Mining Environmental Management

CODES OF PRACTICE

Tailings Management

Guyana Geology and Mines Commission

Brickdam, Georgetown, Guyana

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1.0 Introduction

This Code of Practice for **Tailings Management** in small and medium -scale gold and diamond mines is intended to provide environmental management guidance and 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 a Code of Practice for Mining Environmental Management prior to its incorporation into the Regulations.

The Codes of Practice were intended to provide critical environmental guidance to the Mining Industry, particularly small and medium-scale gold mines. The importance of the Code of Practice 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/Tailings]

1.2 Justification for the Tailings Management Code of Practice

Tailings management is often the most significant environmental challenge associated with mining projects. A spate of recent and well-publicized incidents involving tailings impoundments, such as the Omai spill in 1995, has placed the mining industry in general under intense scrutiny. The environmental, financial, and political consequences of well-publicized failures have made it clear to the mining industry

[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.

that safe tailings management practices are in its own best interest. The main public concerns regarding tailings containment are the following:

1. Structural stability of dams and the possible release of large volumes of water and semi-fluid tailings
2. Potential impact of tailings operations on the quality of life of people living in the immediate area, and
3. Potential pollution of ground and surface water.

Tailings are the residue remaining after metals of interest have been extracted from mined ores. Often, as in the case of large-scale lode gold mining, ores are first milled/crushed and finely ground, and then treated in a hydrometallurgical plant. In small-scale or medium-scale mining operation, precious metals are usually separated by a gravimetric method and the ore does not undergo comminution or size reduction. In both cases, since the extracted metals represent only a small percentage of the entire ore mass, a vast proportion of the mined material ends up as tailings. Most tailings that are mass-produced worldwide are dumped in large-area impoundments, usually called “tailings dams.”

Guyana’s small-scale mining industry basically generates the following two types of tailings:

1) Hydraulic tailings, which consist of slurry containing the residual material left over after valuable minerals (mostly gold and diamonds), have been extracted by a gravimetric method (sluice boxes, jigs, etc.)
2) Amalgamation tailings, which are a concentrate of heavy minerals containing residual mercury and/or amalgam.

Both types are a major source of pollution and therefore require proper management.

In Guyana, a large volume of conventional hydraulic tailings are generated each day through the use of 4, 5 and 6-inch dredges. This process involves the slurrying of both overburden and gravel, resulting in a permanent loss of organic cover and slow re-vegetation. Estimates suggest that over 200,000,000 m^3 of tailings, comprising over 80% water, are generated each year. A large percentage, if not all, 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 with their dramatic impacts on riverine ecosystems.

Hydraulic tailings are therefore a component of the effluent from Guyana’s small-scale mining industry.

Sustainable tailings management involves more than constructing and operating a tailings dam, although this is the most important aspect. Tailings management requires miners to provide some degree of stability and physical planning for the effective containment of predetermined volumes of tailings and effluent for predetermined periods of operation. Because dredges can move to different locations several times a year, planning for proper tailings management becomes very difficult. Pre-Exploration, reserves estimates, and mine planning are critical to a truly sustainable approach to tailings management, but they are obviously beyond the scope of this Code of Practice.

The Tailings Management Code of Practice is based on sound management practices exercised elsewhere and on principles and approaches from various sources. Because there is no such code for small and medium-scale mining operations anywhere else, procedures usually designed for large, high-tech operations have been adapted and streamlined to suit the purposes of this Code of Practice.

1.3 Administration of Codes and Responsibilities of Owners and Workers

The best 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 Code and associated Provisions
- 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 tailings management, the Mine Owners and operators must:

- Manage their operations in compliance with the tailings management regulations
- Provide their employees with required training and orientation in tailings management regulations, and the related the regulations, codes and guidelines
- Provide employees with orientation and training on the Code of Practice for the Use of Small Dams for the Control of Water/Tailings

2.0 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 (ARD)	Drainage of acid water containing dissolved metals as a result of the 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 (Zones)	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	Means the Environmental Code of Practice for the operation of mines that is published by the Commission and which shall be read as part of the Mining (Amendment) Regulations 2005. (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)

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 or safely closed down..
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 200m^3, but less than 1000m^3 of material, inclusive of any overburden, is excavated or processed as an aggregate in any continuous period of twenty-four hours.
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 20m^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.
NGO	Stands for **N**on-**G**overnment **O**rganization.
Orphan site	An abandoned mine for which a responsible party no longer exists or cannot 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 a state, or local government agency given authority to do so by the appropriate legislature

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	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, or approved alternative beneficial 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 settable 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 Sectorial 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.

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.
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. Also called Care and Maintenance
Turbidity	The state, condition or quality of opaqueness, cloudiness or reduced clarity of a fluid, due to the presence of suspended material
Whole-of-mine -life process	A process that is carried out throughout the life of a mining operation.

3.0 Mission and Objectives

3.1 Mission Statement

The mission of the Tailings Management Provision of the Code of Practice is to:

Promote sound tailings management practices in Guyana's small and medium scale gold and diamond mining industries in order to minimize impacts on communities and the environment.

3.2 Objectives

1) Protect communities and the environment from potential adverse environmental effects caused by tailings discharges into the environment.
2) Promote sustainable tailings management in Guyana's small and medium-scale gold and diamond industries.
3) Foster a holistic approach to stewardship of tailings facilities by small and medium-scale miners considering all stages in the life-cycle of a facility.
4) Promote the Code's use by small and medium-scale gold and diamond miners.
5) Raise the awareness of, and educate all parties as to, the importance of sound tailings management practices.
6) Promote tailings management practices that are adaptive and dynamic over time.
7) Promote credible and verifiable tailings management practices.

4.0 Scope

This mandatory Provision of the Code of Practice applies to small and medium-scale gold and diamond mining operations. Compliance with the rules, regulations and statutes is therefore mandatory.

Mining strategies and practices in small and medium scale mines vary considerably, requirements that apply to one type of operation may not be relevant to others.

Tailings dams are usually a challenge for small-scale miners. One option would be to design and locate a common dam to service a number of adjacent small-scale operations. Additionally, other types of containment facilities may be proposed for this scale of mining. Tailings produced by small and medium-scale operations consist largely of water; small-scale miners might construct water containment facilities, such as settling ponds, for tailings disposal.

Guidelines for the management of tailings in small-scale mining should be prepared by GGMC.

This Code of Practice addresses only environmental issues related to tailings management and does not deal with any occupational health and safety (OH&S) issues related to tailings management.

This Provision of the Code of Practice covers all stages in the life cycle of a tailings facility, i.e., site selection and design, construction, operation and decommissioning. Tailings dam reclamation is addressed in the related Provision, Mine Reclamation and Closure.

No guarantee is made in connection with application of the Code to prevent hazards, accidents, incidents or injuries to workers and/or members of the public at any specific site where tailings are stored.

5.0 Principles & Standard Practice

The principles and standards of practice on which this Code is based (except for overburden stripping) draw upon the following simplified management framework derived and adapted from the Mining Association of Canada (MAC) *Guide to the Management of Tailings Facilities*.

1) Planning

- Roles and responsibilities
- Managing risks
- Managing change

2) Implementation

- Operational control
- Competency

3) Control, Monitoring and Corrective Measures

This is an all-encompassing framework for tailings management throughout the entire life cycle of a mine.

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

5.1 Overburden Stripping

Principle: Promote the mechanical or manual removal of overburden in order to reduce the amount of tailings generated and recover valuable topsoil.

Standards of Practice

5.1.1 Promote the development of technical support programs and pilot projects aimed at helping miners use “dry methods” for overburden removal.

5.1.2 Hydraulic removal of overburden is not in the interest of good tailings management and is discouraged (hydraulicing).

5.1.3 Make miners more aware of the benefits in terms of tailings management that overburden stripping offers over hydraulicing.

5.2 Tailings Dam Site Selection and Design

Principle: Select a site and design a tailings facility in accordance with sound engineering practice and in compliance with permits and regulations.

Standards of practice

Planning

5.2.1 Develop general site selection and design criteria for tailings facilities (Regulator's responsibility) and ensure that these criteria are disseminated to miners.
5.2.2 Develop site selection and design criteria for the tailings facility.
5.2.3 Establish a process for site selection and risk assessment of design options.
5.2.4 Provide training and awareness on tailings dam site selection and design criteria for Regulator and miners

Implementation

5.2.5 Select an appropriate site and design the tailings facility.
5.2.6 Obtain approvals for the selected site and design from the relevant regulatory agencies.
5.2.7 Use professionals with qualifications (large dams) or experience (small dams) in appropriate technical and scientific disciplines to carry out site selection and design in accordance with sound engineering practices.

5.3 Tailings Dam Construction

Principle: Construct the tailings facility as per the design and in a safe and environmentally acceptable manner in compliance with permits, licenses and regulations.

(Please refer to ***Appendix A, Main Types of Tailings Impoundments)***

Standards of practice

Planning

5.3.1 Establish criteria and procedures to ensure that construction of the tailings facility conforms to the design, meets legal requirements, performs according to specifications, provides ongoing protection of public health and safety facilitates implementation of the closure plan, and prevents or minimizes adverse environmental impacts.
5.3.2 Prepare detailed plans for building the tailings facility in order to ensure quality control throughout the construction work and ensure that environmental objectives are met.
5.3.3 Prepare procedures for identifying and documenting changes made to approved-plans and procedures for the construction of the tailings facility.
5.3.4 Provide training and awareness on tailings dam construction for Regulator and miners

Implementation

5.3.5 Obtain construction approvals and permits, as required.
5.3.6 Construct the tailings facilities according to the design. Identify deviations from the design and plans.
5.3.7 Assign qualified and/or experienced personnel to construct the tailings facility in accordance with sound engineering practices.

Control, Monitoring and Corrective Measures

5.3.8 Establish a routine inspection program for assessing the environmental and safety performance of the construction work.

5.3.9 Carry out periodic inspections and reviews of the tailings facility in addition to routine inspections.

5.3.10 Develop and implement action plans and record corrective measures taken with regard to non-conforming items.

5.4 Tailings Dam Operation

Principle: Operate the tailings impoundment facility in such a way that all structures are stable and all solids and water are managed within the area designated in the design in compliance with permits and regulations.

Standards of practice

Planning

5.4.1 Assign a qualified and/or experienced person responsible for the tailings facility operation and assign qualified personnel to operate the tailings facility.

5.4.2 Develop operating plans in accordance with the design in order to meet legal requirements, achieve specified performance standards, provide ongoing protection of public health and safety, and prevent or minimize adverse environmental impacts. Include preparations for eventual decommissioning and closure in ongoing operations.

5.4.3 Develop and test a local-level emergency awareness and preparedness (APELL) plan.

5.4.4 Prepare procedures for identifying and documenting changes made to approved-plans and procedures for operating the tailings facility.

5.4.5 Provide training and awareness on tailings dam operation for Regulator and miners

Implementation

5.4.6 Obtain commissioning approvals and permits, as required.

5.4.7 Operate the tailings facility in accordance with design specifications, plans and legal requirements.

5.4.8 Prepare an operating manual for the tailings facility.

5.4.9 Establish a preventive maintenance schedule and reporting system.

5.4.10 Implement operational procedures to manage flood control, tailings deposition, physical stability, site security and wildlife protection.

5.4.11 Implement documentation control measures to ensure that appropriate documents are prepared, maintained and accessible.

Control, Monitoring and Corrective Measures

5.4.12 Establish and maintain a routine inspection program for assessing the ongoing environmental and safety performance of the impoundment and its appurtenances, including all critical structures such as dams, dikes, ditches, ponds, pipes, spillways and decant structures.

5.4.13 Establish a Dam Monitoring Plan.

5.4.14 In addition to the routine inspection program, arrange for an annual inspection of the tailings facility by an experienced engineer.

5.4.15 Develop action plans and implement and record corrective measures taken with regard to non-conforming items identified in routine and/or periodic inspections and reviews.

Decommissioning and Closing of a Tailings Facility

Principle: Decommission and close the tailings facility in such a way that all remaining dams and associated structures are safe and stable. All solids and water shall be managed within the area designated in the closure plan and in compliance with permits and regulations.

Standards of practice

Planning

5.5.1 Assign a qualified and/or experienced person responsible for the overall decommissioning and closure of the tailings facility operation and assign qualified personnel to decommission and close the tailings facility.

5.5.2 Prepare detailed implementation plans for closure of the facility.

5.5.3 Prepare procedures for identifying and documenting changes made to approve plans and procedures for decommissioning the tailings facility.

5.5.4 Provide training and awareness on tailings dam decommissioning for Regulator and miners.

Implementation

5.5.5 Obtain decommissioning approvals and permits.

5.5.6 Decommission and close the tailings facility as per the detailed closure design and plans in order to meet legal requirements and effectively facilitate surrender of the land or transfer of the land to non-mining use consistent with regional land-use objectives or approved uses; or provide for long-term care and maintenance, ensure long-term stability of dams and related tailings facilities, provide ongoing protection of public health and safety, achieve specified performance standards, and prevent or minimize adverse environmental impacts.

Control, Monitoring and Corrective Measures

5.5.7 Implement a program for monitoring physical and environmental stability during and after the closure period.

5.5.8 Carry out comprehensive inspections and reviews in order to assess the effectiveness of the closure in relation to designed performance measurements.

5.5.9 Develop action plans and implement and record corrective measures taken with regard to non-conforming items identified in routine and/or periodic inspections and reviews.

6.0 Code Implementation

6.1 Overburden Stripping

6.1.1 Identify (the Regulator) possible mining operations where "dry mining "pilot projects could be carried out. Obtain the Guyana Gold and Diamond Miners Association's (GGDMA) participation and find appropriate funding.

6.1.2 Carry out pilot projects (Regulator's responsibility) in various areas. Carefully review and analyze results of the projects.

6.1.3 Develop an educational program to disseminate information and results from the pilot projects.

6.2 Tailings Dam Site Selection and Design

Site selection

6.2.1 Select a preferred site. Prepare a documented rationale for selecting the site, along with a discussion of alternative sites that were studied and rejected. Compile all relevant information.

6.2.2 The following four types of considerations must be taken into account when selecting a site: (a) environmental considerations; (b) planning considerations; (c) decommissioning/reclamation considerations; and (d) cost considerations.

6.2.3 Environmental considerations include the following (at minimum):

- Effluent treatment requirements
- Surface water contamination
- Groundwater contamination
- Watershed use
- Impact on vegetation, wildlife and aquatic life
- Potential dust problems
- Water balance.

6.2.4 Planning considerations include the following (at minimum):

- Accessibility
- Distance from the mine or mill
- Distance from habitation and areas of human activity
- Topography
- Land and resources use
- Property ownership and mineral rights
- Amerindian land claims
- Watershed and surface area
- Volumetric capacity

- Construction material availability
- Dam and basin foundation conditions
- Composition and characteristic of tailings
- Downstream hazards
- Hydrology and groundwater
- Contaminant seepage
- Potential impact area
- Human and environmental risks
- Water management scheme and preliminary water balance
- Operational and deposition plan
- Preliminary containment and water management structures
- Cost estimate
- Conceptual risk assessment.

6.2.5 Decommissioning/reclamation considerations include the following (at minimum):

- Revegetation potential
- Long-term stability
- Ease of establishing permanent drainage
- Reduction and/or control of acid rock drainage and other contaminants
- Dust control
- Long-term maintenance, monitoring and treatment requirements.

6.2.6 Cost considerations include the following (at minimum):

- Capital cost
- Cost of tailings transport
- Tailings facility operation and maintenance costs
- Closure costs
- Cost per ton of mined ore.

6.2.7 Compile information relative to the dam site from the literature survey and field/laboratory investigations.

6.2.8 Tailings characterization and settleability.

Design Elements

6.2.9 Determine design parameters, including the following: dam classification, stability, earthquake criteria, safety factors, design permeability, acid-rock drainage, wildlife, dust, and closure considerations

6.2.10 Analyze the stability of the foundation, dam and appurtenances under static and dynamic conditions

6.2.11 Determine the requirements for preparation of the dam and pond foundations, including considerations of vegetation removal, excavation of organic soils, cut-off walls, bedrock cleaning, groundwater control and containment, dewatering requirements and diversion channels

6.2.12 Assess the requirement for seepage control, including seepage into groundwater

6.2.13 Compile information relative to the dam site from the literature survey and field/laboratory investigations

6.2.14 Carry out a qualitative risk assessment

6.3 Tailings Dam Construction

(Please refer to ***Appendix A, Main Types of Tailings Impoundments)***

6.3.1 Develop a plan for carrying out initial dam construction and subsequent lifts, including sequencing and requirements for stability monitoring. Establish a construction methodology, schedule and anticipated costs.

6.3.2 Typical components of a construction management system include the following planning and scheduling; survey control (layout, as-built records); grouting monitoring; foundation preparation monitoring; material quality control; compaction control; instrumentation monitoring and data synthesis; record-keeping; and construction safety

6.3.3 Determine potential environmental impacts of construction based on the proposed design and volume and nature of tailings.

6.4 Tailings Dam Operation

6.4.1 The site's Awareness and Preparedness Emergency at Local-Level. (APELL) Plan should include tailings facility aspects in the overall site emergency preparedness plan.

6.4.2 A tailings basin deposition plan must be developed for the mine's projected life cycle. The plan ensures efficient use of tailings capacity provides for long and short-term scheduling of dam lifts and ensures effective closure of the facility.

6.4.3 To develop a deposition plan, it is necessary to have information on tailings slurry quantity, density and production estimated from the process/mill water balance, and to include provisions for estimating uncertainty and contingencies. The basic parameters should be validated and updated on a periodic or regular basis.

6.4.4 Minimize dust releases from the tailings facility. This may include keeping the tailings wet and/or using short or long-term chemical or organic covers.

Control, Monitoring and Corrective Measures

6.4.5 Performance monitoring and visual inspections shall be carried out very frequently and include the following: groundwater pressure (level), seepage, deformation (settlement and stability), weather influence, seismic events (after the fact), and special inspection programs after major events (earthquakes or floods).

6.4.6 The following are indicators of instability: soft zones and boils along the toe; dirty sediments in seepage; increased seepage rates; new areas of seepage; longitudinal and transverse cracking; and settlement.

6.4.7 The following are areas requiring special attention: spillways, decant structures, drain and pressure relief wells, concrete structures, pipes and conduits through dams, riprap areas, siphons, weirs, trees and animal holes.

6.4.8 Stability monitoring program plans include the following: locations of control stations; schedule; type of monitoring (visual, measurements of parameters); appropriate level of instrumentation

(e.g., piezometers); inspection methods; data compilation and evaluation; persons responsible for monitoring; data storage and reporting systems.

6.5 Decommissioning and Closure of a Tailings Facility

Closure plans and performance criteria must be developed in the early stages of facility design, and then verified and updated periodically through the operating life of the facility in preparation for decommissioning and closure.

6.5.2 A closure plan includes the following background data:

- History of the site
- Infrastructure
- Process flow controls
- System operations, mineralogy and topography
- Hydrology/water management
- Hydrogeology
- Soil capability
- Revegetation
- Impact assessment
- Long-term maintenance
- Geotechnics
- Chemistry and geochemistry
- Monitoring program
- Communications
- Financial assurance
- Stakeholder consultation
- Potential end land use
- Closure technology (e.g., dry cover, flooded, wetlands, perpetual treatment, or vegetative cover)

6.5.3 Closure plans require a thorough re-assessment of the facility and of dam stability under closure conditions. All aspects of the facility and dam stability must be reviewed.

6.5.4 Structural monitoring and inspections should be continued for all facilities and dams until they are decommissioned, and continued thereafter as appropriate.

6.5.5 Prepare action plans to deal with shortcomings in closure quality and/or difficulties in complying with closure specifications.

7.0 Monitoring and Surveillance

Guidance for the monitoring and surveillance for tailings dams are addressed in this Code of Practice , Section 5.3 Sub-section, Control Monitoring and Corrective Measures(6.45 – 6.48) Section 6.4 Tailings Dam Operation , Sub-section Control Monitoring and Corrective Measures(6.45 – 6.48),

8.0 Emergency Measures

Tailings dam failure is the major potential emergency associated with tailings dam operations. There are other potential emergencies associated with the mining environment.

The Contingency and Response Plan Code of Practice details the approach and strategies for addressing emergencies associated with the construction and operation of tailings dams.

Tailings Dam Failure

Typical Causes	*Potential Impacts*
Poor water management, overtopping, foundation failure, drainage failure, piping, erosion, and earthquakes.	*Loss of life, contamination of water supplies, destruction of aquatic habitat and loss of crops and contamination of farm land, threat to protected habitat and biodiversity and loss of livelihood.*

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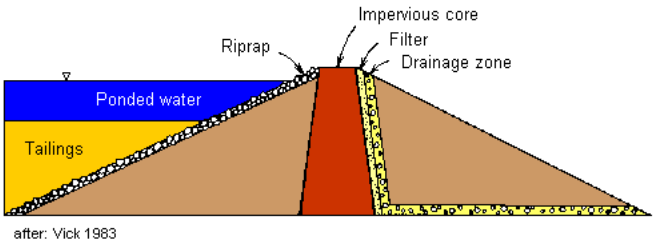
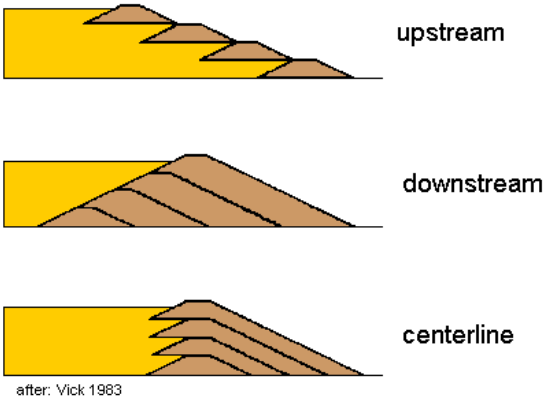
http://xmlwords.infomine.com/xmlwords.htm (on-line dictionary of mining terms)

APPENDIX A - MAIN TYPES OF TAILINGS IMPOUNDMENTS

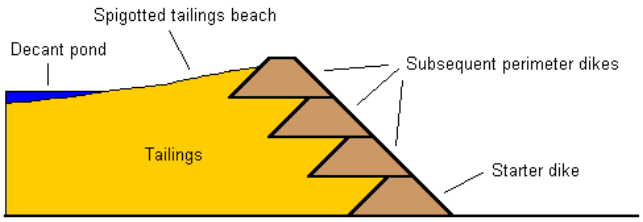
Water-retention type dam for tailings storage



Types of sequentially raised tailings dams



Upstream tailings dam



Figures from Vick (1983) taken from http://www.antenna.nl/wise/uranium/mdap.html