Mining Environmental Management

CODES OF PRACTICE

Mine Effluents

Guyana Geology and Mines Commission

Brickdam, Georgetown

August 2010

Rev – 0

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1.0 Introduction

This Code of Practice for **Mine Effluents** in small and medium-scale gold and diamond mines is intended to provide environmental management guidance, and to promote the application of related best management practices. It is not a design manual[1].

1.1 Regulatory Authority/Mandate

The Mining (Amendment) Regulations 2005[2] were promulgated in 2004. Regulation 248 of the Mining (Amendment) Regulations 2005 stipulated that the Guyana Geology and Mines Commission (GGMC) prepare Codes of Practice for Mining Environmental Management prior to finalization of the Regulations.

The Codes of Practice were intended to provide critical environmental management guidance to the Mining Industry, particularly small and medium-scale gold mines. The importance of the codes was even more enhanced by the development of the Low Carbon Development Strategy.

The following ten (10) provisions of the Codes of Practice for Environmental Management were indentified:

- Use of Mercury
- Tailings Management
- Contingency and Emergency Response Plans
- Mine Effluents
- Mine Reclamation and Closure Plans
- Mine Waste Management and Disposal
- Environmental Effects Monitoring Program
- Quarrying
- Sand and Loam Mining
- Use of Small Dams for the Control of Water and Tailings

1.2 Justification for the Mine Effluents Code of Practice

The Mining (Amendment) Regulations (2005), Articles 224, 237 state that the GGMC shall prepare a Code of Practice to provide further guidance for effluent management, disposal and other practices, and that this Code shall form part of the Regulations.

The nature and volume of effluents generated in a mining operation is a function, in part, of the type of mine and deposit. While, currently in Guyana, only a limited number of minerals are mined, the Code of

[1] This document is **NOT** a design manual. Users of this document shall assume full responsibility for the design of facilities and for any action taken as a result of the information contained in this document.

[2] The Mining Regulations, made under the Mining Act (1989), was amended by the Mining (Amendment) Regulations 2005: Collectively they address all the important aspects of mining environmental management.

Practice for Mine Effluents must anticipate the mining of, and related generation of effluents from, other minerals.

In Guyana the effluents currently generated in the small and medium-scale gold and diamond mines include:

- Discharges from tailings ponds
- Discharges from sluices (slurried tailings) and settling ponds
- Surface runoff
- Small amounts of mercury, cyanide and chemically-contaminated fluids

The Mining (Amendment) Regulations 2005 sets standards for the turbidity levels for discharges to streams and rivers. The Regulations also addresses and is aimed at the improvement of the management of poisonous fluids used in the mining industry. To this end the Regulatory Agency, the GGMC, is empowered to set contamination concentration levels for contaminants of concern.

The sluicing of pay dirt produces large amounts of suspended material that can be discharged into receiving waters. According to estimates, over 200,000,000 m^3 of tailings, consisting of more than 80% water, are generated each year by dredges in alluvial mines. A large percentage of this material flows directly into the receiving environment, causing turbidity plumes in waterways, reduced light penetration, siltation, channel alteration and changes in stream-bottom characteristics along with their dramatic impacts on riverine ecosystems.

The only pollution-control measure practiced by the small and medium scale gold and diamond mining industry is to reduce particulate matter in water discharged into surface watercourses. This is achieved by relying solely on settling/tailings ponds, by using a combination of storage areas and settling/tailings ponds, or by discharging effluent into large areas of gravel or previous tailings, water recycling and to a lesser extent the use of chemicals to promote settling of solids.

The Guyana mining sector is joining with mining industries in other countries in the shift towards more sustainable practices in order to address public concerns and increasingly stringent regulations: Efficient management of mine effluents is a major focus.

This Code of Practice for Mine Effluent Control will provide the environmental guidance, and address the various concerns raised previously. The Code of Practice is based on sound management practices exercised elsewhere and on principles and approaches from various sources.

1.3 Administration of Codes and Responsibilities of Owners and Workers

A useful strategy for sustainable environmental management in the small and medium-scale gold and diamond mining is co-regulation by the various stakeholders including the GGMC, and the Miners, and Mining Industry.

GGMC's mandate or role as defined by the Mining Act 1989 and the Mining (Amendment) Regulations 2005 is to develop, administer and enforce the mining regulations. Specific responsibilities include:

- Development and upgrading of the codes
- Consultations with the stakeholders in the mining industry including mining organizations and miners.
- Public education, orientation and training
- Enforcement of the mining regulations
- Monitor compliance with, and enforcement of the Mining (Amendment) Regulations 2005

The prime responsibility for the implementation of, and compliance with, the Mining (Amendment) Regulations 2005, and the application of sound environmental management practices rests with the Mine Owners and operators. Specifically, with the respect to the control of mine effluents, the Mine Owners and operators must:

- Manage their operations in compliance with the Mine Effluent Regulations and Guidelines
- Provide their employees with required training and orientation in Mine Effluent Control, and the related the regulations, codes and guidelines

2.0 Glossary of Terms

Amalgamation	The process by which mercury is alloyed with some other metal (mostly gold) to produce an amalgam.
Abandoned site	An area formerly used for mining and mineral processing, where closure is incomplete and for which a titleholder still exists.
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, air, and water..
Appurtenances	Structures and equipment within a tailings facility, other than the dam itself. They include, but are not limited to, facilities such as pipelines, spillways, drains, intake towers, tunnels, canals, low-level outlets, and water treatment, control and release facilities. They may also include mechanical equipment and electrical control and power supply equipment.
Amalgamation	The process by which mercury is alloyed with some other metal (mostly gold) to produce an amalgam.
Best practice	The best way of doing things. The objective of best practices is to prevent or (when that is not possible) minimize risks to human health, as well as adverse environmental, social and economic impacts.
Buffer areas	Means land on either bank of rivers or watercourses from the low watermark of the bank to 20 meters (20 m) inland, and extending from the mouth of the river or navigable watercourse to its source; or any area within 30 meters (30 m) of a public road; or100 meters (100 m) of approved residences, commercial/industrial developments; or 1 kilometer (1 km) of an approved nature reserve or park.
Co-Regulation	The mechanism whereby a Community legislative act entrusts the attainment of the objectives defined by *the legislative authority* to parties which are recognized in the field (such as economic operators, the social partners, non-governmental organizations, or related industry associations).
Code of practice	A collection of rules and ethical principles related to a specific field of activity. A code of practice describes procedures and sets out standards considered to be best practices in the said field of activity. The code may be voluntary or mandatory.

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Community	For the purpose of an emergency response plan, the sum of all affected communities plus the immediate community, whether it is affected or not.
Cut-off trench	Channel or ditch usually excavated around a mining structure in order to collect groundwater.
Effluent	Means any fluid including airborne particles of matter and other substances in suspension or solution in the fluid and includes mine de-watering discharges , site runoff , discharges from a tailings basin or settling pond, discharges from a processing plant or dredging operation which is released to the surface or ground water and other substances such as colloids , in solution or suspension.
End of mine life process	A process undertaken when the mining operation is about to be decommissioned.
Freeboard	The difference in elevation between the maximum operating water surface of the impoundment dam and the low point on the upstream edge of the crest.
Grouting	The injection of grout into fissured, jointed, or permeable rocks in order to reduce their permeability or increase their strength.
Guidelines	A non-binding document, usually designed to provide users with information, explanations, guidance and help with respect to a specific topic. Guidelines are a tool frequently used to enforce new regulations. Users can be either the Regulator itself or the industry.
HSE	Stands for **H**ealth, **S**afety and **E**nvironment.
Hydraulicing	The excavating of alluvial or other mineral deposits by means of high-pressure water jets.
Medium-scale mine	A mine for which a mining permit has been issued and from which a volume in excess of 200 m^3, but less than 1 000 m^3, of material, including any overburden, is excavated or processed as an aggregate in any continuous 24-hour period.
Mine	Includes any excavation, processing facility and/or related facilities for the recovery of metal, mineral or quarriable material and excludes any

	excavation, processing facility or related facilities that excavate or process less than 20 m^3 in any continuous period of twenty-four hours.
Mine closure	A whole of mine life process which typically should culminated in relinquishment of the mining property or part thereof. 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.
NGO	Stands for **N**on-**G**overnment **O**rganization.
Orphan site	An abandoned mine for which a responsible party no longer exists or can be located.
Open circuit	Any process whereby the ore that has been in contact with mercury, the water used in processing or the mercury itself may enter a waterway or infiltrate into the soil. It also includes the vaporization of mercury into the atmosphere.
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, and surface. It may or may not include topsoil.
Pay dirt	Earth, ore or gravel that is profitable to mine
Placer mining	The removal of high-density minerals (such as native gold) from alluvial deposits by washing with water.
Progressive reclamation	Reclamation that is carried out throughout the mine life, in day-to-day operations.
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” enacted by the appropriately authorized state, federal or local government agency. Regulations are generally very specific and are also referred to as rules, or simply administrative law. Regulations are official rules and must be followed. Regulations are generally very specific and are also referred to as rules or simply administrative law. Regulations are official rules and must be followed.

Relinquishment Point	Where the mining company has met agreed completion criteria to the satisfaction of the responsible authority. At this point, the site is no longer a danger to public health and safety is not a source of ongoing pollution or instability and allows a productive use of the land similar to its original use. A mining company has no further obligations regarding a specific property once its relinquishment has been accepted by the regulatory authorities.
Riparian	Pertaining to or situated on the bank of a body of water, especially of a watercourse such as a river, e.g., riparian land situated along or abutting on a stream bank, or a riparian owner who lives along or has property on a riverbank.
Risk analysis	The systematic use of available information to identify hazards and to estimate quantitatively or qualitatively, the likelihood and consequences of those hazards being realized.
Risk assessment	The process of evaluating what might go wrong with a facility and its associated plans and procedures in addition to the consequences of failure. Risk assessments are the basis for developing a risk management strategy that includes communications, contingencies, mitigation measures and emergency response plans.
Settling pond	Refers to a basin designed to receive water, runoff, or similar discharges to facilitate removal of settleable solids.
Siltation	The deposition of sediments in a water body as fine suspended particulate matter.
Slurry	A semi-fluid, murky mass of sediment resulting from treatment of water, sewage or industrial or mining wastes.
Small-scale mine	A mine for which a claim license has been issued 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.
Stakeholders	The sum of all representative institutions of the community as well as the relevant sectoral Regulatory bodies.
Stream	Any watercourse, no matter how small or large it is; Includes creeks and rivers.

Stripping	The removal of earth or non-ore rock materials in order to gain access to desired 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 of overburden to raw tons of mineral material.
Sustainable Development (SD)	Development that meets present-day needs without compromising the ability of future generations to meet their needs.
Tailings	The gangue and other waste 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.
Tailings pond	An impoundment to which tailings are transported and in which solids settle to make it possible for liquid to be decanted.
Topsoil	Dark-colored, organic, well-decomposed soil material consisting of the residues of plant and animal materials together with synthesized cell substances of soil organisms and various inorganic elements.
Temporary closure	Phase following temporary cessation of operations when infrastructure remains intact and the site continues to be managed.
Turbidity	The state, condition or quality of opaqueness, cloudiness or reduced clarity of a fluid attributable to the presence of suspended matter.
Whole-of-mine -life process	A process that is carried out throughout the life of a mining operation.

3.0 Mission & Objectives

3.1 Mission Statement

The following is the Mine Effluent Code of Practice mission statement:

Prevent and minimize environmental damage (terrestrial, aquatic) and unacceptable impacts associated with the release of effluents from mining operations and processes.

3.2 Objectives

- Protect communities and the environment from the adverse effects of uncontrolled discharge of mine effluents into the environment including of water/fluids containing a high content of suspended material, sediments and chemical byproducts.
- Ensure and promote proper effluent management in the Guyana gold and diamond mining industry.
- Promote the Code's use by small and medium-scale gold and diamond miners.
- Raise the awareness of and educate all parties as to the importance of sound effluent management practices.
- Ensure that effluent management practices are flexible and dynamic overtime.
- Ensure that effluent management practices are credible and verifiable.

4.0 Scope

This Code of Practice is a mandatory code that applies to small-scale and medium-scale gold and diamond mining operations.

This Code of Practice addresses only environmental issues related to effluent management in the Guyana gold mining industry and does not deal with any occupational health and safety (OH&S) issues related to effluent management. This Code of Practice should be complemented by the Environmental Effects Monitoring Code of Practice.

Two stages in the life cycle of a mine are covered by this Code, construction and operation. Closures and reclamation will be dealt with in a specific Code of Practice on mine site reclamation.

This Code is subject to the Mining (Amendment) Regulations 2005 and is intended to complement the regulatory requirements, not to replace them. Compliance with the rules, regulations and statutes is therefore required.

No guarantee is made in connection with the application of the Code to prevent hazards, accident, or incidents or injuries to workers and/or members of the public at any specific mine site where effluent is managed.

5.0 Principles & Standards of Practice

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

5.1 Site Preparation and Construction

Principle: Protect communities and the environment from adverse effects of the discharge of water (effluent) containing high suspended material and sediment content into waterways during site preparation and construction phases.

Standards of Practice

5.1.1 Leave a buffer zone of undisturbed riparian vegetation between the area to be worked and an existing stream channel or live body of water.

5.1.2 Limit the amount of vegetation removed in order to reduce and control runoff from unvegetated areas.

5.1.3 Install appropriate runoff control structures. (See Appendix A)

5.1.4 Design open pits to prevent surface waters from entering the workings.

5.1.5 If diversion structures are needed, obtain permits and approvals prior to proceeding with stream diversion.

5.1.6 Clearing and debushing should be phased and limited to what is needed for operation and support facilities.

5.1.7 Determine the size and location of settling/tailings pond(s).

5.1.8 GGMC, as the Regulatory body, should provide information on settling rates and retention times to enhance the performance of settling ponds.

5.1.10 Segregate and stockpile overburden and topsoil for use in reclamation.

5.1.11 Reclamation should be an important consideration in the mine plan.

5.2 Mining Operations

Principle: Protect communities and the environment from adverse effects of the discharge of mine effluents containing a high content of suspended material and chemical residues and by products into waterways during operation.

Standards of Practice

5.2.1 Limit the amount of vegetation removed in order to reduce and control runoff from unvegetated areas.

5.2.2 Control the use and disposal of chemical and poisonous substances.

5.2.3 Install appropriate runoff control structures. (See Appendix A)

5.2.4 Segregate and stockpile topsoil and overburden for use in reclamation.

5.2.5 Prevent wind and water erosion of topsoil stockpiles.

5.2.6 Inspect and clean sediment control structures to maintain their efficiency. (See Appendix B)

5.2.7 Monitor water quality prior to discharge into the environment.

5.2.8 Tailings from river dredging operations should be discharged into a tailings pond on land or to a river, creek or stream where the critical turbidity has not exceeded 30 NTU.

5.3 Monitoring of Discharges

Principle: Monitor discharges to ensure prescribed Regulatory limits are not exceeded and to ensure that the communities and the environment are impacted by uncontrolled discharges.

The pre-operation investigations, assessment and mine plan should project the sources and characteristics of effluent discharges. The initial planning should also establish effluent controls and mitigation measures.

5.2.9 Pre-operation investigations or environmental assessments should determine the contaminants of concern and the monitoring criteria.

5.2.10 Establish the discharge criteria for waste streams and effluents

5.2.11 Prepare an effluent discharge monitoring plan

5.2.12 Establish the points of discharge.

6.0 Code Implementation

6.1 Site Preparation and Construction

During site preparation and construction of a mine facility it is important to control and minimize the generation of effluents. The various control structures are detailed below.

Suggested Runoff Collection Methods (see Appendix A)

6.1.1 Diversion Dike/Ditch: Diversion dikes/ditches should be used whenever it is necessary to dispose of concentrated surface water without causing erosion. They can be used to divert creeks or streams away from mining areas. Diversions should be used in conjunction with a silt fence or sediment ponds.

6.1.2 Interceptor Trench: An interceptor trench should be used to divert surface runoff around mining structures, such as stockpiles, waste dumps, pits, settling/tailings ponds and tailings impoundments. Can be used to interrupt long slope faces on gentle slopes (less than 3:1).

6.1.3 Open Top Box Culverts: An open top box culvert should be used to convey surface runoff and flow from inside ditches across the roadway onto the downhill slope of a road.

6.1.4 Siltation Berm: A siltation berm should be placed around a disturbed site to capture and contain surface runoff so that sediment can be filtered prior to discharge of the water.

6.1.5 Waterbars: A waterbar should be constructed across the roadway to divert storm runoff away from unpaved surfaces or other disturbed areas.

6.1.6 Corrugated Metal Culverts: Corrugated metal culverts can be used instead of open top box culverts to remove water from roadways. They are permanent water conveyance systems.

6.1.7 Drain Fields: Drain fields can be used to discharge infiltrating water and/or groundwater away from a site.

6.1.8 Stream alteration: Stream alteration, which consists of diverting a stream into a new channel, pipe or culvert, (Principal Regulations 60 and 61 of the Mining Act stipulates that prior approval and a permit is required) must be managed by a qualified professional

6.1.9 Road sloping: Road sloping can be used to divert surface water off the entire road surface so that water does not concentrate in any specific location.

Location Criteria for Settling/Tailings Ponds

6.1.10 Ponds should be located in a geologically stable area, at least 20 metres away from the low water mark of a riverbank.

6.1.11 Ponds should be located so that all surface water may be diverted around them. This may necessitate diverting streams, and other surface waters away from the site.

6.1.12 Ponds should be located so that groundwater seepage into the pond is kept to a minimum. Should excess seepage occur, line the pond with bentonite or other impermeable clay or other impermeable liners, or by installing cut-off trenches around the pond.

Design Criteria for Settling/Tailings ponds

The design and construction of tailings ponds/dams is addressed in the Tailings Management and the Use of Small Dams to Control Water/Tailings Codes of Practice.

6.1.13 Settling/tailings ponds should be designed with appropriate technical input and oversight.

6.1.14 Several settling/tailings ponds in a series are often preferable to one large pond. Water can be retained for a longer period in multiple ponds, thus allowing sediments more time to settle out before water is discharged. One pond in the series might be the principal sediment trap, while another could be used to hold clarified water that can be discharged or recycled.

6.1.15 Control the flow through velocity in settling ponds to improve embankment stability and settlement rates. The length to width ratio of settling ponds should be greater that one (≥1.0).

6.1.16 Settlement ponds should be an integral part of the surface water and run-off control. The design capacity should allow containment all sediment-laden process water as well as seepage, surface runoff and precipitation from the design storm event with a minimum freeboard of 0.60 m (2 feet).

Construction Criteria for Settling/Tailings Ponds

The design and construction of tailings ponds/dams is addressed in the Tailings Management and the Use of Small Dams to Control Water/Tailings Codes of Practice.

6.1.17 If the pond cannot be built below ground level, build the pond embankment on clean, stable foundation material. This will help prevent seepage between the embankment and the foundation material.

6.1.18 Construct the containment embankment with well-compacted, competent soil free of organic debris.

6.1.19 Settling ponds can also be excavated below ground level with an accompanying compacted embankment. The foundations of excavated ponds should be designed/constructed to control/limit seepage to adjacent streams or other surface waters.

6.1.20 Decant pipes/systems must be installed so that sediment-free water can be discharges

6.1.21 Emergency spillways may be necessary to prevent overtopping. Spillways must be riprapped with coarse material to prevent erosion.

6.1.22 Surface water and effluent control systems should be functional before general mining activities commence.

6.2 Mining Operations

Operating Parameters of Settling/Tailings Ponds

6.2.1 Do not fill ponds above the 60% of the design capacity: Excess solids may be excavated and used in reclamation.

6.2.2 Maintain 0.6m free board

6.2.3 Chemical flocculants such as alum or lime can be added to settling/tailings ponds to enhance settlement of solids

Sediment Control Structures (See Appendix C)

6.2.4 Straw Barrier: Straw, fibrous tree roots or plaited cocorite leaves can be used where temporary diversions or berms are required. The straw, roots or leaves allow water to filter through and retains the sediment. Frequent inspection is necessary

6.2.5 Sediment Traps or Catch Basins: *Small* temporary structures should be used to catch runoff containing sediment from temporary roads and construction sites. Larger permanent basins should be constructed to catch periodic sediment-laden runoff from permanent erosion control structures, such as culverts and waterbars.

6.2.6 Vegetated Buffer Strip: A strip of vegetated ground can be established at many locations between the source of sediment and live water sources. Vegetation catches and holds sediment from runoff water flowing across it.

6.2.7 Silt Fence/Filter Fence: Silt fences should be used on small intermittent drainages where surface water collects or leaves a mine site. They are made of filter fabric, wire and steel or wooden posts and used to filter sediment out of runoff water before it is discharged.

6.2.8 Brush Sediment Barrier: Brush sediment traps can be an effective permanent or temporary erosion control structure and are used below any surface disturbance.

6.2.9 Sediment/Settling/tailings Ponds: Sediment/settling/tailings ponds can serve as effective sediment traps, holding and storing sediment-laden water for long periods of time. They can be designed with spillway so that sediment free water can be allowed to decant off during periods of peak flow.

6.2.10 Log and Brush Check Dams: Log and brush check dams can be used to prevent or reduce erosion of banks and bottoms of channels, streams, and drainage-ways by reducing gradient and flow velocities.

Control of Chemicals and Poisonous Substances

Chemicals and poisonous substances should be controlled to prevent and minimize the generation of toxic effluents

6.2.13 Maintain a registry of all chemicals and poisonous substances. The registry should record source, storage, use, and disposition.

6.2.14 Material Safety Data Sheets (MSDS) must be maintained for all chemicals stored/used on site.

6.2.15 The use of cyanide in the processing of gold must be governed by a permit granted by the GGMC. The application for the cyanide use-permit must address:

- Processing method
- Disposal of tailings
- Possible environmental effects
- Mitigation measures, if needed.

6.2.16 Mercury should not be used in open systems or in sluices /systems which discharge to the open environment

6.2.17 Water containing poisonous or injurious substances must be treated before discharging to streams, rivers or open bodies of water

6.2.18 Oil and petroleum products must not be poured onto the ground or into water bodies.

Effluent and Water Quality Monitoring

6.2.19 Establish the sources and characteristics of all effluent streams in the planning and permitting stages of the mine operation

6.2.20 The contaminants of concern must be identified : their discharge concentration limits must be set by the Regulator, the GGMC

6.2.21 Monitoring of water quality and effluent discharges at the established locations (points of discharge) should be carried out at the frequency required by regulations and the approved monitoring plan.

6.2.22 The contents of the monitoring plan should include:

- Contaminants of concern
- Points of discharge
- Monitoring locations
- Sampling methods and frequency
- Effluent discharge criteria and limits
-

7.0 Monitoring and Surveillance

Monitoring in support of effluent control is designed for the following results:

- Maintenance of the various facilities and structures
- The determination of the effectiveness and efficiency of the various run-off and sediment control structures
- Determination and control of the water quality at points-of discharge
- The structural stability of settling/tailings ponds and other effluent control structures

Guidance for the monitoring and surveillance for effluent control is addressed in Sections 5.0 and 6.0 of this Code of Practice.

8.0 Emergency Measures

Structural failure of settling/tailings ponds, tailings dams and other control structures is the major potential emergency associated with effluent control

The Contingency and Emergency Response Plan Code of Practice details the approaches and strategies for addressing emergencies associated with the construction and operation of tailings dams, settling/tailings ponds and related structures.

9.0 References

Australia Environment Protection Agency (1995), *Water Management.* Best Practice Environmental Management in Mining, 1999, 34 p.

GENCAP, Draft Code of Practice, Effluent Control for Small and Medium-Scale Mines, Georgetown, Guyana, 2003

GENCAPD Mining, *Workshop on Producing Environmental Codes of Practice for the Mining Industry of Guyana. Summary Report.* September 30, 2003.

GGMC, *Conceptual Review of Tailings Management for Small-Scale Industry.* Georgetown, Guyana, 2002.

Government of Guyana, *Regulations made under the Mining Act (No. 20 of 1989. Proposed Amendments 2002.*

Idaho Department of Lands, Best Management Practices for Mining in Idaho. Idaho Department of Lands, 112 p.

Ripley, E.A., Redman, R.E. and Crowder, A. (1996), *Environmental Effects of Mining.* St. Lucie Press, 1996, 356 p.

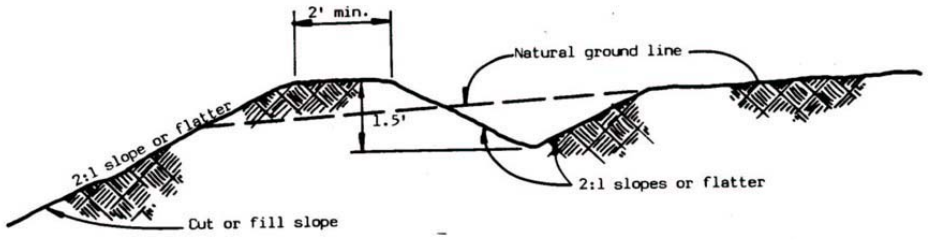
Web sites

http://xmlwords.infomine.com/xmlwords.htm (on-line dictionary of mining terms)
http://www.northstar.k12.ak.us/schools/upk/gold/facts/dredge/dredge.html (How a gold dredge works)
http://www.nalms.org/bclss/mining.html (Best management practices for water quality)
http://www.nalms.org/bclss/runoff.html
http://www.nalms.org/bclss/aquatichabitat.html

APPENDIX A

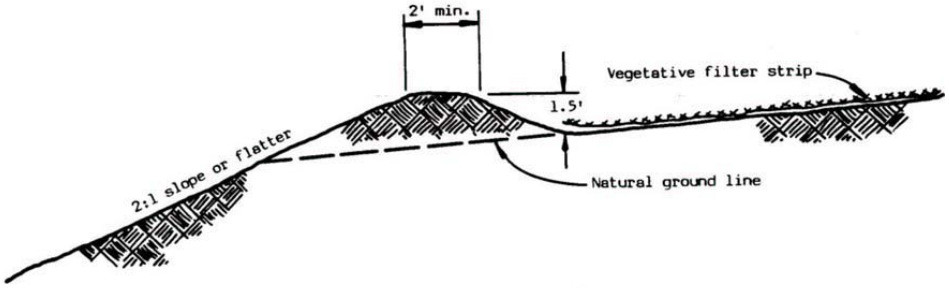
Runoff Collection Structures

Diversion Dike/Ditch



NOTE: Bed of dike to be riprapped.

SECTION

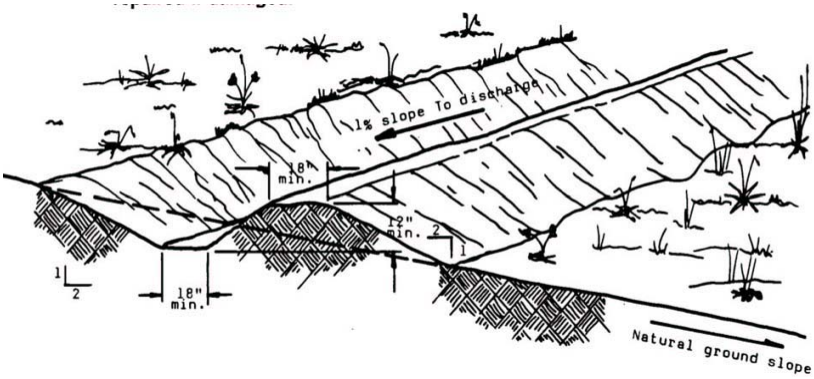


NOTES: 1) Dike constructed by dozer moving soil upslope and dumping at top of slope.
2) Outlet to stabilized vegetated soil.

SECTION

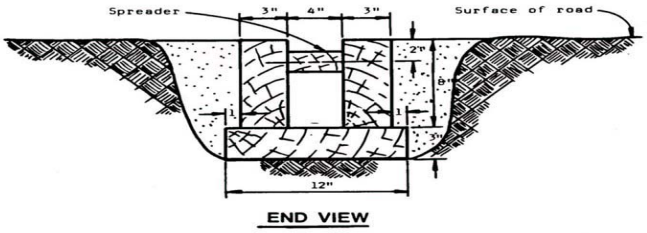
After Idaho Department of Lands, 1992

Interceptor Trench



After Idaho Department of Lands, 1992

Open Top Box Culvert



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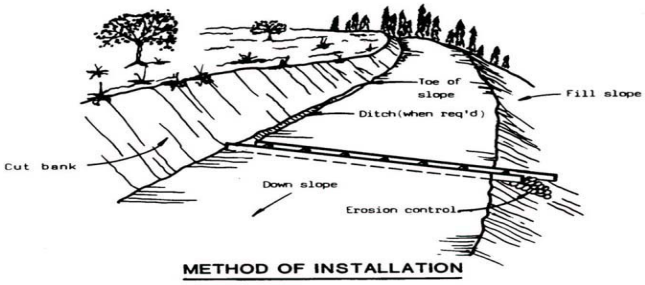
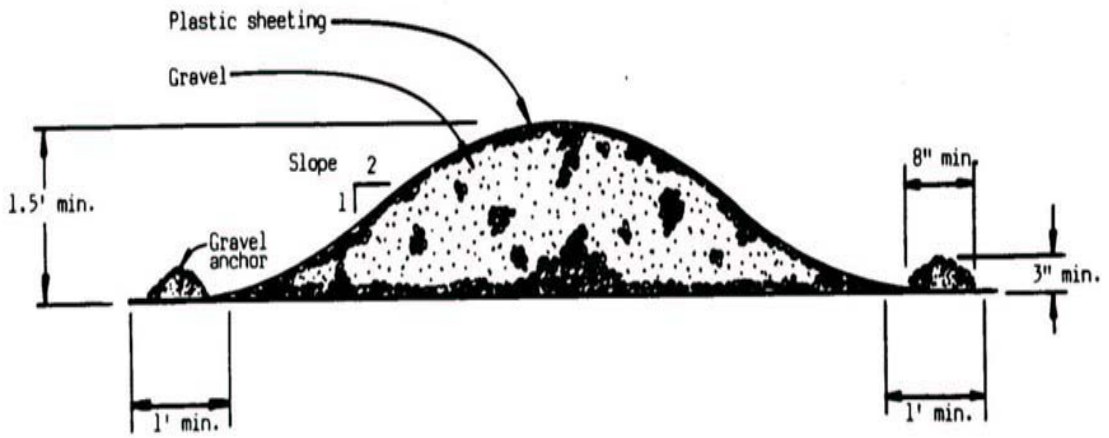


METHOD OF INSTALLATION

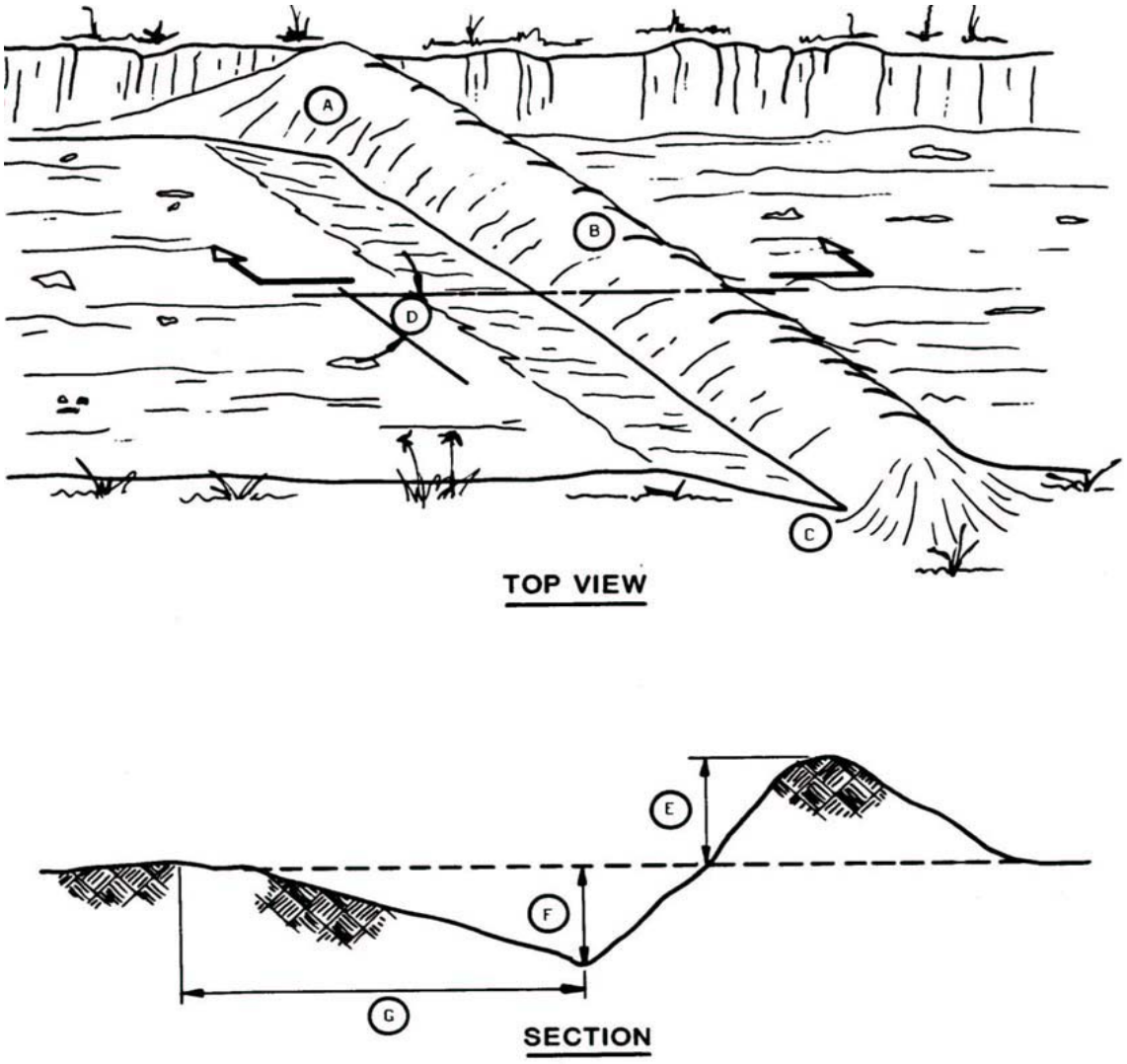
After Idaho Department of Lands, 1992

Siltation Berm



After Idaho Department of Lands, 1992

Waterbars



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.

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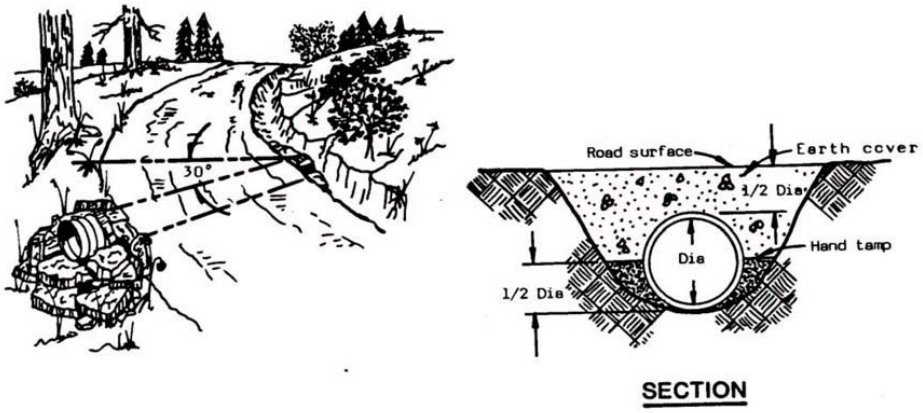
Culvert Installation



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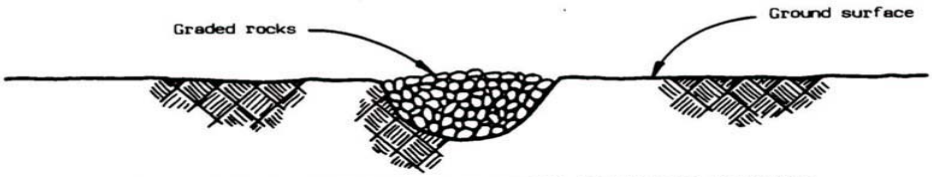
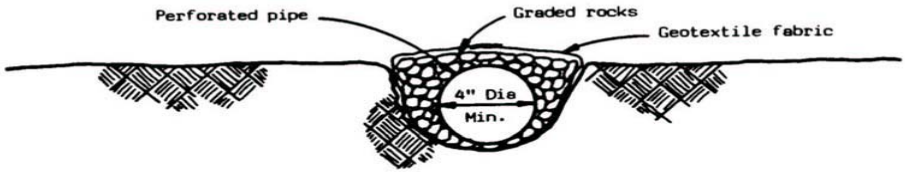
Drain Fields

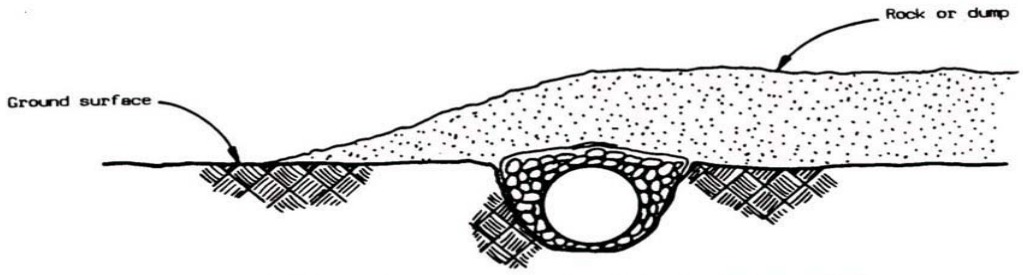


DRAIN FIELD TRENCH LINED WITH GRADED ROCKS



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

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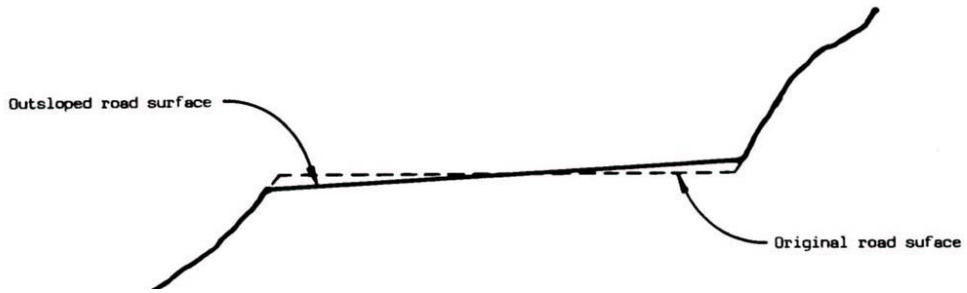
Road Sloping



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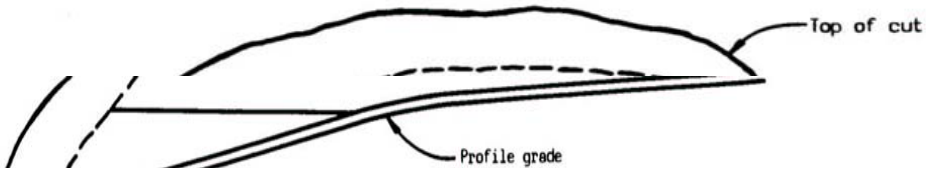
APPENDIX B

Runoff Dispersion Structures

Benched Slopes



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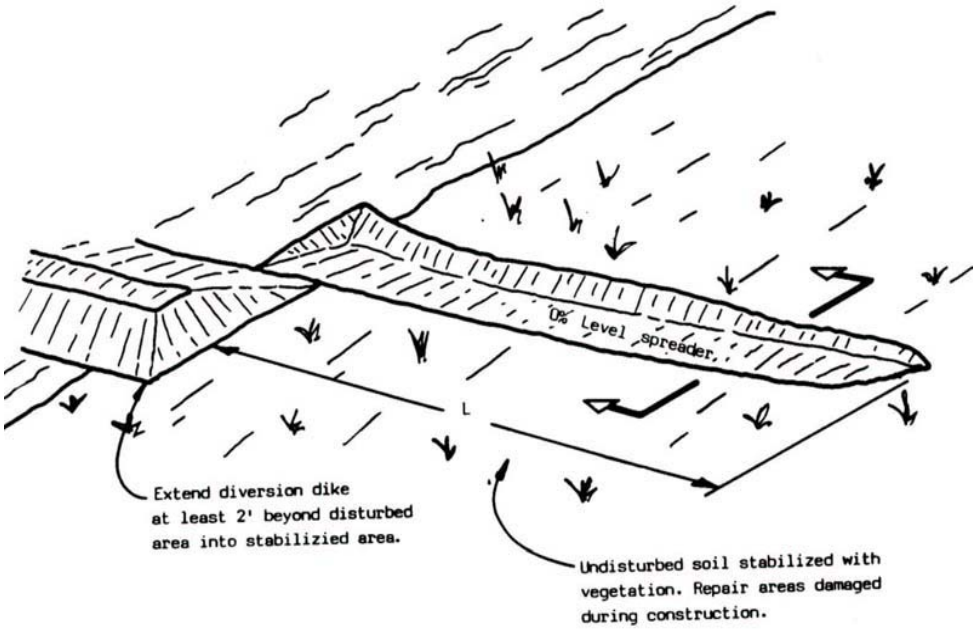
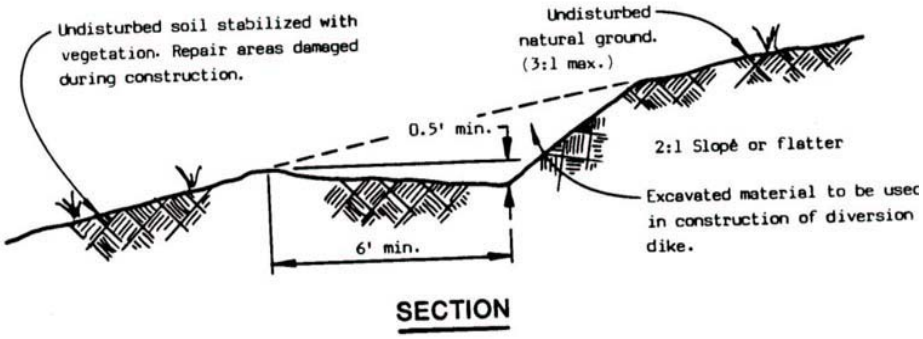
Level Spreader





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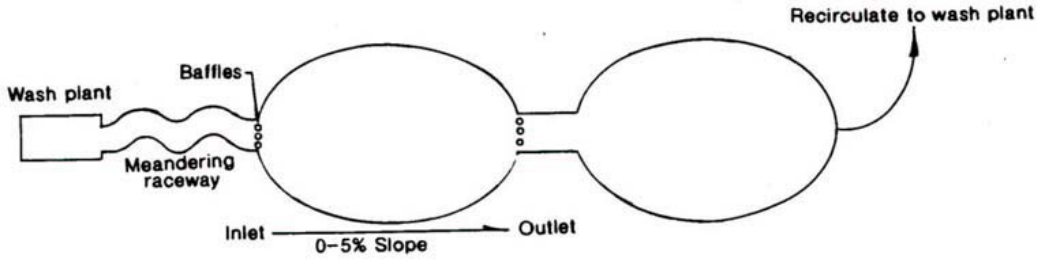
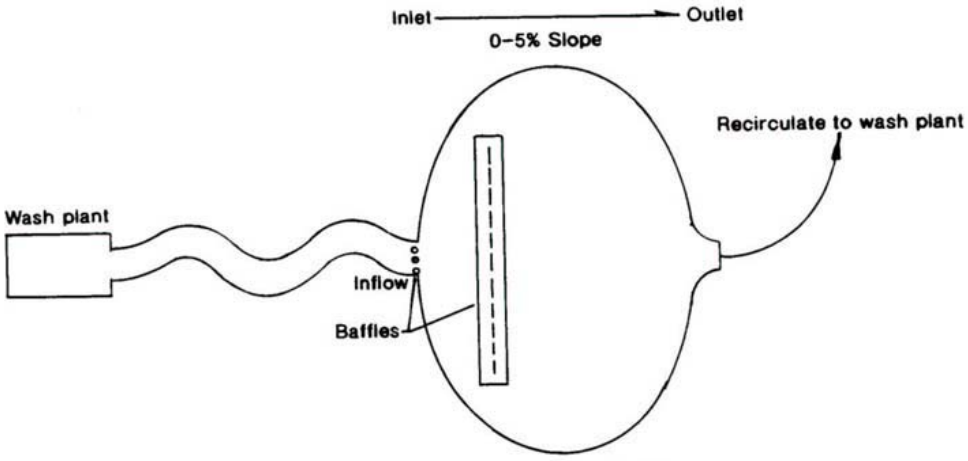
APPENDIX C

Sediment Collection Structures

Diagram of Settling/Tailings Ponds for Placer Mining



STANDARD SETTLING PONDS IN SERIES



SETTLING POND WITH BAFFLES

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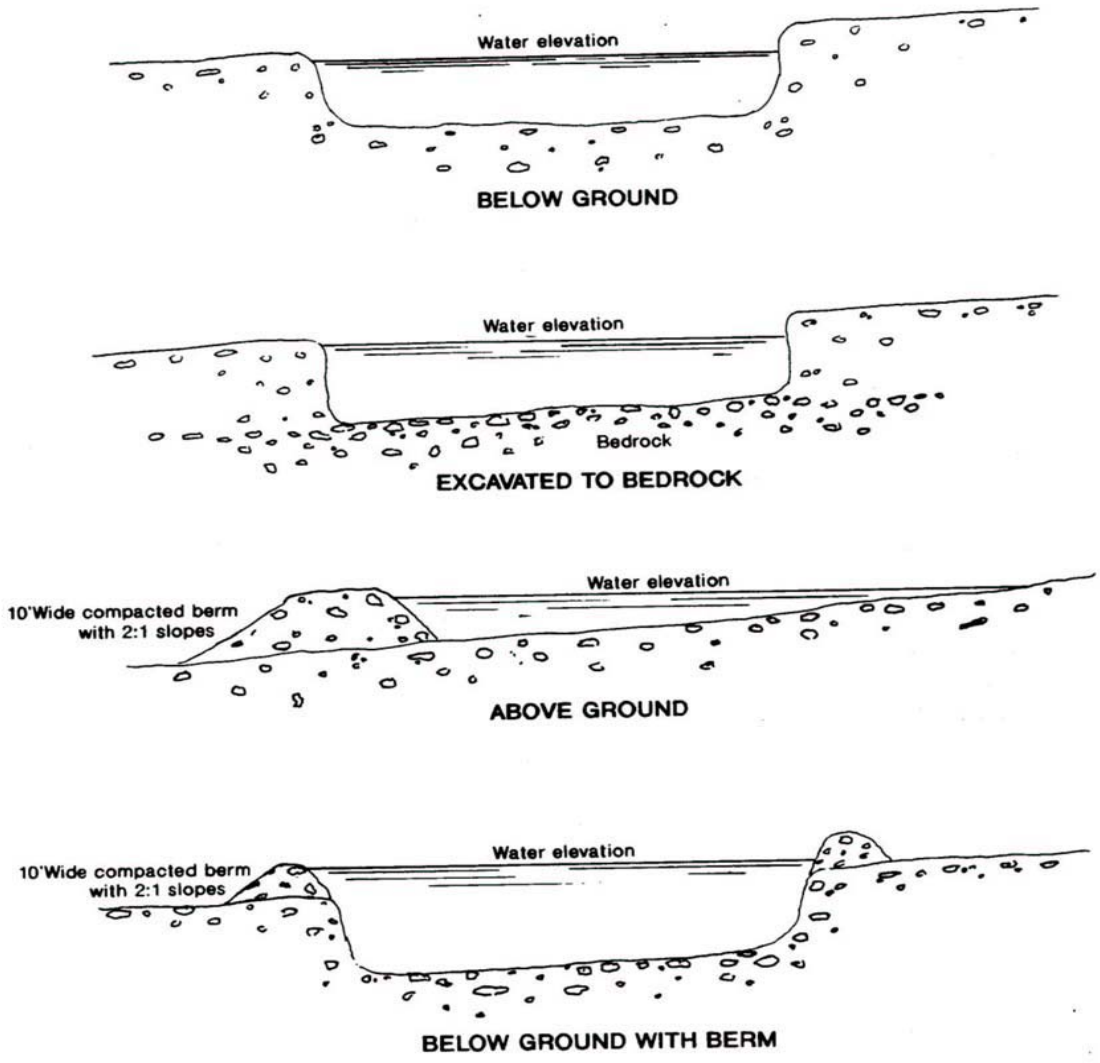
Settling/Tailings Pond Construction Options



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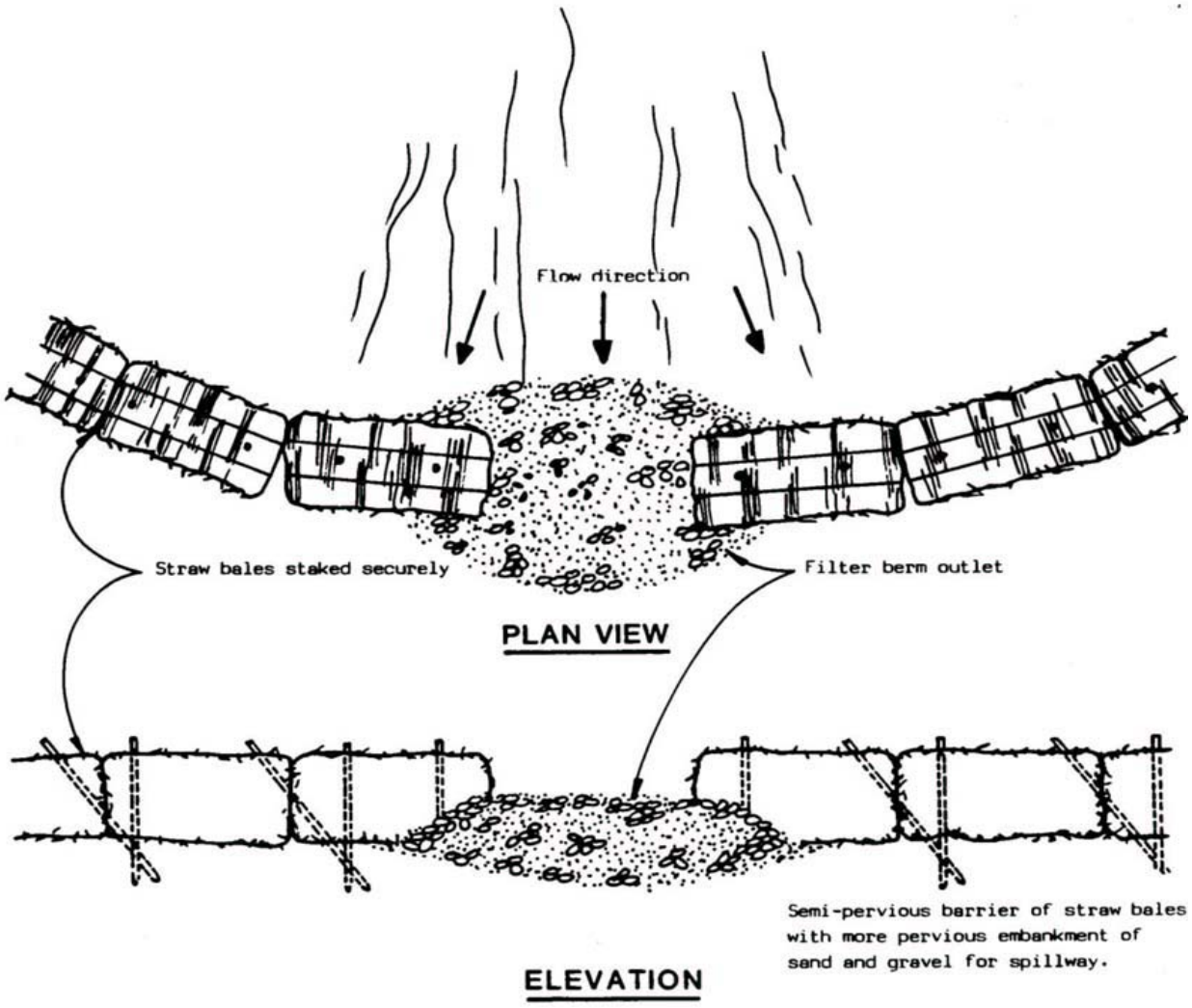
Straw Bale Sediment Barrier



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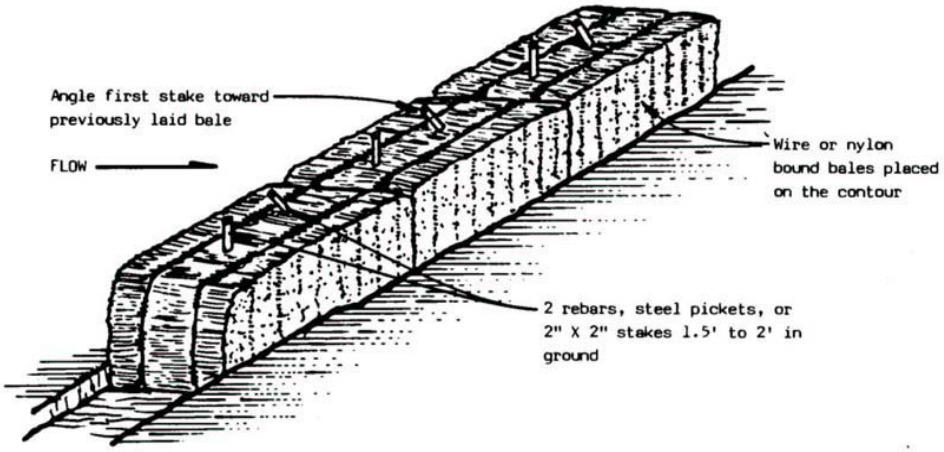
Straw Bale Sediment Barrier *(cont'd)*

EMBEDDING DETAIL



ANCHORING DETAIL

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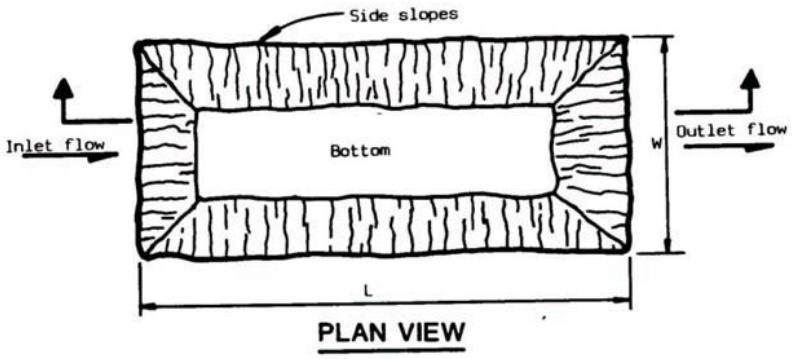
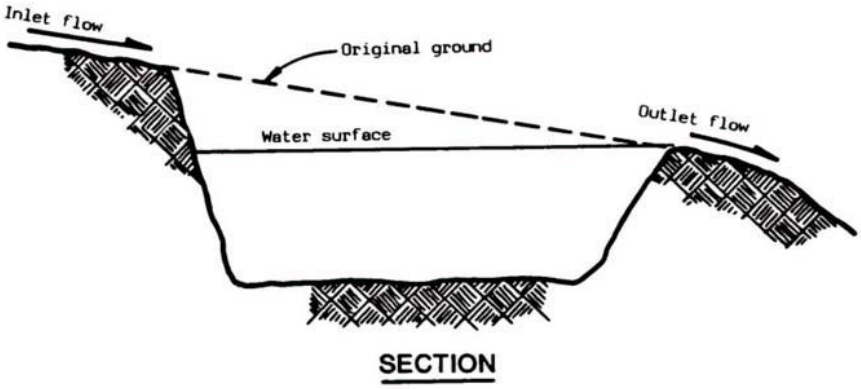
Sediment Traps or Catch Basins





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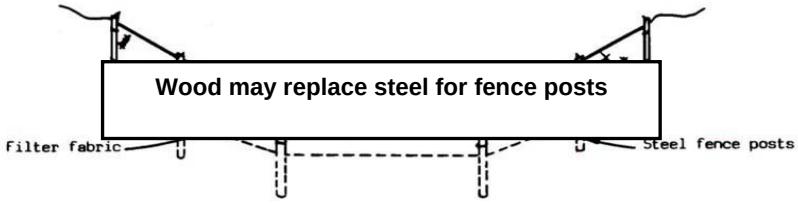
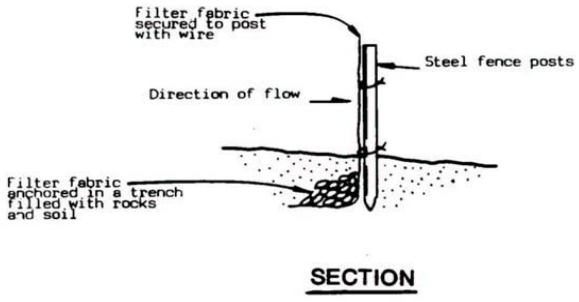
Silt Fence/Filter Fence





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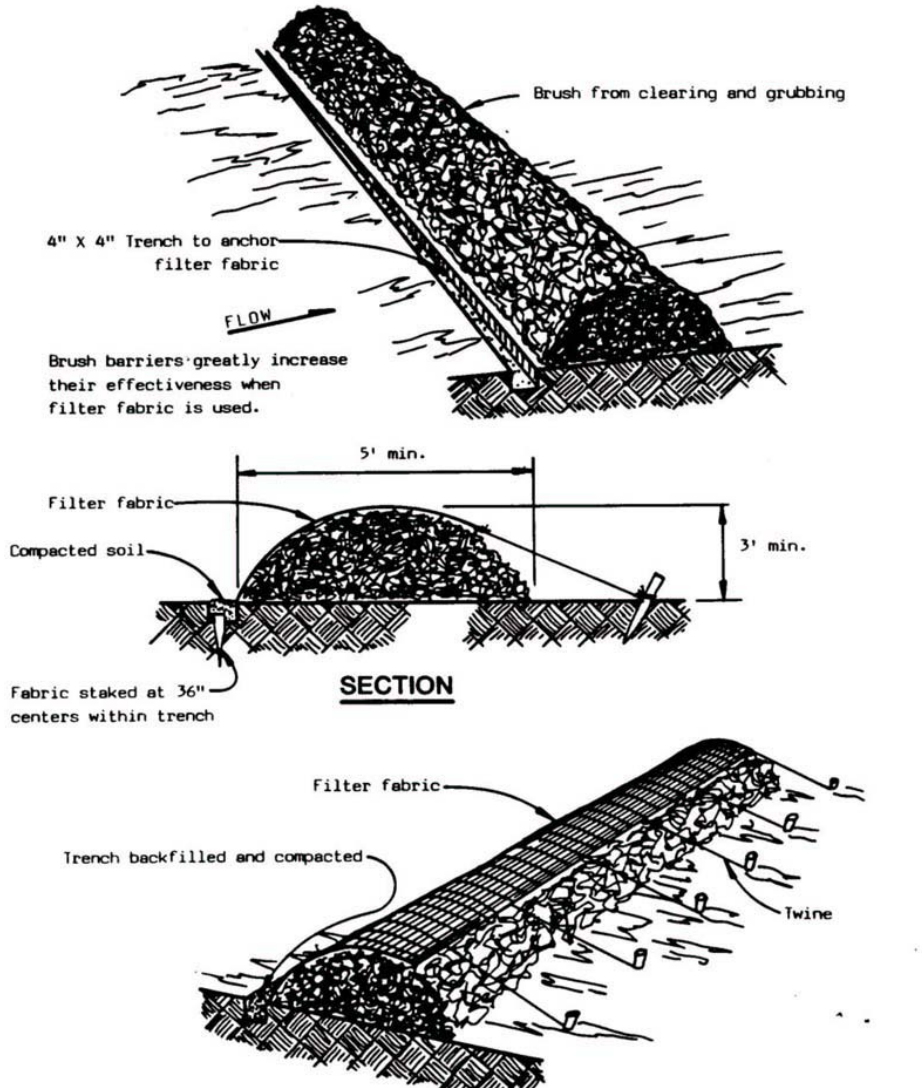
Brush Sediment Barrier



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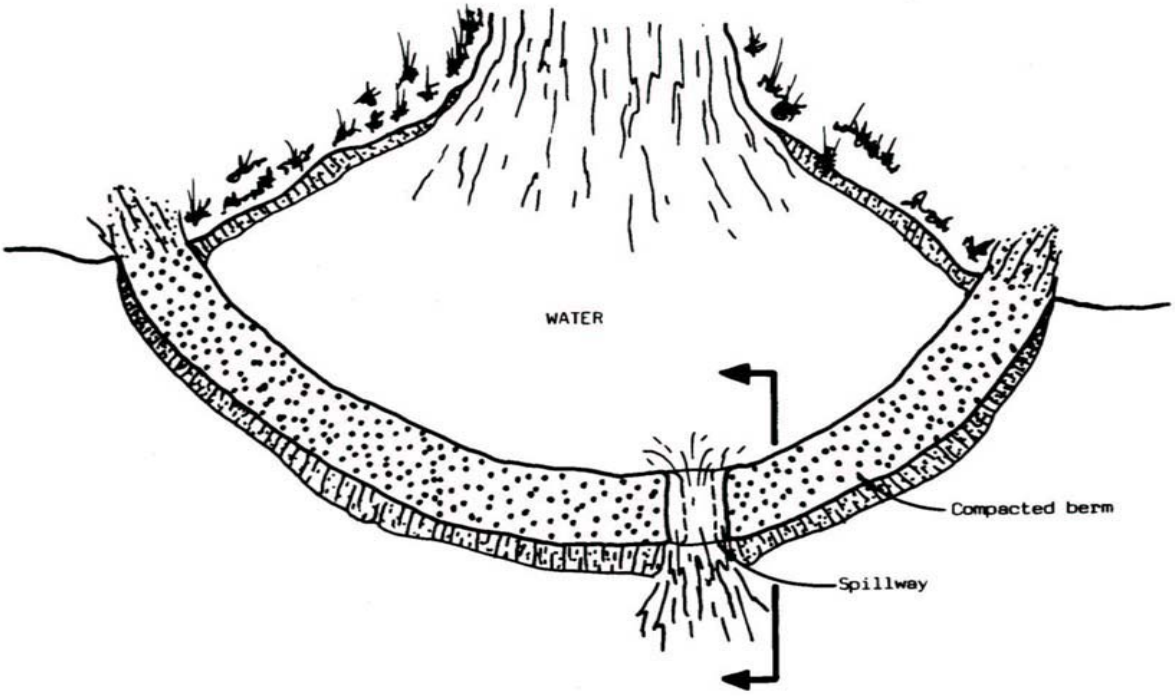
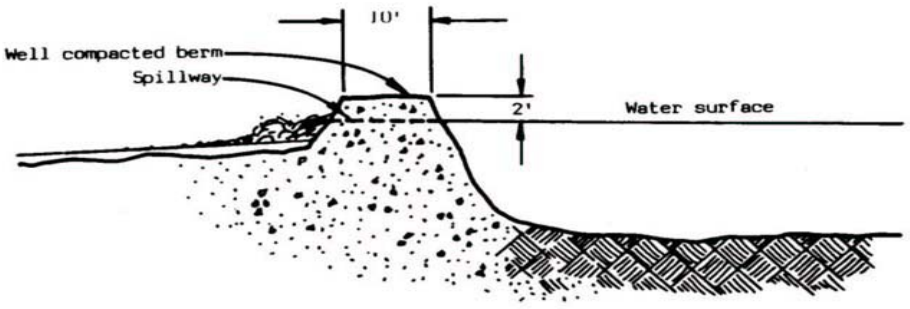
Sediment/Settling/Tailings Pond



PLAN VIEW



CROSS SECTION

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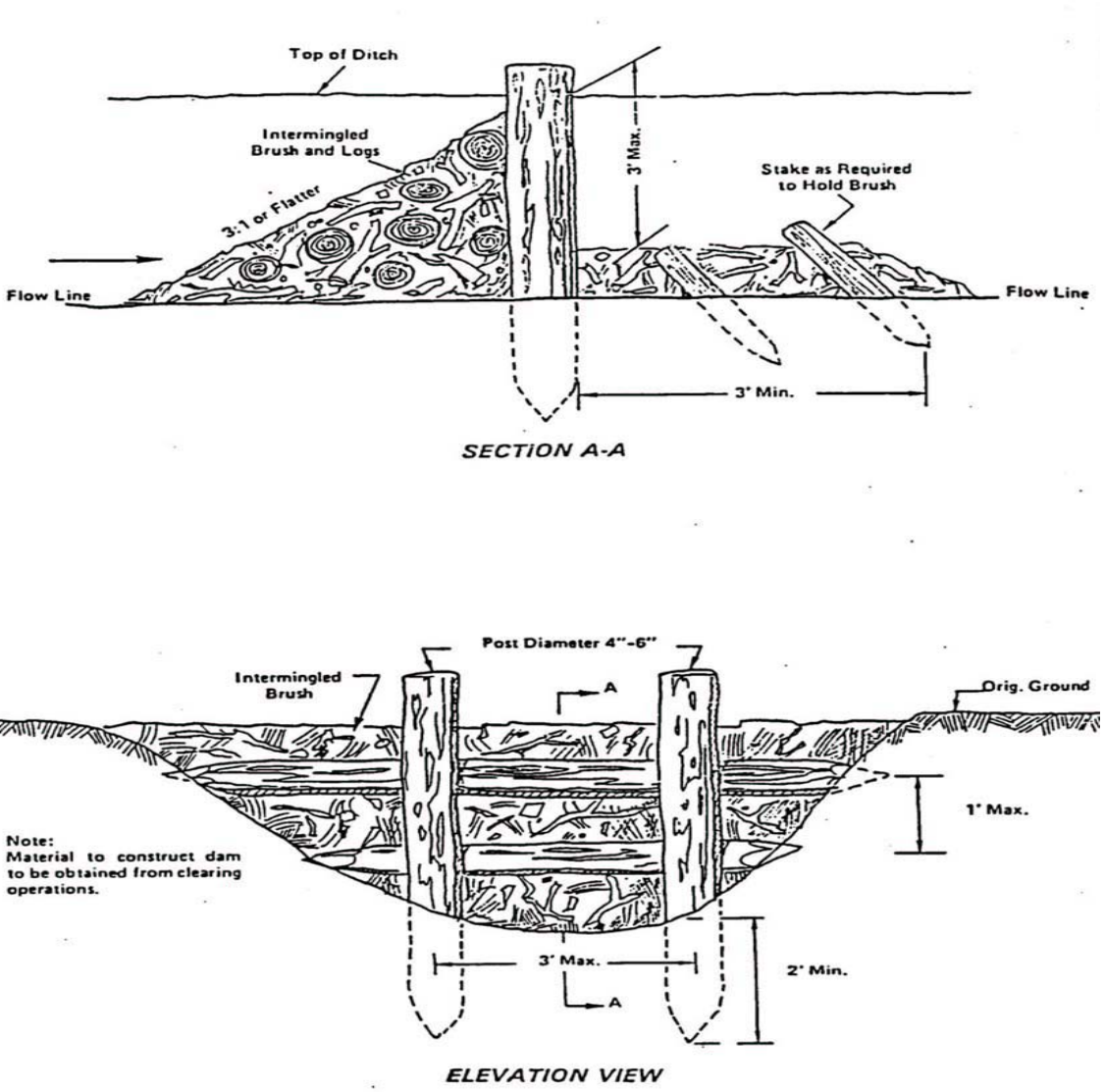
Log and Brush Check Dam



After Idaho Department of Lands, 199