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

PROJECT**: CODE OF PRACTICE FOR MINE RECLAMATION AND CLOSURE PLANS 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 reclamation and closure 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 reclamation and closure plan?

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 reclamation and closure plan is among the topics to be addressed by these Codes.

Site disturbance before, during and after mining is the most visible impact to most people. Apart from visibility, the land-use and pollution aspects of mined out areas are of great importance. In some cases land stability and catastrophic failures of structures such as tailings dams represent a potential risk during and perhaps long after operations.

Responsible companies no longer see the control of such impacts as an externality to be left to future generations or to be remediated at public expense. Reclamation has become an integral part of a mining operation. The *cradle to grave approach* is now prevailing in the mining industry who is, more than ever before, under public scrutiny on that aspect.

Mine reclamation and closure is the process of shutting down a mining operation with the broad objective of leaving the area in a safe and stable condition that is consistent with the surrounding physical and social environment and does not need ongoing maintenance. The mine area may also be suitable for alternative, post-mining land uses depending on site-specific circumstances.

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 were also incorporated into the Code.

2. GLOSSARY OF TERMS

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	Drainage of acid water containing dissolved metals as a result of natural oxidation of sulphides found in waste rock, ore and tailings exposed to air 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.
Comminution	The breaking, crushing, or grinding by mechanical means of stone, coal, or ore, for direct use or further processing.
Effluent	A liquid, solid, or gaseous product, frequently waste, discharged or emerging from a process.
End of mine life process	A process undertaken when the mining operation is about to be decommissioned.
Externality	In project analysis, an effect of a project felt outside the project and not included in the valuation of the project. In general, economists consider an externality to exist when production or consumption of a good or service by one economic unit has a

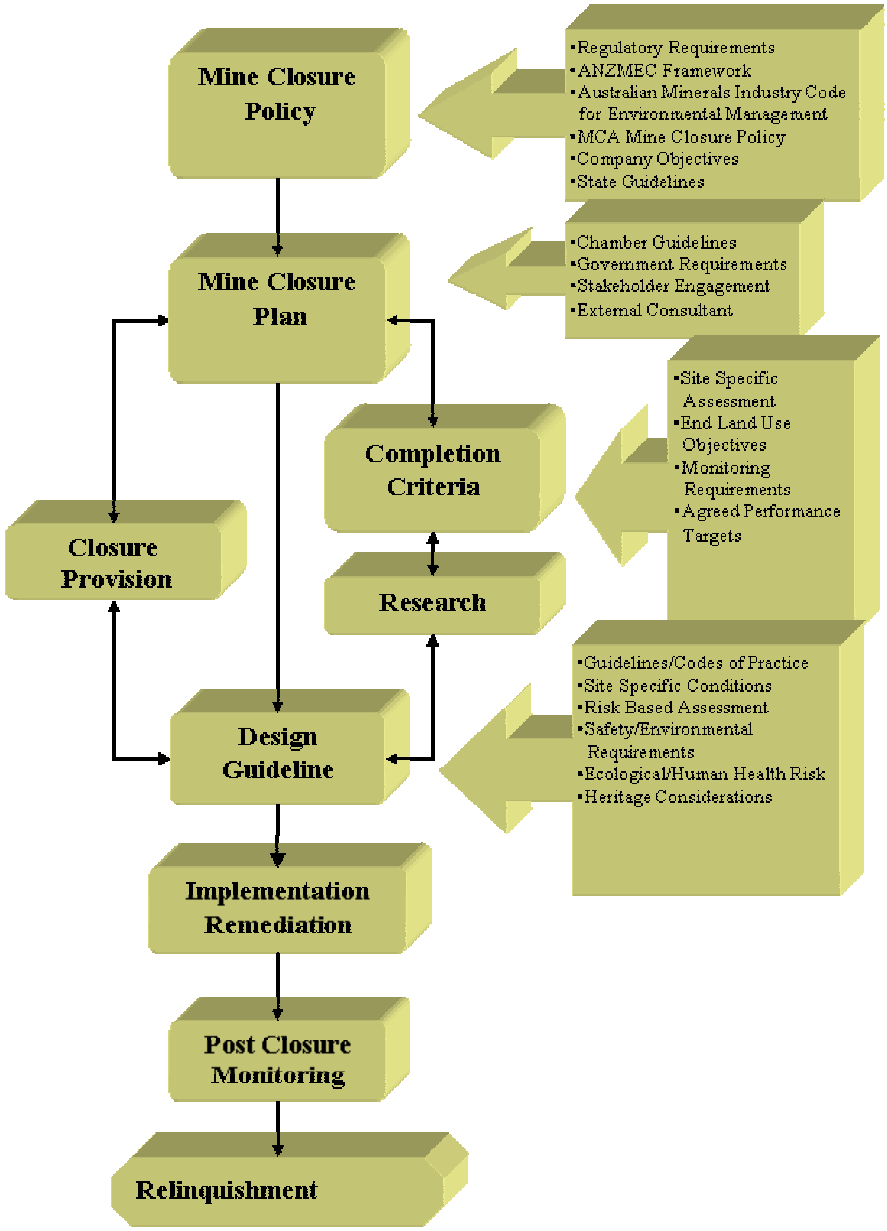
	direct effect on the welfare of producers or consumers in another unit.
Guidelines	Non-binding document, generally designed to provide the user with information, explanations, guidance and help on a specific topic. Guidelines are a tool frequently used to enforce new regulations. The user can be either 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	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 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.
Orphan site	An abandoned mine for which a responsible party no longer exists or can be located.
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.
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" 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.
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.
Risk assessment	The process of addressing what could go wrong with a facility and its associated plans and procedures and what are the consequences of failure. Risk assessment provides a basis for the development of risk management, including communication, contingency, mitigation and emergency and response plans.
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.

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.
Temporary closure	Phase following temporary cessation of operations when infrastructure remains intact and the site continues to be managed. Also called Care and Maintenance.
Turbidity	The state, condition, or quality of opaqueness or reduced clarity of a fluid, due to the presence of suspended matter.
Whole of mine life process	A process that is carried out throughout the life of a mining operation.

Figure 2-1
Closure Planning Process

(after Environment Australia, 2002)



3. MISSION AND OBJECTIVES

3.1 Mission Statement

The Code's Mission Statement is the following:

To foster sustainable practices so as to prevent and minimize adverse long-term 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 subsequent land use.

3.2 Objectives

1) Ensure that mining sites are restored to a satisfactory condition by:

   - Eliminating unacceptable health hazards and ensuring public safety;
   - Limiting the production and circulation of substances that could damage the receiving environment and, in the long-term, trying to eliminate maintenance and monitoring;
   - Restoring the site to a condition in which it is visually acceptable to the community;
   - Reclaiming the areas where infrastructures are located (excluding the accumulation areas) for future use.

2) Improve the level of awareness and education of all parties on the importance of introducing reclamation planning and actions at the early stage of a mine operation.

3) Ensure that reclamation and closure practices are adaptive and dynamic over time.

4) Ensure that reclamation and closure 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 all issues related to mine reclamation and closure, including progressive reclamation.

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

Mine reclamation is guided by 6 basic principles that apply whatever the size of the operation:

- Planning reclamation prior to the commencement of mining;
- Rehabilitation carried out concomitantly with mining (the "close as you go" approach);
- Ensuring physical and chemical stability of the site;
- Land use (visual aspect and productivity);
- Monitoring;
- Relinquishment.

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

5.1 Reclamation Planning

Principle: Ensure that reclamation is planned prior to the commencement of mining operations so that the process of closure occurs in an orderly, cost effective and timely manner with the allocation of adequate resources.

Standards of practice

5.1.1 The Regulatory body should set clear and unambiguous reclamation goals and objectives for small-scale and medium-scale mining taking into account applicable regulations and outcome of community consultations.

5.1.2 The Regulatory body should prepare reclamation alternatives for small-scale and medium-scale mining and assess the different reclamation alternatives' viability against a number of criteria such as: the ability to meet expected environmental conditions, cost effectiveness, available technologies and maintenance and monitoring requirements.

5.1.3 The mining licence or mining permit holder should select a reclamation alternative and prepare a conceptual Reclamation Plan.

5.2 Progressive Reclamation

Principle: Integrate mine decommissioning and closure with day to day management.

Standards of practice

5.2.1 The mining licence or mining permit holder should prepare a more detailed Reclamation Plan as the mine develops to ensure the greatest efficiencies are achieved through progressive reclamation.

5.2.2 The mining licence or mining permit holder should integrate progressive reclamation into the conceptual Reclamation Plan.

5.2.3 Plan decommissioning and reclamation throughout the life of the mining operation: "*Close as you go*".

5.2.4 The mining licence or mining permit holder should update the Reclamation Plan regularly to accommodate changes as a result of factors such as: future developments; changes in industry practices and available technology; rehabilitation success as determined by monitoring, increase/decrease of expected ore reserves; land use options.

5.2.5 The mining licence or mining permit holder should provide adequate securities to protect the community from closure liabilities.

5.3 Physical and Chemical Stability of the Site

Principle: Ensure that all materials and structures remaining on a mine site after operations have ceased are physically and chemically stable so as to eliminate unacceptable health hazards, ensure public safety and protect the environment.

Standards of practice

5.3.1 Correct any hazard to the public associated with openings to surface (shafts, raises, stopes open to the surface, adit, etc.) in underground mines.

5.3.2 Prevent and/or control safety hazards related to slope stability including impoundment structures such as tailings ponds and settlings ponds.

5.3.3 Control erosion processes that may cause sediment release.

5.3.4 Prevent or stabilize any surface disruption (caving, collapse of crown pillars, subsidence) that may present a hazard to the public.

5.3.5 In underground mining, prevent rib or barrier pillars instability in order to protect neighboring operations.

5.3.6 Prevent and/or correct acid mine drainage and/or leaching of contaminants.

5.3.7 Minimize visual impacts and ensure productivity of land once mining has ceased.

5.4 Land Use

Principle: Ensure that mined lands are restored to a an acceptable alternate use when pre-mining conditions may not be the most desirable post-reclamation land use.

Standards of practice

5.4.1 Restore the site to a condition in which it is visually acceptable to the community and productive for further uses. Ensure that the rehabilitated land blends in with the surrounding landscape.

5.4.2 Reclaim the site to the extent that the area impacted will be amenable to support a balanced diversity of flora and fauna.

5.4.3 Prevent drainage interruption and groundwater loss.

5.5 Pre and Post-Closure Monitoring

Principle: Verify that reclamation goals, targets and objectives are being met during progressive reclamation and after decommissioning through an appropriate monitoring program.

Standards of practice

5.5.1 The Regulatory body should develop a pre and post-closure monitoring program that will address physical and chemical stability of all materials and structures on the mine site as well as environmental impacts and biological response.

5.5.2 Implement the monitoring program as mining progresses and as progressive reclamation actions are performed.

5.5.3 Verify performances against goals and targets and update Reclamation Plan accordingly.

5.6 Relinquishment

Principle: Relinquish mine title once all agreed standards and completion criteria for decommissioning and reclamation have been achieved and 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 or an acceptable alternative.

Standards of practice

5.6.1 The Regulatory body should define, during operating life of the mine, a set of generic standards and completion criteria for decommissioning and reclamation.

5.6.2 The Regulatory body should identify a responsible authority to be held accountable for making the final decision.

5.6.3 Relinquish the mining title once all agreed standards and completion criteria for decommissioning and reclamation have been achieved.

5.6.4 The Regulatory body should keep a record of the history of the closed site to facilitate future land use planning.

6. CODE IMPLEMENTATION

6.1 Reclamation Planning

Content of the reclamation Plan

6.1.1 The contents of the Reclamation Plan should include all or most of the following:

- Schedule;
- Site Security and Safety;
- The backfilling of placer mine pits, where applicable;
- The sealing or capping of shafts at closed mines;
- Revegetation of disturbed lands;
- Restoration of watercourses, where appropriate;
- Mine workings;
- Mine development Rock, Overburden and Topsoil Piles;
- Tailings Impoundment;
- Water Management and Treatment;
- Buildings, Equipment and Infrastructure;
- Landfill Waste Disposal;
- Chemical and Fuel Storage Areas;
- Hazardous Waste Storage and Disposal.

6.1.2 Mine closure should not be an “end of mine life process” but should be integral to “whole of mine life” if it is to be successful.

6.1.3 A schedule should be provided to describe the implementation of progressive reclamation. Such a schedule should also be provided for each stage of reclamation during the shut-down and decommissioning procedure.

6.1.4 If necessary, estimating costs for decommissioning at the early stages of mine planning can be achieved using unit costs (per ha, per m, per ton, etc.) for similar work done elsewhere.

6.2 Progressive Reclamation

6.2.1 As far as possible, the site should be rehabilitated progressively in step with the rate of mining. This will permit optimizing reclamation efforts and will bring about substantial costs reduction by avoiding re-mobilizing heavy equipment or manpower to the site.

6.2.2 Always remove and keep the soil for subsequent rehabilitation.

6.2.3 Ensure that erosion by wind and water is minimized during and following operations and reclamation.

6.2.4 Re-vegetate the area throughout mine life with plant species that will control erosion, provide diversity and enable plant succession so as to restore a stable and compatible ecosystem. The sooner re-vegetation is initiated, the faster an ecosystem will be re-established.

6.2.5 Where possible, respread cleared vegetation on disturbed areas.

6.3 Physical and Chemical Stability of the Site

Rehabilitation measures are summarized in Tables 6-1, 6-2, 6-3 and 6-4, taken from *Mine Rehabilitation for Environment and Health Protection - a trainers manual (UNEP/WHO, 1998).* Soils Stabilization and Seeding and Revegetation techniques are provided in Appendix A and B.

Table 6-1
Reclamation Measures- Surface Workings

(modified after UNEP/WHO 1999)

Issue	Reclamation Objectives	Control Technologies
PHYSICAL STABILITY ISSUES		
• Safety • Hazardous cliffs • Water hazard • Failing slopes	• Restrict access to hazardous areas • Emergency access to drinkable water in case of groundwater disruption	• Ditch and berm • Fence, & sign post, if necessary • Slope stabilisation where practicable • Provide emergency access to water
• Slope Failure • Deep seated or overall slope failure • Erosion	• Prevent deep seated failure, if practicable • Restrict access to unstable areas • Control sediment release, if necessary	• For potentially unstable slopes, either stabilise by flattening slopes or constructing toe berm, or restrict access with ditch/berm &, if necessary, fence & sign post • Establish vegetation or place riprap • Provide stable spillway & overflow channel, rehabilitate for fish, waterfowl, wildlife habitat.
CHEMICAL STABILITY ISSUES		
• Acid drainage and/or leaching of metals • Turbidity	• Meet water quality objectives by; 1. Control reactions 2. Control migration 3. Collect and treat 4. Settlement	• Flood to control reaction • Cover to control reactions and/or migration • Collect and treat, active treatment to be avoided where possible • Settlement to control turbidity
LAND USE ISSUES		
• Productivity of land • Visual impacts • Visual impact of river diamond mining tailings piles	• Return to approved alternative use	• Backfill pit where practicable & beneficial • Flatten slopes • Contour - blend with natural topography • Establish vegetation • Return tailings to riverbed

Table 6-2
Reclamation Measures- Mine Rock and Overburden Piles

(modified after UNEP/WHO 1999)

Issue	Reclamation Objectives	Control Technologies
PHYSICAL STABILITY ISSUES		
• Slope failure - deep seated or overall slope failure - erosion • Drainage disruption	• Avoid deep seated failure • Avoid large surface slumps and sediment release • Avoid blockage of drainage	• Site selection to avoid low strength foundations (P) • Internal drains to prevent water table rise • Construct in lifts to achieve flatter slopes • Covers to control infiltration of water • Ditches for water management • Bulldoze crest, if required, to flatten slope • Construct toe berm to stabilise slope and to flatten inclination • Collect sediment in ponds • Establish vegetation or riprap, where required • Monitor
CHEMICAL STABILITY ISSUES		
• Acid drainage and/or leaching of metals or contaminants • Turbidity	• Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat 4. Settlement	• Underwater disposal to control reactions • Pre-treatment-blending of alkaline material to mitigate acid drainage (P) • Cover to control reactions and/or migration and/or turbidity • Settle to control turbidity • Segregation of deleterious materials for controlled disposal or cellular pile construction • Collect and treat, active treatment to be avoided where possible • Monitor • Complete detoxification of all cyanide dumps, as required
CHEMICAL STABILITY FOR SPENT ORE PILES		
• Flushing of mill reagents - cyanide	• Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	• Detoxify by flushing with water or other solution to degrade cyanide to pH<7 • Regulate seepage to meet water quality objectives with covers and/or retention pond prior to release
• Flushing of acid		• Detoxify by flushing with lime solution to achieve effluent water quality which meets mine effluent objectives, if possible • Regulate seepage to meet water quality objectives with cover • Collect and treat - active treatment to be avoided where possible
LAND USE ISSUES		
• Productivity of land • Visual impacts	• Returned to acceptable alternative use	• Contour-blend with natural topography • Establish vegetation where practical

(P) - Option to be implemented at approved pre-mine stage.

Table 6-3
Reclamation Measures- Tailings Impoundment

(modified after UNEP/WHO 1999)

Issue	Reclamation Objectives	Control Technologies
PHYSICAL STABILITY ISSUES		
• Tailings - dust - water erosion	• Control dust migration • Control tailings erosion	• Establish erosion resistant covers of vegetation soil, riprap or water • Monitor
• Dams - deep seated or overall slope failure - surface slump - erosion	• Factor of safety >1.5 for static conditions • Erosion resistant overtopping protection • Restrict access	• Appropriate site selection and dam design (P) • Where necessary, stabilise embankments by constructing toe berm to flatten overall slope • Riprap or vegetation cover to control erosion • Increase freeboard and/or upgrade spillway to prevent overtopping • Ditch/berm/fence to prevent erosion by motorised vehicles • Monitor • Internal + toe drains
• Weathering • Destruction of permanent - structures - spillways - decant towers & pipes • Drainage disruption	• Remove or establish long-term stability • Integrate with local drainage	• Remove or plug/backfill structures • Diversions and spillways designed for long-term stability • Plug/seal decant lines through embankments • Define and provide for long-term monitoring and maintenance • Avoid ongoing operation where possible
CHEMICAL STABILITY ISSUES		
• Tailings and pore water - acid drainage - leaching - mill reagents (including mercury) - Water quality	• Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	• Implement permanent control measures • Flood to control reactions • Pre-treatment-removal of deleterious material for controlled disposal elsewhere or blending with alkali material to mitigate acid drainage (P) • Cover to control acid reactions and/or migration using inert material or bog (biological filter) • Ditch to divert runoff • Collect and treat - active treatment to be avoided where possible (requires continued maintenance)
• Dams, structures	• Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	• Do not construct with materials which are potential acid producers or are leachable • Decontaminate and/or remove acid generating or leaching materials
LAND USE ISSUES		
• Productivity of land • Visual impacts	• Return to acceptable land use	• Rehabilitate by one or more of the following means: - flood, contour, cover, establish vegetation, wetland

(P) - Option to be implemented at approved pre-mine stage.

Table 6-4
Reclamation Measures- Water Management

(modified after UNEP/WHO 1999)

Issue	Reclamation Objectives	Control Technologies
PHYSICAL STABILITY ISSUES		
• Water dams - stability - erosion - overtopping - intakes/ decant towers	• Ensure long-term stability • Protect erodible slopes • Ensure no overtopping • Seal pipes	• Maintain embankment indefinitely • Breach dam • Maintain operating spillway in durable Rock • Plug intakes with concrete, plug decants and remove towers • Monitor
• Ditches - overtopping - erosion	• Adequate flood capacity • Prevent blockage • Prevent erosion	• Design for extreme events • Construct from materials suitable for long-term stability • Riprap protection • Provide for long-term maintenance • Monitor
• Storage Tanks - stability	• Remove	• Drain, remove or knock down, fill, & cover • Monitor
• Pipelines - collapse - obstruction	• Remove surface and large shallow pipes	• Remove all surface and large shallow pipes • Plug those pipes at depth • Monitor
• Culverts - blockage - collapse	• Ensure maintenance free passage of water under design flood conditions	• Remove and breach if not required • Upgrade to pass design flood • Provide for long-term maintenance • Monitor
CHEMICAL STABILITY ISSUES		
• Contaminated reservoirs	• Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	• Drain, treat and discharge • Strip and dispose of contaminated soils in tailings dam or approved location • Breach dam • Establish vegetation • Treat indefinitely, if necessary • Monitor
LAND USE ISSUES		
• Dams - interruption of drainage	• Restore drainage patterns • Determine if alternative use exists	• Breach and restore to erosion resistant drainage • Stabilise to maintain dam
• Reservoirs - productivity of land - potential water supply	• Return to acceptable alternative use	• Maintain dam • Drain and establish vegetation
• Ditches	• Restore drainage patterns	• Grade to restore natural drainage • Establish vegetation

Table 6-5
Reclamation Measure – Buildings and Equipment

(modified after UNEP/WHO 1999)

Issue	Rehabilitation Objectives	Control Technologies
PHYSICAL STABILITY ISSUES		
• Safety and access • Maintenance and stability - building - hoist & shaft facility - power plant - conveyors - mobile equipment	• Control access	• Decontaminate if necessary • Disassemble & remove all equipment and buildings • Backfill excavations • Remove buried tanks • Restore natural drainage
CHEMICAL STABILITY ISSUES		
• Buildings - insulation • Chemical storage areas • Mill reagents • Petroleum products • PCBs • Explosives	• Make secure • Monitor stored supplies • Meet water quality criteria • Dispose of surplus chemicals off-site	• Chemicals of all types to be recycled, returned to vendor, sold, or disposed of in an approved site
LAND USE ISSUES		
• Alternative uses • Productivity • Visual	• Original or acceptable alternative use	• Contour • Vegetate • Break and bury concrete • Restore natural drainage

Table 6-6
Reclamation Measures- Underground Workings

(modified after UNEP/WHO 1999)

Issues	Reclamation Objectives	Control Technologies
PHYSICAL STABILITY ISSUES		
• Openings to surface which are hazardous to public (shafts, raises & stopes open to the surface, and portals to adits & declines)	• Prevent inadvertent access • Permanently seal openings	• Minimise number of openings (P) • Permanently plug or seal all access openings to surface • Backfill shafts & stopes, if practical • Fence areas • Place warning signs around • Vent water & gas pressures
• Surface disruption which are hazardous to public (caving, collapse of crown pillars)	• Prevent inadvertent access • Surface stabilisation • Underground stabilisation	• Use mining method resulting in stable surface (P) • Stabilise surface, if feasible • Ditch/berm &, if necessary, fence & sign post unsafe areas until natural stabilisation occurs • Backfill surface openings, if practical
• Surface disturbance (subsidence)	• Surface re-contouring where beneficial	• Use mining method resulting in stable surface (P) • Re-contouring or diversion to establish drainage patterns
• Barrier pillars stability which are hazardous to neighbouring operations	• Prevent collapse and flooding of adjacent mine • Prevent collapse and stress transfer to adjacent mine	• Permanently support boundary pillar, if practical and necessary • Ensure access to neighbouring mine and continued pumping, if required
CHEMICAL STABILITY ISSUES		
• Acid drainage and/or leaching of minerals or contaminants • Seepage of mill reagents from backfill	• Meet water quality objectives by: 1. Control reactions 2. Control migration 3. Collect and treat	• Flood workings to control reactions • Permanently plug workings & drill-holes to control migration • Collect & treat passively; active treatment to be avoided where possible • Drain all oil containing equipment, motors, transformers, etc.
LAND USE ISSUES		
• Productivity & aesthetics • Drainage interrupted • Groundwater lost	• Return to original or accepted alternative use • Establish surface and groundwater drainage patterns	• Backfill disrupted portions & openings where practicable • Contour surface • Flood workings • Establish vegetation

(P) - **Option to be implemented at approved pre-mine stage.**

6.4 Land Use

See Tables 6-1 to 6-6 above for Reclamation measures regarding land use.

6.5 Monitoring

Physical and chemical stability monitoring

6.5.1 A sound monitoring program should detail:

- Its objective;
- Contact informations of the persons responsible for monitoring;
- Location of control stations;
- Inspection frequency;
- Type of monitoring (visual inspections, measurements, parameters, etc.);
- Instrumentation used;
- Data compilation and evaluation of information gathered.

Environmental monitoring

6.5.2 An environmental monitoring program should detail:

- Its objective;
- Contact informations of the persons responsible for monitoring and the laboratory responsible for analysis;
- Location of control stations (on-site, upstream and downstream of the receiving environment, groundwater, etc.);
- Parameters (physical, chemical and biological);
- A description of the sampling tools and measurement systems used (pH, flows, etc);
- Sampling frequency;
- Description of analytical techniques and their accuracy including instruments used;
- Method used to compile and assess data.

6.5.3 In case of having an effluent treatment facility to be maintained on site, a specific monitoring program should be designed and implemented for the facility.

6.6 Relinquishment

6.6.1 Relinquishment of a mining title may be a staged process as progressive completion criteria and targets are achieved.

6.6.2 A sufficient period of time should have elapsed to demonstrate the stability of the site. For re-vegetated areas, this may require that the vegetation has reached, or is trending towards, a self-sustaining status. Potential impacts on groundwater may also take several years of monitoring to establish or refute.

6.6.3 The responsible authority designated by the Regulatory body will make a judgment on the achievement of the agreed completion criteria after consultation with other involved regulatory agencies, including the future land manager.

7. REFERENCES

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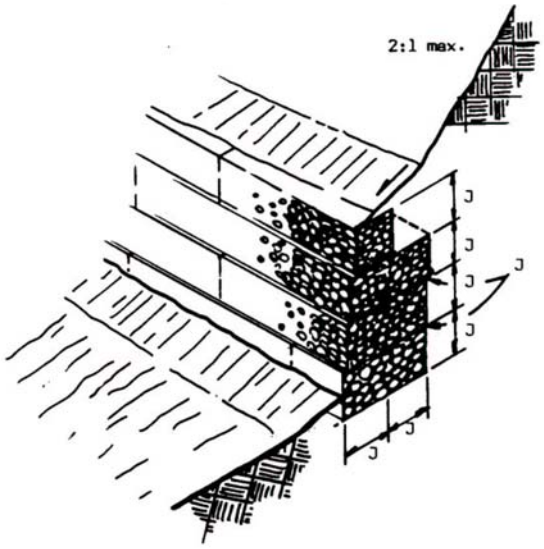
Web site

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

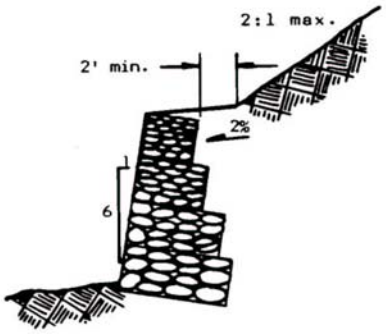
APPENDIX A

Permanent Soil Stabilization Techniques

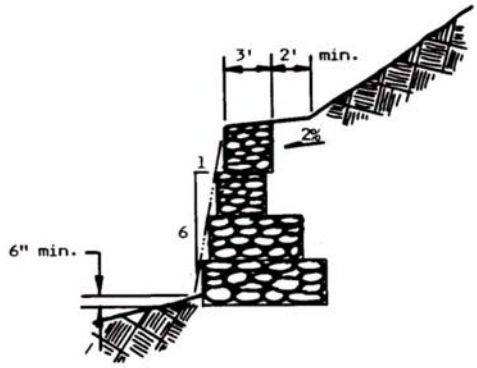
Gabions



3-DIMENSIONAL



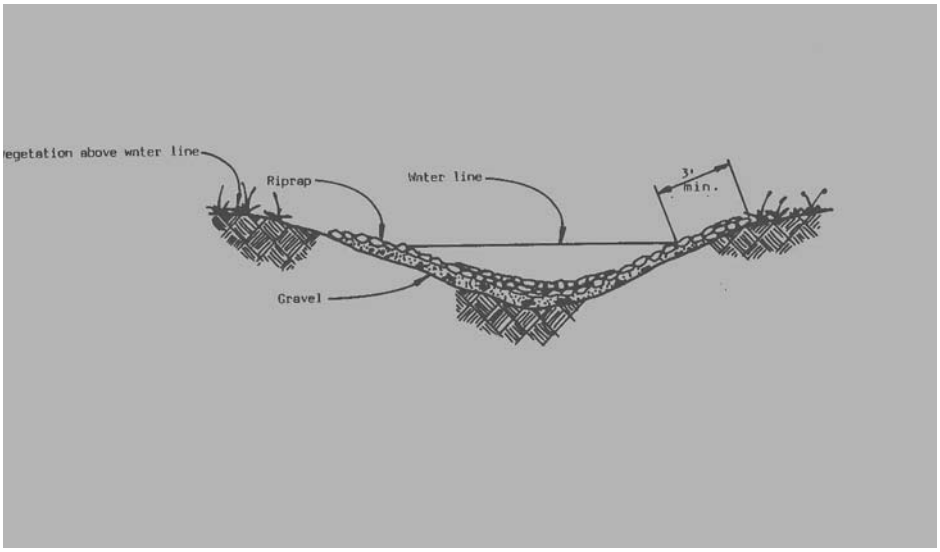
SECTION



SECTION

After Idaho Department of Lands, 1992

Riprap



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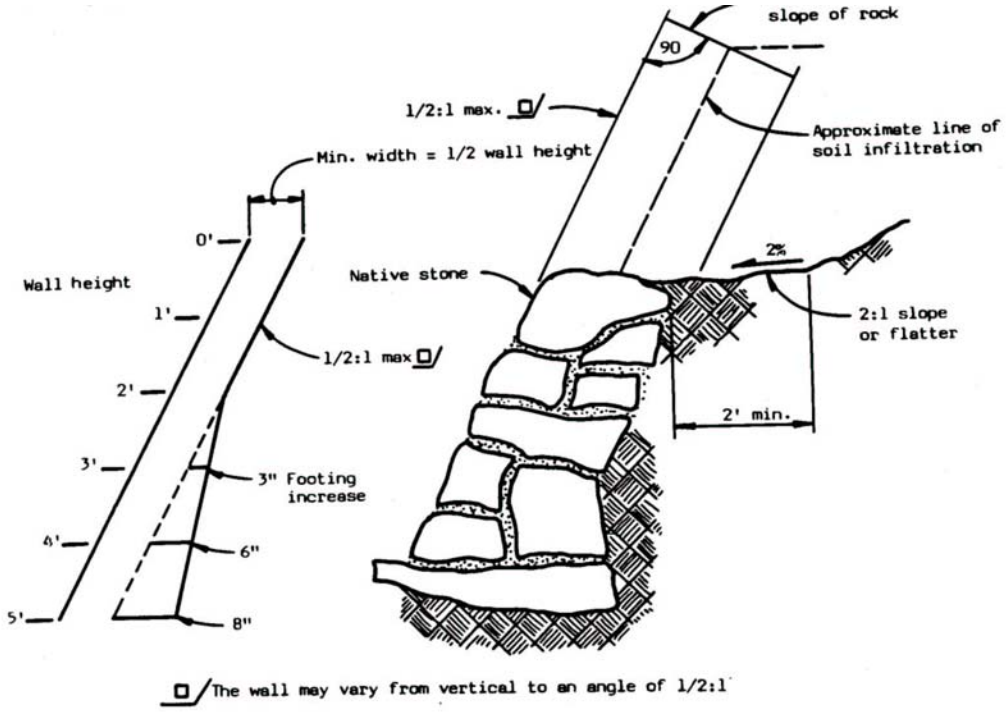
Native rock retaining wall



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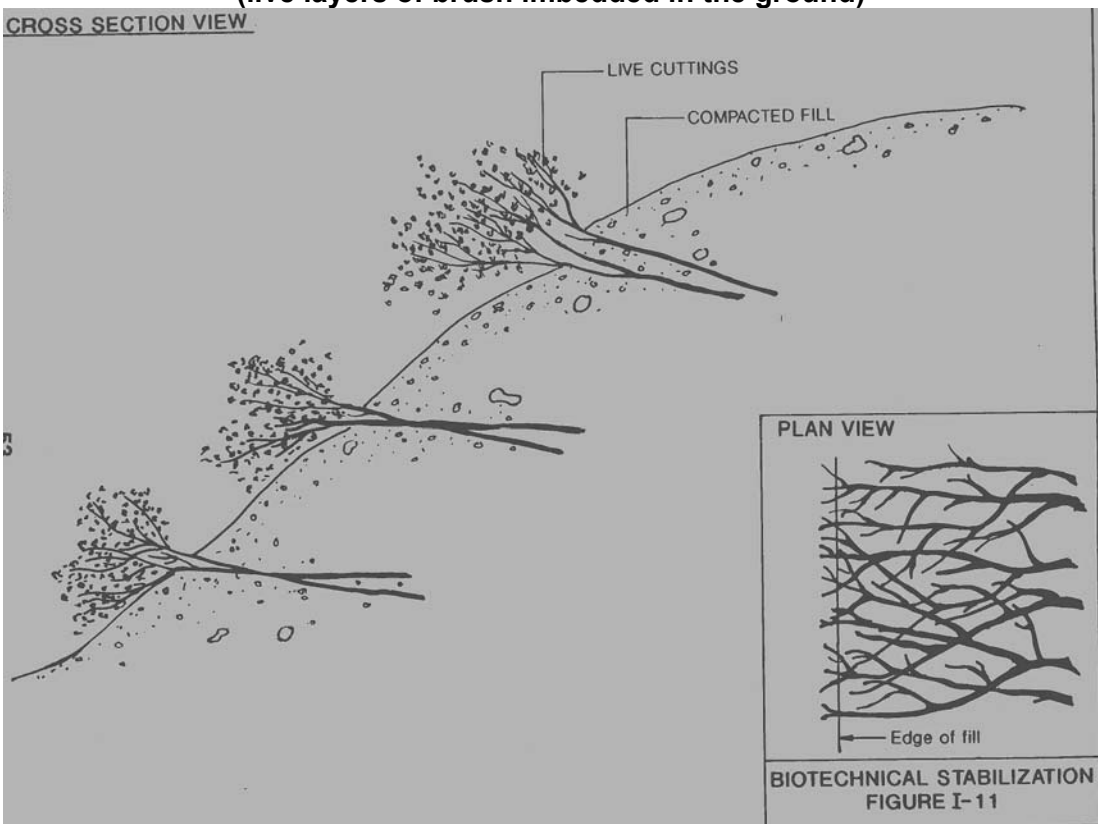
Biotechnical Stabilization

(live layers of brush imbedded in the ground)



After Idaho Department of Lands, 1992

APPENDIX B

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.