APPENDIX C

EROSION AND SEDIMENTATION CONTROL BEST MANAGEMENT PRACTICES (BMP)

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DRAWING LISTING

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Table C-1: Erosion Control Measures - Protection of Exposed Surface

BMP #	BMP Name	Applications				Comments	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
25	Topsoiling	X	X	X	X	Placing topsoil provides excellent medium for vegetation root structure to develop in; organic content promotes plant growth, reuse organics (topsoil or peat) stripped from the site at start of grading; absorb raindrop energy to minimize erosion potential	Cannot be effective without seeding and allowing time for plant growth; not appropriate for slopes steeper than 2H:1V (steep slopes will require soil covering over topsoil and specialized design); dry topsoil susceptible to wind erosion, susceptible to erosion prior to establishment of vegetation
22	Seeding	X	X	X	X	Inexpensive and relatively effective erosion control measure, effectiveness increases with time as vegetation develops, aesthetically pleasing, enhances terrestrial and aquatic habitat	Must be applied over prepared surface (topsoiled), grasses may require periodic maintenance (mowing), uncut dry grass may be a fire hazard, seeding for steep slopes may be difficult, seasonal limitations on seeding effectiveness may not coincide with construction schedule, freshly seeded areas are susceptible to runoff erosion until vegetation is established, reseeding may be required for areas of low growth
23	Mulching	X	X	X	X	Used alone to protect exposed areas for short periods, protects soil from rainsplash erosion, preserves soil moisture and protects germinating seed from temperature extremes, relatively inexpensive measure of promoting plant growth and slope protection	Application of mulch on steep slopes may be difficult, may require additional specialized equipment not commonly used in typical highway construction
24	Hydroseeding - Hydromulching	X	X	X	X	Economical and effective on large areas, mulch tackifier may be used to provide immediate protection until seed germination and vegetation is established, allows re-vegetation of steep slopes where conventional seeding/mulching techniques are very difficult, relatively efficient operation, also provides dust and wind erosion control	Site must be accessible to hydroseeding-hydromulching equipment (usually mounted on trucks with a maximum hose range of approximately 150 m), may require subsequent application in areas of low growth as part of maintenance program
26	Sodding	X	X	X	X	Provides immediate vegetation and protection, instant buffer strip and/or soft channel lining, can be used on steep slopes, relatively easy to install, may be repaired if damaged, aesthetically pleasing	Expensive, labour intensive to install (hand installation), sod may not be readily available in all areas of the province, relatively short 'shelf-life' (sod can't be stored on-site for excessive periods of time)
14	Riprap Armoring	X	X			Most applicable as channel lining with geotextile underlay, used for soils where vegetation not easily established, effective for high velocities or concentrations, permits infiltration, dissipates energy of flow from culvert inlets/outlets, easy to install and repair, very durable and virtually maintenance free, flexible lining for ditches with ice build-up	Expensive, may require heavy equipment to transport rock to site and place rock, may not be feasible in areas of the province where appropriate rock is not readily available, may be labour intensive to install (hand installation); generally thickness of riprap is higher when compared to gabion mattress
16	Gravel Blankets	X	X			Stabilizes soil surface with rock lining thus minimizing erosion, permits construction traffic in adverse weather, may be used as part of permanent base construction of paved areas, easily constructed and implemented, can be used to stabilize seepage piping erosion of slope	Must be designed by qualified geotechnical personnel, expensive, may not be feasible in areas of the province where gravel is not readily available, areas of high groundwater seepage may require placement of non-woven geotextile underlay and additional drainage measures
13	Rolled Erosion Control Products (RECP)	X	X			Provides a protective covering to bare soil or topsoiled surface where degree of erosion protection is high, can be more uniform and longer lasting than mulch, wide range of commercially available products	RECP use must be based on design need and risk assessment of site, certification on QA/QC of RECP products must be issued by the AT approved supplier on pre-approved products, certification of physical properties and performance criteria (tractive resistance) is required (permissible velocities can be provided as reference), labour intensive to install, temporary blankets may require removal prior to restarting construction activities, RECP not suitable for rocky slopes, proper site preparation is required to seat RECP onto soil correctly; high performance is tied to successful vegetation growth
15	Cellular Confinement System	X			X	Lightweight cellular system and easily installed, uses locally available soils or grout for fill to reduce costs,	Not readily used in Alberta highway construction, expensive, installation is labour intensive (hand installation), not suitable for slopes steeper than 1H:1V

Table C-1: Erosion Control Measures - Protection of Exposed Surface

BMP #	BMP Name	Applications				Comments	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
27	Planting Trees and Shrubs	X		X	X	Establishes vegetative cover and root mat, reduces flow velocities on vegetative surface, traps sediment laden runoff, aesthetically pleasing once established, grows stronger with time as root structure develops, usually has deeper root structure than grass	Expensive, may be labour intensive to install, not readily used in Alberta highway construction projects, revegetated areas are subject to erosion until plants are established, plants may be damaged by wildlife, watering is usually required until plants are established
29	Chemical Stabilization	X	X		X	Increase cohesion of soil thus reduces soil moisture evaporation and erosion, easily applied, may be applied in conjunction with hydroseeding-hydromulching, longevity increases as application rate increases	Not commonly used in highway construction projects, may be expensive, site must be accessible to spraying equipment, may require specialized equipment, temporary measure only, higher application rates may prevent seed germination and growth, crust-forming chemical stabilizers may crack during freeze-thaw cycles, requires specialized design
30	Riparian Zone Preservation	X	X	X	X	Preserve a native vegetation buffer to filter and slow runoff before entering sensitive (high risk) areas, most effective natural sediment control measure, slows runoff velocity, filters sediment from runoff, reduces volume of runoff on slopes	Stipulate construction activities with careful planning to include preservation areas, freshly planted vegetation for newly created riparian zones requires substantial periods of time before they are as effective as established vegetation at controlling sediment
32	Scheduling	X	X	X	X	Identifies protection issues and plans for efficient, orderly construction of BMPs; minimizes bare soil exposure and erosion hazard; allows early installation of perimeter control for sediment entrapment; and early installation of runoff control measures; good construction practice	
34	Slope Texturing	X			X	Roughens slope surface to reduce erosion potential and sediment yield; suitable for clayey soils	Additional cost; not suitable for silty and sandy soils; not practical for slope length <8 m for dozer operation up/down slope

Table C-2: Erosion Control Measures - Control of Runoff

BMP #	BMP Name	Applications				Comments	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
34	Slope Texturing	X		X	X	Contouring and roughening (tracking) of slope face reduces runoff velocity and increases infiltration rates; collects sediment; holds water, seed and mulch better than smooth surfaces; promotes development of vegetation, provides loss of soil reduction in soil erosion compared with untracked slopes	May increase grading costs, may cause sloughing in sensitive (wet) soils, tracking may compact soil, provides limited sediment and erosion control and should not be used as primary control measure
21	Offtake Ditch	X		X	X	Collects and diverts sheet flow or runoff water at the top of a slope to reduce downslope erosion potential, incorporated with permanent project drainage systems	Channel must be sized appropriately to accommodate anticipated flow volumes and velocities, lining may be required, may require design by qualified personnel, must be graded to maintain positive drainage to outlets to minimize ponding
17	Energy Dissipator	X	X			Rip rap or sandbags slow runoff velocity and dissipate flow energy to non-erosive level in relatively short distances, permits sediment collection from runoff	Small diameter rocks/stones can be dislodged; grouted rip-rap armouring may breakup due to hydrostatic pressures, frost heaves, or settlement; may be expensive, may be labour intensive to install; may require design by qualified personnel for extreme flow volumes and velocities
19	Slope (Down) Drains	X				Directs surface water runoff into drain pipe instead of flowing over and eroding exposed soils of slope face	Pipes must be sized appropriately to accommodate anticipated flows, erosion can occur at inlet/outlet if protection is not incorporated into design, slope drain must be anchored to slope
2	Gabions		X			Relatively maintenance free, permanent drop structure, long lasting (robust), less expensive and thickness than rip-rap, allows smaller diameter rock/stones to be used, relatively flexible, commercially available products, commonly used in Alberta highway construction projects; suitable for resisting high flow velocity	Construction may be labour intensive (hand installation), extra costs associated with gabion basket materials
7	Rock Check Dam		X		X	Permanent drop structure with some filtering capability, cheaper than gabion and armouring entire channel, easily constructed, commonly used in Alberta highway construction projects	Can be expensive in areas of limited rock source, not appropriate for channels draining areas larger than 10 ha (4 acres), requires extensive maintenance after high flow storm events, susceptible to failure if water undermines or outflanks structure
8	Aggregate Filled Sand Bag Check Dam		X		X	More effective as energy dissipator to slow flow velocities, cheaper than gabions or armouring entire ditch, easily constructed and reusable	Not appropriate for channels draining areas larger than 2 ha (5 acres), requires extensive maintenance after high flow storm events, low filtering capabilities, labour intensive to install (hand installation), temporary measure only
9	Log Check Dam		X			Equally effective as silt fences for sediment trapping and straw bale barriers as drop structure, may include timber salvaged from site during clearing operations, most applicable at clearing/grubbing stages of construction	May be expensive, not commonly used after stripping stage, not appropriate for channels draining areas larger than 4 ha (10 acres), labour intensive to construct, gaps between logs may allow sediment laden runoff to escape, logs/timbers will rot over time (not permanent)
11	Straw Bale Check Dam		X		X	Temporary drop structures appropriate for channel slopes with 3% to 5% grades, straw bales are readily available in most areas of the province, biodegradable	Temporary measure only; not appropriate for: channels draining areas larger than 2 ha (5 acres), channels steeper than 5%, and/or flow velocities greater than 0.3 m/s; requires extensive maintenance after high flow storm events, must be installed by hand with keying and staking; maximum height of one straw bale
10	Synthetic Permeable Barriers		X			Reusable/moveable, reduces flow velocities and dissipate flow energy; retains some sediments; used as grade breaks in conjunction with sturdy permanent drop structures along steep grades	Not to be used as check structures, must be installed by hand in conjunction with RECP, become brittle in winter and are easily damaged by construction equipment or recreational vehicles, only partially effective in retaining some sediment, primarily used for reducing flow velocities and energy dissipation

Table C-2: Erosion Control Measures - Control of Runoff

BMP #	BMP Name	Applications				Comments	
		Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
20	Groundwater Control (Subsurface Drain)	X				Relief subsurface groundwater seepage and winter ice build-up; lower groundwater table to minimize piping erosion; enhance slope stability performance	Requires design by a geotechnical engineer; can be a slope instability issue
28	Fibre Rolls and Wattles	X				Function well in freeze-thaw conditions, low cost solution to sheet flow and rill erosion on slopes, low to medium cost flow retarder and silt trap, can be used on slopes too steep for silt fences or straw bale barriers, biodegradable	Labour intensive to install (hand installation), designed for slope surfaces with low flow velocities, designed for short slope lengths with a maximum slope of 2H:1V, not widely used on Alberta highway construction projects
32	Scheduling	X	X	X	X	Identifies protection issues and plans for efficient, orderly construction of BMPs; minimizes bare soil exposure and erosion hazard; early installation of perimeter control for sediment entrapment; and early installation of runoff control measures; good construction practice	

Table C-3: Sediment Control Measures

BMP #		BMP Name	Applications				Comments	
			Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile	Advantages	Limitations
30	Filtering and Entrapment	Riparian Zone Preservation	X	X	X	X	Preserve a native vegetation buffer to filter and slow runoff before entering sensitive (high risk) areas, most effective natural sediment control measure, slows runoff velocity, filters sediment from runoff, reduces volume of runoff on slopes	Stipulate construction activities with careful planning to include preservation areas, freshly planted vegetation for newly created riparian zones requires substantial periods of time before they are as effective as established vegetation at controlling sediment
12		Straw Bale Barrier			X	X	Relatively inexpensive if bales are locally available, biodegradable, cheaper and easier to install than other barriers	Short service life due to biodegradation, straw bales may not be readily available in all areas of the province, maximum barrier height of one straw bale, require extensive maintenance after high flow storm events, require proper keying and staking
3		Brush or Rock Filter Berm	X	X	X	X	More effective than silt fences, uses timber and materials salvaged from site during clearing and grubbing, can be wrapped and anchored with geotextile fabric envelope	More expensive than silt fences, temporary measure only, not effective for diverting runoff, expensive to remove, not to be used in channels or ditches with high flows
28		Fibre Rolls and Wattles	X				Function well in freeze-thaw conditions, low cost solution to sheet flow and rill erosion on slopes, low to medium cost flow retarder and silt trap, can be used on slopes too steep for silt fences or straw bale barriers, biodegradable	Labour intensive to install (hand installation), designed for slope surfaces with low flow velocities, designed for short slope lengths with a maximum slope of 2H:1V, not widely used on Alberta highway construction projects
31		Pumped Silt Control Systems (Silt Bags)		X			Filter bag is lightweight and portable, simple set up and disposal, sediment-laden water is pumped into and contained within filter bag for disposal, different aperture opening sizes (AOS) available from several manufacturers; for emergency use only under overflow conditions	May be expensive, requires special design needs for use, not readily used in Alberta highway construction projects, requires a pump and power source for pump, suitable for only short periods of time and small volumes of sediment laden water, can only remove particles larger than aperture opening size (AOS)
1		Silt Fence	X	X		X	Economical, most commonly used sediment control measure, filters sediment from runoff and allows water to pond and settle out coarse grained sediment, more effective than straw bale barriers	May fail under high runoff events, applicable for sheet flow erosion only, limited to locations where adequate space is available to pond collected runoff, sediment build up needs to be removed on a regular basis, damage to filter fence may occur during sediment removal, usable life of approximately one year
5		Earth Dyke/Barrier			X	X	Easy to construct, relatively inexpensive as local soil and material is used; can be easily converted to Sediment Pond/Basin (BMP #18)	Geotechnical design required for fill heights in excess of 3 m, may not be suitable for all soil types or sites; riprap spillway and/or permeable outlet may be required
2		Gabions		X			Relatively maintenance free, permanent drop structure, long lasting (robust), less expensive and thickness than rip-rap, allows smaller diameter rock/stones to be used, relatively flexible, commercially available products, commonly used in Alberta highway construction projects; suitable for resisting high flow velocity	Construction may be labour intensive (hand installation), extra costs associated with gabion basket materials
7		Rock Check Dam		X		X	Permanent drop structure with some filtering capability, cheaper than gabion and armouring entire channel, easily constructed, commonly used in Alberta highway construction projects	Can be expensive in areas of limited rock source, not appropriate for channels draining areas larger than 10 ha (4 acres), requires extensive maintenance after high flow storm events, susceptible to failure if water undermines or outflanks structure
8		Aggregate Filled Sand Bag Check Dam		X		X	More effective as energy dissipator to slow flow velocities, cheaper than gabions or armouring entire ditch, easily constructed and reusable	Not appropriate for channels draining areas larger than 2 ha (5 acres), requires extensive maintenance after high flow storm events, low filtering capabilities, labour intensive to install (hand installation), temporary measure only

Table C-3: Sediment Control Measures

BMP #		BMP Name	Applications				Comments	
			Slopes	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile	Advantages	Limitations
9	Filtering and Entrapment	Log Check Dam		X			Equally effective as silt fences for sediment trapping and straw bale barriers as drop structure, may include timber salvaged from site during clearing operations, most applicable at clearing/grubbing stages of construction	Not commonly used after stripping stage, not appropriate for channels draining areas larger than 4 ha (10 acres), labour intensive to construct, gaps between logs may allow sediment laden runoff to escape, logs/timbers will rot over time (not permanent)
11		Straw Bale Check Structures		X		X	Temporary drop structures appropriate for channel slopes with 3% to 5% grades, straw bales are readily available in most areas of the province, biodegradable	Temporary measure only; not appropriate for: channels draining areas larger than 2 ha (5 acres), channels steeper than 5%, and/or flow velocities greater than 0.3 m/s; requires extensive maintenance after high flow storm events, must be installed by hand with keying and staking; maximum height of one straw bale
10		Synthetic Permeable Barriers		X			Reusable/moveable, reduces flow velocities and dissipate flow energy; retains some sediments; used as grade breaks in conjunction with sturdy permanent drop structures along steep grades	Partially effective as check dam structure, must be installed by hand in conjunction with RECP, become brittle in winter and are easily damaged by construction equipment or recreational vehicles, only partially effective in retaining some sediment, primarily used for reducing flow velocities and energy dissipation
4		Continuous (earth-filled geotextile) Berm	X		X	X	Temporary measure; divert and intercept sheet or overlaid flow to form pond and allow sedimentation; ;flexibility of shape of construction; no trenching	Require specialized continuous berm machine to manufacture earth-filled geotextile berm on site; sandy/gravel soil is preferable fill material
6		Storm Drain Inlet - /Sediment Barrier			X		Temporary measure; easy to install and remove	Limited sediment entrapment capacity; requires regular clean-out maintenance
32	All BMPs	Scheduling	X	X	X	X	Identifies protection issues and plans for efficient, orderly construction of BMPs; minimizes bare soil exposurte as erosion hazard; early installation of perimeter control for sediment entrapment; early dimension planning of runoff control measures; good construction practice	
18	Impoundment	Sediment Pond/Basin		X		X	May be constructed of a variety of materials, collects sediment laden runoff and reduces velocity of flow and deposition of sediment, can be cleaned and expanded as needed, capable of handling large volumes of sediment laden runoff	Normally requires 250 m^3/ha storage volume per area of exposed soil, Can require large areas of land, requires periodic maintenance to remove sediment build up, requires design by qualified personnel, usually requires 'back-up' control measures in case pond/basin overflows,

Table C-4: Minimum Measures (Planning Strategies) for Erosion and Sediment Control

Measures	Applications				Comments	
	Slope	Ditches and Channels	Large Flat Surface Areas	Borrow And Stockpile Area	Advantages	Limitations
Minimize Exposed Soils	X	X	X	X	Minimizes disturbed soil area, decreases erosion potential and decreases quantity of sediment and sediment control measures required thus decreasing costs	May require efficient scheduling of topsoiling/seeding completed areas, limits the stripping of new areas
Operate During Fisheries Windows	X	X	X	X	Minimizes possible negative impacts on aquatic wildlife	May affect schedule of adjoining works
Maximize Favourable Weather	X	X	X	X	Increasing work capacity in favourable conditions, minimizes volume of work required in less desirable (wet) conditions, thus decreasing potential for erosion and sediment loss	May require additional equipment and resources to increase scale of production/construction
Install BMP's Early	X	X	X	X	Early installation of sediment and erosion control measures ensures sediment losses are minimized during construction and provide good housekeeping	May cause difficulties with site access or traffic
Avoid Wet Weather Periods	X	X	X	X	Avoiding construction in wet weather periods minimizes erosion potential	Shutdowns may prolong/delay construction activities
Topsoil and Seed Early	X	X	X		Topsoiling and seeding as early as possible covers exposed soil and reduces erosion potential	
Surface Roughen (Slope Texturing)	X			X	Texturing of soils along contours reduces erosion potential by as much as 10%	Equipment may need to be retasked at a slight increase in costs
Preserve and Use Existing Drainage Systems	X	X	X	X	Minimize disturbance of drainage pattern	Care must be taken to observe drainage directions
Control Construction Traffic				X	Controlling where traffic is allowed avoids over-trafficking sensitive areas or areas with increased disturbance	Forcing traffic into localized areas may increase disturbance in high-traffic areas
Signage	X	X	X	X	Clearly labeling sensitive zones or areas not to be disturbed ensures all workers on-site are aware of where work can occur and where it cannot thus minimizing confusion	Increased costs of signs

Silt Fence (Filter Fence) Sediment Control	B.M.P. #1

Description and Purpose

- Permeable fabric barriers installed vertically on support posts along contours to collect and/or filter sediment laden sheet flow runoff
- Causes water to pond allowing sediment to settle out as water filters through fabric
- Decreases flow velocity in channels with low to moderate flows (< 0.03 m^3/s)
- Entraps and minimizes coarse sediment from sheet flow or overland flow from entering waterbodies
- Perimeter control for sediment transport and deposition

Applications

- Temporary measure
- Used at bottom of cut or fill slopes to collect sediment laden runoff
- Used in swales or ditches with low flow velocity and flow less than 0.03 m^3/s
- Used along streams (or channels) banks
- Used around stockpiles
- Midslope grade-break (using "J-hook" or "smile" pattern to effect ponding, filtering and sedimentation)

Advantages

- Low permeability silt fences have high filtering capabilities for fine sand to coarse silt
- Filter fence more effective than straw bales at filtering out sediment

Limitations

- Applicable for sheet flow, normally cannot handle concentrated channel flow volumes
- May fail under high runoff events
- Limit to locations suitable for temporary ponding of sediment laden runoff
- Not to be used in swales or ditches with flow greater than 0.03 m^3/s
- Low permeability silt fences may not be strong enough to support weight of water retained behind it and may require reinforcement (i.e. wire mesh and stronger support post)
- Sediment build up needs to be removed at 1/2 height and on a regular basis
- Damage to fence may occur during sediment removal
- Useable life of approximately one year dependent on maintenance and sediment requirement

Silt Fence (Filter Fence) Sediment Control	B.M.P. #1

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Two methods of installation are commonly used
  - Trench method
  - Mechanical (slicing) installation method (e.g. Tommy Silt Fence Machine or equivalent)
- Trench Method
  - Select location of silt fence (usually along contours)
  - Drive support posts a minimum of 0.3 (preferable 0.6 m) into ground, spaced a maximum of 2 m apart
  - Excavate trench approximately 0.15 m deep by 0.15 m wide for entire length of fence along upstream side of posts
  - Attach the wire mesh or snow fencing, if used as reinforcement to fence fabric, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts
  - Backfill and compact soil in trench, being careful not to damage fence
- Mechanical Installation Method
  - Select location of silt fence (usually along contours)
  - Use mechanical installation machine to embed the fabric a minimum of 0.15 m into the ground. One mechanical installation method is by slicing (with special equipment) the geotextile fabric to embed into the ground without excavation and backfill. Minor disturbance of ground if affected and only tamping of ground is required for compaction.
  - Drive support posts a minimum of 0.3 (preferable 0.6 m) into ground, spaced a maximum of 2 m apart
  - Attach the wire mesh or snow fencing, if used as reinforcement to silt fence fabric, to upstream side of posts with staples
  - Extend filter fabric to base of trench and attach over wire mesh or snow fence, if used, on upstream side of posts

Construction Considerations

- Site Selection
  - Size of drainage area should be no greater than 0.1 ha per 30 m length of silt fence
  - Maximum flow path length above silt fence should be no greater than 30 m
  - Maximum slope gradient above the silt fence should be no greater than 2H:1V
  - For use in swales, gradient should be less than 2% and drainage area less than 0.8 ha
- Fence should be placed on contour to produce proper ponding
- Fence should be placed far enough away from toe of slope to provide adequate ponding area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of fence should be angled upslope to collect runoff
- Fence should not extend more than 0.6 m above grade
- Posts can be wood or metal material dependent on design and ground conditions

Silt Fence (Filter Fence) Sediment Control	B.M.P. #1

- Posts should be placed on downstream side of fence
- Posts should be driven at least 0.3 m (preferable 0.6 m) into the ground
- Posts should not be spaced greater than 2 m apart
- Wire mesh or standard snow fencing may be placed between the posts and filter fabric to provide additional strength and support reinforcement
- Filter fabric should be cut from a continuous roll to avoid joints (if joints are necessary, the wrapping of fabric around the fence post and a minimum overlap of 0.2 m with staples should be used to attach the fabric to the post)
- Fence (and wire mesh or snow fence, if used) should be attached to posts with heavy duty staples, tie wires, or hog rings
- Fence (and wire mesh or snow fence, if used) should be dug into a trench at least 0.15 m deep to prevent undercutting of fence by runoff
- Trench backfill should be compacted
- Long runs of silt fence are more prone to failure than short runs
  - Maximum length of each section of silt fence should be 40 m
  - Silt fence should be installed in 'J' hook or 'smile' configuration, with maximum length of 40 m, along contours allowing an escape path for ponded water (minimizes overtopping of silt fence structure)

Inspection and Maintenance

- Inspections should occur twice per week and after significant storm events (1:2 year storm event and/or +40 mm rainfall over 24 hours duration)
- Repair undercut fences and repair or replace split, torn, slumping or weathered fabric immediately
- Sediment build up should be removed once it accumulates to a depth of 0.2 m or at ½height of fence
- Remove fence after vegetation is established
- Deactivate fabric by cutting-off top portion of fabric above ground; bottom trenched-in portion of fence fabric can be left in-ground thus minimizing ground disturbance

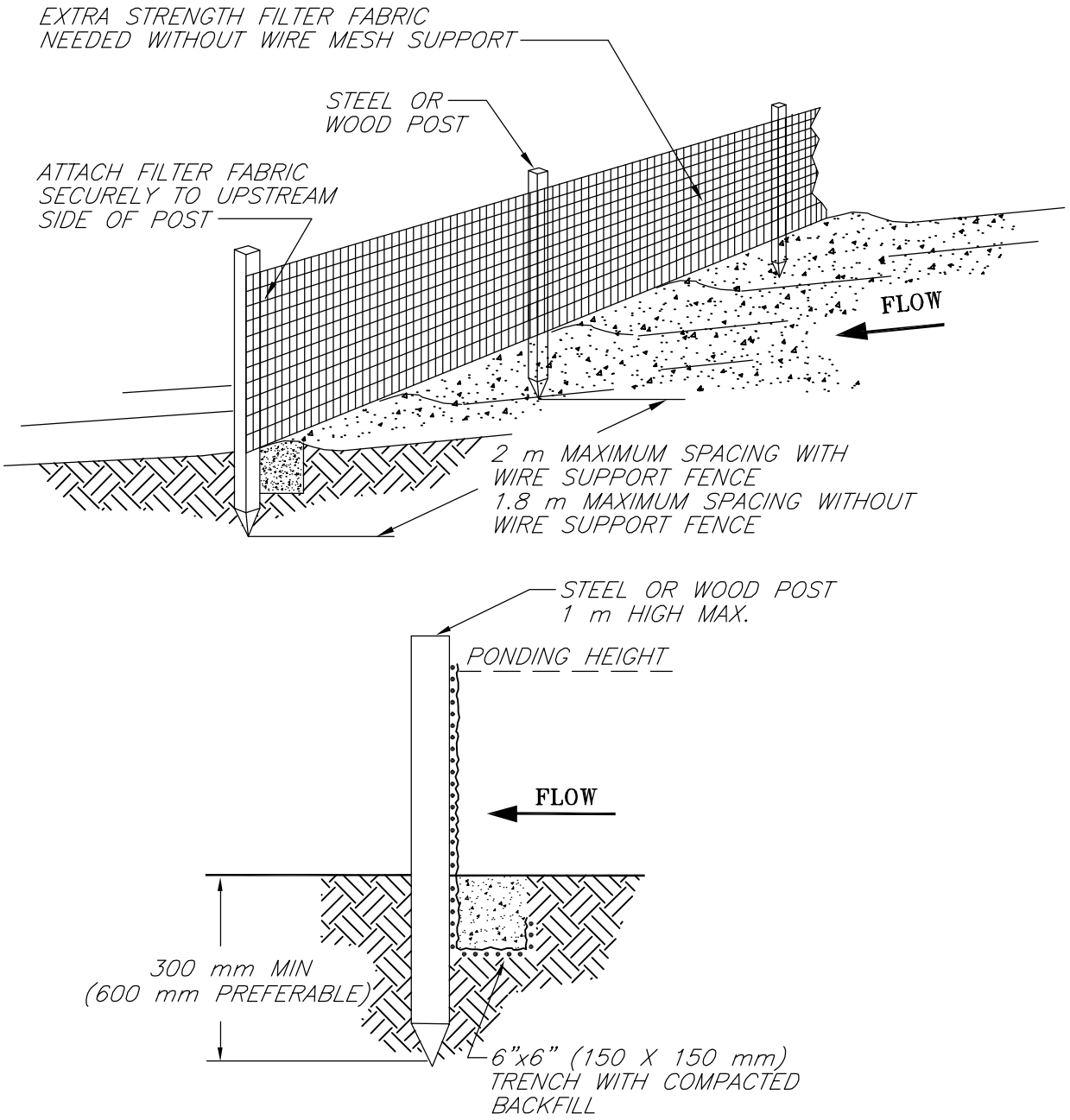
Similar Measures

- Straw Bales
- Rock Barrier
- Check Dams
- Permeable/Synthetic Barriers

Silt Fence (Filter Fence) Sediment Control	B.M.P. #1

Design Considerations

- For a silt fence system to work as a whole, the following factors should be considered:
  1) quantity – adequate number and frequency of fence for efficient ponding and sedimentation
  2) installation – workmanship
  3) compaction – backfill and trenching of fabric
  4) support – posts adequately embedded and of strong material and close spacings
  5) attachment – secure fabric to post
- Install silt fences in a 'J' hook or 'smile' configuration to allow efficient ponding and sedimentation as well as escape route for excess runoff along the ends
  – Minimizes overtopping of structure



TRENCH METHOD OPTION DETAIL

NOTES:

1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT (1:2 YEAR STROM AND/OR +40 mm RAINFALL OVER 24 HOUR DURATION) AND REMOVE SEDIMENT WHEN ACCUMULATED SILT REACHES 1/2 FENCE HEIGHT OR 225 mm MAXIMUM SUGGESTED STORAGE HEIGHT.
3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA WILL NOT CONTRIBUTE SEDIMENT OFF-SITE.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

SILT FENCE

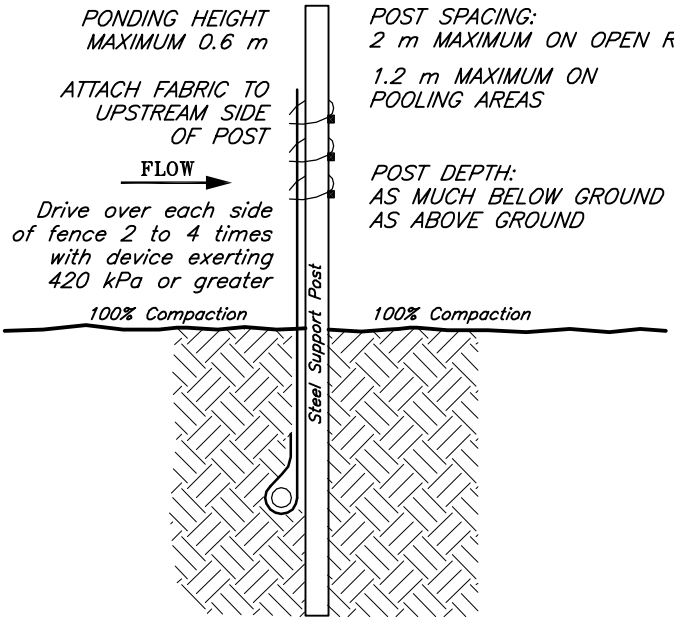
(TRENCH METHOD OPTION)

FILE: SILTFENC

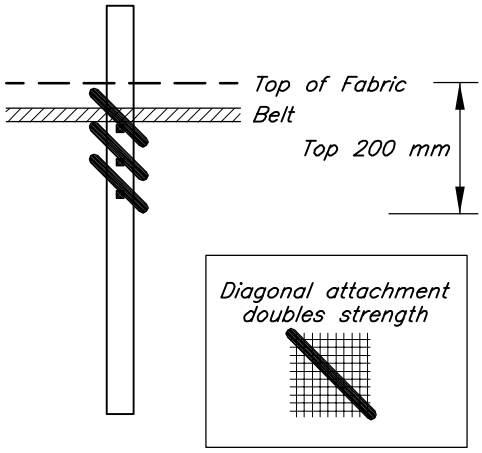
Alberta TRANSPORTATION

B.M.P. #1
Typical Section

0104-01-23211/BMP01A-A.dwg



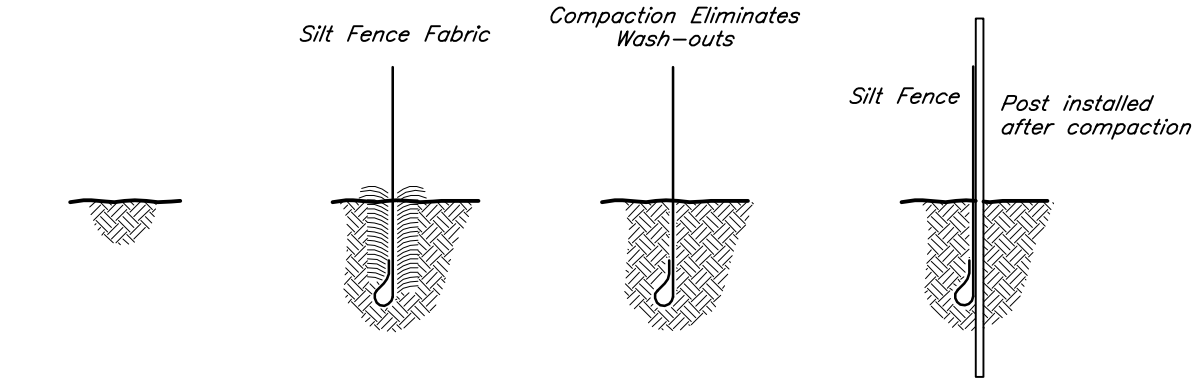
NO MORE THAN 0.6 m OF A 0.9 m FABRIC
IS ALLOWED ABOVE GROUND



ATTACHMENT DETAILS:

- Gather fabric at posts, if needed.
- Utilize three ties per post, all within top 200 mm of fabric.
- Position each tie diagonally, puncturing holes vertically a minimum of 25 mm apart.
- Hang each tie on a post nipple and tighten securely.
- Use cable ties (50 lbs) or soft wire.

THE MECHANICAL (SLICING) METHOD



a) Before Installation

b) During fabric insertion. Disrupted soil.

c) After Compaction. Greater stability.

d) Completed Installation

THE MECHANICAL (SLICING) METHOD INSTALLATION SEQUENCE

NOTES:

1. INSTALLATION MACHINE MUST ALLOW CONTINUOUS SLICING AND EMBEDMENT OF GEOTEXTILE INTO GROUND WITH MINOR GROUND DISTURBANCE.
2. INSTALLATION MACHINE TYPES WILL VARY WITH MANUFACTURER.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

SILT FENCE

(MECHANICAL METHOD OPTION)

SOURCE: CARPENTER T. 2000

Alberta TRANSPORTATION

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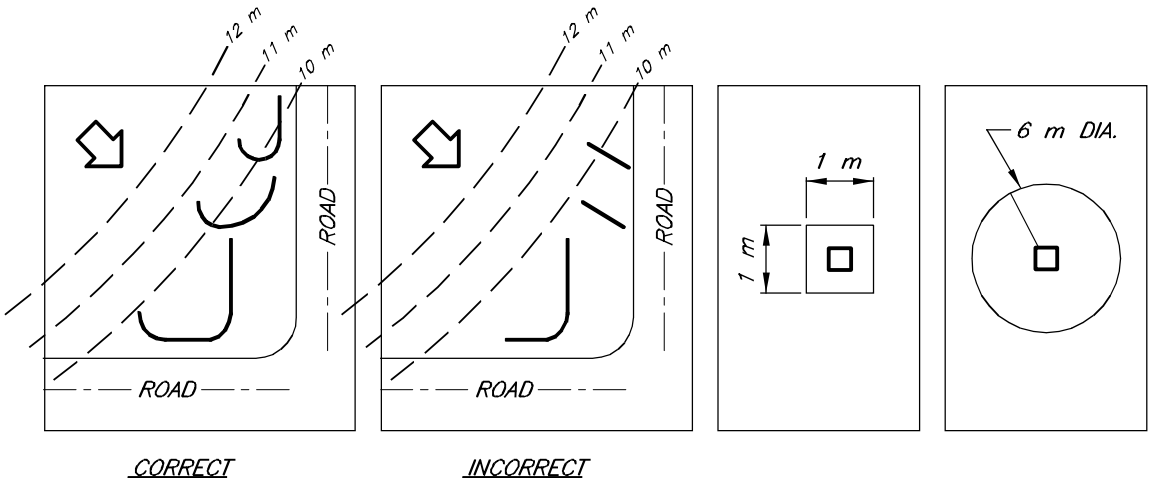
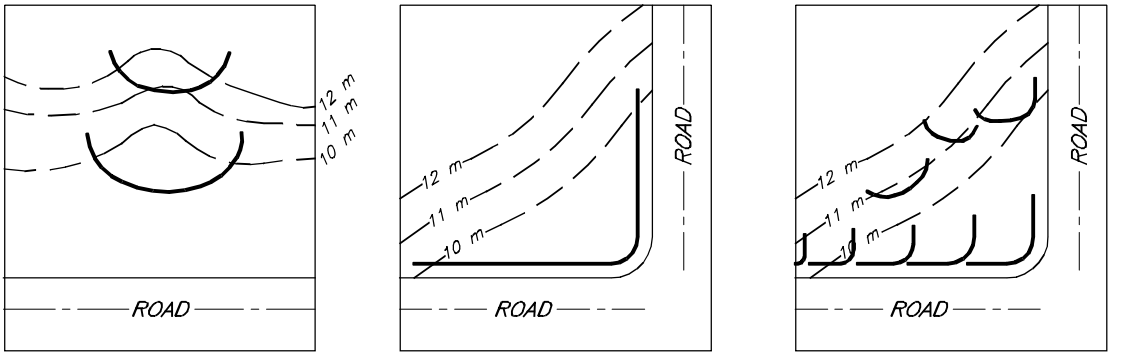


CORRECT INCORRECT

"J" CONFIGURATION

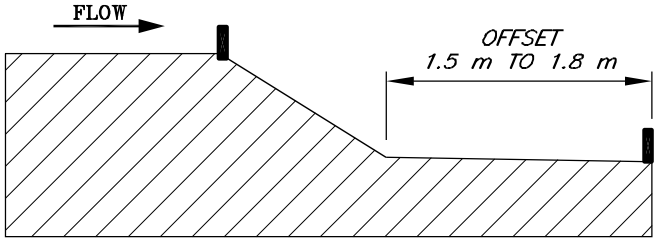
SILT FENCE BARRIER AT STORM INLET



"SMILE" CONFIGURATION

AVOID LONG INSTALLATION

COMBINATION OF "SMILE" AND "J" CONFIGURATIONS



LOCATION AT TOP AND BOTTOM OF SLOPE

NOT TO SCALE

NOTE:

1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

SILT FENCE
(CONFIGURATION PLAN)

SOURCE: CARPENTER T. 2000

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Gabions (a – c) Erosion Control and Sediment Control	B.M.P. #2 (a-c)

Description and Purpose

- Consist of rock placed inside wire baskets to protect steep or erodible slopes from sheet flow erosion
- Protects erodible stream channel banks from potentially high erosive concentrated flow velocities or high tractive forces

a) Slope and Banks
b) Single Gabion Drop Structure for Ditch Channel
c) Double Gabion "Energy Dissipator" Drop Structure for Ditch Channel

Applications

- Permanent measure
- May be used on stream bank aprons and blankets where flow velocities do not exceed 6 m/s
- May be constructed to 0.5H:1V as a low height toe protection structure of slope
- May be used on slopes up to 1.5H:1V as slope protection, a grade break and sediment barrier
  – Gabion matting is an alternative to riprap armouring of channels
- May be used to construct dikes or weirs
- Used as a drop structure (check structure) to reduce grade between structures and as sediment barrier in channels
- Used as a splash pad to slow down flow velocity and dissipate flow energy

Advantages

- Relatively maintenance free
- Long lasting and sturdy structure
- Lower thickness requirement for gabion (can be 1/2 to 1/3 riprap thickness) compared with riprap thickness for identical severe hydraulic conditions.
- Allows smaller diameter rock material to be used where it would normally be erodible with riprap placement
- Gabions are porous, free-draining and flexible so they are less affected by frost heaving and hydrostatic pressures
- Trap sediment and support plant growth to effect higher channel resistance to flow; however, cumulative built-up of silt may render gabion less effective with a diminished height

Limitations

- Construction is labour intensive
- Extra costs associated with wire for mesh cages and rock fill plus geotextile fabric or sand filter layer

Gabions (a – c) Erosion Control and Sediment Control	B.M.P. #2 (a-c)

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Prepare subgrade at designated gabion location to found on mineral soil
- Subexcavate trench a minimum of 0.15 m deep to 'key-in' gabion structure
- Construct gabion basket as per manufacturers recommendations
- Line interior of basket with non-woven geotextile OR a gravely sand filter layer (if required by design) along areas where the basket is in contact with soil
  - Geotextile must be non-woven fabric to act as a separator (filter) between rock-infill and subgrade soils to minimize infiltration of fine grained particles into the gabion structure
- Backfill basket with rock with wire bracing at 1/3 points (or 0.3 m spacings)
- Install gabion basket top
- Backfill trench and compact soil around edges of completed basket

Construction Considerations

- Gabions should be placed on a properly graded surface
- Non-woven geotextile should be used to prevent loss of underlying material and infiltration of fine grained particles into the gabion structure
- Rock in the baskets may be placed by hand to enhance dense packing of stones and decrease void spaces
- Construct gabions with internal wire diaphragms to maintain structural stability (shape)

Inspection and Maintenance

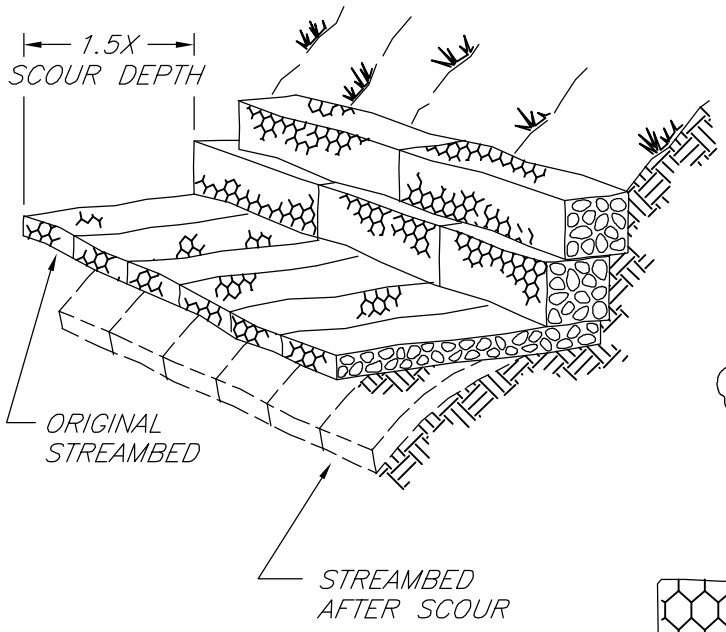
- Should be inspected after major storm events, especially where undermining at the toe of the basket is a concern
  - Repairs as necessary; repair may include hand grading and/or infilling undermined area with rocky material
- Removal and clean out requirement of silt should be determined based on amount of siltation, the level channel erosion and vegetation re-establishment observed

Similar Measures

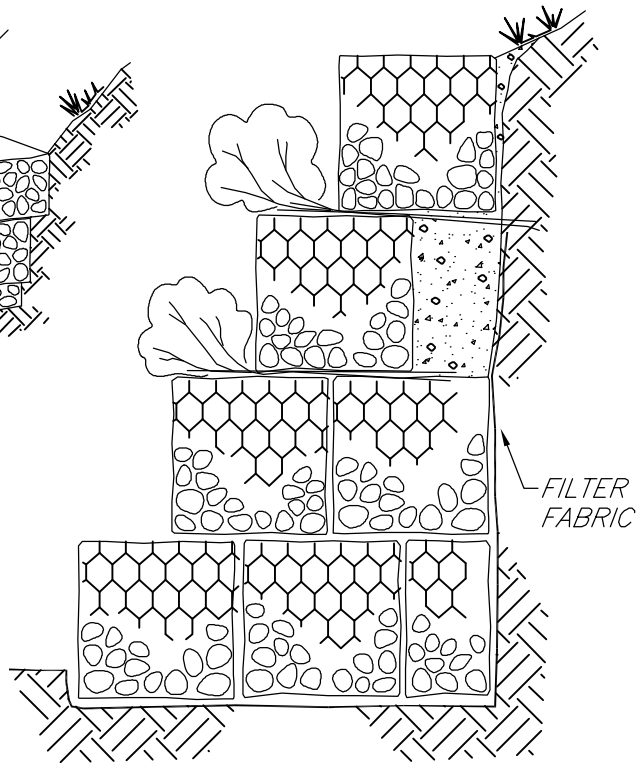
- Berms/Barriers
- Check Dams
- Permeable/Synthetic Barriers
- Rock/Brush barriers
- Sand/Gravel Bag Barriers

Design Considerations

- The design should include an energy dissipator (i.e. a gabion mat as a splash pad) at toe of downstream side of gabion if overtopping of the gabion is anticipated.

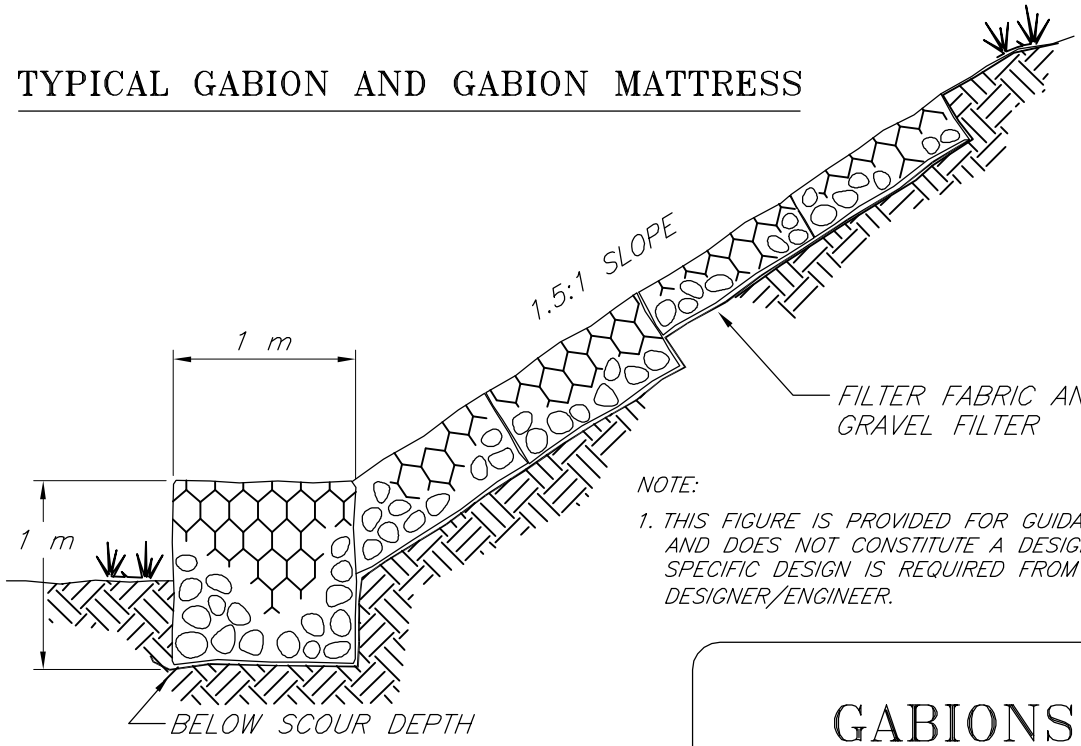


TYPICAL GABION APRON



TYPICAL VEGETATED ROCK GABION

TYPICAL GABION AND GABION MATTRESS



NOTE:

1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

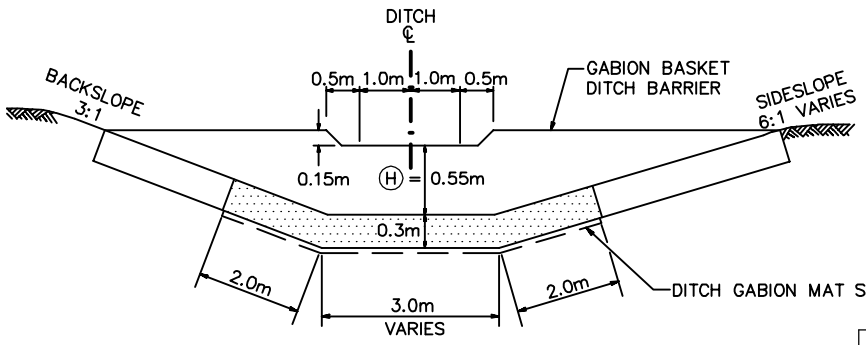
GABIONS
(SLOPE AND BANK)

FILE: GABIONS

Alberta TRANSPORTATION

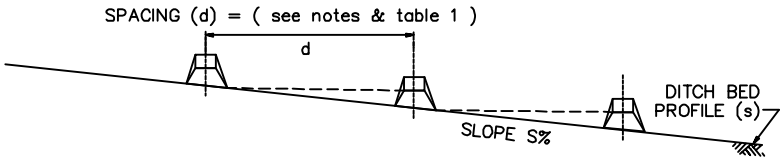
B.M.P. #2a
Typical Section

0104–01–23211/BMP02A–A.dwg



FRONT VIEW FROM DOWNSTREAM
TYPICAL DITCH CROSS–SECTION
GABION BASKET DITCH BARRIER

N.T.S.

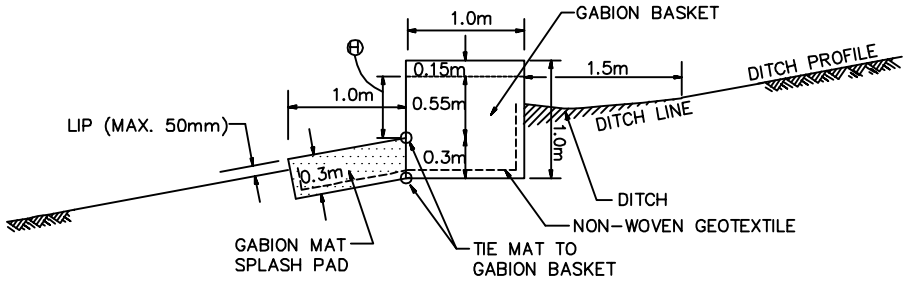


TYPICAL BARRIER SPACING

N.T.S.

SUGGESTED SPACING (d)		
S (%)	(m)	REMARKS
5–7	30	OPTION TO INSTALL A GRADE BREAK (s.a. WEAVE BARRIER) BETWEEN STRUCTURES.
7–8	25	A DOUBLE GABION FOLLOWS EVERY 2 SINGLE GABIONS.
>8%	≤15	DESIGN BY ENGINEER REQUIRED.

TABLE 1



CROSS–SECTION VIEW
"SINGLE GABION" BASKET DITCH BARRIER
& GABION MAT SPLASH PAD

N.T.S.

NOTES:

1. SUITABLE FOR MEDIUM TO STEEP GRADES AND CHANNELS LEADING TO WATER COURSE 4% < S < 10%.
2. i) SPACING TO BE DETERMINED BY ENGINEER BASED ON HYDRAULIC CONDITIONS. – –

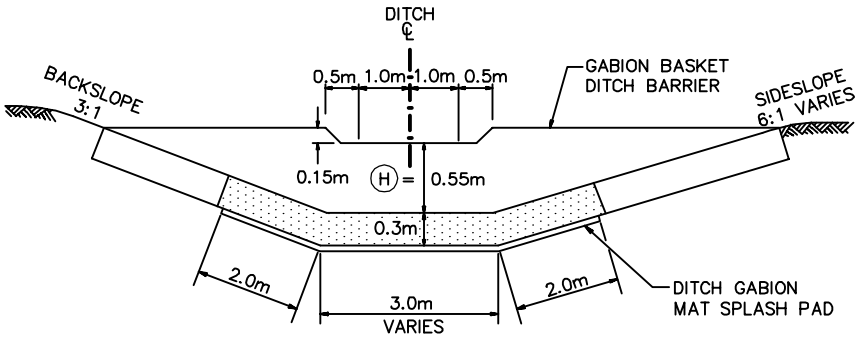
   ii) USE IN CONJUNCTION WITH DOUBLE GABIONS OR OTHER BARRIER STRUCTURES.
3. SOIL COVERING BETWEEN STRUCTURES SUGGESTED FOR STEEP GRADE SOIL DITCH.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

GABIONS
SINGLE GABION DROP STRUCTURE FOR DITCH CHANNEL

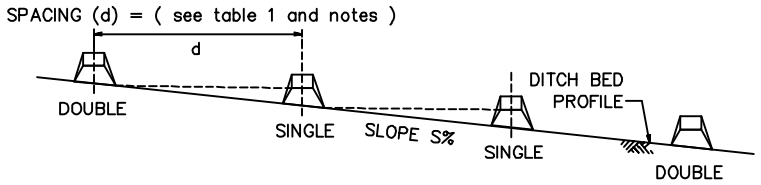
Alberta TRANSPORTATION

B.M.P. #2b
Typical Section

0104–01–23211/BMP2B–A.dwg



FRONT VIEW FROM DOWNSTREAM
TYPICAL DITCH CROSS–SECTION
GABION BASKET DITCH BARRIER
N.T.S.



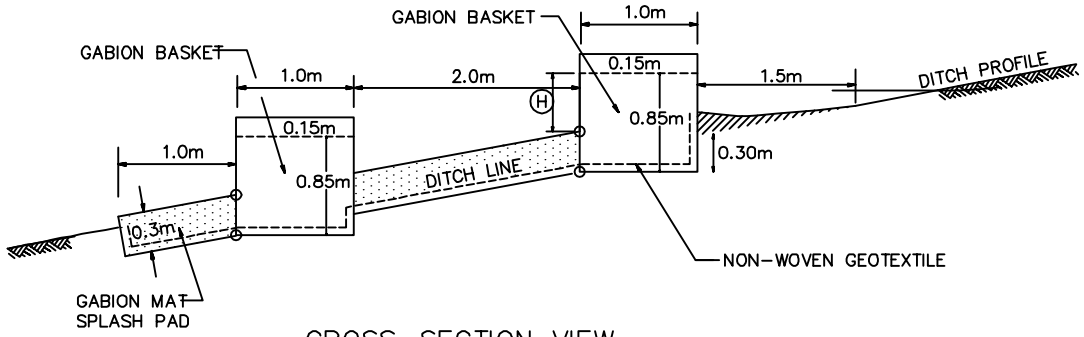
TYPICAL BARRIER SPACING
N.T.S.

SUGGESTED SPACING (d)		REMARKS
S (%)	(m)	
6–8	25	INTER–SPACED WITH 2 SINGLE GABIONS BETWEEN STRUCTURES
	35*	*SEE NOTES
>8%	≤15	DESIGN BY ENGINEER REQUIRED

TABLE 1

NOTES:

1. SUITABLE FOR STEEP GRADES (6%<S<12%) AND CHANNELS LEADING TO WATER COURSE
2. i) SPACING (d) TO BE DETERMINED BY ENGINEER BASED ON HYDRAULIC CONDITIONS.
   ii) USE IN CONJUNCTION WITH SINGLE GABIAN AND/OR OTHER GRADE BREAK STRUCTURES.
3. SUGGESTED TWO SINGLE GABIONS AT INTERVAL BETWEEN DOUBLE GABIONS.
4. SOIL COVERING BETWEEN STRUCTURES SUGGESTED FOR STEEP GRADE SOIL DITCH.
5. IF d* = 35 m at 7 to 8% GRADE
   – GRADE BREAK (s.a. PERMEABLE WEAVE BARRIER) SHOULD BE PLACED BETWEEN STRUCTURES.
   – LONG SPACING ALLOWABLE WHEN HYDRAULIC CONDITIONS NOT SEVERE.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.



CROSS–SECTION VIEW
"DOUBLE GABION" ENERGY DISSIPATION GABION STRUCTURE
(TWO SINGLE GABIONS COMBINED)
N.T.S.

GABIONS
DOUBLE GABION "ENERGY DISSIPATOR" DROP STRUCTURE FOR DITCH CHANNEL

Alberta TRANSPORTATION

B.M.P. #2c
Typical Section

0104–01–23211/BMP2C–A.dwg

Brush or Rock Filter Berm Sediment Control	B.M.P. #3

Description and Purpose

- Temporary barriers of brush wrapped in filter fabric and secured in place, or rock anchored in place to intercept and filter sediment laden stormwater runoff from disturbed areas, retain sediment, and release water as sheet flow

Applications

- Temporary measure
- Perimeter control
- Near toe of slopes subjected to sheet flow and rill erosion
- Along crest or tops streams and channels
- Around drain inlets
- Maximum drainage area of less than 250 m^2 per 25 m length of barrier

Advantages

- May be equally effective filter as silt fences

Limitations

- Temporary measure only
- Maximum drainage area of less than 250 m^2 per 25 m length of barrier
- Sufficient area behind berm required for ponding and clean out of sediment
- Not effective for diverting runoff (filters allow runoff to seep through)
- Rock filter berms are expensive to remove at completion of service life
- Not to be used across ditches, channels, or swales where high concentrated flows are anticipated

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Brush filter berm
  - Size of the brush filter berm will vary depending upon amount of material available and condition of the site
  - The height of the berm shall be at least 1 m tall and the width shall be a minimum of 1.5 m at its base
  - Berm is constructed by piling brush, roots, stumps and/or stones into a mounded row along contours
    - During clearing and grubbing, equipment can push the material into windrows along toe of slopes or other areas prone to erosion

  - Filter fabric is then laid across the berm, with edges overlapping, and secured in a trench immediately upstream of the berm
    - Trench shall be 15 cm wide and 15 cm deep and shall run for the entire length of the berm
  - The filter fabric in the trench shall be staked down with stakes spaced approximately 1 m apart
  - The trench is then backfilled and compacted over the staked filter fabric
  - The fabric is anchored with twine/wire to stakes on the downstream side of the berm
- Rock filter berm
  - Constructed similar to brush filter berm, replacing brush with rock (D_{50} = 75 mm to 150 mm)

Construction Considerations

- Use rock or brush material smaller than 150 mm in diameter, or use filter cloth to encapsulate the material, to promote filtration
- There is no predetermined shape for filters
- Water must be forced to filter through the berm and not flow around it
- Brush barriers can generally be constructed of clean organic material made available from clearing and grubbing operations that is normally burned or discarded
- Rock and brush filter berms are temporary measures and should be removed upon completion of service life, but not prior to revegetation of areas upslope

Inspection and Maintenance

- Inspect berms on a weekly basis and before and after significant rainfall events (1:2 year storm event and/or 40 mm rainfall over 24 hours duration)
- Reshape berms as needed and replace lost or dislodged rock, brush, and/or filter fabric
- Inspect for sediment accumulation and remove sediment when depths reach approximately one-third the berm height or 300 mm, whichever occurs first
- Inspect for toe undercutting, weathered/deteriorated filter fabric, and end runs and erosion of the filter and repair immediately

Similar Measures

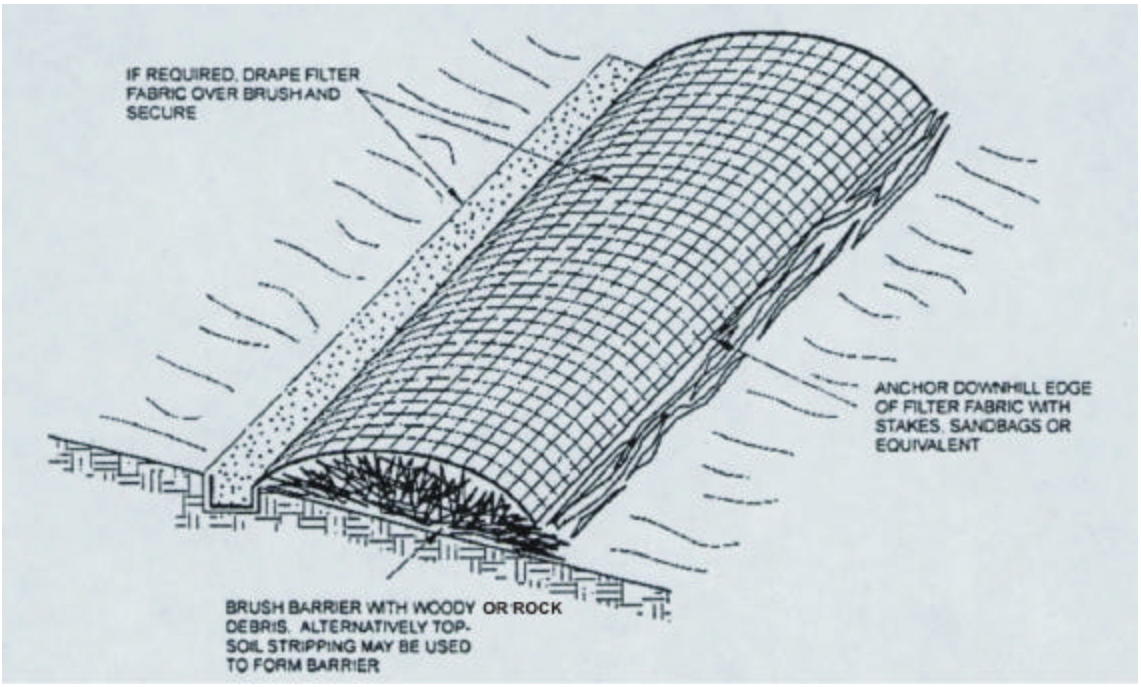
- Berms/Barriers
- Check Dams
- Permeable/Synthetic Barriers
- Sand/Gravel Bag Barriers

Brush or Rock Filter Berm Sediment Control	B.M.P. #3

- Design Considerations

- Material properties
  - Rocks
    - Shall consist of hard, durable, clean mineral particles free of organic matter, clay lumps, soft particles, or other substances that might interfere with drainage and filtering properties
    - D_{50} of 75 mm to 150 mm preferable

- Brush
  - Material shall be less than 150 mm in diameter



NOT TO SCALE

NOTES:

1. EXCAVATE 100 mm X 100 mm TRENCH ALONG UPSTREAM SIDE OF BRUSH OR ROCK FILTER BERM.
2. DRAPE FILTER FABRIC OVER BRUSH OR ROCK FILTER BERM ENSURING UPSTREAM SIDE IS IN TRENCH.
3. BACKFILL AND COMPACT SOIL OVER FILTER FABRIC IN EXCAVATED TRENCH.
4. SECURE FILTER FABRIC OVER BRUSH OR ROCK FILTER BERM BY STAKING ON DOWNSTREAM SIDE OF BERM.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

BRUSH or ROCK FILTER BERMS

Alberta TRANSPORTATION

B.M.P. #3
Typical Section

0104-01-23211/BMP03-A.dwg

Continuous (Earth-Filled Geotextile) Berm Sediment Control	B.M.P. #4

Description and Purpose

- Constructed of sand or gravel-filled geotextile
- Used to divert and intercept sheet or overland flow
- May be used to form ponds and allow sediment to settle out

Applications

- Temporary measure
- May be used in place of silt fences or straw bale barriers to retain sediment on construction sites

Advantages

- Trenching not required as weight and flexibility of berm allows continuous contact with ground surface

Limitations

- Requires Continuous Berm Machine (CBM) for construction

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Use CBM to form berm a minimum of 2 m away from toe of slope to provide adequate ponding area on upstream side of berm
- Follow operating procedures for CBM
- Use of woven geotextile is preferred due to higher tensile strength and small deformation
- If required, 50 mm diameter (recommended) PVC drainage pipes may be inserted in downstream side of berm, spaced 100 to 150 mm apart, to facilitate drainage
- If required and appropriate, slits may be cut in upstream side of berm to facilitate filtering and drainage

Construction Considerations

- Berm constructed of sand, aggregate, or other pervious soil encased in geotextile fabric
- Maximum berm height is approximately 0.4 m
- Higher permeability fill materials should be used in ‘drainage chambers’ in low areas

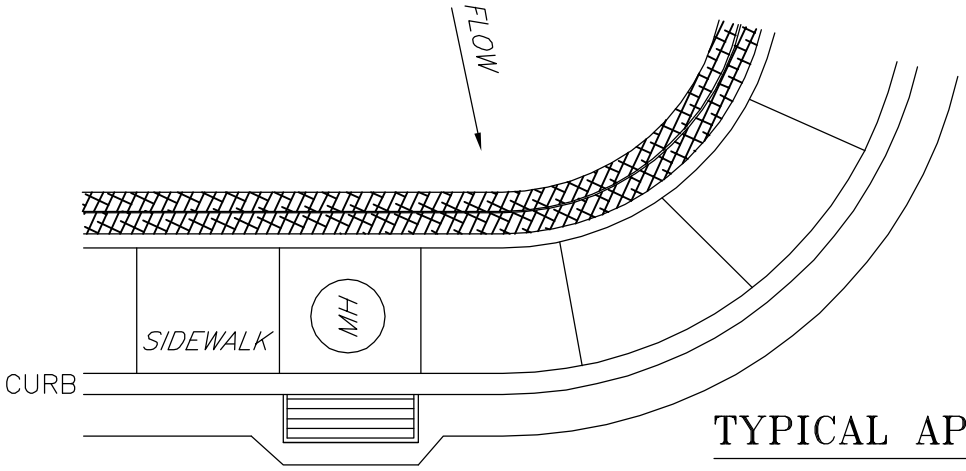
Continuous (Earth-Filled Geotextile) Berm Sediment Control	B.M.P. #4

Inspection and Maintenance

- Minimal maintenance is required
- Inspect berms on a weekly basis and before and after significant rainfall events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Inspect for sediment accumulation and remove sediment when depths reach approximately one-third the berm height
- Inspect for toe undermining, weathered/deteriorated filter fabrics, and end runs and erosion of the filter and repair immediately
  - Damaged sections may be repaired by restapling or placing another section of continuous berm upstream of the damaged section to provide seal-off
- Removal of berm is accomplished by splitting the berm, spilling fill material and removing fabric

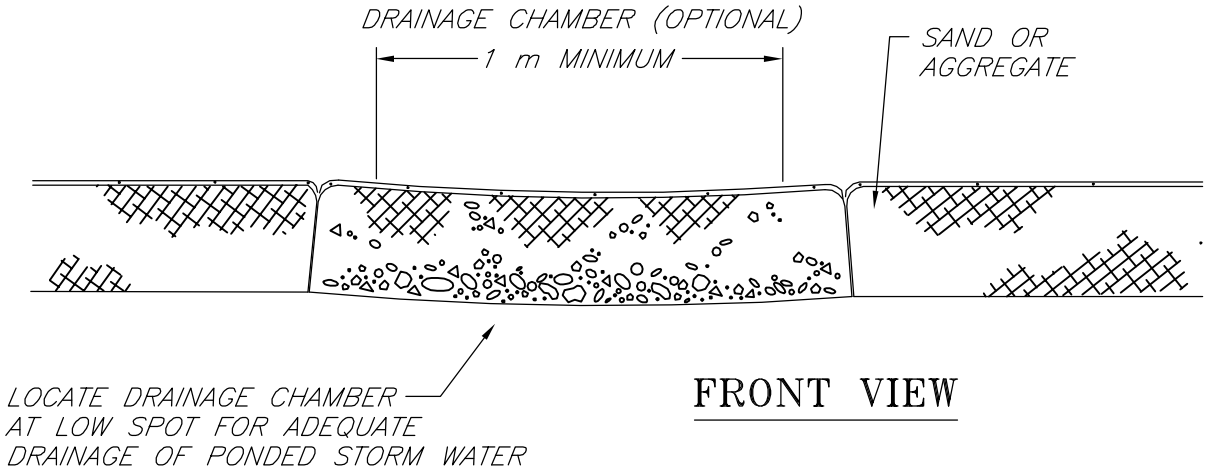
Similar Measures

- Berms/Barriers
- Sand/Gravel Bag Barriers

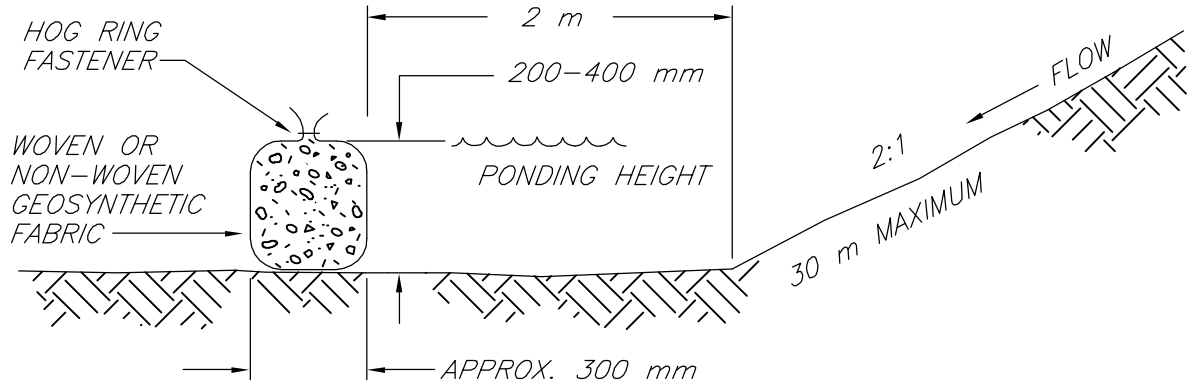


TYPICAL APPLICATION

PERIMETER SEDIMENT BARRIER



FRONT VIEW



SIDE VIEW

NOTES:

1. *USE OF WOVEN GEOTEXTILE IS PREFERRED FOR CONTINUOUS BERM.*
2. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

CONTINUOUS BERM

(EARTH FILLED GEOTEXTILE)

FILE: CONTBERM

Alberta TRANSPORTATION

B.M.P. #4
Typical Section

0104–01–23211/BMP04–A.dwg

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Earth Dyke Barrier Sediment Control	B.M.P. #5

Description and Purpose

- Barrier constructed of compacted soil to intercept and divert flow of runoff water away from sensitive areas or water bodies
- A spillway outlet of erosion-resistant granular material constructed to allow exit of diverted water to less sensitive areas.

Applications

- Temporary or permanent measure
- Used instead of (or in conjunction with) diversion ditches
- Perimeter control
- Placed along contours at toe of slope to divert run-off from sensitive areas
- Used to divert water to sediment control structures

Advantages

- Easy to construct
- Can be converted to sedimentation/impoundment pond with the design of a permeable filter berm at the exit spillway area (see BMP #18b)

Limitations

- Generally, earth dyke barrier can be 1 to 2 m in height. Design by a geotechnical engineer is required for barriers greater than 3 m in height in accordance with dam design guidelines and regulatory requirements. The consequences of failure will influence the level of design and construction requirements.

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Construct barrier from bottom up by placing and compacting subsequent lifts of soil
- Degree of compaction of each lift to be determined by the design engineer based on consequences of failure

Construction Considerations

- The barrier shall be trapezoidal in section
- Low barriers should have the slopes tailored to the construction material used
  - 1.5H:1V for granular soils (predominantly gravel)
  - 2H:1V or flatter for compacted mixed or fine grained soils
    - Slope should be flattened to a minimum of 3H:1V for uncompacted fine grained soils

Earth Dyke Barrier Sediment Control	B.M.P. #5

Inspection and Maintenance

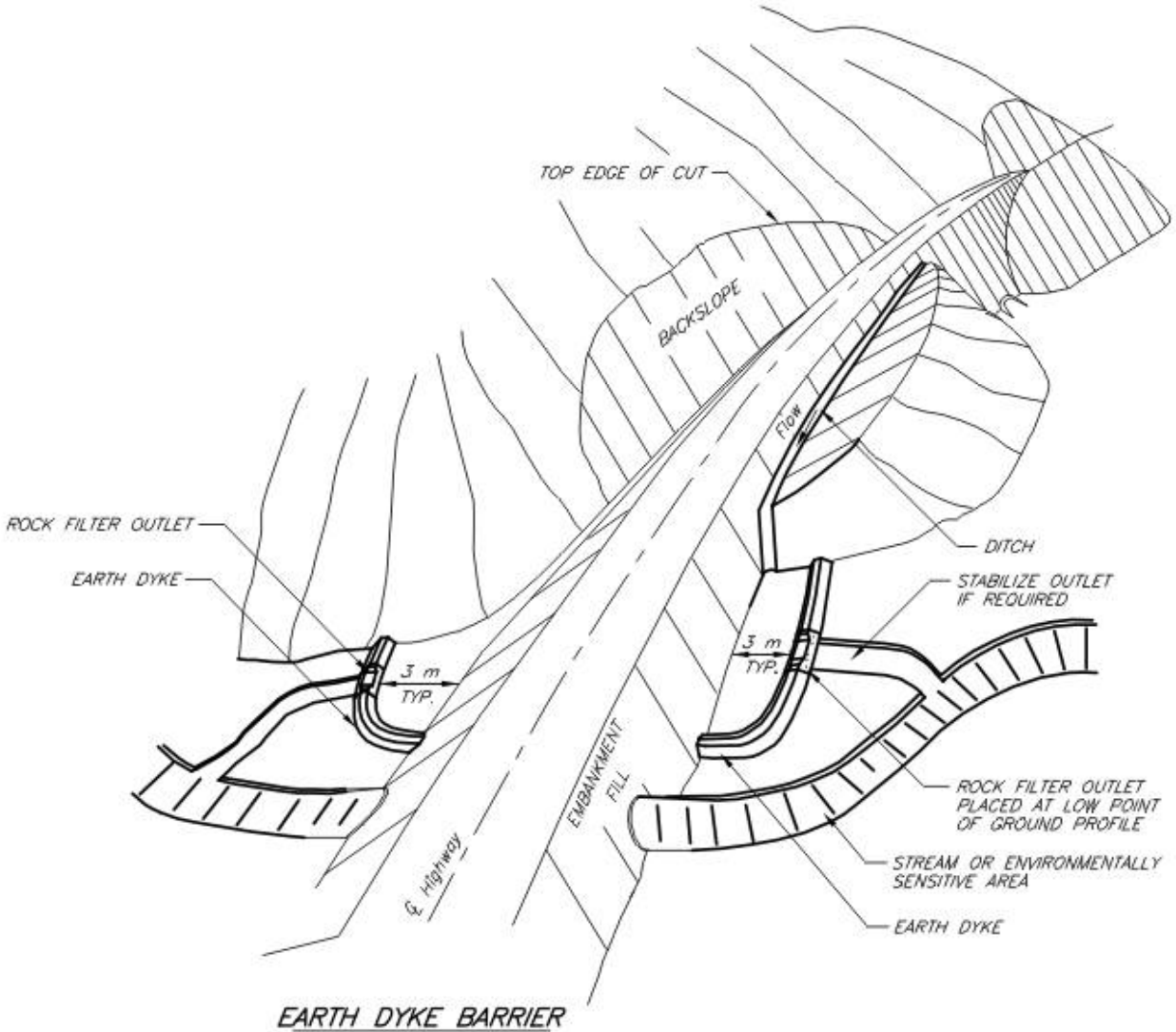
- The degree and extent of inspection and maintenance performed on an earth dyke barrier is directly related to the consequences of failure. Depending on the consequences of failure, an engineer experienced in embankment design and inspection may be required for inspection, design of remedial measures and supervision of their implementation.
- Inspect barriers on a weekly basis and before and after significant rainfall events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Piping failures may be remedied by replacing saturated soils with drier compacted soil and/or by placement of geotextile over the failed area and placing a stabilizing toe berm constructed in the granular materials over the non-woven materials where disturbance is evident
- Inspect for sediment accumulation and remove sediment when depths reach approximately one-half the barrier height
- Deactivate and remove barrier once soils upslope have stabilized and return barrier location to conditions that are equivalent or better than prior to barrier construction

Similar Measures

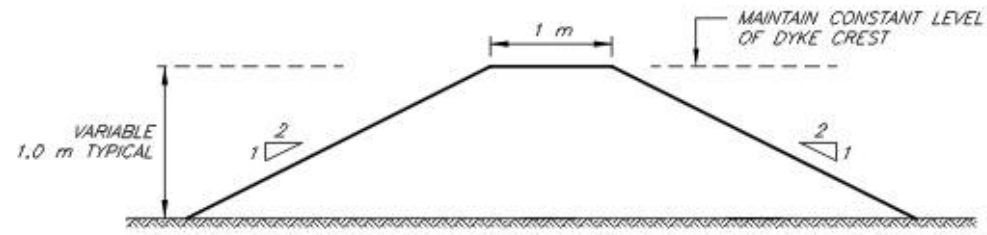
- Berms
- Sand/Gravel Bag Barriers

Design Considerations

- Geotechnical design required for barriers constructed of fine grained soils and greater than 3 m in height



EARTH DYKE BARRIER
TYPICAL LOCATION



TYPICAL SECTION
EARTH DYKE

NOTES:
1. SILT ACCUMULATION TO BE REMOVED WHEN HALF EARTH DYKE HEIGHT COVERED.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

EARTH DYKE BARRIER

Alberta TRANSPORTATION

B.M.P. #5
Typical Section

0104-01-23211/BMP05-A.dwg

Earth Dyke Barrier Sediment Control	B.M.P. #5

Storm Drain Inlet Sediment Barrier (a – f) Sediment Control	B.M.P. #6 (a – f)

Description and Purpose

- Temporary devices constructed to minimize the amount of sediment entering a storm drain by ponding sediment laden runoff at the inlet
- Storm Drain Inlet protection can consist of the following measures:

a) Block and Gravel Sediment Barrier – Option 1
b) Block and Gravel Curb Inlet Sediment Barrier – Option 2
c) Sand Bag Curb Inlet Sediment Barrier – Option 1
d) Sand Bag Curb and Gutter Sediment Barrier – Option 2
e) Straw Bale / Gravel Sediment Barrier - Option
f) Silt Fence Sediment Barrier - Option

Applications

- Temporary measure
- Used where storm drains are operational prior to establishing vegetation on disturbed drainage areas
- Can be effective where drainage enters municipal sewers or watercourses
- Used for small, nearly level (less than 5% grade) drainage areas
- Used as curb inlet barriers in gently sloping ditches and gutters
- Used where drainage area is 0.4 ha (1 ac) or less
- Used in open areas subjected to sheet flow and concentrated flows less than 0.014 m^3/s (0.5 cfs)
- Block and gravel bag barriers are applicable when sheet flows or concentrated flows exceed 0.014 m^3/s (0.5 cfs) and is necessary to allow for overtopping to prevent flooding
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected and overflow capacity is required

Advantages

- Easy to install and remove
- Sand bags may be reusable

Limitations

- Ponding around inlet may result in excessive local flooding
- Use only when ponding will not encroach into vehicular traffic, onto erodible surfaces and slopes or beyond the limits of the construction site
- Frequent removal of sediment required for high flow situations

Storm Drain Inlet Sediment Barrier (a – f) Sediment Control	B.M.P. #6 (a – f)

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Place inlet sediment barrier around entrance to drain/pipe. The option appropriate for use is dependent on site conditions.
- Silt fence barrier can be used for soil surfaces
- Gravel or aggregate filled sand bags should be used for asphalt or concrete surfaces
- Aggregate filled sand bags
  - Place sand bags stacked one or two bags high around inlet
- Gravel barriers
  - Place concrete blocks stacked one or two blocks high, with cavities of blocks aligned with direction of flow, around inlet
  - Wrap 13 mm (1/2 inch) wire mesh around concrete blocks
  - Place 25 mm to 38 mm diameter rock around block and wire mesh assembly ensuring rock extends down from top of blocks to asphalt or concrete surfacing
- Gravel filter curb inlet
  - Place concrete blocks stacked one or two blocks high around inlet, with cavities of blocks aligned with direction of flow, forming a 'U' shape
  - Wrap 13 mm (1/2 inch) diameter wire mesh around concrete blocks
  - Place 25 mm to 38 mm diameter rock around block and wire mesh assembly ensuring rock extends down from top of blocks to asphalt or concrete surfacing

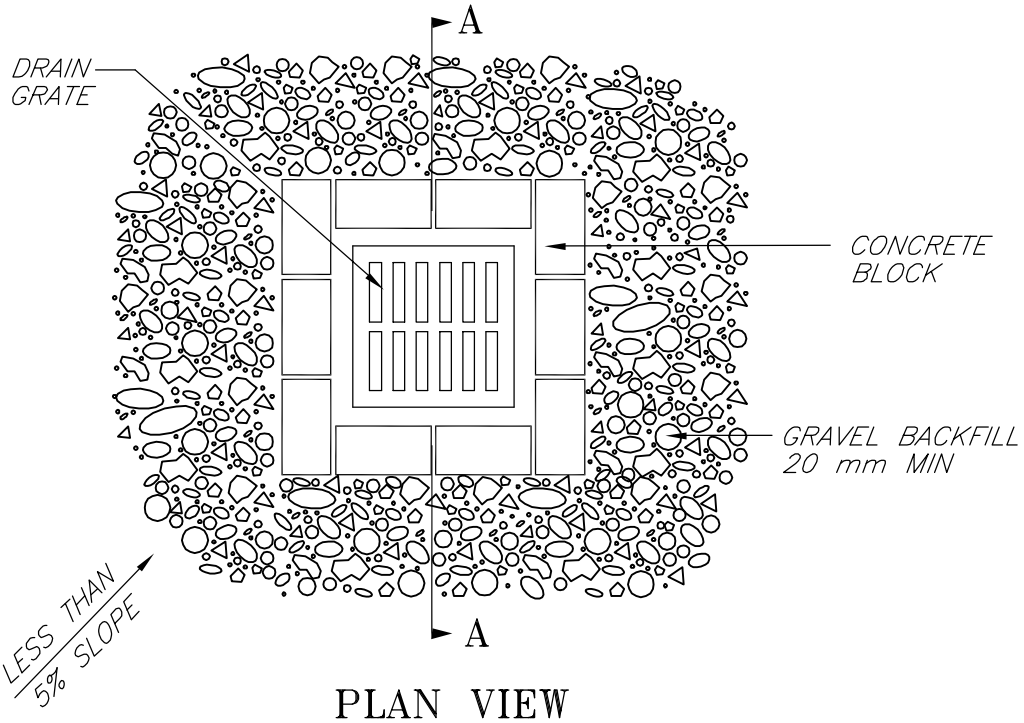
Construction Considerations

- Gravel or aggregate filled sand bags should be used for asphalt or concrete surfaces
- Aggregate filled sand bags
  - Sand bags should be filled with pea gravel, drain rock, or other free draining material
  - Gravel or aggregate filled sand bags should be filled only ¾full to allow sand bag to be flexible to mould to contours, maintaining continuous contact with surface
  - Barrier should be placed at least 0.1 m from inlet to be protected
  - Several layers of sand bags should be overlapped and tightly packed against one another
  - A one sand bag wide gap should be left in the lowest point of the upper layer to act as an emergency spillway
- Gravel filter inlet berm and gravel filter curb inlet
  - Slope gravel towards inlet at a maximum slope of 2H:1V
  - Maintain at least 0.3 m spacing between toe of gravel and inlet to minimize gravel entering inlet
  - 25 mm wire mesh may be placed over inlet to prevent gravel from entering inlet
- For drainage areas larger than 0.4 ha (1 ac) runoff should be directed towards a sediment retention device designed for larger flows before allowing water to reach inlet protection structure
- Use aggregate sand bags filled with 25 mm diameter rock in place of concrete blocks for gravel filter inlet berm or gravel filter curb inlet

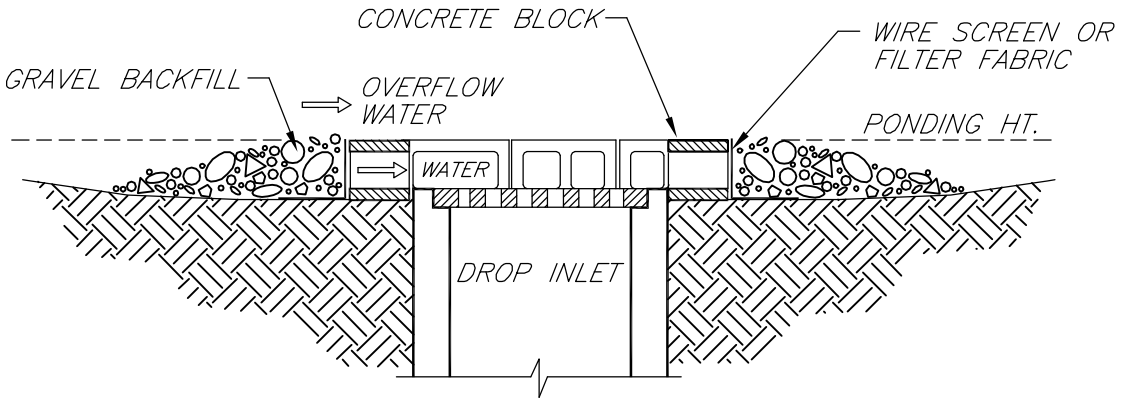
Storm Drain Inlet Sediment Barrier (a – f) Sediment Control	B.M.P. #6 (a – f)

Inspection and Maintenance

- Inspect barriers at least once a week and before and after each significant rainfall event (1:2 year storm and/or 40 mm in a 24 hour period)
- Remove sediment build up after each storm event
  - Sediment and gravel should not be allowed to accumulate on roads
- Replace gravel if it becomes clogged with sediment
- Remove all inlet protection devices when inlet protection is no longer required



PLAN VIEW



SECTION A – A

NOTES:

1. STORM DRAIN DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%).
2. EXCAVATE A BASIN OF SUFFICIENT SIZE ADJACENT TO THE STORM DRAIN DROP INLET.
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. A TEMPORARY DYKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

STORM DRAIN DROP INLET SEDIMENT BARRIER

(BLOCK AND GRAVEL – OPTION 1)

FILE: BGSEDBAR

Alberta TRANSPORTATION

B.M.P. #6a
Typical Section

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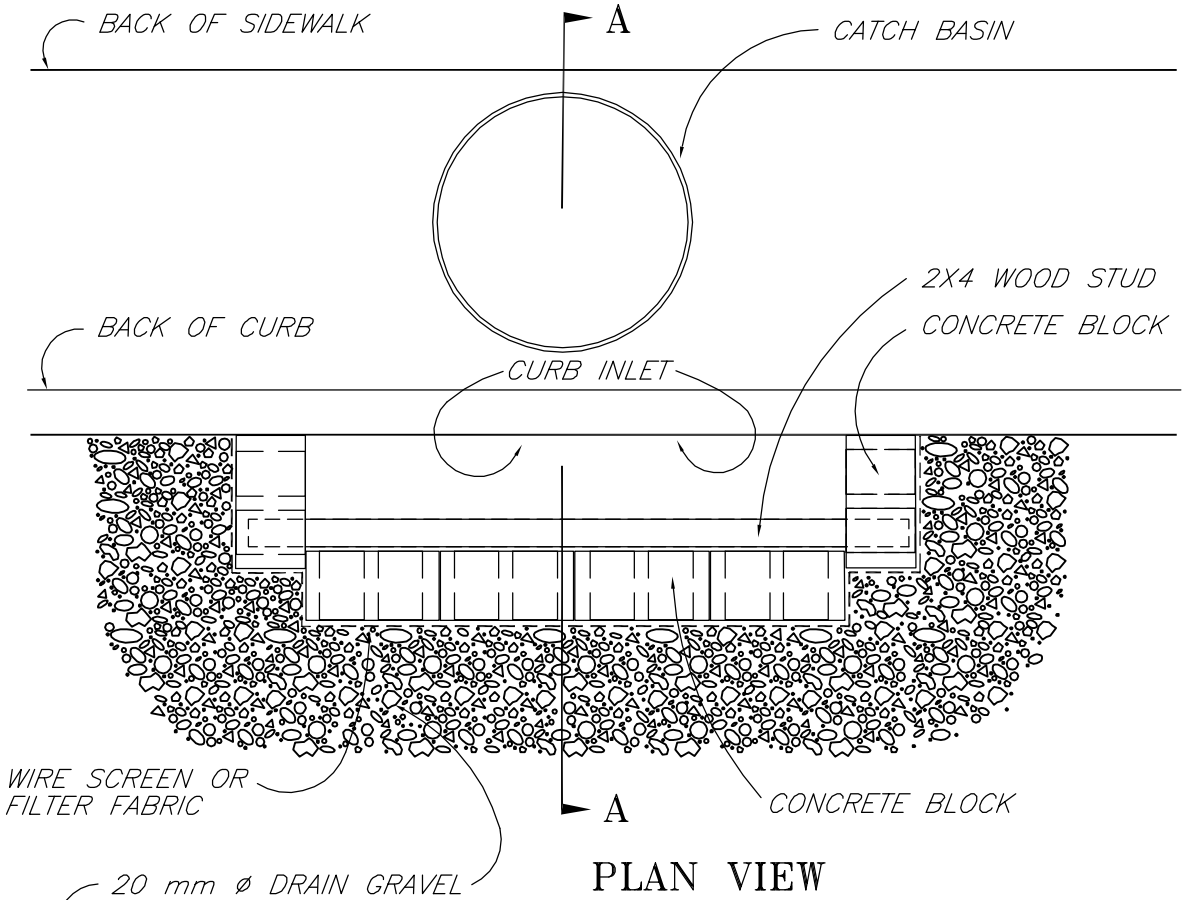
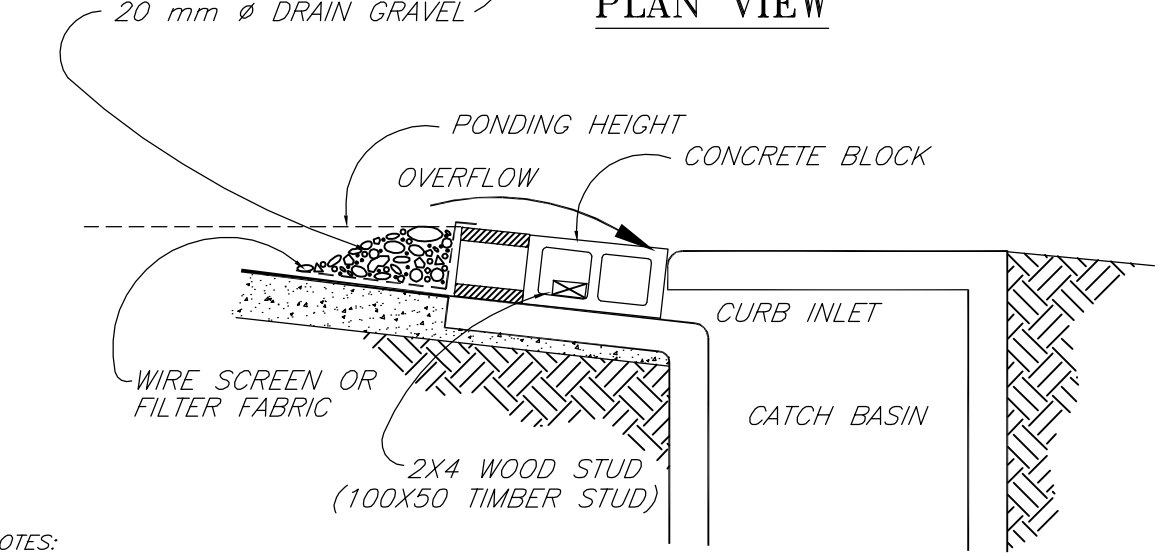


PLAN VIEW



SECTION A – A

NOTES:

1. USE BLOCK AND GRAVEL TYPE SEDIMENT BARRIER WHEN CURB INLET IS LOCATED IN GENTLY SLOPING STREET SEGMENT, WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. BARRIER SHALL ALLOW FOR OVERFLOW FROM SEVERE STORM EVENT.
3. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

FILE: BLCKCURB

STORM DRAIN CURB INLET SEDIMENT BARRIER

(BLOCK AND GRAVEL – OPTION 2)

Alberta TRANSPORTATION

B.M.P. #6b
Typical Section

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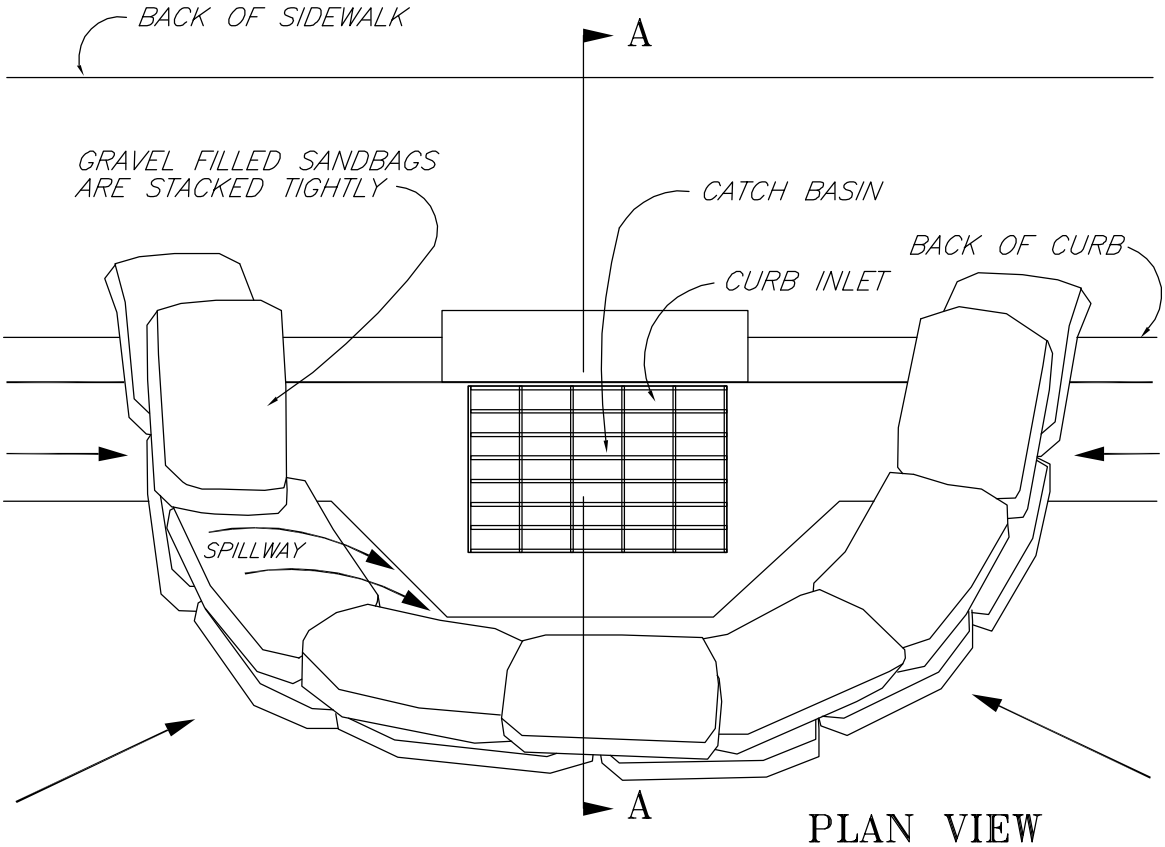
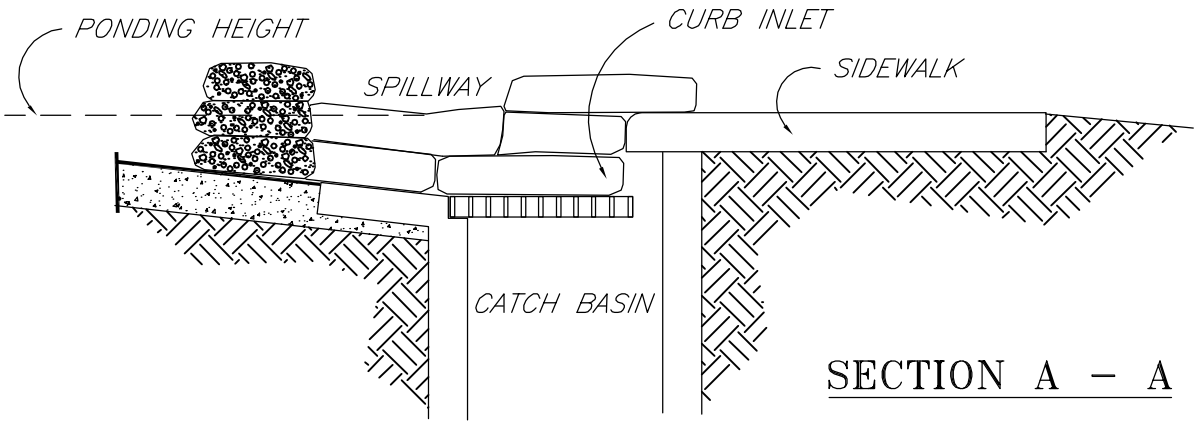


PLAN VIEW



SECTION A – A

NOTES:

1. PLACE CURB TYPE SEDIMENT BARRIERS ON GENTLY SLOPING STREET SEGMENTS WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. SANDBAGS, OF EITHER BURLAP OR WOVEN GEOTEXTILE FABRIC, ARE FILLED WITH GRAVEL, LAYERED AND PACKED TIGHTLY.
3. LEAVE ONE SANDBAG GAP IN THE TOP ROW TO PROVIDE A SPILLWAY FOR OVERFLOW.
4. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

STORM DRAIN CURB INLET SEDIMENT BARRIER

(SANDBAGS – OPTION 1)

FILE: SANDCURB

Alberta TRANSPORTATION

B.M.P. #6c
Plan View and Section

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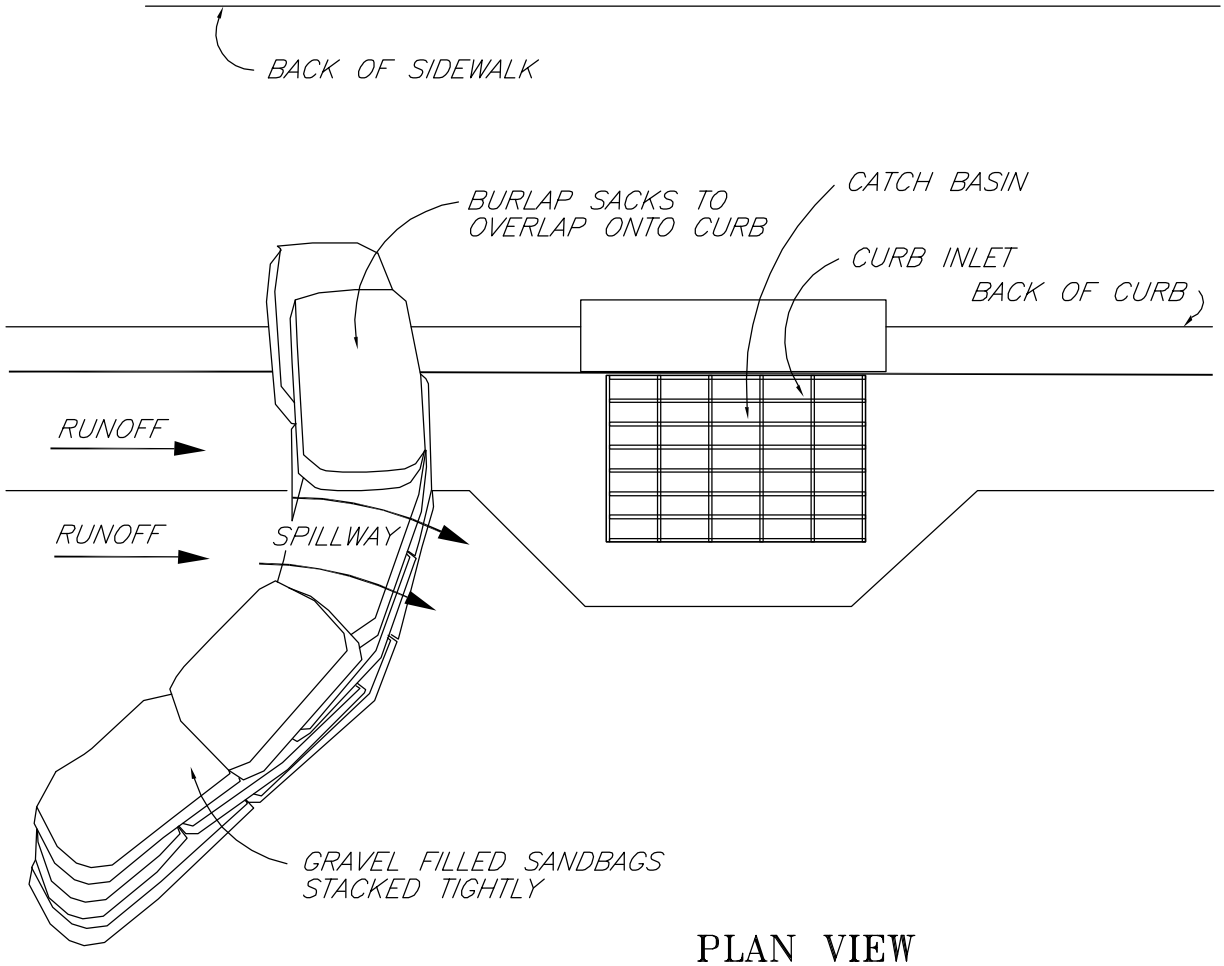

PLAN VIEW

NOTES:

1. PLACE CURB TYPE SEDIMENT BARRIERS ON GENTLY SLOPING STREET SEGMENTS, WHERE WATER CAN POND AND ALLOW SEDIMENT TO SEPARATE FROM RUNOFF.
2. SANDBAGS OF EITHER BURLAP OR WOVEN 'GEOTEXTILE' FABRIC, ARE FILLED WITH GRAVEL, LAYERED AND PACKED TIGHTLY.
3. LEAVE A ONE SANDBAG GAP IN THE TOP ROW TO PROVIDE A SPILLWAY FOR OVERFLOW.
4. INSPECT BARRIERS AND REMOVE SEDIMENT AFTER EACH STORM EVENT. SEDIMENT AND GRAVEL MUST BE REMOVED FROM THE TRAVELED WAY IMMEDIATELY.
5. DESIGN CENTRE SPILLWAY LOWER THAN OUTSIDE EDGE TO MINIMIZE FLOW OUTFLANGING.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

STORM DRAIN INLET CURB AND GUTTER SEDIMENT BARRIER

(SANDBAGS – OPTION 2)

FILE: CURBGTTR

Alberta TRANSPORTATION

B.M.P. #6d
Plan View

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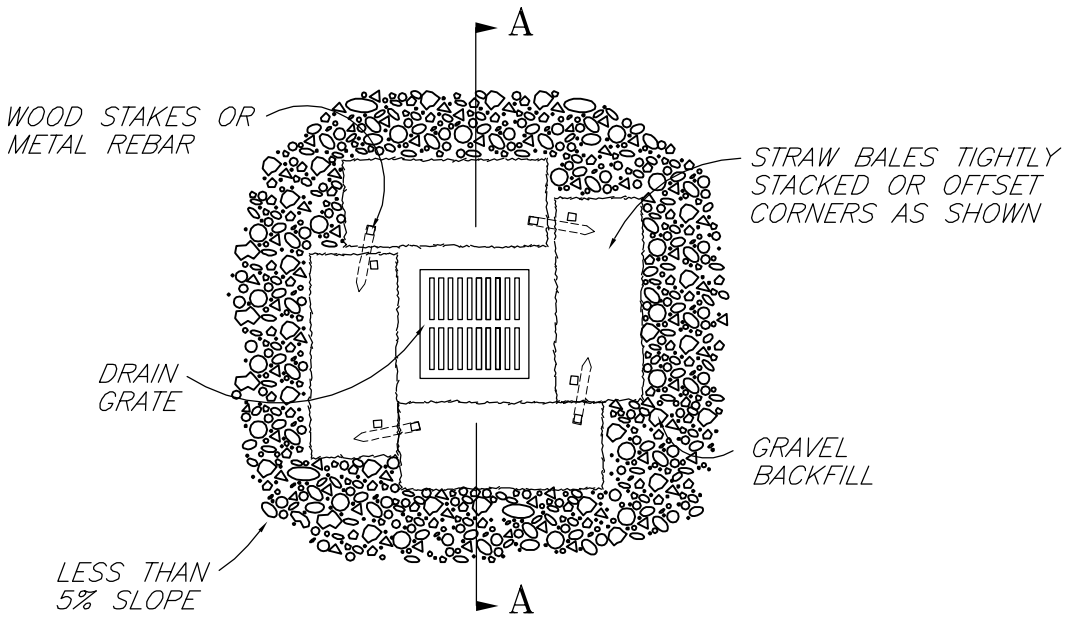
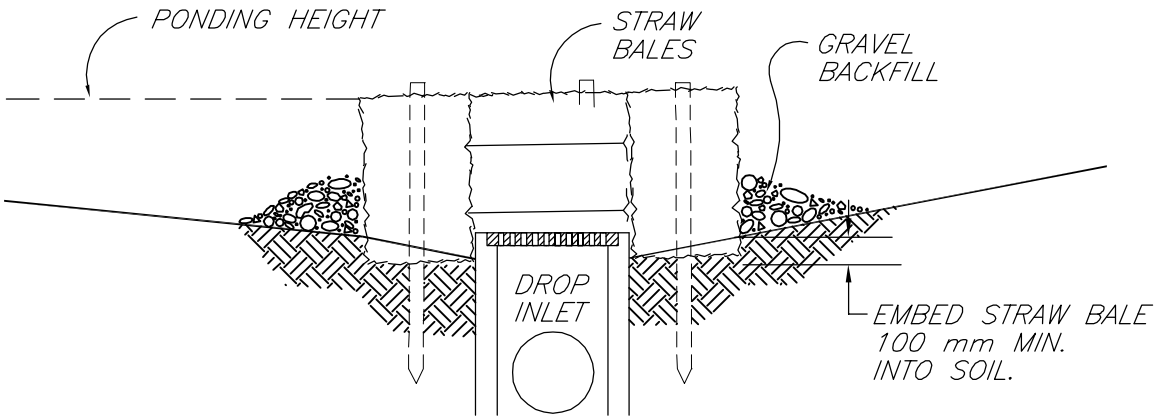


PLAN VIEW



SECTION A–A

NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. EMBED THE BALES 100 mm INTO THE SOIL AND OFFSET CORNERS OR PLACE BALES WITH ENDS TIGHTLY ABUTING. GRAVEL BACKFILL WILL PREVENT EROSION OR FLOW AROUND THE BALES.
3. THE TOP OF THE STRUCTURE (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BYPASSING THE INLET. EXCAVATION OF A BASIN ADJACENT TO THE DROP INLET OR A TEMPORARY DIKE ON THE DOWNSLOPE OF THE STRUCTURE MAY BE NECESSARY.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

STORM DRAIN DROP INLET SEDIMENT BARRIER

(STRAW BALE / GRAVEL – OPTION)

FILE: STRWGRVB

Alberta TRANSPORTATION

B.M.P. #6e
Typical Section

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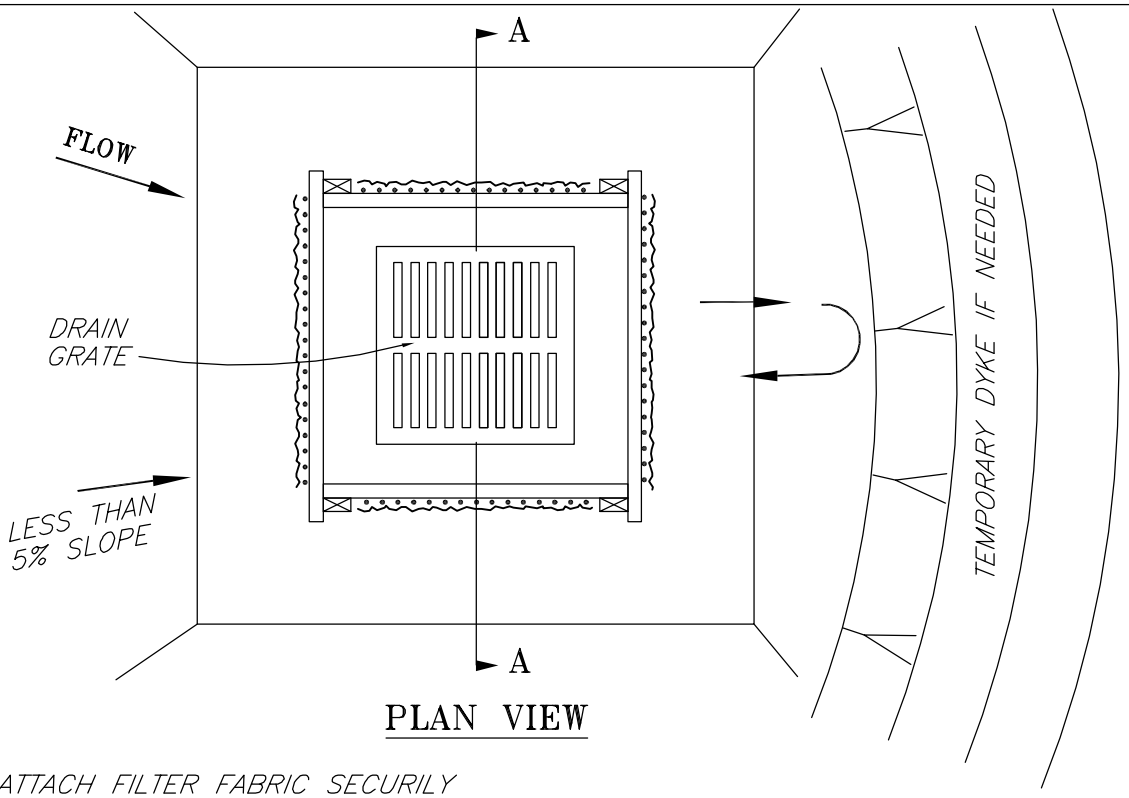
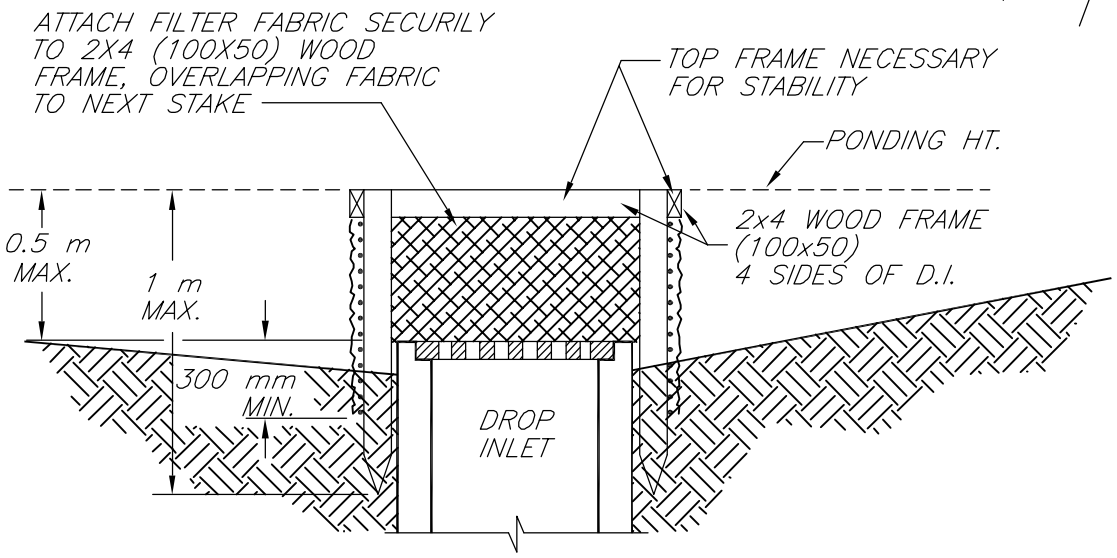


PLAN VIEW



SECTION A–A

NOTES:

1. DROP INLET SEDIMENT BARRIERS ARE TO BE USED FOR SMALL, NEARLY LEVEL DRAINAGE AREAS. (LESS THAN 5%)
2. USE 2"X4" (100X50mm) WOOD OR EQUIVALENT METAL STAKES, 1 m MINIMUM LENGTH.
3. INSTALL 2"X4" (100X50mm) WOOD TOP FRAME TO INSURE STABILITY.
4. THE TOP OF THE FRAME (PONDING HEIGHT) MUST BE WELL BELOW THE GROUND ELEVATION DOWNSLOPE TO PREVENT RUNOFF FROM BY–PASSING THE INLET. A TEMPORARY DYKE MAY BE NECESSARY ON THE DOWNSLOPE SIDE OF THE STRUCTURE.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

FILE: SILTFDIB

STORM DRAIN DROP INLET SEDIMENT BARRIER

(SILT FENCE – OPTION)

Alberta TRANSPORTATION

B.M.P. #6f
Typical Section

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Rock Check Dam

Erosion Control and Sediment Control

B.M.P. #7

Description and Purpose

- Small dam constructed of rock placed across steep channel
- Decrease flow velocities to reduce erosion caused by storm runoff
- Sediment laden runoff is retained allowing sediment to settle out

Applications

- Temporary or permanent measure
- Reduces long steep grade to intervals of gentle grades between successive structures
- Reduces flow velocities and kinetic energy to decrease erosion potential caused by runoff
- Sediment laden runoff is retained behind structure allowing sediment to settle out
- May be used in channels that drain 4 ha (10 ac) or less
- May be used in steep channels where storm water runoff velocity is less than 1.5 m/s (5 fps)

Advantages

- More effective than straw bales for stabilizing medium to steep gradient ditches as a permanent measure
- Cheaper than using riprap armouring or gabion structures in a ditch
- Easy to construct

Limitations

- Not appropriate for high flow velocity >1.5 m/sec; (use gabion structures for flow velocity >1.5 m/sec)
- Not appropriate for channels draining areas larger than 4 ha (10 ac)
- Not to be placed in grass lined channels unless erosion is anticipated
- Susceptible to failure if water undermines or outflanks structure

Rock Check Dam Erosion Control and Sediment Control	B.M.P. #7

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Excavate a trench key a minimum of 0.15 m in depth at the rock check structure location
- Place non-woven geotextile fabric over footprint area of rock check
- Construct structure by machine or hand
- Structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of structures should be less than 0.8 m in height to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 3H:1V (minimum)
- Upstream slope of the check dam should be 2H:1V (minimum)

Construction Considerations

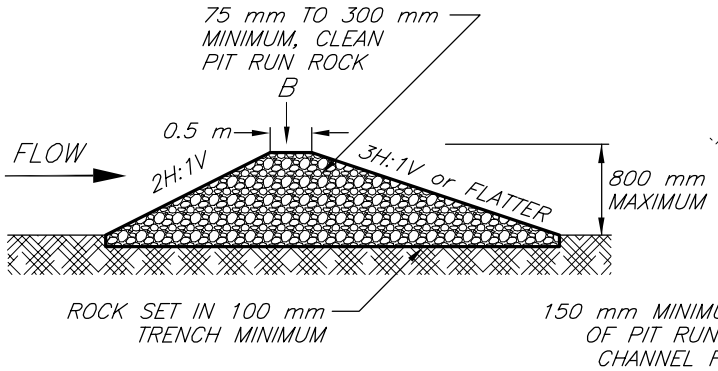
- Height and spacing between structures should be designed to reduce steep channel slope to intervals of flatter gradient
- Rock check structures should be constructed of free draining aggregate
- Aggregate used should have a mean diameter (D_{50}) of between 75 mm and 150 mm and must be large enough to remain in place during high velocity flow situations. Maximum rock diameter should not exceed 150 mm if the structure is to be used as a sediment trap.
- If rock check structures are to be placed in channels with significant high flows, they must be properly designed for stone size and structure spacings

Inspection and Maintenance

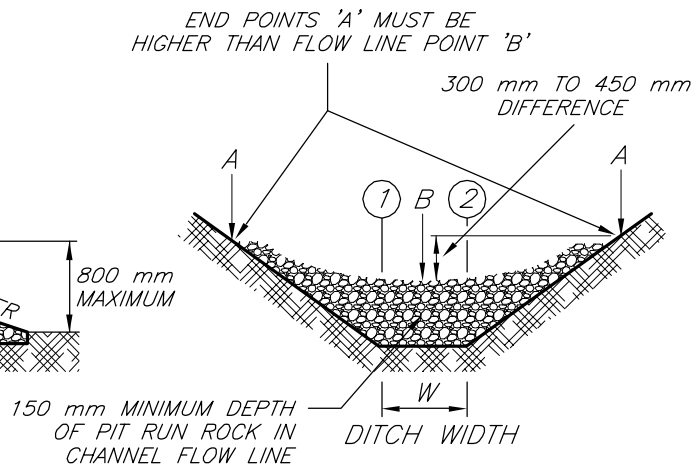
- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged aggregate immediately with heavier aggregate or gabion structures

Similar Measures

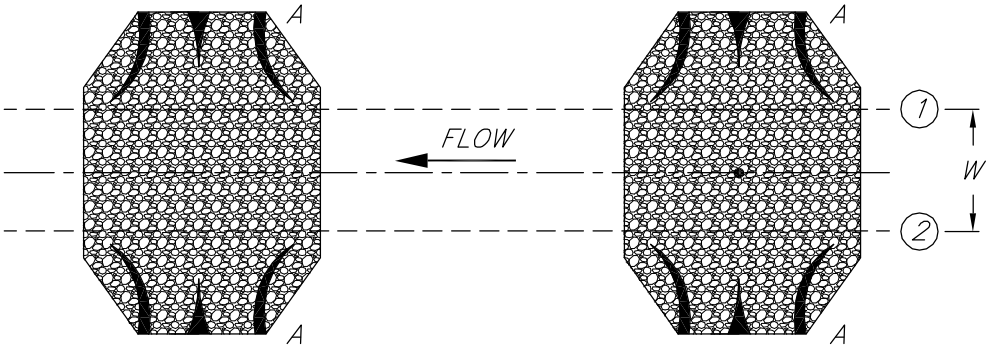
- Sand bag check dam
- Wood check dam
- Straw bale check dam

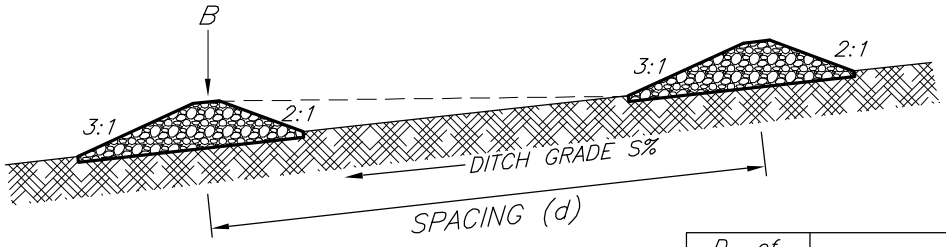


SIDE VIEW



FRONT VIEW





D_{50} of ROCK (mm)	MAXIMUM FLOW DEPTH OVER ROCK (mm)
75	50
150	100

SUGGESTED ROCK DIAMETER AND OVERFLOW DEPTHS

NOTES:

1. SUITABLE FOR FLOW VELOCITY ≤ 1.5 m/s.
2. SUITABLE FOR DRAINAGE AREA ≤ 4 ha.
3. SUITABLE FOR GRADES FROM 5% TO 8%.
4. SPACING (d) AND ROCK SIZE (D_{50}) TO BE DETERMINED BY ENGINEER BASED ON HYDRAULIC CONDITIONS.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

ROCK CHECK DAM

Alberta TRANSPORTATION

B.M.P. #7
Typical Section

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Sand Bag Check Dam Erosion Control and Sediment Control	B.M.P. #8

Description and Purpose

- Small dam constructed with aggregate filled sand bags
- Decrease flow velocities to reduce erosion caused by storm runoff
- Sediment laden runoff is retained allowing sediment to settle out

Applications

- Temporary measure
- May be used in small open channels that drain 2 ha (5 ac) or less
- May be used in steeply graded channels to reduce gradient, especially in highly erodible soils (sand and silt)
- May be used until vegetation is established
- May b used in temporary channels or ditches where short service life does not warrant installation of erosion-resistant linings
- Perimeter control

Advantages

- More effective than silt fences or straw bales for a temporary drop structure and sediment trap for stabilizing major ditches
- Cheaper than armouring entire channel or ditch
- Easily constructed and reusable

Limitations

- Not appropriate for channels draining areas larger than 2 ha (5 ac)
- Require extensive maintenance following high velocity flows associated with storm events
- No filtering capabilities
- Sand bags need to be placed by hand to avoid ripping bags during placement

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Place sandbags by hand at check structure location
- Check structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- Height of check structures should be less than 0.8 m to avoid impounding large volumes of runoff
- Downstream slope of the check dam should be 2.5H:1V (minimum)
- Upstream slope of the check dam should be 1.5H:1V (minimum)

Sand Bag Check Dam Erosion Control and Sediment Control	B.M.P. #8

Construction Considerations

- Height and spacing of check structures should be designed to reduce channel slope to intervals of flatter gradient
- Sandbags should only be filled ¾full to allow bag to mould to contours, allowing continuous contact between the bag and the soil

Inspection and Maintenance

- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged or damaged bags immediately

Similar Measures

- Rock check dam
- Wood check dam
- Straw bale check dam

Log Check Dam Erosion Control and Sediment Control	B.M.P. #9

Description and Purpose

- Small dam constructed of wood (logs/timbers)
- Decrease flow velocities to reduce erosion caused by storm runoff
- Used to reduce steeply graded channels to intervals of flatter gradients to reduce erosion flow velocity and energy especially in highly erodible soils (sand and silt)
- Sediment laden runoff is retained allowing sediment to settle out

Applications

- Temporary or permanent measure
- Used in small open channels that drain 4 ha (10 ac) or less
- Used in areas where logs/timber is readily available
- Can be economical by reusing suitable timber material salvaged from clearing operations

Advantages

- More effective than silt fences or straw bales as temporary drop structure and sediment entrapment for stabilizing major ditches
- Cheaper than gabion structures depending on the availability of timber and its proximity to the construction site

Limitations

- Not appropriate for channels draining areas larger than 4 ha (10 ac)
- Not to be placed in grass lined channels unless erosion is anticipated
- Labour intensive construction
- Undermining and outflanking around the ends may occur if constructed improperly
- Gaps between logs may allow sediment laden runoff to escape
- Logs/timbers will decay and rot with time

Log Check Dam Erosion Control and Sediment Control	B.M.P. #9

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Embed ends of logs at least 0.5 m into channel or ditch bed
- Ensure there are minimal gaps between logs
- Install horizontal cross brace at top of the downstream side of structure to connect logs together providing integral support
- Structure should extend from one side of the ditch or channel to the other
- Structure should be constructed so that centre of the crest is depressed to form a centre flow width which is a minimum of 0.30 m lower than the outer edges
- To avoid impounding large volumes of runoff, check structures should be less than 0.5 m in height above the base of the ditch.

Construction Considerations

- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- Wood check dams placed in ditches with high anticipated flow velocity should have their spacing and height design according to the anticipated hydraulic condition
- Bracing should be installed to provide support to embedded logs

Inspection and Maintenance

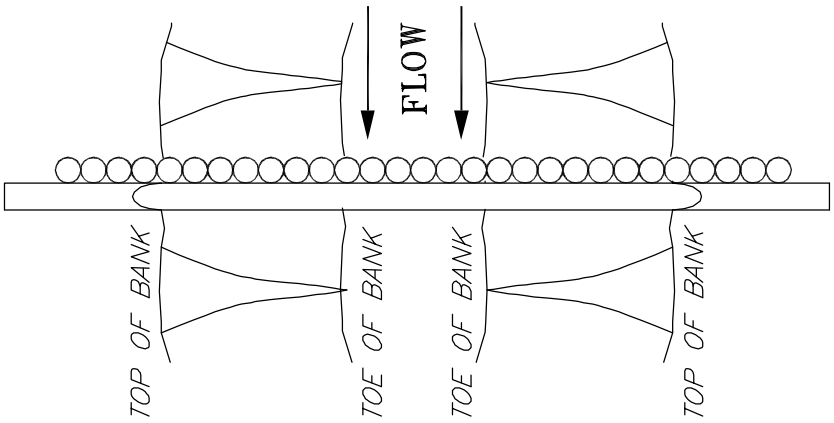
- Inspect barriers at least once a week and before and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace dislodged, decayed, or damaged wood immediately

Similar Measures

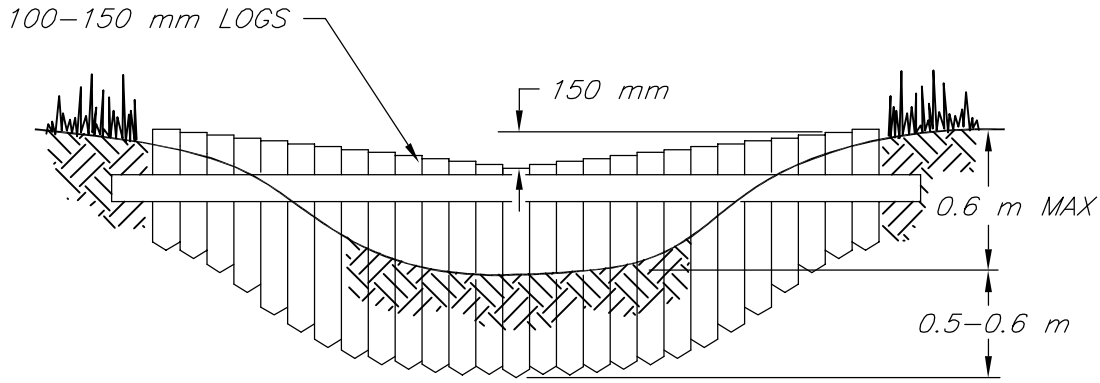
- Rock check dam
- Sand bag check dam
- Straw bale check dam

Design Considerations

- Install splash pad (energy dissipater) on downstream side of structure to reduce erosion potential of water overtopping the structure
  - Splash pad can be constructed of gravel, riprap, or bound woody debris

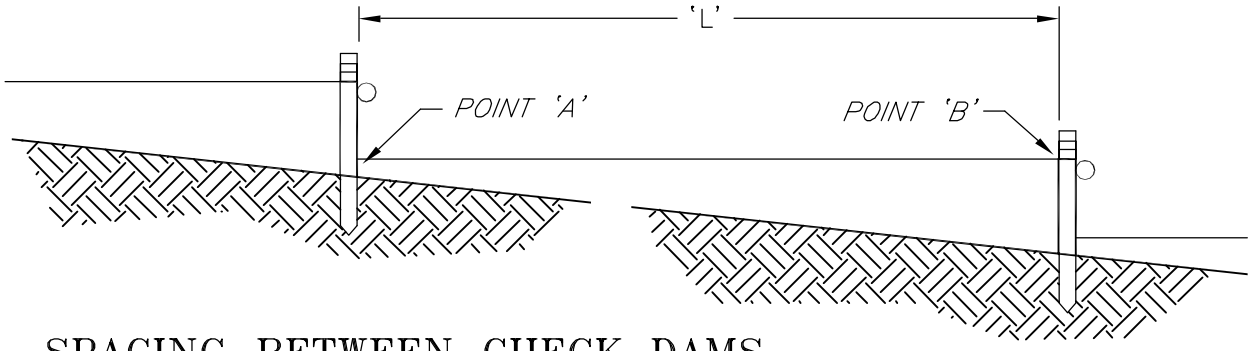


PLAN VIEW



VIEW LOOKING UPSTREAM

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION



SPACING BETWEEN CHECK DAMS

NOT TO SCALE

NOTES:

1. KEY THE ENDS OF THE CHECK DAM INTO THE CHANNEL BANK. LOGS SHALL BE PRESSURE TREATED IF GRADE STABILIZATION STRUCTURE IS INTENDED TO BE PERMANENT.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

FILE: LOGCHKDM

LOG CHECK DAM

Alberta TRANSPORTATION

B.M.P. #9
Typical Section

0104–01–23211/BMP09–A.dwg

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Synthetic Permeable Barrier Erosion Control and Sediment Control	B.M.P. #10

Description and Purpose

- Double panel, low profile, uni-body porous synthetic barriers used to dissipate flow energy and reduce velocity
- Barriers of patented design constructed of lightweight and durable synthetic materials
- May be used to create a grade break to reduce flow energy and velocities allowing some sediment to settle out at the upstream barrier panel of the barrier structure
- Can be used to dissipate flow energy and trap sediment during the period of revegetation; should be removed at successful re-establishment of vegetation

Applications

- Temporary structure
- May be placed across trapezoidal ditch to dissipate flow energy and reduce flow velocities
- Can be used to supplement as grade breaks along ditch interval between permanent drop structures along steep ditch grades
- May be used as midslope grade breaks along contours of midslope or at toe of disturbed slopes
- Usually used as grade breaks along ditch (3 to 7% grade) in conjunction with erosion control matting or non-woven geotextile as soil covering mattings; usually used in conjunction with permanent gabion structure (i.e. gabion) at steep grade (+6%) areas
- Designed to be reusable

Advantages

- Prefabricated
- Reusable/moveable
- More appropriate for installing at transition areas of changing grades of channels so that hydraulic jumps (or change of flow regime from supercritical to subcritical) may be simulated to dissipate flow energy, thus minimizing erosion potential
- Provide portable drainage control for construction sites, ditches, channels, roads, slopes
- The double panel porous barrier may allow significant energy loss as the flow of water undergoes from supercritical flow to sub-critical flow from the upstream panel to the downstream panel with a more laminar flow evolving downstream and roughly parallel to the stream bed. Less turbulence and erosion energy may be created when compared with cascading, over-topping and tumbling flow from drop structures (i.e. gabions, check structures, straw bales)
- Barriers constructed of UV resistant material may be left in place for final channel stabilization as UV degradation is low
- Observed to enhance aggregation of silt material and to function as a sediment barrier with the formation of an earth block at behind the upstream barrier panel area; the downstream flow exiting at the downstream barrier panel may be of laminar nature and less erosive

Synthetic Permeable Barrier Erosion Control and Sediment Control	B.M.P. #10

Limitations

- More appropriate for use as a grade break and may be installed between permanent drop structures
- Partially effective in retaining some sediment and reducing flow velocities
- Less sturdy as drop structures in resisting high flow impact
- Not to be designed as drop structures
- Must be hand installed
- Become brittle in winter and may be easily damaged by highway maintenance activities or by public
- At the time of deactivation of the structure after vegetation establishment, metallic anchor pins, if not biodegradable, may require removal at time of completed revegetation
- Stick-up of metallic anchor pin above ground may be a nuisance and, may cause damage to human and maintenance equipment
- The use of biodegradable anchor pins may be advisable

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Install as per manufacturers recommended installation instructions
- Normally installed in conjunction with erosion control matting in ditches and channels
- Prepare soil surface
- Install basal layer of erosion mat or geotextile fabric; key-in basal mat/fabric at upstream end
- Place and anchor barrier panels with adequate pin anchors to basal soils

Construction Considerations

- Maintain intimate contact between base of barrier and soil with laying of basal matting/fabric intimate to ground surface
- Ensure side panel of barrier is extended to outer edges of channel to sufficient height to provide freeboard of channel flow

Inspection and Maintenance

- Inspect barriers at bi-weekly intervals and after each significant rainfall event
- Remove sediment build-up before it reaches one-half the check structure height
- Do not damage barrier panel during removal of sediment
- Partial or non-removal of sediment build-up will create a non-permeable barrier and low level earth mini-drop structure which will force water flow over-topping the barrier. The option of non-removal of sediments may be open to converting the sediment build-up into a "vegetated earth mini-drop structure" along the ditch with the non-removal of synthetic permeable barrier in-place. This will require topsoil and seeding (or intensive mulch seeding) to promote vegetation growth.

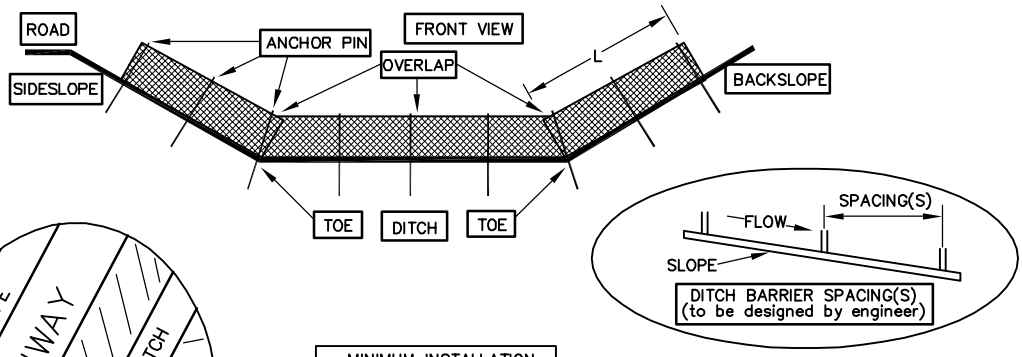
- If erosion is noted at the toe or upslope edges of the structure, hand regrading or suitable repairs should be made immediately to prevent failure of the structure
- Remove and deactivate at 1 year after vegetation is established

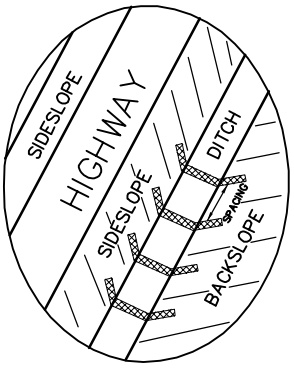
Similar Measures

- Silt fences or straw bales partially equivalent in retaining sediment
- Brush or rock filter berms

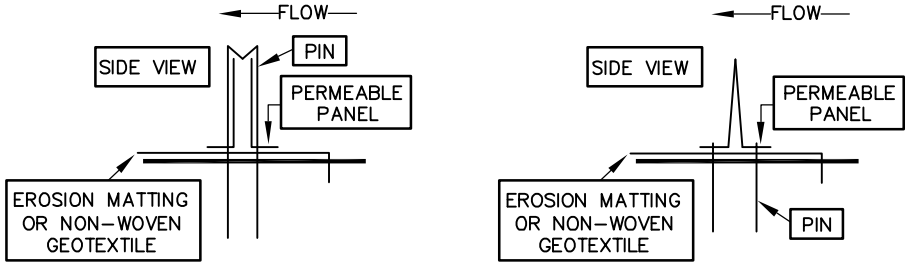
Design Considerations

- Install synthetic permeable barrier along ditch interval between permanent drop structures (i.e. gabion); can be economic alternative and supplemental to (i) total hard armouring of complete channel length, or (ii) high frequency of gabion installation required for high flow applications in steep ditch grade





MINIMUM INSTALLATION LENGTH UP SLOPES	
SLOPE	LENGTH: L (m)
2:1	0.55
2.5:1	1.1
3:1	1.1
3.5:1	1.1
4:1	1.1
5:1	1.3
6:1	1.5



1) DOUBLE PANEL

2) TRIANGLE PANEL

SYNTHETIC PERMEABLE DITCH BARRIER

N.T.S.

NOTES:

1. *FOR USE MAINLY AS A GRADE BREAK STRUCTURE FUNCTIONING AS A FLOW ENERGY DISSIPATOR AND VELOCITY RETARDER.*
2. *FOR SECONDARY USE AS SEDIMENT BARRIER.*
3. *REQUIRES NON-WOVEN GEOTEXTILE FABRIC OR BIODEGRADABLE (COCONUT FIBRE PREFERABLE) EROSION BLANKET MAT AT BASE AND KEY-IN TO SOIL AT UPSTREAM END.*
4. *MAY BE INSTALLED AS GRADE BREAK AT GRADE TRANSITION AREAS TO CREATE DISSIPATION OF FLOW ENERGY AND A MORE LAMINAR FLOW REGIME DOWNSTREAM OF STRUCTURE.*
5. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

SYNTHETIC PERMEABLE (ditch) BARRIERS

Alberta TRANSPORTATION

B.M.P. #10
Typical Section

0104-01-23211/BMP10-A.dwg

Straw Bale Check Dam Erosion Control and Sediment Control	B.M.P. #11

Description and Purpose

- Small, temporary dam constructed of straw bales as drop structures placed across channels
- Sediment laden runoff is ponded allowing sediment to settle out or is filtered through the straw bale
- Reduce steep grade to intervals of flatter grades between structures
- Decrease flow velocities to reduce erosion potential caused by storm runoff

Applications

- Temporary measure
- May be used in small open channels that drain 2 ha (5 ac) or less
- May be used in channels with grade of less than 5%
- May be used for flow velocities of 0.3 m/s or less
- May be used until vegetation is established
- May be used in temporary channels or ditches (offtakes) where short service life does not warrant installation of erosion-resistant linings

Advantages

- Economical in areas where straw is readily available or within an economical hauling distance
- Biodegradable

Limitations

- Not appropriate for channels draining areas larger than 2 ha (5 ac)
- Not appropriate for channels graded greater than 5%
- Not appropriate for flow velocities greater than 0.3 m/s as straw bale can be damaged by high flow impacts
- Require extensive maintenance following high velocity flows associated with storm events
- Not as robust as rock, wood, or sand bag check dams
- Susceptible to failure if bales are not properly trenched and anchored thus allowing water to undermine or outflank the structure
- Service life is short
- Must be installed by hand
- Straw bale check structure should only be a maximum of one straw bale in height or 0.5 m maximum

Straw Bale Check Dam Erosion Control and Sediment Control	B.M.P. #11

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Excavate a trench approximately 0.15 m deep with a width of two straw bales at the straw bale check structure location
- Place two rows of straw bales in excavated trench perpendicular to flow direction ensuring bales are staggered so that no joints are aligned on the upstream and downstream rows. Ensure twine or wire is not in contact with the soil
- Infill all joints with straw
- The centre of the crest of the check structure should be a centre flow width at least 0.15 m lower than the outer edges along the channel walls
- Drive two 50 mm square section wooden stakes 1.2 m long through each straw bale, ensuring stake is embedded a minimum of 0.15 m into soil
- Backfill and compact the upstream and downstream edges of the check structure to seat the straw bales into the base of the ditch
- Geotextile wrapping may be specified. The geotextile shall be pinned to the straw bale subgrade.

Construction Considerations

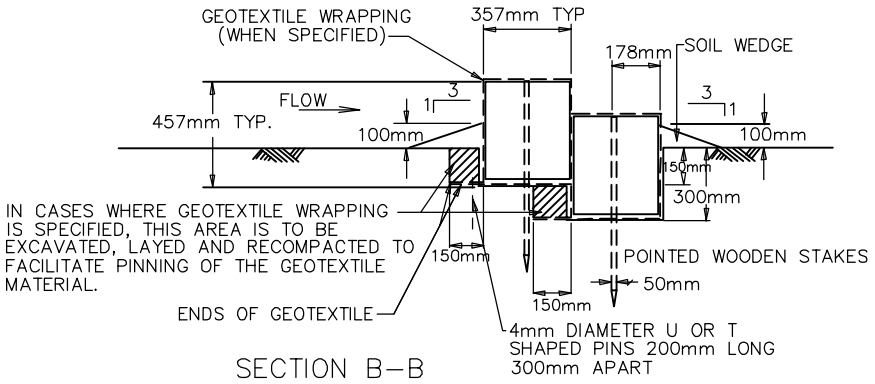
- Height and spacing of structures should be designed to reduce gradient to a flatter grade
- To avoid impounding large volumes of runoff, check structures should be a maximum of one straw bale high
- Straw bales should be:
  - Machine-made
  - Weed free cereal crop straw such as wheat, oats, rye, or barley
  - Tightly compacted and bound with two rows of wire or synthetic string and shall show no signs of weathering
  - No more than year old

Inspection and Maintenance

- Inspect barriers at weekly intervals and after each significant rainfall event (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Remove sediment build up before it reaches one half the check structure height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace damaged, decayed, or dislodged straw bales immediately
- Straw bale check structure should be maintained until no longer required

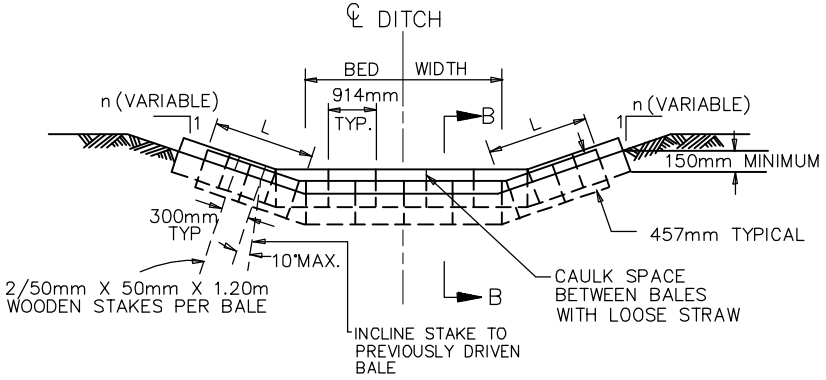
Similar Measures

- Rock check dam
- Aggregate filled sand bag check structure
- Log check dam



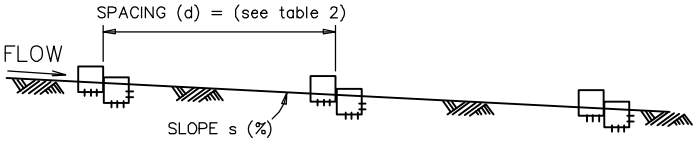
SECTION B–B

TABLE 1	
MINIMUM INSTALLATION LENGTH UP SLOPES	
SLOPE n	LENGTH L (m)
2	1.0
2.5	1.25
3.0	1.50
3.5	1.65
4	1.80
5	2.35
6	2.75

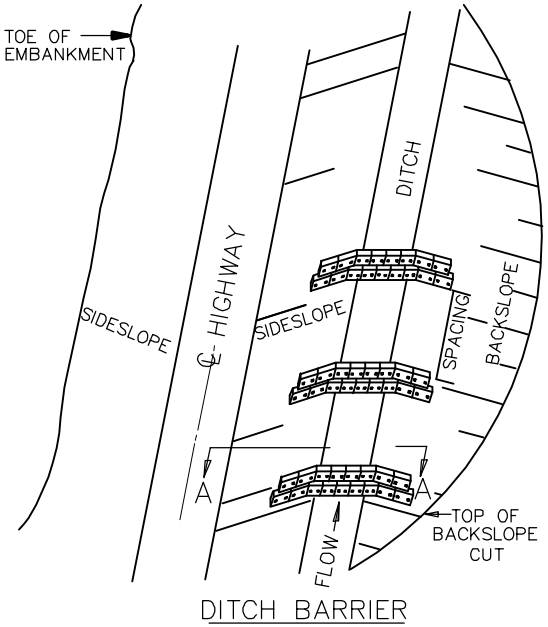


ELEVATION A–A (WOODEN STAKES OMITTED FOR CLARITY)

TABLE 2	
SUGGESTED SPACING (d)	
S (%)	d (m)
3	40
4	35
5	25



TYPICAL DITCH BARRIER SPACING



DITCH BARRIER

NOTES:

1. *SUITABLE FOR S < 5% AND HYDRAULIC CONDITIONS NOT SEVERE FOR S > 5%, THE ENGINEER MUST ASSESS USE OF THIS STRUCTURE VERSUS OTHER OPTIONS.*
2. *EMBED BALES 100 TO 150 mm INTO THE SOIL AND "KEY BALES INTO THE CHANNEL BANKS.*
3. *PLACE BALES PERPENDICULAR TO THE FLOW WITH ENDS TIGHTLY ABUTTING.*
4. *BALE HEIGHT SHALL NOT EXCEED 0.5 m.*
5. *INSPECT AFTER EACH SIGNIFICANT STORM, MAINTAIN AND REPAIR PROMPTLY.*
6. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

STRAW BALE CHECK DAM

Alberta TRANSPORTATION

B.M.P. #11
Typical Section

0104–01–23211/BMP11–A.dwg

Straw Bale Barrier Sediment Control	B.M.P. #12

Description and Purpose

- A barrier of strawbale primarily used as a perimeter sediment control measure
- May be used to intercept and retain sediment laden runoff allowing a portion of the sediment load to be retained

Applications

- Temporary measure
- Suitable for flow velocities of 0.3 m/s or less
- Usually placed at 1m to 2 m offsets from toe of disturbed slopes
- Size of drainage area should be no greater than 0.1 ha per 30 m length of straw bale sediment barrier
- Maximum flow path length upstream of barrier should be less than 30 m
- Maximum slope gradient above the barrier should be no greater than 2H:1V
- May be used in conjunction with filter fabric as external wrap to encapsulate the bale

Advantages

- Straw bales are biodegradable
- Only requires one row of straw bales
- Easier to install than other barriers and economical if straw bales are readily available

Limitations

- Not appropriate for flow velocities greater than 0.3 m/s
- Require extensive maintenance following high velocity flows associated with storm events
- Not as robust as earth berms or continuous berms
- Susceptible to undermining and erosion damage if not properly keyed into substrate soil or if joints are not completely infilled with straw
- Short service life
- Must be installed by hand
- Not to be used on asphalt or concrete covered surfaces
- Availability of appropriate bales may be limited in certain areas of the province
- Maximum straw bale barrier height of one straw bale or 0.5 m maximum height

Straw Bale Barrier Sediment Control	B.M.P. #12

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Straw bale barrier should be located a minimum distance 1.8 m away from the toe of the slope to provide adequate ponding and sedimentation area
- Excavate a trench approximately 0.10 m deep with a width of one straw bale at the straw bale barrier location
- Place straw bales in excavated trench along contour, perpendicular to flow direction
  - Ensure twine or wire is not in contact with the soil
  - Ensure straw bale is in continuous contact with base of trench
  - Ends of barrier should be angled upslope to form enclosure to contain runoff
- Infill all joints with loose straw
- Drive two 50 mm by 560 mm section wooden stakes 1.2 m long through each straw bale, ensuring each stake is embedded a minimum of 0.15 m into soil
- Backfill and compact the upstream and downstream edges of the check structure to seat the straw bales into the subgrade

Construction Considerations

- Maximum lengths of barriers should be 40 m, including 'J-hook' or 'smile' (similar to silt fence in BMP #1) configuration, to allow escape route for excess runoff
- Barrier should be placed far enough away from toe of slope to provide adequate ponding and sedimentation area (minimum of 1.8 m away from toe of slope is recommended)
- Ends of barriers should be angled upslope (in a 'J-hook' or 'smile' configuration) to form enclosure to collect runoff
- Straw bales should be:
  - Machine-made
  - Weed free cereal crop straw such as wheat, oats, rye, or barley
  - Tightly compacted and bound with two rows of wire or synthetic string and shall show no signs of weathering
  - No more than one year old

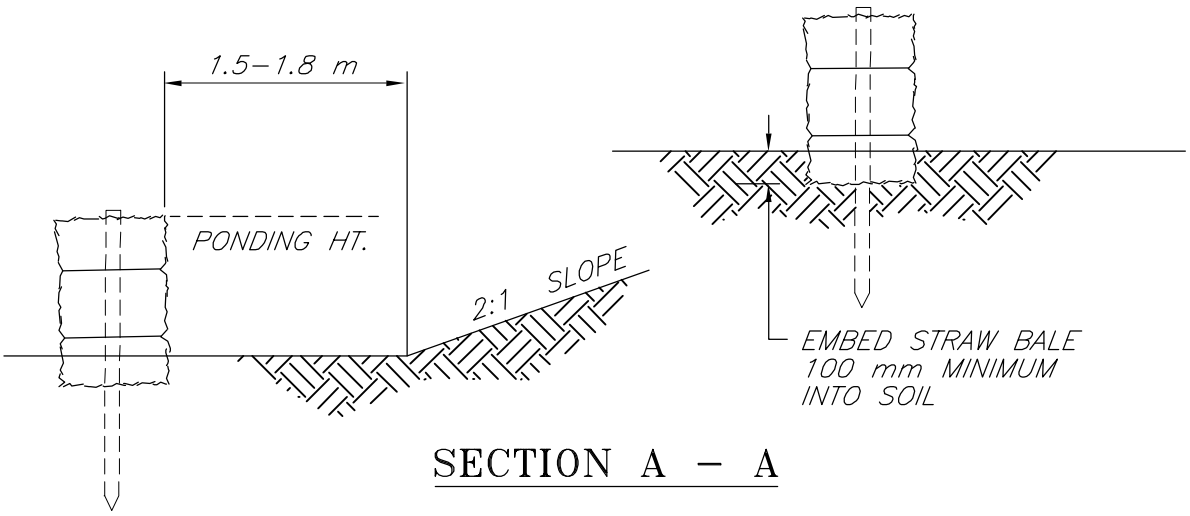
Inspection and Maintenance

- Inspect barriers at least at weekly intervals and after each significant rainfall event (more than 25 mm in a 24 hour period)
- Remove sediment build up before it reaches one half the check barrier height
- Erosion repairs should be made immediately to prevent failure of the structure
- Replace damaged, decayed or dislodged straw bales immediately

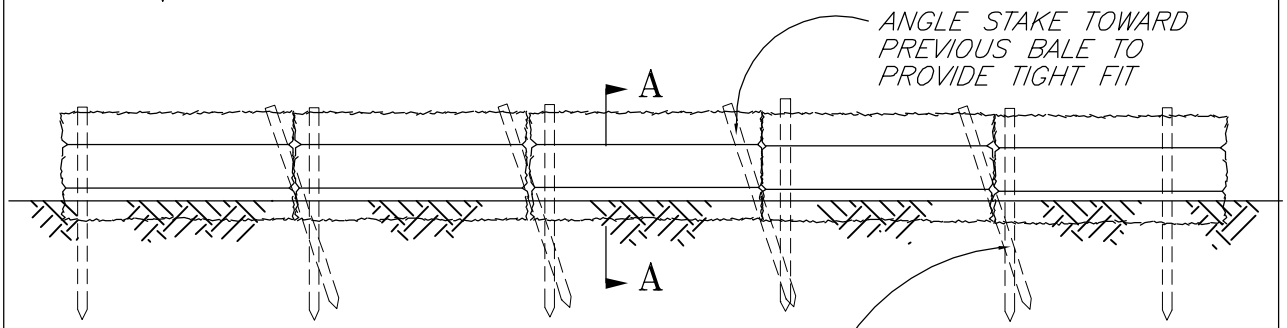
Straw Bale Barrier Sediment Control	B.M.P. #12

Similar Measures

- Silt fences
- Continuous (earth-filled geotextile) berms
- Earth Dyke Barrier

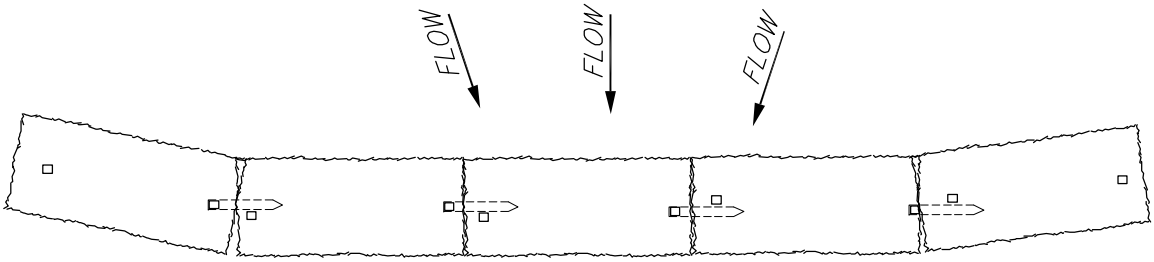


SECTION A – A



SECTION B – B

WOODEN STAKE
OR REBAR DRIVEN
THROUGH BALE.



PLAN

NOTES:

1. THE STRAW BALES SHALL BE PLACED ON SLOPE CONTOUR.
2. BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING.
3. KEY IN BALES TO PREVENT EROSION OR FLOW UNDER BALES.
4. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

STRAW BALE BARRIER

FILE: STRWDIKE

Alberta TRANSPORTATION

B.M.P. #12
Typical Section

0104–01–23211/BMP12–A.dwg

Rolled Erosion Control Products (RECP) a) Channel Installation b) Slope Installation Erosion Control	B.M.P. #13

Description and Purpose

- Biodegradable or synthetic soil coverings used for temporary or permanent protection of disturbed soils at slopes and channels
- Categories of Rolled erosion control products (RECP) can be:
  - Erosion control blankets (ECB) (generally biodegradable and temporary)
  - Turf reinforcement mats (TRM)
  - Composite turf reinforcement mats (C-TRM)
- RECP may be manufactured of organic material, synthetic material, or as a composite of organic and synthetic materials
- Protect disturbed soils from raindrop impact and surface runoff erosion, increase water infiltration into soil, retains soil moisture and decreases evaporation loss
- Protect seeds from raindrop impact, runoff, and predators
- Stabilizes soil temperature to promote seed germination and enhance vegetation growth

Applications

- Temporary or permanent measure
- May be used to protect disturbed, exposed soils for cut or fill slopes at gradients of 2.5H:1V or steeper
- May be used on slopes where erosion potential is high
  - Silts and sands have higher erosion potential than high plastic clays
- May be used on slopes where vegetation is likely to be slow to develop
- May be used to protect disturbed exposed soils in ditches and channels (with high flow velocities) by providing additional tractive resistance cover in conjunction with a successful high density vegetative growth established

Advantages

- Degree of erosion protection is higher, more uniform, and longer lasting than for sprayed-on products (e.g. mulches)
- Wide range of commercially available temporary (biodegradable) or permanent products

Limitations

- Non-performance of RECP may result from the following:
  - Low density vegetation growth (beneath RECP) due to non-favorable weather and growth conditions (i.e. soil type, moisture, storm events at critical times). It is noted that values of tractive resistance of RECP products for vegetative growth may be generally tested in laboratory after a growth period (e.g. 3 months) under greenhouse growth conditions. The effectiveness of RECP, especially along channels, is very dependent on success of vegetation growth on site. It is important that the designer should assess the effectiveness of RECP in accordance with site, soil, terrain and vegetation growth conditions.

  - Hydraulic uplift of RECP and erosion of underlying soils can occur under rapid snow melt conditions when dammed up melt water generates a hydraulic head and high flow velocity generated in constricted snow melt channel. This situation can occur along steep channels interlaced with drop structures and with RECP lining installed in-between the drop structures. Ponding of melt water and non-anchored RECP joint areas allow flow entry beneath the RECP and generate hydraulic heads to uplift the RECP. This can occur along un-anchored edges of RECP at upper edges of ditch when snow melt occurs at tops of ditch and flow beneath the RECP. This is especially critical when underlying soil is easily erodible. (e.g. fine grained non-cohesive silty soils). It is important to trench-in and anchor the edges of the RECP installations and installed anchor pin (staples) at sufficient dense intervals.
  - Ice buildup from groundwater seepage source can uplift and dislocate the RECP and causing flow beneath the RECP to erode the substrate soils. Winter ice accumulation may be related to groundwater regime and investigative design on subsurface drainage by a geotechnical engineer is required.
- Can be labour intensive to install
- Must be installed on unfrozen ground
- Temporary blankets may require removal before implementation of permanent measures
- Rolled erosion control products (RECP) are not suitable for rocky sites
- Proper surface preparation is required to ensure intimate contact between blanket and soil
- Plastic sheeting can be used at sensitive slopes with precautions:
  - Plastic sheeting RECP product can be easily torn, ripped, non-biodegradable, and should be disposed of in a landfill
  - Plastic sheeting product, if used, results in 100% runoff, thus increasing erosion potential in downslope areas receiving the increased flow volumes
  - Plastic sheeting should be limited to temporary covering of sensitive soil stockpiles or temporary covering of small critical unstable slope areas

Construction (Slopes)

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- RECP should be installed in accordance with manufacturers directions
- The following is a general installation method
- Prepare surface and place topsoil and seed
- Surface should be smooth and free of large rocks, debris, or other deleterious materials
- Blanket should be anchored at top of slope in a minimum 0.15 m by 0.15 m trench for the entire width of the blanket

- The blanket should be rolled out downslope
  - (1) Where the blanket roll is not long enough to cover the entire length of the slope, a minimum 0.15 m by 0.15 m check slot should be excavated at the location of the lap, and the downslope segment of blanket anchored in the check slot, similar to the method used for the top of the slope, or (2) when blankets, must be spliced down the slope, place blanket end over end (shingle style with approximately 0.10 m overlap. Staple through overlapped area at 0.3 m intervals.
  - The upslope portion of blanket should overlap the downslope portion of blanket, shingle style, at least 0.15 m with staple anchors placed a maximum 0.3 m apart
  - Adjacent rolls of blanket should overlap a minimum 0.1 m
  - Anchors should be placed along central portion of blanket spaced at $4/m^2$ minimum (0.5 m spacing) for slopes steeper than 2H:1V and $1/m^2$ (1 m spacing) for slopes flatter than 2H:1V
  - Anchors along splices between adjacent rolls should be placed 0.9 m apart

Construction (Channels)

(For guidance only. A site specific design is required from designer/engineer)

- A Blanket should be installed in accordance with manufacturers directions
- The following is a general installation method
  - Prepare surface and place topsoil and seed
    - Surface should be smooth and free of large rocks, debris, or other deleterious materials
  - Begin by excavating a minimum 0.15 m deep and 0.15 m wide trench at the upstream end of channel and place end of RECP into trench
    - Use a double row of staggered anchors approximately 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
    - Backfill and compact soil over RECP in trench
  - Roll centre RECP in direction of water flow on base of channel
  - Place RECP end over end (shingle style) with a minimum 0.15 m overlap downgrade
    - Use a double row of staggered anchors approximately 0.1 m apart to secure RECP to soil
  - Full length edge of RECP at top of sideslopes must be anchored in a minimum 0.15 m deep and 0.15 m wide trench
    - Use a double row of staggered staple anchors a maximum of 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
    - Backfill and compact soil over RECP in trench
  - Overlap RECP on sideslopes (shingle style down channel) a minimum of 0.1 m over the centre RECP and secure RECP to soil with anchors spaced a maximum of 0.2 m apart
  - In high flow channels, a check slot across the width of the channel is recommended at a maximum spacing of 10 m to anchor the ends of the RECP to the underlying soil
    - Use a double row of staggered staple anchors a maximum of 0.1 m apart (0.2 m linear spacing) to secure RECP to soil in base of check slot
    - Backfill and compact soil over RECP in check slot

  - Anchor terminal ends of RECP in a minimum 0.15 m deep and 0.15 m wide trench
    - Use a double row of staggered anchors a maximum of 0.1 m apart (i.e. 0.2 m linear spacing) to secure RECP to soil in base of trench
    - Backfill and compact soil over RECP in trench

Construction Considerations

- Slopes should be topsoiled and seeded prior to placing RECP
- Ensure blanket is in intimate contact with the soil by properly grading soil, removing rocks or deleterious materials, prior to placing blanket
- In channels, blankets should extend to above the anticipated flow height, with a minimum 0.5 m of free board
- For turf reinforcement mat (TRM), blanket should be placed immediately after topsoiling
- Blanket should be anchored by using wire staples, metal geotextile stake pins, or triangular wooden stakes
  - All anchors should be a minimum of 0.15 to 0.2 m in length
  - For loose soils, use longer anchors
- Blankets should be placed longitudinal to direction of flow, with fabric not stretched but maintaining contact with underlying soil
- It is essential to understand product specifications and follow manufacturers instructions on installation methods

Product Quality Assurance/Quality Control (QA/QC) Certification

RECPs should be certified by the supplier/manufacturer to ensure product performance and compliance with specified property requirements. A certificate for QA/QC testing of manufactured products is required. The performance and QA/QC testing should be carried out by reputable laboratories (e.g. TxDoT – Hydraulic and Erosion Control Laboratory OR equivalent laboratory) to ensure a commonly acceptable QA/QC standard. Dependent on product type and intended performance, the product information certificate should be provided by the product supplier/manufacturer to include the following:

- Manufacturer's Certificate on
- Performance specification
  - Permissible Tractive Resistance (include testing methods and vegetative growth conditions)
  - Permissible Flow Velocity (if available)
  - Longevity (for biodegradable or non-biodegradable products)
- Minimum Average Roll Values (MARVs) along with specified testing methods for
  - Physical properties
    - Mass per unit area
    - Thickness
    - Tensile strength
    - UV Resistance

  - Other physical properties (for non-woven below Erosion Mat (if specified)
    - Grab tensile strength
    - Grab elongation
    - Puncture strength
    - Trapezoidal tear
    - UV Resistance

Inspection and Maintenance

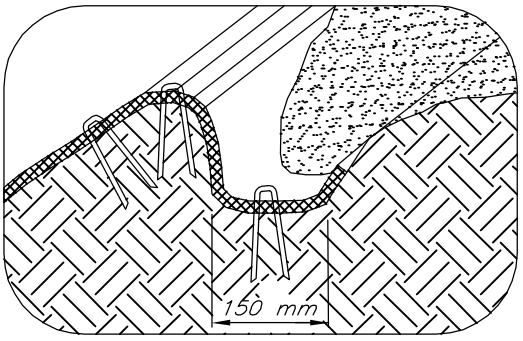
- Area covered with blankets should be regularly inspected/remediated, especially after periods of severe rainfall or storm events, to check for blanket separation or breakage
- Any damaged or poorly performing areas should be repaired/remediated immediately. Regrading of the slope by hand methods may be required in the event of rill or gully erosion.
- Inspection and maintenance should continue until dense vegetation is established
- Areas with low vegetation density should be reseeded
- After approximately one year, a top dressing of fertilizer may be applied to improve vegetation cover and assist degradation of temporary blankets

Similar Measures

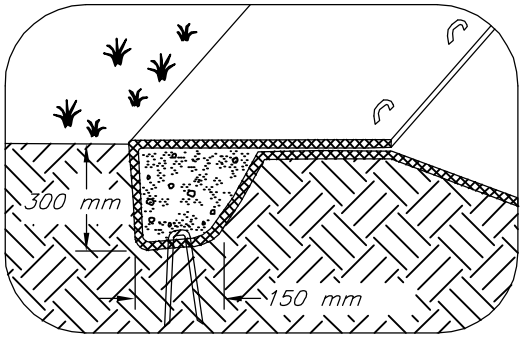
- Mulching (for slopes only)
- Chemical stabilization (for slopes only, e.g. tackifiers)
- Rip rap (primarily in channels)
- Gabion mattresses (primarily in channels)

Design Considerations

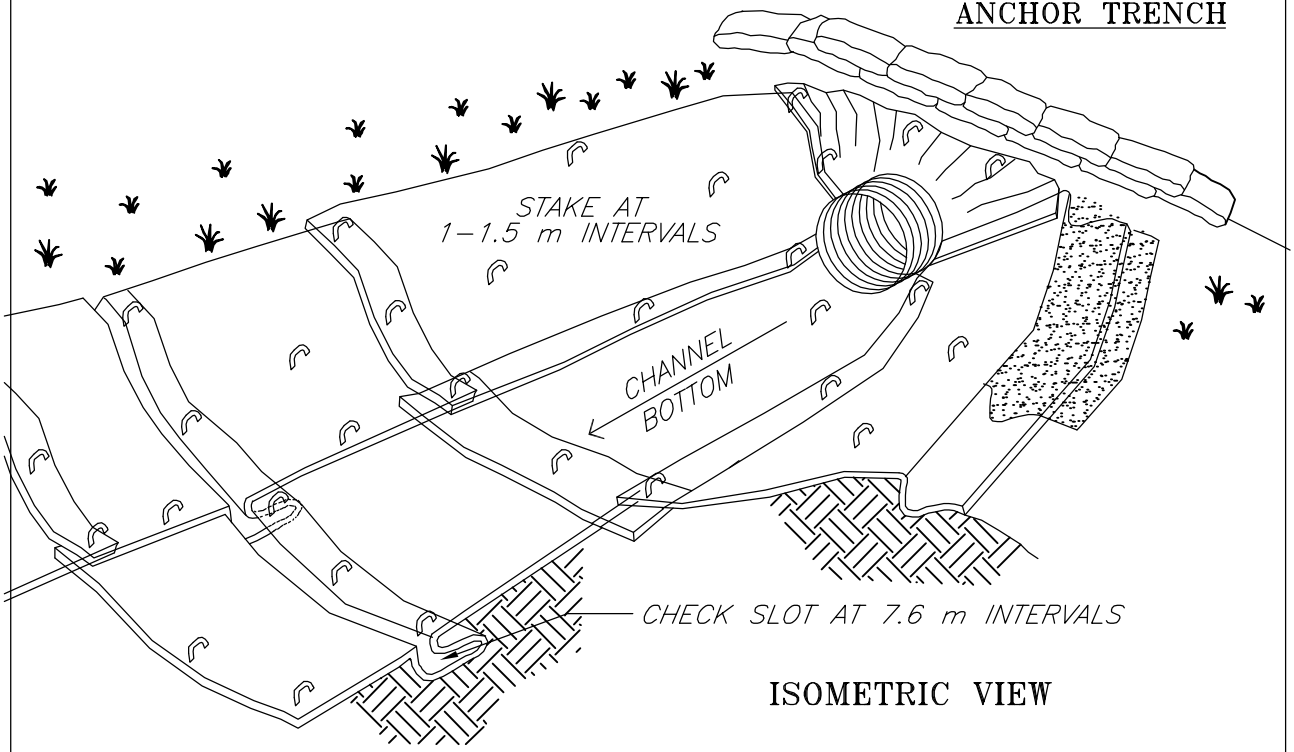
- Assess hydraulic flow conditions and tractive stress on channel
- Assess local soil, weather and growth conditions (favourable/non-favourable) for revegetation (within 3 to 12 months) to allow a determination on use or non-use of RECP as a protective measure. If the revegetation conditions are assessed favourable, the use of RECP can be considered
- Assess suitability of a RECP product using tractive resistance data tested for (i) bare soil, and (ii) vegetated (a specified duration of growth period) condition
- It is noted that tractive resistance data are adopted as selection criteria of RECP and permissible velocity data can be provided for reference.



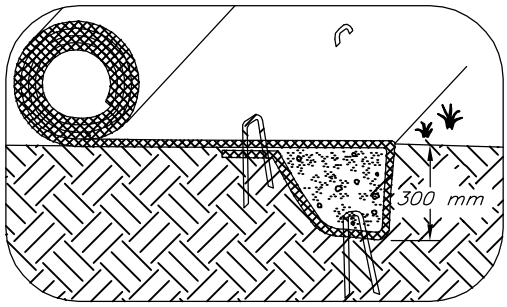
LONGITUDINAL ANCHOR TRENCH



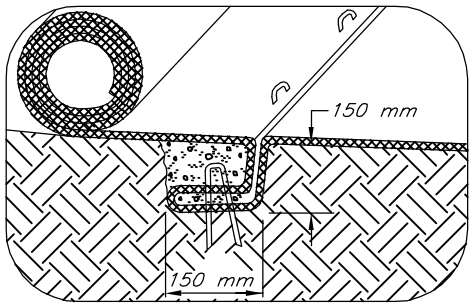
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH



ISOMETRIC VIEW



INITIAL CHANNEL ANCHOR TRENCH



INTERMITTENT CHECK SLOT

NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.
3. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

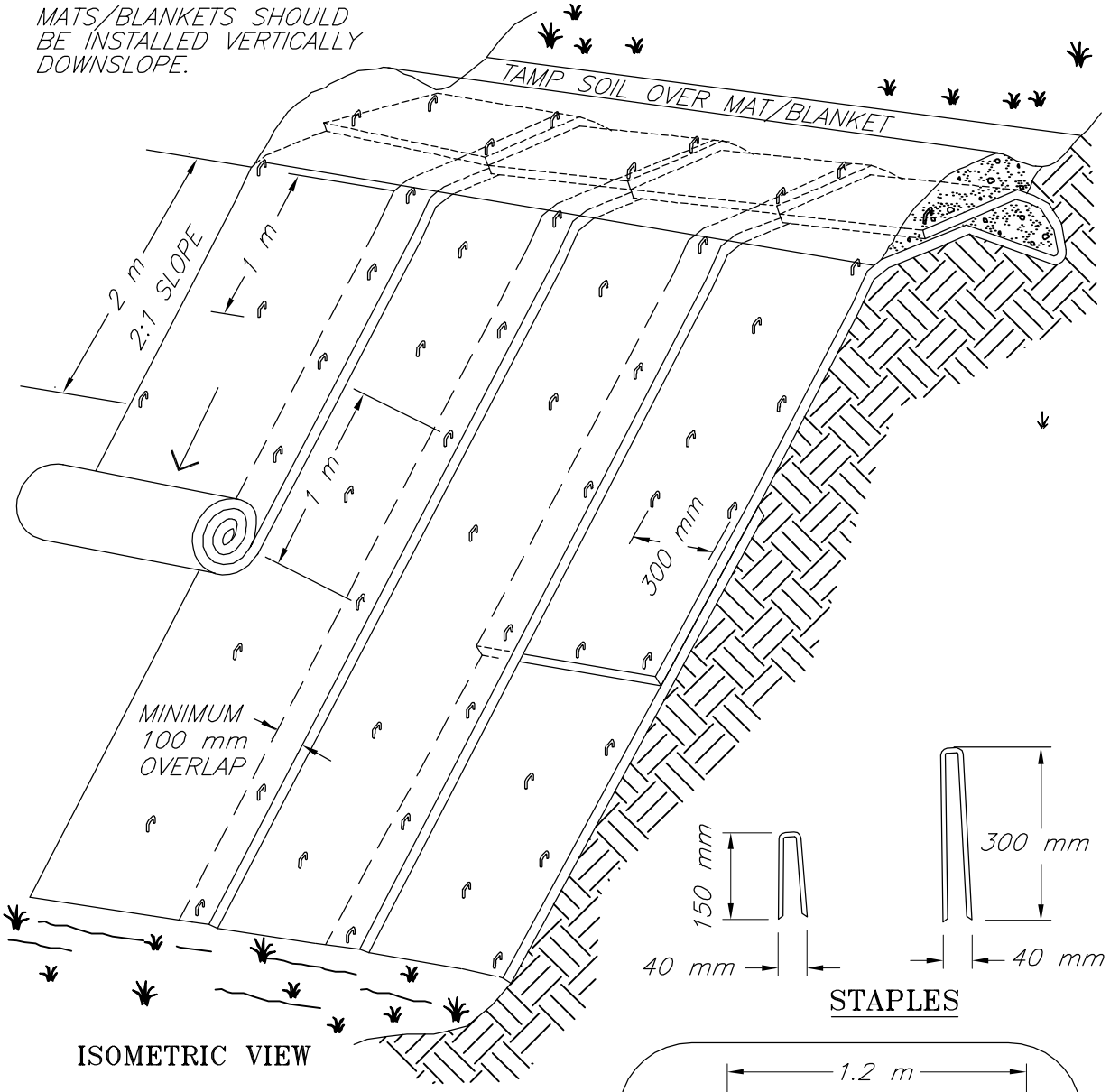
ROLLED EROSION CONTROL PRODUCTS (RECP)

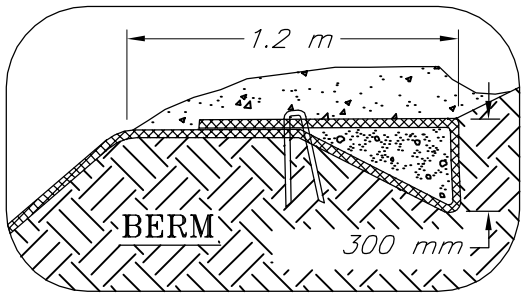
CHANNEL INSTALLATION

Alberta TRANSPORTATION

B.M.P. #13a
Typical Section

0104–01–23211/BMP13A–A.dwg





NOT TO SCALE

TYPICAL SLOPE SOIL STABLIZATION

NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/ BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
4. CHECK SLOTS, STAKING, STAPLING AND OTHER CONSTRUCTION DETAILS PER MANUFACTURES SPECIFICATIONS.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

ROLLED EROSION CONTROL PRODUCTS (RECP) SLOPE INSTALLATION

Alberta TRANSPORTATION

B.M.P. #13b
Typical Section

0104–01–23211/BMP13B–A.dwg

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Riprap Armouring a) Slope Protection b) Channel Protection Erosion Control	B.M.P. #14 (a & b)

Description and Purpose

- Large, loosely placed cobbles or boulders placed along channel banks or slopes to protect underlying soil from erosion due to flowing water
- Can protect slopes and channel banks against erosion

Applications

- Permanent measure
- May be used on channel banks and slopes with flow velocities ranging from 2 m/s to 5 m/s (dependent on rock size and thickness); appropriate for slopes that do not exceed 2H:1V
- Riprap only needs to be placed at lower portion of channel section to the anticipated flow height (mean annual peak flow) plus freeboard
  - Other form of soft armouring (RECP blankets, seeding) can be used to promote vegetation to protect soil at upper portion of channel slopes, above riprap
- Must be used in conjunction with a non-woven geotextile underlay acting as a filtration separator with basal soil
- For fluctuating high flow channel, the riprap should be underlain by a layer of granular filter material for cyclic drawdown long-term performance with/without an extra layer of non-woven geotextile as underlay

Advantages

- Easy to install and easy to repair
- Very durable, long lasting, and virtually maintenance free
- Flexible

Limitations

- Expensive form of channel lining and stabilization
- Requires heavy equipment and transport of rock to site
- May not be feasible in areas where suitable rock is not available
- Riprap may have to be placed by hand
- Normally 2 to 3 times riprap thickness is required in comparison with gabion mattress thickness for equivalent protection performance under identical hydraulic conditions
- Use of gabion is preferred at flow greater than 3 m/s due to larger nominal size of riprap and thickness required for erosion protection during flow velocities of this magnitude.

Riprap Armouring a) Slope Protection b) Channel Protection Erosion Control	B.M.P. #14 (a & b)

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Grade the slope or channel to final design grade
- Place filter (underlay) layer on prepared slope
  - Filter layer can consist of non-woven geotextile underlay and/or well graded granular material dependent on hydraulic conditions
- Place riprap layer
- Riprap should consist of a graded mixture of sound, durable stone or pit-run gravel with at least 50% of the riprap material being larger than 200 mm in diameter
- Riprap should be sized according to the following gradation and mass:

		Riprap Class			
		1M	**1**	**2**	**3**
Nominal Mass **Nominal Diameter**	**kg** **mm**	**7** **175**	**40** **300**	**200** **500**	**700** **800**
None heavier than:	kg or mm	40 300	130 450	700 800	1800 1100
No less than 20% or more than 50% heavier than:	kg or mm	10 200	70 350	300 600	1100 900
No less than 50% or more than 80% heavier than:	kg or mm	7 175	40 300	200 500	700 800
100% heavier than:	kg or mm	3 125	10 200	40 300	200 500
Percentage quoted are by mass. Sizes quoted are equivalent spherical diameters, and are for guidance only.					

Source: AT bridge Spec. 2001

- Non-woven geotextile fabric underlay below riprap should meet the following specifications and physical properties:

Non-Woven Geotextile Filter Fabric
Specifications and Physical Properties

	Class 1M, 1 and 2	**Class 3**
Grab Strength	650 N	875 N
Elongation (Failure)	50%	50%
Puncture Strength	275 N	550 N
Burst Strength	2.1 MPa	2.7 MPa
Trapezoidal Tear	250 N	350 N
Minimum Fabric Overlap to be 300 mm		

Source: AT bridge Spec. 2001

Riprap Armouring a) Slope Protection b) Channel Protection Erosion Control	B.M.P. #14 (a & b)

Construction Considerations

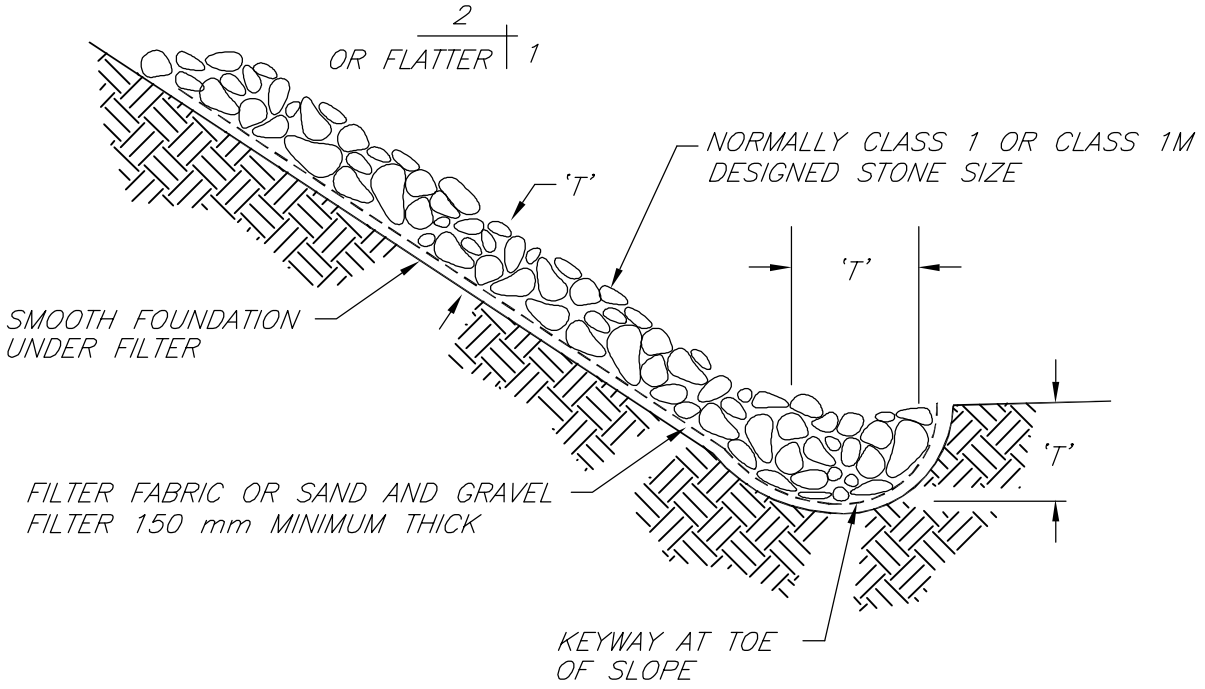
- Riprap should be placed in a uniform thickness across the channel so as not to constrict channel width
- Blasted rock is preferred (if available)
- Riprap layer should be 1.5 to 2 times the thickness of the largest rocks used, 1.5 to 3 times the thickness of the d_{50} material, and not less than 300 mm in thickness

Inspection and Maintenance

- Little maintenance is required
- Periodic inspections to check for erosion of protected material or movement of riprap

Similar Measures

- Rolled erosion control products (RECP) well vegetated; not for use at severe flow and high velocity areas
- Gabion mattresses



TYPICAL SECTION

NOTE:

1. 'T' = THICKNESS: THICKNESS SHALL BE DETERMINED BY THE ENGINEER.
   MINIMUM THICKNESS = 300 mm. (i.e. 1.5x D_{50}) FOR D_{50} = 200 mm.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

RIPRAP ARMOURING FOR SLOPE

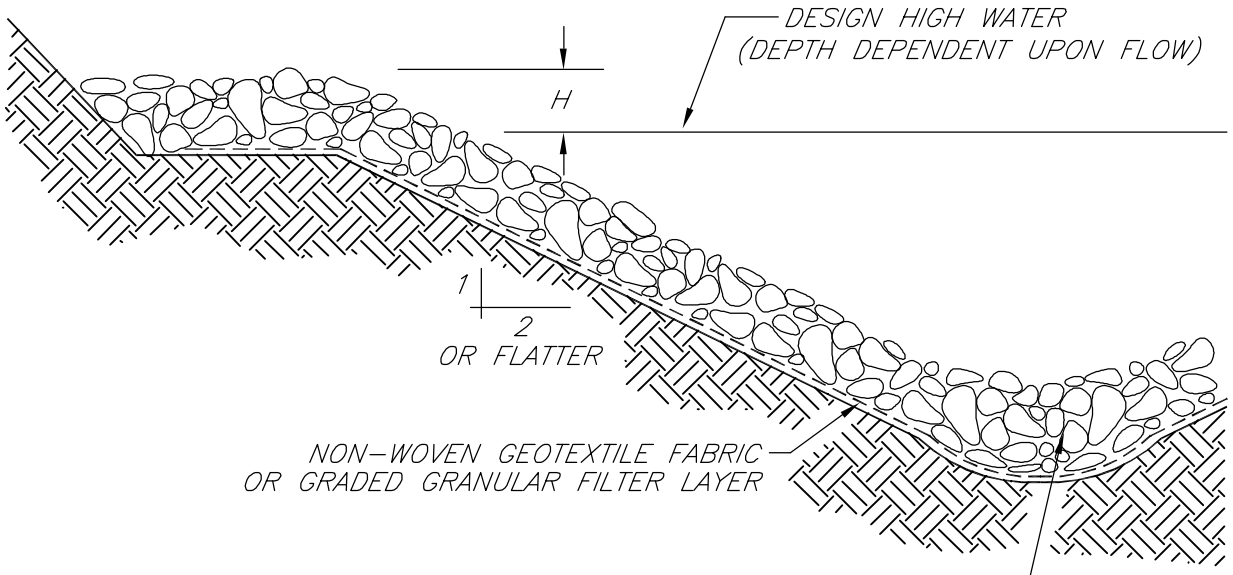
FILE: RIPRAP

Alberta TRANSPORTATION

B.M.P. #14a
Typical Section

0104–01–23211/BMP14A–A.dwg

DESIGN HEIGHT (H), WIDTH AND STONE SIZE SHALL
BE DETERMINED BY THE ENGINEER



TYPICAL SECTION

NOTES:

1. RIPRAP GRADATION AND THICKNESS SHALL BE DETERMINED BY THE ENGINEER IN ACCORDANCE WITH HYDRAULIC CONDITIONS.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

RIPRAP ARMOURING FOR CHANNEL

FILE: RCKCHNEL

Alberta TRANSPORTATION

B.M.P. #14b
Typical Section

0104–01–23211/BMP14B–A.dwg

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Cellular Confinement System (Geocomposites) Erosion Control

B.M.P. #15

Description and Purpose

- 3-dimensional, plastic matting with open cells filled with topsoil or aggregate
- 3-dimensional structure stabilizes cut or fill slopes
- Cells confine infilled topsoil or aggregate and protect root zone while permitting surface drainage

Applications

- Permanent measures
- May be used with granular infill on cut or fill slopes up to a slope of 1H:1V
- May be used with granular infill on slopes and in ditches where flow velocities are 3 m/s or less
- May be used as a flexible channel lining
- May be used in temporary low-water stream crossing as granular pad for stream fording
- Matting is light, expandable, and easy to transport and place
- Use of native fill materials reduces costs; local granular fill is preferred

Limitations

- Not widely used in Alberta highway construction
  - Availability can be limited, therefore expensive in some areas
- Installation can be labour intensive
- Not to be used on slopes steeper than 1H:1V
- Slopes of 1H:1V can be hazardous to work on

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Cellular Confinement System should be installed in accordance with manufacturer's directions
- The following is a general installation method
  - Slope should be graded to design elevations and grades
  - Rocks or other deleterious debris should be removed from matting location
  - Matting should be installed in a trench as deep as the matting is thick, extending 0.6 to 1.2 m beyond crest of slope, and matting should be installed so that the top of the matting is flush with surrounding soil
    - Every other cell along crest of slope should be anchored to soil using 'J' pins or other suitable sturdy anchoring device
  - The matting should be rolled out downslope
  - Where the blanket roll is not long enough to cover the entire length of the slope, the downslope section of matting should be butt-jointed to the upslope section and secured using staples, hog rings, or other suitable fasteners

  - Adjacent rolls of matting should be butt-jointed and secured using staples, hog rings, or other suitable fasteners
  - Anchors are placed at 1 m intervals down the slope
    - Additional anchors may be required to ensure matting is in intimate contact with soil
    - Additional anchors may be required along edges of matting
  - Backfilling should start at the crest of the slope and proceed downslope
    - For topsoil, overfill cells approximately 25 to 50 mm and lightly compact so that top of topsoil is flush with matting
    - For granular fill, overfill cells approximately 25 mm and tamp compact so that top of fill is flush with matting
  - Seeding should be applied after fill placement

Construction Considerations

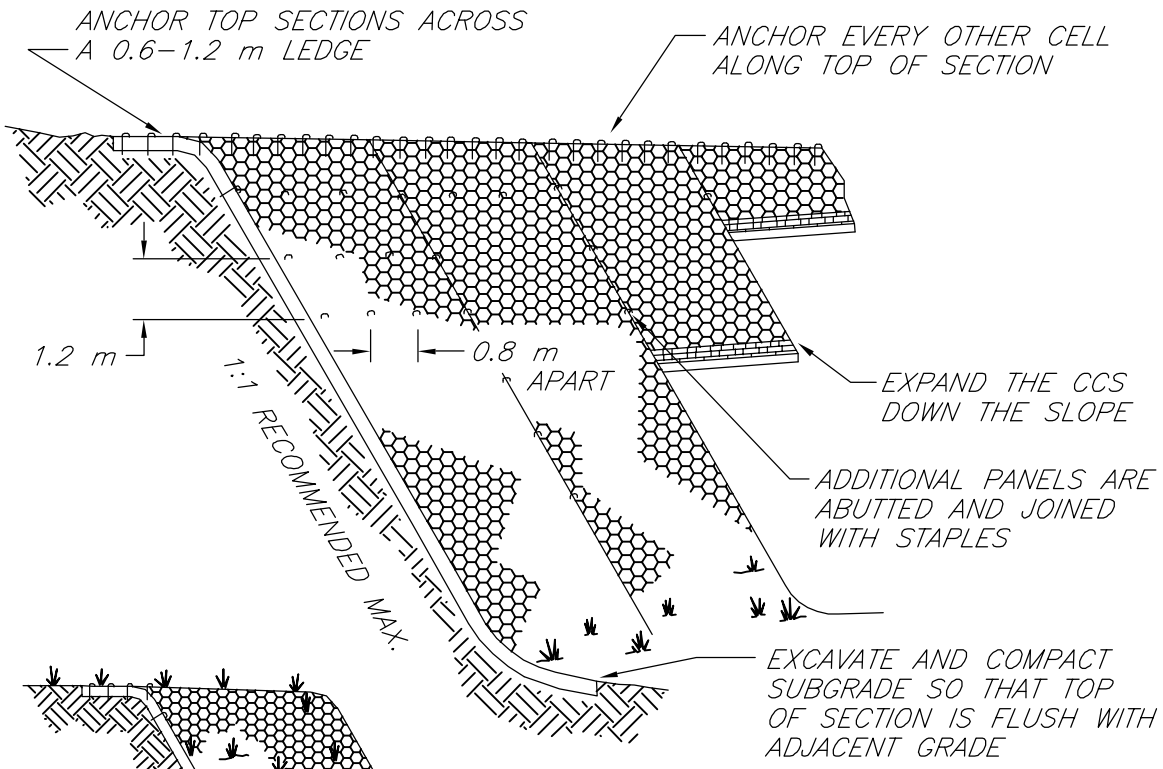
- Properly grading soil surface, removing rocks or deleterious materials, prior to placing matting to ensure matting is in intimate contact with the soil
- Matting should be placed longitudinal to direction of flow or downslope
- Use only a single layer of matting
- Matting elevation should be subexcavated to thickness of matting so that the top of the matting is flush with the adjacent terrain
- Infill from top of slope ensuring placement height of fill into cellular mat is less than 1 m

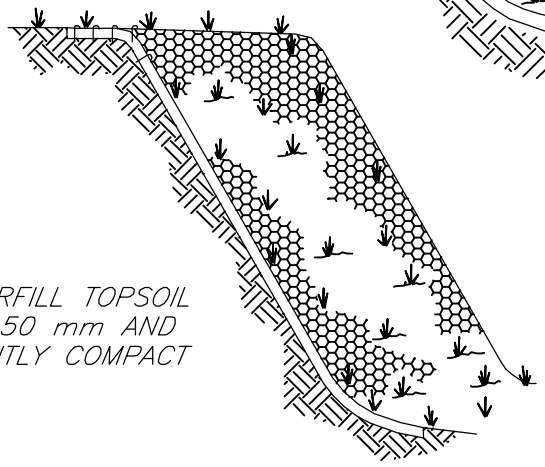
Inspection and Maintenance

- Area covered with matting should be regularly inspected, especially after periods of heavy rainfall storms to check for damage or loss of material
  - Any damaged areas should be repaired immediately
- Temporary inspection should continue until vegetation is established
  - Areas where vegetation fails to grow should be reseeded immediately
- If matting is broken or damaged and washout of the underlying soil occurs, the matting should be repaired or replaced after regrading the slope

Similar Measures

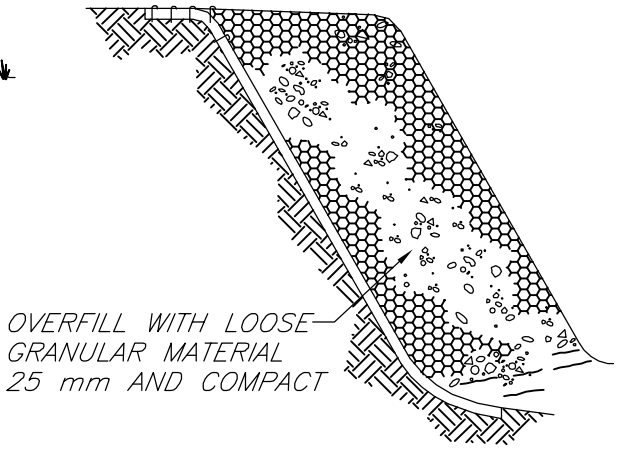
- Rolled erosion control products (RECP)
- Rip rap armouring





CCS INFILLED WITH TOPSOIL AND VEGETATED WITH GRASS

CCS INFILLED WITH AGGREGATE



NOTES:

1. SURFACE OF SLOPE SHALL BE LEVELED WITH GULLIES FILLED AND WELL COMPACTED.
2. SHAPE AND COMPACT SUBGRADE SURFACES TO DESIGN ELEVATIONS AND GRADES.
3. THE CELLS SHALL BE ANCHORED SECURELY TO PREVENT DISPLACEMENT AND DEFORMATION OF PANELS WHEN BACKFILLING.
4. INFILL FROM CREST OF THE SLOPE TO TOE TO PREVENT DISPLACEMENT. LIMIT DROP HEIGHT TO 1 m.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

CELLULAR CONFINEMENT SYSTEM FOR SLOPE STABILIZATION

FILE: CELLSYS

Alberta TRANSPORTATION

B.M.P. #15
Typical Section

0104–01–23211/BMP15–A.dwg

Cellular Confinement System (Geocomposites) Erosion Control	B.M.P. #15

Gravel Blankets Erosion Control and Sediment Control	B.M.P. #16

Description and Purpose

- Crushed stone or gravel layer/blanket placed directly to erodible slopes under influence of groundwater seepage piping erosion as well as surface water erosion
- For remediation of unstable slope caused by piping loss of soil resulting from strong groundwater exit gradient and subground erosion.
- To secure the soil, reduce erosion, and provide continuous all-weather protection
- Protects piping erosion of underlying soil as well as surface erosion from raindrop impact, and sheet flow
- Prevents transportation of soil from areas subject to groundwater seepage
- Acts as a filter to minimize seepage erosion of soil from areas subjected to groundwater seepage
- Provides hard armour protection for slope

Applications

- Permanent measure
- May be used on highly erodible slopes (silt and sand) that cannot be effectively stabilized by vegetative methods
- May be used when cover must be placed immediately as a toe filter to minimize seepage erosion due to strong groundwater seepage exit on cut slopes
- Must be used in conjunction with non-woven geotextile fabric underlay for areas of high groundwater seepage exits
- In most situations, subsurface drains are designed in conjunction with gravel blankets.

Advantages

- Easily constructed and implemented

Limitations

- Must be designed by qualified geotechnical personnel
- Requires equipment and transport of gravel to site
- May be unfeasible in areas where gravel is not readily available
- Areas of high groundwater seepage may require other subsurface drainage measures

Gravel Blankets Erosion Control and Sediment Control	B.M.P. #16

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Place non-woven geotextile as underlay, as a general good practice to provide filtration separator with subgrade soils
- Place gravel
- Grade gravel blanket to design thickness

Construction Considerations

- Aggregate must be placed evenly over slope
- On slopes of highly erodible materials (silt and sand) gravel blanket thickness should be 0.4 m minimum and should be assessed by a qualified geotechnical engineer
- Generally for slope protection for subground piping erosion, the blanket can be constructed of clean pit run gravel (Designation 6 Class 125 AT Specifications) to 0.4 m thickness

Metric Sieve Size (mm)	**Percent Passing**
125,000	100
50,000	5-100
25,000	38-100
16,000	32-85
5,000	20-65
315	6-30
80	2-10

Inspection and Maintenance

- Inspect gravel blanket after significant storm events and repair any damaged or wash out sections immediately
  - Sections washed out may need to be regraded prior to replacing gravel and geotextile

Similar Measures

- Subdrain systems

Energy Dissipators a) for Culvert Outlet b) for Trough at Bridge Headslope Erosion Control	B.M.P. #17 (a & b)

Description

a) Hard armour (rip rap, gravel, sand bags, concrete) placed at pipe outlets, in channels, and at downstream side of check structures to reduce velocity and dissipate energy of concentrated flows (BMP 17a)
b) Standard Drain Trough Terminal Protection Structure generally used at bridge headslope (BMP 17b)

- Minimizes scour at flow impact location with dissipated flow energy

Applications

- Permanent measure
- May be used at outlets of pipes, drains, culverts, conduits, or channels with substantial flows
- May be used at slope drain outlets located at the bottom of mild to steep slopes
- May be used where lined channels discharge into unlined channels
- May be used as splash pad on downstream side of gabions, check structures, berms, barriers, and silt fences to prevent erosion caused by overtopping of structure

Advantages

- Reduces flow energy in a relatively small area

Limitations

- Small rocks or stones can be dislodged during high flows
- Grouted rip rap may breakup due to hydrostatic pressure, frost heave, or settlement
- May be expensive if construction materials (rip rap, gravel, or concrete) is not readily available
- May be labour intensive to place and construct
- Extreme flow velocities may require paved outlet structures, stilling basins, plunge pools, drop structures, baffles, or concrete splash pads which will require special design by qualified personnel. Energy dissipators constructed of rip rap may not be adequate for extreme flow velocities

Energy Dissipators a) for Culvert Outlet b) for Trough at Bridge Headslope Erosion Control	B.M.P. #17 (a & b)

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Grade the area to final design grades and elevations
- Sub-excavate energy dissipator location to thickness of energy dissipator
- Place filtration bedding material on base of excavation
  - Bedding can be comprised of well graded sand and gravel or non-woven geotextile
  - Acts as separating filter between fine grained subgrade and riprap size energy dissipator material
- Place energy dissipator material (rip rap, gravel, sand bags, concrete) over filtration bedding material
  - Top of energy dissipator should be flush with surrounding grade

Construction Considerations

- Length of energy dissipator (L_a) at outlets shall be of sufficient length to dissipate energy
  - $L_a = 4.5 \times D$ (where D is the diameter of the pipe or channel at the outlet)
  - Energy dissipator should extend upstream of the outlet approximately a minimum distance of 0.5 x D
- Width of energy dissipator (W_a) at outlets shall be of sufficient width to dissipate energy
  - $W_a = 4 \times D$
- Thickness of energy dissipator (d_a) at outlets shall be of sufficient thickness to dissipate energy
  - d_a = 1.5 x maximum rock diameter (with a minimum thickness of 0.30 m)
- Energy dissipator (splash pad, apron) shall be set at zero grade and aligned straight, with the direction of flow at the outlet
- Bedding (filtration) layer can comprise either non-woven geotextile or a minimum of 0.15 m well graded sand and gravel layer
- Energy dissipator should be constructed of well-graded rip rap
  - Minimum d_{50} = 150 mm. Preferable d_{50} = 300 mm
  - Minimum thickness = a) 1.5 x d_{50} or b) 0.30 m to 0.45 m thickness. (a or b whichever is greater)
- Energy dissipator shall be designed to accommodate a 10-year peak runoff or the design discharge of the upstream channel, pipe, drain, or culvert, whichever is greater
- The energy dissipator shall be constructed flush with the surrounding grade and shall be directly in line with direction of outlet flow

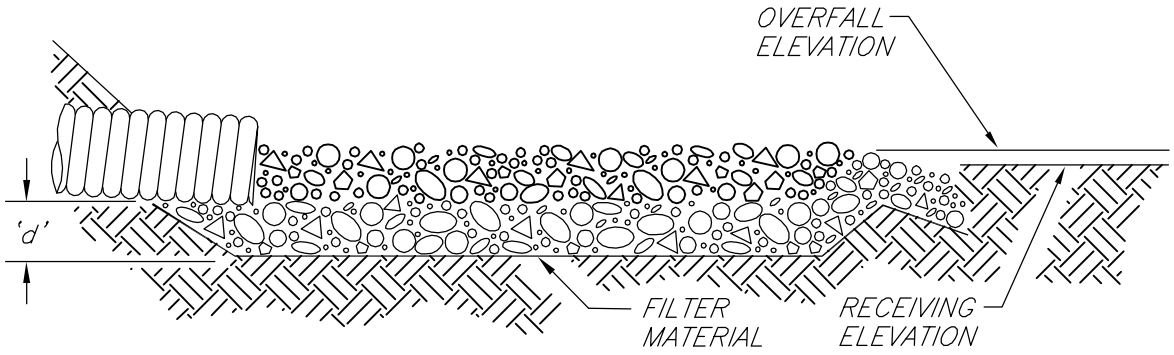
Energy Dissipators a) for Culvert Outlet b) for Trough at Bridge Headslope Erosion Control	B.M.P. #17 (a & b)

Inspection and Maintenance

- Periodic inspections to check for damage should occur at least once a month, or after storm events (1:2 year storm and/or 40 mm rainfall over 24 hour duration)
- Any damage should be repaired immediately

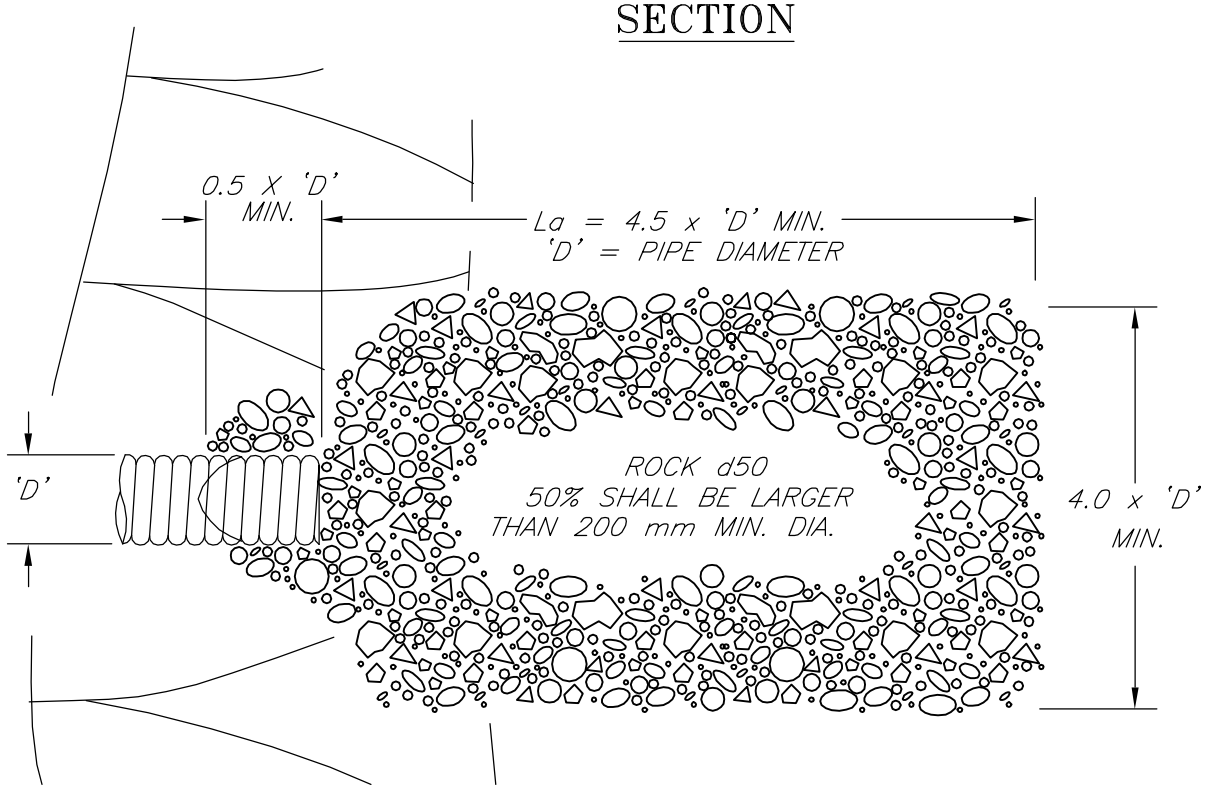
Similar Measures

- Gabion mattresses



B) MINIMUM THICKNESS = 300 mm. (i.e. 1.5x D_{50}) FOR D_{50} = 200 mm.

SECTION



PLAN

NOTES:

1. 'La' = LENGTH OF APRON. DISTANCE 'La' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY.
2. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
3. FILTER MATERIAL SHALL BE FILTER FABRIC OR 150 mm THICK MINIMUM GRADED GRAVEL LAYER.
4. FOR PIPE DIAMETER > 600 mm, DESIGN BY ENGINEER IS REQUIRED.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

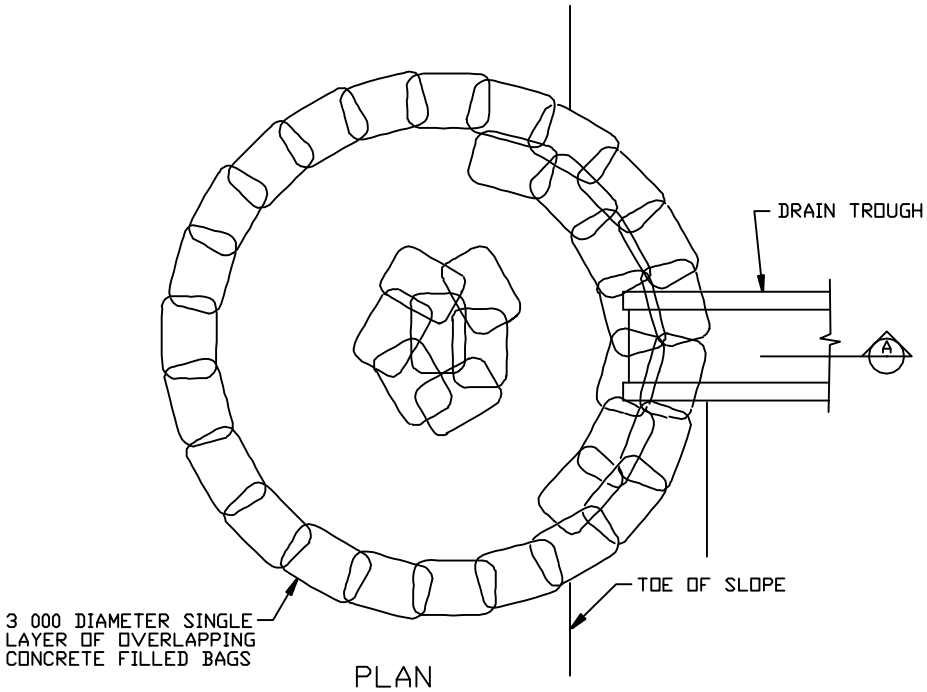
ENERGY DISSIPATOR FOR CULVERT OUTLET

FILE: ENRGYDIS

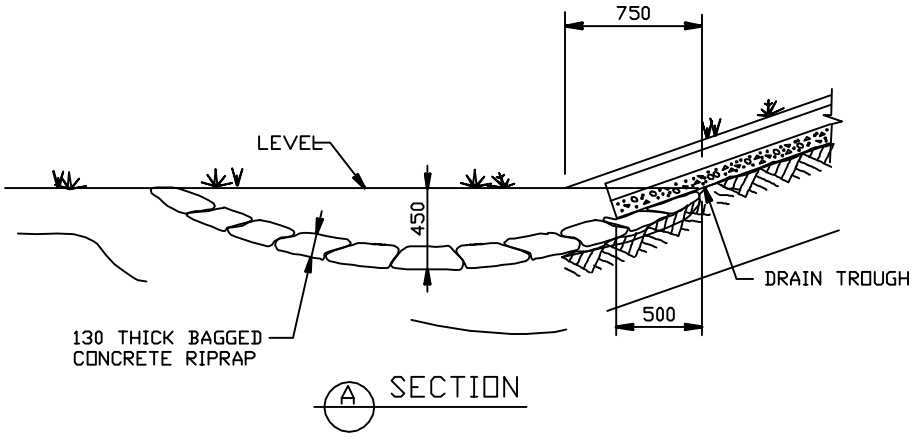
Alberta TRANSPORTATION

B.M.P. #17a
Typical Section

0104–01–23211/BMP17–A.dwg



PLAN



A SECTION

GENERAL NOTES

- DIMENSIONS ARE GIVEN IN mm. DETAILS ARE NOT TO SCALE.
- PLACING OF BAGGED CONCRETE RIPRAP SHALL START AT THE BOTTOM CENTRE OF THE DISHED AREA AND SHALL PROCEED IN A CONTINUOUS SPIRAL FASHION OUTWARD UNTIL THE ENTIRE DISH IS COVERED. EACH CONCRETE FILLED BAG SHALL LAP OVER THE EDGES OF THE PREVIOUSLY PLACED BAGS.

  SOURCE: ALBERTA TRANSPORTATION: SPECIFICATIONS FOR BRIDGE CONSTRUCTION
  DRAWING: S-1410-91

- THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

ENERGY DISSIPATOR

FOR SEMI-CIRCULAR TROUGH DRAIN TERMINAL PROTECTION FOR BRIDGE HEADSLOPE

Alberta TRANSPORTATION

B.M.P. #17b
Typical Section

0104-01-23211/BMP17A.dwg

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Sediment Traps and Basins a) Riser Outlet Option b) Permeable Rock Berm Outlet Option Sediment Control	B.M.P. #18 (a & b)

Description and Purpose

- Low height dam enclosure for impoundment of sediment laden storm water, sedimentation of silt size particles and release of treated storm water
- Used to trap sediment laden run off and promote settlement of sediment prior releasing to enter downstream or watercourses
- Constructed by excavating a pond or building embankments above the original ground surface
- Sediment traps and basins can be divided on size of pond impoundment enclosure
  - Basin (Type I) for pond area ≥500 m²
  - Trap (Type II) for pond area ≤500 m²

Applications

- Permanent measure
- Used at terminal or selective intermediate points of concentrated runoff for impoundment of runoff and sedimentation of silt prior to release of treated runoff downstream
- Used as sedimentation control measure at perimeter of construction sites where sediment laden run off may enter watercourses, storm drains, or other sensitive areas
- Used where there is a need to impound a significant amount of sediment from significant areas of land disturbance
- Sediment basins (Type I) used for disturbed drainage areas greater than 2.0 ha
- Sediment traps (Type II) used for disturbed drainage areas of 2.0 ha, or less
- Where practical, contributing drainage areas should be subdivided into smaller areas and multiple sedimentation impoundment installed

Advantages

- High capacity of runoff impoundment and more efficient means of sedimentation necessary along perimeters of construction sites with high risk sensitive environmental areas and watercourses
- Sediment can be cleaned out easily
- Robust
- Can be deactivated easily by breaching the enclosure dyke

Sediment Traps and Basins a) Riser Outlet Option b) Permeable Rock Berm Outlet Option Sediment Control	B.M.P. #18 (a & b)

Limitations

- Requires specialized design by qualified personnel
- Sediment traps and basins do not remove 100% of the sediment; net efficiency for sedimentation of silt may be around 50% dependent on design
- Anticipated service life of 3 years or longer due to possible clogging of outlets in the long-term
- Sedimentation traps and basins with a riser outlet should have an auxiliary spillway with adequate erosion protection to permit overflow in the event that the riser pipe outlet clogs during a storm event
- For drainage areas greater than 40 ha, multiple basins may be required
- Efficiency on sedimentation is very dependent on surface area; sediment basins require large surface areas to permit settling of sediment
- Fences and signage may be required to reduce danger to the public
- May provide breeding habitat for mosquitoes and other pests
- Sediment traps only remove medium and large diameter silt particles and upstream erosion or sediment control measure is required to reduce the amount of sediment laden to the runoff at downstream sensitive areas
- Periodic removal of sediment build up is required

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- The consequences of failure for any water retaining structure will determine the level of effort in the design and construction phases. The construction guidelines presented herein are minimum requirements. A geotechnical engineer should design water retaining structures if the consequences of failure warrant.
- All footprint area for embankment dyke should be stripped of vegetation, topsoil, and roots to expose mineral subgrade soils
- Embankment fill material should be clean mineral soil with sufficient moisture to allow proper compaction
  - Fill should be placed in lifts not exceeding 150 mm in compacted thickness and should be compacted to a minimum of 95% Standard Proctor maximum dry density (SPD)
- The main outlet structure should be installed at farthest possible point from inlet
  - Outlet should be placed on firm, smooth ground and should be backfilled to 95% SPD
  - Proper inlet and outlet protection should be installed to protect from scour
  - Outlet pipe should consist of corrugated steel pipe to protect (against pinching and blockage)
- The embankment should be topsoiled, seeded or protected with gravel or riprap immediately after construction
- Construct an emergency spillway to accommodate flows not carried by the principle outlet

  - Emergency spillway should consist of an open channel (earth or vegetated) over native undisturbed soil (not fill)
  - If spillway is elevated, it should be constructed of rip rap
  - Spillway crest should be depressed at least 0.15 m below embankment

Construction Considerations

- Preferable to strip to mineral soil only along the footprint area required for dyke construction; can leave pond floor centre area cleared but unstripped
- Can be constructed by excavating, constructing embankments, or a combination of the two methods
- Baffles should be provided to prevent short-circuiting of flow from inlet to outlet
- Construct sediment ponds and basins at site perimeter and environmentally sensitive areas prior to wet season and construction activities
- Sediment pond/basin bottom should be flat or gently sloping towards outlet
- Dyke slopes should not be steeper than 2H:1V and should be compacted
- Basins should be located where:
  - Low embankment can be constructed across a swale or low natural terrain
  - It is accessible for maintenance work, including sediment removal

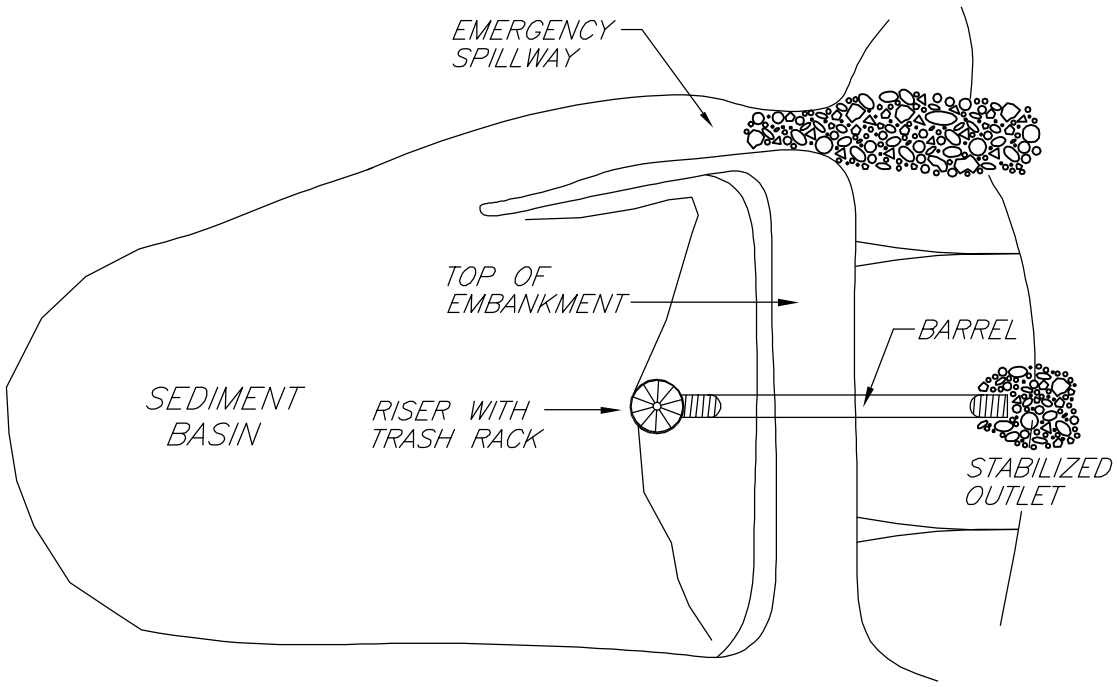
Inspection and Maintenance

- Regular inspection is required to identify seepage, structural soundness, outlet damage or obstruction and amount of sediment accumulation
- Inspections should be performed weekly and after significant storm events (1:2 yr storm and/or 40 mm rainfall in 24 hours)
- Sediment should be removed upon reaching 1/2 height of the containment berm or within 0.4 m of crest of embankment
- Sediment traps may be deactivated or removed after vegetation of previously disturbed upstream areas has been established

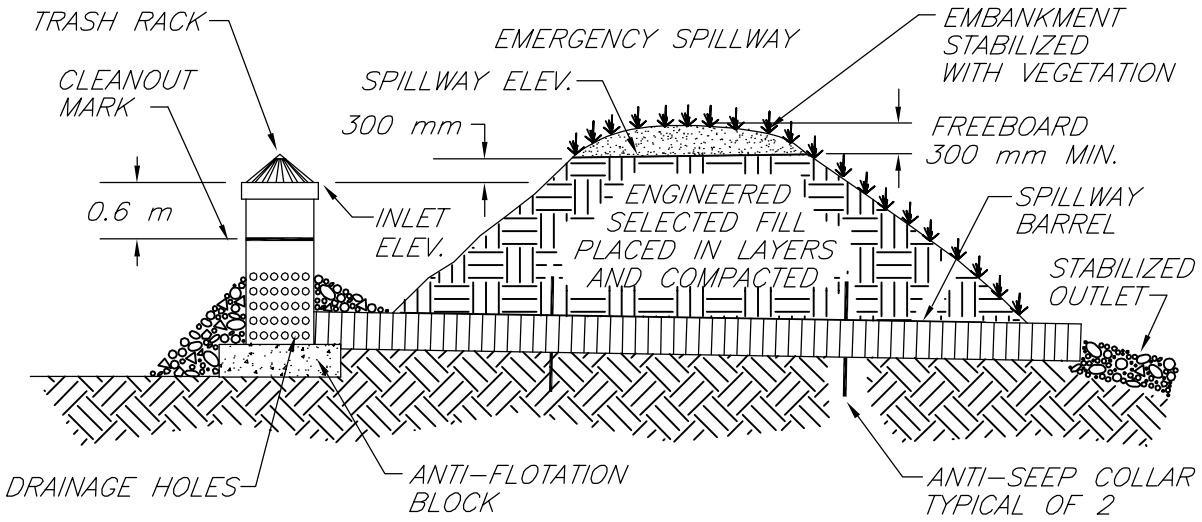
Sediment Traps and Basins a) Riser Outlet Option b) Permeable Rock Berm Outlet Option Sediment Control	B.M.P. #18 (a & b)

Design Considerations

- The design can consist of (1) a riser outlet option or (2) a permeable rock berm outlet option. (The permeable rock berm outlet option is preferable for Alberta highway construction)
- Minimum particle size for rip-rap rock shall be 200 mm
- If the design of a riser outlet is utilized
  - Main outlet pipe shall be fabricated from corrugated steel pipe conforming to CSA standard CAN 5-G401-M81 or the latest revision thereof
  - Outlet pipe shall consist of a horizontal pipe welded to a similar vertical riser at a 45E mitre joint
- Close to the base of the riser pipe, a 100 mm diameter hole shall be fabricated and a mesh with 12 mm square openings tack welded over the hole as a screen
  - A similar hole shall be provided along the riser pipe immediately above the elevation of the maximum sediment buildup (usually 0.4 m below crest of embankment)



PLAN



SECTION

NOTES:

1. THE TEMPORARY SEDIMENT BASIN, DESIGNED BY A QUALIFIED PROFESSIONAL, IS REQUIRED FOR DISTURBED AREAS GREATER THAN 2.02 HECTARES (5 ACRES) WITH A DRAINAGE AREA LESS THAN 40.4 HECTARES (100 ACRES).
2. THE SEDIMENT BASIN MAY BE REMOVED WITHIN 3 YEARS.
3. HEIGHT OF ENGINEERED SELECTED FILL EQUAL TO 1 m.
4. FOR CONFIGURATION AND FLOW CHAMBER DESIGN (i.e. LENGTH(L) & WIDTH(W_e) OF BASIN), REFER TO BMP 18b.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

TYPICAL SEDIMENT BASIN (RISER OUTLET OPTION)

FILE: SEDBASIN

Alberta TRANSPORTATION

B.M.P. #18a
Typical Section

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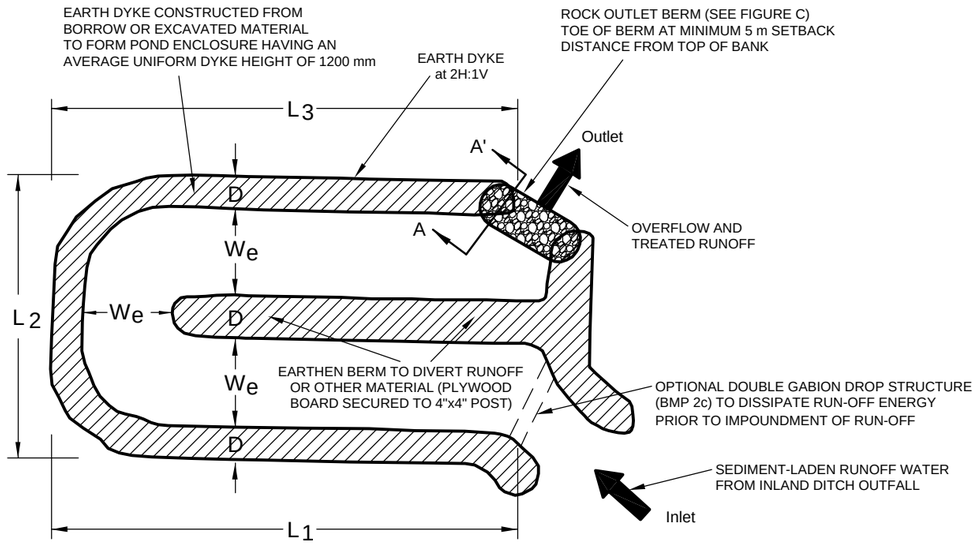
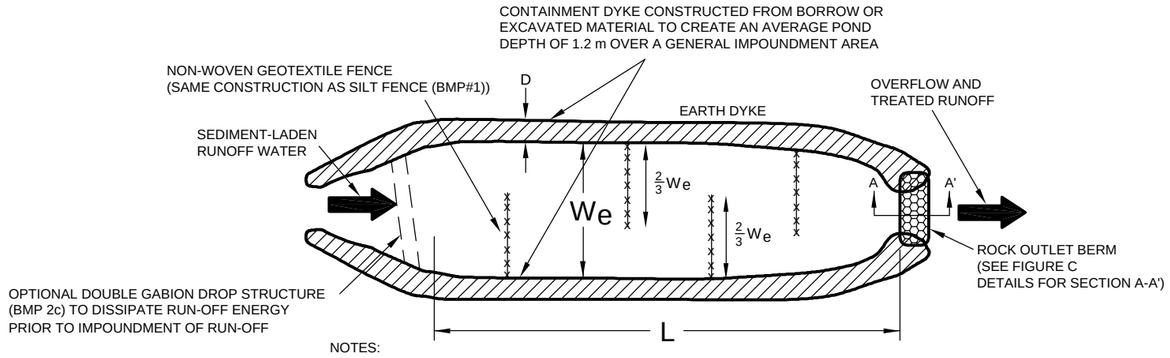


NOTES:

1. CONTRIBUTING RUNOFF AREA CAN BE LARGER THAN 2.0 ha BUT LESS THAN 40.0 ha.
2. EFFECTIVENESS APPROPRIATE FOR REMOVING MEDIUM TO COARSE SILT PARTICLES SUSPENDED IN RUNOFF.
3. FLOW PATH L = $L_1 + L_2 + L_3$ FLOW WIDTH W $\geq$ 6 m MINIMUM
4. PROVIDE 1 TO 2 m (1 TO 2% GRADE) ELEVATION DROP BETWEEN INLET AND OUTLET GRADES.
5. SHAPE OF POND TO CONFORM TO TOPOGRAPHY WITH OUTLET AT MINIMUM 5 m FROM TOP OF BANK.
6. CONSTRUCTION TO ENSURE SWALES AND BAFFLES ARE TO CHANNEL WATER INTO THE PROPOSED SEDIMENTATION PONDS.

Plan View

Figure A Type 1 Sedimentation Pond Containment Structure (Sediment Basin)

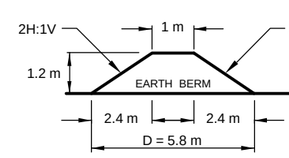


NOTES:

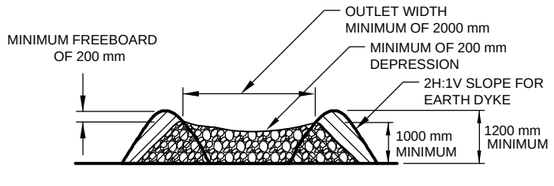
1. CONTRIBUTING RUNOFF AREA SHOULD BE OR SMALLER THAN 2.0 ha.
2. EFFECTIVENESS APPROPRIATE FOR REMOVING MEDIUM TO COARSE SILT PARTICLES SUSPENDED IN RUNOFF.
3. L/W_e RATIO 3:1 CAN BE APPROPRIATE.
4. W_e = 8 m MINIMUM BOTTOM WIDTH.
5. NON-WOVEN GEOTEXTILE FABRIC WITH A0S 0.15mm.

Plan View

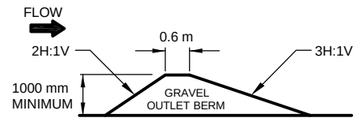
Figure B Type II Containment Structure (Sediment Trap)



EARTH DYKE(D)



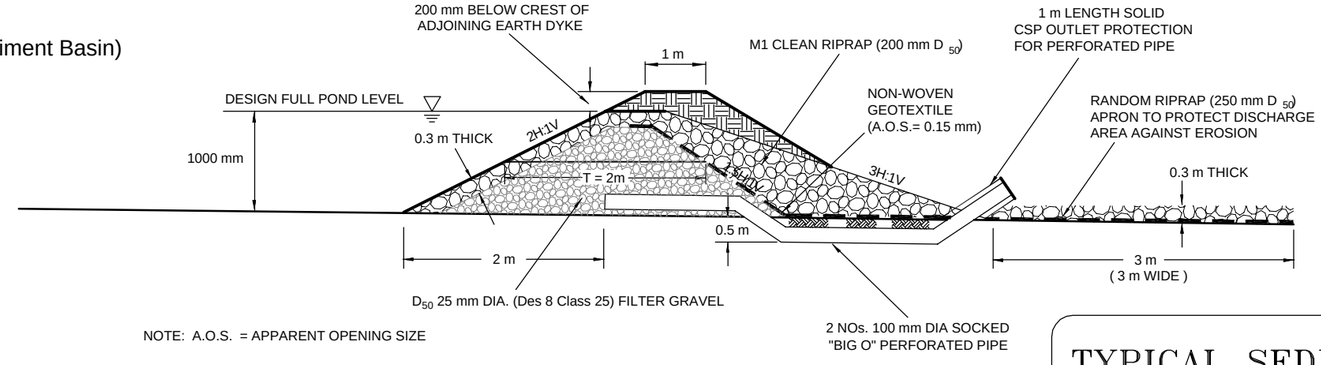
OUTLET FRONT VIEW



SECTION A-A' (SIMPLIFIED)

NOTES:

1. *DEACTIVATED WITHIN 3 YEARS AFTER SATISFACTORY FULL REVEGETATION OF THE DISTURBED AREA OF POTENTIAL EROSION SOURCES UPSTREAM.*
2. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*



NOTE: A.O.S. = APPARENT OPENING SIZE

Figure C Section A-A' - Details for Sedimentation Pond
(Permeable Structure with Rock Filter Barrier and Perforated Pipe)

SOURCE: 1) FIFIELD (2001) FOR STRUCTURE PLAN
2) EBA FOR OTHER DESIGN DETAILS

TYPICAL SEDIMENT BASIN (PERMEABLE ROCK BERM OUTLET OPTION)

Alberta TRANSPORTATION

B.M.P. #18b
Typical Section

0104-01-23211/BMP18b-A.dwg

Slope Drains (Temporary Pipes) a) Slope Drain b) Overside Drain Erosion Control	B.M.P. #19

Description and Purpose

- Heavy duty, flexible pipe "Big O" that carries water from top to bottom of fill or cut slope to prevent concentrated water flowing downslope and eroding face of slope

Applications

- Temporary or permanent measure
- Used on cut or fill slopes where there is a high potential for upslope runoff waters to flow over the face of the slope causing erosion, especially at areas where runoff converges resulting in concentrated runoff flows (e.g. possible breach of low catchwater ditch at top of a cut slope)
- Used in conjunction with some form of water containment or diversion structures, such as diversion channels, berms, or barriers, to convey upslope runoff water and direct water towards slope drain

Limitations

- Pipes must be sized correctly to accommodate anticipated flow volumes
- Water can erode around inlet if inlet protection is not properly constructed
- Erosion can occur at base if outlet protection or energy dissipator is not constructed
- Slope drain must be anchored securely to face of slope

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Construct diversion or intercept channel, ditch block, barrier, or other inflow apron structure at crest of slope to channel flow toward the slope drain inlet
- Install slope drain through inlet berm or barrier with a minimum of 0.45 m of soil cover above top of drain pipe to secure the inlet
  - Install scour inlet protection (such as rip rap, sand bags)
- Install energy dissipator (such as rip rap, gravel, concrete) at downslope outlet end of slope drain
  - Outlet must not discharge directly onto unprotected soil
- Secure the pipe from movement by tying to steel anchor stakes, hold-down grommets, or other approved anchor method
  - Space anchors on each side of drain pipe at maximum 3 m intervals along entire length of drain pipe

Slope Drains (Temporary Pipes) a) Slope Drain b) Overside Drain Erosion Control	B.M.P. #19

Construction Considerations (For guidance only)

- Use coiled drain pipe for low flows only
- If constructing inflow apron at crest of slope out of sandbags, only fill each sandbag ¾full, this will allow sandbag to be flexible enough to mould around drain pipe and remain in continuous contact with the ground
- Several slope drains may be required if upslope drainage areas are too large for one drain pipe

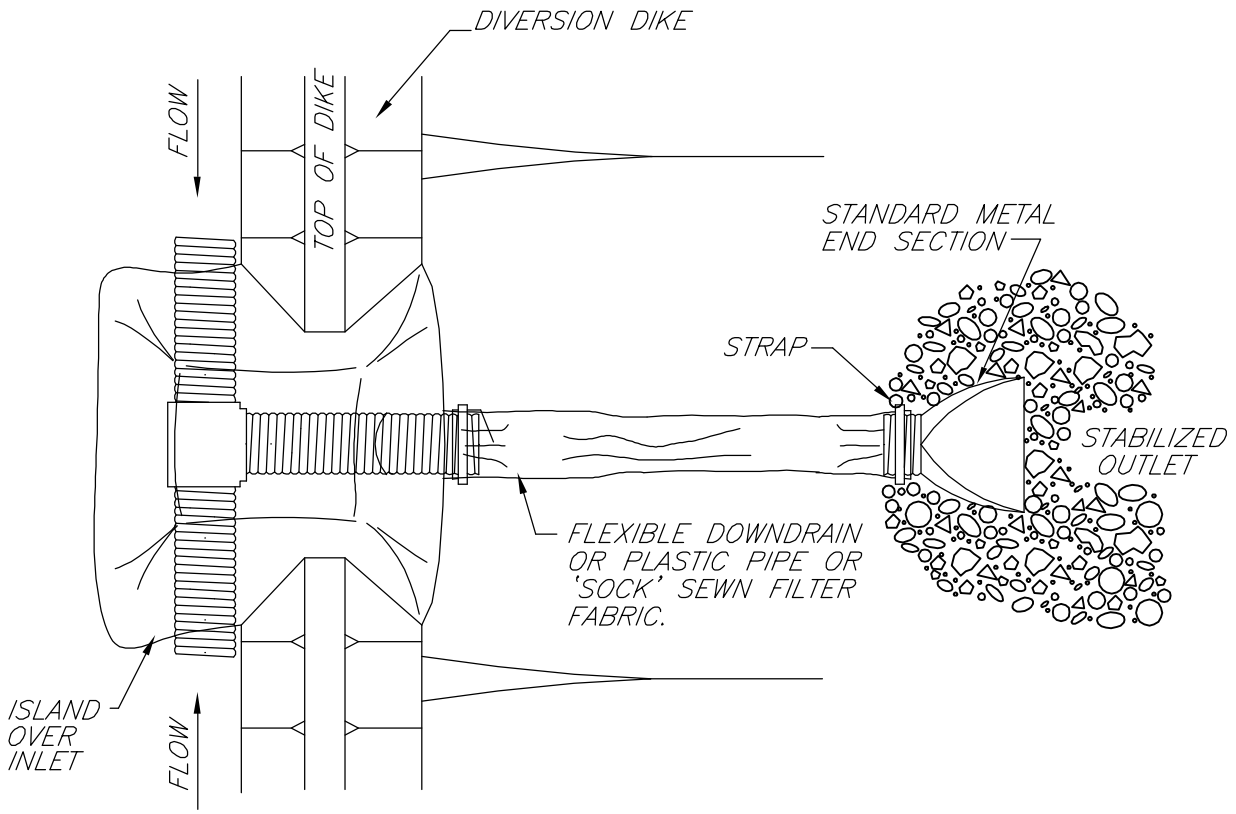
Size of Slope Drain	
Maximum Drainage Area (ha)	Pipe Diameter (mm)
0.2	300
0.6	450
1.0	530
1.4	600
2.0	760

Inspection and Maintenance

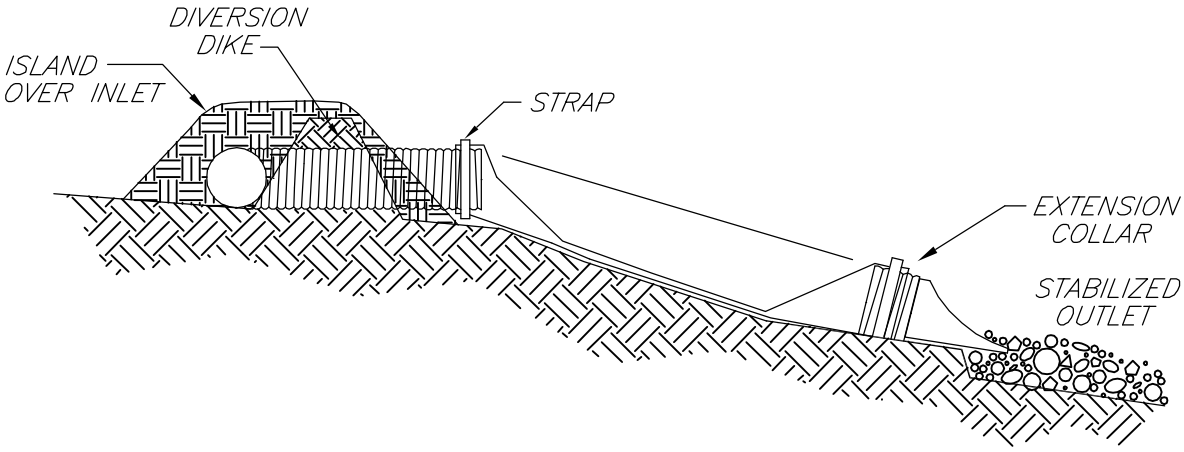
- Inspect slope drains at least once per week, or after significant storm events (1:2 year storm and/or 40 mm precipitation in 24 hours)
- Repair any damaged section of pipe immediately
- If evidence exists of pipe movement, install additional anchor stakes to secure and anchor at zones of movement
- Remove sediment from upslope inflow apron area after each storm event otherwise either downslope sediment transport will occur or cause the drainpipe to be plugged which could result in overtopping of inflow apron structure and sheet flow over slope face.

Similar Measures

- Rock lined channel
- Permanent Pipe (slope drains)
  - Corrugated steel pipe (CSP) downdrain (AT Drawing No. CB-6 2.4 M17)
  - Half-round corrugated steel (1/2 CSP) downslope drain (AT Drawing No. CB-6 2.4 M4) for low flow areas such as bridge headslopes



PLAN VIEW



SECTION

NOTE:

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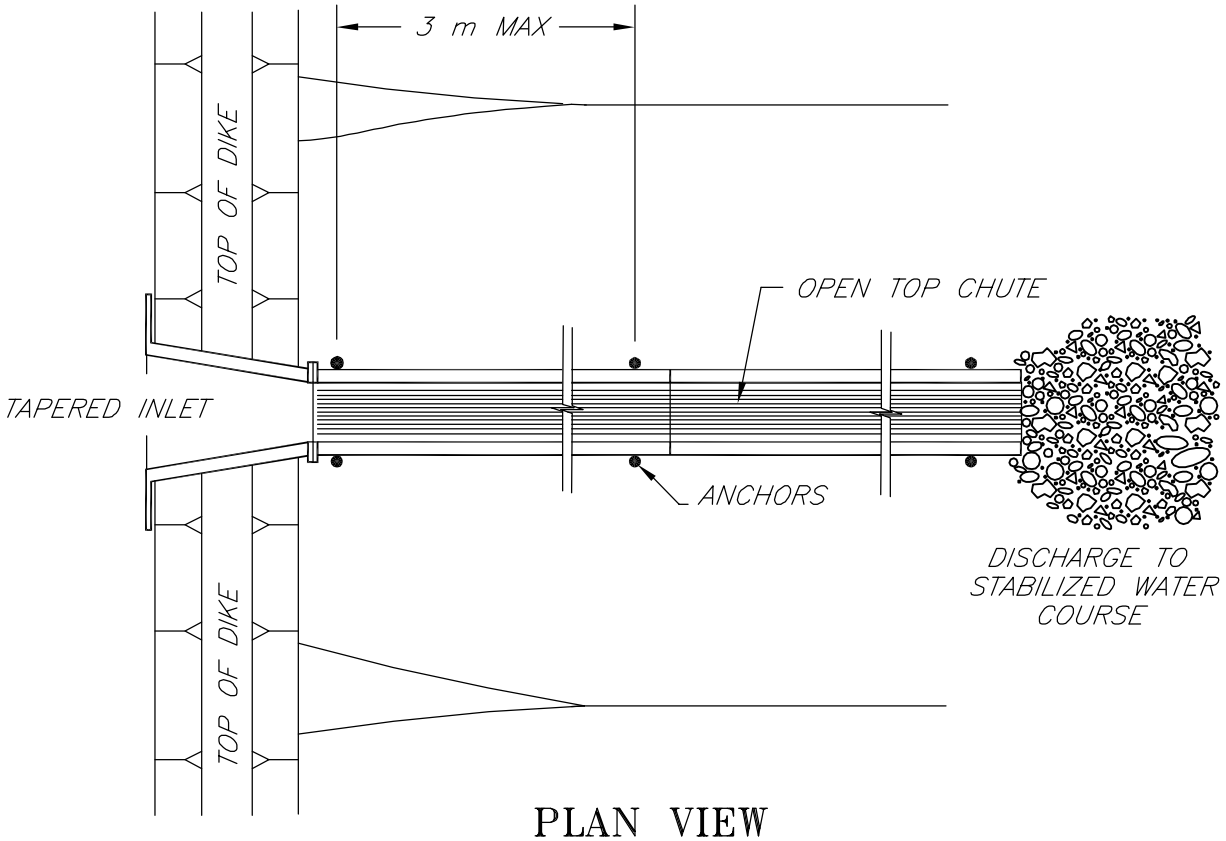
SLOPE DRAIN

FILE: SLOPEDRN

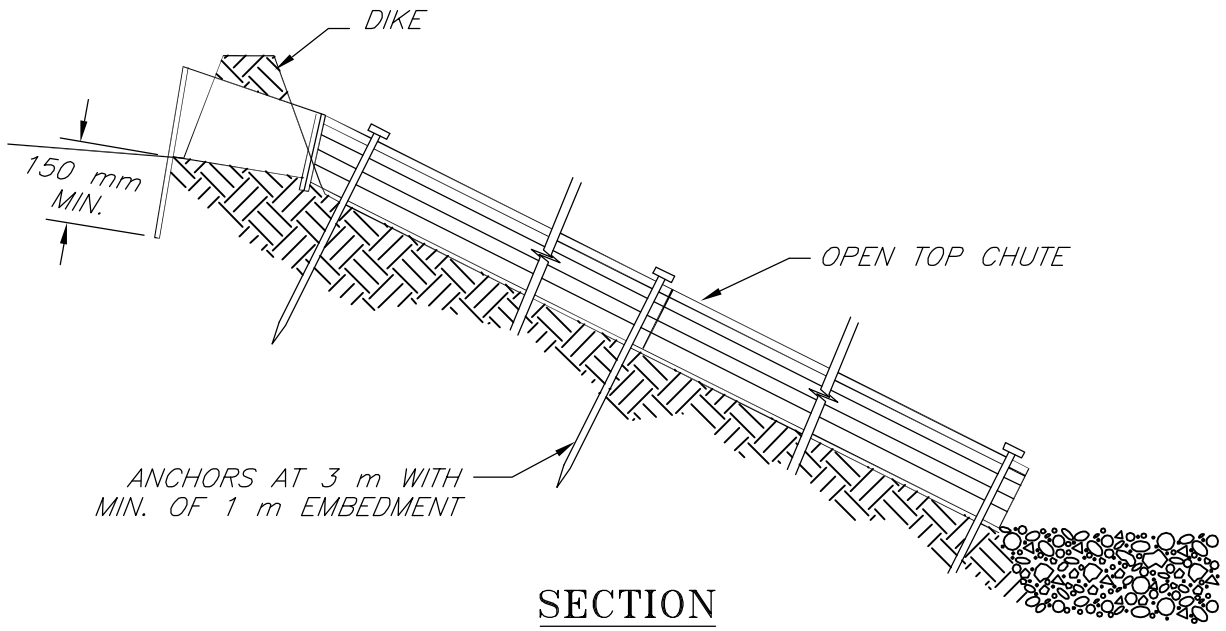
Alberta TRANSPORTATION

B.M.P. #19a
Typical Section

0104–01–23211/BMP19A–A.dwg



PLAN VIEW



SECTION

NOTE:

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OVERSIDE DRAIN

FILE: OSDRAIN

Alberta TRANSPORTATION

B.M.P. #19b
Typical Section

0104-01-23211/BMP19B-A.dwg

Groundwater Control (Subsurface Drains or Finger Drains) Erosion Control	B.M.P. #20

Description and Purpose

- Drains that intercept and collect subsurface groundwater and divert it from slope, thus lowering groundwater table to minimize piping erosion reducing seepage flow on slopes and increase slope stability
- Relief drains (perforated finger-drains or French drains) to mitigate high groundwater table to minimize piping erosion

Applications

- Permanent measure
- Used on cutslopes where groundwater seepage exits on slope face

Limitations

- Must be designed by a geotechnical engineer
- Can be expensive to install
- Plugging of drainage outlet can be detrimental to cause build-up of pore pressure; it is mandatory to protect the outlet area to ensure free draining condition

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Excavate trench at subsurface drain location
- Install drain pipe
- Backfill with clean, coarse drainage gravel and/or non-woven geotextile fabric to provide filtration separation with adjacent soils

Construction Considerations

- When signs of seepage and unstable excavation slope are encountered at excavations, it is advisable to install trench protection measures for safety (i.e. trench box)
- Carry out work as soon as possible to mitigate seepage damage, soil loss and deterioration of unstable slope
- Excavate and install drains to the grade and spacings according to design and recommendations made by the geotechnical engineer
- Protect outlet of drainage with sturdy pipe to ensure free draining condition

Inspection and Maintenance

- Drains installed below grade will require manhole at frequent intervals (100 m maximum) to facilitate inspection and maintenance
- Flushing and maintenance clean out of drains can be carried out through manhole locations

Offtake Ditch (Intercept Ditch) Erosion Control	B.M.P. #21

Description and Purpose

- Channels or swales commonly located along the crest of cuts slopes to intercept and convey runoff away from flowing down a newly excavated bare soil slope and to minimize erosion of slope from overlanding sheet flow
- Can be tied to outfall to slope drains (or downdrains) which carry water from higher slope elevations to lower elevation of a slope

Applications

- Permanent measure
- Effective method of intercepting runoff to avoid excessive sheet flow over slope and causing erosion, especially on cut slopes in highly erodible soils (sand and silt)
- Can be used in conjunction with slope drains which was installed down a large cut slope
- May be lined with vegetation, rip rap, erosion control blankets, or some other erosion protection measure, but this requirement may be appropriate only at highly sensitive and high risk environmental areas
- Can be used in conjunction with sediment control measures, such as check structures or permeable synthetic barriers as normal channel design, but this requirement may be appropriate only at highly sensitive and high risk environmental areas

Limitations

- Ditch may require lining to minimize soil erosion from concentrated flow
- Ditch may require design by qualified personnel if flow velocities and/or volumes are large
- Channel must be graded to maintain adequate depth, positive drainage to avoid ponding and breaching of channel flow, which may lead to overtopping of the channel to result flow to cause in downslope erosion
- Removal of sediment build up and ditch maintenance may be difficult due to limited access space as offtake ditches are commonly constructed at crest of slopes

Offtake Ditch (Intercept Ditch) Erosion Control	B.M.P. #21

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Use backhoe to form ditch a minimum offset distance of 2 m between crest of highway slope and top of offtake ditch sideslope, thus providing a dyke width of 1 m
  - Place and compact excavated soil to form a dyke between crest of highway slope and offtake ditch channel to provide adequate depth (1 m) of the offtake ditch
    - The consequence of failure on this dyke will determine the level of compaction effort required
  - Sideslopes of ditch should not be steeper than 2H:1V (depending upon material type)
  - Depth of ditch (from base of ditch to top of embankment) should be a minimum of 1 m in depth; width of ditch should be 1 m minimum
  - Ditch grade should be graded a minimum of 1% to promote positive drainage and outfall

Construction Considerations

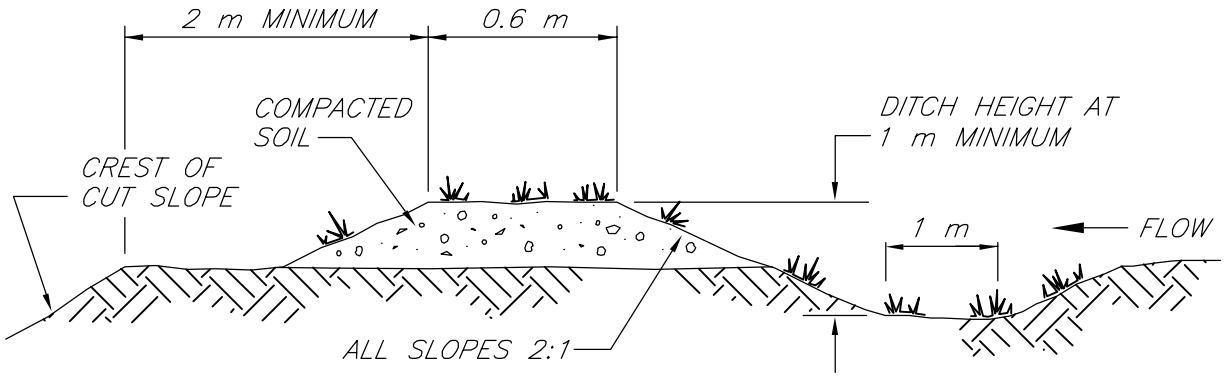
- Channel should be graded towards nearest outfall (draw) or drainage pipe

Inspection and Maintenance

- Inspect ditches at least at biweekly intervals and after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Repair any damage to channel immediately

Similar Measures

- Berms
- Barriers



TYPICAL OFFTAKE DITCH

NOTES:

1. *THE DITCH BEHIND THE DYKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.*
2. *THE DYKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.*
3. *FOR SENSITIVE HIGH RISK AREAS, THE DITCH SHALL BE STABILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.*
4. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

OFFTAKE DITCH
(INTERCEPT DITCH)

FILE: TEMPDIKE

Alberta TRANSPORTATION

B.M.P. #21
Typical Section

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Seeding Erosion Control	B.M.P. #22

Description and Purpose

- The planting or placing seed into soils of cut slope or fill embankment slopes after a layer of organic topsoil is spread over the slope
- Provides erosion protection through development of a shallow root structure from seed germination and plant growth

Applications

- Permanent or temporary measure
- Temporary seeding with rapidly growing plants may be applied to interim stockpile/excavation areas which will be exposed for more than 30 days
- Permanent seeding may be applied to exposed bare soil areas which have been graded to final contours
- Permanent seeding may be applied to landscape corridors, slopes and channels by broadcasting, furrowing or spraying on with mulch tackifier
- Provides habitat for wildlife after vegetation establishment
- Can be enhanced with a protective layer of mulches or rolled erosion control products (RECP) to improve growth environment

Advantages

- Enhances terrestrial and aquatic habitat with vegetation growth re-establishment
- Aesthetically pleasing with vegetation cover
- Grows stronger with time as root structure develops
- Generates vegetation to enhance infiltration of runoff and transpiration of groundwater
- Seeding with a mixture of grasses and herbaceous legumes in disturbed areas is an inexpensive method of stabilizing the soil, particularly if the area is flat to gently sloping
- Cost of seeding disturbed areas is relatively low and its effectiveness on a long-term basis is relatively high

Limitations

- Grasses may require regular maintenance (mowing) along ditches
- Uncut dry grass may present a fire hazard and site distance obstruction adverse to highway safety
- Seeding of steep slopes may be difficult without using measures such as RECP's or hydroseeding-hydromulching methods
- Seasonal windows on planting (early spring or fall) may not coincide favourably with construction schedule
- Areas that have not been covered with seeded topsoil are susceptible to erosion until vegetation is established if RECP are not used.
  - Use of topsoil and mulch can reduce rain drop erosion potential during germination and until vegetation is established

  - Additional erosion control measures, such as RECP, may be required for steep slopes and channels
- Reseeding will be required in areas of limited plant growth
- Time to establish root structure may be unacceptable for some high risk areas. Shallow sodding should be considered for these areas

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- The site to be seeded should be prepared prior to seeding
  - Surface should be graded to design grades and then topsoiled
  - Topsoil should be roughened, harrowed, or grooved
  - Seedbed should be 75 to 150 mm deep, with the top 75 mm consisting of topsoil free of large clods or stones
- Seed should be applied immediately after seedbed preparation using broadcast seed spreaders, cyclone (broadcast) spreaders, or seed drills to ensure uniformity of application
  - Seedbed should be harrowed, raked, or chain-dragged to ensure proper seed-soil contact
- Fertilizer should then be applied after seeding

Construction Considerations

- Seeding rate for all mixes should be 25 kg/ha minimum
- Fall rye may be added to each mix to provide early growth and protection from soil erosion
  - Fall rye seeding rate is 5 kg/ha
- Selection of proper vegetation seed mix depends on soil conditions, climate conditions, topography, land use, and site location
  - Alberta Transportation approved seed mixes (provided below depending on site location) should be used
  - Seed mixes were developed based on general historic positive performance results throughout Alberta
- Planting of seeds by hydraulic seeding and mulching techniques should be considered for slopes steeper than 3H:1V where seedbed preparation is difficult, or where application of seed, mulch, and fertilizer in one continuous operation is desirable
- Sod may be installed for faster results, however it is very costly but essential for high risk sensitive areas
- If mulch is placed as a germination medium for seeds, the mulch layer may be further protected with a biodegradable matting to prevent mulch from being washed or blown away

Inspection and Maintenance

- Inspect seeded areas one year after initial seeding or after significant storm events to evaluate germination and seedling density results
- Freshly seeded areas should be inspected frequently to ensure growth is progressing
- Additional stormwater control measures should be considered for areas damaged by runoff
- Reseedings may be required within 1 to 5 year intervals after initial seeding
- Small bare spots may need to be reseeded several times at subsequent years after initial application
  - Larger areas may need to be completely retreated
- Cutting or mowing grasses will encourage the establishment and spread of the grass

Similar Measures

- Hydraulic seeding and mulching
- Sodding

Design Considerations

- Seed application rate of 25 kg/ha may be used
- If fall rye is to be added, it should have an application rate of 5 kg/ha
- When using a seed drill or brillion seeder, grasses and legumes shall not be planted deeper than 1 cm
- Bacterial inoculants must be used when seeding with legumes
  - A specific inoculants shall be used for the legume being seeded in accordance with the suppliers recommendations
- Fertilizer, in lieu of a soil test, shall be as stated in the following table OR follow supplier's recommendations
  - It shall be applied at a rate of 50 to 75 kg of nitrogen/ha, depending upon site conditions
  - Fertilizer use shall be carefully controlled as this may increase nutrient loading to receiving streams if runoff is not controlled properly
- Seeding shall occur during periods when germination can be successful and plants have sufficient time to become established before the end of the growing season (approximately May 15 to June 1 and/or August 15 to September 15)
  - Seeding should not occur after the 50% frost probability date for the site
- Mulch is required when broadcast seeding or if seeding is carried out after the date specified in which fall seeding should not be carried out
- For specific needs of local growth environment, specific design and advice from local seed supplier or Professional Agrologist (P.Ag.) may be required
- Alberta Transportation has adopted seed mixes (provided below) depending on site location. The various areas of the province used in selecting the seed mix are presented (Alberta Transportation District map).

Alberta Transportation Seeding Mixes

Seeding and Fertilizer Mixes

Area (A)	The Vermilion District, Red Deer District, Edson District, the Grande Cache area and all areas west of and including Highway 22 and Highway 6:	
Fertilizer	11-52-0	75 kg/ha
Slender/Awned/Bearded Wheatgrass	Agropyron trachycaulum	30%
Mountain Brome	Bromus carinatus	25%
Sheep Fescue	Festuca ovina	25%
Green Needle Grass	Stipa viridula	5%
Western Wheatgrass	Agropyron smithii	5%
Northern/Streambank Wheatgrass	Agropyron dasystachyum	5%
Fringed/Nodding Brome	Bromus ciliatus/anomalus	5%
Fall Rye		*

Area (B)	The Grande Prairie (except the Grande Cache area), Peace River and Athabasca Districts:	
Fertilizer	11-52-0	75 kg/ha
Slender/Awned/Bearded Wheatgrass	Agropyron trachycaulum	30%
Sheep Fescue	Festuca ovina	25%
Fowl Bluegrass	Poa palustris	5%
Northern/Streambank Wheatgrass	Agropyron dasystachyum	5%
Fringed/Nodding Brome	Bromus ciliatus/anomalus	5%
Mountain Brome	Bromus carinatus	25%
Tufted Hair Grass	Deschampia cespitosa	5%
Fall Rye		*

Area (C)	The Hanna, and the Calgary and Lethbridge Districts east of Highway 22:	
Fertilizer	11-52-0	75 kg/ha
Slender/Awned/Bearded Wheatgrass	Agropyron trachycaulum	35%
Green Needle Grass	Stipa viridula	5%
Sheep Fescue	Festuca ovina	35%
Western Wheatgrass	Agropyron smithii	5%
Northern/Streambank Wheatgrass	Agropyron dasystachyum	5%
Indian Rice Grass	Oryzopsis hymenoides	5%
Blue Grama	Bouteloua gracilis	5%
Alkali Grass	Puccinellia distans/nuttalliana	5%
Fall Rye		*

Source: Spc_G039.wpd

* If fall rye is to be used to provide early growth and protection against soil erosion, it should be applied at a seeding rate of 5 kg/ha and it should be added to the above noted seed mixes

Mulching Sediment Control and Erosion Control	B.M.P. #23

Description and Purpose

- Application of organic material or other normally biodegradable substances as a protection layer to the soil surface (i) to minimize raindrop/runoff erosion and conserve a desirable soil moisture property for plant growth, and/or (ii) to promote seed germination and plant growth
- Mulches conserve soil moisture, reduce runoff velocities and surface erosion, control weeds, help establish plant cover, and protect seeds from predators, raindrop impact, and wind/water erosion

Applications

- Temporary measure
- Can be used as an organic cover or growth medium for seeds where topsoil is not readily available
- Can be used to provide temporary and permanent erosion control
- May be used with or without seeding in areas that are rough graded or final graded
- May be applied in conjunction with seeding to promote plant growth
- May comprise organic mulches (such as straw, wood fibres, peat moss, wood chips, pine needles, compost) or chemical mulches (such as vinyl compounds, asphalt, rubber, or other substances mixed with water)
  - Chemical mulches may be used to bind other mulches in a hydroseeding-hydromulching application

Advantages

- Relatively cheap method of promoting plant growth and slope protection

Limitations

- Application of mulch may be difficult on steep slopes
  - May require spray-on method to apply mulch with tackifier to provide adhesion to steep slopes

Installation

- Prepare soil surface by removing large rocks or other deleterious materials
- Apply topsoil and seed (if required) (if topsoil available)
- Apply mulch as per supplier's recommendations
  - Certain mulches may require additional anchoring to minimize loss of mulch due to wind or water erosion

Construction Considerations

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Install mulches as per manufacturers' or suppliers' recommendations
- Organic Mulches
  - Straw
    - Refers to stalks or stems of small grain (primarily wheat) after drying and threshing
    - Straw should be free of weeds
    - Loose straw is very susceptible to movement by blowing wind and water runoff and should be anchored either with chemical tackifier or some form of netting
    - When properly secured to surface, straw is highly suitable for promoting good grass cover quickly, however, it may be a fire hazard in dry conditions
  - Raw Wood Fibre
  - Mixture of cellulose fibres a minimum of 4 mm in length extracted from wood
  - Wood fibres usually require a soil binder and should not be used as erosion control during periods of hot dry weather in the summer or for late fall seeding unless it is used in conjunction with another suitable mulch as it is prone to removal by blowing wind or water runoff
  - Wood fibre is primarily used in hydroseeding-hydromulching operations where it is applied as part of a slurry and when used in conjunction with a tackifier, it is well suited for tacking straw mulch on steep slopes
  - Peat Moss
    - Comprises partly decomposed mosses and organic matter under conditions of excessive moisture
    - Usually available in dried and compressed bundles
    - Should be free of coarse material
    - Useful soil conditioner to improve organic content of soil promoting plant growth
    - Highly susceptible to removal by blowing wind and water runoff if dry and spread on top of soil
  - Wood Chips
    - By-products of timber processing comprised of small, thin pieces of wood
    - Decompose slowly
    - Suitable for placing around individual plants (shrubs and trees) and for areas that will not be closely mowed
    - Highly resistant to removal by blowing wind and water runoff
  - Bark Chips (Shredded Bark)
    - By-products of timber processing comprised of small, thin pieces of tree bark
    - Suitable for areas that will not be closely mowed
    - Have good moisture retention properties and are resistant to removal by blowing wind and water runoff

- Pine Needles
  - Comprise needles from coniferous trees (pine, spruce)
  - Needles should be air dried and free of coarse material
  - Decompose slowly
  - Suitable for use with plants that require acidic soils
  - Resistant to removal by blowing wind and water runoff
- Compost (Straw Manure)
  - Comprised of organic residues and straw that have undergone biological decomposition until stable
  - Should be well shredded, free from coarse material, and not wet
  - Has good moisture retention properties and is suitable as a soil conditioner promoting plant growth
  - Relatively resistant to removal by blowing wind and water runoff if not dried out completely
- Chemical Mulches
  - Comprised of acrylic co-polymers, vinyl compounds, asphalt, rubber, or other substances mixed with water
  - Usually used in hydroseeding-hydromulching applications
  - Should be applied in accordance with supplier's recommendations

Inspection and Maintenance

- Inspect mulched areas at least once per year or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or rilling should be regraded if necessary and recovered with mulch immediately
- Additional stormwater control measures should be considered for areas of severe rilling erosion damaged by runoff
- Small bare spots may need to be reseeding and recovered with mulch

Similar Measures

- Topsoiling
- Hydraulic seeding and mulching (hydroseeding, hydromulching)
- Rolled erosion control products (RECP)

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Hydroseeding - Hydromulching

Sediment Control and Erosion Control

B.M.P. #24

Description and Purpose

- The spraying-on of a slurry to a slope or channel surface to provide a layer of seed and growth bedding medium
- The slurry consists of seed, fertilizer, mulch, tackifiers, and water which are mixed together in a tank
- Enables quick re-vegetation of very steep or rocky/gravelly slopes where re-vegetation by any other method would be very difficult or unsafe; frequent re-seeding and special mix design may be required
- When sprayed on the soil, the slurry forms a continuous blanket with seeds and protects the soil from wind and water erosion and raindrop impact by aggregating (or adhering) them in place
- The slurry conserves moisture, reduces soil moisture evaporation, and decreases soil surface crusting due to evaporation/drying of soil

Applications

- Temporary measure
- Slurry is held in suspension through consistent agitation and is sprayed onto disturbed areas using high pressure pumps
- Can be used for spray-on seeding covering large areas efficiently after placement of topsoil
- Can be used to provide temporary and permanent erosion control prior to establishment of vegetation
- May be used to provide soil stabilization for seeding disturbed soil areas
- Can also be used with higher efficiency and large area coverage with advantages over conventional methods (broadcast seeders, drill seeders)
- Can be used in areas where little topsoil is available

Advantages

- Relatively cheap and efficient spraying method of seeding and promoting plant growth as well as erosion protection
- Allows spray-on re-vegetation of steep slopes where conventional re-vegetation methods are very difficult
- Minimizes effort required to re-vegetate disturbed areas as hydroseeding-hydromulching usually only requires one spray-on operation in comparison with planting and farrow method
- Relatively efficient operation with high coverage rates
- Provides dust control and protection from wind erosion

Hydroseeding - Hydromulching

Sediment Control and Erosion Control

B.M.P. #24

Limitations

- Site must be accessible to hydroseeding-hydromulching equipment
  - Usually mounted on trucks
  - Maximum hose range of approximately 150 m
- May require subsequent spraying to reseed bare spots or areas with low growth

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Prepare soil surface by removing large rocks or other deleterious materials
- Apply topsoil if available
- Spray on hydroseed-hydromulch as per supplier's recommendations

Construction Considerations

- Seed
  - Seed selection should be made in accordance with Alberta Transportation approved seed mixes
  - Alberta Transportation has adopted seed mixes (provided below) depending on site location. The various areas of the province used in selecting the seed mix are presented (Alberta Transportation District map).
  - Seed mixes have been developed based on historic performance results throughout Alberta

Alberta Transportation Seeding Mixes

Seeding and Fertilizer Mixes

Area (A)	The Vermilion District, Red Deer District, Edson District, the Grande Cache area and all areas west of and including Highway 22 and Highway 6:	
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Sheep Fescue	Festuca ovina	25%
Green Needle Grass	Stipa viridula	5%
Western Wheatgrass	Agropyron smithii	5%
Northern/Streambank Wheatgrass	Agropyron dasystachyum	5%
Fringed/Nodding Brome	Bromus ciliatus/anomalus	5%
Fall Rye		*

Seeding and Fertilizer Mixes (continued)

Area (B) The Grande Prairie (except the Grande Cache area), Peace River and Athabasca Districts:		
Fertilizer	11-52-0	75 kg/ha
Slender/Awned/Bearded Wheatgrass	Agropyron trachycaulum	30%
Sheep Fescue	Festuca ovina	25%
Fowl Bluegrass	Poa palustris	5%
Northern/Streambank Wheatgrass	Agropyron dasystachyum	5%
Fringed/Nodding Brome	Bromus ciliatus/anomalus	5%
Mountain Brome	Bromus carinatus	25%
Tufted Hair Grass	Deschampia cespitosa	5%
Fall Rye		*

Area (C) The Hanna, and the Calgary and Lethbridge Districts east of Highway 22:		
Fertilizer	11-52-0	75 kg/ha
Slender/Awned/Bearded Wheatgrass	Agropyron trachycaulum	35%
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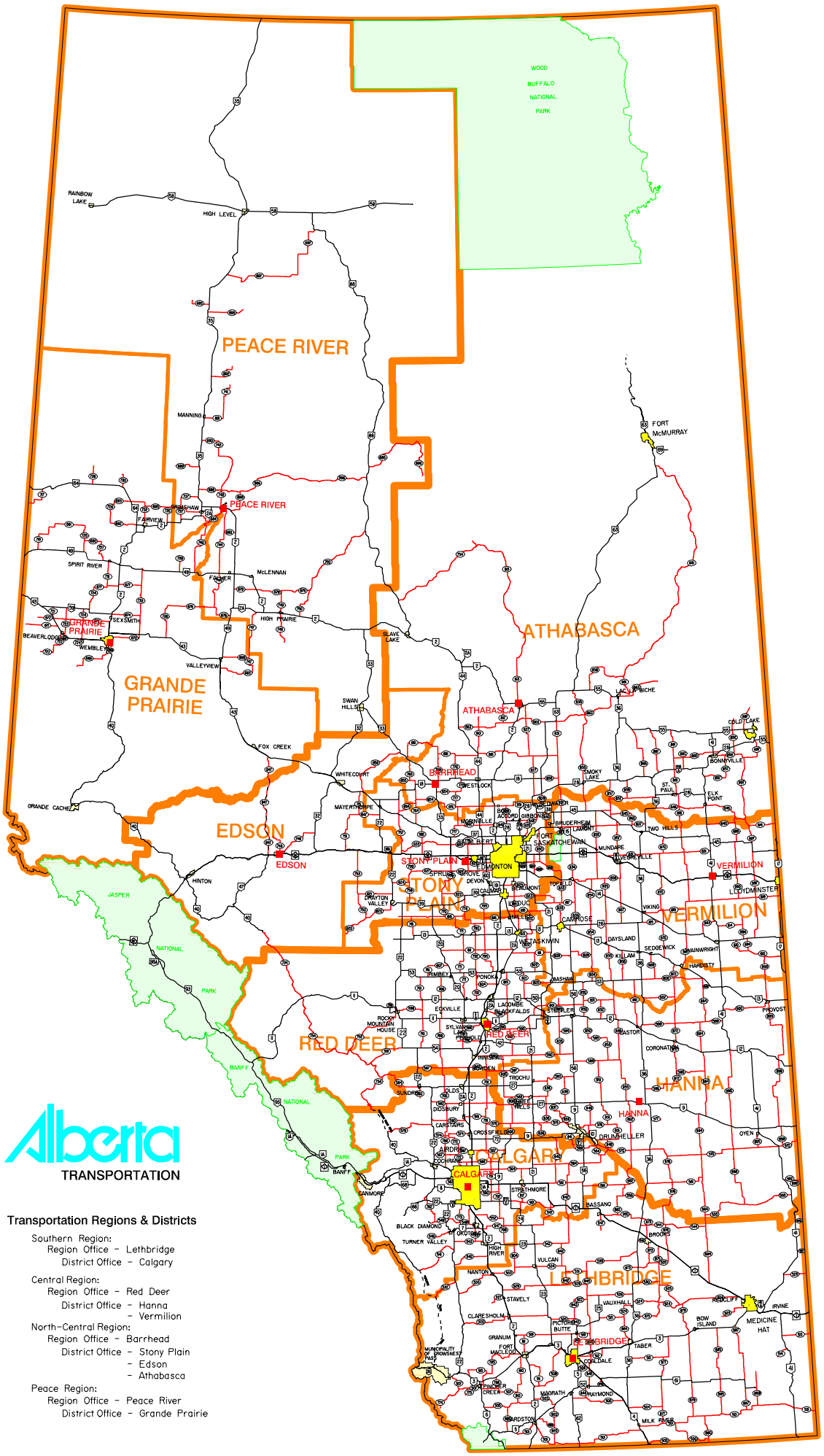
Sheep Fescue	Festuca ovina	35%
Western Wheatgrass	Agropyron smithii	5%
Northern/Streambank Wheatgrass	Agropyron dasystachyum	5%
Indian Rice Grass	Oryzopsis hymenoides	5%
Blue Grama	Bouteloua gracilis	5%
Alkali Grass	Puccinellia distans/nuttalliana	5%
Fall Rye		*

Source: Spc_G039.wpd

* If fall rye is to be used to provide early growth and protection against soil erosion, it should be applied at a seeding rate of 5 kg/ha and it should be added to the above noted seed mixes

- Hydraulic Mulches
  - Cellulose
    - Comprised of recycled paper from newspapers, magazines, or other paper sources
    - Rapid method for applying seed, fertilizer, mulch, and water in almost any disturbed areas
    - Usually installed without tackifier in slurry
    - Short fibre lengths and lack of tackifier limits erosion control effectiveness and does little to moderate moisture content and temperature within the soil
    - Residual inks within the recycled paper may leach into soil, potential problem on environmentally sensitive areas
    - Longevity significantly shorter than for wood fibre mulches or bonded fibre matrices (BFM)
    - Cheaper than wood fibre mulches and bonded fibre matrices (BFM)

  - Wood Fibre
    - Comprised of whole wood chips
    - Industry standard, provides quick and uniform method and medium for re-vegetating large areas quickly and economically
    - Longer fibre lengths than for cellulose mulches
    - Longer lasting and has better wet-dry characteristics than cellulose mulches
    - Provides limited erosion control even when sprayed on with tackifiers
    - Provides limited moderation of soil moisture content and temperature when applied at higher rates
    - Cheaper than BFM, however, less effective than BFM
    - More expensive than cellulose mulches, however, more effective than cellulose mulches
  - Bonded Fibre Matrices (BFM)
    - Slurry comprised of either cellulose mulch, wood fibre mulch, or a combination of the two
    - Mulches are bound together using chemical bond, mechanical bond, or a combination of the two
    - All fibres and binding agents are premixed by manufacturer, ensuring uniformity and consistency throughout the application
    - Well suited for sites with existing desirable vegetation and where worker safety and minimal ground disturbance are desired
    - Degree of protection similar to that obtained from rolled erosion control products (RECP)
    - Quicker installation/application than for RECP
    - Chemically bonded BFM may require a ‘set-up’ or curing/drying period
      - Application must be limited to periods where there is no threat of rain during curing period
      - Mechanically bonded BFM have no curing time and are effective immediately after application
    - Application on dry soils is not recommended
    - More expensive than cellulose and wood fibre mulches
    - More effective than cellulose or wood fibre mulches
- Tackifiers
  - May include vinyl compounds, asphalt, rubber, or other substances mixed with water



Alberta
TRANSPORTATION

Transportation Regions & Districts

Southern Region:
- Region Office - Lethbridge
- District Office - Calgary

Central Region:
- Region Office - Red Deer
- District Office - Hanna
- Vermilion

North-Central Region:
- Region Office - Barrhead
- District Office - Stony Plain
- Edson
- Athabasca

Peace Region:
- Region Office - Peace River
- District Office - Grande Prairie

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ALBERTA TRANSPORTATION

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Topsoiling Erosion Control	B.M.P. #25

Description and Purpose

- The covering of exposed mineral soils with soils of high organic content to minimize raindrop erosion potential
- Provides a medium for vegetation to grow

Applications

- Temporary or permanent measure
- May be used to provide a bedding medium for seed germination and a cover to exposed soil that is not suitable to promote vegetation growth
- May be used on slopes with a maximum gradient of 2H:1V
- Normally topsoil is placed prior to seeding, mulching, hydroseeding-hydromulching, seeding and installing rolled erosion control products (RECP), or planting of trees/shrubs

Advantages

- Placing topsoil provides enriched organic medium for vegetation root structure to grow
- Topsoil organic content provides nutrients to promote plant growth
- Absorb raindrop energy to reduce erosion

Limitations

- Not appropriate for slopes steeper than 2H:1V
- Placing and grading topsoil can be time consuming and expensive
- Dry topsoil may be removed by blowing wind
- Topsoil may not be readily available in some areas

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Prepare ground surface to final grade by removing large rocks or other deleterious materials
- Apply topsoil with dozer or light track equipment to design thickness
- Track walk upslope or downslope (do not overcompact topsoil by heavy equipment; only track walk one pass) to provide a contour of roughness of topsoil to further minimize erosion

Topsoiling Erosion Control	B.M.P. #25

Construction Considerations

- Topsoil should be free of weeds which may inhibit re-vegetation of desirable plants (i.e. grass)
- Subgrade should be roughened by track walking up/down the slope prior to topsoiling to promote adhering of topsoil to subgrade (surface roughening of subgrade is especially required if topsoiling is not scheduled immediately after completion of the grade)
- Topsoil should be moistened regularly during periods of hot dry weather to minimize wind erosion
  - Hydroseeding-hydromulching topsoil will minimize wind erosion of topsoil

Inspection and Maintenance

- Inspect topsoiled areas at least once per month after initial application or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or rilling should be regraded and re-topsoiled immediately

Similar Measures

- Hydroseeding-hydromulching
- Mulching
- Rolled erosion control products (RECP)

Sodding Erosion Control	B.M.P. #26

Description and Purpose

- Use of grass sod to cover and stabilize disturbed areas of bare soil
- Rapidly establishes vegetative cover in environmentally sensitive areas where complete cover of the disturbed soil surface is essential and conventional or hydroseeding and mulching may not be effective to erosion protection for high risk areas
- Acts as a vegetative buffer
- Sod may be nursery or field sod composed of one or more species/cultivars of grasses and may contain associated plants such as legumes

Applications

- Temporary or permanent measure
- Irrigation (watering) required after placement
- May be used to protect soil surface from water and wind erosion where adequate topsoil and fertilizer can be provided
- Best used for areas that have steep grades or require immediate protection, or at locations where aesthetic appearance is a priority

Advantages

- Immediate protection for sensitive area from water and wind erosion
- Aesthetically pleasing
- Sod can be maintained or left unmanaged

Limitations

- Expensive
- Labour intensive to install
- Sod may not be readily available in all areas of the province
- Field sod is not specifically produced for sale as turf and is generally not certified as to its composition or degree of weed infestation
- Sod can’t be stored on-site for long periods of time

Sodding Erosion Control	B.M.P. #26

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Prepare smooth ground surface by removing large rocks or other deleterious materials
- Apply approximately 0.1 to 0.15 m of topsoil and fertilizer (if required)
- Lay sod strips on prepared surface with long axis perpendicular to direction of slope (or in channels, perpendicular to anticipated direction of flow)
  - Butt-joint ends of adjacent sod strips tightly together
  - Roll or tamp each sod strip to ensure continuous contact between topsoil and underside of sod strip
  - Secure each strip of sod with an anchor embedded a minimum of 0.15 m into underlying soil
  - Anchors should be spaced a maximum distance of 0.6 m apart
- Adjacent rows of sod strips should have staggered joints

Construction Considerations

- Sod must not be placed on frozen ground
- During hot and dry periods, topsoil should be cool and wetted by irrigation prior to placing sod strips
- Freshly installed sod should be irrigated (watered) to moisten the topsoil to minimum depth of 0.1 m
  - Irrigation aids in the development of root matrix within the topsoil
- Successful installation requires the use of freshly cut, healthy sod
  - Storage time of cut sod on-site prior to installation should be kept to as short a time period as possible

Inspection and Maintenance

- Inspect sodded areas at least once per week for the first two months after placement or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
  - Areas damaged by washout or rilling should be regraded and resodded immediately
- Additional erosion control measures should be considered for rilled or gullied areas
- Small bare spots may need to be resodded
- Sodded areas should be maintained by periodically fertilizing, irrigating (watering), mowing, and weed control, depending on location and maintenance plan
- Sod that is to be mowed periodically as part of its maintenance plan should not be mowed within one month of installation
- Grass clipping from mowing operations should be left on the sod unless they accumulate to a depth greater than 1 cm

Sodding Erosion Control	B.M.P. #26

Similar Measures

- Mulching
- Hydroseeding-hydromulching
- Rolled erosion control products (RECP)

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Planting Trees and Shrubs a) Live Staking b) Brush-Layering Erosion Control	B.M.P. #27 (a & b)

Description and Purpose

- Consists of installing woody plantings (trees and shrubs) to develop a root matrix within the soil, increasing subsurface soil strength and stabilizing slopes with deeper root systems than grasses
- Reduces erosion potential of slopes and channel banks

Applications

- Temporary or permanent measure
- May be used on slopes stable enough to support vegetation; however, there is a low success rate for steep slopes and channel banks with gradients greater than 1H:1V
- May be used on slopes and channel banks with adequate sunlight, moisture, and wind protection to support vegetation
- May be used as bio-engineering stabilization of historical shallow slope instability soil movements on eroded slopes and gullies
- May be used along channels to provide higher channel roughness to reduce flow velocity and in sedimentation ponds to provide higher sedimentation duration of runoff impoundment

Advantages

- Promotes development of organic mat
- Dense leaves and large diameter plant stalks increases channel roughness and reduces flow velocities in channel thus decreasing erosion potential
- Traps sediment laden runoff and stabilizes soil
- Aesthetically pleasing once developed
- Grows stronger with time as root structure develops
- Usually has deeper root penetration than grass with greater depth of stabilization
- Manual planting may be attempted on steep slopes that are sensitive to machinery disturbance or represent an area of high erosion potential

Limitations

- Can be labour intensive to install
- Some level of uncertainty as success of plant growth is dependent on various unknown site parameters (i.e. moisture, soil, terrain, weather, seeding conditions, etc.)
- Revegetated areas are susceptible to erosion until vegetation develops; and should be used in conjunction with hydroseeding and/or mulching
- Plants may be damaged by wildlife
- Potential for low success rate
- Few precedents as this measure is generally not used on AT construction projects

Planting Trees and Shrubs a) Live Staking b) Brush-Layering Erosion Control	B.M.P. #27 (a & b)

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Live Staking
  - Used on cut or fill slopes or in ditches/channels
  - Comprised of willow or poplar stakes inserted into the ground; other indigenous plants may be acceptable
  - Individual dormant willow or poplar stakes should be cut to a minimum length of 0.5 m using pruning shears
    - Cuts should be made at a 45° angle a minimum of 0.05 m (5 cm) below a leaf bud
    - All side shutes should be trimmed to within 0.05 m of the main stem
  - Install live stakes in a 1 m by 1 m grid
  - Make a pilot hole a minimum of 0.3 m in depth to insert live stake into
    - Use iron bar, broom handle or other tool to make pilot hole
  - Insert live stake into pilot hole and lightly tamp soil around live stake
  - A minimum of two leaf buds should remain above grade
- Brush Layers
  - Used on cut or fill slopes or on channel/ditch walls susceptible to erosion
  - Comprised of layers of live branches placed on terraces on slopes
  - Excavate terraces perpendicular to direction of slope spaced approximately 1 m apart across entire width of slope to be protected
    - Slope terraces at an angle of 108 upwards from the back of the terrace towards the slope face
  - Place layers of branches on the terrace
    - Use Individual dormant willow or poplar branches a minimum length of 1 m and a minimum diameter of 0.025 m (25 mm)
    - Place brush layer approximately 0.1 to 0.2 m thick
    - Ensure a minimum length of 0.1 to 0.2 m of the branch is protruding from face of slope
  - Backfill and tamp soil over brush layer

Planting Trees and Shrubs a) Live Staking b) Brush-Layering Erosion Control	B.M.P. #27 (a & b)

Construction Considerations

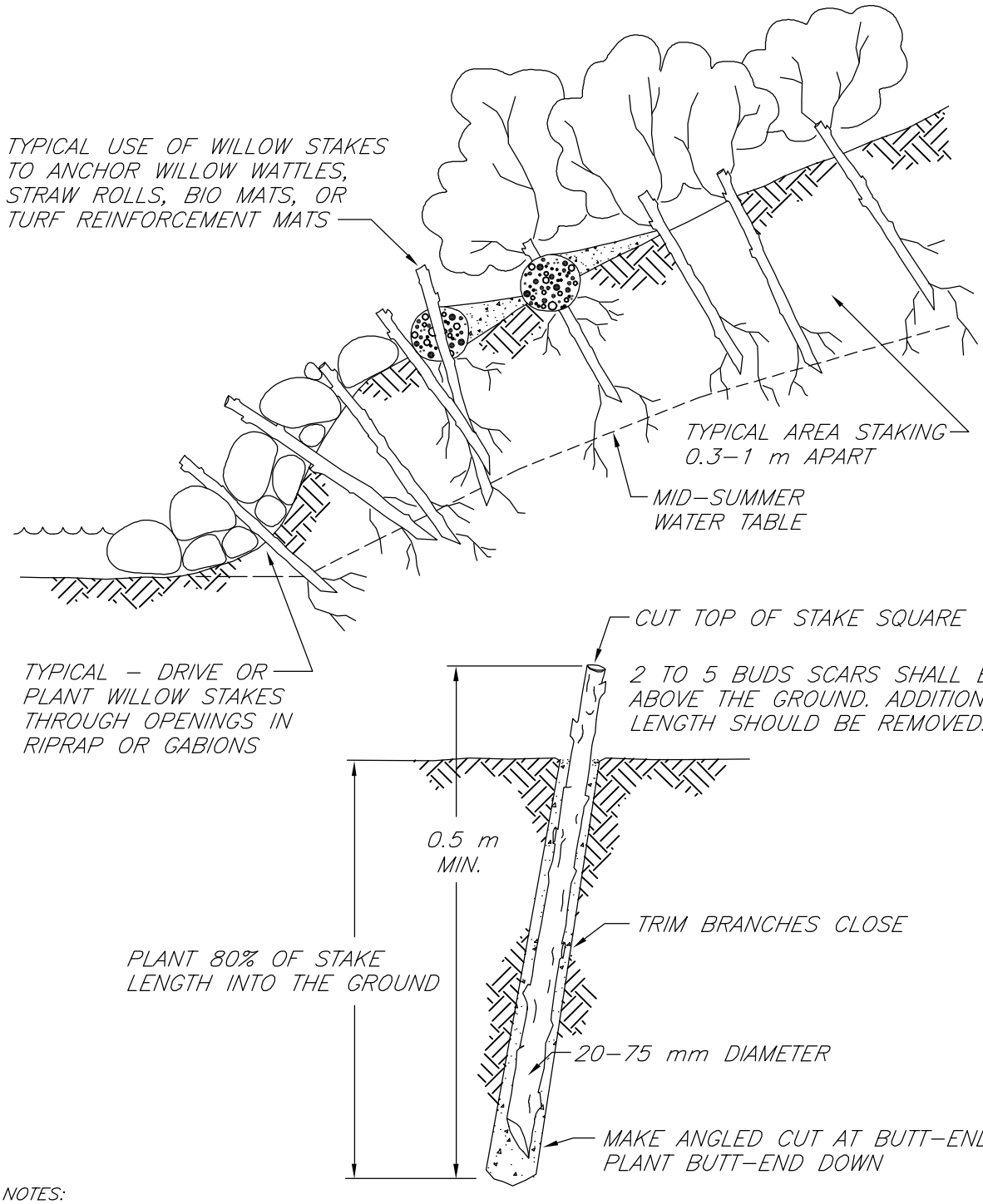
- Successful installation requires the use of freshly cut branches or stakes
  - Storage time of cut branches/stakes on-site prior to installation should be kept to as short a time period as possible
- Successful growth dependant on soil moisture and rainfall conditions
- Consultation with agrologist, greenhouse growers, local expertise can be beneficial in selecting and procuring appropriate species for planting

Inspection and Maintenance

- Inspect planted areas at least twice per year or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
  - Areas damaged by washout or erosion rilling should be replanted immediately
- Additional stormwater control measures should be considered for severe rilling areas damaged by runoff
- Watering plants is required for first one to two months after planting

Similar Measures

- Seeding
- Mulching
- Hydroseeding-hydromulching
- Rolled erosion control products (RECP)



NOTES:
1. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
2. USE HEALTHY, STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION, USE A PILOT BAR IN FIRM SOILS.
4. SOAK CUTTINGS FOR 24 HOURS (MIN.) PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

NOT TO SCALE

LIVE STAKING

FILE: LIVESTK

Alberta TRANSPORTATION

B.M.P. #27a
Typical Section

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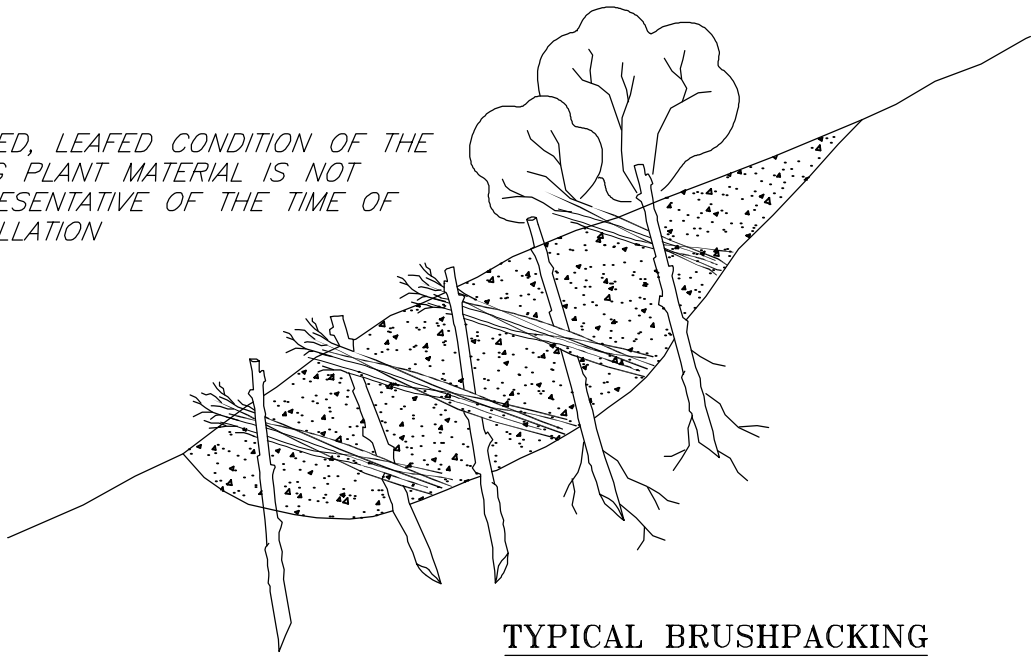
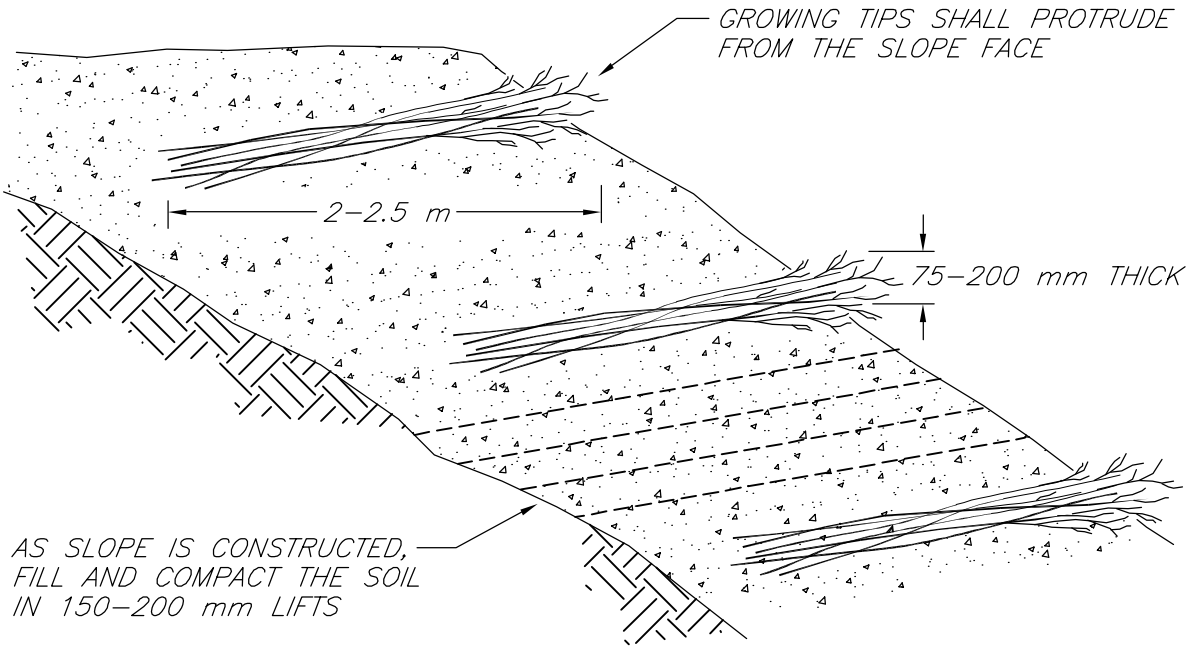
NOTE:
ROOTED, LEAFED CONDITION OF THE LIVING PLANT MATERIAL IS NOT REPRESENTATIVE OF THE TIME OF INSTALLATION



TYPICAL BRUSHPACKING

COVER BRUSHLAYER IMMEDIATELY WITH 150 mm OF FILL SOIL, WATER AND COMPACT ACCORDING TO SPECIFICATIONS



TYPICAL BRUSHLAYERING WITH SLOPE CONSTRUCTION

NOTE:

1. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

FILE: BRSHLAYR

BRUSHLAYERING

Alberta TRANSPORTATION

B.M.P. #27b
Typical Section

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Fibre Rolls and Wattles a) Straw Roll b) Wattles (Live Fascine) Sediment Control and Erosion Control	B.M.P. #28 (a & b)

Description and Purpose

- Straw roll consists of bundled straw (or natural fibre) wrapped in photo-degradable open-weave plastic netting staked into the soil along slope contours as a grade break to reduce erosion potential
- Wattles consist of bundled live fascine to stake into the soil along slope contours
- Fibre rolls are installed across slope contours as a grade break to reduce erosion potential by reducing overland flow velocities
- Normally life stake can be installed to anchor the Fibre Rolls and Wattles to provide deep root vegetation with potential favourable moisture retention provided by Fibre Roll
- Fibre rolls and wattles also capture sediment, organic matter, and seeds carried by runoff

Applications

- Temporary measure
- May be used on slopes stable enough to support vegetation (steep, confined, slopes and channel banks with gradients greater than 1H:1V may have low success potential)
- May be used on slopes and channel banks with adequate sunlight, moisture, and wind protection to support vegetation
- May be used along long slopes as a grade break to shorten slope length between line of fibre rolls at different contour elevations
- May be used as grade breaks, where slopes transition from flatter to steep gradients
- May be used on lake shores as wave break to assist in revegetation and stabilization of banks
- Can be used in conjunction with live staking as bioengineering measure

Advantages

- Grade break measure to lower sheet and rill erosion potential
- Can be used on slopes too steep for silt fences or straw bales sediment barriers
- In time, plastic netting will degrade due to the sunlight and straw will degrade and be incorporated into the soil
- Primary purpose is erosion control, however fibre rolls due provide some sediment control

Fibre Rolls and Wattles a) Straw Roll b) Wattles (Live Fascine) Sediment Control and Erosion Control	B.M.P. #28 (a & b)

Limitations

- Designed for low sheet flow velocities
- Designed for short slopes with a maximum gradient of 1H:1V
- May be labour intensive to install
- Few precedents as this measure is generally not used on AT construction projects
- Straw rolls have short life span due to natural degradation
  - Usually only functional for two seasons
- Susceptible to undermining and failure if not properly keyed into the soil
- Labour intensive maintenance may be required to ensure rolls are in continuous contact with the soil, especially when used on steep slopes or sandy soils

Construction

(Waiver: For guidance only. A site specific design is required from the designer/engineer)

- Prepare slope face and remove large rocks or other deleterious materials
- Excavate small trenches a minimum of 0.15 m deep and 0.15 m wide across the width of the slope, perpendicular to slope direction, starting at the toe of the slope and working upwards towards crest of slope
- Space trenches a maximum of 3 to 8 m apart along the slope incline, with steeper slopes having trenches spaced closer together
- Place fibre rolls into trench ensuring continuous contact between fibre roll and soil surface
- Butt-joint adjacent fibre roll segments tightly against one another
- Use a metal bar to make pilot hole through middle of the fibre roll a minimum depth of 0.3 m into underlying soil
- Pilot holes should be spaced a maximum of 1 m apart
- Secure fibre roll to soil using wooden stake or other appropriate anchor; live stake may be used as alternate anchor
- Place soil excavated from trench on upslope side of fibre roll and compact to minimize undermining of fibre roll by runoff
- Seed the soil along the upslope and downslope sides of the fibre roll to promote vegetation growth

Construction Considerations

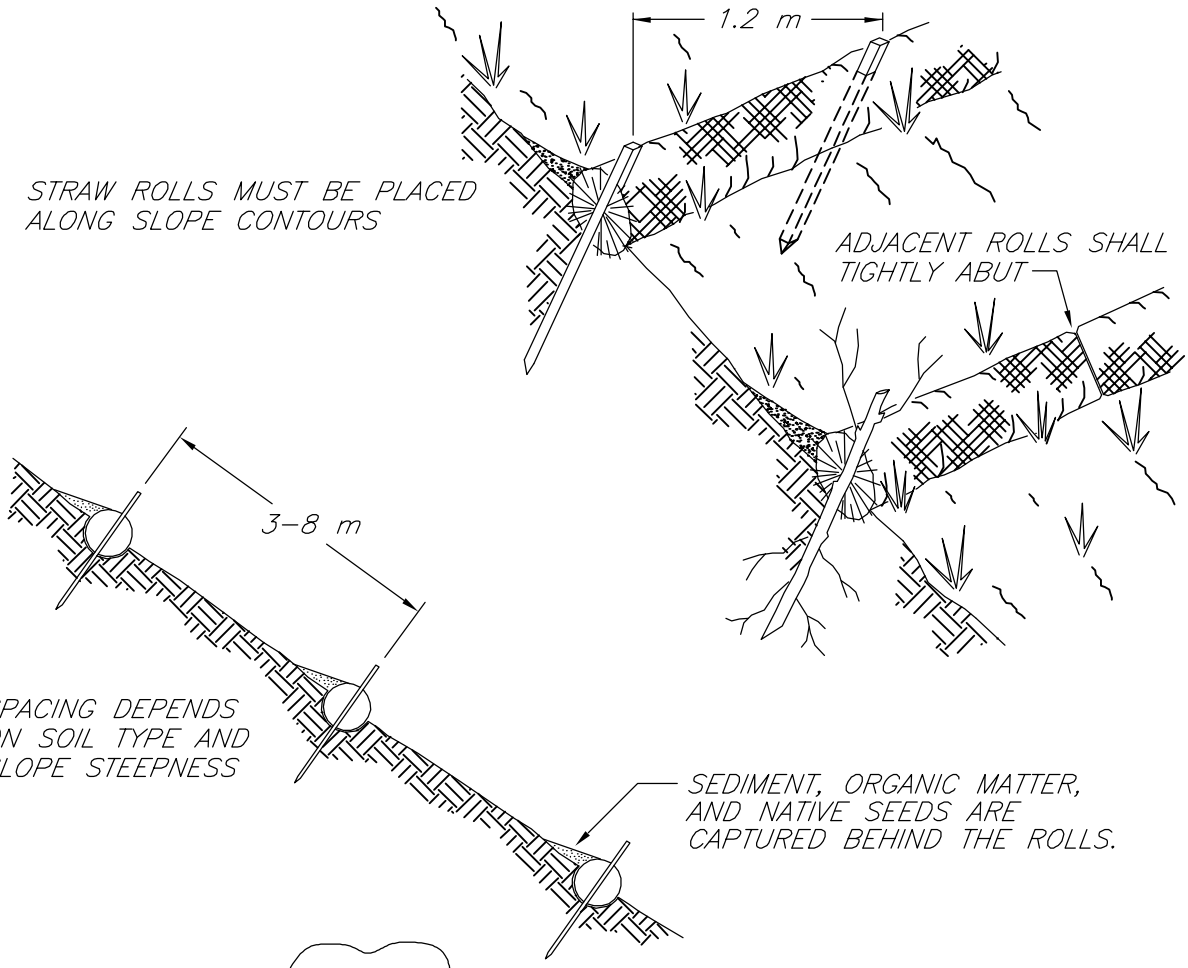
- Use live stakes in place of wooden stakes
- If the slope soil is loose and uncompacted, excavate trench to a minimum depth of 2/3 of the diameter of the fibre roll
- For steep slopes, additional anchors placed on the downslope side of the fibre roll may be required

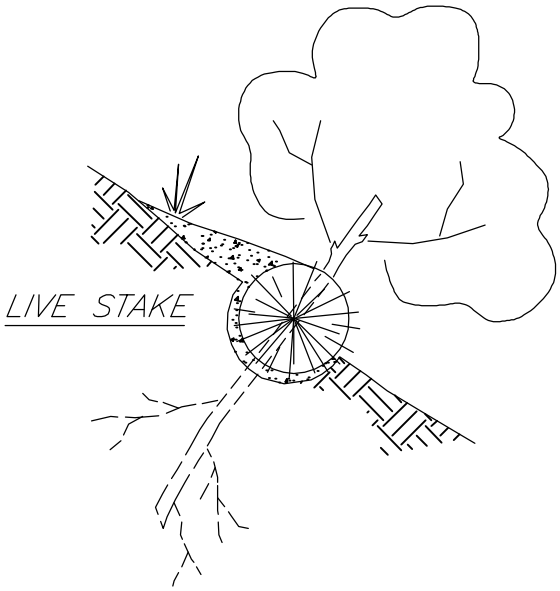
Inspection and Maintenance

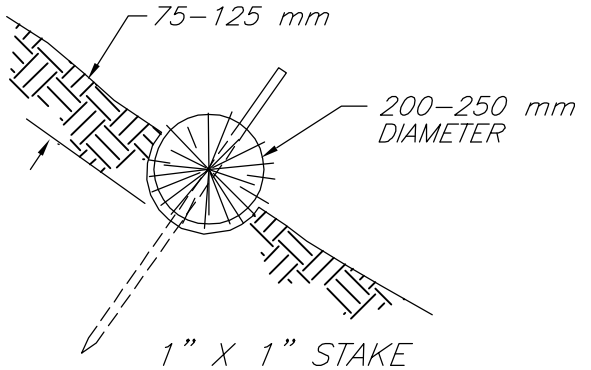
- Inspect structures at biweekly intervals or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Areas damaged by washout or rutting should be repaired immediately
- Additional stormwater control measures should be considered for rilling areas damaged by runoff

Similar Measures

- Synthetic permeable barriers







NOT TO SCALE

NOTE:

1. STRAW ROLL INSTALLATION REQUIRES THE PLACEMENT AND SECURE STAKING OF THE ROLL IN A TRENCH, 75–125 mm DEEP, DUG ON CONTOUR. RUNOFF MUST NOT BE ALLOWED TO RUN UNDER OR AROUND ROLL.
2. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

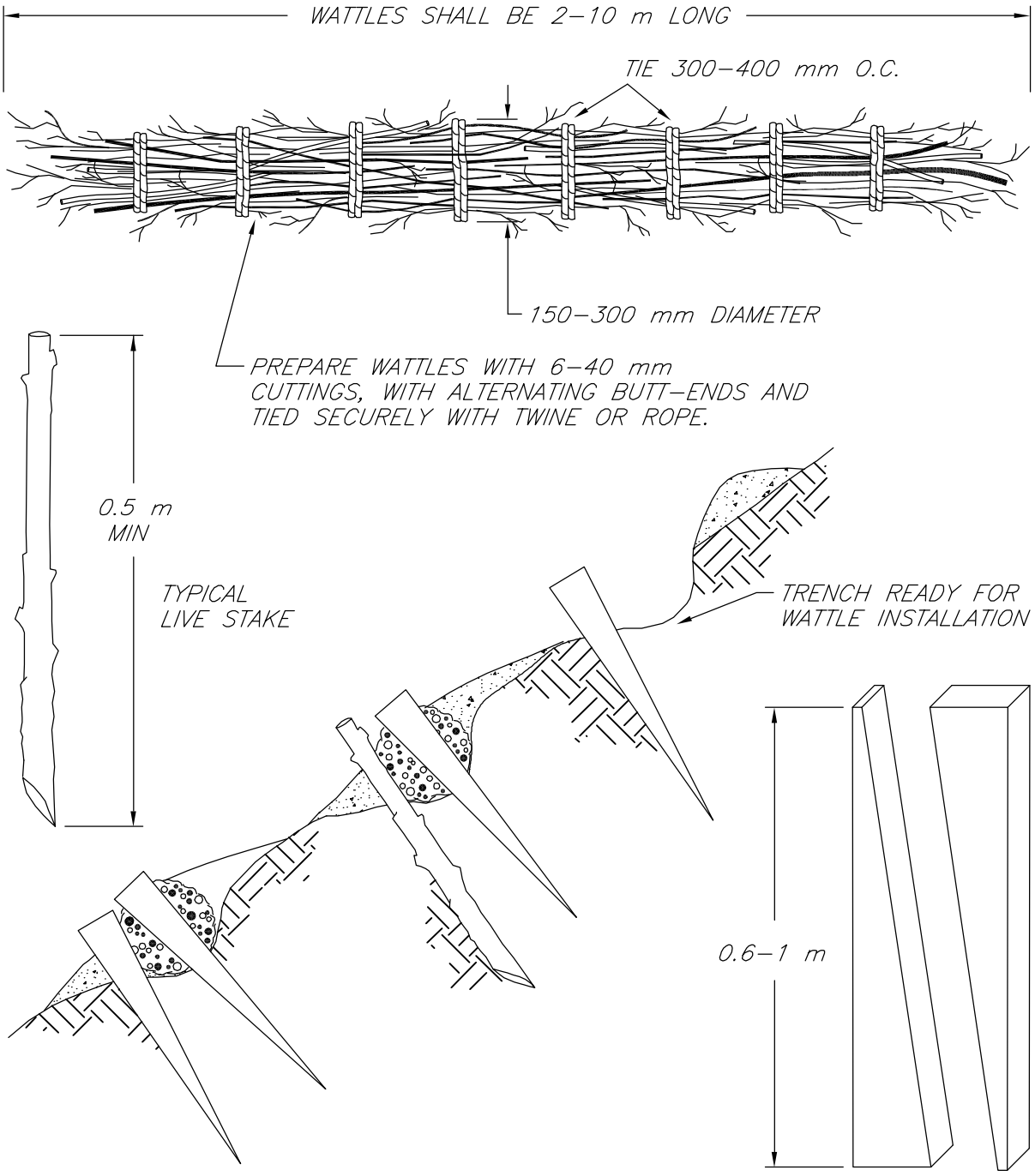
STRAW ROLLS

FILE: STRWROLL

Alberta TRANSPORTATION

B.M.P. #28a
Typical Section

0104–01–23211/BMP28A–A.dwg



NOTES:

1. HARVEST AND INSTALL WATTLES DURING DORMANT SEASON.
2. INSTALL WATTLES ON SLOPE CONTOURS.
3. ALL WORK PROCEEDS FROM THE BOTTOM OF THE SLOPE TO THE TOP.
4. FILL OR PARTIALLY COVER WATTLE WITH SOIL FROM SLOPE OR TRENCH ABOVE.
5. COMPACT AND WORK SOIL INTO COMPLETED WATTLES.
6. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

TYPICAL CONSTRUCTION STAKE
SAW 2X4 (100X50 mm) LUMBER
ON DIAGONAL

NOT TO SCALE

WATTLE
(LIVE FASCINE)

FILE: WATTLE

Alberta TRANSPORTATION

B.M.P. #28b
Typical Section

0104–01–23211/BMP28B–A.dwg

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Chemical Stabilization (Tackifiers) Erosion Control	B.M.P. #29

Description and Purpose

- Chemical substances that are sprayed onto disturbed soils to effect a change of soil properties, generally by aggregating finer soil particles
- Aggregated finer soil particles are less susceptible to erosion and reduce erosion potential of exposed slopes

Applications

- Temporary measure
- May be used in place of, or in conjunction with, mulch materials to act as both a soil stabilizer and mulch binding agent
- May be used for exposed soils not subject to traffic during the temporary establishment of a seedbed
- May be used to provide temporary erosion protection before revegetation is started
- May be used in areas where success of vegetation as a soil stabilizer is very difficult
- Primarily used on dry, highly permeable soils or in soils already in place which are subjected to sheet flow rather than concentrated flows
- May be used in wind erosion prone areas as temporary protection

Advantages

- Chemical stabilizers increase cohesion of soil surface which helps development of permanent vegetative cover by reducing erosion and reducing evaporation of soil moisture
- Efficiently sprayed over large areas of exposed soils

Limitations

- Site must be accessible to hydroseeding-hydromulching equipment
  - Usually mounted on trucks
  - Maximum hose range of approximately 150 m
- May require additional specialized equipment not commonly used during construction activities
- Increased longevity if chemical stabilizer application rate is increased, however, increased application rates may prevent seeds from germinating
- Crust-forming chemical stabilizers (such as bitumen) may crack during freeze-thaw cycles

Chemical Stabilization (Tackifiers) Erosion Control	B.M.P. #29

Construction

- Prepare slope face and remove large rocks or other deleterious materials
- Place topsoil and seed (if required)
- Spray on chemical stabilization according to suppliers recommended application rate

Construction Considerations

(Waiver: For guidance only. A site specific design is required from designer/engineer)

Chemical Soil Stabilizers

Type	Characteristics
Alginate	Paste-like emulsion or granulate produced from sea algae and consisting largely of natural carbohydrates with associated minerals added
Aquatain	Water dispersible, non-toxic
Asphalt Sprays	Available as an asphalt emulsion or as a liquid asphalt
Bitumen	Thick-flowing undilutable emulsion or a cold emulsion, 50% dilutable with water
DCA – 70	Water dispersible, non-toxic, non-phytotoxic
Hydrosillicates Methylcellulose	Gel-like elastic film in a powder form or as a water based emulsion
Plastic Emulsion	Usually a liquid which can be diluted with water producing a thin film to cover the soil surface
Polyvinyl Alcohol	An emulsion with water

Inspection and Maintenance

- Inspect treated areas at biweekly intervals or after significant storm events (1:2 year storm and/or 40 mm rainfall in 24 hours)
- Additional stormwater control measures should be considered for severe rilling areas damaged by runoff
- Period of effectiveness lasts from a few weeks to a few months, depending on application rate
  - Repetitive application will prolong effectiveness

Similar Measures

- Hydroseeding-hydromulching
- Rolled erosion control products (RECP)

Riparian Zone Preservation

Sediment Control and Erosion Control

B.M.P. #30

Description and Purpose

- Protection of existing plants and trees adjacent to all natural water bodies (riparian zones) adjacent to construction areas
- Existing vegetation acts as an effective vegetative buffer strip as a form of erosion and sediment control measure

Applications

- Permanent measure
- Existing established vegetation acts as an effective sediment control and erosion control buffer strip barrier to slow down flows and allow sedimentation filtration to occur
- May be used along property boundaries to minimize sediment transport off construction site despite non-presence of watercourse adjacent

Advantages

- Existing dense vegetation is more effective than any man-made structures or devices for sediment or erosion control, however, other forms of sediment and erosion control measures may be required on construction sites in addition to preserved riparian zones
- Any demuding of vegetation along steep valley slope with highly erodible soil will be detrimental and inducive to long-term sedimentation yield; it is important only to strip necessary areas along the footprint of construction. Preservation of riparian zone is mandatory along river valley slopes and along the edge corridor of waterbodies

Limitations

- Preservation of riparian zones may interfere with construction efficiency
- Careful planning is required to work around preserved riparian zones

Riparian Zone Preservation Sediment Control and Erosion Control	B.M.P. #30

Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer).

- It is highly important to preserve an established vegetative buffer as freshly planted vegetation generally require substantial growth periods before they are as effective as established riparian zones
- Wherever possible, retain as much existing vegetation as possible between construction areas and sensitive zones (wetlands, marshes, streams, floodplains, etc.) to entrap sediment and to minimize sediment transport off of the construction site into the sensitive zones
- Define and delineate riparian zones to be preserved in Environmental Construction Operations Plan (ECO Plan) prior to commencement of construction
- Clearly mark riparian zones to be preserved in the field (with construction fencing, survey flagging, or other highly visible measure) so all personnel involved with construction operations can identify areas to be preserved

Construction Considerations

- Riparian zones must be fenced off immediately to minimize trespassing and to ensure effectiveness of riparian zone is maintained
- Do not allow equipment to enter areas not necessary to construction

Inspection and Maintenance

- Maintain fences protecting riparian zones from trespassing

Pumped Silt Control Systems (Filter Fabric Bags) Sediment Control and Erosion Control	B.M.P. #31

Description and Purpose

- The extraction of sediment is effected by pumping sediment laden runoff into a bag manufactured with a permeable geotextile. Water will filter through the filter bag with the sediment being retained within the filter bag

Applications

- Temporary measure
- Can be used in high risk areas to supplement performance of containment pond systems
  - An example area would be where containment pond space is limited on construction site and appropriate sized containment pond cannot be constructed adjacent to high risk areas
- Useful for additional extraction of sediment dewatering sumps, sediment ponds, or other retention facilities with accumulations of sediment laden runoff

Advantages

- Filter bag is lightweight and portable
- Simple cleanup and disposal
- Sediment is captured within filter bag for removal from site

Limitations

- May be expensive
  - Extra costs associated with cost of filter bags and costs of pumping out retention facilities
- Power supply for pumps may be required
- Useful for only short periods of time and small volumes of water
- Can only retain particle sizes larger than the Apparent Opening Size (AOS) of the filter fabric bag
- Refer to manufacturers' product performance information
- Generally for available non-woven filtration geotextile, AOS values of 0.15 mm range or lower can be realistically manufactured. Potentially, only particle size larger than the design AOS value can be removed from the bag types. It is important to require manufacturer to provide performance specification and physical properties of the bags. The designer and supplier of the filter bag should choose the fabric and AOS based on the anticipated gradation of the sediments to ensure the sediments are retained in the bag.
- Few precedents as this measure is generally not used on AT construction projects, however, it can be resorted as emergency measure for highly sensitive sites

Pumped Silt Control Systems (Filter Fabric Bags) Sediment Control and Erosion Control	B.M.P. #31

Implementation

(Waiver: For guidance only. Site and product specific installation procedure is required from designer).

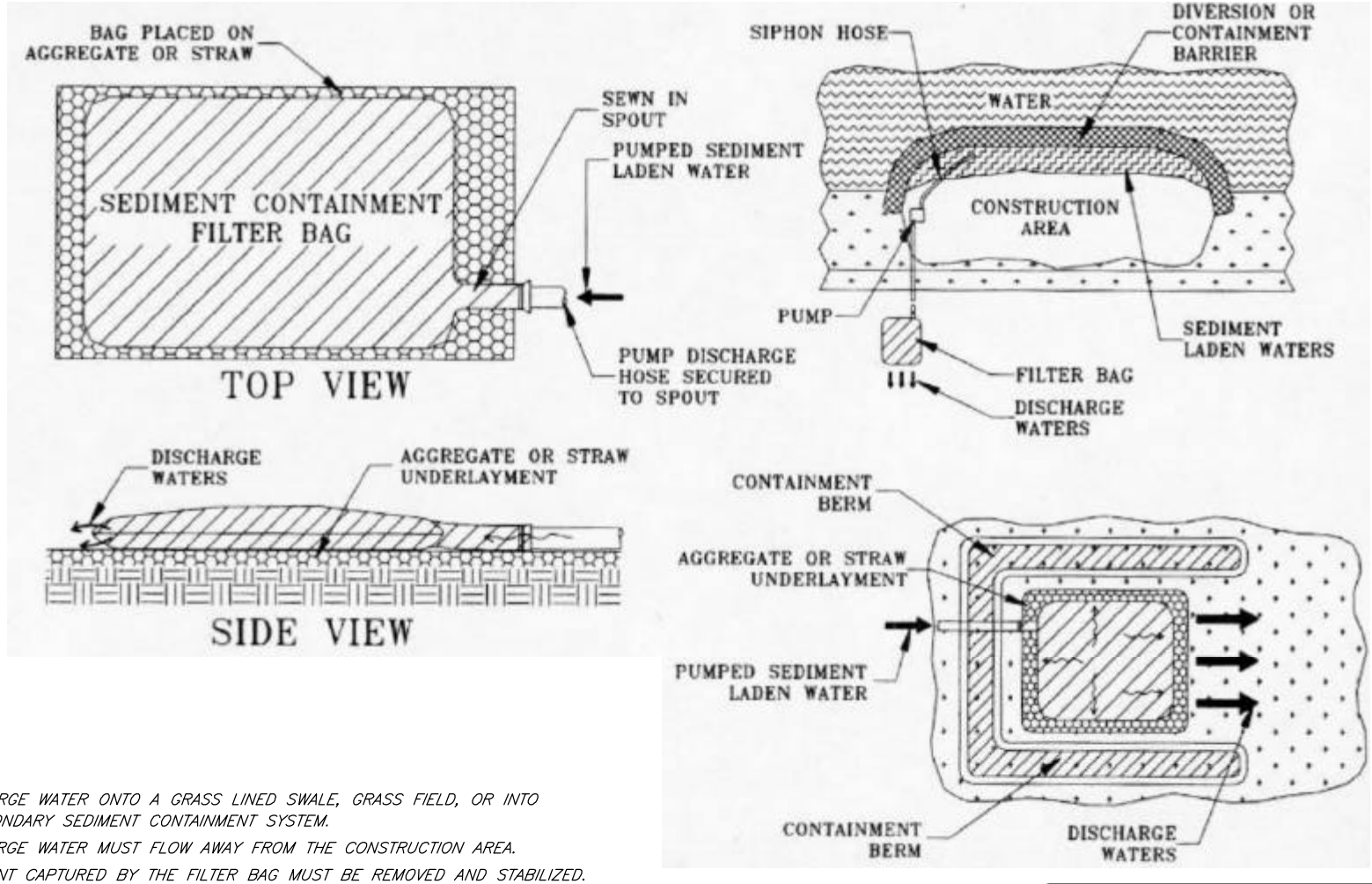
- Place filter bag on free-draining base (such as gravel pad or straw pile) on a slight slope, with opening to silt bag facing upslope
- Attach hose to opening of filter bag
  - Ensure tight seal to prevent discharge of sediment laden runoff outside of bag
- Attach hose to pump and insert extraction hose into retention facility to be dewatered
- Turn on pump and remove sediment laden water until filter bag is full of sediment
- Disengage pump once filter bag is full, tightly close opening to filter bag to prevent spilling of sediment and remove bag
- Repeat process (using new filter bags) until retention facility is dewatered to acceptable levels

Implementation Considerations

- Full filter bags can be removed from site or buried in designated locations on-site
- Care should be taken to ensure filter bag is not overfilled, which may cause filter bag to tear, spilling sediment
- Care should be taken when transporting full filter bags to ensure filter bag is not torn

Inspection and Maintenance

- Inspect all hoses and connections before and during pumping operations to minimize leaks



NOTES:

1. *DISCHARGE WATER ONTO A GRASS LINED SWALE, GRASS FIELD, OR INTO A SECONDARY SEDIMENT CONTAINMENT SYSTEM.*
2. *DISCHARGE WATER MUST FLOW AWAY FROM THE CONSTRUCTION AREA.*
3. *SEDIMENT CAPTURED BY THE FILTER BAG MUST BE REMOVED AND STABILIZED.*
4. *THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.*

SOURCE: FIFIELD 2001

PUMPED SILT CONTROL SYSTEM

Alberta TRANSPORTATION

B.M.P. #31
Typical Section

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Scheduling

Sediment Control and Erosion Control

B.M.P. #32

Description and Purpose

- Scheduling the sequence and timing arrangement of construction activities (1) to efficiently maximize the amount of erosion protection installed (such as topsoiling and seeding) as soon as a portion of grade construction is completed, and (2) to limit the portion of land disturbance (construction) compatible with the efficient rate of construction of erosion control measures achievable
- Incorporating erosion and sedimentation control concerns during the scheduling phase will minimize the amount and duration of bare soil exposure to erosion elements and ensure erosion and sedimentation control measures are implemented at an appropriate time
- Scheduling may be designed during planning stages by the contractor and altered during construction to suit actual conditions encountered

Applications

- Temporary measure

Advantages

- Ensures erosion and sedimentation control issues are identified during the planning stage by the Contractor
- May be used to minimize bare soil exposure and erosion hazard with careful planning and utilization of equipment in construction projects

Limitations

- May be more costly as erosion control measures (such as topsoiling and seeding) have to be implemented immediately after completion of each phase or a short section of construction

Implementation

- Incorporate a schedule with erosion protection perspective to form part of the overall construction plan
- Determine sequencing and timetable for the start and end of each item, such as clearing, grubbing, stripping, etc.
- Incorporate installation of appropriate erosion and/or sediment control measures in construction schedule
- Allow sufficient time before rainfall begins to install erosion and/or sediment control measures
- Whenever possible, schedule work to minimize extent of site disturbance at any one time
- Incorporate staged topsoiling and revegetation of graded slopes as work progresses
  - Don’t leave all topsoiling and revegetation until the very end of the project

Inspection and Maintenance

- Routinely verify that construction activities and the installation of erosion and sediment control measures is progressing in accordance with schedule
  - If progress deviates from schedule, take corrective action
- When changes to the project schedule are unavoidable, alter the schedule as soon as practicable to maintain control of erosion

Stabilized Worksite Entrances

Sediment Control and Erosion Control

B.M.P. #33

Description and Purpose

- Comprised of a gravel pad located at site access points (entrances) that are used to reduce the amount of sediment carried off construction sites by vehicles
- Collect sediment from vehicle washing and retains sediment on construction site
- Should include water supply to wash off excess soil from vehicles prior to exiting the constructions site

Applications

- Temporary measure
- For use anywhere vehicles enter or exit a construction site

Advantages

- Retains sediment on construction site, where it belongs
- Reduces deposition of sediments on public roads which may be carried by runoff into natural watercourses or drains

Limitations

- Sediment control measures should be installed to collect sediment laden runoff from gravel pad
- Installation of gravel pads may be limited by space constraints
- A supply of water is required for washing

Implementation

(For guidance only. A site specific implementation design is required from designer)

- Install gravel pad at planned entrances to worksite
  - Gravel pad (minimum of 15 m in length) should be of sufficient length to accommodate longest anticipated vehicle entering or exiting the site
  - Width of pad should be sufficient to accommodate the widest anticipated vehicle entering or exiting the site (minimum of 3.6 m in width)
  - Thickness of gravel pad should be a minimum of 0.30 m thick (0.3 m thickness is preferred for highway projects) and should comprise 50 to 150 mm diameter coarse aggregate placed on top of woven geotextile filter fabric
- Water supply with pump system should be incorporated to wash vehicle undercarriages and wheels to minimize amount of sediment being transported from site
- Install temporary sediment control measures (such as straw bale barriers or silt fences) to collect washed off sediment from gravel pad

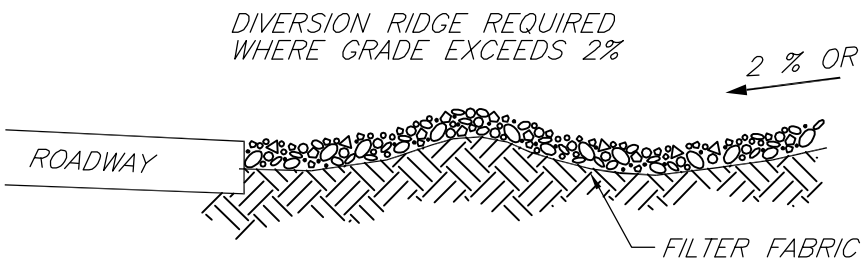
Stabilized Worksite Entrances Sediment Control and Erosion Control	B.M.P. #33

Construction Considerations

- Should be constructed at all access points to construction sites
  - If impractical to construct at all access points, limit vehicle access traffic to stabilized worksite entrances only
- Entrances located with steep grades or at curves on public roads should be avoided
- Woven geotextile filter fabric should be used as underlay below gravel pad as strength requirement
- Install an elevated ridge adjacent to roadway if gradient of the gravel pad is steeper than 2%, sloped towards the roadway

Inspection and Maintenance

- Granular material should be regraded when required
  - Material may need to be added to fill large voids to maintain a minimum pad thickness of 0.30 m
- Inspect and clean out downstream sediment control measures at least once per week and after periods of significant rainfall
- Material accidentally deposited onto public roads should be cleaned as soon as possible



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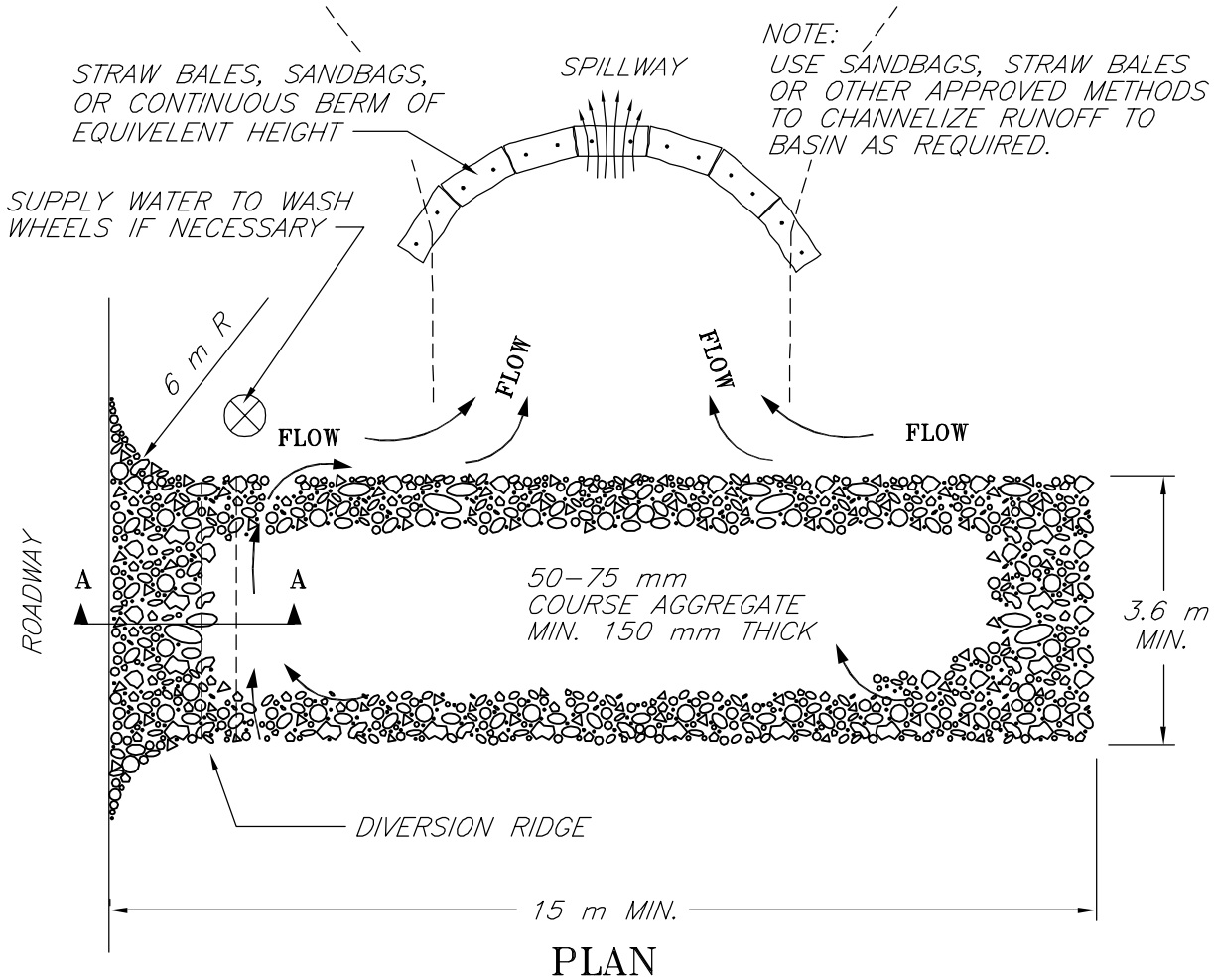

PLAN

NOTES:

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT–OF–WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT–OF–WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABLIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.
4. FOR HIGHWAY CONSTRUCTION, 300mm THICKNESS OF GRAVEL IS PREFERRED.
5. THIS FIGURE IS PROVIDED FOR GUIDANCE ONLY AND DOES NOT CONSTITUTE A DESIGN. A SITE SPECIFIC DESIGN IS REQUIRED FROM DESIGNER/ENGINEER.

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT

FILE: ENTRANCE

Alberta TRANSPORTATION

B.M.P. #33
Typical Section

0104–01–23211/BMP33–A.dwg

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Slope Texturing (a-c) Erosion Control	B.M.P. #34 (a – c)

Description and Purpose

- Texturing of slopes, either by roughening the surface, tracking the surface, or installing grooves or benches
- Texturing reduces the runoff velocity, traps sediment, and increases the infiltration of water into the soil

a) Surfacing Roughening
b) Grooved or Serrated Slope
c) Stepped or Terraced Slope

Applications

- Temporary measure
- May be used to roughen the exposed soils on the slope surface in the direction of water flow to minimize erosion and to entrap some sediments
- May be used on fresh cut or fill slopes (8 m length or longer practical travel reach of a dozer) with gradients of generally 3H:1V or steeper (2H:1V as general steepness limit) constructed in cohesive soils
- May be used on slope subgrade that will not be immediately topsoiled, vegetated or otherwise stabilized
- May be applied to topsoiled slope to provide track serration to further reduce erosion potential
- May be used in graded areas with smooth and hard surfaces
- As part of slope design, benching (terracing) may be used to effect a reduction of erosion hazard where a long slope length needs to be shortened into smaller sectional lengths with mid-benches; normally a 3 m wide bench can be appropriate
  - Benching (terracing) is usually a permanent slope design feature and should only be designed by a qualified geotechnical engineer
  - Benching of a long slope section to divide into short sections can reduce erosion hazard in the range of 30 to 50% (e.g. sediment yield for 15 m high 3H:1V slope with mid-bench)

Advantages

- Reduces erosion potential of a slope
- Texturing will create protrusions to increase surface roughness to reduce overland flow velocities and erosion energy
- Texturing will create minor spaces to entrap a portion of the coarse sediment and reduces amount of sediment transported downslope
- Texturing of slopes will benefit development of vegetation
- Texturing of slopes aids in performance of mulches and hydroseeding
- Texturing with track-walking up/downstream may effect a 10% reduction of sediment yield compared with untracked slope

Slope Texturing (a-c) Erosion Control	B.M.P. #34 (a – c)

Limitations

- Surface roughening and tracking may increase grading costs
- Surface roughening and tracking may cause sloughing in certain soil types (i.e. sandy silt) and seepage areas; geotechnical advice is recommended
- Texturing provides limited sediment and erosion control and should be used as a temporary measure prior to topsoiling
  - Should be used in conjunction with other erosion and sediment control measures (i.e. offtake ditches) to limit the sheet flow downslope

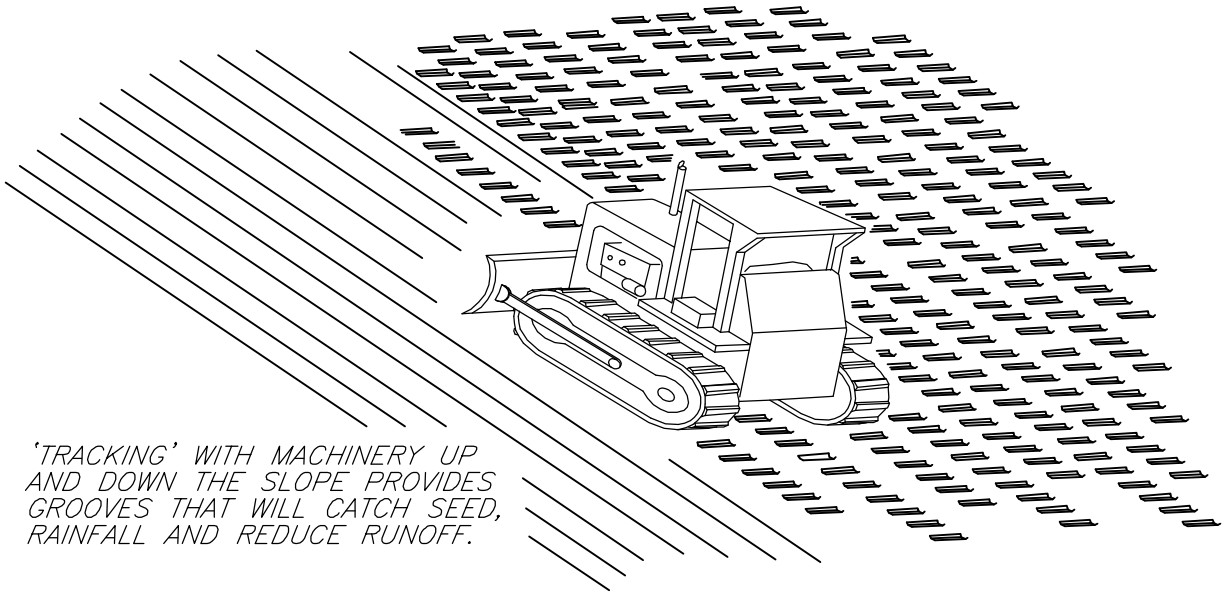
Construction

(Waiver: For guidance only. A site specific design is required from designer/engineer)

- Surface Roughening
  - Leave soil in rough grade condition, do not smooth grade soil
  - Large lumps of soil will aid in decreasing runoff velocities, trap sediment, and increase infiltration of water
- Surface Tracking
  - Using tracked construction equipment to move up and down the slope, leaving depressions perpendicular to the slope direction; limit passes to prevent overcompaction of the surface
  - Depressions in the soil will aid in decreasing runoff velocities, trap sediment, and increase infiltration of water
- Grooving
  - Excavating shallow furrows across the width of the slope, perpendicular to the direction of the slope
  - If used, contour grooves should be approximately 0.1 to 0.2 m in depth
- Grooves can be made by using equipment or hand
- Terracing/Benching
  - Construction of narrow, flatter sections of soil on the slope, perpendicular to the direction of the slope
  - Benches/terraces should be designed by qualified geotechnical engineer

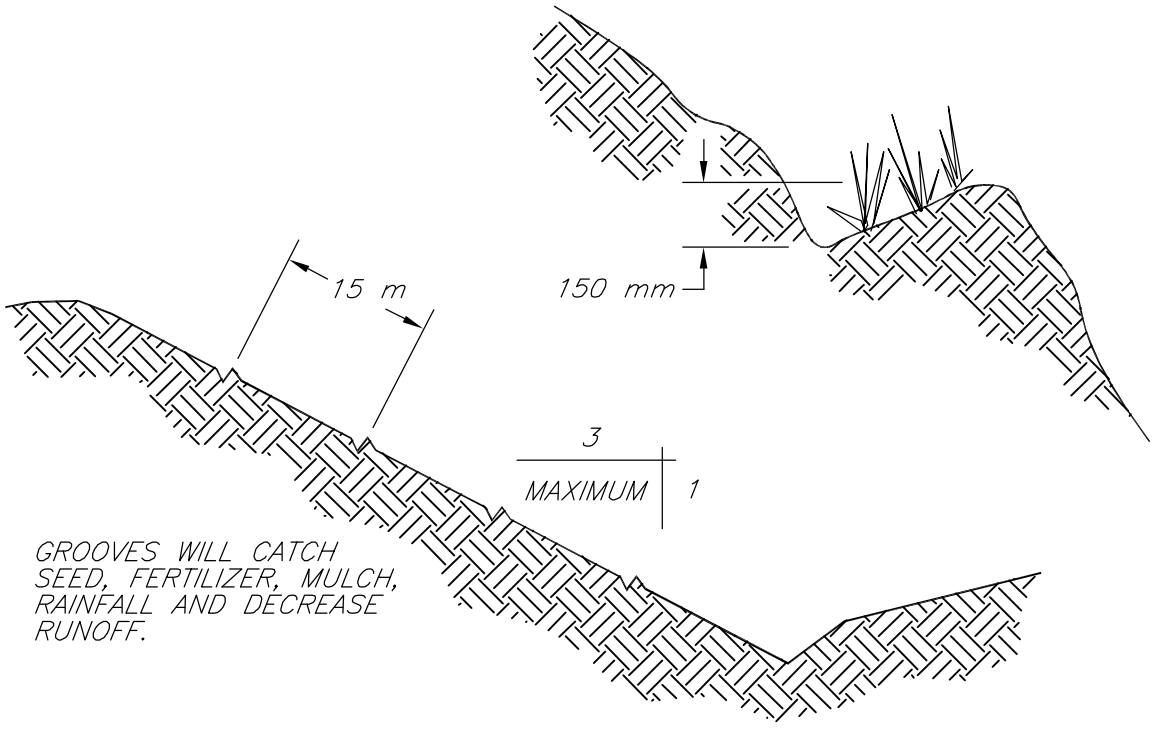
Construction Considerations

- During tracking operations, care must be taken to minimize disturbance to the soil where the equipment turns or changes direction
- Minimize the number of tracking passes to 1 to 2 times to avoid overcompaction, which can negatively impact the vegetation growth
- It is practical to track roughen a slope length of greater than 8 m for practical up/down slope operation of a small bulldozer. It is important to minimize the loosening of soil caused by turning movement of the bulldozer at the end of each pass. As the erosion potential is lower for slope of low vertical height (<3 m height and 3H:1V slope), the tracking of low height slope is not required and not practical for bulldozer tracking operation.



'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, RAINFALL AND REDUCE RUNOFF.

TRACKING



CONTOUR FURROWS

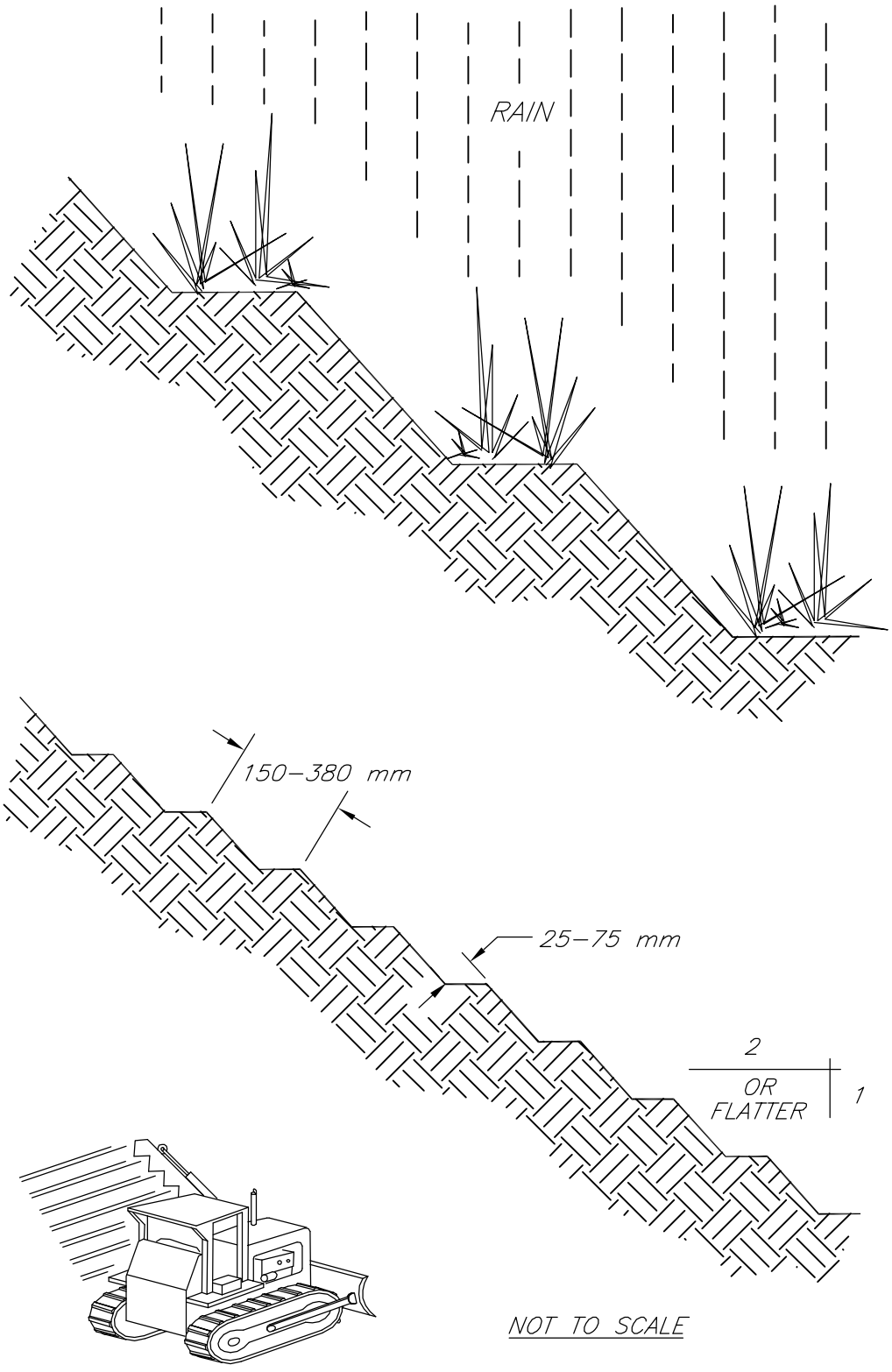
SURFACE ROUGHENING

FILE: SRFROUGH

Alberta TRANSPORTATION

B.M.P. #34a
Typical Section

0104–01–23211/BMP34A–A.dwg



NOT TO SCALE

NOTE:

GROOVE BY CUTTING SERRATIONS ALONG THE CONTOUR. IRREGULARITIES IN THE SOIL SURFACE CATCH RAINWATER, SEED, MULCH AND FERTILIZER.

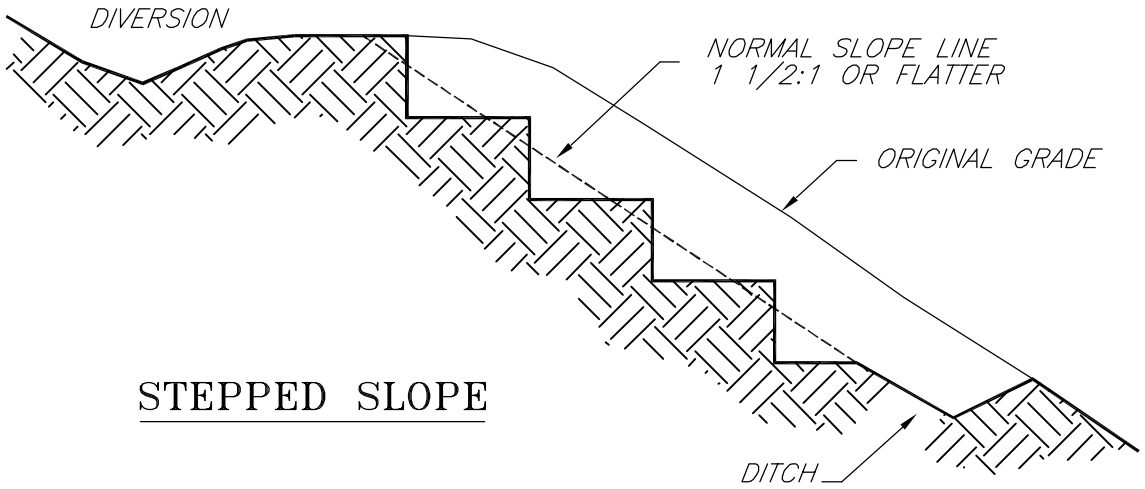
GROOVED OR SERRATED SLOPE

FILE: SERSLOPE

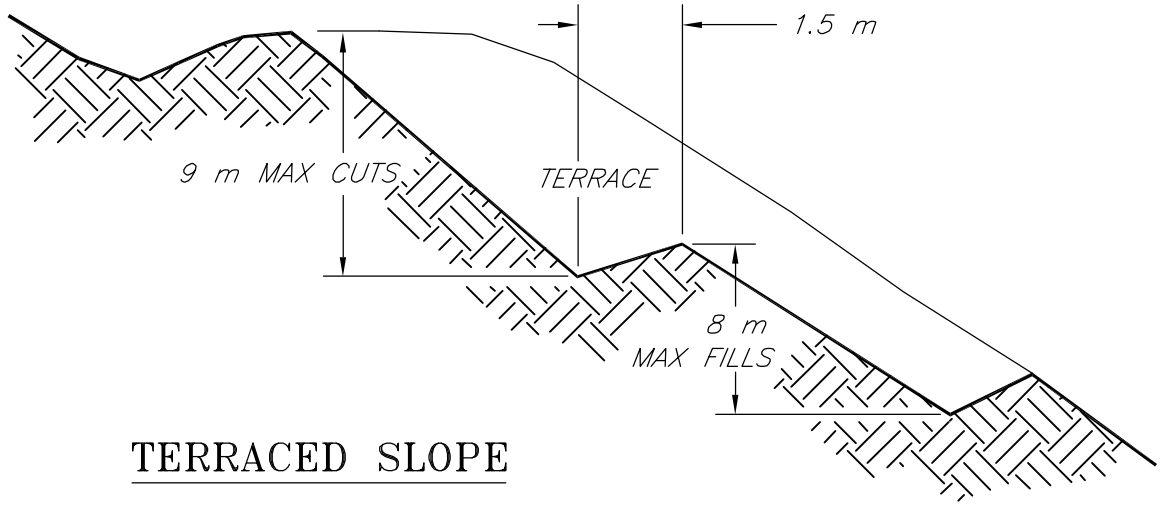
Alberta TRANSPORTATION

B.M.P. #34b
Typical Section

0104–01–23211/BMP34B–A.dwg



STEPPED SLOPE



TERRACED SLOPE

NOT TO SCALE

NOTES:
1. VERTICAL CUT DISTANCE SHALL BE LESS THAN HORIZONTAL DISTANCE.
2. VERTICAL CUT SHALL NOT EXCEED 0.6 m IN SOFT MATERIAL AND 0.9 m IN ROCKY MATERIAL.

STEPPED OR TERRACED SLOPE

FILE: STPSLOPE

Alberta TRANSPORTATION

B.M.P. #34c
Typical Section

0104–01–23211/BMP34C–A.dwg