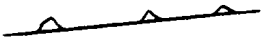
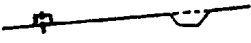



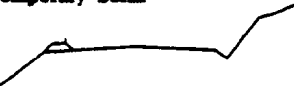
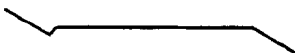












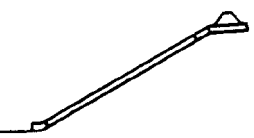
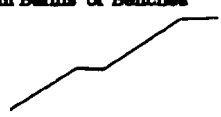
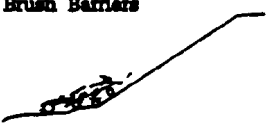
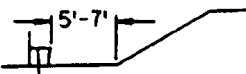
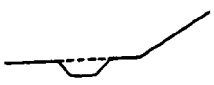
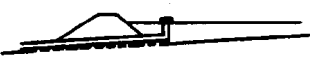
EROSION CONTROL MEASURES

TREATMENT PRACTICE	ADVANTAGES	DISADVANTAGES
ROADWAY DITCHES		
<p>Check Dams</p> 	<p>Maintain low velocities Catch sediment Can be constructed of logs, rock, lumber, masonry or concrete</p>	<p>Close spacing on steep grades Require clean-out Unless keyed at sides and bottom, erosion may occur</p>
<p>Sediment Traps/ Erosion Bale Combination</p> 	<p>Can be located as necessary to collect sediment during construction Clean-out often can be done with on-the-job equipment Simple to construct Top of lowest bale must be lower than bottom of end bale. See S.D.D.</p>	<p>Little direction on spacing and size Sediment disposal may be difficult Must be periodically cleaned. May require seeding or sodding when removed during final cleanup.</p>
<p>Sodding</p> 	<p>Easy to place with a minimum of preparation Can be repaired during construction Immediate protection May be used on sides of riprap ditches to provide increased capacity.</p>	<p>Requires water during first few weeks Sod not always available Will not withstand high velocity or severe abrasion from sediment load May not be salt tolerant. May not work well on sandy soils.</p>
<p>Seeding with Mulch</p> 	<p>Usually least expensive Effective for ditches with very low velocity. Easily placed in small quantities with inexperienced personnel</p>	<p>Will not withstand higher velocities.</p>
<p>Seed with Erosion Mat</p> 	<p>Three classes of mat available. Higher classes are able to withstand greater velocities. Cost effective alternative to riprap or rigid liners. Easily placed.</p>	<p>Requires proper installation. Initial cost greater than seed and mulch.</p>
<p>Riprap, Grouted Riprap</p>	<p>Effective for high velocities May be part of the permanent erosion control effort</p>	<p>Cannot always be placed when needed because of construction traffic and final grading and dressing Initial cost is high</p>
ROADWAY SURFACE		
<p>Crowning to Ditch or Sloping to Single Temporary Berm</p> 	<p>Directing the surface water to a prepared or protected ditch minimizes erosion</p>	<p>None - should be part of good construction procedures</p>
<p>Compaction</p>	<p>The final lift of each day's work should be well compacted and bladed to drain to ditch or berm section. Loose or uncompacted material is more subject to erosion</p>	<p>None - should be part of good construction procedures</p>
<p>Crushed Aggregate Cover</p> 	<p>Minimizes surface erosion Permits construction traffic during adverse weather May be used as part of permanent base construction</p>	<p>Requires reworking and compaction if exposed for long periods of time Loss of surface aggregates can be anticipated</p>
<p>Seed/Mulch</p>	<p>Minimizes surface erosion</p>	<p>Must be removed or is lost when construction of pavement is commenced.</p>

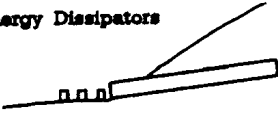




EROSION CONTROL MEASURES (Continued)

TREATMENT PRACTICE	ADVANTAGES	DISADVANTAGES
CUT SLOPES		
<p>Intercepting Embankment (Permanent Berm at top of cut)</p> 	<p>A permanent device Diverts water from cut Collects water for slope drains/ditches May be constructed before grading is started</p>	<p>Access to top of cut Difficult to build on steep natural slope or rock surface Concentrates water and may require channel protection or energy dissipation devices Can cause water to enter ground, resulting in sloughing of the cut slope</p>
<p>Diversion Dike</p> 	<p>May be either temporary or permanent Collects and diverts water at a location selected to reduce erosion potential May be incorporated in the permanent project drainage</p>	<p>Access for construction May be continuing maintenance problem if not paved or protected Disturbed material or berm is easily eroded</p>
<p>Slope Benches</p> 	<p>Slows velocity of surface runoff Collects sediment Provides access to slope for seeding, mulching and maintenance Collects water for slope drains or may divert water to natural ground</p>	<p>May cause sloughing of slopes if water infiltrates Requires additional ROW Not always possible due to rotten material etc. Requires maintenance to be effective Increases excavation quantities</p>
<p>Slope Drains or Flumes</p> 	<p>Prevents erosion on the slope Can be temporary or part of permanent construction Can be constructed or extended as grading progresses</p>	<p>Requires berms to collect water. Permanent construction is not always compatible with other project work Usually requires some type of energy dissipation</p>
<p>Seeding/Mulching or Erosion Mat</p> 	<p>The end objective is to have a completely grassed slope. Early placement is a step in this direction. The mulch provides temporary erosion protection until grass is rooted. Temporary or permanent seeding may be used. Mulch should be anchored. Larger slopes can be seeded and mulched with smaller equipment if stage techniques are used. For steep slopes erosion mat may be used in place of mulch.</p>	<p>Difficult to schedule high production units for small increments Time of year may prevent seeding. May require supplemental water Contractor may perform this operation with untrained or inexperienced personnel and inadequate equipment if stage seeding is required</p>
<p>Sodding</p> 	<p>Provides immediate protection Can be used to protect adjacent property from sediment and turbidity</p>	<p>Difficult to place until cut is complete Sod not always available May be expensive</p>
<p>Slope Pavement, Riprap</p> 	<p>Provides immediate protection for high risk areas and under structures May be cast in place or off site</p>	<p>Expensive Difficult to place on high slopes May be difficult to maintain</p>
<p>Temporary Cover</p>	<p>Plastics or geotextile fabrics are available in wide rolls and large sheets that may be used to provide temporary protection for cut or fill slopes Easy to place and remove Useful to protect high risk areas from temporary erosion</p>	<p>Provides only temporary protection Original surface usually requires additional treatment when plastic is removed Must be anchored to prevent wind damage</p>
<p>Temporary Seccrated Slope</p> 	<p>Lowens velocity of surface runoff Collects sediment Holds moisture Minimizes amount of sediment reaching roadside ditch</p>	<p>May cause minor sloughing if water infiltrates Construction compliance</p>






EROSION CONTROL MEASURES (Continued)

TREATMENT PRACTICE	ADVANTAGES	DISADVANTAGES
FILL SLOPES		
<p>Temporary Fill Diversion (Berms at Top of Embankment)</p> 	<p>Prevent runoff from embankment surface from flowing over face of fill Collect runoff for slope drains or protected ditch Can be placed as a part of the normal construction operation and incorporated into fill or shoulders</p>	<p>Cooperation of construction operators to place final lifts at edge for shaping into berm Failure to compact outside lift when work is resumed Sediment buildup and berm failure Can cause water to enter embankment resulting in sloughing of the slope.</p>
<p>Diversion Dike</p> 	<p>May be either temporary or permanent Collects and diverts water at a location selected to reduce erosion potential May be incorporated in the permanent project drainage</p>	<p>Access for construction May be continuing maintenance problem if not paved or protected Disturbed material or berm is easily eroded</p>
<p>Slope Drains or Flumes</p> 	<p>Prevent fill slope erosion caused by embankment surface runoff Can be constructed of full or half section pipe, asphalt, metal, concrete, plastic or sod Can be extended as construction progresses May be either temporary or permanent</p>	<p>Permanent construction as needed may not be considered desirable by contractor Removal of temporary drains may disturb growing vegetation Energy dissipation devices are required at the outlets Consider salt tolerant sod for flumes.</p>
<p>Fill Berms or Benches</p> 	<p>Slows velocity of slope runoff Collects sediment Provides access for maintenance Collects water for slope drains</p>	<p>Requires additional fill material if waste is not available May cause sloughing Additional ROW may be needed</p>
<p>Seeding/Mulching or Erosion Mat</p>	<p>Timely application of mulch and seeding decreases the period a slope is subject to severe erosion Mulch that is cut in or otherwise anchored will collect sediment. The furrows made will also hold water and sediment For steep slopes erosion mat may be used in place of mulch.</p>	<p>Time of year may prevent seeding. Watering may be necessary Steep slopes or locations with low velocities may require supplemental treatment</p>
PROTECTION OF ADJACENT PROPERTY		
<p>Brush Barriers</p> 	<p>Use slashing and logs from clearing operation Can be covered and seeded rather than removed Eliminates need for burning or disposal off ROW</p>	<p>May be considered unsightly in urban areas</p>
<p>Erosion Bale Barriers</p> 	<p>Bales are readily available in many areas When properly installed, they filter sediment and some turbidity from runoff</p>	<p>Require removal Subject to vandal damage Flow is slow through straw requiring considerable area</p>
<p>Sediment Traps</p> 	<p>Collects most of the sediment spill from fill slopes and storm drain ditches Inexpensive Can be cleaned and expanded to meet need</p>	<p>Does not eliminate all sediment and turbidity during construction Space is not always available Must be periodically cleaned</p>
<p>Retention/Retention Ponds</p> 	<p>Can be designed to handle large volumes of flow Both sediment and turbidity are removed May be incorporated into permanent erosion control plan</p>	<p>Requires prior planning, additional ROW and/or flow easement If removal is necessary, can present a major effort during final construction stage Clean-out volumes can be large Access for clean-out not always convenient</p>

EROSION CONTROL MEASURES (Continued)

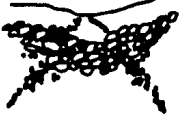




TREATMENT PRACTICE	ADVANTAGES	DISADVANTAGES
PROTECTION OF ADJACENT PROPERTY (continued)		
Energy Dissipators 	Slows velocity to permit sediment collection and to minimize channel erosion Can be constructed of concrete, rock, wood or other suitable materials.	Collects debris and requires cleaning. Requires special design and construction.
PROTECTION OF LAKES OR STREAMS		
Construction Dike 	Usually constructed of earth. Permits work to continue during normal stream stages Controlled flooding can be accomplished during periods of inactivity	Usually requires pumping of work site water into sediment pond Subject to erosion from stream and from direct rainfall on dike
Sheet Piling Cofferdam 	Work can be continued during most anticipated stream conditions Clear water can be pumped directly back into stream No material deposited in stream Good for heavy flow conditions.	Expensive May cause sediment release into waterway when removed.
Temporary Stream Channel Change or Diversion Channel	Temporary channel to keep flows away from construction Good for heavier flows when cofferdams cannot be used	New channel usually will require protection Stream must be returned to old channel and temporary channel refilled
Riprap or Grouted Riprap	Easy to stockpile and place Can be installed in increments as needed Grouted riprap is a rigid liner and can withstand higher velocities.	Expensive
Temporary Culverts for Haul Roads 	Eliminates stream turbulence and turbidity Provides unobstructed passage for fish and other water life Capacity for normal flow can be provided with storm water flowing over the roadway	Space not always available without conflicting with permanent structure work May be expensive, especially for larger sizes of pipe Subject to washout
Rock-lined Low-Level Crossing 	Minimizes stream turbidity Inexpensive May also serve as ditch check or sediment trap	May not be fordable during rainstorms During periods of low flow, passage of fish may be blocked
Silt Screen	Minimizes sediment transport into water. See detail drawing.	Not to be used where current exceeds 1.65 ft./sec. (0.5 m/sec.) Do not place perpendicular to flow.
Turbidity Barrier	Eliminates sediment transport into water. See detail drawing.	Not to be used where current exceeds 4.95 ft./sec. (1.5 m/sec.) Do not place perpendicular to flow.

SUMMARY OF CONTROL MEASURE APPLICATIONS

CONTROL MEASURE	PURPOSE	CONDITION NEEDING CONTROL					
		CUT SLOPES	FILL SLOPES	DENUDED GENTLY SLOPING OR FLAT AREA	ERODING STREAMBANK	ERODING SWALE	PROTECTION OF ADJACENT PROPERTY
Temporary and permanent planting of exposed soils 	To stabilize soils by absorbing the impact of raindrops, reducing velocity of runoff, and allowing precipitation to enter the soil.	●	●	●			●
Temporary and permanent grass protection of waterways, swales and dikes 	To protect drainageways by lowering water velocity over the soil surface and by binding soil particles with roots.				●	●	●
Intercepting embankment 	To intercept storm runoff from small upland areas and divert it to an outlet.	●					●
Temporary fill diversion 	To intercept storm runoff and divert it to a stable outlet or sediment-trapping device, or to prevent runoff from entering a disturbed area and to direct sediment-laden runoff leaving the disturbed area.	○	●	●			●
Temporary grade stabilization structure 	To convey concentrated, high-velocity runoff down slopes without causing erosion.	●	●				




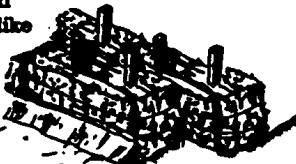
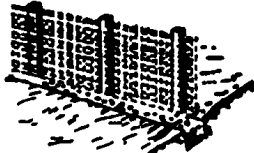
KEY: ● Preferred control measure ○ Alternative but less effective control measure.

SUMMARY OF CONTROL MEASURE APPLICATIONS (con't)

CONTROL MEASURE	PURPOSE	CONDITION NEEDING CONTROL					
		CUT SLOPES	FILL SLOPES	DENUDED GENTLY SLOPING OR FLAT AREA	ERODING STREAMBANK	ERODING SWALE	PROTECTION OF ADJACENT PROPERTY
<p>Check dam</p> 	<p>To reduce the velocity of concentrated stormwater flows in swales or ditches draining small areas.</p>				●	●	●
<p>Diversion dike ①</p> 	<p>To prevent runoff from entering a disturbed area and sediment-laden runoff from leaving the disturbed area. Diversion dike can be placed at either position 1 or 2.</p>		●				●
<p>Riprap or grouted riprap</p> 	<p>To protect a soil surface, drainageway or outlet from the erosive forces of water.</p>	○			●	●	●
<p>Culvert pipe</p> 	<p>To convert pipe flow to channel flow and reduce water velocity.</p>				●	●	○
<p>Permanent subsurface drain</p> 	<p>To remove runoff from and prevent water movement into a wet area, to regulate the water table and groundwater flow to improve plant growth and to dewater a sediment basin.</p>	○	○	○			○


KEY: ● Preferred control measure ○ Alternative but less effective control measure.

SUMMARY OF CONTROL MEASURE APPLICATIONS (con't)

CONTROL MEASURE	PURPOSE	CONDITION NEEDING CONTROL					
		CUT SLOPES	FILL SLOPES	DENUDED GENTLY SLOPING OR FLAT AREA	ERODING STREAMBANK	ERODING SWALE	PROTECTION OF ADJACENT PROPERTY
Retention/Detention ponds 	To collect and hold runoff to allow suspended sediment to settle out.	●	●	●			●
Sediment trap 	To intercept small quantities of sediment-laden runoff and trap the sediment.	○	○	●			●
Temporary stabilized construction entrance 	To reduce the tracking or flowing of sediment onto public rights-of-way.						●
Erosion bale dike 	To intercept and detain small amounts of sediment from small unprotected areas.			○			○
Silt fence 	To intercept and detain the sediment in runoff from small erodible areas while decreasing the velocity of the runoff.			○			○

KEY: ● Preferred control measure ○ Alternative but less effective control measure.

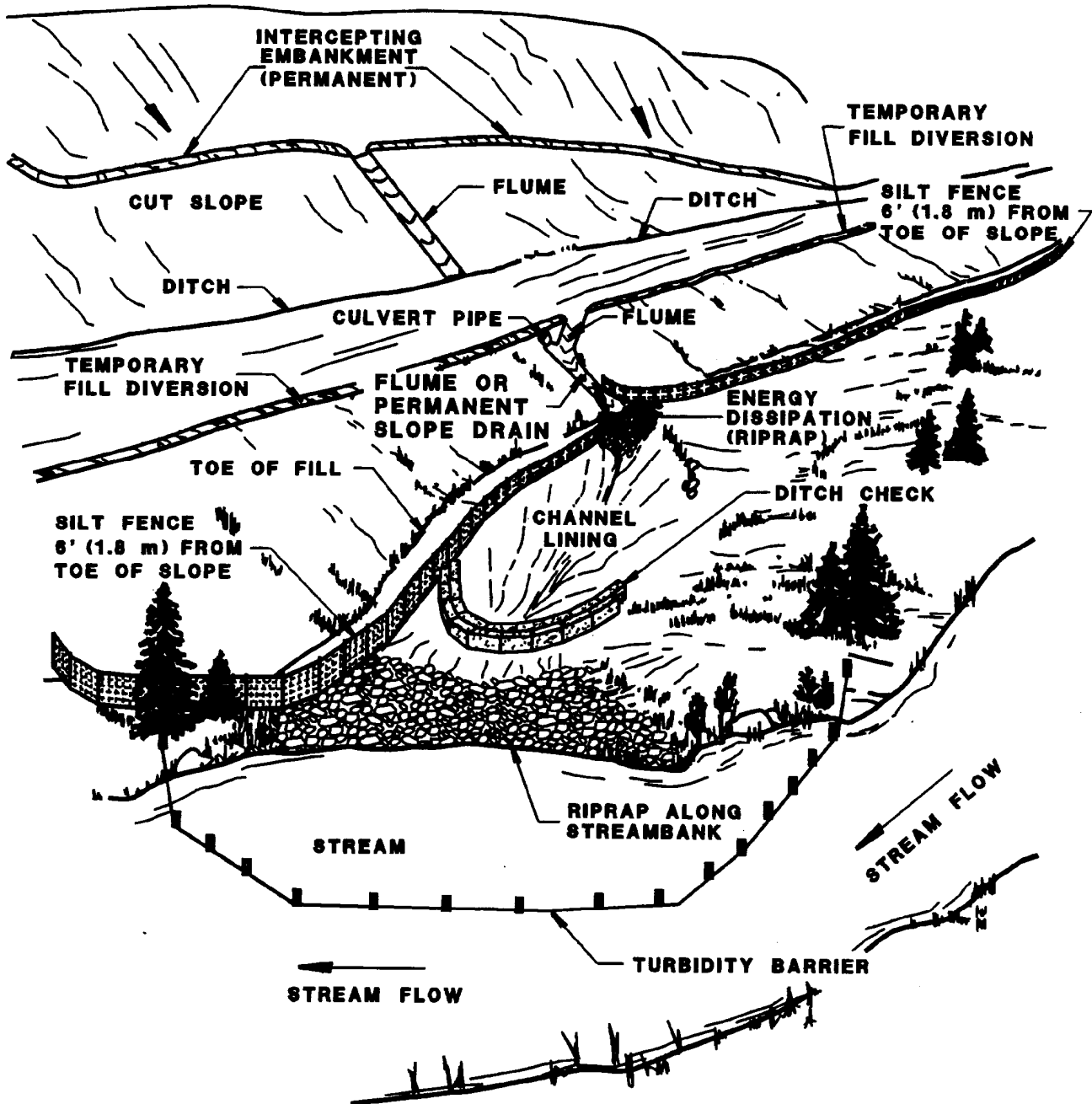
SUMMARY OF CONTROL MEASURE APPLICATIONS (con't)

CONTROL MEASURE	PURPOSE	CONDITION NEEDING CONTROL					
		CUT SLOPES	FILL SLOPES	DENUDED GENTLY SLOPING OR FLAT AREA	ERODING STREAMBANK	ERODING SWALE	PROTECTION OF ADJACENT PROPERTY
General land grading practices for minimizing erosion 	To provide for erosion control and plant establishment on areas where topography is to be re-shaped by grading	●	●	●			●

KEY: ● Preferred control measure

○ Alternative but less effective control measure.

EXAMPLE OF SELECTED CONTROL MEASURES USED IN COMBINATION



EROSION MAT

**CLASS I
SHORT TERM
ORGANIC**

**CLASS II
MODERATE TERM
ORGANIC**

**CLASS III
PERMANENT
SYNTHETIC**

TYPE A
SHEAR 1.0
SLOPES UP TO 2 1/2:1

TYPE A
JUTE
FOR SOD REINFORCEMENT

TYPE A
SHEAR 2.0
ECRM MAT
SLOPES UP TO 2:1
CHANNEL LINER

TYPE B
SHEAR 1.5
SLOPES UP TO 2:1
LIGHT DUTY
CHANNEL LINER

TYPE B
SHEAR 2.0
SLOPES UP TO 2:1
MEDIUM DUTY CHANNEL
LINER
SYNTHETIC NETTING
ALLOWED

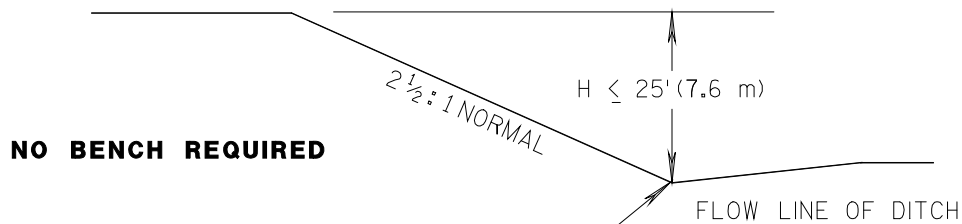
TYPE B
SHEAR 2.0
TRM MAT
SLOPES UP TO 2:1
CHANNEL LINER

TYPE C
SHEAR 2.0
SLOPES UP TO 2:1
MEDIUM DUTY CHANNEL
LINER
100% ORGANIC FIBER
REQUIRED

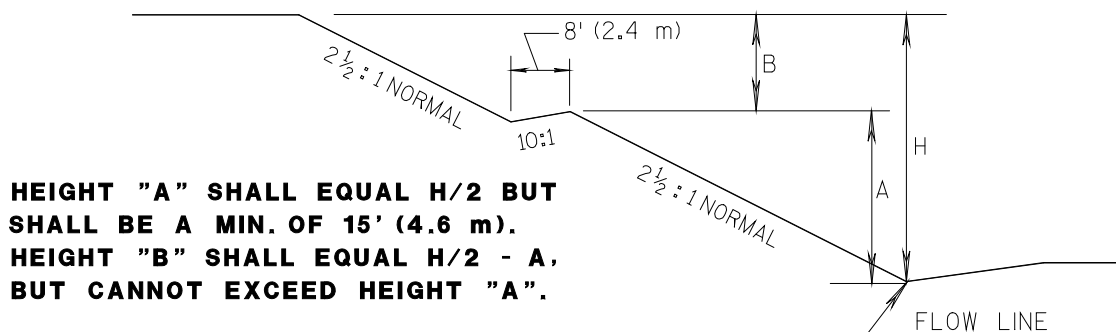
TYPE C
SHEAR 3.5
TRM MAT
SLOPES UP TO 2:1
HEAVY DUTY
CHANNEL LINER

TYPE D
SHEAR 5.0
TRM MAT
SLOPES UP TO 1:1
HEAVY DUTY
CHANNEL LINER

**CONDITION 1: SLOPES LESS THAN 25' (7.6 m) IN HEIGHT
 $H \leq 25' (7.6 \text{ m})$**

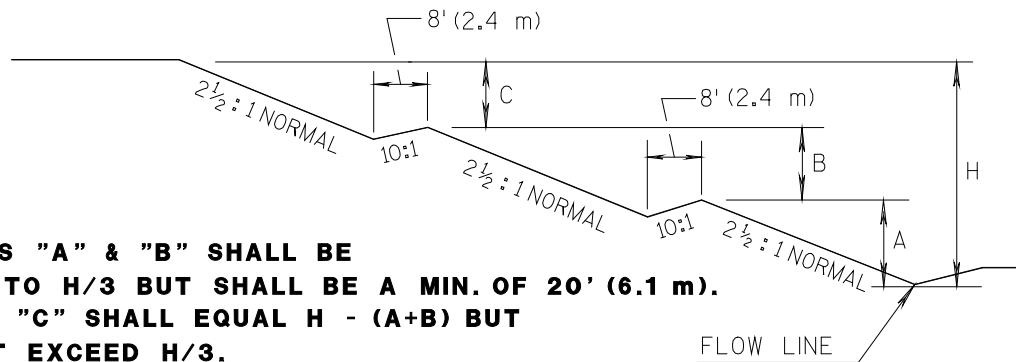


**CONDITION 2: SLOPES WITH 25' (7.6 m) < H AND
 $\leq 50' (15.2 \text{ m})$**



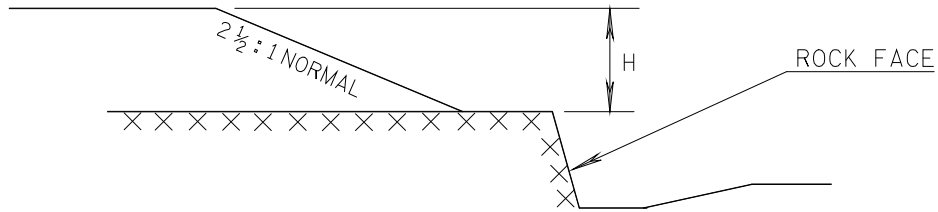
**BENCHED SLOPE EXAMPLES
 (SLOPES IN UNCONSOLIDATED MATERIAL)**

CONDITION 3: SLOPE WITH $H > 50'$ (15.2 m)



HEIGHTS "A" & "B" SHALL BE EQUAL TO $H/3$ BUT SHALL BE A MIN. OF 20' (6.1 m). HEIGHT "C" SHALL EQUAL $H - (A+B)$ BUT CANNOT EXCEED $H/3$.

CONDITION 4: SLOPES ABOVE ROCK CUTS



CONDITIONS 1, 2 & 3 SHALL APPLY BUT HEIGHT "H" SHALL BE TAKEN AS THE HEIGHT ABOVE THE EXPOSED ROCK FACE.

**BENCHED SLOPE EXAMPLES
(SLOPES IN UNCONSOLIDATED MATERIAL)**