CLIENT **: GUYANA ENVIRONMENTAL CAPACITY DEVELOPMENT PROJECT (GENCAPD)**

PROJECT**: CODE OF PRACTICE FOR MINE WASTE MANAGEMENT AND DISPOSAL IN GUYANA'S SMALL AND MEDIUM-SCALE MINING**

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DISCLAIMER

The primary purpose of this publication is to provide a Code of Practice for mine waste management and disposal in the small and medium-scale mining industry of Guyana. It expresses the professional opinion of SNC-LAVALIN INC. (SLI) regarding the matters set out herein, based on SLI's professional judgment and reasonable due diligence. It is to be read in the context of the agreement dated August 4, 2003 (the "Agreement") between SLI and Natural Resources Canada (the "Client"), and the methodology, procedures and techniques used, the assumptions SLI made, and the circumstances and constraints under which SLI carried out its mandate. This document is meant to be read as a whole, and sections or parts thereof should thus not be read or relied upon out of context.

This document is **NOT** a design manual. The user of this document should assume full responsibility for the design of facilities or for any action taken as a result of the information contained in this document. SLI and Natural Resources Canada (through the GENCAPD Mining project) make no warranty of any kind with respect to the content and accept no liability either incidental, consequential, financial or otherwise arising from the use of this publication.

1. INTRODUCTION

1.1 Why a Code of Practice for Mine Waste Management and Disposal?

The proposed amendments to the Guyana Mining Regulations, which strongly focus on the environment, call for the publication or approval by the Guyana Geology and Mines Commission (GGMC) of a number of Codes of Best Practice for Environmental Mining within eighteen months of the enactment of these regulations. Mine waste management and disposal is among the topics to be addressed by these Codes.

No other industry produces more waste than mining. Because the concentration of valuable material is so small (especially in metal and diamond mining), most of ore rock extracted is turned into waste that must be managed and disposed of. These wastes, that may be major sources of pollution, include waste rock, tailings, overburden and topsoil. In open-pit operations, the volume of waste rock and overburden that must be removed (the stripping ratio) is often 3 to 6 times higher than the amount of ore. No wonder therefore why waste rock dumps are usually the most visual landforms left after open pit mining. Together with tailings storage facilities, they are also the most prone to erosion. Small-scale alluvial mining is no exception as it generates large amount of tailings through the hydraulicking of valuable topsoil that usually end up in the watercourses, causing turbidity plumes as well as mercury emissions.

For these reasons, careful planning before and during construction is essential to prevent excessive erosion, and generation of acid rock drainage while ensuring a stable and safe landform amenable to rehabilitation/revegetation.

This publication is the result of a comprehensive literature review and of a collaborative effort by the GENCAPD Mining Project stakeholders under the guidance of SNC-LAVALIN ENVIRONMENT INC. Valuable inputs from the participants at the Workshops will also be incorporated into the Code.

2. GLOSSARY OF TERMS

Acid Rock Drainage (ARD)	Drainage of acid water containing dissolved metals as a result of natural oxidation of sulphides found in waste rock, ore and tailings exposed to wind and water.
Artisanal mine	A small, medium or even large-scale, informal, legal and illegal mining operation that use rudimentary processes to extract gold from orebodies, either primary or secondary.
Best Practice	The "best way of doing things". The objective of Best Practice is to prevent or (when that is not possible) minimize risks to human health, as well as adverse environmental, social and economic impacts.
Code of Practice	A collection of rules and ethical principles related to a specific field of activity, describing the procedures and setting forth standards considered to be Best Practice in said field of activity. The Code may be either voluntary or mandatory.
Effluent	A liquid, solid, or gaseous product, frequently waste, discharged or emerging from a process.
Encapsulation:	A disposal process whereby a mining waste is covered and enclosed in such a way that no leakage can occur under normal circumstances.
Guidelines	Non-binding document, generally designed to provide the user with information, explanations, guidance and help on a specific topic. Guidelines are a tool frequently used to enforce new regulations. The user can be either the Regulator itself or the industry.
Medium-scale mine	Means a mine which is the subject of a Mining Permit and from which a volume in excess of 200 m^3 but less than 1000 m^3 of material, inclusive of any overburden, is excavated or processed as an aggregate in any continuous twenty-four hour period.

Mine closure	A whole of mine life process which typically culminates in tenement relinquishment. Closure includes decommissioning and rehabilitation. This term is often used interchangeably with Mine decommissioning.
Mine decommissioning	The process that begins near, or at, the cessation of mineral production. This term is often used interchangeably with Mine Closure.
Overburden	Loose soil, sand, gravel, etc. that lies above the bedrock or above a deposit of useful materials, ores, or coal. Also called burden, capping, cover, drift, mantle, surface. It may or may not include topsoil.
Reclamation (rehabilitation)	The return of the disturbed land to a stable, productive and self-sustaining condition, taking into account beneficial uses of the site and surrounding land.
Regulations	A type of “delegated legislation” promulgated by a state, federal or local administrative agency given authority to do so by the appropriate legislature. Regulations generally are very specific in nature, they are also referred to as “rules” or simply “administrative law”. Regulations are official rules and must be followed.
Small-scale mine	A mine which is the subject of a Claim Licence and from which a volume in excess of $20m^3$ but less than $200m^3$ of material, inclusive of any overburden, is excavated or processed as an aggregate in any continuous twenty-four hour period.
Stripping	The removal of earth or nonore rock materials as required to gain access to the desired coal, ore, or mineral materials; the process of removing overburden or waste material in a surface mining operation.
Stripping ratio	The unit amount of spoil or overburden that must be removed to gain access to a unit amount of ore or

	mineral material, generally expressed in cubic yards of overburden to raw tons of mineral material.
Sustainable Development (SD)	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Tailings	The gangue and other refuse material resulting from the washing, concentration, or treatment of ground ore. Also, those portions of washed ore that are regarded as too poor to be treated further.
Tailings dam	Impoundment to which tailings are transported, the solids settling while the liquid may be withdrawn.
Turbidity	The state, condition, or quality of opaqueness or reduced clarity of a fluid, due to the presence of suspended matter.

3. MISSION AND OBJECTIVES

3.1 Mission Statement

The following is the Code's mission statement:

To foster sustainable waste management and disposal practices so as to prevent and minimize adverse environmental (physical, social and economic) impacts generated by small- and medium-scale mines in Guyana, and to create a stable landform suitable for some agreed postmining land use.

3.2 Objectives

1) Ensure that waste rock dumps, and overburden and topsoil piles are managed in a safe and sustainable manner through:

   - Wind and water erosion control;
   - Ensuring their physical stability;
   - Restoration of the waste piles to a condition in which they are visually acceptable to the community.

2) Improve the level of awareness and education of all parties on the importance of introducing sound and sustainable mining waste management and disposal practices.

3) Ensure that waste management and disposal practices are flexible and dynamic over time.

4) Ensure that waste management and disposal practices are credible and verifiable.

4. SCOPE

This Code of Practice is a mandatory code that applies to alluvial gold and diamond mining operations ranging in size from small-scale to medium-scale as well as to large artisanal mines (>20 m^3 per day). It addresses mining waste, i.e. topsoil, overburden and waste rock generated within the context of land-based extraction and/or treatment of mineral resources, with the exception of tailings (addressed by a specific Code of Practice on tailings management). It also addresses wastes that are not specific to the extractive industries such as hazardous wastes and household wastes. Reclamation considerations are covered by this Code of Practice even though they are the subject of a specific Code of Practice on reclamation and mine closure. The reason for this apparent duplication of effort is that progressive reclamation is an essential part of mine waste management.

This Code is subordinate to the Mining Regulations (that are presently being amended), made under the Mining Act of Guyana (No. 20 of 1989). The Code is intended to complement regulatory requirements, not to replace them. Compliance with the rules, regulations and laws is therefore necessary.

No guarantee is made in connection with the application of the Code to prevent hazards, accidents, incidents, or injury to workers and/or members of the public at any specific site where mine reclamation is carried out.

5. PRINCIPLES AND STANDARDS OF PRACTICE

A waste management hierarchy should be considered for all materials used at a mine. In order of preference, options selected should be:

- Waste avoidance - practices that prevent the generation of waste altogether;
- Waste reduction – practices that reduce waste;
- Waste reuse – direct reuse of waste materials for the same grade of use;
- Waste recycling or reclamation – using valuable components of waste in other processes;
- Waste treatment – to reduce hazard or nuisance, preferably at the site of generation;
- Waste disposal.

(For further details on how the following principles may be implemented, the readers should refer to ***Section 6 Code Implementation***).

5.1 Waste Dumps

Principle: Ensure that waste dumps are adequately located, designed, managed and reclaimed.

Standards of practice

5.1.1 Locate waste dumps away from surface waters, springs, seeps and wetlands (swamps and marshes).

5.1.2 Take preventive measures to minimize water and wind erosion.

5.1.3 Enhance the long-term mass stability of a dump by locating and constructing it so that the potential of failure is minimized.

5.1.4 Characterize the waste material prior to construction of the dump.

5.1.5 Take preventive measures to avoid ARD generation.

5.1.6 Avoid ARD being dispersed into the environment.

5.1.7 Create appropriate conditions for rapid revegetation after mining has ceased.

5.2 Topsoil and overburden piles

Principle: Ensure that topsoil and overburden piles are adequately located, designed, managed and reutilized for revegetation works.

Standards of practice

5.2.1 Build separate piles for topsoil and overburden material.

5.2.2 Locate topsoil and overburden piles as far from surface waters, springs, seeps and wetlands (swamps and marshes) as possible.

5.2.3 Enhance the long-term mass stability of piles by locating and constructing them so that the potential of failure is minimized.

5.2.4 Take preventive measures to avoid water and wind erosion.

5.2.5 Keep topsoil biologically active to retain its value as a plant growth medium.

5.2.6 Ensure proper debushing prior to removal of top soil.

5.3 Hazardous Waste

For the purpose of the present Code of Practice, hazardous waste also include hydrocarbons (fuels and lubricants).

Principle: Protect communities and the environment by ensuring that hazardous waste are properly managed and disposed of so as to avoid their accidental release into the environment.

Standards of Practice:

5.3.1 Identify materials and prepare hazardous waste inventories.

5.3.2 Describe methods for transport, storage and handling of hazardous waste.

5.3.3 Identify options for disposal and long term storage of hazardous waste.

5.3.4 Prepare an Awareness and Preparedness Emergency plan at Local Level (APELL).

5.3.5 Provide training on hazardous waste handling and storage for workers.

5.4 Household Waste

Household waste include all other materials such as paper, glass, plastics, wood, food and vegetation.

Principle: Foster the application of waste minimization principles so as to reduce the amount of household wastes that are disposed of and ensure that sound waste disposal practices are implemented.

Standards of Practice:

5.4.1 Promote waste avoidance, reduction, reuse and recycling practices.

5.4.2 Compost organic waste such as food, leaves, and roots. This compost could be used for revegetating the site.

5.4.3 Bury non-recyclable and non-compostable waste in an appropriate landfill complying with corresponding national or local landfill regulations.

5.4.4 Develop and implement an awareness program on waste minimization for mine workers.

6. CODE IMPLEMENTATION

6.1 Waste Dumps

6.1.1 When selecting the location of any waste dump:

- Take into account property boundaries;
- Don't interrupt significant drainage lines;
- Blend the dumps into natural hill sides if possible;
- Choose a location that will not be in the way of any possible future pit cut back or any other development;
- Make sure the toe of any waste dump is not closer to the pit than the abandonment bund for that pit;
- Design the pit abandonment bund according to international standards;
- Backfill earlier mined out pits.

6.1.2 Before construction of the waste dump commences, it is essential to know the types of material that will be placed in the dump, so that their location within the dump can be planned. Materials that:

- Have ARD potential;
- Have high salinity;
- Have potentially polluting leachate;
- Are highly dispersive;

should be appropriately encapsulated in the dump.

6.1.3 Where characterization indicates that ARD may be generated, prevention measures should be taken. These measures may include impermeable caps and liners, surface water diversions (see APPENDIX A), and/or blending acid consumption materials such as limestone with wastes.

6.1.4 Where preventive measures are impractical, water treatment will be necessary until acidic discharge meets water quality standards, a process that may last decades.

6.1.5 The material that will be used for the outer surfaces, when covered with topsoil, should be suitable for revegetation.

6.1.6 Design the profile of the dump (e.g. height and slope angles) to ensure that the final structure is safe, stable and not prone to significant erosion. Factors that should be considered in the design are material types, proposed vegetation cover, natural topography and climate.

6.1.7 Construct the dump in successive lifts, starting at the toe. A single lift should not exceed fifty (50) feet in height.

6.1.8 It is essential to design and construct drainage control measures that will handle expected rainfall events. Minimizing slope lengths will help reduce water velocity and its resulting erosion potential (see APPENDIX B).

6.19 Any water that runs off the surface of a dump should be diverted behind siltation berms, into catch basins, into sediment ponds, or through silt fences (see APPENDIX C).

6.1.10 Previously cleared topsoil should be spread over all surfaces at a thickness of about 5-20 cm (depending on the nature of the underlying waste rock). The surfaces should then be scarified (see APPENDIX D and E).

6.1.11 Direct seeding at the optimal time for the region will maximize the benefit of annual rainfall events. Select the seed mix that consist of local native species and which will give maximum diversity. Post-mining land use will have a bearing on the seed mix chosen (see APPENDIX E).

6.2 Topsoil and overburden piles

6.2.1 Runoff collection and dispersion as well as sediment collection structures should be implemented in order to prevent suspended material from being discharged into water streams.

6.2.2 Keep the topsoil biologically active for further use in revegetating the site. This can be achieved by moving the soil to allow the introduction of oxygen or by seeding.

6.3 Hazardous Waste

6.3.1 The hazardous substances inventory should list all chemicals on the site, including:

- The chemical name;

- Typical quantities maintained at the site;
- Operating procedures incorporating handling precautions, storage requirements, safety equipment needed, training required and specific instructions for clean-up of spills.

6.3.2 All hazardous wastes storage facilities should be designed with protection of the environment as well as health and safety in mind.

6.3.3 Procedures should be developed and implemented to prevent contaminated stormwater being discharged in this way. Some interception device which would trap the contaminant and therefore prevent this contaminated water entering the environment should be incorporated.

6.3.4 Where storage or transport systems are not clearly visible, as with underground tanks or buried pipes, additional protective measures are needed. Material balances and inventory reconciliation should be used on a regular basis to detect any unaccounted loss of material.

6.3.5 If the storage or disposal area is on the site, it needs inspection to ensure sufficient protection is installed to prevent escape of the material to the environment.

6.3.6 Any disposal area should be clearly identified and labelled.

6.3.7 Disposal areas should be adequately monitored to permit identification of any leakage.

6.3.8 Training programs should include appropriate information about he environmental hazards of materials.

6.4 Household Waste

6.4.1 Waste reduction. reuse, sorting and recycling should be strongly emphasized at the mine site in order to minimize waste generation and to reduce costs.

6.4.2 As much as possible, vegetation from debushing should be used for constructing facilities and equipments such as tables, furniture, posts, sediment collection structures (e.g. brush barrier), soil stabilization structures, etc. The amount of vegetation from debushing that is not used should be kept to a minimum.

6.4.3 Cleared vegetation that is not used should be piled up and burnt.

7. REFERENCES

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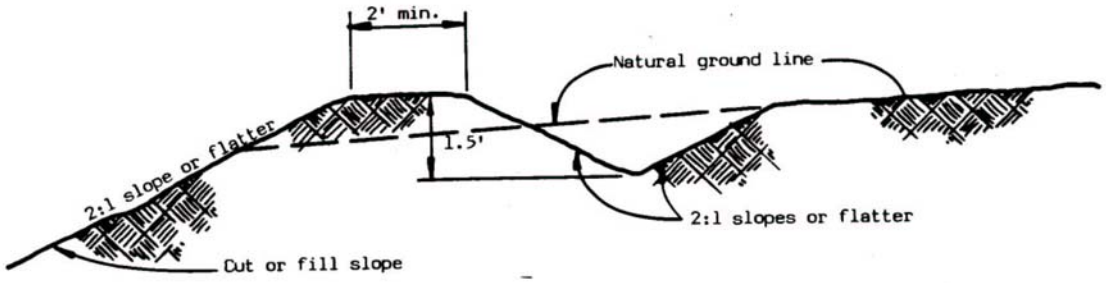
Web site

http://xmlwords.infomine.com/xmlwords.htm (on-line dictionary of mining terms)

APPENDIX A

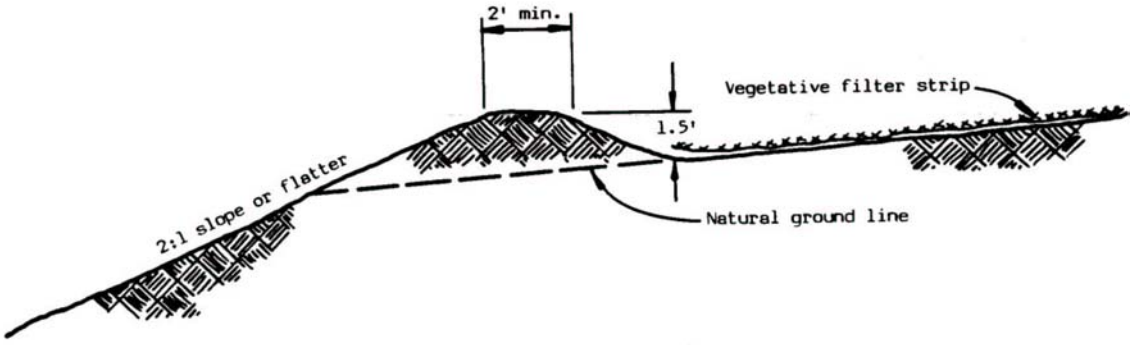
Runoff Collection Structures

Diversion Dike/Ditch



NOTE: Bed of dike to be riprapped.

SECTION

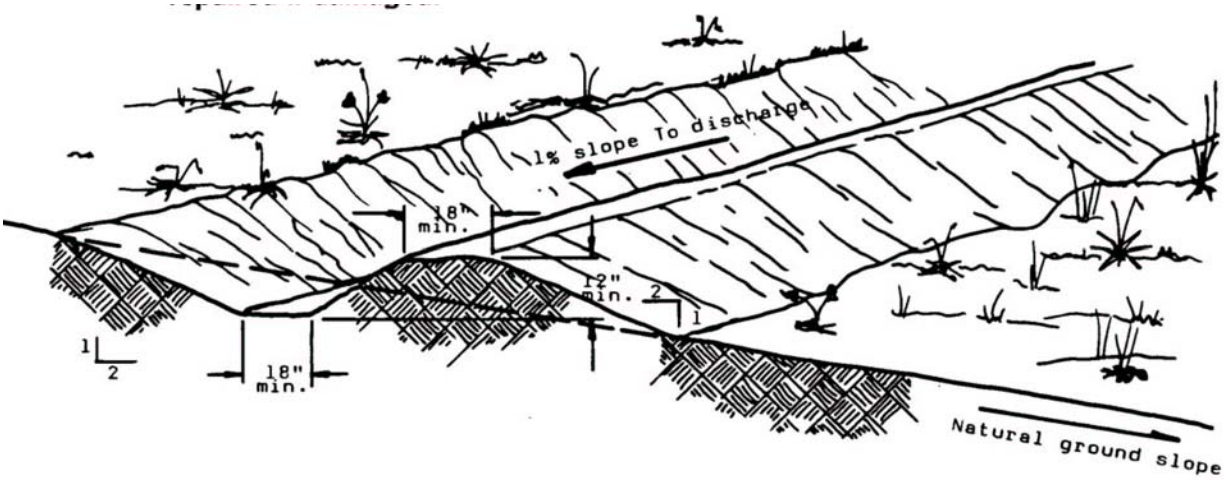


NOTES: 1) Dike constructed by dozer moving soil upslope and dumping at top of slope.
2) Outlet to stabilized vegetated soil.

SECTION

After Idaho Department of Lands, 1992

Interceptor Trench



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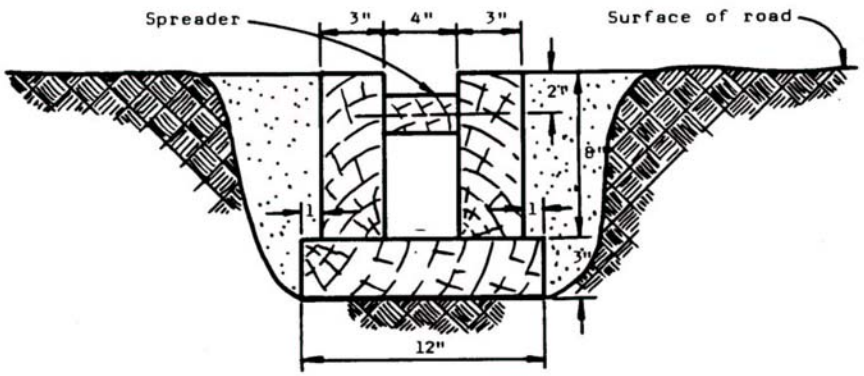
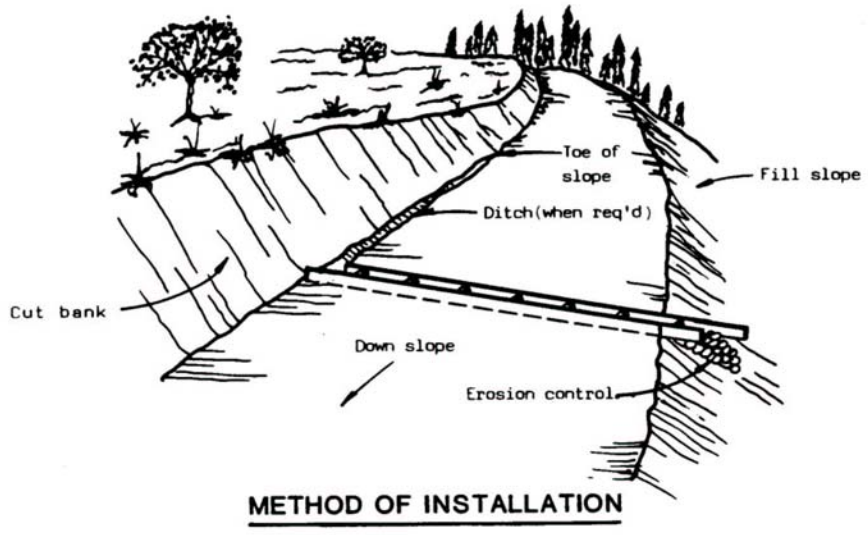
Open Top Box Culvert



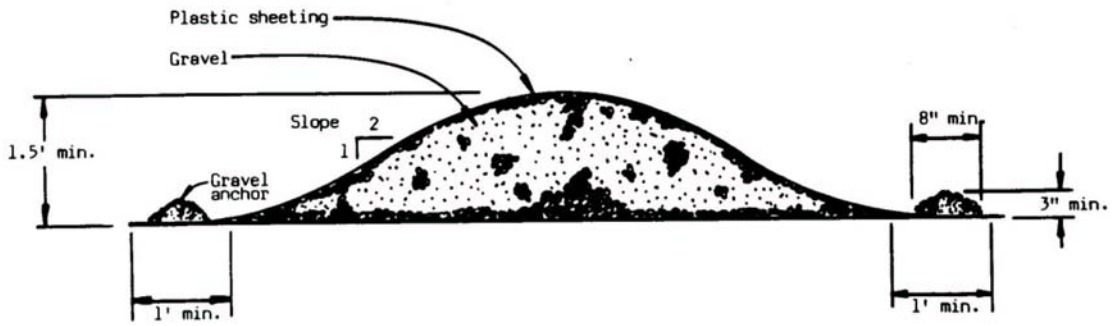
END VIEW



METHOD OF INSTALLATION

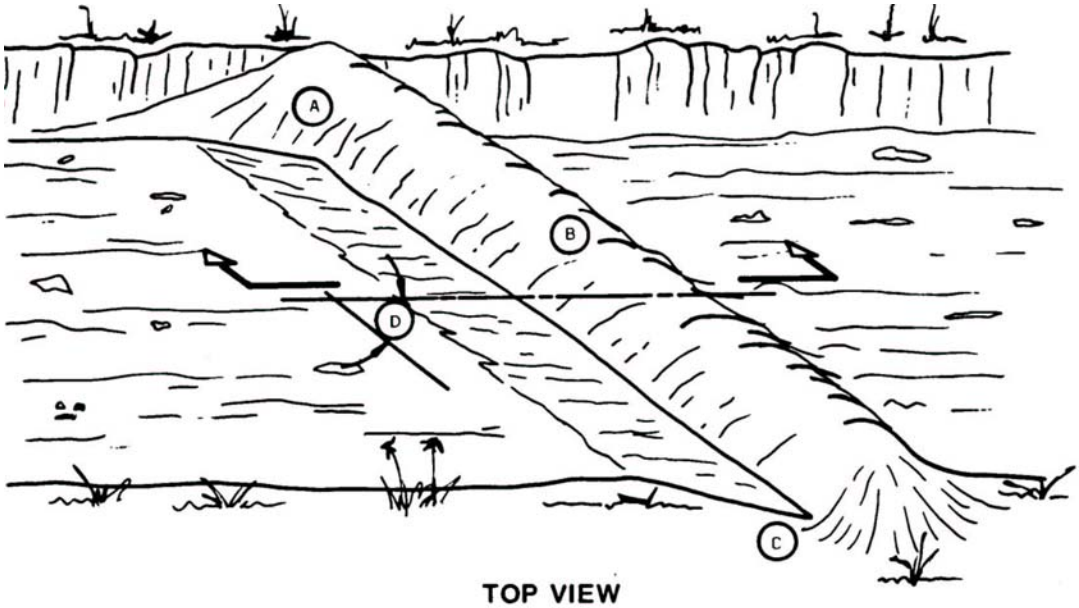
After Idaho Department of Lands, 1992

Siltation Berm

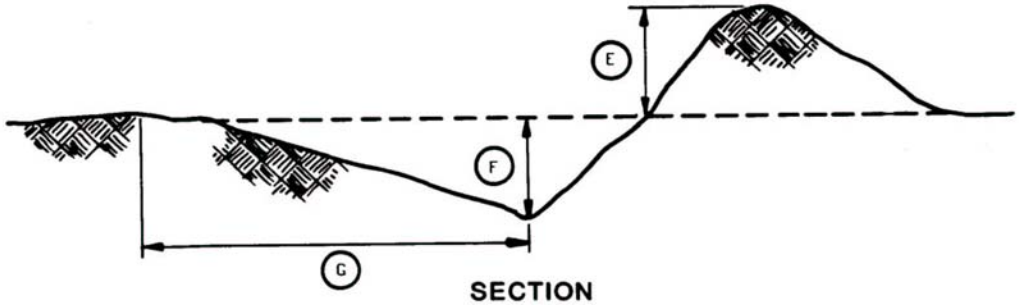


After Idaho Department of Lands, 1992

Waterbars



TOP VIEW

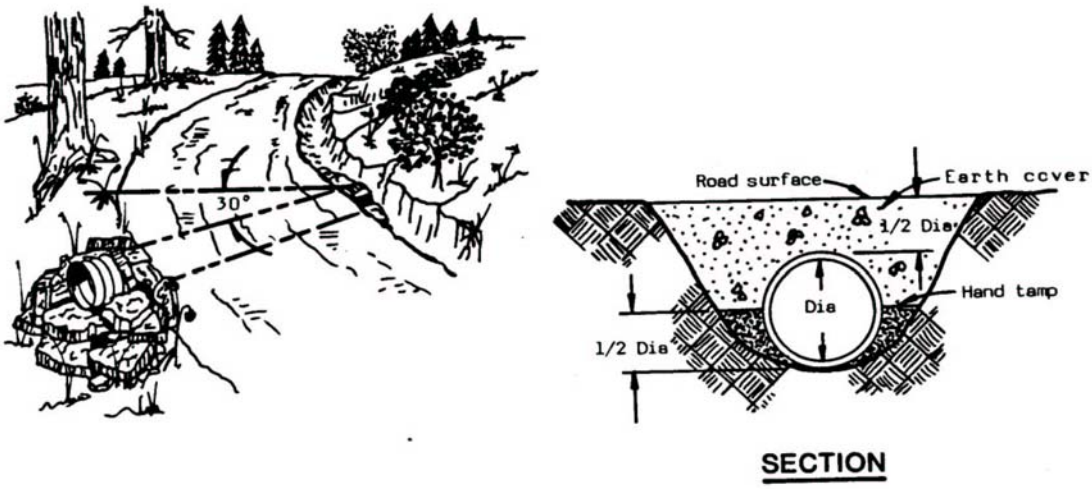


SECTION

WATERBAR (CROSSDITCH). Construction for unpaved forest roads with limited or restricted traffic. Specifications are average and may be adjusted to gradient and other conditions. A, bank tie-in point cut 6 to 12 in. into roadbed; B, cross drain berm height 12 to 24 in. above roadbed; C, drain outlet cut 8 to 16 in. into roadbed; D, angle drain 30 to 40 degrees downward with road centerline; E, height up to 24 in; F, depth to 18 in; G, 36-48 in.

After Idaho Department of Lands, 1992

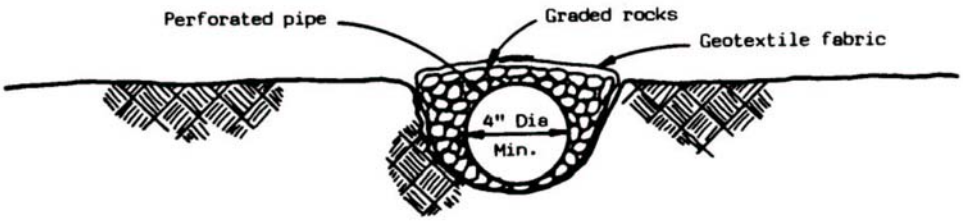
Culvert Installation



After Idaho Department of Lands, 1992

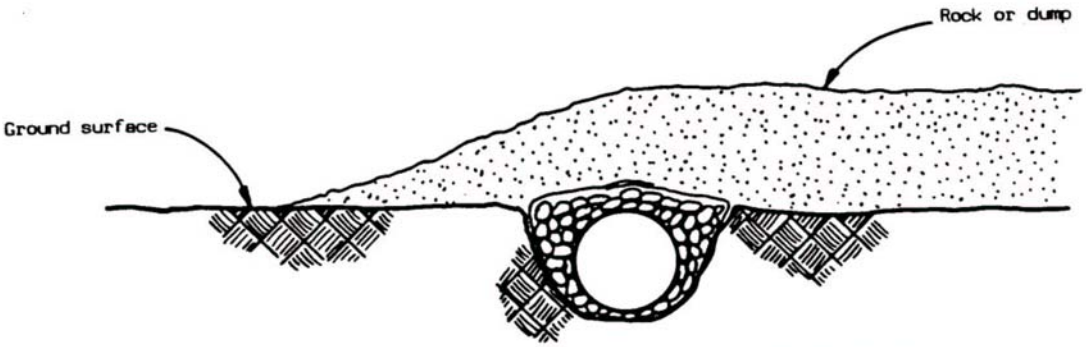
Drain Fields

DRAIN FIELD TRENCH LINED WITH GRADED ROCKS



NOTE: Diameter of pipe to be based on the amount of water to be drained.

TRENCH LINED WITH GEOTEXTILE FABRIC,
GRADED ROCK AND PERFORATED PIPE



SURFACE WASTE OR DUMP TO BE PLACED
OVER UNDERDRAIN AFTER CONSTRUCTION

After Idaho Department of Lands, 1992

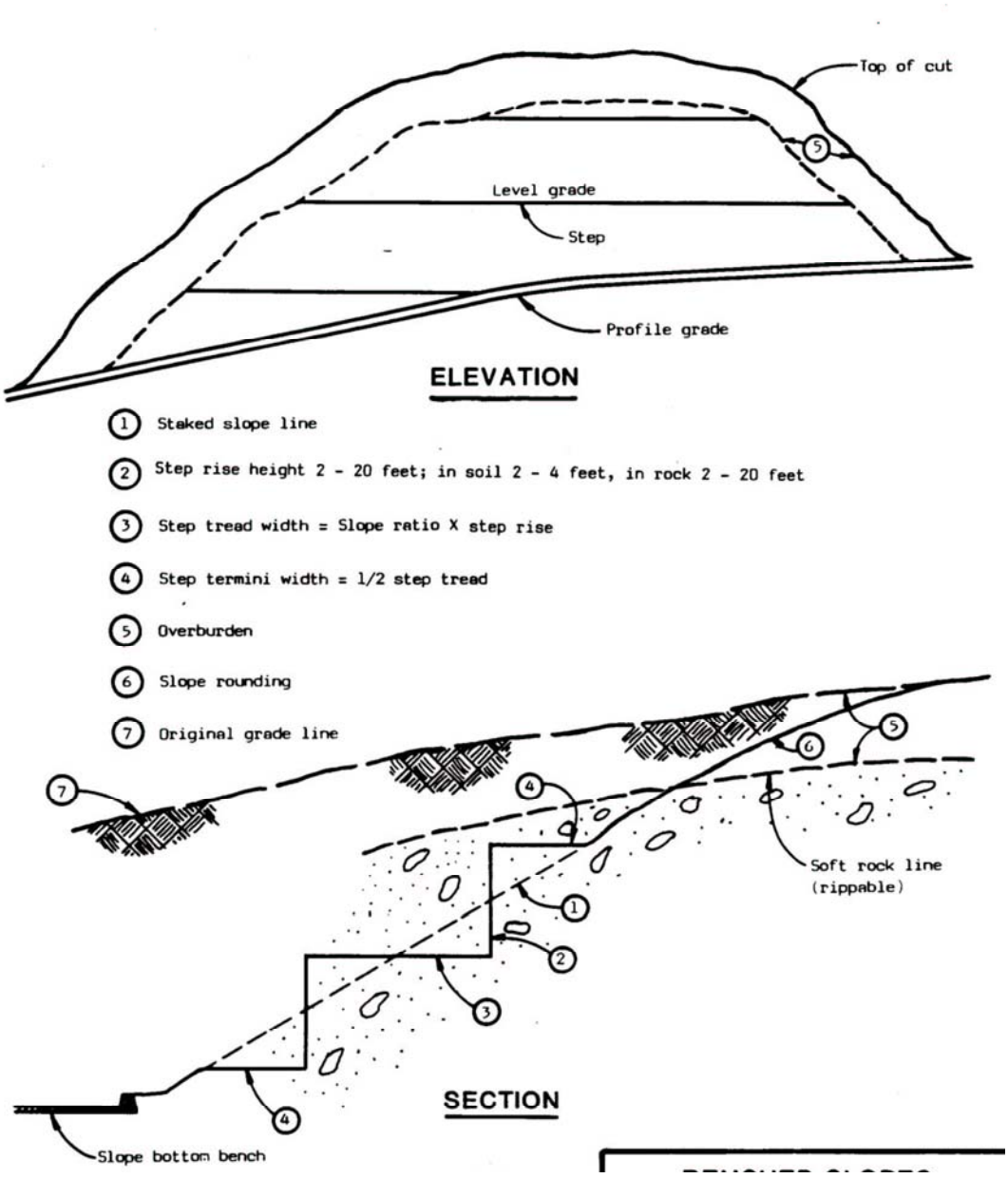
Road Sloping

After Idaho Department of Lands, 1992

APPENDIX B

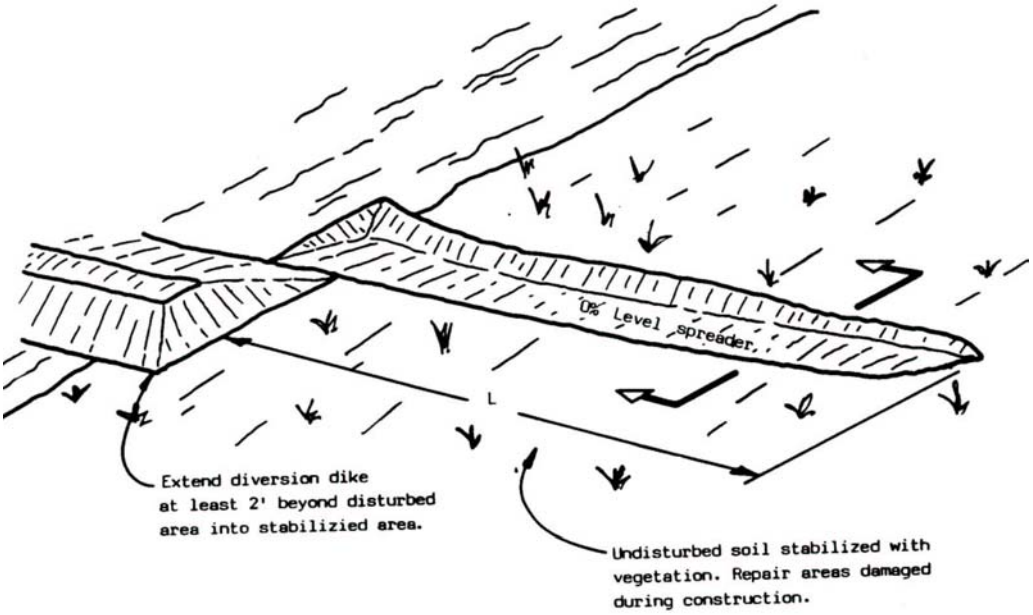
Runoff Dispersion Structures

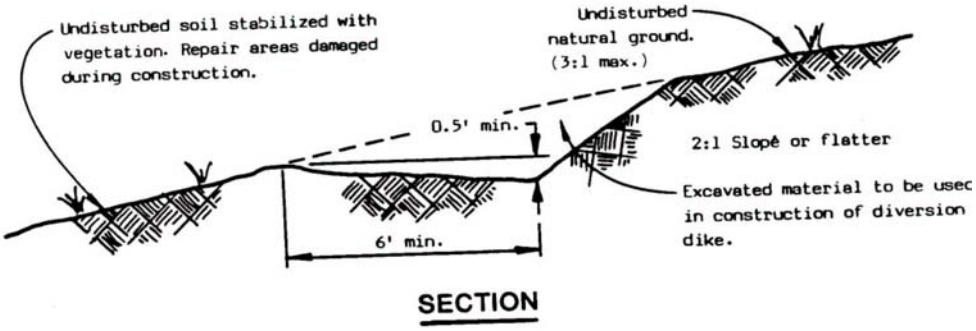
Benched Slopes



After Idaho Department of Lands, 1992

Level Spreader



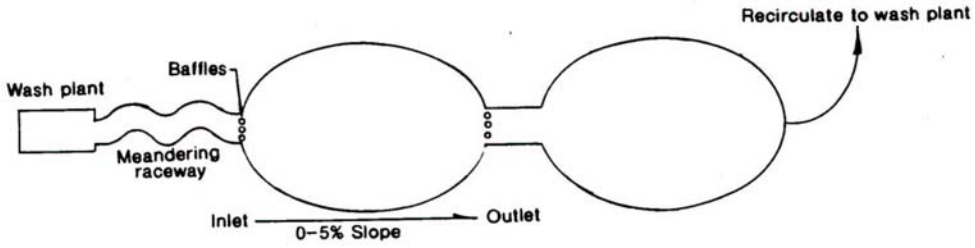


After Idaho Department of Lands, 1992

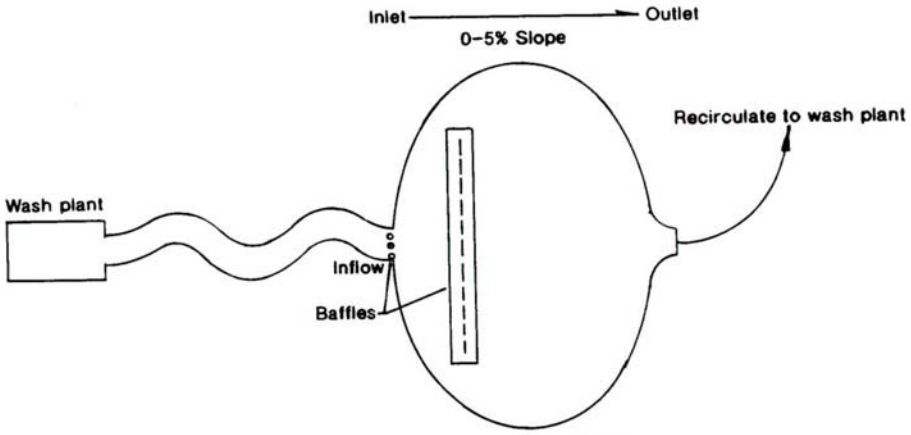
APPENDIX C

Sediment Collection Structures

Diagram of Settling Ponds for Placer Mining



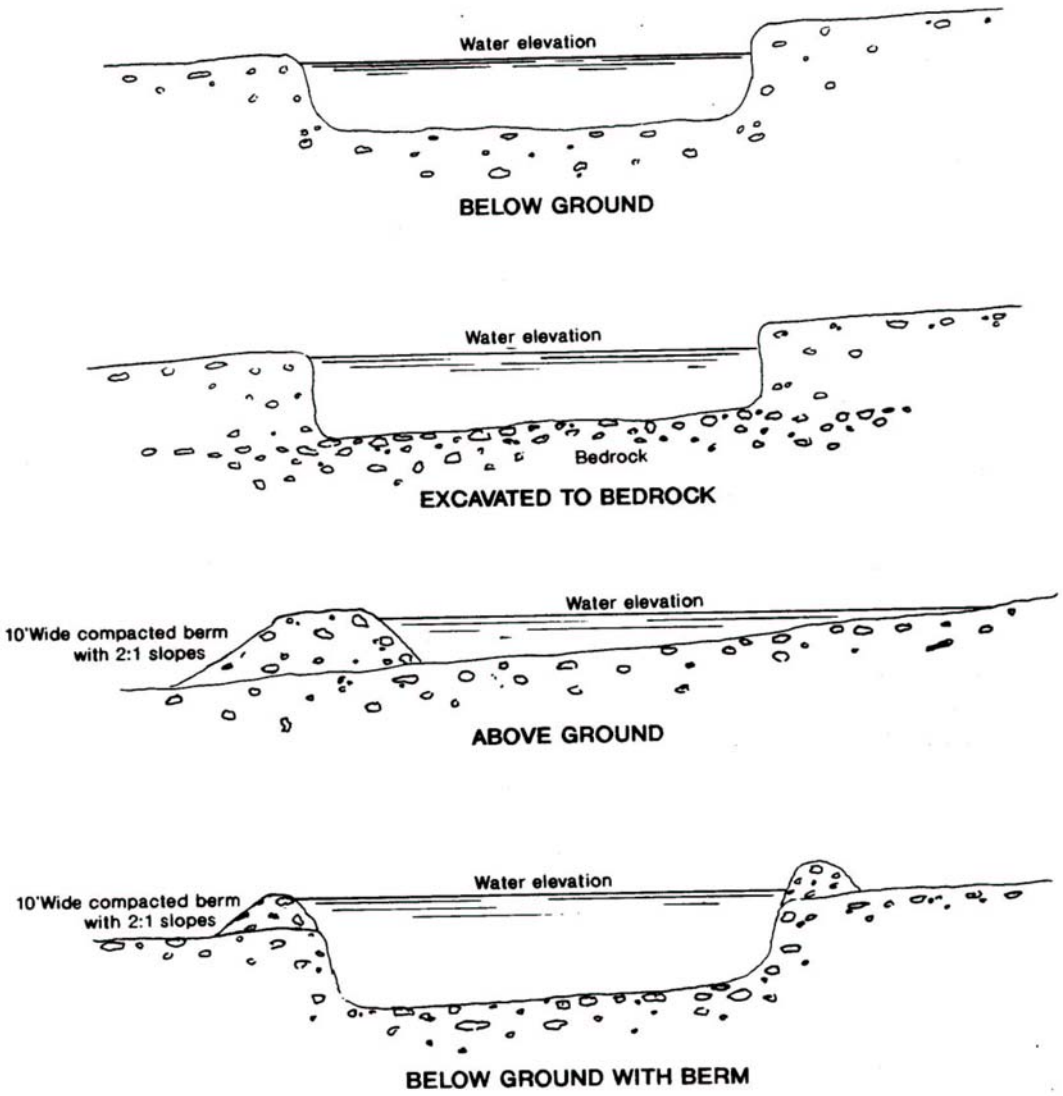
STANDARD SETTLING PONDS IN SERIES



SETTLING POND WITH BAFFLES

After Idaho Department of Lands, 1992

Settling Pond Construction Options



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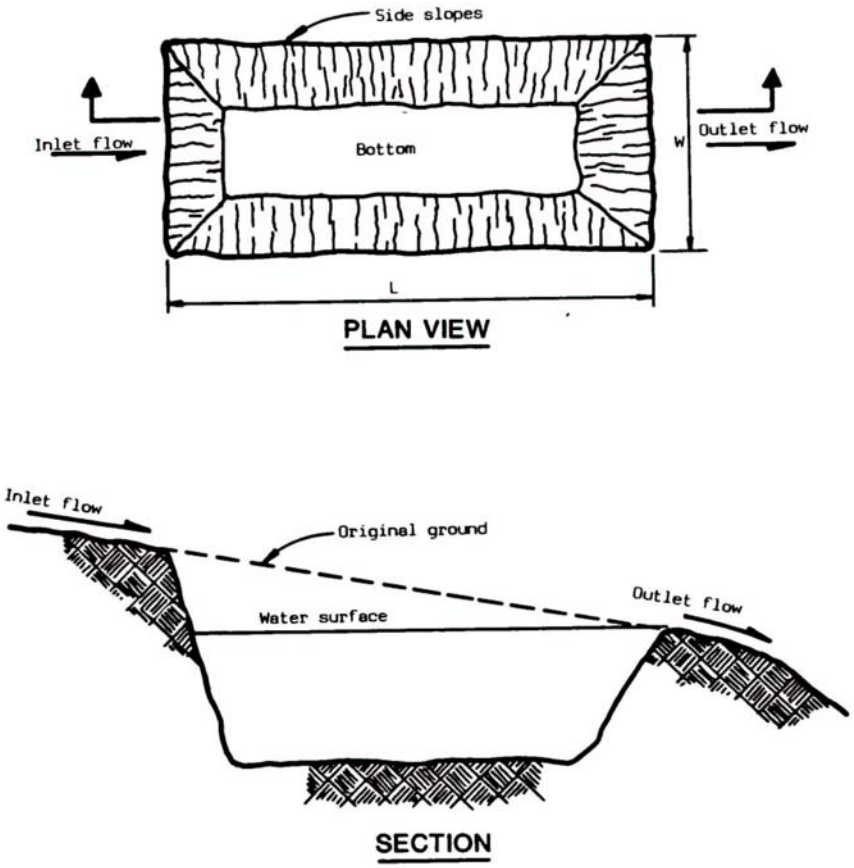
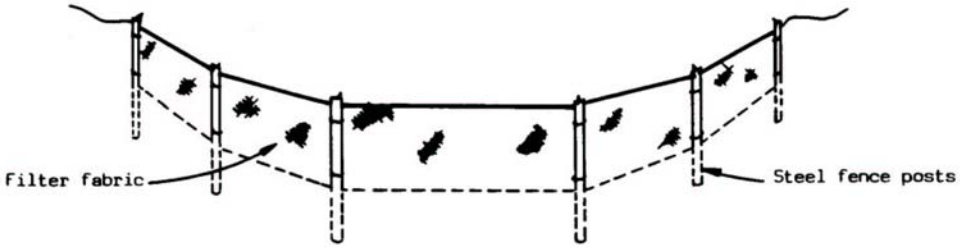
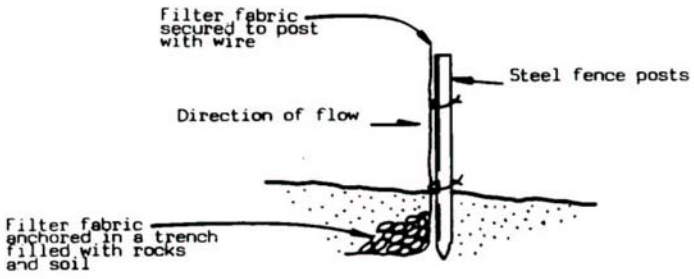
Sediment Traps or Catch Basins



After Idaho Department of Lands, 1992

Silt Fence/Filter Fence





SECTION

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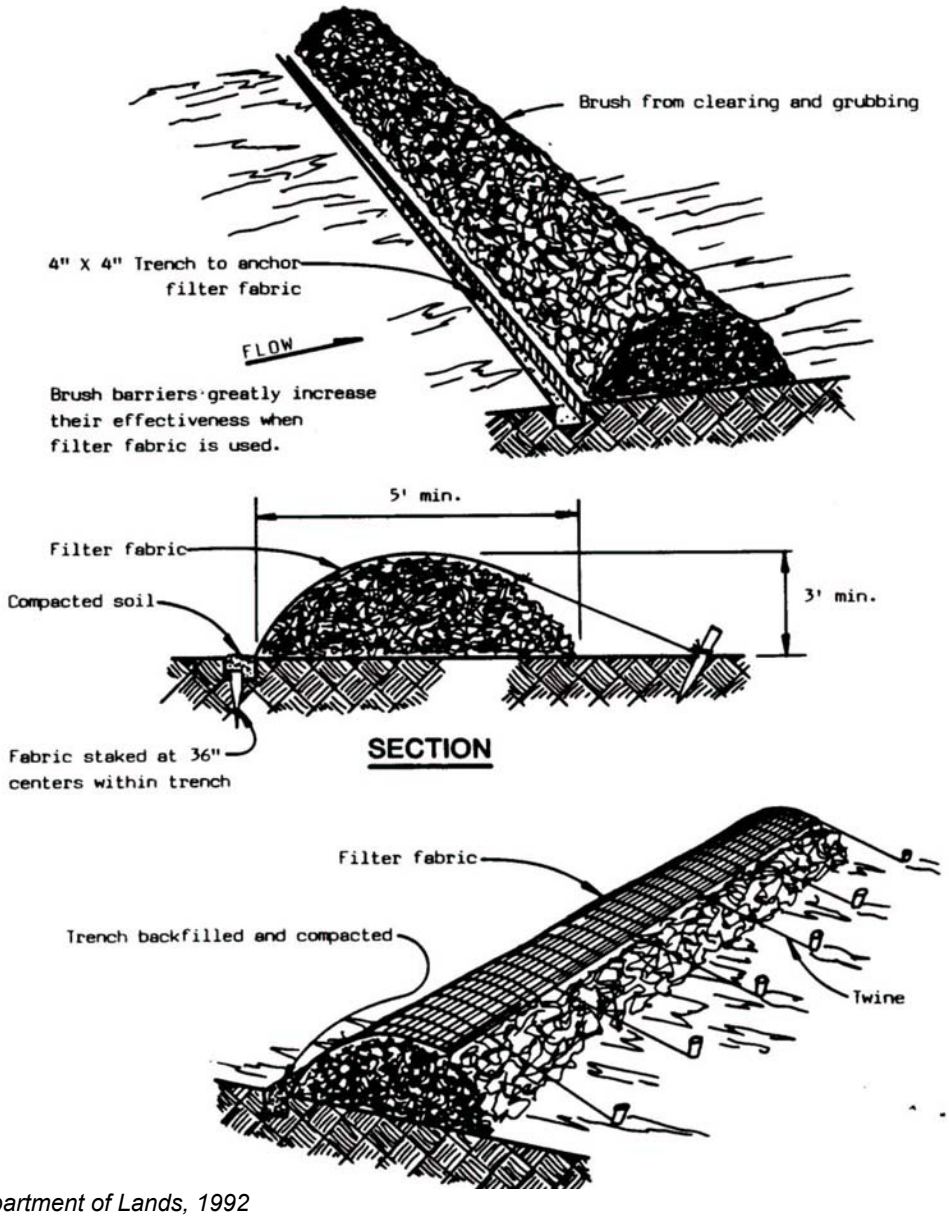
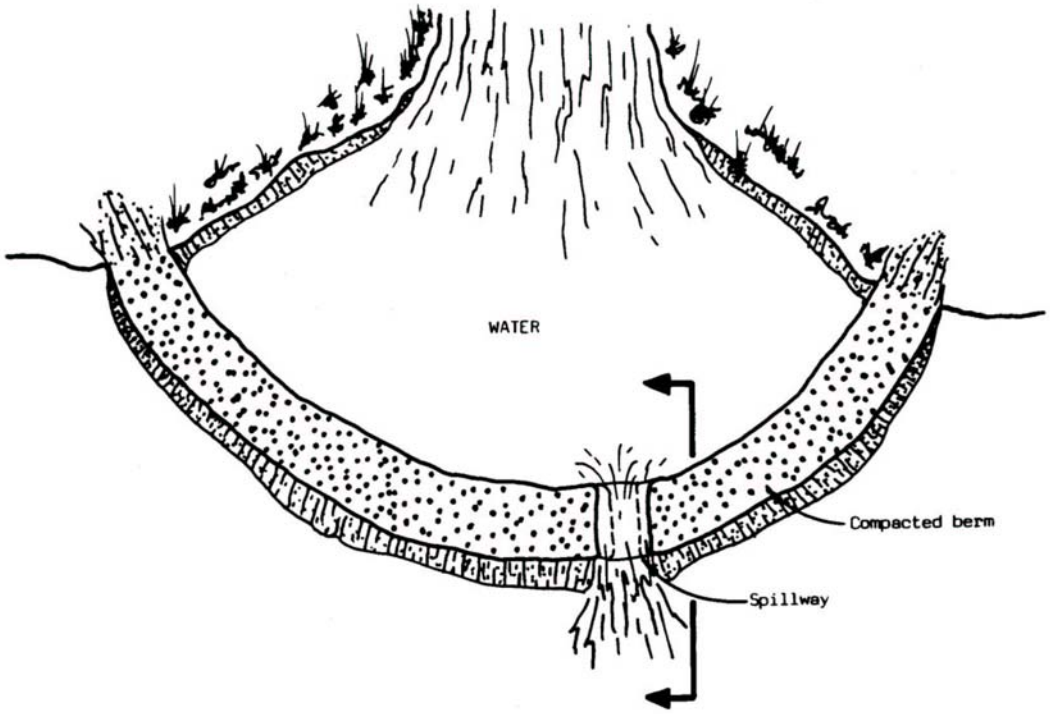
Brush Sediment Barrier

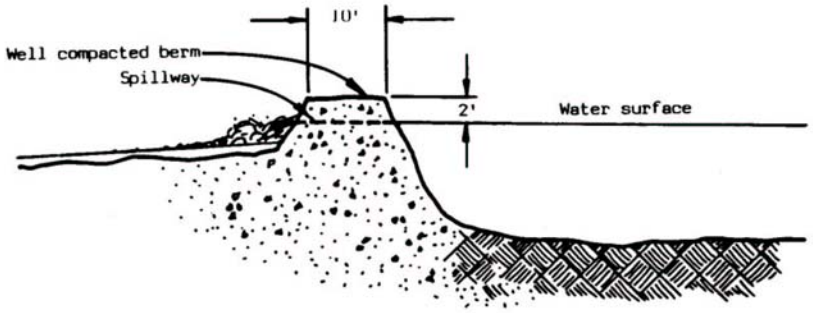


After Idaho Department of Lands, 1992

Sediment/Settling Pond



PLAN VIEW



CROSS SECTION

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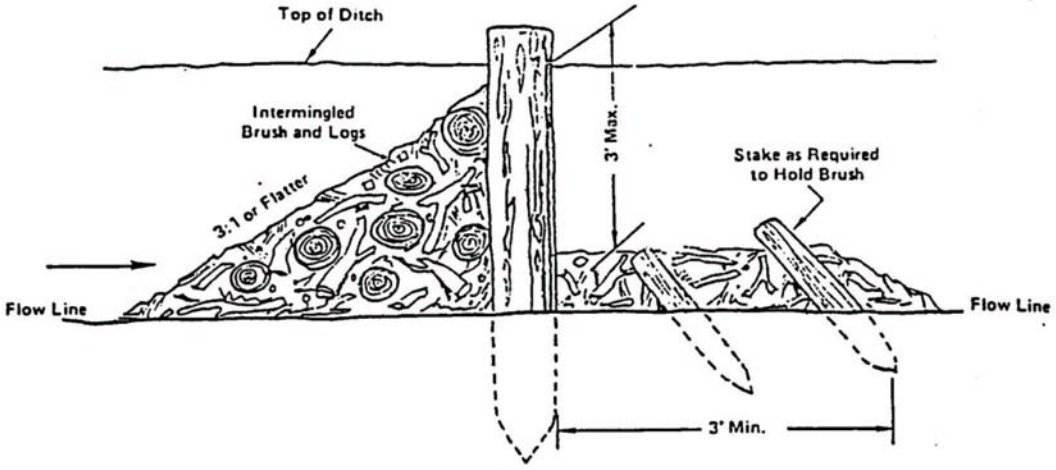
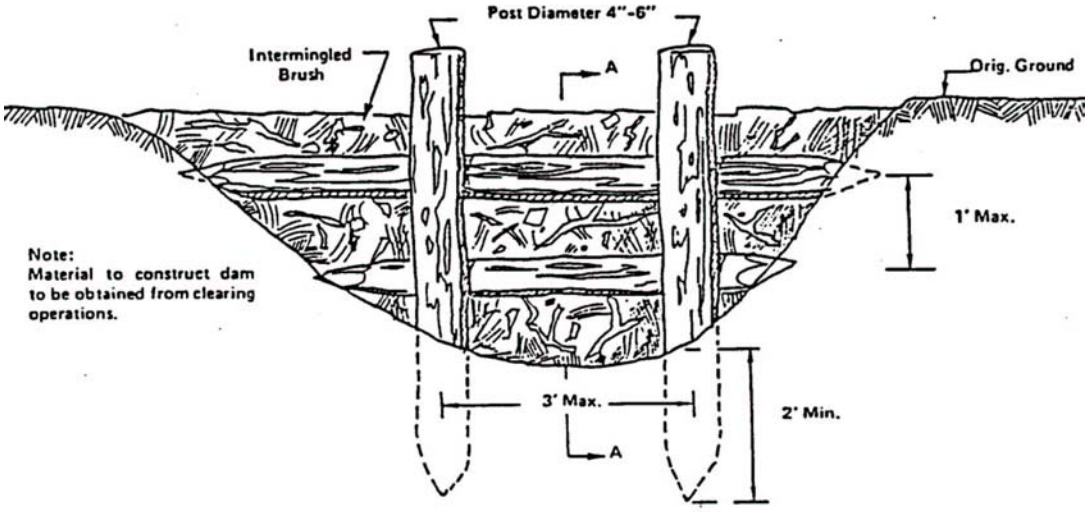
Log and Brush Check Dam



SECTION A-A



ELEVATION VIEW

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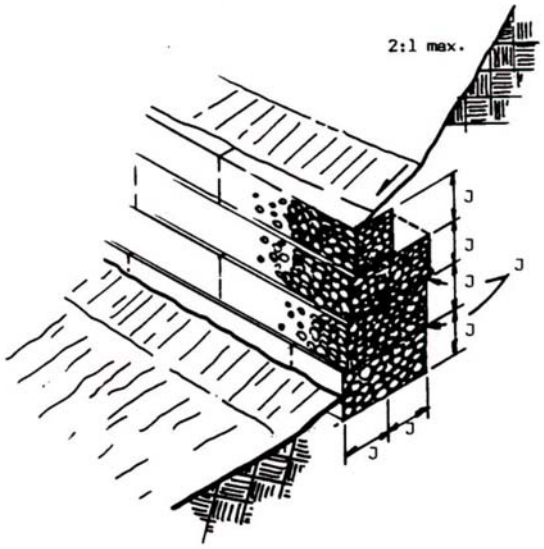
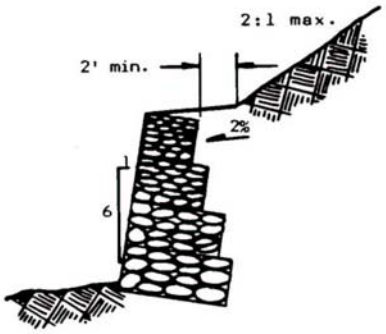
APPENDIX D

Permanent Soil Stabilization Techniques

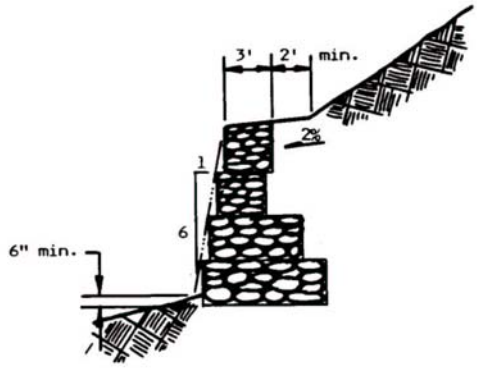
Gabions



3-DIMENSIONAL



SECTION



SECTION

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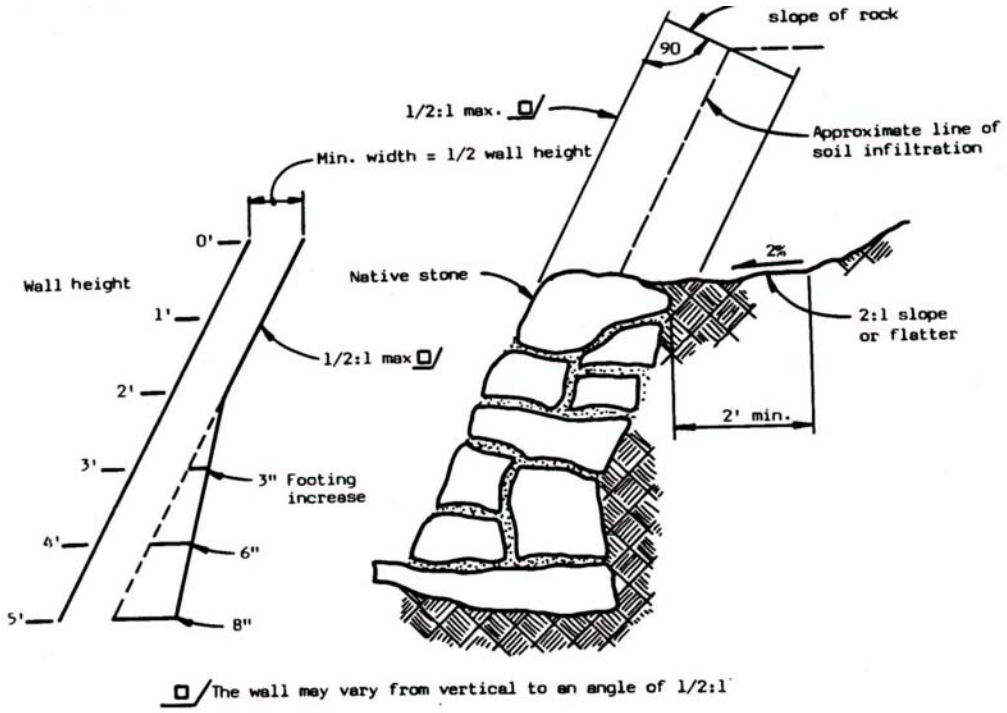
Native rock retaining wall



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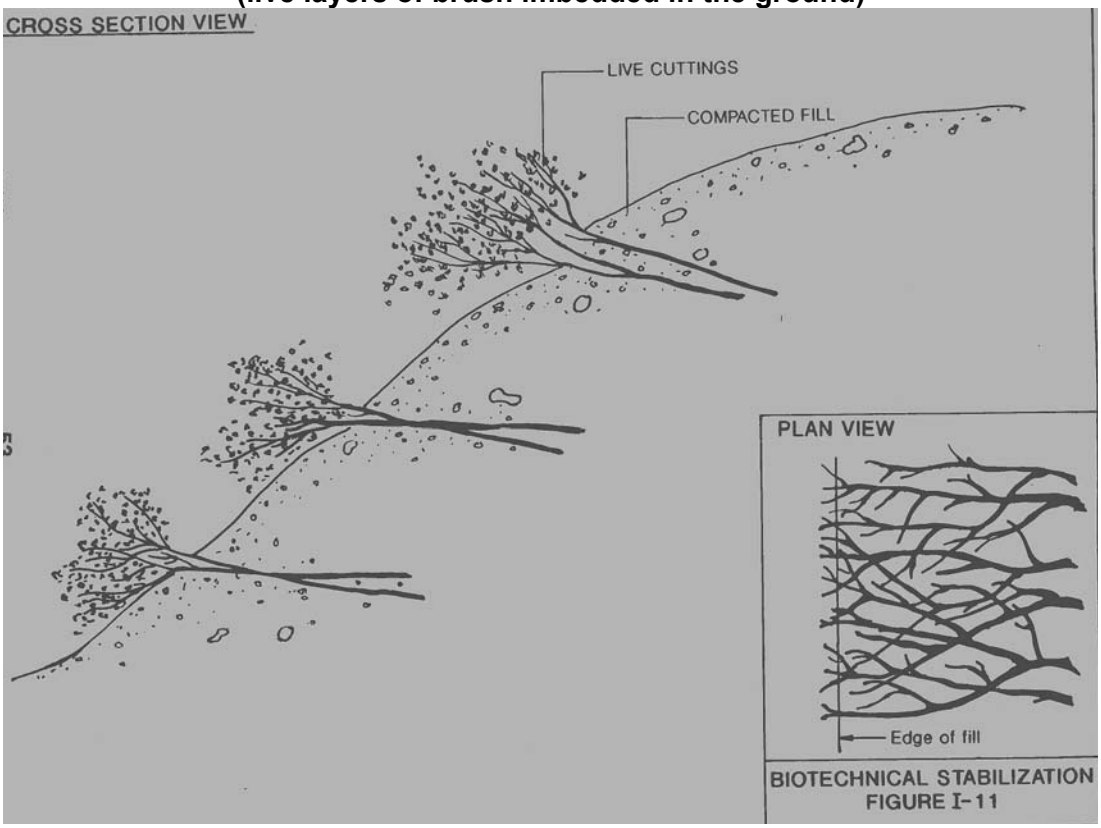
Biotechnical Stabilization

(live layers of brush imbedded in the ground)



After Idaho Department of Lands, 1992

APPENDIX E

Seeding and Revegetation Techniques

Topsoiling

Topsoiling is the placement of topsoil or other suitable plant growth material over a prepared topsoil.

Purpose: To provide a suitable soil medium for vegetative growth.

Seedbed preparation

Seedbed preparation entails preparing the soil by ripping, discing, scarifying and adding soil amendments to make the soil more productive and enhance revegetation efforts.

Purpose: To promote successful revegetation efforts by preparing the soil for planting and creating propped seedbed conditions.

Broadcast seeding

Broadcast seeding is the process of uniformly casting seeds and fertilizer on the soil by hand or mechanical means.

Purpose: Broadcast seeding is employed when seeding grasses, shrubs, forbes, or trees on flat surfaces and slopes where other seeding methods are not appropriate. Broadcast seeding is well suited for use on steep slopes, rocky areas, abandoned roadways, sites with limited access, and where hand labor is used.

Drill seeding

Drill seeding is the process of planting seed and fertilizer using an agricultural or rangeland drill seeder.

Purpose: This method is most effective on flat, non-rocky surfaces. Drill seeding provides the maximum possibility for successful germination and growth, with a minimum investment in fertilizer, seed, and labor because seeds are not damaged or carried away by wind, water, animals, or birds.

Vegetative planting

Vegetative planting means the establishment of vegetation by planting trees and shrubs from nursery stock and transplants.

Purpose: Planting vegetation is an effective means of promoting soil stability and controlling erosion; however, until establishment is complete the site is vulnerable to erosion. Trees and shrubs should be planted in conjunction with grasses and legumes to enhance the overall effectiveness of soil stabilization efforts and erosion control measures.