

# pebble project

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## BACKGROUND

### TAILINGS AND TAILINGS MANAGEMENT

Building and operating a mine is a complex business. It takes rigorous study and careful planning to ensure that the mine is safe, that the environment is protected, and that the interests of local people are met.

One of the most prominent features of an open-pit or underground mine is its tailings storage area. Providing for the safe, permanent storage of tailings is important because tailings material that is not properly contained can have undesirable effects on the local environment.

This backgrounder is intended to provide Pebble Project stakeholders with an understanding of the issues and considerations for tailings management.



*A tailings storage facility at the Highland Valley Mine in British Columbia.*

## What are tailings?

**There are five different kinds of material found at a mine. Each is managed differently. They are:**

1. **Overburden** is made up of soil, gravel, and other loose materials that cover the surface of a mine site. It is often used as a construction material during mine development or may be stored in large piles and used after mining is complete to restore natural conditions.
2. **Ore** is rock that contains high concentrations of minerals – such as copper, gold, molybdenum and silver. Once ore is mined and removed, it is crushed and processed in an on-site milling facility.
3. **Mine rock** is solid material removed from an open-pit or underground mine that does not contain enough minerals to be considered ore. It is stored on site and may be used to construct mine facilities – such as roads and tailings storage areas. Some mine rock can be reactive, which means it produces a mild acid when exposed to air and

water. Look for a future back-grounder on the presence of reactive mine rock at the proposed Pebble mine, and how it will be safely managed.

Once processed at the on-site mill, ore is separated into two materials. They are:

4. **Mineral concentrate** is a mixture of water and finely ground rock that usually contains about 80 to 90 percent of the economic minerals present in ore. Once excess water is removed, mineral concentrate is transported from the mine site for further refining.
5. **Tailings** are a mixture of water and finely ground rock that is left over once mineral concentrate is removed. They are permanently stored in a secure facility at the mine site. Tailings usually contain about 10 to 20 percent of the economic minerals that could not be recovered from the ore.

Look for a future backgrounder on the milling process to be used at the proposed Pebble mine.

## How are tailings managed?

Once valuable minerals have been separated from ore, the remaining tailings are sent through a pipeline to a storage facility.

A tailings facility is a large storage area that is typically located and constructed in a hollow or valley in order to take advantage of natural barriers and provide multiple layers of environmental protection. In many cases, a tailings embankment – or barrier – built of rock and other natural materials is constructed at the low end of the valley to contain the tailings material.

Once placed in a storage facility, the finely ground rock and water that together make up tailings will separate. The heavier solids will settle to the bottom of the tailings embankments for additional stability. The remaining water will accumulate at the surface to form a shallow tailings pond.

Tailings ponds provide an important water source for mine operations. Tailings water is usually pumped back to the mill to be reused in the milling process. In this way, mine water is recycled over and over again, significantly reducing the amount of water that must be taken from the environment.

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## What issues are raised by tailings management?

The first issue is to ensure that tailings storage areas are properly located. Extensive studies are done in an effort to select sites for tailings storage facilities away from sensitive environmental areas – such as lakes and streams, wetlands, fishing and hunting areas – to the greatest extent possible.

Secondly, care must be taken to ensure that tailings material is as environmentally friendly as possible. This can be achieved by designing a milling process that captures the vast majority of the minerals present in ore, and by ensuring that the chemicals present in tailings are kept at predictable and manageable levels.

Finally, tailings storage areas must provide for the safe and permanent storage of tailings material. This is achieved by designing tailings embankments to withstand any potential catastrophic event, and by controlling the seepage of tailings water. Through modern advances in engineering and construction, it is possible to design and build permanent tailings facilities that are able to withstand severe earthquakes, floods and other catastrophic events.

The goal of NDM and its consultants is to design and construct a tailings facility at the Pebble Project that can operate safely and protect the environment, including downstream water quality and fisheries in the region.

## What approach to tailings management will be used at the proposed Pebble mine?

Northern Dynasty Mines (NDM) and its consultants have conducted extensive studies and investigations to determine the best design options and site locations for a proposed tailings facility at the Pebble Project. NDM will rely on the best engineering practices and build its facilities to meet or exceed the engineering standards and safety requirements required and enforced by state and federal agencies. The location and footprint of the tailings storage area will be determined prior to the submission of a comprehensive mine plan for the Pebble Project in late 2008 or 2009.

What we do know is that there will be a lot of tailings to be managed, as the Pebble Project is comprised of two large world-class deposits known as Pebble West and Pebble East. An integrated mine plan for both deposits is being developed that will likely involve open-pit mining at Pebble West, and some form of underground mining at the deeper but richer Pebble East deposit.

Most of the material to be mined at Pebble West and Pebble East is considered ore, which contains valuable minerals that will be extracted through the milling process. The remainder will be overburden and mine rock. Once the ore is crushed, watered and put through an on-site mill, it will be separated into mineral concentrate and tailings. Most of the total volume of processed ore will end up as tailings; the remainder will be mineral concentrates containing copper, gold, silver and molybdenum.

NDM will continue technical and environmental studies to refine its plans for the proposed tailings facility at the Pebble Project, but each option will include embankments designed to withstand any seismic event that could conceivably occur in the region. These embankments will be raised in stages to heights of about 700 feet, which is smaller in size than the ultimate height of several tailings facilities currently under construction at modern copper mines operating elsewhere in the world.

The final proposal for tailings management at Pebble will be included in the integrated mine plan to be completed in late 2008 or 2009. This proposal will be subject to an exhaustive regulatory review and permitting process involving state and federal agencies and the people of Alaska that could take another three years to complete.



## How are tailings embankments built?

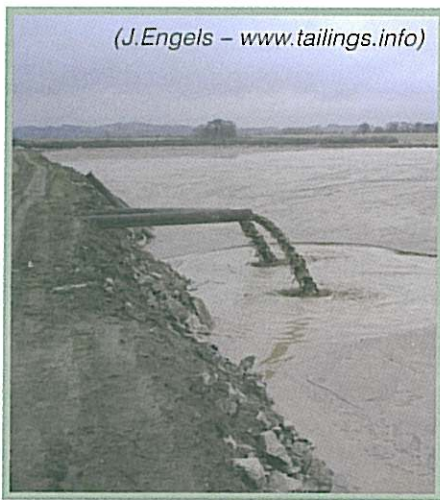
Once the best possible site has been chosen for a tailings storage facility, a plan must be developed to ensure it can safely and permanently store all of the tailings produced over the life of a mine. This usually means an embankment is built at the low end of the area selected for tailings storage, and that a pipeline is constructed to carry tailings from the mill to the top of the embankment.

Unlike water dams, tailings embankments are made of rock and sand, and have a very wide base. They are engineered structures built to withstand earthquakes, floods, and other catastrophic events. They are designed and built to exacting standards enforced by state and federal government experts. They also employ the very best engineering practices and technology from around the world.

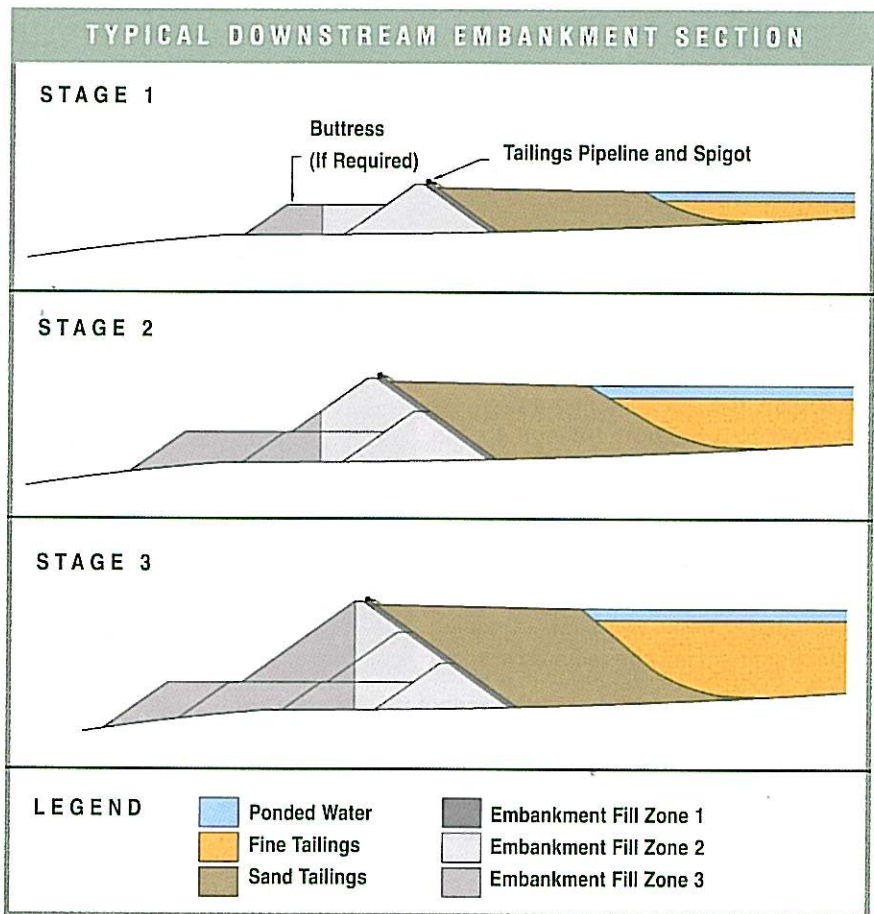
As the volume of tailings material contained in the storage area grows, so too must the height of the tailings embankment and the elevation of the tailings pipeline. Each stage of the process is carefully planned, highly engineered and carefully scrutinized by state and federal experts.



A tailings embankment – or barrier – is usually built at the low end of a valley to contain tailings material. (A tailings embankment near Jefferson City, Montana.)



Tailings material – water and ground rock – is transported from the mill to the tailings storage area via pipeline.



As the volume of tailings material contained in the storage area grows, so must the height of the tailings embankment and the elevation of the tailings pipeline.



## How do you make sure that mine tailings do not harm the environment?

The first step to effective tailings management is to design a milling process that produces tailings that are as 'clean' as possible. This means that the mineral content is low, and that chemicals are kept at manageable and predictable levels.

The second priority is to ensure that tailings material remains safely stored. This is achieved by building an embankment capable of retaining all of the tailings material over the life of a mine. Tailings embankments are engineered to be permanent structures.

Over time, the sand and silt-sized particles within tailings will accumulate at the bottom of the storage facility to form a dense layer that is highly resistant to water movement. This natural barrier will become several hundred feet thick over the life of a mine – considerably deeper than the relatively shallow pool of water it contains.

The separation of tailings solids and tailings water is an important safeguard for the environment. Not only do tailings solids help contain the tailings pond, they also attract and accumulate the mineral content that exists in tailings water.

Over time, these minerals will stabilize in the tailings solids and safely settle in the dense layer that forms at the bottom of the storage facility.

Another design feature of tailings facilities is the incorporation of seepage control and collection measures to ensure no impairment of the groundwater surrounding a mine site. This issue is managed differently at different mines.

In some cases, waterproof liners are used in combination with water collection systems to control and manage seepage that occurs from storage areas. In other cases, water collection systems are used to ensure that any water that seeps from a tailings storage area is collected and recycled. This approach has been proven to achieve 100% recovery of tailings water at other mines.

The final design feature to be considered in tailings management relates to the control of tailings dust dispersal. This dispersal can be managed by keeping the tailings material saturated at all times.

## What happens when mining is complete?

Mining companies are required to design and build permanent tailings storage facilities. But some important changes are made when mining is complete.

Of course, the pipelines and equipment required to transport tailings to the storage area and water to the mill are removed. The water collection system is operated until monitoring shows that water in the tailings pond is entirely safe. This may occur naturally at some mine sites, usually within five years. Ongoing water treatment may be required in some cases.

Additionally, after mining is complete, tailings storage areas are reclaimed – or returned to a natural-like condition. This means that the area is recontoured to blend into the surrounding environment. Soil and other overburden is replaced and native vegetation is re-established.

Once water in the tailings pond is safe, it can be reconnected to the natural water system through a series of channels and streams. In this way, water balance in the area can be re-established. Depending on environmental conditions



*A trophy rainbow trout fishery has been established at a reclaimed tailings pond at the Highland Valley Mine in British Columbia, Canada.*

*(J.Engels – [www.tailings.info](http://www.tailings.info))*



*A reclaimed tailings pond in Sudbury, Ontario, Canada.*

before development, former tailings ponds can become lakes capable of supporting fish populations. Land areas become revegetated and provide habitat for local wildlife.

In all cases, state and federal laws require that mining companies post a financial surety before any areas can be disturbed for mine construction or operations. This ensures that enough money is always available to restore disturbed areas to a natural-like condition.