Mining Environmental Management

CODES OF PRACTICE

Use of Small Dams
Water/Tailings Management

Guyana Geology and Mines Commission
Brickdam, Georgetown, Guyana

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1.0 Introduction

This Code of Practice for the **Use of Small Dams** to Contain Water/Tailings in small and medium-scale 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 Codes of Practice for Mining Environmental Management prior to their incorporation into 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/ Tailings

1.2 Justification for Use of Small Dams for Water/Tailings Management Code of Practice

The Mining (Amendment) Regulations (2005) Article 248, states that the GGMC shall prepare a Code of Practice to provide further guidance for the use of small dams and that this Code shall form part of the Regulations. Small dams are used extensively in small and medium-scale mines to manage/contain

[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.

tailings, water and effluent discharges. They are therefore very critical in mining environmental management.

The use and design of small dams were previously not regulated in Guyana. Small dams were usually not constructed with the same rigorous technical planning and oversight as large dams. Materials used in their construction are generally selected from onsite sources and constructed by existing (not specialized) machinery. Small dams are therefore much more susceptible to structural instability and failure. Instability and failure of small dams are often related to poor siting and construction, uncontrolled flows, seepage and over topping.

The consequences of failure of dams, particularly in small and medium-scale mines, at first glance do not seem as dramatic the failure of large dams, but this does not preclude sound planning. There is a cost, in terms of production, potential environmental damage and even loss of life.

The small and medium-scale gold and diamond mining industry in Guyana must do more to prevent accidents and to meet public and regulatory expectations. The development of the Code of Practice for the Use of Small Dams is intended to improve environmental management in relation to the stability and operations of small dams in small and medium-scale mines.

1.3 Administration of Codes and Responsibilities of Owners and Workers

A useful strategy for sustainable environmental management in the small and medium-scale 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. Regulation 248 provides the basis for the Use of Small Dams for the Control Water and Tailings. Specific responsibilities include:

- Development and upgrading of the codes of practice
- Consultations with the stakeholders in the mining industry including mining organizations and miners on the development, and utility of the Codes 0f Practice.
- Public education, orientation and training
- Enforcement of, and monitoring compliance with, 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 Use of small dams, the mine owners and operators must:

- Manage their operations in compliance with the Mining (Amendment) Regulations 2005, and the related Codes of Practices and Guidelines
- Provide their employees with required training and orientation on the design, construction, and use of small dams, and the related the regulations, codes and guidelines

2.0 Glossary of terms

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 air and water.
Artisanal mine	a small, medium or even large-scale, informal, legal or illegal mining operation that uses rudimentary processes to extract gold from either primary or secondary ore bodies.
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.
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, 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).
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 , or related industry associations).
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.
Controlled discharge	Discharge from a dam or impoundment that is manually instigated to reduce the level or quantity of water stored. Control is managed through gates.
Cut-off trench	Channel or ditch usually excavated around a mining structure in order to collect groundwater.

Decommissioning	**A** general term for a formal process to remove something from active status
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.
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.
Full supply level	The level in a reservoir at its maximum design capacity. This is the level of the minimum free board
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.
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 period of twenty-four hours.
Mine closure	A whole of mine life process which typically culminates in property relinquishment. Closure includes decommissioning and rehabilitation. This term is often used interchangeably with Mine decommissioning.
Mine decommissioning	The process that begins near, or at, the cessation of mineral production. This term is often used interchangeably with Mine Closure.
Overburden	Loose soil, sand, gravel, etc., that lies above the bedrock or above a deposit of useful materials, ores, or coal. Also called burden, capping, cover, drift, mantle, and surface, it may or may not include topsoil.

Piping	Internal erosion of the foundation or embankment caused by. Generally, erosion starts at the downstream toe and works back toward the reservoir, forming channels or pipes under the dam.
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.
Retention dams	A retaining structure often of rock or soil designed to impoundment /retain primarily water.
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.
Seepage	Seepage is the continuous movement of water from the upstream face of the dam toward its downstream face
Slope stability	The tendency of a slope to remain in place
Small dam	A dam less that 6 m in height
Small-scale mine	A mine for which a claim license has been issued and from which a volume in excess of 20 m^3, but less than 200 m^3, of material, including any overburden, is excavated or processed as an aggregate in any continuous Twenty-four hour period.
Spillway	A channel specifically designed to carry excess water over or around a dam

Tailings	The gangue and other waste material resulting from the washing, concentration or treatment of ore. Also those portions of washed ore regarded as too poor for further treatment.
Tailings dam	An impoundment to which tailings are transported, the solids settling while the liquid may be withdrawn.
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 Use of Small Dams Code of Practice's (the Code) mission is to:

To ensure the stability and effective use of small/tailings dams, to control flows through the dams, and to prevent uncontrolled discharge of tailings and other effluents.

3.2 Objectives

1) Provide guidance on the planning, construction and operation of small dams to effect better control of flow
2) Provide information on the various factors that contribute to, or control of flow through dams
3) Reduce the incidences of seepage/flow-induced structural failures of dams
4) Support better integration of mine planning, tailings management and effluent control.
5) Provide guidance on the operation and maintenance of small dams.

4.0 Scope

This Code of Practice is a mandatory code that applies to mining operations ranging in size from small-scale to medium-scale mines (>20 m^3 per day). Many of the dams constructed in small and medium-scale mines are tailings dams, constructed from tailings. Therefore, this Code of Practice will also address the use of tailings. The governing principles are common to both tailings and water-retention dams; however the use and management of tailings require special considerations

The technical considerations are the same for all small dams but the site conditions and availability of equipment in small and medium-scale mines may dictate different strategies and practice.

This Code is subordinate to the Mining (Amendment) Regulations 2005 and 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 small dams are constructed or operated. Guidelines for the emergency and response planning for artisanal and small-scale mining have been prepared.

5.0 Principles and Standards of Practice

The effectiveness of small/tailings dams, their structural stability, and their ability to contain water and tailings are directly related to their locations (site), their design, construction, and maintenance during operation.

A dam is effective when it can retain its structural integrity while managing all projected inflows and through- flows under the various conditions. A dam's effectiveness is ensured through the careful execution of the following sequence of activities, as depicted in Figure 1, Small Dams – Preplanning through Operation:

- Planning
- Siting
- Design
- Construction ,
- Operation
- Decommissioning

The principles and standards, associated with these activities are presented subsequently.

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

Small Dams

A small dam is defined as one having a height of 6 meters or less with a maximum associated reservoir depth of 5 meters. A typical earthen small dam is illustrated in Figure 2.0, Typical Earthen Small Dam. The basic features of dams are:

- Compacted fill
- Crest of dam
- Downstream Slope (DSS)
- Embankments
- Erosion protection, rip rap
- Foundation
- Freeboard
- Full supply level
- Upstream Slope (USS)
- Spillway
- Seepage control features/drains, toe drain

Since dams have site-specific designs, some dams may not have all the features listed

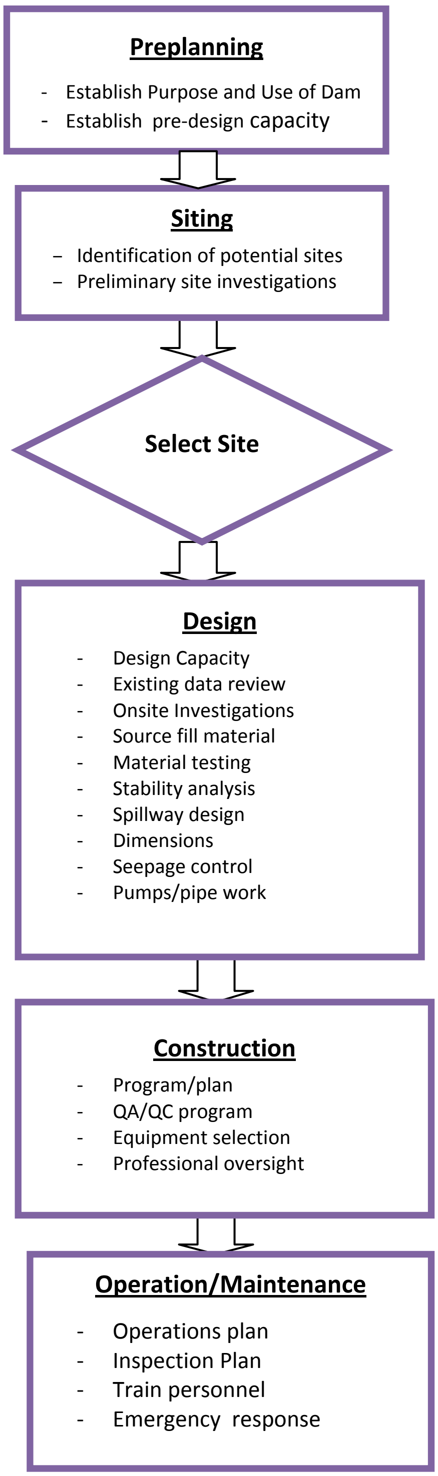

Figure 1.0 Small Dams – Planning Through Operation

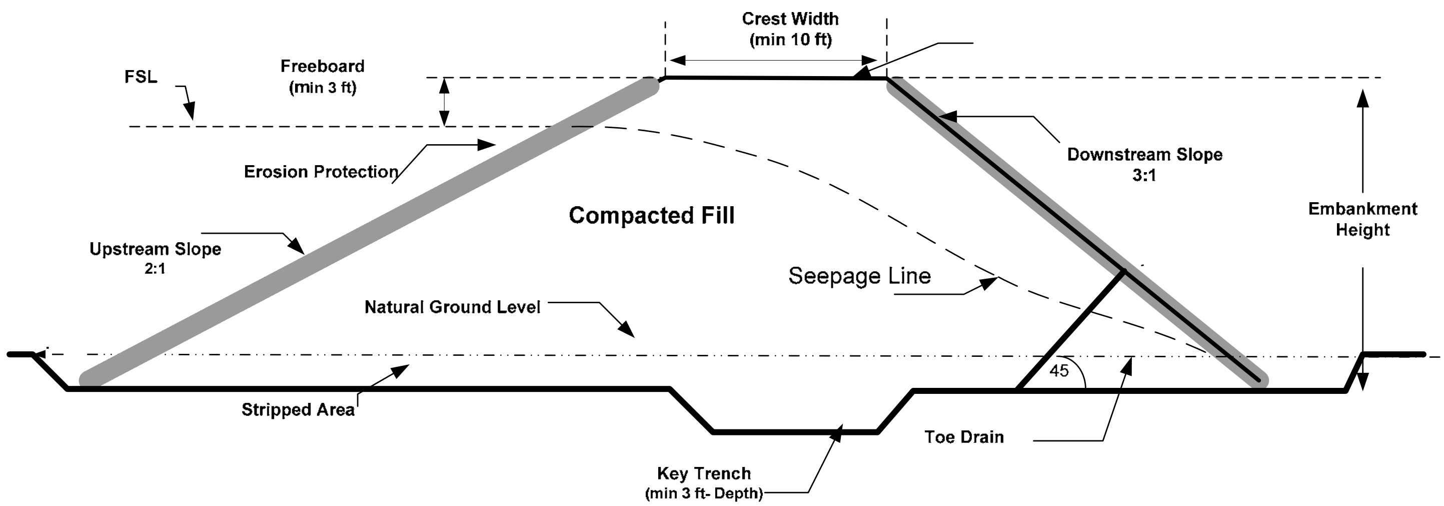

Figure 2.0 Typical Earthen Small Dam

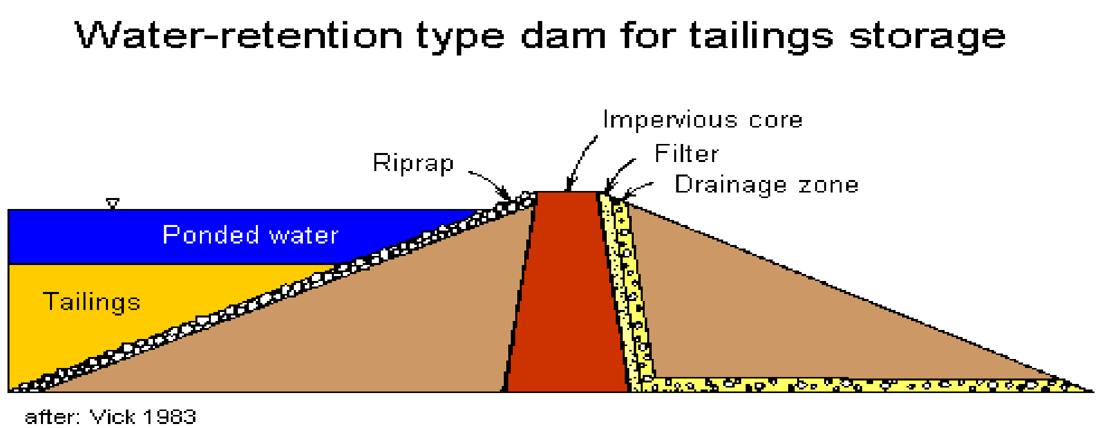

Figure 3.0 Water-Retention Type Dams for Tailings Storage

Tailings Dams

Tailings dams are earthen dams but they are functionally different in that they are intended to receive and retain tailings to facilitate the decanting of associated water. A second important difference is that the tailings (solids) once settled from the original slurry are often used to construct or raise the dam (embankment).

There is considerable variation in the material properties of tailings depending on the original ore, the milling process and the method of deposition in the impoundment. The use of tailings as embankment fill must be carefully managed.

Large tailings dams are constructed by the sequential raising of smaller dams as illustrated in Figure 4.0, Types of Sequentially-Raised Tailings Dams.

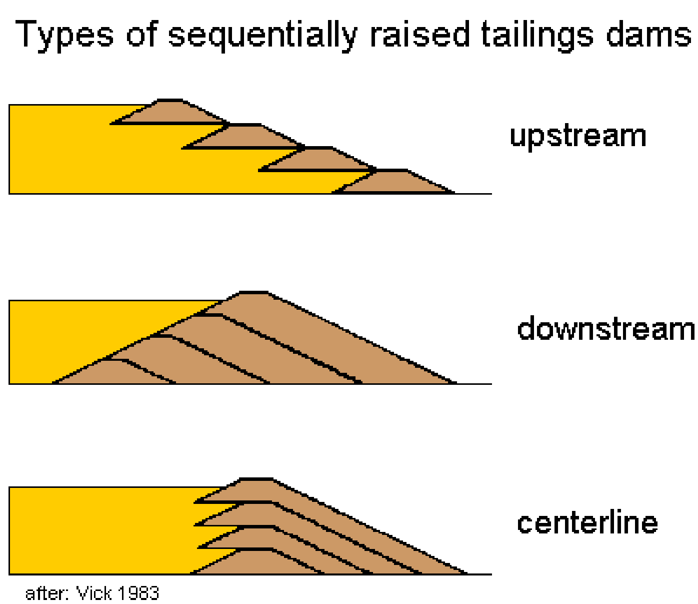

Figure 4.0 Types of Sequentially-Raised Tailings Dams

5.1 Planning

Principle: Effective management and operation of small/tailings dams begins with careful planning.

Standards of practice

5.1.1 Planning for the small/tailings dams must be part of the feasibility study for the mine operation
5.1.2 Develop general site selection and design criteria for the proposed dam (Regulator's responsibility)
5.1.3 Regulatory criteria and applicable industry standards must guide the development of the tailings facility
5.1.4 The purpose and use of the dam must be established prior to design or site selection; for small scale mines the purpose may include control of effluents, retention of tailings, or water storage

5.1.5 The intended use or purpose of the dam dictates the design capacity; in the case of retention of tailings the capacity would depend on the projected rate of generation of the tailings and the regional rainfall and drainage patterns
5.1.6 Part of the planning would include the gathering of available data and information
5.1.7 The use of tailings for embankment fill has special considerations; these include the method of deposition, grain size, composition and water content of the tailings.
5.1.8 Identify alternate sites or location for further study and evaluation
5.1.9 Local, regional experience and practices should be assessed

5.2 Site Selection

Principle: The site selected for a small dam must ensure stability and efficient operation.

Standards of Practice

5.2.1 The site selected should, as much as possible. minimize the required height of the dam
5.2.2 Ideally the dam should be sited on impervious, geologically stable soils in order to minimize seepage and provide foundation support
5.2.3 Use maps and existing data in the preliminary site investigation to minimize the need for subsurface investigation
5.2.4 Conduct a basic subsurface investigation to assess permeability and competence of the subsurface soils
5.2.5 Develop a good sense of surface hydrology and drainage patterns
5.2.6 Locate tailings dams as close as possible to the milling (crushing) operations, sluice boxes, etc, to minimize conveyance cost of the tailings

5.3 Design of Small Dams

Principle: The designs of small dams are direct functions of their intended purpose and use. Designs are usually site-specific; they are functions of the quantity and properties of the tailings or materials to be contained, climatic, geological, geotechnical and hydrological conditions at the location, post-closure use of the site, and regulatory criteria.

The use of tailings in the construction of dams and their embankments is an important consideration in small and medium scale mines. While the basic principles are common to water-retention and tailings dams, the unique properties of tailings dictate special approaches to their construction and operation.

Standards of practice

5.3.1 The source and properties of the proposed embankment material must be determined; the use of tailings or onsite materials reduces costs and construction duration
5.3.2 The height and dimensions of the dam would depend on the topography of the selected site, required retention capacity and the properties of the fill material
5.3.3 Spillways must be part of the design; they are important to prevent over topping and handling of excess flows associated with storms and other climatic variations
5.3.4 The final design should minimize flow through the dam, control seepage and protect the embankment/slopes from structural failure and overtopping.

5.3.5 The design would help to determine construction method and sequence, compactive effort and appropriate equipment.

5.3.6 The design should include:

- Dimension (height, width of crest, size of foot print)
- Storage capacity , design storm
- Slope of upstream and downstream embankments)
- Stability analysis
- Dimensions and type
- Spill way (dimensions, type, finish)
- Slope protection
- Seepage control and internal drainage
- Embankment fill material

5.4 Construction of Small Dams

Principle: The permeability and strength of embankments and the efficiency of drains are all functions of the construction efforts and methods. Therefore, carefully planned and managed construction is critical to the efficiency and structural stability of the dam. The construction sequence and type of material would depend on the design identified during the planning stage.

The possible types of tailings dams are illustrated in Figure 2.0, Types of Sequentially Raised Tailings Dams. However the starter dams would be equivalent to the small dams that is the focus of this code of practice.

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

Standards of practice

5.4.1 Site preparation should reflect the proposed design and operation plans

- Prepare foundation, remove top soil, install toe drains, cut off trench and related drainage

5.4.2 Assign qualified and/or experienced personnel to provide construction or Regulatory oversight to assure good sound engineering practices

5.4.3 Construct the tailings facilities according to the design. Identify deviations from the design and plans.

5.4.4 A starter dyke is an essential part of all sequentially-raised tailings dams and should be considered.

- Use previously identified materials with suitable material properties
- Use appropriate equipment to achieve the required level of compaction – this is important for stability of the dam and to control piping and underflow
- Institute a basic quality assurance/control program with respect material selection, placement and compaction.

5.5 Inspection and Maintenance

Principle: Small dams continually adjust after construction in response to operational and environmental stresses. Some of the adjustment includes settlement, clogging of drains, and sloughing; left unattended these could lead to reduced efficiency and failure. Regular inspection would detect potential problems and allow for repair and maintenance before the structure is compromised.

Standards of practice

Inspection

5.5.1 Dams should be inspected regularly and after any major storm event.

5.5.2 Inspections should focus on mechanisms that could potentially compromise the dam or cause failure. These include:

- Erosion of embankment/slopes
- Piping
- Cracking at the crest and slopes
- Slumping
- Landslides
- Unusual flows or ponding

5.5.3 Inspections should be documented

5.5.4 An inspection plan should be developed to guide inspections. This should include reporting mechanisms

5.5.5 Personnel must be trained to conduct the inspections

Maintenance

Maintenance is implemented to sustain a continued safe operation of the dam. The maintenance activity is driven by routine and scheduled inspections.

5.5.6 Address and repair all defect s noted in the inspections

5.5.7 Clean and unclog drains and spillways

5.5.8 Establish routine maintenance schedule for pumps and other mechanical equipment.

5.6 Decommissioning

Principle: Decommissioning is the process of removing a dam and the associated reservoir area from active status and planning for post –closure use. The decommissioning of dams and associated facilities should be part of Reclamation and Closure Plan. Decommissioning should result in a safe, stable and sustainable environment in compliance with permits and regulations. Decommissioning options include:

- Closure in place
- Removal

In-place Closure

The in-place decommissioning of small dams must support the post-operation use of the area or facility. The critical issue would long term stability of the dam under closure conditions. Other considerations include:

- Revegetation potential
- Long-term stability
- Ease of establishing permanent drainage
- Reduction and/or control of contaminant releases through seepage/drainage

- Dust control
- Long-term maintenance, monitoring and treatment requirements

Removal

In the removal option the dam is completely or partially removed and the material stored behind the dam excavated or released into the downstream basin. The following considerations are important in the implementation of the removal option for commissioning of a dam:

- The hydraulic properties of the flow through water system
- Where would the released sediment be deposited and how will it impact the downstream environment, channels, and flood plains.
- The ecological impact of the released sediments

Standards of practice

5.6.1 Planning

The Closure and Reclamation Plan should clearly establish the goals and criteria for decommissioning of the dam; establish whether the dam would be removed or closed-in-place. A qualified and/or experienced person should be assigned the responsibility for the overall decommissioning of the dam. The following are required to support the successful decommissioning of the dam:

- Detailed closure and implementation plans for decommissioning of the dam.
- Risk analysis of the decommissioning options
- Provide training and awareness on small dam decommissioning for Regulator and Miners.

5.6.2 Implementation

- Obtain decommissioning approvals and permits.
- Decommission the dam as per the detailed closure design and plans in order to meet regulatory requirements and facilitate transfer of the land to non-mining
- For dams that will be left in place implement action plans for long-term care and maintenance, stability of dams and prevent or minimize adverse environmental impacts.
- For dams that will be removed implement action plans for breaching or dismantling of the embankment, release or excavation of sediments and downstream monitoring

5.6.3 Control, Monitoring and Corrective Measures

- Implement a program for monitoring physical and environmental stability during and after the closure period.
- Implement a program for monitoring and tracking the projected physical and environmental impacts associated with the removal of the dam and release of sediments
- Carry out comprehensive inspections and reviews in order to assess the effectiveness of the closure in relation to designed performance measurements.
- 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 Planning

The design of a small dam begins with planning and establishment of its purpose and use

6.1.1 Obtain construction approvals and permits, as necessary.

6.1.2 Planning and preliminary input, including the following:
- Establish the purpose and intended use of the dam
- Use information from the feasibility study to do the initial planning
- Gather preliminary information and inputs (maps, topographic data, reports, regional climatic data, geological information, etc.)
- Establish the preliminary design capacity based on intended use; in the case of a tailings dam establish the rate of generation of tailings
- Identify potential sites
- Conduct a preliminary site assessment

6.2 Site Selection

A dam must be stable, have a firm foundation and be able to effectively handle all inflows. The selected site must therefore meet these requirements and the purpose and intended use of the dam. If there are options, site selection and location involves screening and identification of the optimal site. Factors to be evaluated include:

- The results of surface and subsurface geologic investigations
- Surface and groundwater hydrology
- Diversion of surface run-off around the impoundment and dam
- Availability of fill materials
- Site topography with respect to the projected volume of water or tailings
- Proximity to the processing facility
- Availability of professionals with experience (small dams) in appropriate technical and scientific disciplines to carry out site selection and design in accordance with sound engineering practices
- What height of dam would be required to contain the project volume of water or tailings?
- What are the activities downstream? Any environmental considerations
- What are the alternative or future plans for the site?

6.3 Design of Small Dams

6.3.1 Establish the design capacity based on :
- The design storm event
- Surface drainage patterns
- Established design criteria
- A minimum freeboard of 1m above the fill supply level (FSL)
- Projected volume of tailings to be generated
- Stream and other surface inflows

6.3.2 Fill Material

- Ideally it should be a clay, a clayey silt, or a mixture of clay, silt, sand and gravel
- Establish Source (Tailings, onsite burrow, offsite)
- Determine material properties (empirical, previous studies, testing, or investigations
- Tailings fill: consider method of processing, deposition methods, grain size distribution, and water content
- Conduct stability analysis

6.3.3 Design:

The design should address or include most of the following:

- Dimension (height, width of crest, size of foot print)
- Design storm
- Slope of upstream and downstream embankments
- Spillway (dimensions, types, finish, protection)
- Slope protection (natural liners, synthetic liner, rip rap)
- The slope of a tailings dam can be less than that of a purely water retention dam
- Seepage control and internal drainage
- Methods of controlling discharges from the dam
- Method of discharge of tailings
- Control of flows into tailings impoundments by diversion of creeks and runoff around dams

6.4 Construction of Small Dams

A well planned and executed construction is critical to a stable dam and operation.

6.4.1 A construction plan must be prepared to guide the construction. It should include:

- A QA/QC plan
- Design of the dam
- Preferred equipment
- Compaction specifications
- Site preparation requirements
- Design of the filters and drains

6.4.2 The topsoil must be removed from the dam foundation area to ensure a good bond between the foundation and the fill

6.4.3 Construct the tailings facilities according to the design. Identify deviations from the design and plans

6.4.4 Construction must be supervised by a trained professional preferably with local or regional experience

6.5 Inspection and Maintenance

Regular inspection would detect potential problems and allow for repair and maintenance before the structure is compromised. Dams should be inspected regularly and after any major rain storm.

Inspection

6.5.1 Develop and Implement an inspection plan and schedule to guide inspections. This should include reporting mechanisms

6.5.2 Use checklists and photographs (APPENDIX 1) to document Inspections

6.5.3 The inspection plan/checklists should address some or all of the following:

- Crest
- Upstream (UPS) slope, downstream (DSS) slope
- Spill ways
- Liner systems
- Toe drains
- Internal drains
- Seepage control systems
- Outlet works and pipes

6.5.4 Monitoring is essential to detect seepage and other mechanisms that could cause failure: Inspections should focus on mechanisms that could potentially compromise the dam or cause failure. These include:

- Erosion of embankment/slopes
- Freeboard
- Piping
- Cracking at the crest and slopes
- Slumping
- Landslides
- Discharge conduits
- Spillways
- Quantity and content of flows
- Unusual flows or ponding

6.5.5 Routine Inspections should be ongoing and conducted by trained site personnel

6.5.6 There should be an annual (periodic) inspection conducted by a trained professional

Maintenance

Maintenance is implemented to sustain a continued safe operation of the dam. The maintenance activity should be driven by the results from routine and scheduled inspections. Some of the maintenance activities include:

6.5.7 Address and repair all defects noted in the inspections

6.5.8 Clean and unclog drains and spillways

6.5.9 Regular maintenance of internal embankment and foundation drainage outlet

6.6 Decommissioning

The decommissioning of dams and associated facilities should be part of Reclamation and Closure Plan. Decommissioning activities must result in a safe, stable and sustainable environment in compliance with permits and regulations. Manage all solids and water within the area designated in the closure plan and in compliance with permits and regulations.

The in-place decommissioning of small dams must support the safe and sustainable post-operation use of the area or facility. In the removal option, the dismantling of the embankment and the release or extraction of the sediments must be carefully managed so as to reduce or mitigate any physical or environmental impacts to the reservoir area or downstream locations.

6.6.1 Planning

- Re-evaluate the Reclamation and Closure plan to determine if the following issues are addressed :
  - ✓ Long-term stability
  - ✓ Plans for permanent drainage
  - ✓ Reduction and/or control of contaminant releases through seepage/drainage
  - ✓ Dust control
  - ✓ Post closure performance criteria
  - ✓ Long-term maintenance, monitoring and treatment requirements
  - ✓ Revegetation potential
- Conduct a risk analysis of the decommissioning options
- Conduct an environmental assessment to delineate and mitigate the potential impacts of removal of the dam, if that option is selected
- Evaluate the long term stability of the dam under closure conditions
- Prepare a detailed closure and implementation plans for decommissioning of the dam. The plan should include:
  - ✓ Closure Plan Option
  - ✓ Basis for selection of closure option
  - ✓ Decommissioning Schedule
  - ✓ Approvals and permits
  - ✓ Results of risks and environmental assessments
  - ✓ Maps and other supporting illustrations
  - ✓ Mechanisms for breaching of embankment, extraction or release of sediments (removal option)
  - ✓ Projected performance of dam over time (In-place option)
  - ✓ Monitoring goals and requirements
  - ✓ Plans for corrective action
  - ✓ Organization chart depicting responsibilities for closure and post closure monitoring

6.6.2 Implementation

- Obtain decommissioning approvals and permits.
- Decommission the dam as per the detailed closure design and plans
- Implement action plans for long-term care and maintenance, stability of dams and prevent or minimize adverse environmental impacts as necessary for in-place closure.
- Implement action plans for breaching or dismantling of the embankment, release or excavation of sediments and downstream monitoring
- Assign qualified or trained personnel to provide technical oversight of the decommissioning of the dam

6.6.3 Control, Monitoring and Corrective Measures

- monitor physical and environmental stability during and after the closure period.
- Monitoring and track the projected physical and environmental impacts associated with the removal of the dam and release of sediments as defined in the monitoring program
- Conduct comprehensive inspections and reviews in order to assess the effectiveness of the closure in relation to designed performance measurements.
- Implement action plans and record corrective measures taken with regard to non-conforming items identified in routine and/or periodic inspections and reviews

7.0 Monitoring and Surveillance

There is no specific monitoring associated with the implementation of this Code of Practice other than those detailed in Sections 5.5 and 6.5.. GGMC Mines and Environmental Officers must check for and review Inspection check lists and reports as part of their site audits and environmental reviews.

8.0 Emergency Measures

The Site/Operations Contingency and Emergency Response Plan is designed to guide emergency measures.

9.0 References

Doyle, M., Stanley, E., Harbor, J. and Grant, G. 2003. Dam Removal in the United States: Emerging Needs for Science and Policy. Eos 84: 29, 32-33.

Ferguson, K.A., I.P.G. Hutchinson, and R.L. Schiffman. "Water Balance Approaches to Prediction of

Government of Alberta: Alberta Environment, "Inspection of Small Dams", Publication No. T/434

Klohn, E.J. 1981a. *"Geotechnical Investigations for Siting Tailings Dams - Design and Construction of Tailings Dams*." Proceedings of a Seminar November 6-7, 1980, Golden, Colorado.

Klohn, E.J. 1981b. "*The Development of Correct Tailings Dam Design and Construction Methods-Design and Construction of Tailings Dams*." Proceedings of a Seminar November 6-7, 1980, Golden, Colorado.

Lighthall, P.C., B.D. Watts and S. Rice. 1989. "Deposition Methods for Construction of Hydraulic Fill

Loughborough University Leicestershire; Water Engineering and Development Center," *Technical Brief 48, Small Earth Dams*"

Tailings Dams." In: *Geotechnical Aspects of Tailings Disposal and Acid Mine Drainage*.

The Vancouver Geotechnical Society, Vancouver, British Columbia, May 26, 1989.

Mississippi Department of Environmental Quality: Office of Land & Water Resources, January, 2009, "*Guidelines for Inspection of Dams"*

Nelson, K. D., "Design and Construction of Small Earth Dams", Inkata, Melbourne, 1985.

New Zealand Society for Large Dams, "Guidelines on the Inspection of Small Dams", November 2007

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

Seepage from Mine Tailings Impoundments." In: *Seepage and Leakage from Dams and Impoundments*. 1985.

"Solid Waste", CRA Report to the U.S. Environmental Protection Agency #730.

Szymanski, Maciej B. (1999), *Tailings Dams from the Perspective of Conventional Dam Engineering*. Canadian Dam Association, Conference, Sudbury, October 1999.

U.S. Army Corps of Engineers. 1974. "National Dam Safety Program, Proposed Guidelines for Safety Inspection of Dams" Federal Register Vol. 39, No. 168 (Aug. 28), p. 31331-31346.

U.S. Department of the Interior; Design of Small Dams, Revised 3rd Edition, January 2006

U.S. Environmental Protection Agency, Office of Solid Waste, Special Waste Branch; *"Technical Report, Design and Installation of Tailings Dams"*, August 1994

Vick, S.G. 1990. "*Planning, Design and Analysis of Tailings Dams"*. BiTech Publishers Ltd.

Websites:

http://www.tailings.info/index.htm
www.lboro.ac.uk/departments/cv/wedc/
http://www.epa.gov/waste/nonhaz/industrial/special/mining/techdocs/tailings.pdf
Http://www.Infomine.com/pubicationsons/docs/Szymanski1999.pdf

Appendix A: Small Dams Inspection Checklist/Report

SMALL/TAILINGS DAM INSPECTION CHECKLIST/REPORT

ITEM	DESCRIPTION	NOTES
File# Date: **Owner:** **Location:** **Inspector:** **Date constructed:** **Engineered by:** **Last inspected:** **Next inspection**		
1. EARTH DAM		
Dam size and material Dam height: Reservoir: Top width: Crest length: Material:		
U/S slope Vegetation*: Grass, trees?* Condition: *Slides, erosion, sinkholes?* Comments:		
U/S Protection Size: Condition:		

Comments:		
ITEM	**DETAILS**	**NOTES**
<u>D/S slope</u> Vegetation: *Grass cover, trees?* Condition: Seepage: *New, existing, change, sand boils*? Comments:		
<u>Crest</u> Cracks: - Location: - Orientation/ Depth: - Width: Ponding: Sinkholes: Unusual settlement: Displacement :		
2. OUTLETS		
(a) Pipes Location: - Condition: - Type: Size: - Inlet: - Outlet: Barrel: Valve/Gate D/S		

Discharges? Comments:		
ITEM	**DETAILS**	**NOTES**
<u>(b) Spillway</u> Location: Condition: Type: Capacity: Inlet channel: Bed width: Head walls: Floor slab: Chute walls: Wing walls: Outlet Drains: D/S Comments:		
(c) Emergency spillway Location: Condition: Type: Bed width: Comments:		
<u>5. RESERVOIR</u> Use: Level: Freeboard: Source of supply: Drainage		

Condition:		
ITEM	**DETAILS**	**NOTES**
6. CONDITION OF DAM Channel Vegetation: Habitation: Structures: Tributary to: Comments:		
8. PHOTOGRAPHS		

ITEM	**DETAILS**	**NOTES**
9. REGULATORY PERMITS Agency: Address: Contact Person: Phone:		
10. SKETCHES AND ADDITIONAL COMMENTS		