ENVIRONMENTAL MANAGEMENT PLAN (EMP)
DRILLING ACTIVITY
PSC TL-OT-17-09

APPENDIX K - SOIL EROSION MANAGEMENT PLAN
RUSA #1 WELLSITE & ACCESS ROAD

TR-HSE-PLN-017

REVISION HISTORY

REVISION	DATE	DESCRIPTION
Rev1	04/06/21	Issued for review

MANAGEMENT APPROVAL

POSITION TITLE	NAME	SIGNATURE	DATE
Chief Executive Officer	Suellen Osborne		04/06/21
GM Exploration	Jan Hulse		04/06/21

DISTRUBUTION LIST

AUTHORITY/COMPANY'S NAME	DATE	REVISION
Autoridade Nacional do Petróleo e Minerais	04/06/21	Rev1

TABLE OF CONTENTS

APPENDIX

TABLES

ACRONYMS

EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
TR	Timor Resources

1 INTRODUCTION

1.1 CONTEXT

The project is the construction of a wellsite and access roads for the Timor Resources Rusa #1 exploration well in PSC TL-OT-17-09 on the South Coast of Timor Leste located at Suco Foho Ai-LiCo, Ainaro, Ainaro District.

1.2 PURPOSE

This project was determined to require a Category A Licence under Decree Law No. 5/2011.

The TR Soil Erosion Management Plan fulfils a requirement under the Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP). The EIA identified potential impacts from the project and various plans have been developed to supplement the EIS and EMP. The Plan presented here details the mitigation measures identified to minimise environmental impacts resulting in soil erosion from operational activities, as well as assigning responsibilities to ensure the activities are implemented.

This document is an appendix to the EMP – Appendix K.

1.3 SCOPE

This document will address the soil erosion management through mitigation measure for the PSC: TL-OT-17-09 drilling programme.

1.4 POTENTIAL SOIL EROSION IMPACTS

The most important physical aspects that contribute to erosion are:

- Rainfall intensity
- Soil Type
- Topography
- Ground Cover

The construction of access roads and wellsites exposes the soil to the action of these forces, particularly erosion by water on unprotected ground.

Erosion rates from construction sites are much higher than the average rates in undisturbed areas. Typical erosion rates relative to natural forest land are provided in the Table 1-1 .

Erosion is essentially a two-part process:

- The first part is the loosening of soil particles, caused largely by raindrop impact.
- The second part is the transportation of soil particles, largely in flowing water.

The surface soils in the Rusa #1 wellsite area appear to be Sandy Clays and Clays, this will be confirmed during the geotechnical investigation. These types of soil have relatively low erodibility properties on the soil erodibility scale. Item 6 in Table 1-2 .

The proposed Rusa #1 wellsite is located in an area that requires earthwork cut/fill slopes to form the wellsite pad and along some sections of the access road. The cut/fill slopes will require erosion protection after construction.

Table 1-1: Estimated Relative Rates of Erosion Caused by Land Disturbance Activities

Land Use	Loss Tonnes/hectare per year	Relative to Forest
Forest	0.1	1
Grassland	1	10
Abandoned Surface Mines	10	100
Cropland	20	200
Harvested Forest	50	500
Active Mining Operations	190	1900
Construction	190	1900

Table 1-2: Soil Erodibility Using the Unified Soil Classification (USC)

Hierarchy of Erodability	USC Classification		
	Typical Names	Symbol	Visual and Physical Characteristics
1	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	ML	Not gritty to the fingers, but can be rolled into threads when moist. shrinkage cracks appear on drying.
2	Silty sands, sand-silt mixtures	SM	Most of the particles can be seen without the aid of a magnifier, soils feel gritty to the fingers
3	Clayey sands. Sand-clay mixtures	SC	
4	Inorganic silts, micaceous or diatomaceous fine/sandy or silty soils, elastic silts	MH	Greasy to the touch can be rolled into threads when moist. Shrinks on drying. More than 40% clay particles
5	Organic silts and organic silt clays of low plasticity	OL	Not gritty to the fingers, but can be rolled into threads when moist. shrinkage cracks appear on drying.
6 *	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays and lean clays	CL	
7	Inorganic clays of high plasticity, fat clays	CH	Greasy to the touch can be rolled into threads when moist. Shrinks on drying. More than 40% clay particles
8	Silty-gravels, gravel-sand-silt mixtures	GM	Large particles, easily seen; majority of particles larger than 1.5 mm
9	Poorly-graded gravels or gravel-sand mixtures, little or no fines	GP	
10	Well-graded gravels or gravel -sand mixtures, little or no fines	GW	

Notes:

Soil Type 1 has the highest erosion rate with Soil Type 10 the lowest erosion rate

* The geotechnical investigation report (January 2020) recorded that the upper unit surface soils at the Suai area wellsites are cohesive clays and sandy clays (CL) soils. The boring logs and test pits records can be consulted to evaluate the type of soil in each area and the erosion risk. The Emerson Crumb test on the clay and Sandy Clay soils at the wellsites recorded No Reaction to Moderat Reaction for the dispersion of clay particles into the water. None of the tests recorded a strong reaction, which would have indicated more highly dispersive clays.

Soil Permeability

Observations of the ponding water after rain on existing tracks in the Rusa #1 wellsite area indicate that the near surface clay and sandy clay soils would have a similar hydraulic conductivity (Ksat) range of 1.3×10^{-6} m/s to 2.9×10^{-5} m/s as those previously tested in the Suai area. These low permeabilities provide a good seal against infiltration, but have a higher surface run-off flow when exposed without protection.

1.5 EROSION AND SEDIMENT MITIGATION MEASURES

The two main areas to be controlled are:

- **Erosion -** to prevent or minimize the erosion of soil.
- **Sediment -** to trap suspended soil particles being transported downstream in flowing water to prevent their discharge into the aquatic environment of a stream.

Erosion control is the only effective long-term solution, whereas sediment control is a short-term remedy to minimize the impact of unavoidable erosion that does occur during the construction period and to a lesser extent during the exploration drilling on the wellsite.

The basic principles of erosion and sediment control that are applicable for road and wellsite construction are:

1. **Fit the Roads and Wellsites to the Terrain**

In the planning, design and construction of the access roads and wellsites this means: avoid erodible soil sites; follow the ground contours as much as possible; and, do not construct deeper fills and cuts than the design standard requires.

2. **Minimize the Duration of Soil Exposure**

Limit the duration of exposure by scheduling the work so construction coincides with the dry season where possible and complete grading operations soon after the vegetation clearance operation exposes the soil.

3. **Retain Existing Vegetation Where Practical**

Very little erosion occurs on soil covered with undisturbed natural vegetation. Re-establishment of comparable coverage after construction can take a long time. Limit the soil exposed to the area where construction will actually occur. The cut vegetation cleared from the site can be spread over the exposed earthwork surfaces to reduce the erosion in the short term, as it limits raindrop impact and surface flow velocity. If the cut/fill slopes will be exposed during the rainy season biodegradable jute erosion control matting may need to be used in combination with the shredded vegetation spread over the slope surfaces. Further information provided in the attachments.

4. **Grade Disturbed Soil to a Stable Slope**

The cut and fill slopes should be shaped to a slope between 1.5 and 2.0 horizontal to 1.0 vertical with the continuous down slope lengths optimised to minimise the surface water run-off velocity. Roughening the slope surfaces using the cleats of bulldozer tracks driven up and down the slopes, reduces the water flow velocity and hence erosion until other erosion control measures are applied.

5. **Divert Runoff Away from Exposed Soil**

Surface water drainage that would naturally flow over the exposed soil to be diverted away from the area. Cut-off ditches or berms to be constructed on the uphill side of earth slopes to minimise the water flow down the slope. Run-off collected in roadside ditches should be diverted to an outlet off the right-of-way. The frequency of outlets and cross-drains to carry water from upstream to downstream side of the road will be designed to fit the ground slope involved. Where terrain and land use conditions permit, ditches would not be dug along the sides of the roads to avoid concentrating the flow. The water run-off from the road pavement would be allowed to dissipate either side of the road into the existing vegetated areas.

6. **Keep Run-off Velocities Low**

The energy of flowing water increases with the square of the velocity. Thus, less erosion will occur if the water is moving slowly. Flow velocities can be kept low by lining erodible soils with rough surfaces such as vegetation, rip-rap rock and brush. A good supply of local river rock of suitable sizes is available in the project area. The construction of check dams in ditches will break the flow momentum and reduce velocities. Flattening the steepness of a slope and creating roughness in the flow path of water will reduce velocities. Ditch sizes will be selected to handle the expected runoff from precipitation, this means that larger ditches are needed to handle runoff from larger drainage areas.

7. **Trap Sediment Before it can Cause Damage**

Some erosion during construction is unavoidable. In order to prevent sedimentation of streams it is desirable to trap sediment on land before it reaches the aquatic environment. The most common method used on access roads is the diversion of runoff into the adjacent vegetated areas where suspended soil particles are filtered out as run-off flows through the surface vegetation and litter. The placement of a brush barrier made with slash debris on the lower slope area can also create a filter. Sediment traps can be made by excavating a depression downstream of the sediment source that will pond water so suspended soil can settle out. Another method of trapping sediment is to filter the runoff from an area through a "silt fence" made of geotextile fabric. The water passes through but silt and sand is filtered out. For larger quantity concentrated flows sedimentation basins would be designed for installation in the flow path to provide the retention time required for sedimentation of eroded materials.

8. **Revegetation for Longer Term Use**

For longer term use beyond the exploration drilling phase a properly revegetated soil will be protected from erosion indefinitely without any need for human attention. Revegetation would be carried out by installing the previously stockpiled organic soil over the temporarily protected areas with the addition of seed and fertilizer treatments as applicable.

If the wellsites and roads are not required for long term operations the procedures provided in **Appendix B - Rehabilitation Plan** Rev1 29-12-20 would be implemented.

1.6 Design and Implementation

The erosion and sedimentation control design aspects will be incorporated into the road and wellsite design.
The field installation will be supervised by the Timor Resources construction team.

Installation procedures for the above mitigation procedures are available in the **"International Erosion Control Association"** and other industry procedures.

1.7 ATTACHMENTS

Typical drawings for erosion control methods mostly using resources locally available in Timor Leste are presented in the Appendix.

Reference Documents

IECA Vol 5 - Bioengineering to Control Erosion

IECA Vol 3 - Techniques for Stabilising Gullies and Using Check Dams

IECA Vol 2 - Steep Slope Erosion Control Techniques

IECA - Practical Approaches for Sediment and Erosion Control

API RP 52 - Land Drilling Practices for the Protection of the Environment

Biotechnical Slope Protection and Erosion Control - Donald H. Grey and Andrew T. Leiser

Ground Bioengineering Techniques for Slope Protection and Erosion Control - H.M Schiechtl and R. Stern

Field Manual for Effective Sediment and Erosion Control Methods -Jerald S. Fifield Ph.D., CPESC

Instream Sediment Control Techniques Field Implementation Manual - Trow Consulting Engineers, Ontario

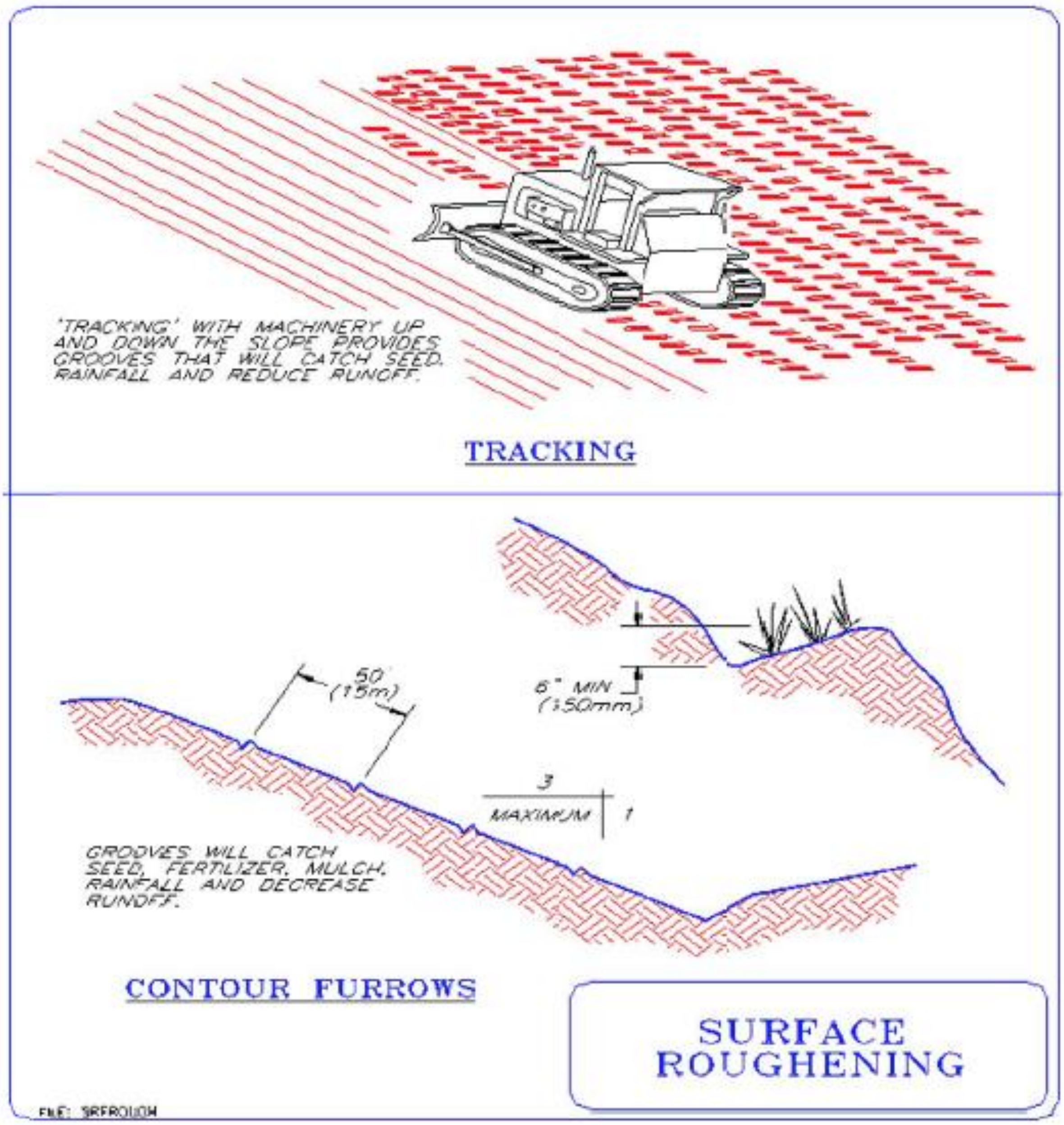
Environmental Guidelines for Access Roads and Water Crossing - Ontario Ministry of natural Resources

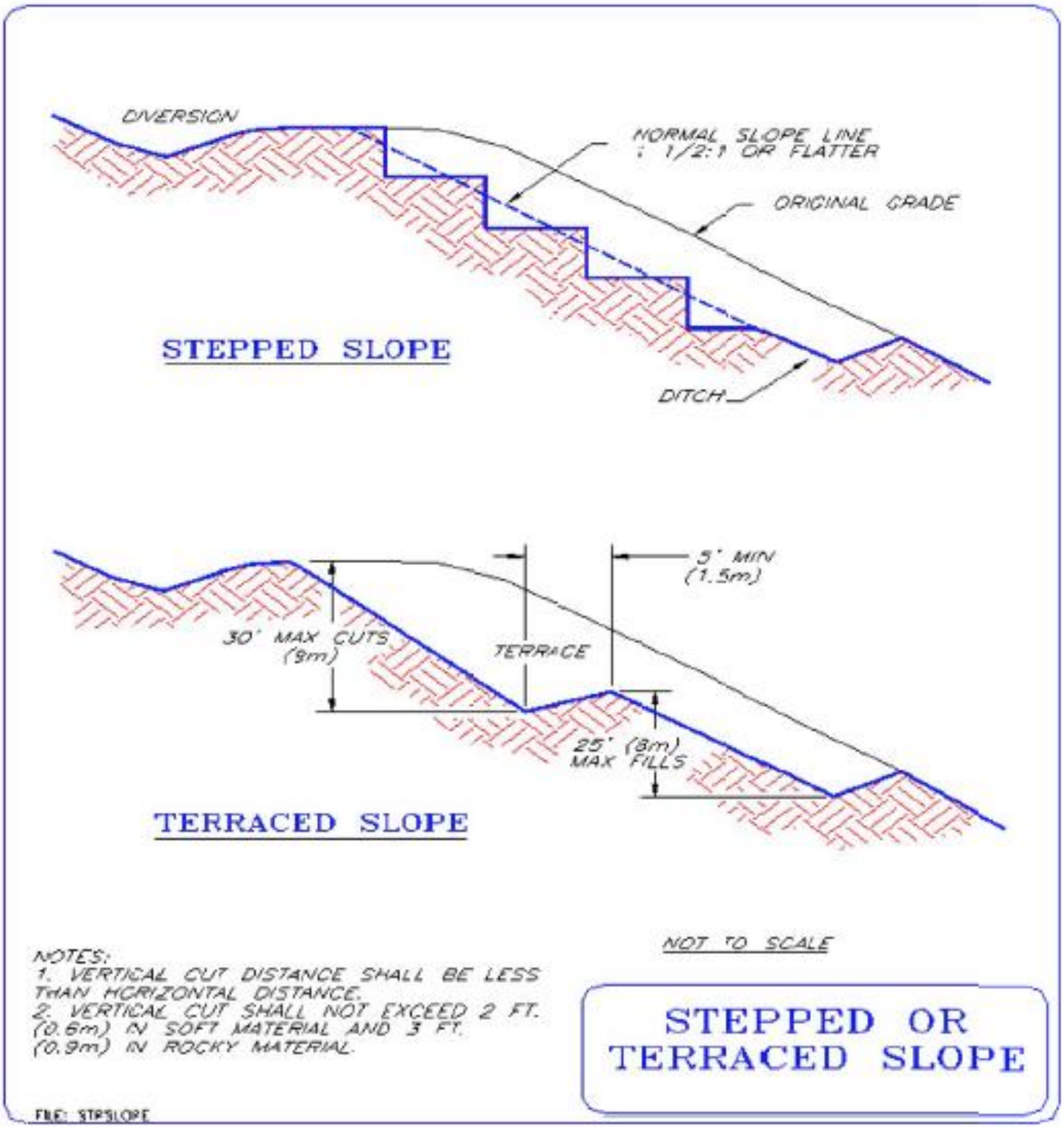
Storm Water Pollution Control - Roy D Dodson, PE

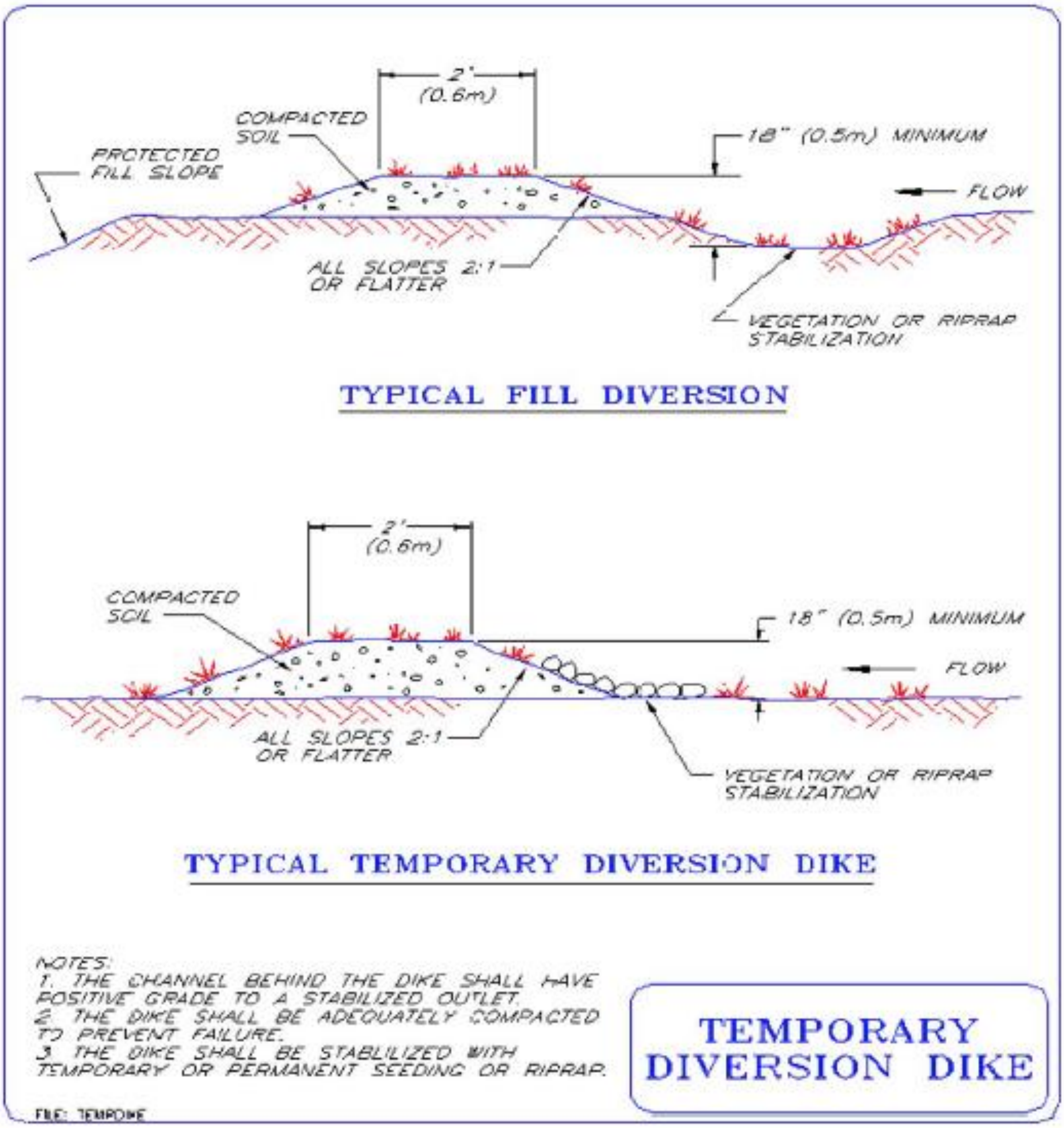
APPENDIX 1: EROSION CONTROL METHODS

Attachments

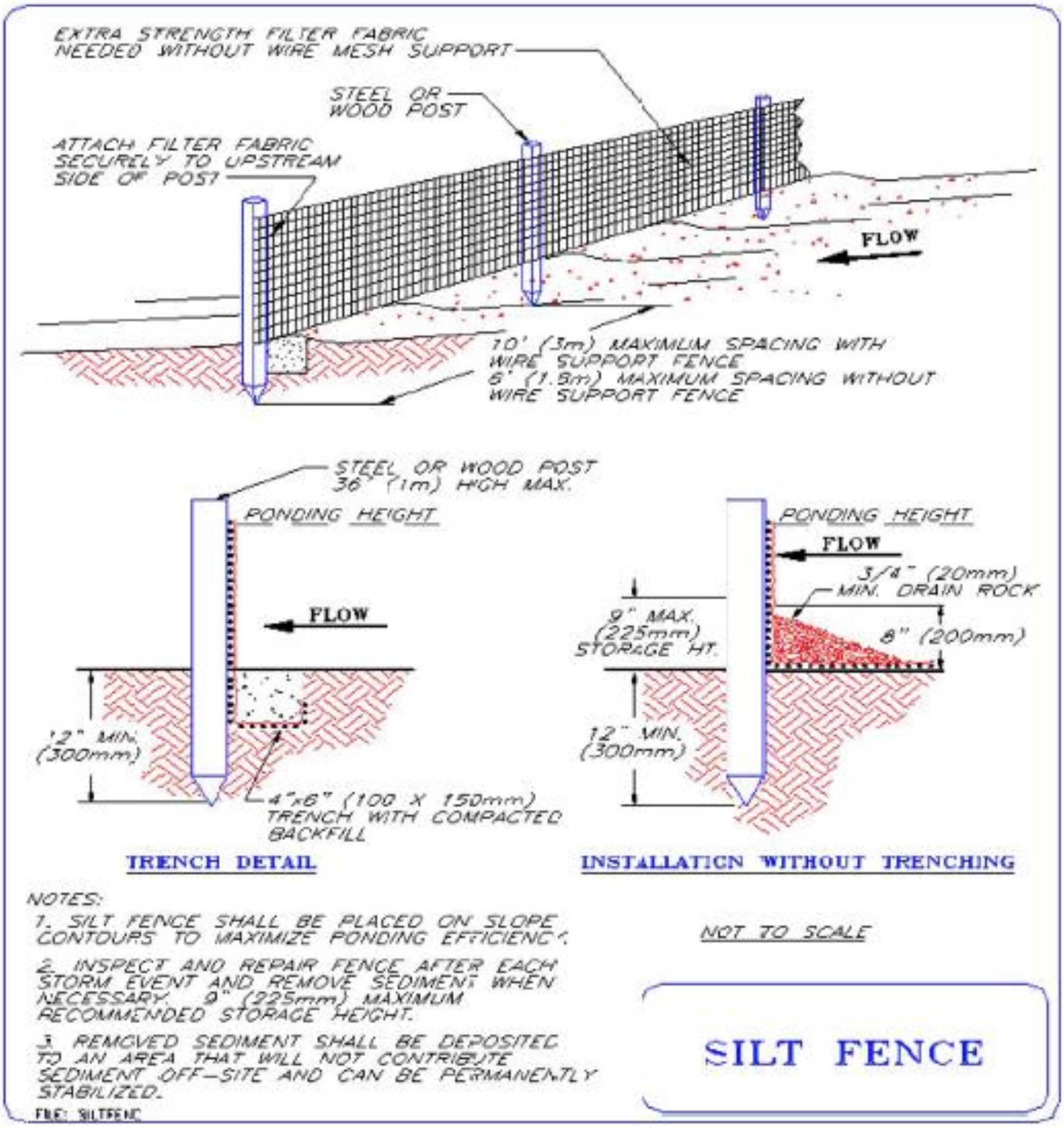
1. Surface Roughening
2. Stepped or Terraced Slope
3. Temporary Diversion Dyke
4. Silt Fence
5. Energy Dissipator
6. Grass Lined Channel - Typical Cross Section
7. Rock Check Dam
8. Rolling Dip and Waterbar
9. Rip Rap Protection
10. Rock Lined Channel
11. Road Drainage Features in the Landscape
12. Location of Run-Off Catch Drains Above Slopes
13. Sediment Basin Cross Section
14. Typical Sediment Basin Photos
15. Typical Installation of Erosion Control Blankets
16. Example of Erosion Control Matting to Stabilise a Slope

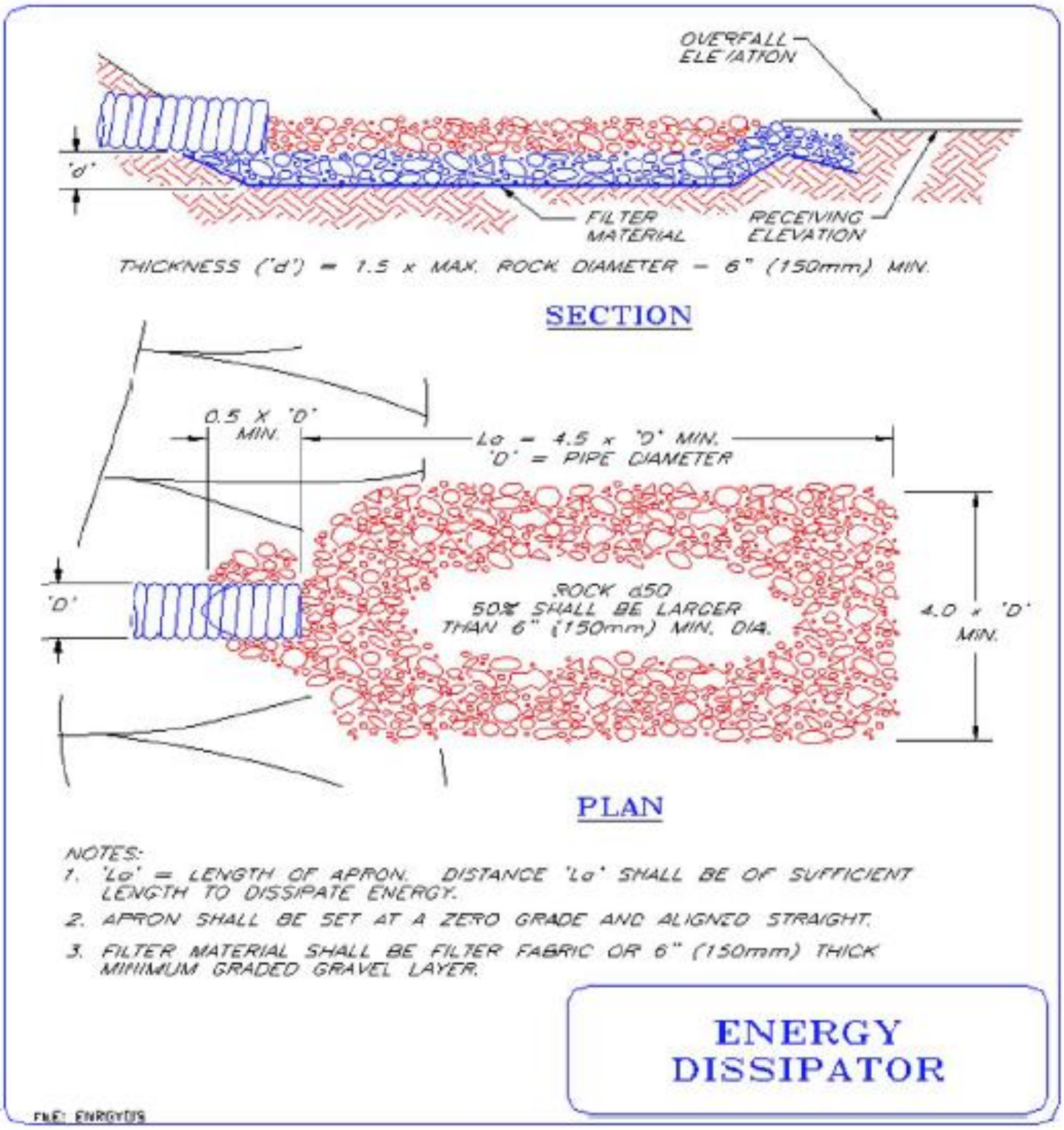

'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, RAINFALL AND REDUCE RUNOFF.
TRACKING
50' (15m)
6" MIN (150mm)
3
MAXIMUM
1
GROOVES WILL CATCH SEED, FERTILIZER, MULCH, RAINFALL AND DECREASE RUNOFF.
CONTOUR FURROWS
SURFACE ROUGHENING
FILE: SRFROUGH

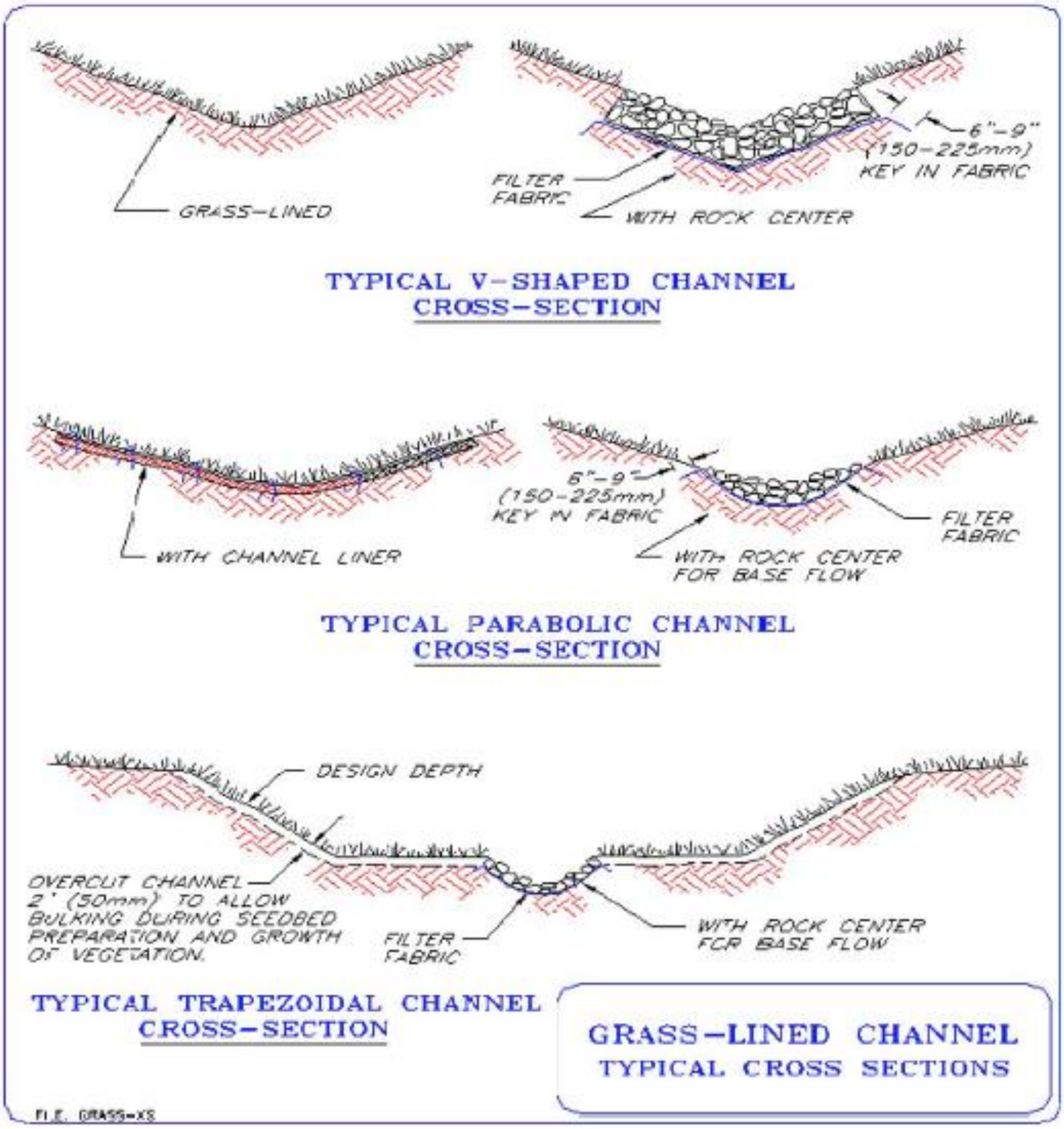

DIVERSION
NORMAL SLOPE LINE
: 1/2:1 OR FLATTER
ORIGINAL GRADE
STEPPED SLOPE
DITCH
5' MIN
(1.5m)
30' MAX CUTS
(9m)
TERRACE
25' (8m)
MAX FILLS
TERRACED SLOPE
NOT TO SCALE
NOTES:
1. VERTICAL CUT DISTANCE SHALL BE LESS THAN HORIZONTAL DISTANCE.
2. VERTICAL CUT SHALL NOT EXCEED 2 FT. (0.6m) IN SOFT MATERIAL AND 3 FT. (0.9m) IN ROCKY MATERIAL.
STEPPED OR TERRACED SLOPE
FILE: STPSLOPE

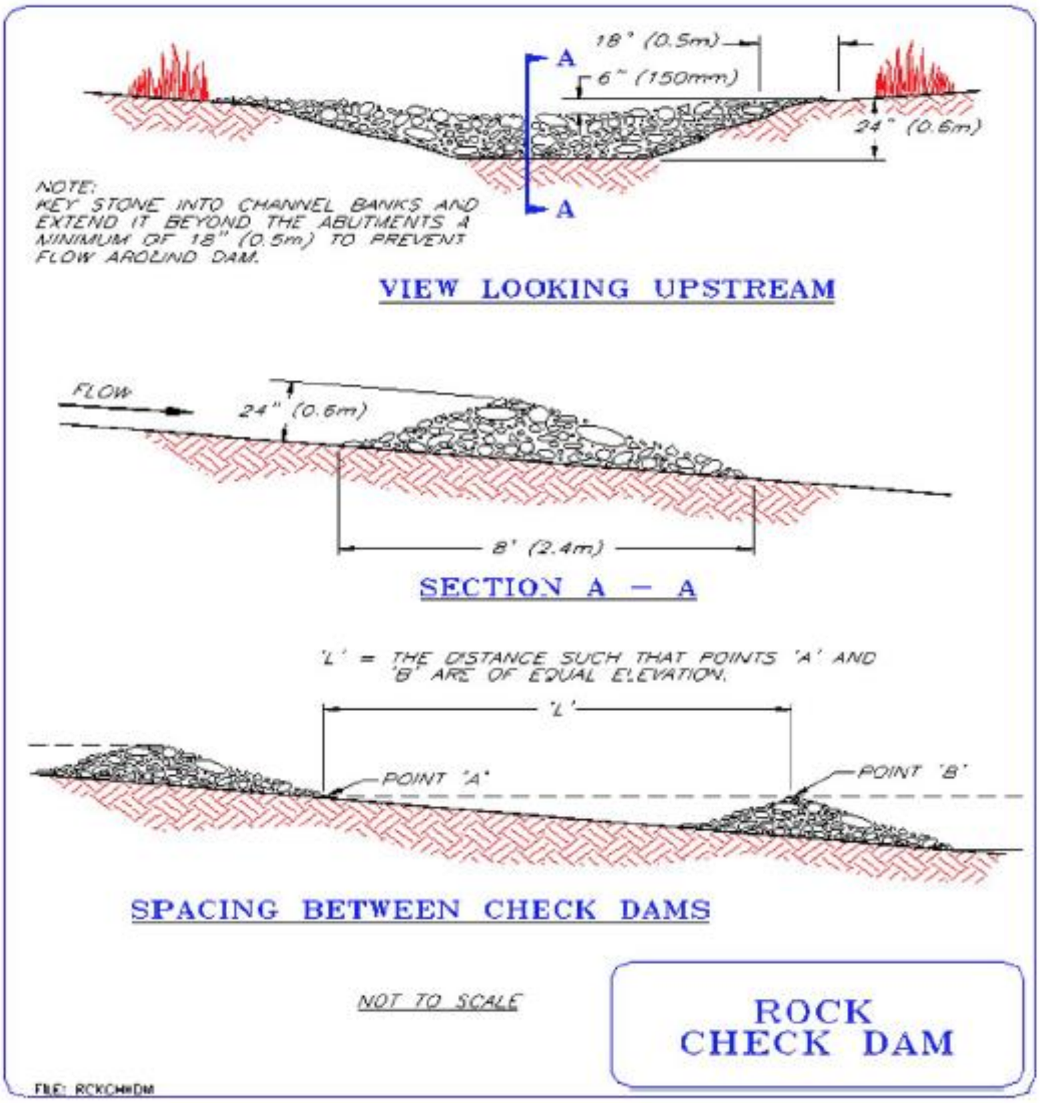


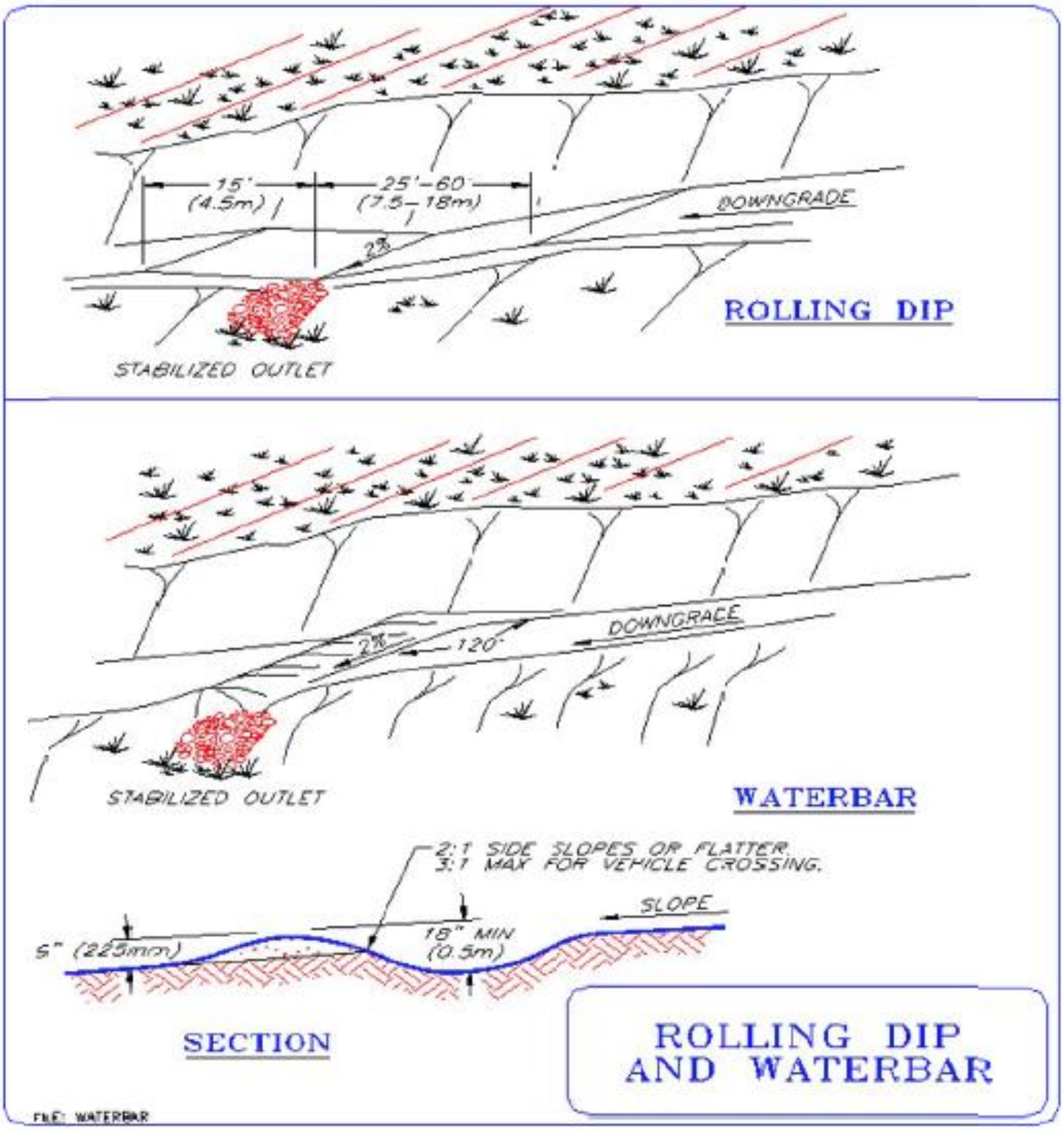
2' (0.6m)
COMPACTED SOIL
PROTECTED FILL SLOPE
18" (0.5m) MINIMUM
FLOW
ALL SLOPES 2:1 OR FLATTER
VEGETATION OR RIPRAP STABILIZATION
TYPICAL FILL DIVERSION
2' (0.6m)
COMPACTED SOIL
18" (0.5m) MINIMUM
FLOW
ALL SLOPES 2:1 OR FLATTER
VEGETATION OR RIPRAP STABILIZATION
TYPICAL TEMPORARY DIVERSION DIKE
NOTES:
1. THE CHANNEL BEHIND THE DIKE SHALL HAVE POSITIVE GRADE TO A STABILIZED OUTLET.
2. THE DIKE SHALL BE ADEQUATELY COMPACTED TO PREVENT FAILURE.
3. THE DIKE SHALL BE STABLILIZED WITH TEMPORARY OR PERMANENT SEEDING OR RIPRAP.
TEMPORARY DIVERSION DIKE
FILE: TEMPDIKE


EXTRA STRENGTH FILTER FABRIC NEEDED WITHOUT WIRE MESH SUPPORT
STEEL OR WOOD POST
ATTACH FILTER FABRIC SECURELY TO UPSTREAM SIDE OF POST
FLOW
10' (3m) MAXIMUM SPACING WITH WIRE SUPPORT FENCE
6' (1.8m) MAXIMUM SPACING WITHOUT WIRE SUPPORT FENCE
STEEL OR WOOD POST 36" (1m) HIGH MAX.
PONDING HEIGHT
FLOW
12" MIN. (300mm)
4"x6" (100 X 150mm) TRENCH WITH COMPACTED BACKFILL
TRENCH DETAIL
PONDING HEIGHT
FLOW
3/4" (20mm) MIN. DRAIN ROCK
9" MAX. (225mm) STORAGE HT.
8" (200mm)
12" MIN. (300mm)
INSTALLATION WITHOUT TRENCHING
NOTES:
1. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
2. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY. 9" (225mm) MAXIMUM RECOMMENDED STORAGE HEIGHT.
3. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.
NOT TO SCALE
SILT FENCE
FILE: SILTFENC

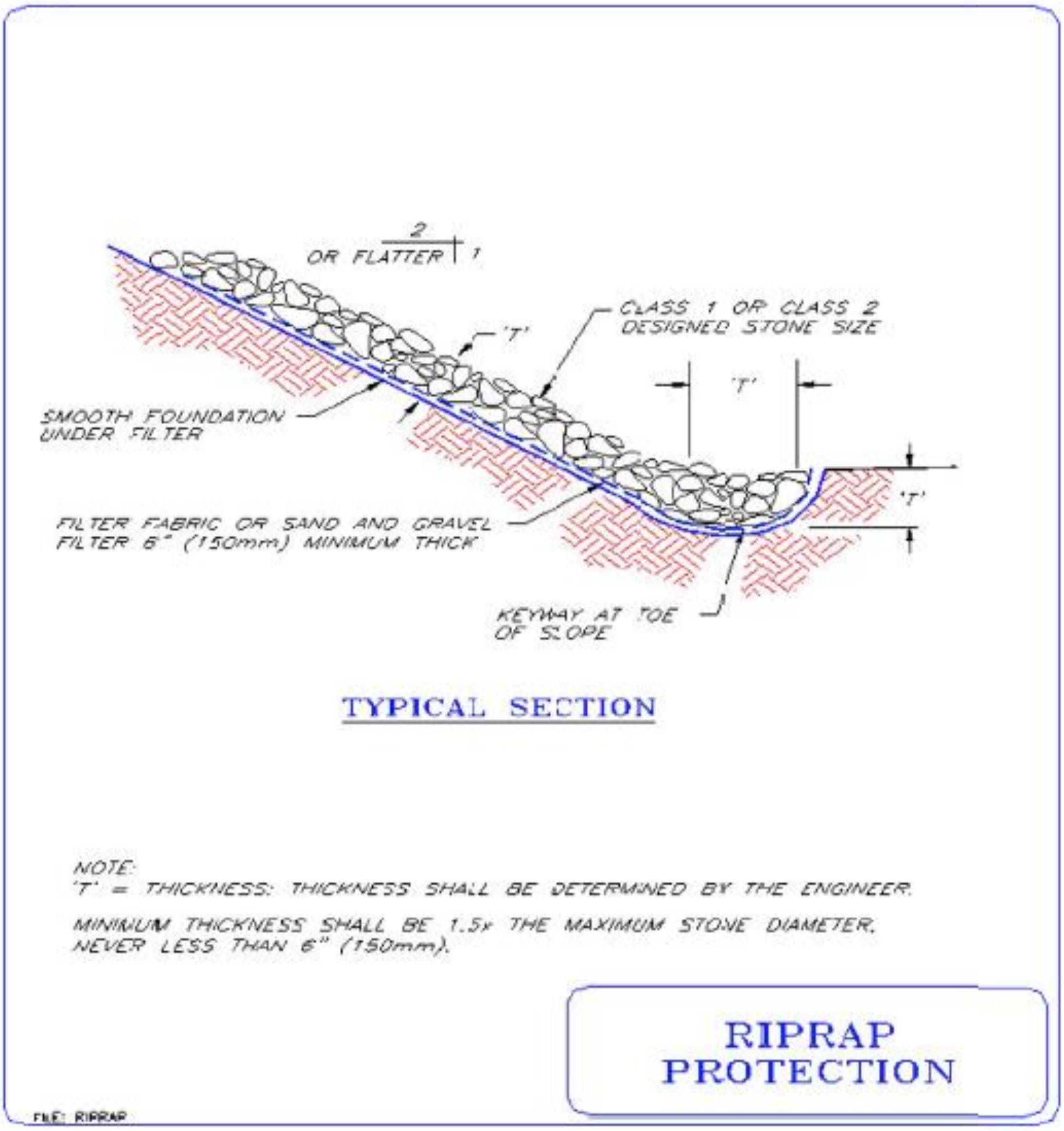

OVERFALL ELEVATION
'd'
FILTER MATERIAL
RECEIVING ELEVATION
THICKNESS ('d') = 1.5 x MAX. ROCK DIAMETER – 6" (150mm) MIN.
SECTION
0.5 X 'D' MIN.
La = 4.5 x 'D' MIN.
'D' = PIPE DIAMETER
'D'
ROCK d50
50% SHALL BE LARGER THAN 6" (150mm) MIN. DIA.
4.0 x 'D' MIN.
PLAN
NOTES:
1. 'La' = LENGTH OF APRON. DISTANCE '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 6" (150mm) THICK MINIMUM GRADED GRAVEL LAYER.
ENERGY DISSIPATOR
FILE: ENRGYDIS

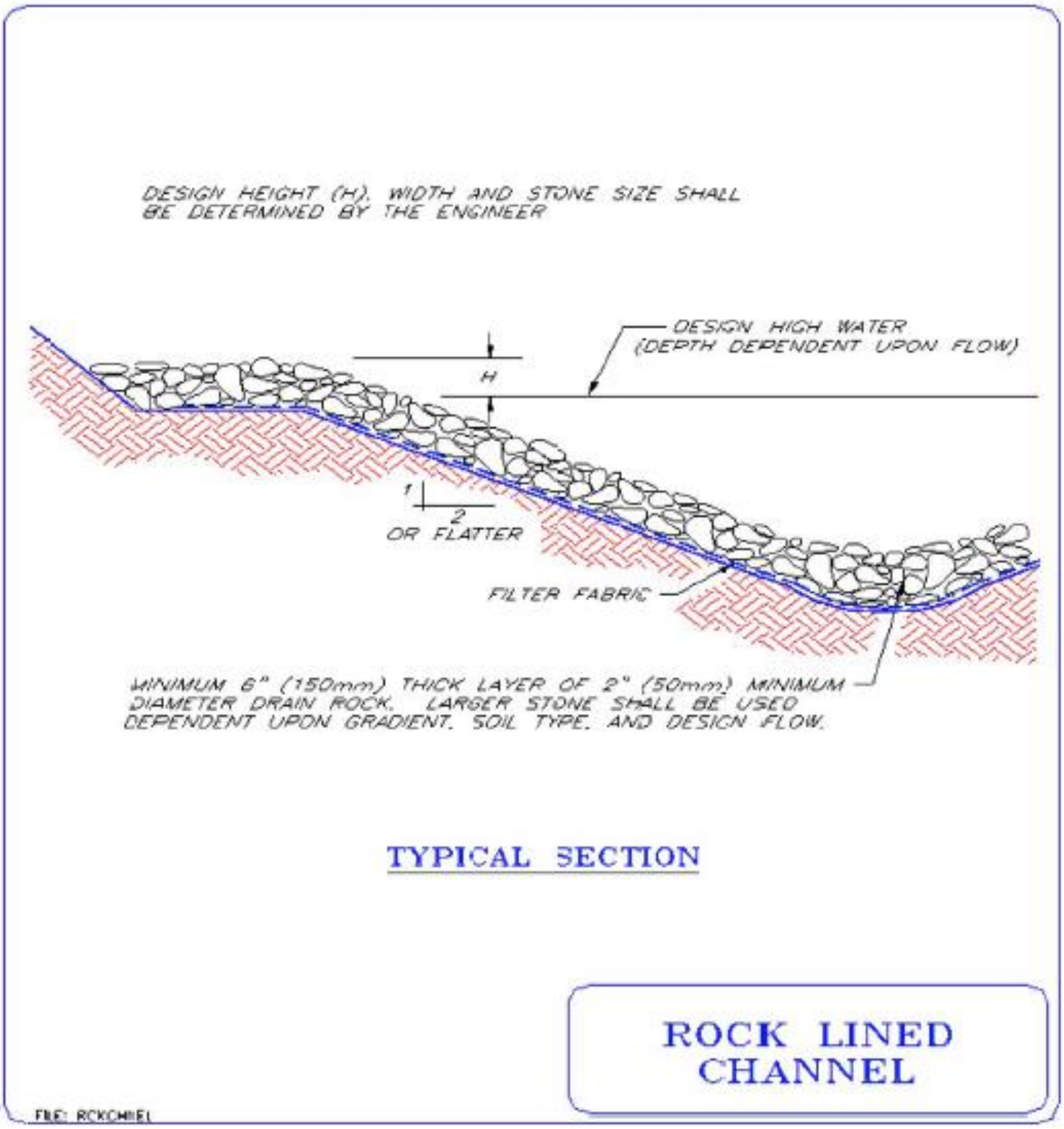

GRASS–LINED
FILTER FABRIC
WITH ROCK CENTER
6"–9" (150–225mm) KEY IN FABRIC
TYPICAL V–SHAPED CHANNEL CROSS–SECTION
WITH CHANNEL LINER
6"–9" (150–225mm) KEY IN FABRIC
WITH ROCK CENTER FOR BASE FLOW
FILTER FABRIC
TYPICAL PARABOLIC CHANNEL CROSS–SECTION
DESIGN DEPTH
OVERCUT CHANNEL 2" (50mm) TO ALLOW BULKING DURING SEEDBED PREPARATION AND GROWTH OF VEGETATION.
FILTER FABRIC
WITH ROCK CENTER FOR BASE FLOW
TYPICAL TRAPEZOIDAL CHANNEL CROSS–SECTION
GRASS–LINED CHANNEL
TYPICAL CROSS SECTIONS
FILE: GRASS–XS

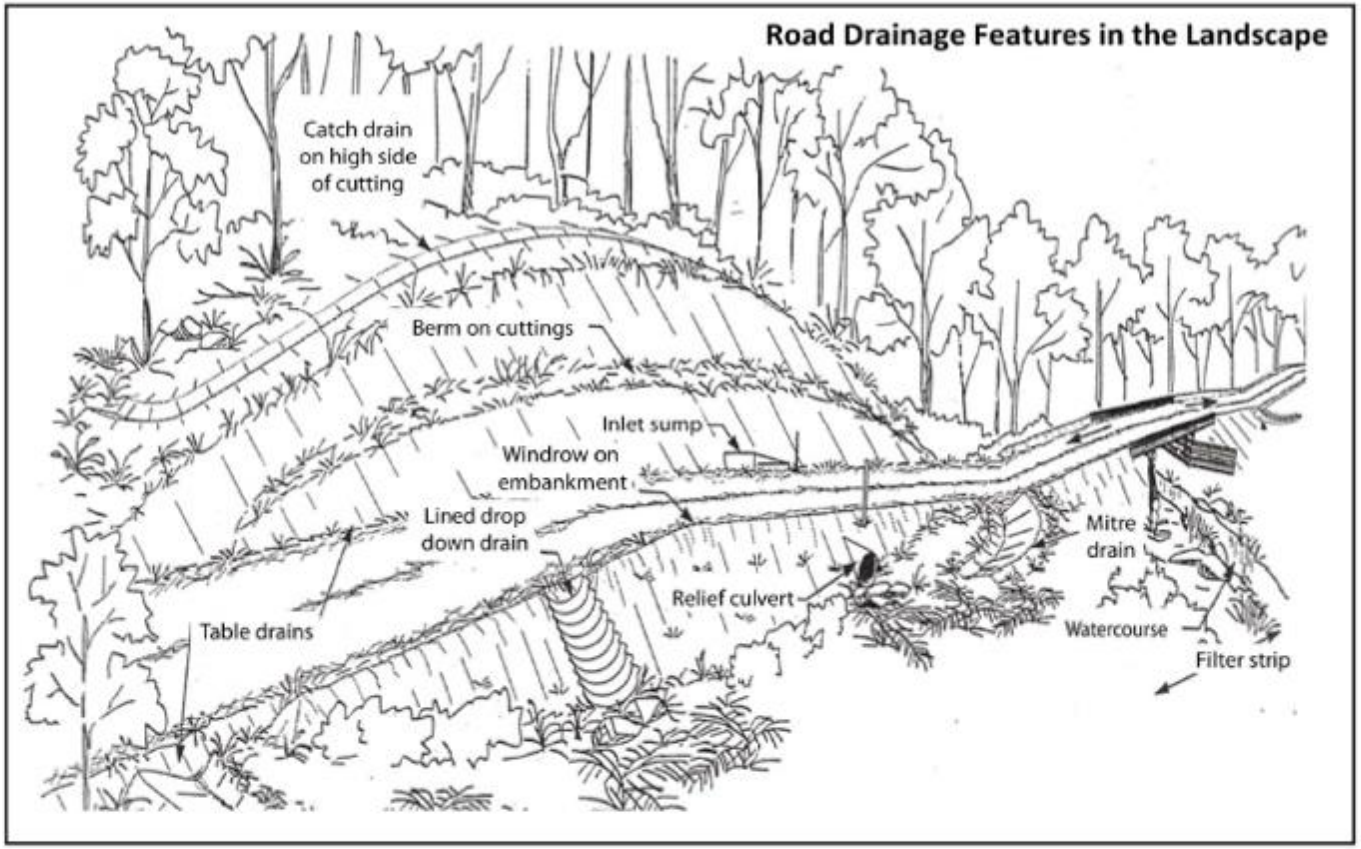

18" (0.5m)
6" (150mm)
24" (0.6m)
A
A
NOTE:
KEY STONE INTO CHANNEL BANKS AND EXTEND IT BEYOND THE ABUTMENTS A MINIMUM OF 18" (0.5m) TO PREVENT FLOW AROUND DAM.
VIEW LOOKING UPSTREAM
FLOW
24" (0.6m)
8' (2.4m)
SECTION A — A
'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION.
'L'
POINT 'A'
POINT 'B'
SPACING BETWEEN CHECK DAMS
NOT TO SCALE
ROCK CHECK DAM
FILE: RCKCHKDM

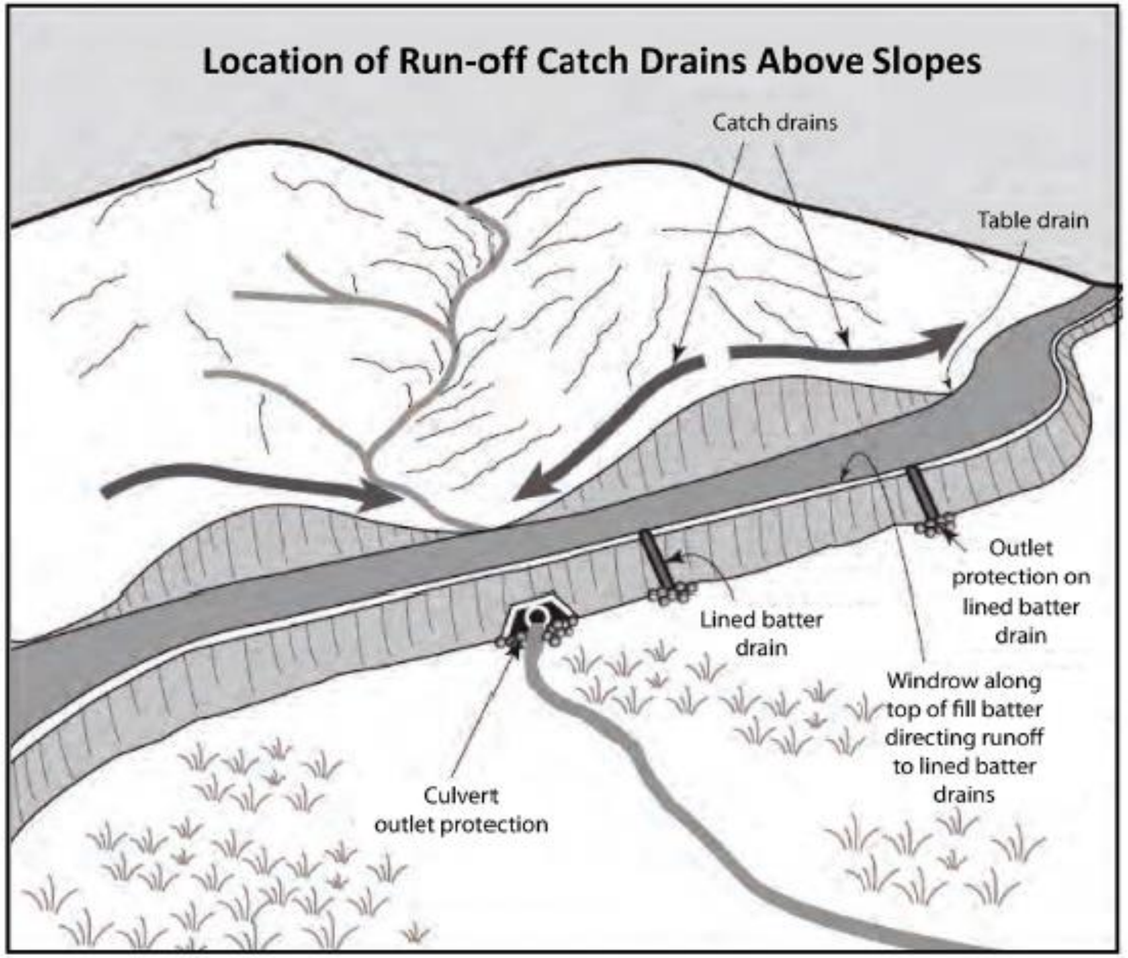


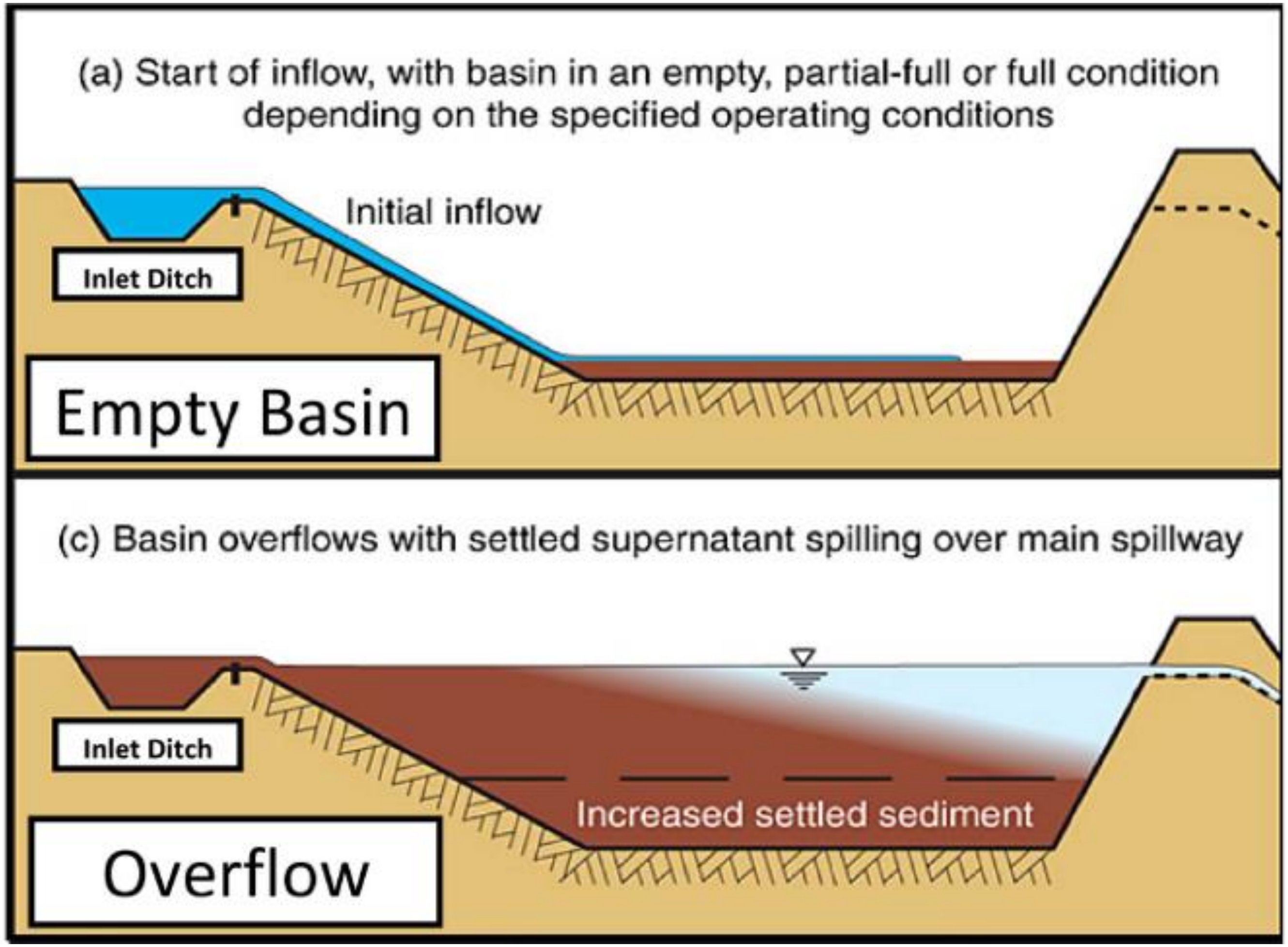
15' (4.5m)
25'-60' (7.5-18m)
2%
DOWNGRADE
ROLLING DIP
STABILIZED OUTLET
2%
120'
DOWNGRADE
STABILIZED OUTLET
WATERBAR
2:1 SIDE SLOPES OR FLATTER.
3:1 MAX FOR VEHICLE CROSSING.
SLOPE
18" MIN (0.5m)
6" (225mm)
SECTION
ROLLING DIP AND WATERBAR
FILE: WATERBAR


2
OR FLATTER 1
CLASS 1 OR CLASS 2
DESIGNED STONE SIZE
'T'
'T'
SMOOTH FOUNDATION
UNDER FILTER
'T'
FILTER FABRIC OR SAND AND GRAVEL
FILTER 6" (150mm) MINIMUM THICK
KEYWAY AT TOE
OF SLOPE
TYPICAL SECTION
NOTE:
'T' = THICKNESS: THICKNESS SHALL BE DETERMINED BY THE ENGINEER.
MINIMUM THICKNESS SHALL BE 1.5x THE MAXIMUM STONE DIAMETER,
NEVER LESS THAN 6" (150mm).
RIPRAP
PROTECTION
FILE: RIPRAP


DESIGN HEIGHT (H), WIDTH AND STONE SIZE SHALL BE DETERMINED BY THE ENGINEER
DESIGN HIGH WATER (DEPTH DEPENDENT UPON FLOW)
H
1
2
OR FLATTER
FILTER FABRIC
MINIMUM 6" (150mm) THICK LAYER OF 2" (50mm) MINIMUM DIAMETER DRAIN ROCK. LARGER STONE SHALL BE USED DEPENDENT UPON GRADIENT, SOIL TYPE, AND DESIGN FLOW.
TYPICAL SECTION
ROCK LINED CHANNEL
FILE: RCKCHNEL


Road Drainage Features in the Landscape
Catch drain on high side of cutting
Berm on cuttings
Inlet sump
Windrow on embankment
Lined drop down drain
Table drains
Relief culvert
Mitre drain
Watercourse
Filter strip

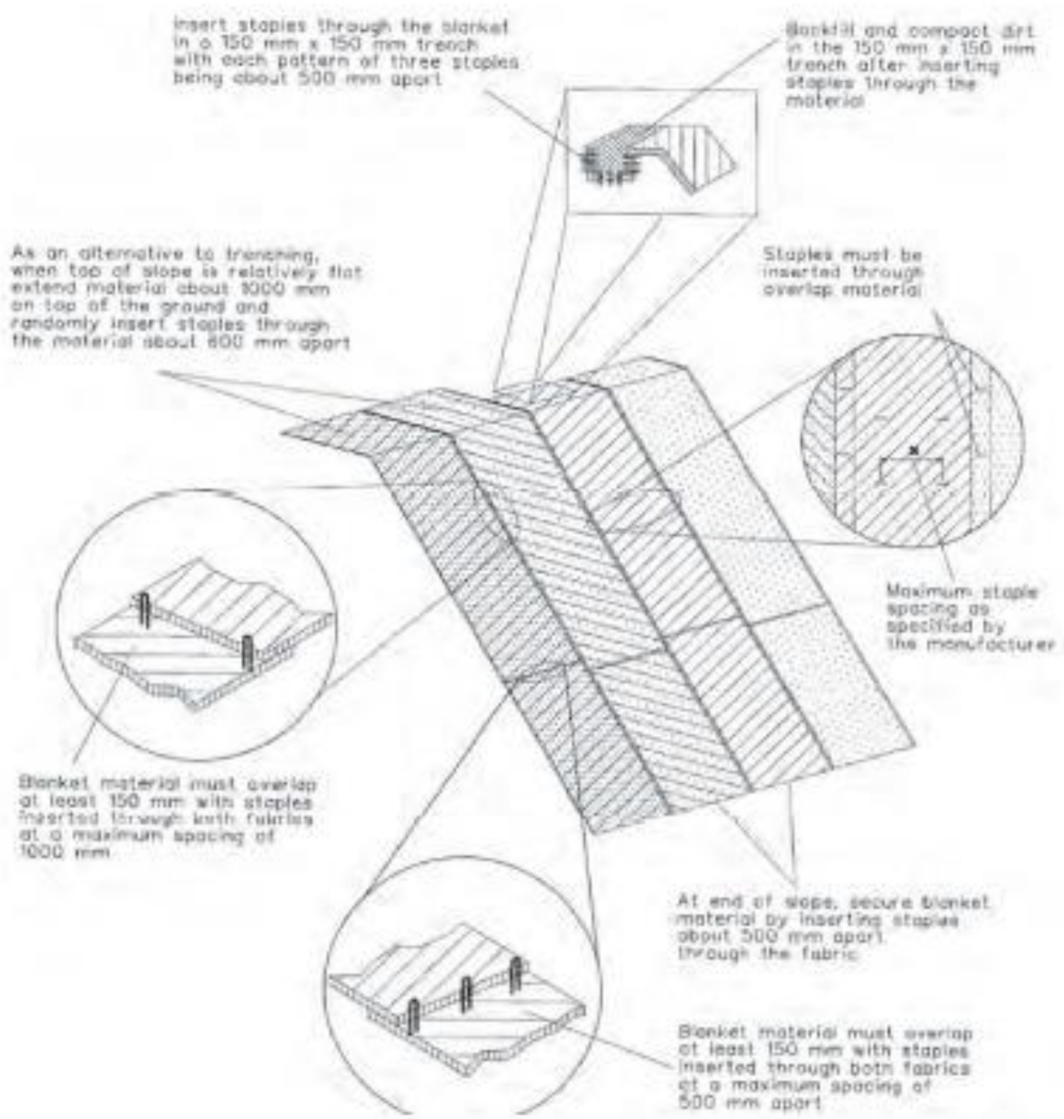

Location of Run-off Catch Drains Above Slopes
Catch drains
Table drain
Outlet protection on lined batter drain
Lined batter drain
Windrow along top of fill batter directing runoff to lined batter drains
Culvert outlet protection


(a) Start of inflow, with basin in an empty, partial-full or full condition depending on the specified operating conditions
Initial inflow
Inlet Ditch
Empty Basin
(c) Basin overflows with settled supernatant spilling over main spillway
Inlet Ditch
Increased settled sediment
Overflow

Sediment Trap with Geotextile Lining

Sediment Trap with Sandbags

Typical Installation of Erosion Control Blankets



Example of Erosion Control Matting to Stabilise a Slope