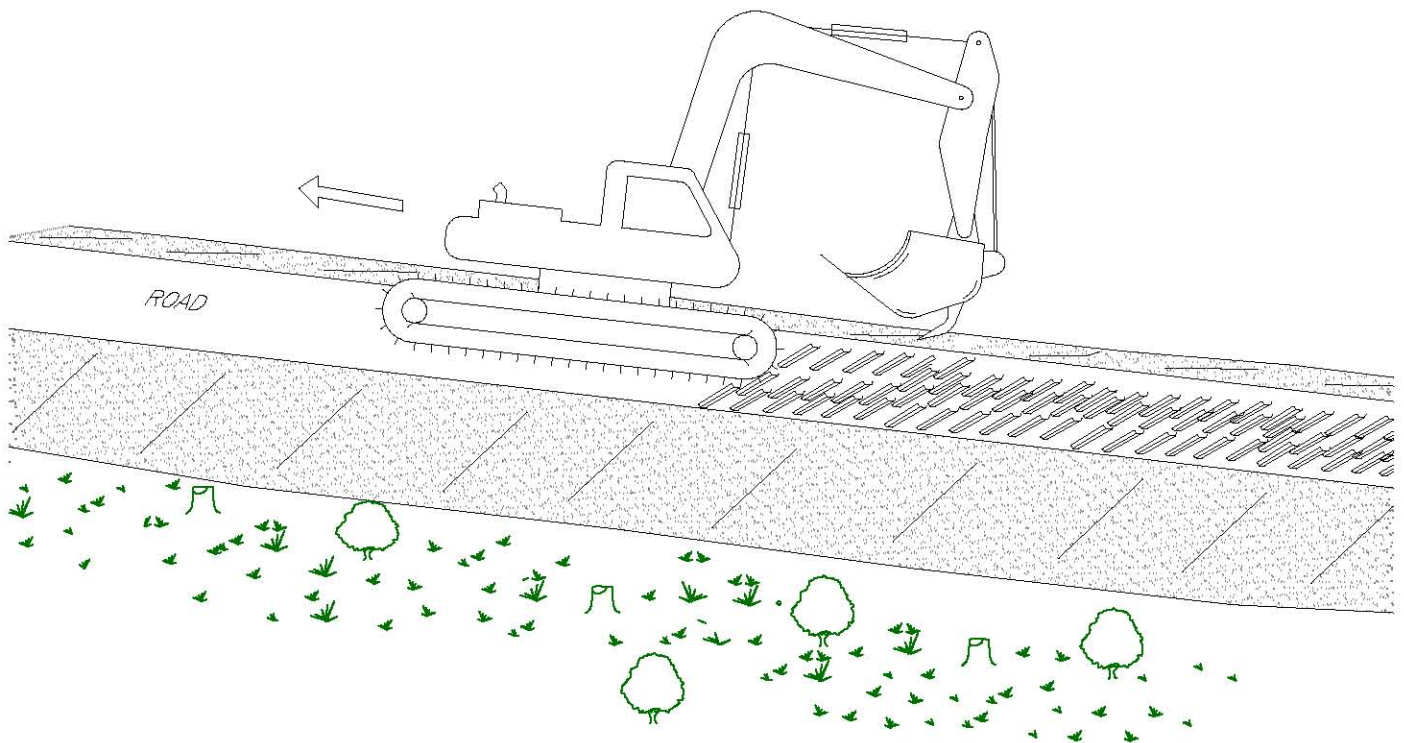
Loosen compacted fills within the existing road grade to provide a suitable growing medium (rooting success) for trees and plants prescribed for planting. This encourages water to penetrate the old road surface allowing establishment of vegetation. The depth of excavation/decompaction should reflect planting objectives (increase depth if trees are scheduled for planting).

Excavator bucket/thumb/ripper, or bulldozer with ripper can be used to loosen road surface as deactivation is carried out.

Planting, seeding and mulching should be carried out immediately after de-compaction is complete.

Inspection/Maintenance

Deactivated road surface should be inspected to ensure establishment of vegetation is successful and no significant sedimentation or erosion is occurring. Replant areas where vegetation failed to establish and mitigate for erosion if evident.



SILT FENCE

Instructions for Installation

Silt fence shall be placed on the slope contours to maximize ponding efficiency.

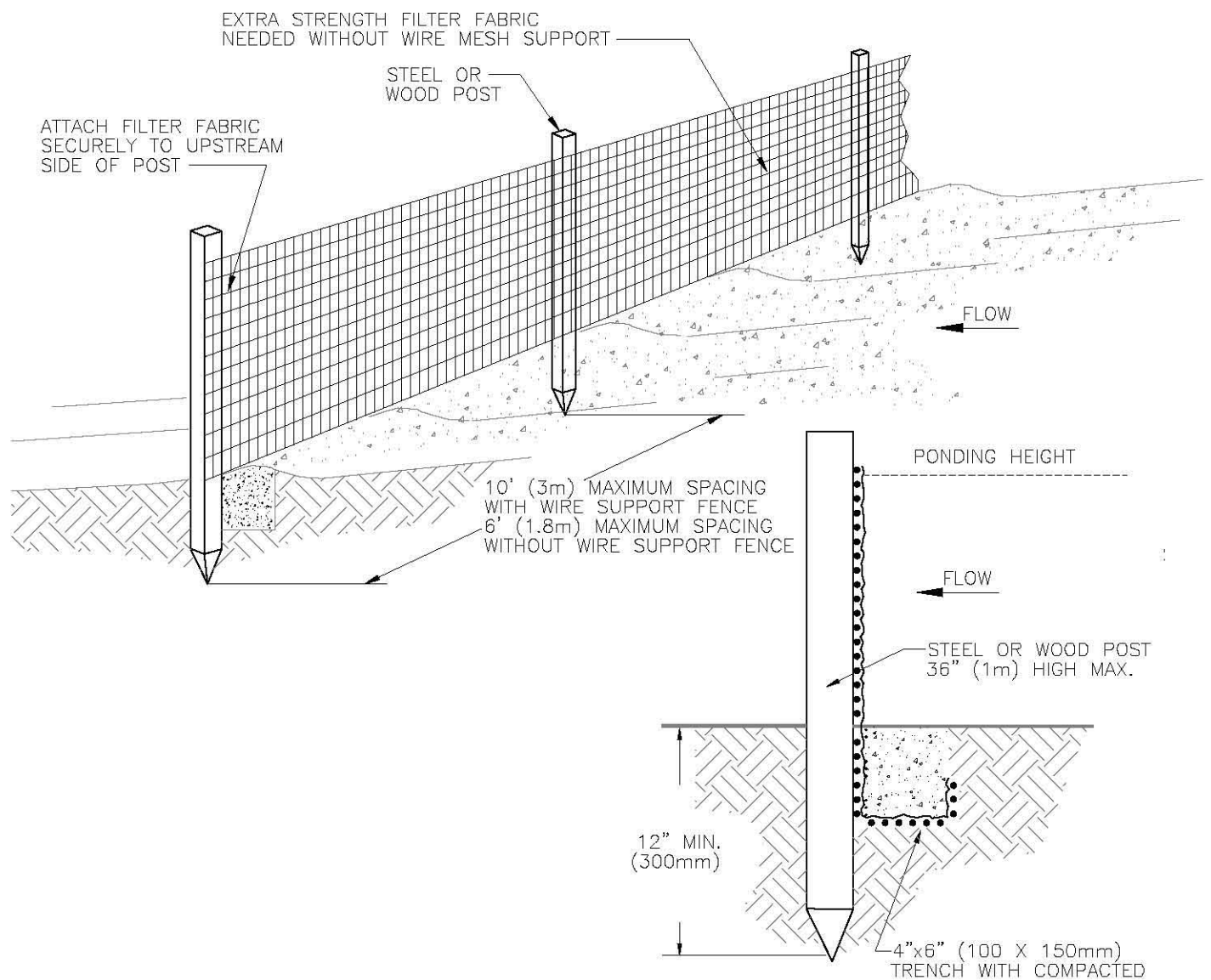
Inspect and repair fence after each storm event and remove sediment when necessary. Maximum storage height is 225.

Removed sediment shall be deposited to an area that will not contribute to sediment off-site and can be permanently stabilized.

The silt fence is a temporary feature that must be removed from the site once sufficient vegetation has been established.

Inspection/Maintenance

Ensure silt fence is not clogged (clean as necessary) and remains upright (as installed) after heavy rain events.



TRENCH DETAIL

IN-STREAM SEDIMENT CURTAINS (NON-FISH BEARING STREAMS)

Instructions For Installation

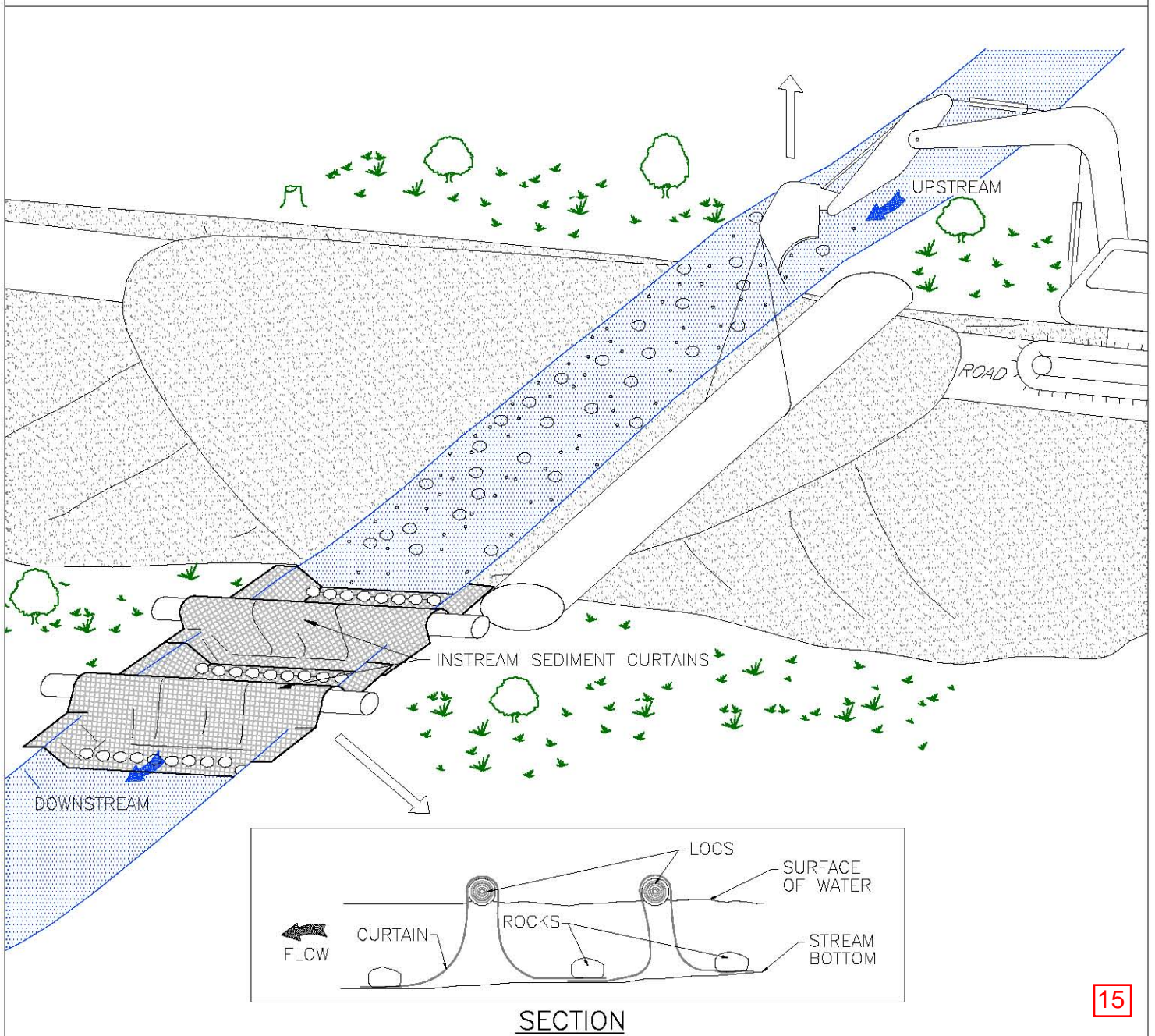
Install immediately below CMP installation location (if flows present). Ensure the bottom edge of the filter cloth is sealed to stream bed with hard substrates and across the entire wetted width of the stream channel.

Drape fabric across material (log/lumber) long enough to span the width of the stream channel. Ensure material is of sufficient strength to support wet filter fabric.

This is a very temporary measure. Do not leave in place too long as fabric will become clogged causing failure/sediment delivery to stream.

Inspection/Maintenance

Filter fabric should be maintained/cleaned if substantial sediment accumulation is noted. Fabric should be removed and disposed of after CMP installation is complete/sediment source has been eliminated.



SEDIMENT DIAPER INSTALLATION

Instructions For Installation

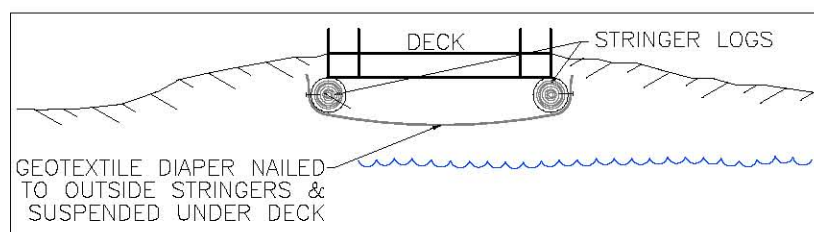
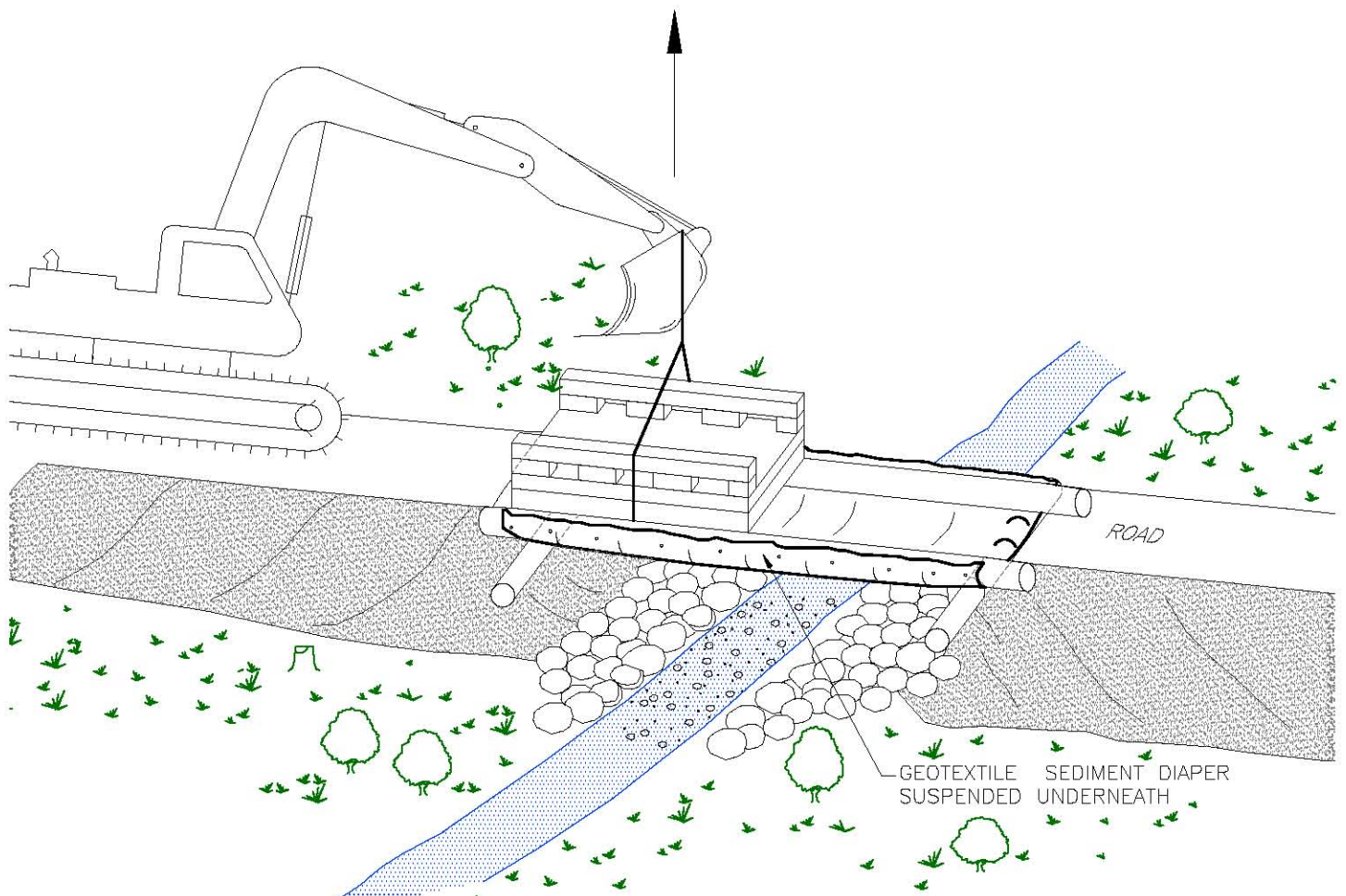
Cut large piece of geotextile fabric/poly large enough to cover the underside of the existing crossing structure. Fasten to outer stringer logs with nails and wrap under structure to opposite stringer log.

Prior to removing structure, sweep sediments off bridge deck. Carefully lift decking off support structures. Next, remove inner stringers first with sediment diaper still fastened to outer stringers. Finally roll outer stringers together with sediment diaper included. Lift entire unit clear from the stream and away from the channel. Remove diaper once decking is out of the riparian zone of the stream.

Inspection/Maintenance

Replace fabric if damage is apparent.

Ensure sediment diaper is securely attached to log stringers or secured to terrain below (steel bridge). Inspect diaper for damage prior to removal of additional modules if present.



CROSS SECTION VIEW

SETTLING BASIN

Instructions For Installation

Construct basin within ditch line where increased gradients are present in areas where ditch lines are anticipated to exhibit fluctuating flows. Basin should be excavated deeper than the existing ditch line.

Typical install at base of through-cut where no potential exists to divert water to forest before it enters the watercourse.

Should be installed in conjunction with wing ditch. The wing ditch should be connected with the settling basin approximately half way up. This will prevent the basin from overflowing while allowing particles to fall out of suspension.

The settling basin should have a length to width ratio of 2:1. Ensure one end of the basin has a lower lip to allow partial flows to leave basin once settling has occurred. Armor outlet of basin as required. The size of the basin should be consistent with the anticipated flows (i.e. long steep uninterrupted ditch lines with no wing ditches require much larger basins [5–6m] than ditches with low gradients and little expected flows [2–3m]).

In higher rise sites, settling basins may be constructed in series for maximum settling time.

Inspection/Maintenance

In areas where heavy silt loads are present within the ditches, the settling basin should be re-excavated to remove accumulated sediments. This should occur once the basin is half full.

