Faro Mine Closure Planning

Salmon Committee Meeting

September 21, 2005

Presentation Outline

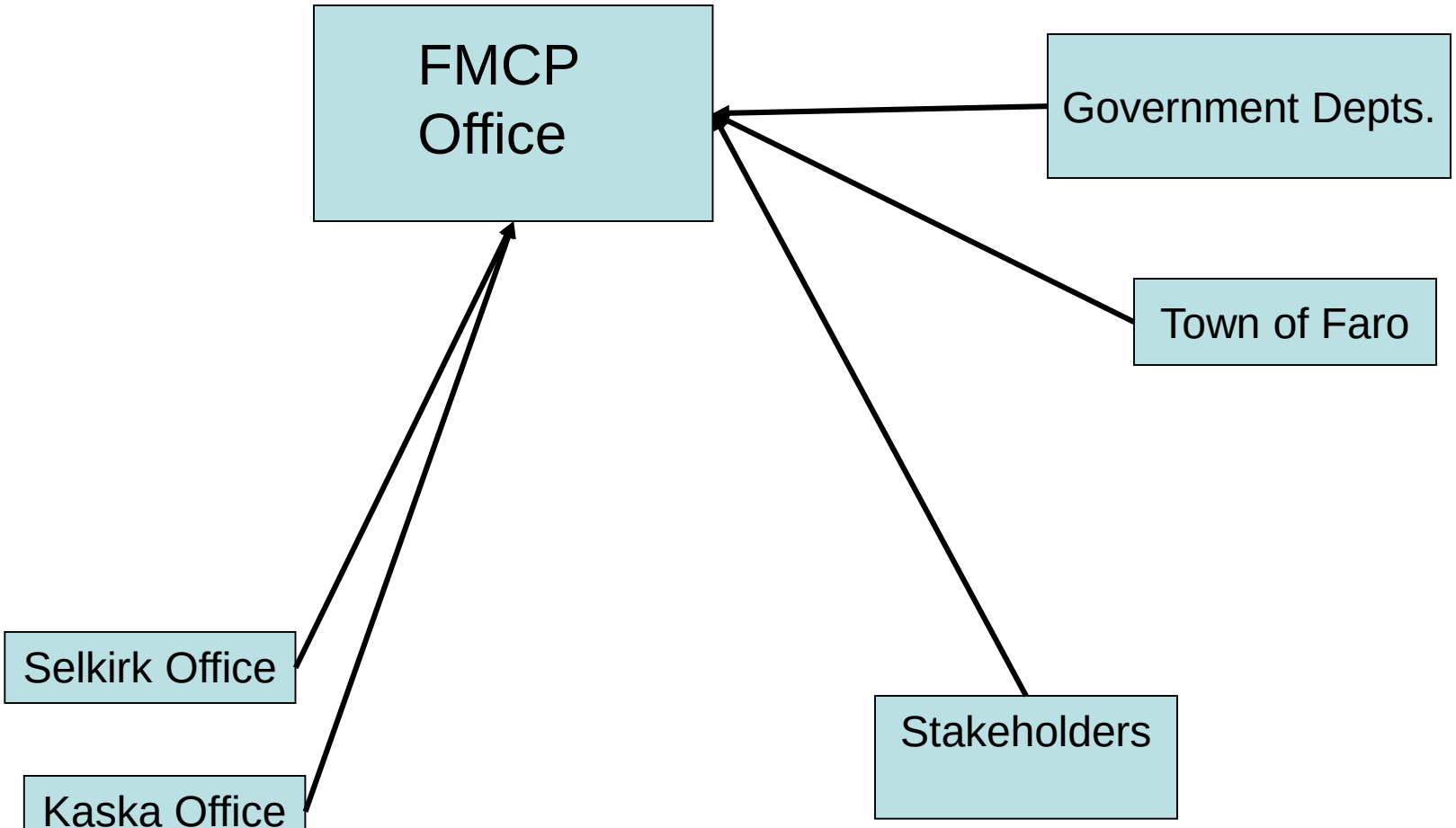
- Closure Planning Administrative Overview
- Closure Objectives
- Overview of site and issues
- Closure Studies and Methods Review
- Next Steps

Administrative Overview

Faro Mine Closure Planning Office

- Whitehorse based Faro Mine Closure Planning office, created in early 2005
- Community based First Nation offices
  - Ross River based Kaska office
  - Pelly Crossing resource person/office
- Town of Faro
  - liaison person (part-time)

Closure Planning Structure



Closure Planning Management

Faro Mine Closure Planning Office is assuming responsibility for:

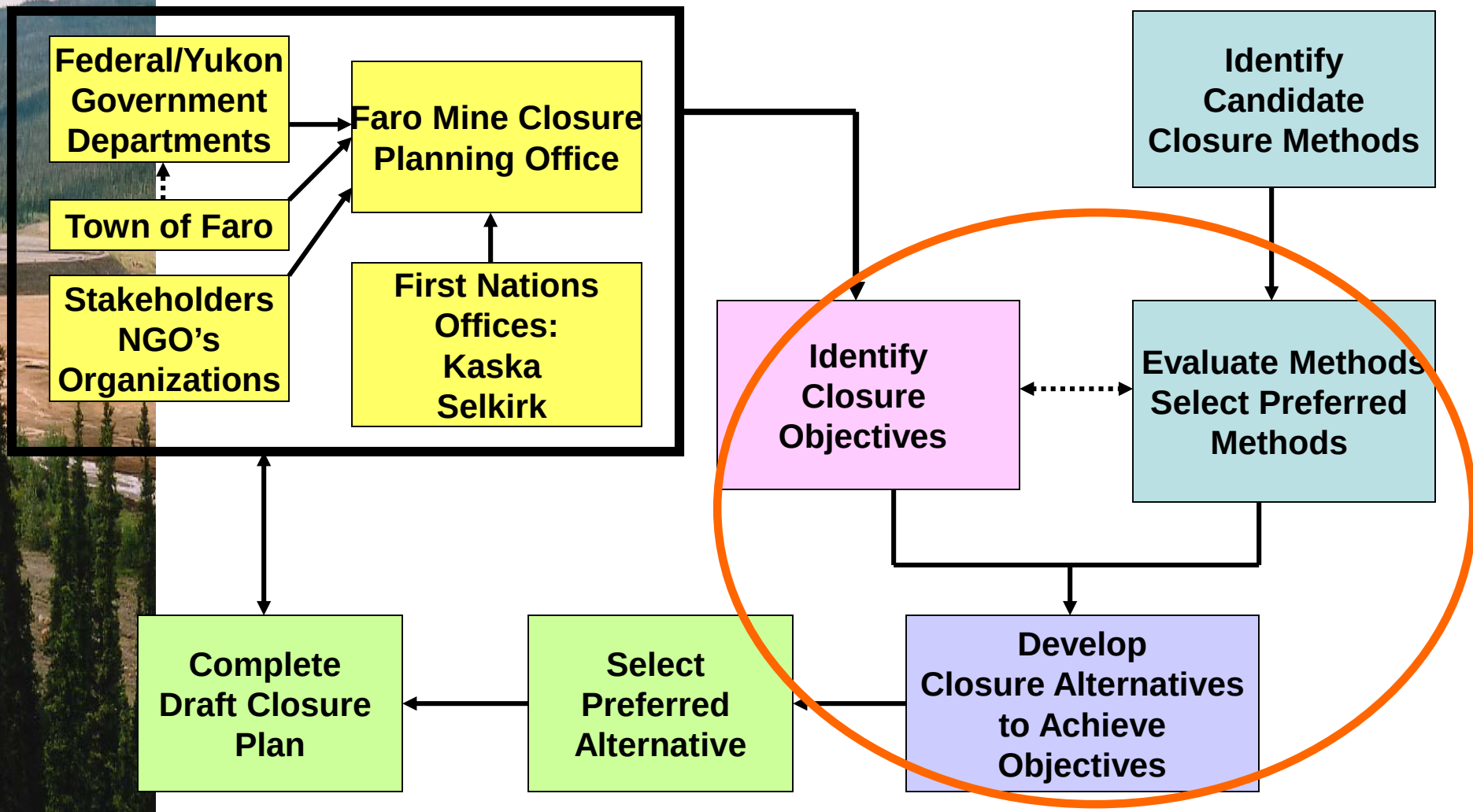
- Overseeing closure planning at the Faro Anvil Range site
- Directing technical studies relating to closure

- Interim Receiver's focus will be on the legal and care and maintenance issues

Faro Mine Closure Planning Process

- Closure Objectives
- Technical Studies
- Identification of Alternatives
- Evaluation of Alternatives versus Objectives
- Selection of Alternatives
- Development of Closure Plan/Design of Closure Alternatives

Closure Plan Development: where we are now

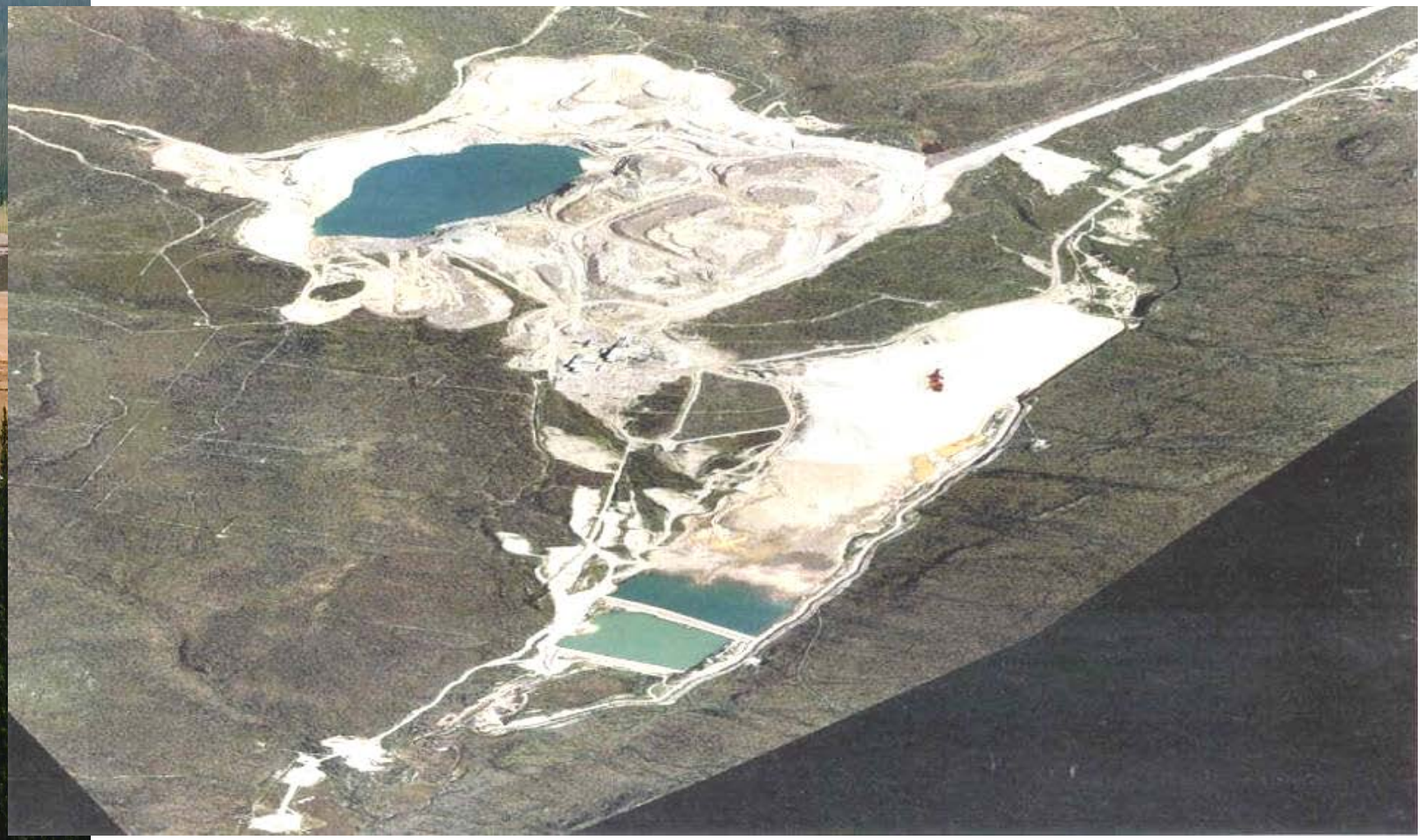


Closure Objectives

Faro Mine – Overarching Closure Objectives

- Protect human health and safety
- Protect and to the extent practicable restore the environment, including land, air, water, fish and wildlife
- Return mine site to an acceptable state of use, that reflects pre-mine land use where possible
- Maximize local and Yukon socio-economic benefits
- Manage long term site risk in a cost effective manner
- Site remediation without transfer of deferred costs to Yukon
- Others

Faro Site Overview



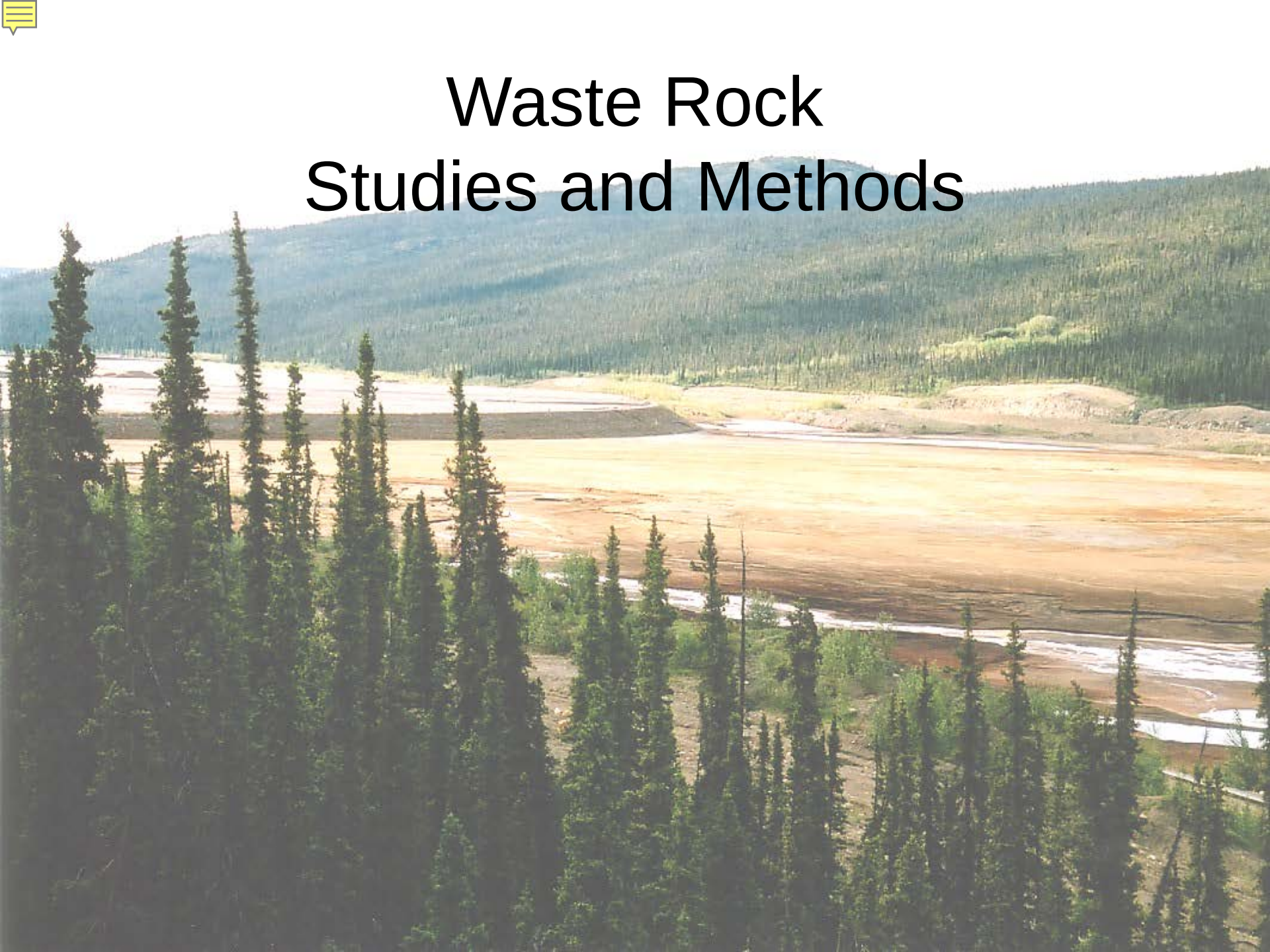
Vangorda/Grum Site Overview

Closure Studies and Methods Review

Studies and Methods Review

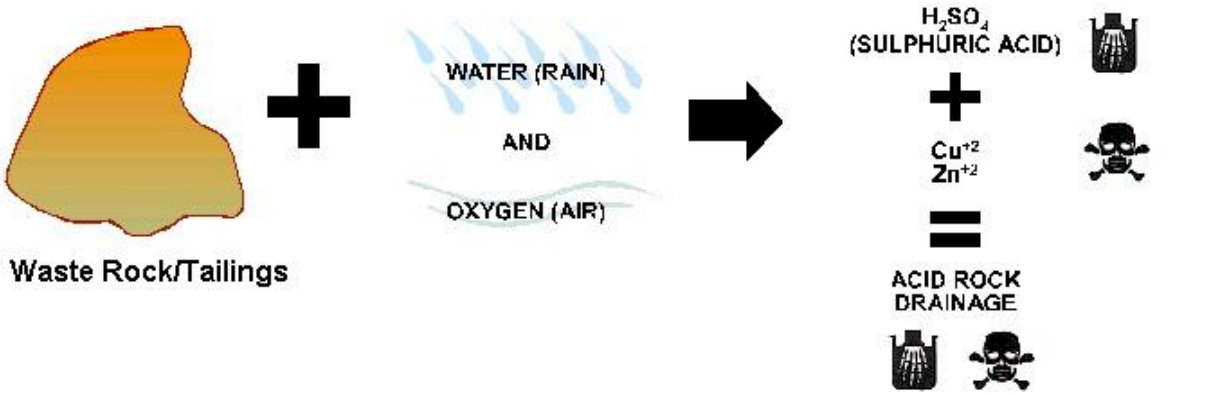
- Study Areas
  - Waste Rock
  - Pits
  - Stream Diversions
  - Down Valley Tailings
  - Environmental Assessment

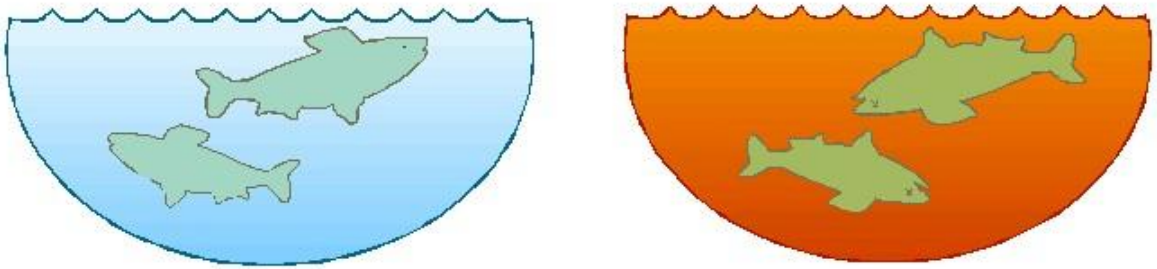
Waste Rock Studies and Methods



Acid Rock Drainage

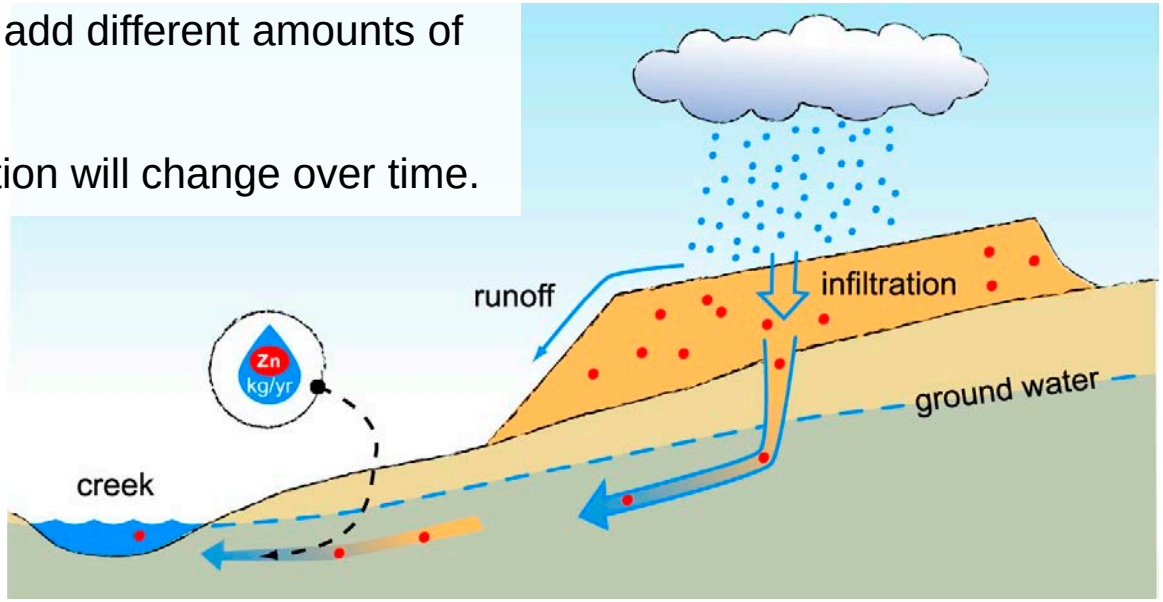
What is Acid Rock Drainage? Contaminated solutions resulting from the oxidation and leaching of sulfide rich rock or tailings upon exposure to air and water.





Waste Rock – Water Quality Predictions

- We want to know how the waste dumps will affect water quality in ground water and nearby streams.
- To predict this, we need to know how much water flows through the dumps (water balance) and the amount of contaminants the rock will add to the water.
- Different types of rock will add different amounts of metals.
- The amount of contamination will change over time.



Waste Rock Water Quality Predictions - Faro

- Estimated current loading from Faro Waste Rock:
  - Sulphate: 1,237 tonnes per year
  - Zinc: 154 tonnes per year
- Estimated future loading from Faro Waste Rock
  - Sulphate: 12,104 tonnes per year
  - Zinc: 2,197 tonnes per year

Waste Rock Water Quality Predictions – Grum

- Estimated current loading from Grum Waste Rock:
  - Sulphate: 196 tonnes per year
  - Zinc: 0.4 tonnes per year
- Estimated future loading from Grum Waste Rock
  - Sulphate: 1,640 tonnes per year
  - Zinc: 265 tonnes per year

Waste Rock Water Quality Predictions – Vangorda

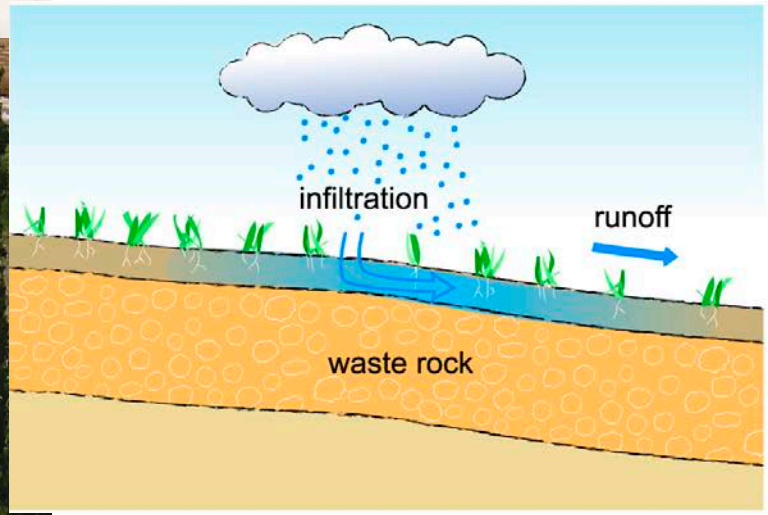
- Estimated current loading from Vangorda Waste Rock:
  - Sulphate: 579 tonnes per year
  - Zinc: 92 tonnes per year
- Estimated future loading from Vangorda Waste Rock
  - Sulphate: 1324 tonnes per year
  - Zinc: 254 tonnes per year

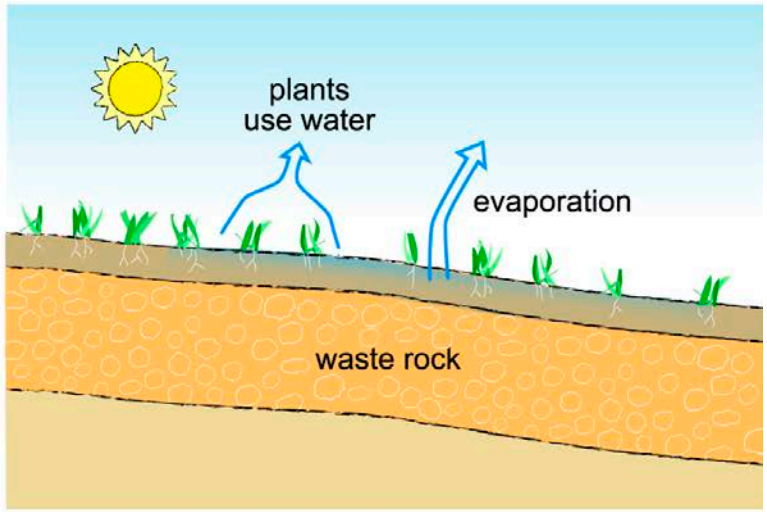
Waste Rock Remediation Methods Water Collection and Treatment

- If all water that passes through waste dumps was collected and treated the amount of lime required could be:
  - At the Faro site:
    - 500 tonnes per year for current conditions
    - 7400 tonnes per year at the highest, in about 200-250 years.
  - At the Vangorda/Grum site:
    - 300 tonnes per year for current conditions
    - 1500 tonnes per year at the highest, in about 40 to 50 years.
- Most waste dumps are not affecting streams yet because the water reaching the streams is still clean. Water collection and treatment from waste dumps won't be started until it is likely to affect streams.

Waste Rock Remediation Methods Covers

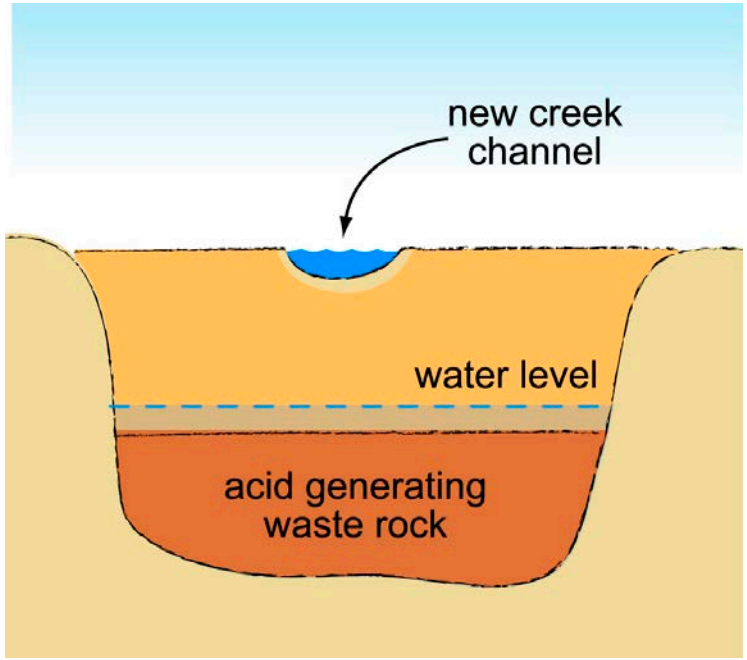
- We need to know how different soil covers will work if we construct them on waste rock.
- A cover was built on some of the Vangorda waste rock in 1994. It give us some information about how a 2 metre thick soil cover works.
- Four additional small trial covers were constructed on Vangorda Waste Rock in 2004. We are monitoring these trial covers to find out:
  - How much water passes through the covers, and
  - Whether the covers will deteriorate with time, especially from winter freezing.
- Covering waste rock will require a lot of regrading of slopes





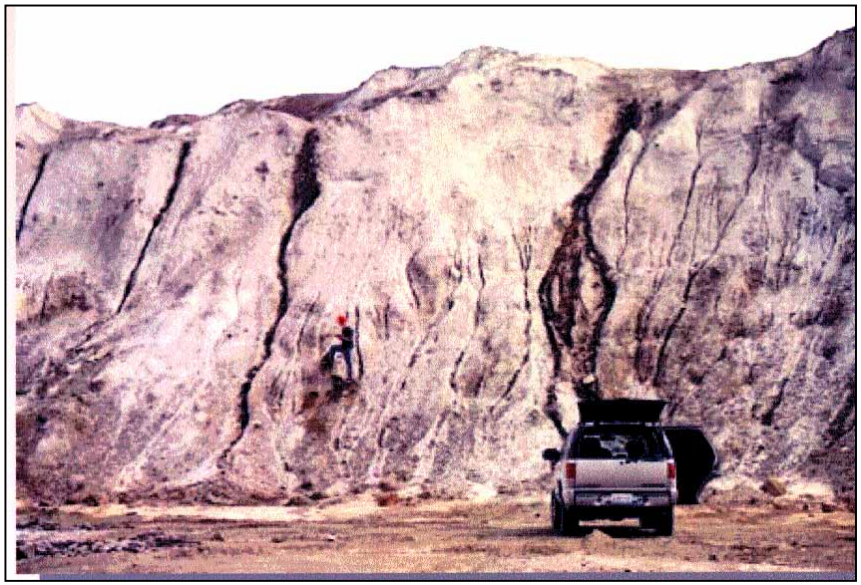
Waste Rock Remediation Methods Relocation (Vangorda Waste Rock)

- Vangorda waste rock, which is mostly acid generating, could be put back in the pit.
- Acid generating rock would mostly be below the water level, which is the best location to lower metal release.
- Lime would likely be added to the acid generating rock.
- Once the pit is full of rock, then Vangorda Creek could be rebuilt near its original location. It would flow across the waste rock in a new channel.
- Water treatment might be needed for ground water passing through the filled pit.

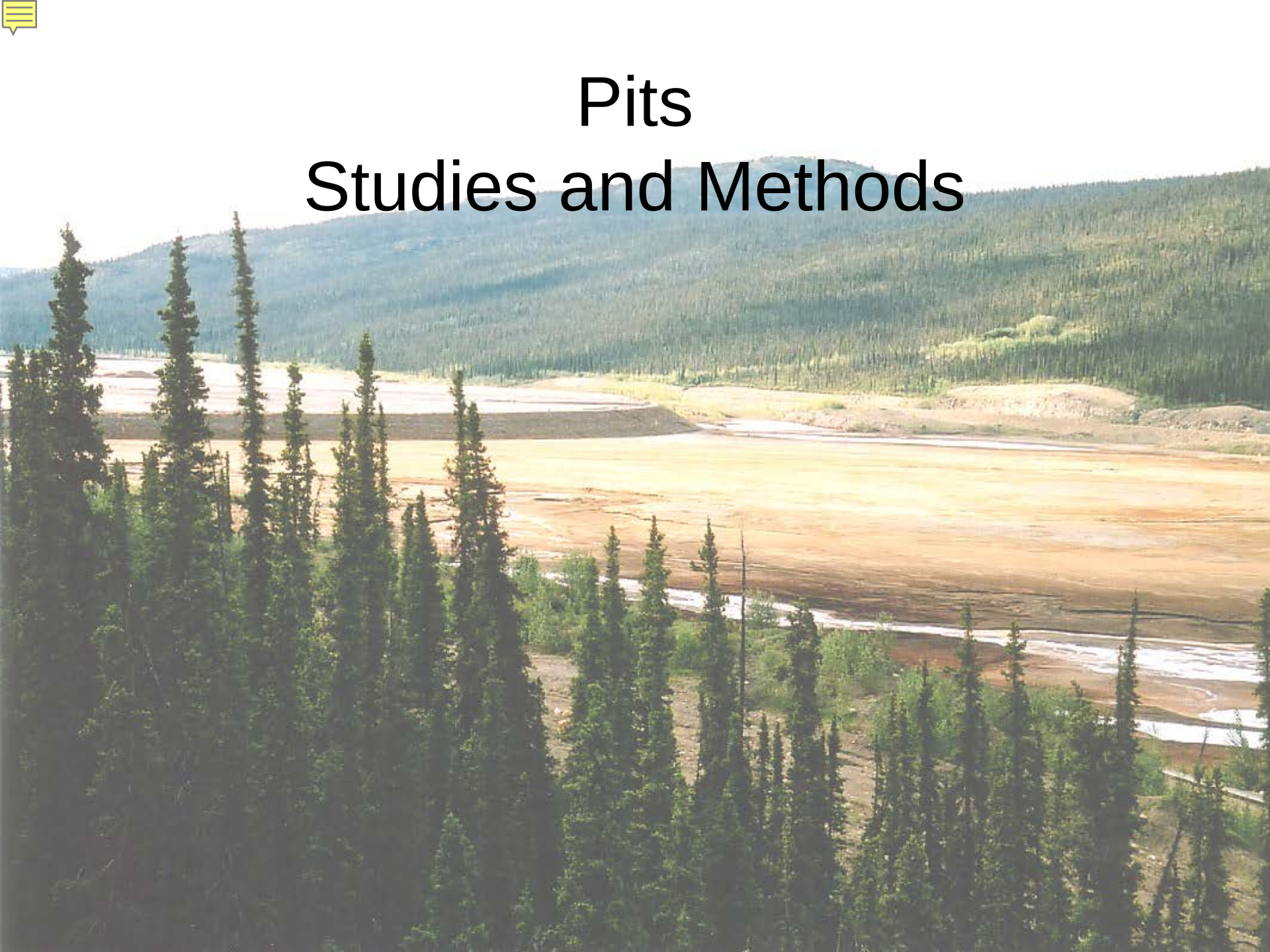


Waste Rock Remediation Methods
Faro – Oxide Fines and Low Grade Ore

- Oxide fines and low grade ore are the worst quality waste rock at the Faro site. They likely cause a lot of the current metal release from waste rock.
- Three options are being considered for reducing metal release by these dumps:
  - Covering them where they are,
  - Moving them all to one location and then covering them, or
  - Moving them into the Faro Pit.
- Both covers and storage in the pit have potential problems:
  - Covers might leak and they might deteriorate from frost and erosion.
  - The materials will cause some short-term (potentially severe) increase of metals in the pit.

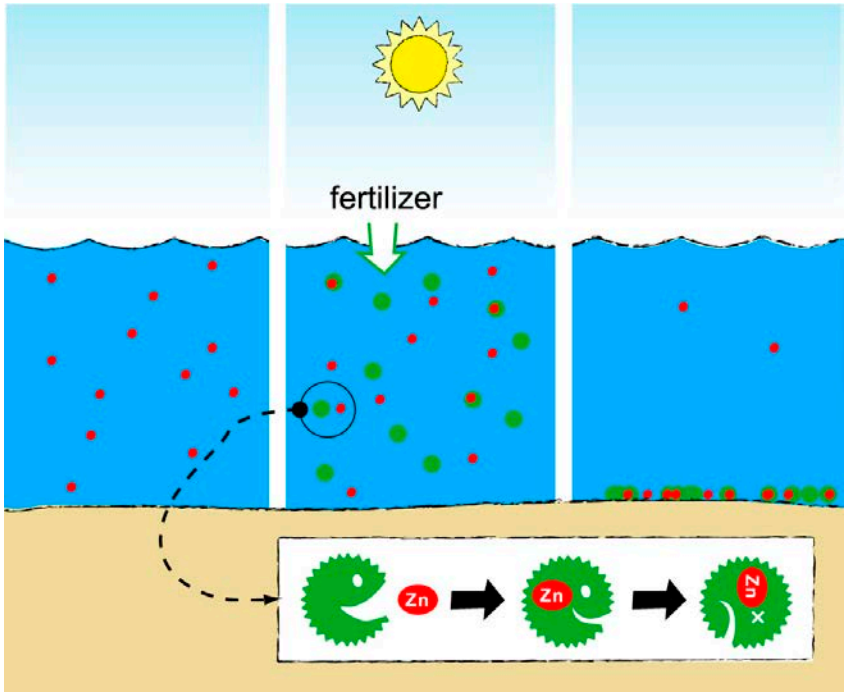


Pits
Studies and Methods



Pit Remediation Methods
In-Pit Biological Treatment

- Algae in pits can help to remove metals from water: they absorb the metals and when they die, they settle to the bottom with the metals.
- Fertilizer has to be added to the pits to feed the algae.
- Biological treatment only works in the summer, when algae can grow. The pits need to be able to store water over the winter.



Pit Remediation Methods

In-Pit Biological Treatment – Test Results

- In the Grum Pit, biological treatment will likely be able to remove metals that will continue to enter the pit water.
- The treatment will likely be able to remove most of the existing metals within about 8 years, before the pit fills. It might be possible to stop treatment after that.

Pit Remediation Methods
In-Pit Biological Treatment – Test Results

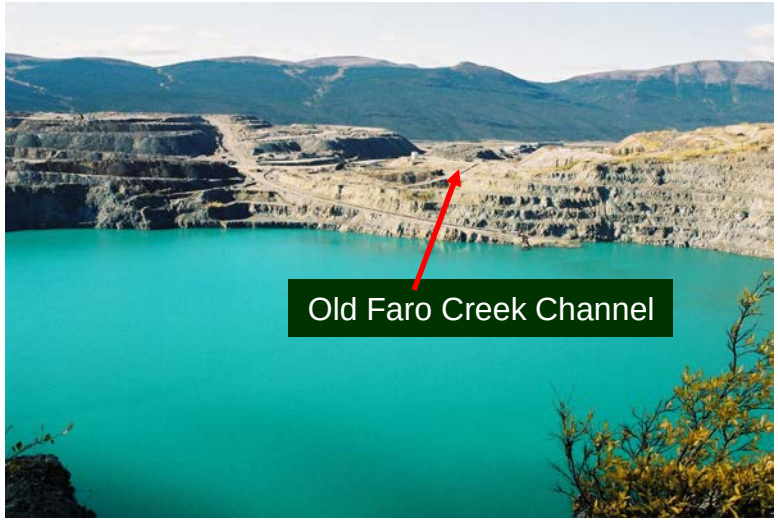
- In the Vangorda Pit, biological treatment will not be able to treat metals that will continue to enter the pit water. Metals come into the pit too quickly.

Pit Remediation Methods
In-Pit Biological Treatment – Test Results

- In the Faro Pit, biological treatment might be able to treat metals that continue to enter the pit water, but only after the pit is full of water.
- The treatment will likely be able to remove most of the existing contamination, but it will take a long time. Even after this, biological treatment will have to continue so that metals do not accumulate.
- Right now, we pump water from the Zone 2 pit into the Faro pit. There are a lot of metals in this water. We don't know if biological treatment can remove these metals.
- There are some seasonal issues related to performance of biological treatment in the Faro pit.

Pit Remediation Methods
Faro Pit Plug Dam

- The Faro Pit has adequate capacity to contain all of the tailings from the Down Valley.
- Once the Faro Pit fills, it would overflow into the buried Zone 2 pit which has very poor water quality. Water would eventually flow to the North Fork of Rose Creek.
- A Plug Dam would let water fill more of the pit. This has two big advantages:
  1. Water could overflow from the pit at in a newly constructed channel that avoids the acid generating rock in zone 2.
  2. More of the pit wall would be under water, which would reduce the metal contamination and allow biological treatment to work better.

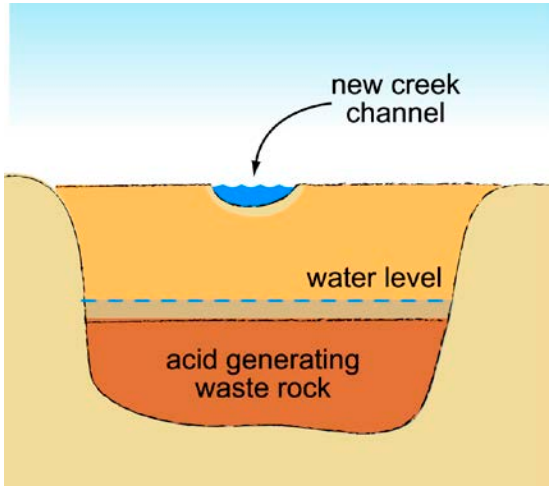


Pit Remediation Methods Vangorda Pit

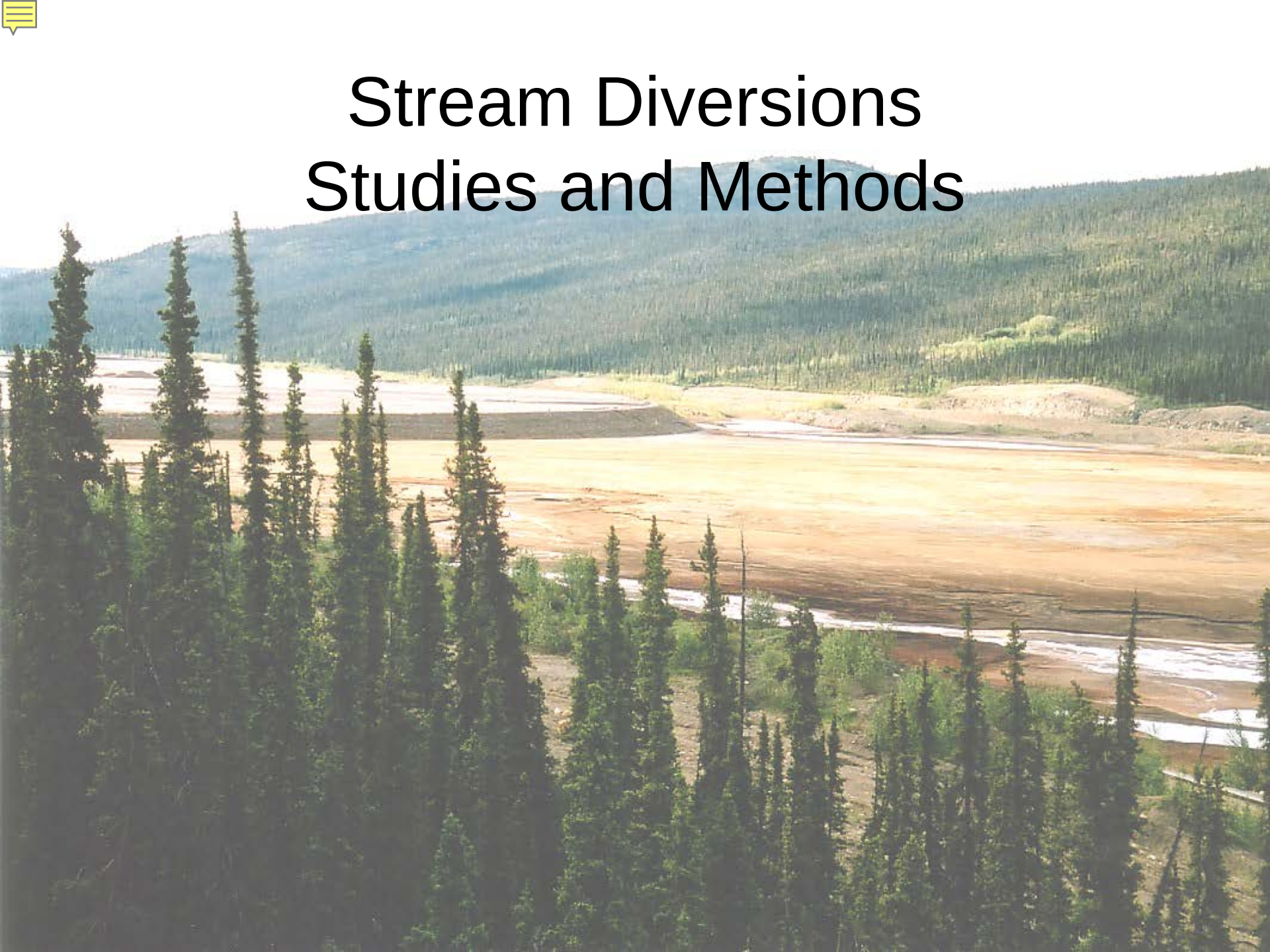
- Two options are being considered for the Vangorda Pit:

1. Backfilling the pit with waste rock.

2. Leaving the pit as a contaminated water reservoir.

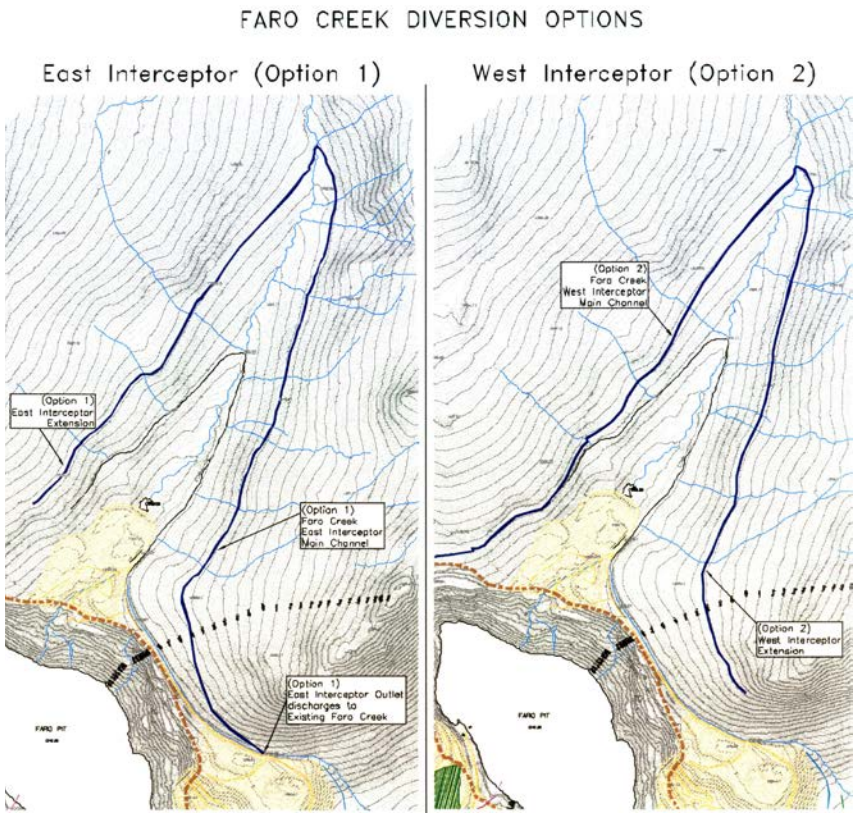


Stream Diversions Studies and Methods



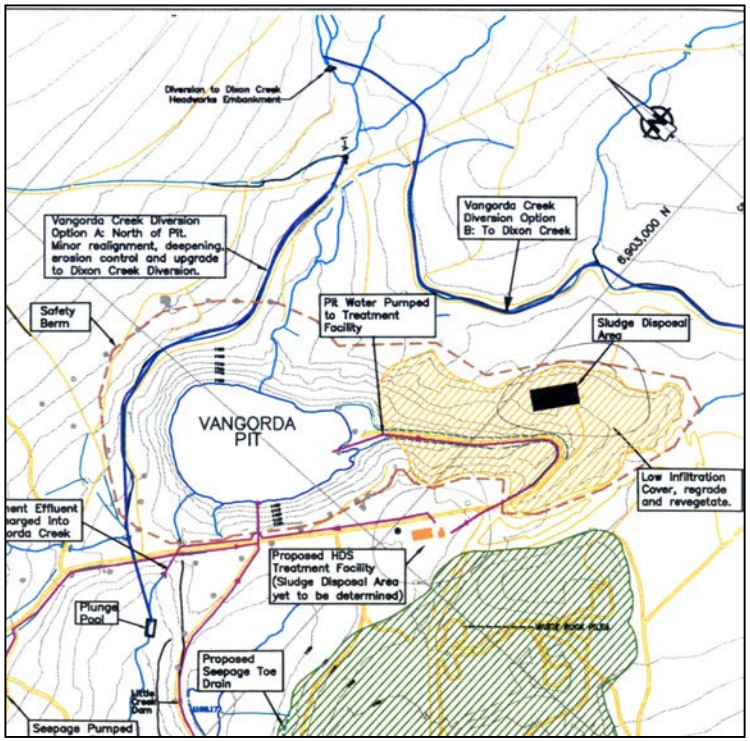
Stream Diversion Remedition Methods
Faro Creek Diversion

- If pit water quality is acceptable Faro Creek Diversion may not be necessary because Faro Creek can flow into the pit. This would require construction of new channels for water to flow into and out of the pit.
- If Faro Creek water has to be kept out of Faro Pit for closure, the diversion will have to be moved. Two options have been considered for an upgraded Faro Creek Diversion:
  - The East Ditch option would flow east, into the North Fork of Rose Creek, at the same location as the existing Faro Creek Diversion.
  - The West Ditch option would flow west, eventually to Rose Creek downstream of the tailings.



Stream Diversion Remedition Methods
Vangorda Creek Diversion

- If the Vangorda Pit is filled with waste rock, Vangorda Creek can flow over the top of the pit near its original location.
- If the Vangorda Pit is not filled with waste rock, the Vangorda Creek Diversion will have to be moved and upgraded. Two options are being considered for an upgraded Vangorda Creek Diversion:
  - A diversion along the same side of the pit as the existing diversion, flowing into Vangorda Creek.
  - A diversion along the east side of the pit, flowing into Dixon Creek.

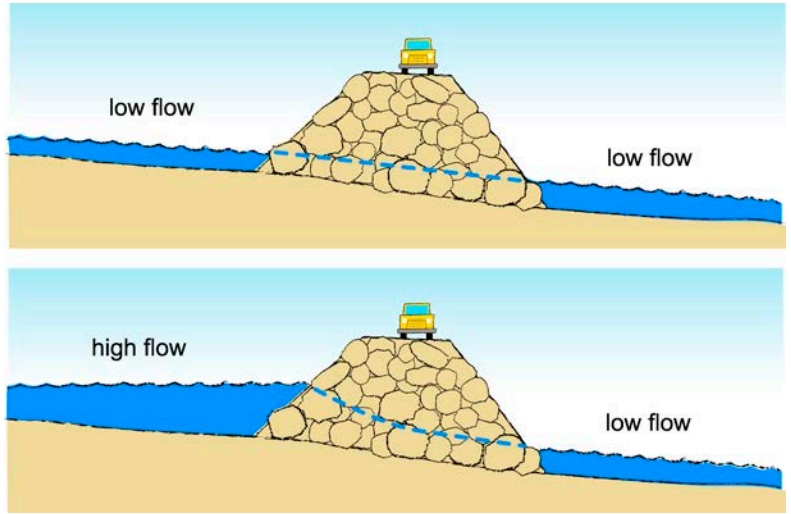


Stream Diversion Remedition Methods
Rose Creek Diversion

- If the tailings remain in the valley, the Rose Creek Diversion will have to be upgraded so that it can withstand severe earthquakes and floods.
- The existing diversion is about 12 metres wide and can probably handle about 80 m^3/s.
- For Closure, the Rose Creek Diversion may need to handle flows of up to several hundred m^3/s. For some flows, this could require widening the channel to approximately 70 metres.

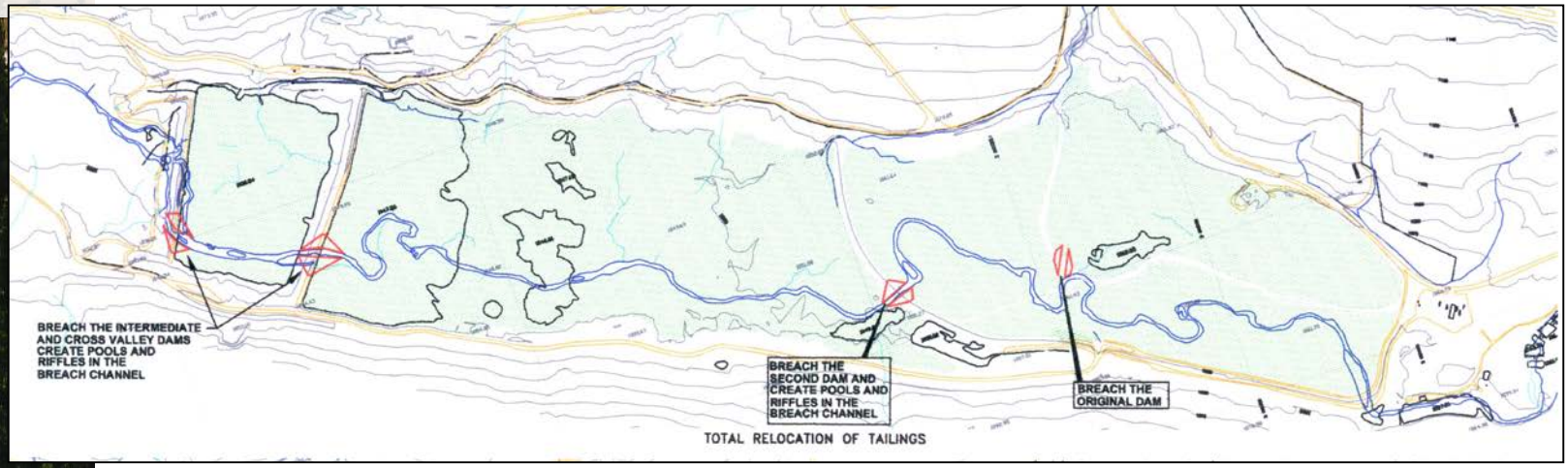
Stream Diversion Remedition Methods
Rose Creek - North Fork Rock Drain

- The North Fork Rock Drain is large rock in the haul road that allows water from the North Fork of Rose Creek to pass through.
- In big floods, the Rock Drain slows some of the water down which means that the flows are lower in the Rose Creek Diversion.
- The Rock Drain wasn't built for this purpose and we still need to understand how well it will work in the long-term and how much it will reduce the flood flows.

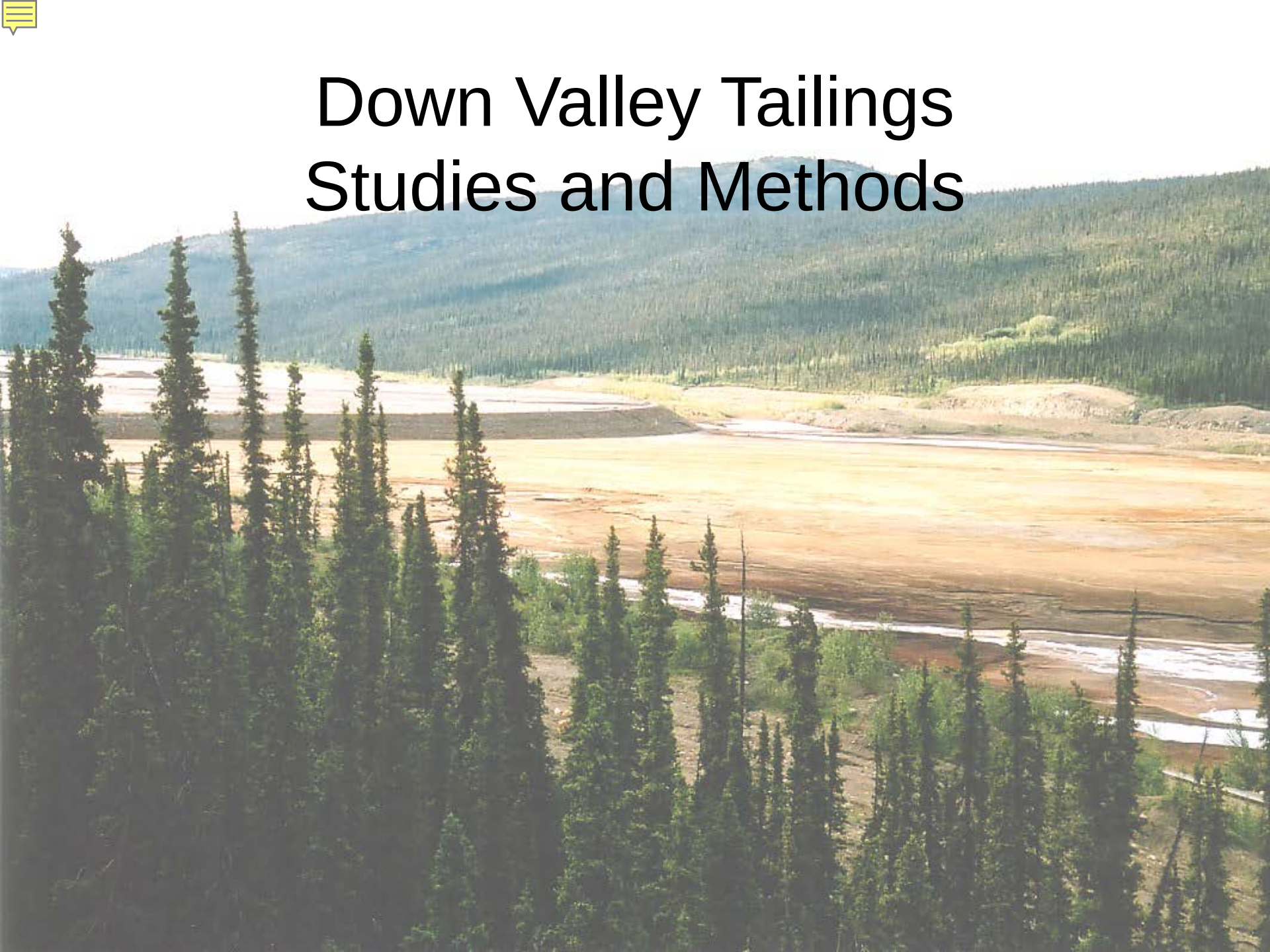


Stream Diversion Remedition Methods
Rose Creek Diversion

- If the tailings are moved, a new Rose Creek channel will have to be built in the valley.
  - The existing diversion and at least one dam would likely be kept until water quality in the valley is acceptable. This may take many years.
  - A new channel in the valley would follow the original Rose Creek channel as much as possible.
  - Remaining metals in the valley would likely slow the process of revegetation in the area.



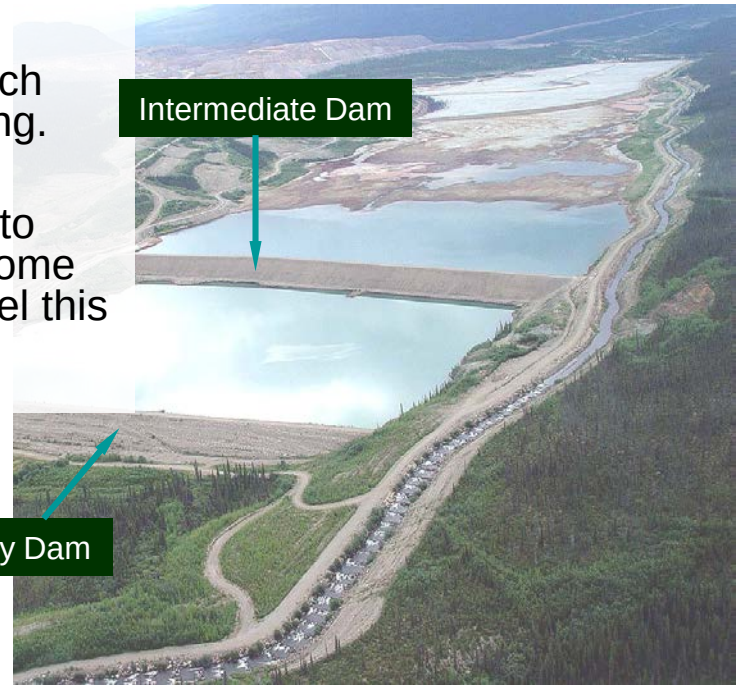
Down Valley Tailings Studies and Methods



Down Valley Tailings Studies

Water Quality in the Rose Creek Ground Water

- To understand how the tailings will affect Rose Creek, we need to know how water flows in the tailings and under the tailings.
- We also need to understand how the contaminants flow.
- For each closure option we need to know how much water will likely have to be treated, and for how long.
- Water takes a long time (approximately 20 years) to flow under the tailings to the Cross Valley Dam. Some metals, like zinc take longer than the water to travel this far.



Down Valley Tailings Studies - Results

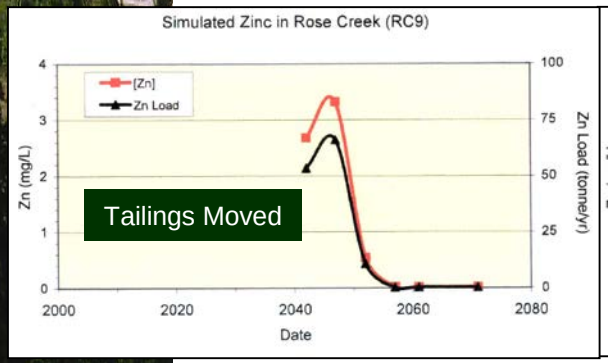
Water Quality in the Rose Creek Ground Water

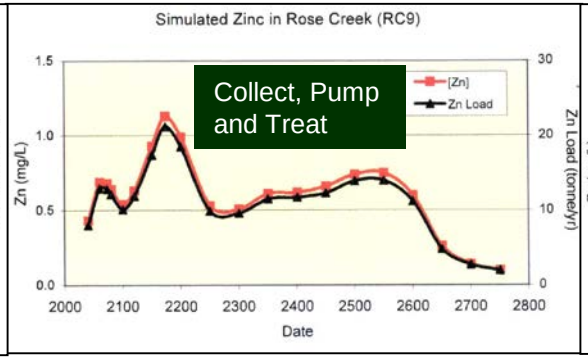
- A lot of contamination in the Rose Creek Valley seems to come from the old Faro Creek Valley – likely from waste rock and the Emergency Tailings Area.
  - Collection and treatment of ground water from this area will be required.
- All of the remediation options, including moving all of the tailings, will likely require some collection and treatment of ground water in the Rose Creek Valley.

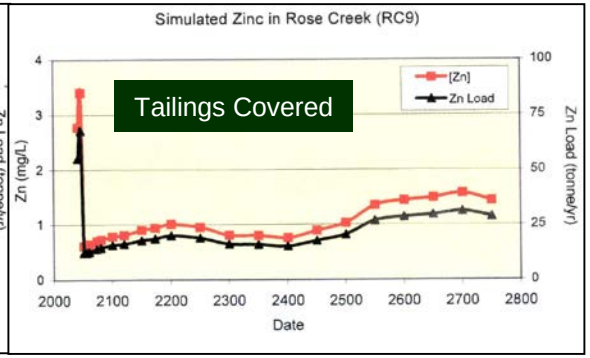
Down Valley Tailings Studies - Results

Water Quality in the Rose Creek Ground Water

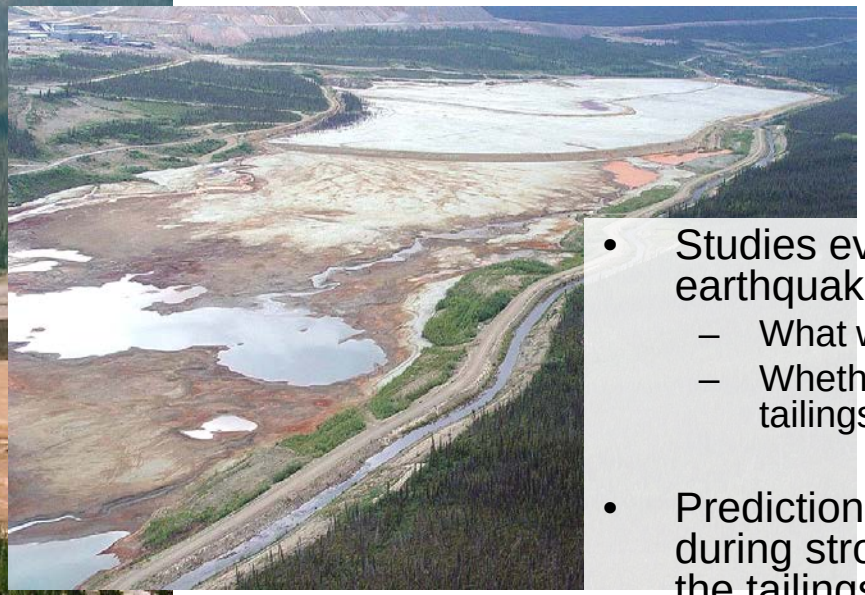
- Predictions about water quality are only preliminary.
  - With no remediation of tailings, but collecting and treating seepage and groundwater at the Cross Valley Dam, zinc levels in Rose Creek would likely remain high for several hundred years.
  - With full relocation of tailings, zinc levels would be high for 40 to 60 years. Seepage and groundwater collection would be needed during this time.
  - Building a high quality soil cover would reduce the zinc levels, but they would still increase to moderately high levels over the next 40 years and remain elevated for several hundred years. Seepage and groundwater collection would be needed during this time.
- We are still evaluating how ground water collection and treatment will work in combination with moving tailings or building covers, but we are confident that the long-term contamination issues can be addressed.





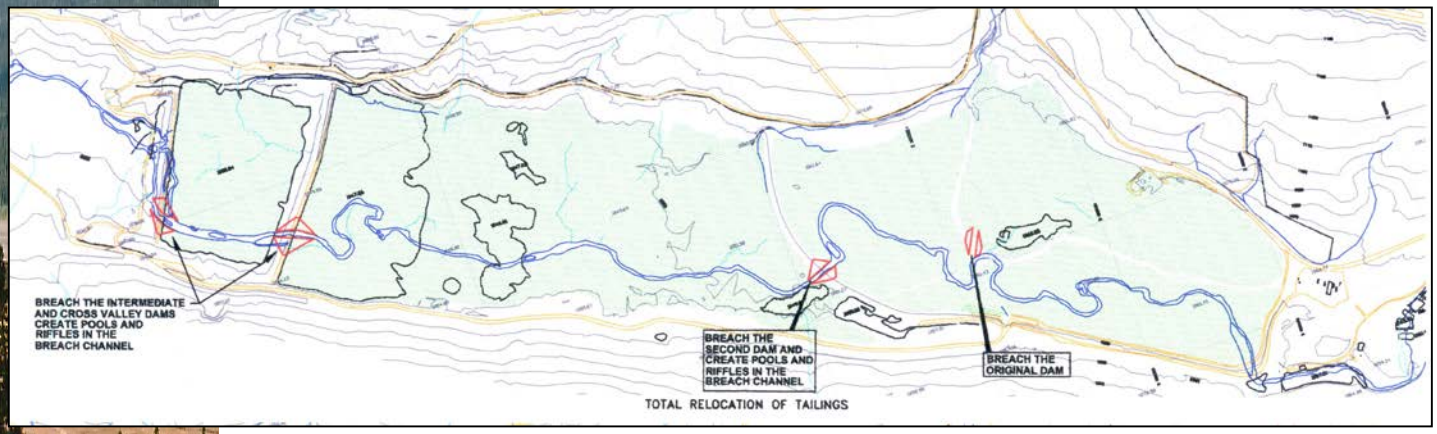


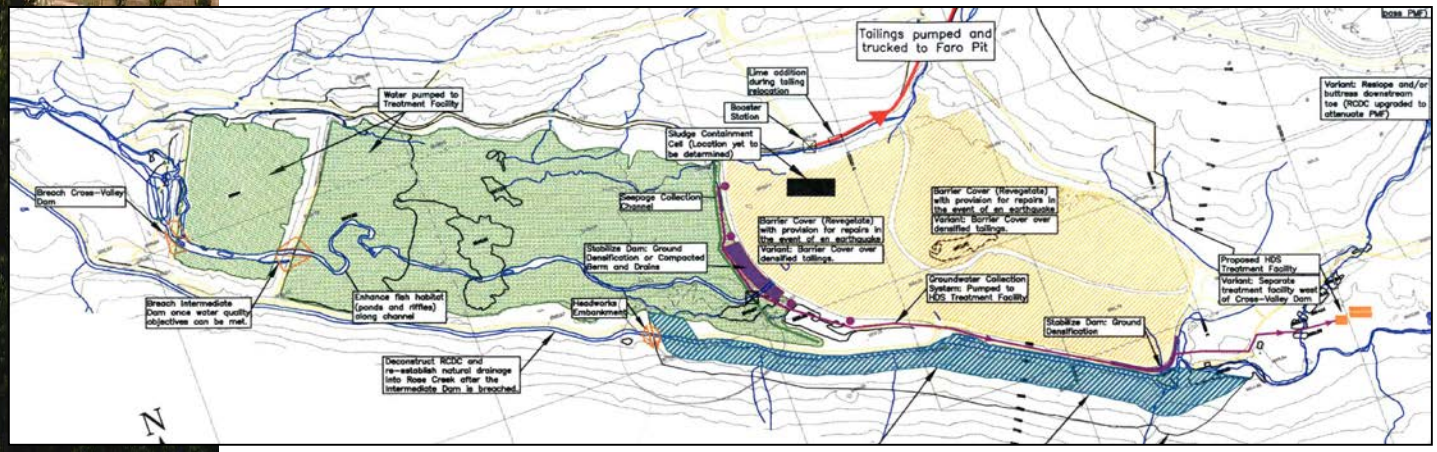
Down Valley Tailings Studies Tailings Properties



- Studies evaluated what would happen to tailings under earthquake conditions. We wanted to know:
  - What would happen if covers were built on tailings.
  - Whether we could construct a diversion channel on top of the tailings.
- Predictions suggest that the tailings would not be stable during strong earthquakes and that they may slide within the tailings impoundment.The dams were evaluated in separate studies.
- Without some additional preparation, the tailings will not provide stable foundations for other structures like diversions.
- Tailings covers would likely be damaged during strong earthquakes and would have to be repaired.

Down Valley Tailings – Methods Tailings Relocation

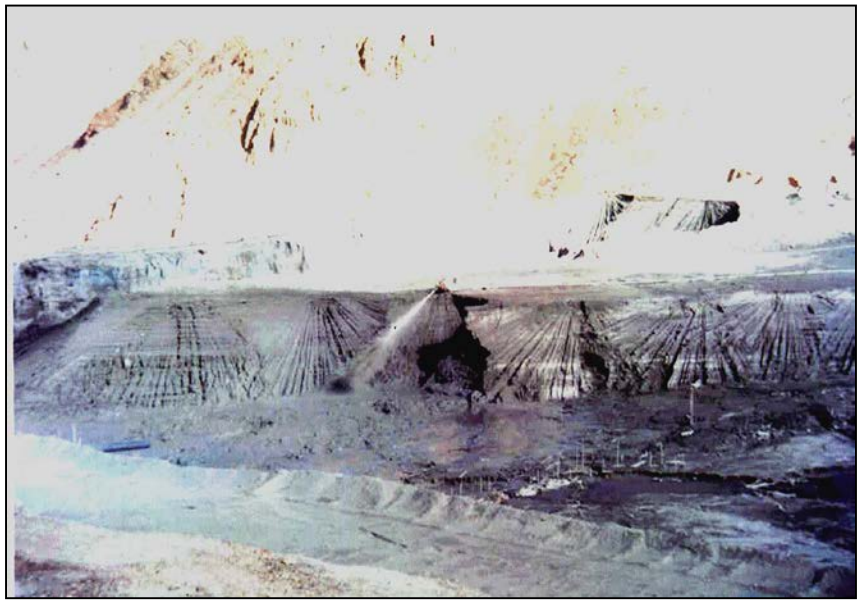




- Two options are under consideration for Tailings Relocation:
  - Moving all of the tailings to the Faro Pit.
  - Moving the tailings from the Intermediate Impoundment to the Faro Pit.

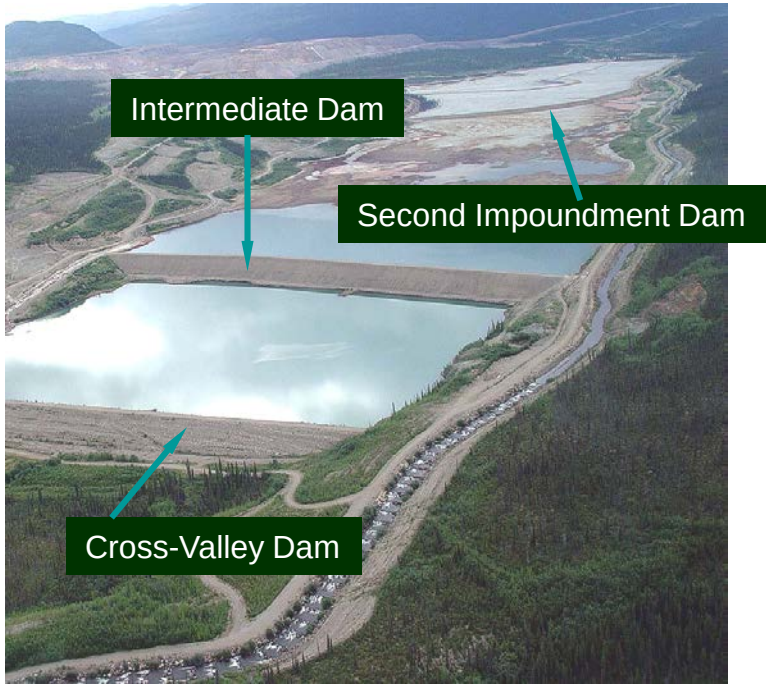
Down Valley Tailings – Methods Tailings Relocation

- Tailings relocation would be done using hydraulic monitoring.
- There are 57,000,000 tonnes of tailings in the Down Valley; 24,000,000 tonnes are in the Intermediate Impoundment
- The partial relocation option will require upgrading the Second Impoundment Dam.
- Any tailings left in the valley will have to be covered, otherwise the collection and treatment of ground water might not be successful in preventing unacceptable effects on Rose Creek.



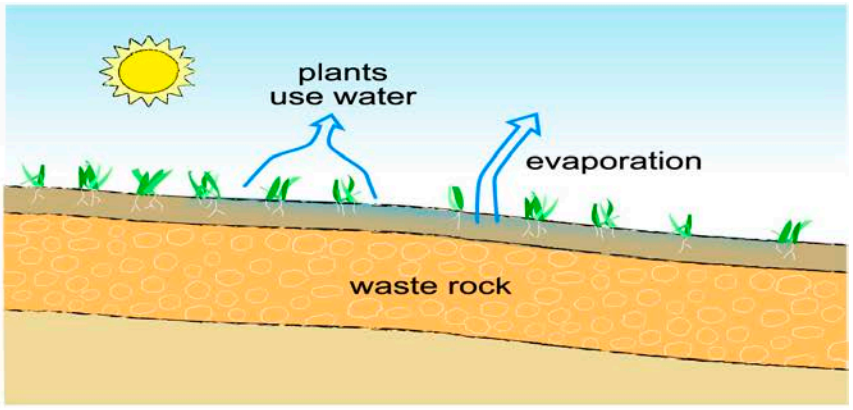
Down Valley Tailings – Methods Dam Upgrades

- If tailings remain in the Rose Creek Valley, dams will have to be retained for the long-term.
- Some dams may require upgrading to withstand strong earthquakes:
  - The foundation of the Second Impoundment Dam may require upgrades in two areas where the soil under the dam is too loose.
  - The foundations of the Intermediate Dam and the Cross-Valley Dam may require upgrades where soils may be too loose. Further investigations are needed.

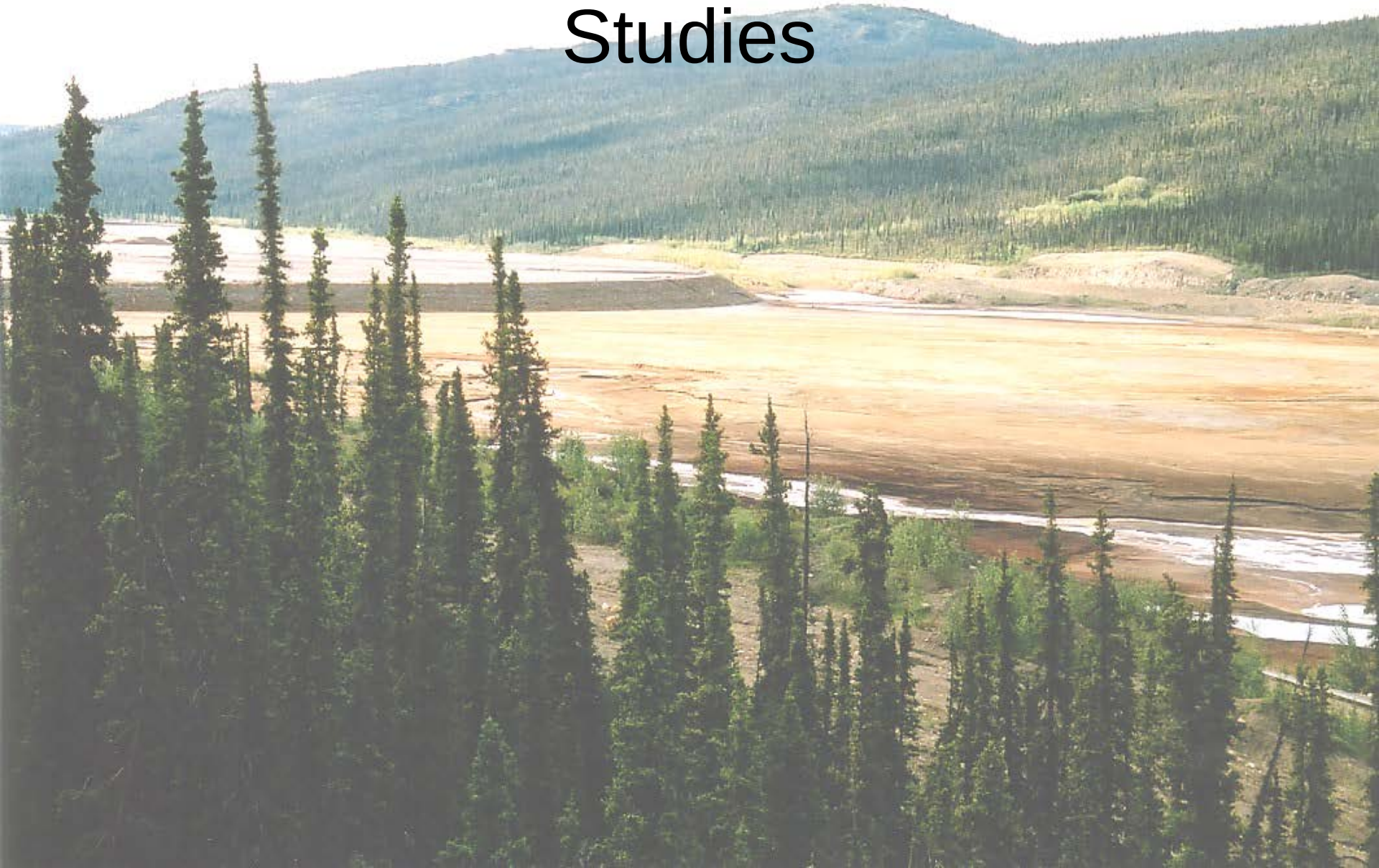


Down Valley Tailings – Methods Soil Covers

- Purpose of tailings covers:
  - Reduce water or air infiltration into tailings
  - Dust control
  - Provide a material for plants to grow
- Types of tailings covers:
  - **Low Infiltration Covers** that reduce water infiltration by providing a tight seal.
  - **Store and Release Covers** that reduce water infiltration because they soak up water so it can evaporate or be used by plants.
- Cover construction on tailings is technically challenging. Soil covers may be affected by frost action.
- We don't know how long a cover would last on tailings because the tailings likely won't be stable in earthquakes. We don't know how much damage would be done to a cover if the tailings moved in an earthquake.



Environmental Assessment Studies



Environmental Assessment
Site Specific Water Quality Objectives

- Studies are underway to determine how contamination from the mine site will affect ecosystems in Rose Creek.
  - At what levels are the contaminants toxic to ecosystems.
  - What levels of contamination are acceptable if we want to avoid long-term effects on the ecosystems.
  - What ecosystem components are most sensitive.
- The results of these studies will be used to decide what remediation activities will prevent unacceptable effects on the ecosystems in Rose Creek.

Environmental Assessment
Terrestrial Effects

- Levels of metals in plants, soil and animals have been studied in 2003 and 2004 (Selkirk First Nation and the Ross River Dena Council helped to identify appropriate plants and animals).
- 2003 test work concluded that metals likely come from mine dust and that they are still high at least 2 to 3 kilometres from the mine site.
- 2004 studies found that metals are still moving from the mine site – using moss bags.
- Lichen and plants eaten by animals and humans have been evaluated in the studies.
  - Berries included kinnikinnick, low bush cranberry, red bearberry, crowberry, soopalallie, blueberry and cloudberry.
- Animals in three categories were studied:
  - Small mammals like voles and shrews.
  - Furbearers including snow shoe hare and marten.
  - Hunted animals including moose and grouse.
- The Conservation Officer Service in Faro and Ross River assisted in collecting furbearer carcasses and animal organs from trappers and hunters.
- Additional studies is being carried out in 2005 to help determine what environmental effects are occurring from the mine.

Environmental Assessment Overall Site Water Balance

- The results of many studies are being combined to explain how water and contaminants move on the site.
- This helps to understand when and where the water will enter the streams (Rose Creek or Vangorda Creek) and what level of contamination may occur.
- The model can be used to predict performance of various remediation options.

Environmental Assessment
Aquatic Effects Study

- Selkirk First Nation began an aquatic effects study in 2001 to assess whether the Faro Mine is causing any downstream effects on the aquatic environment. The program was continued through 2004, and monitoring has now been completed for the 2005 program.

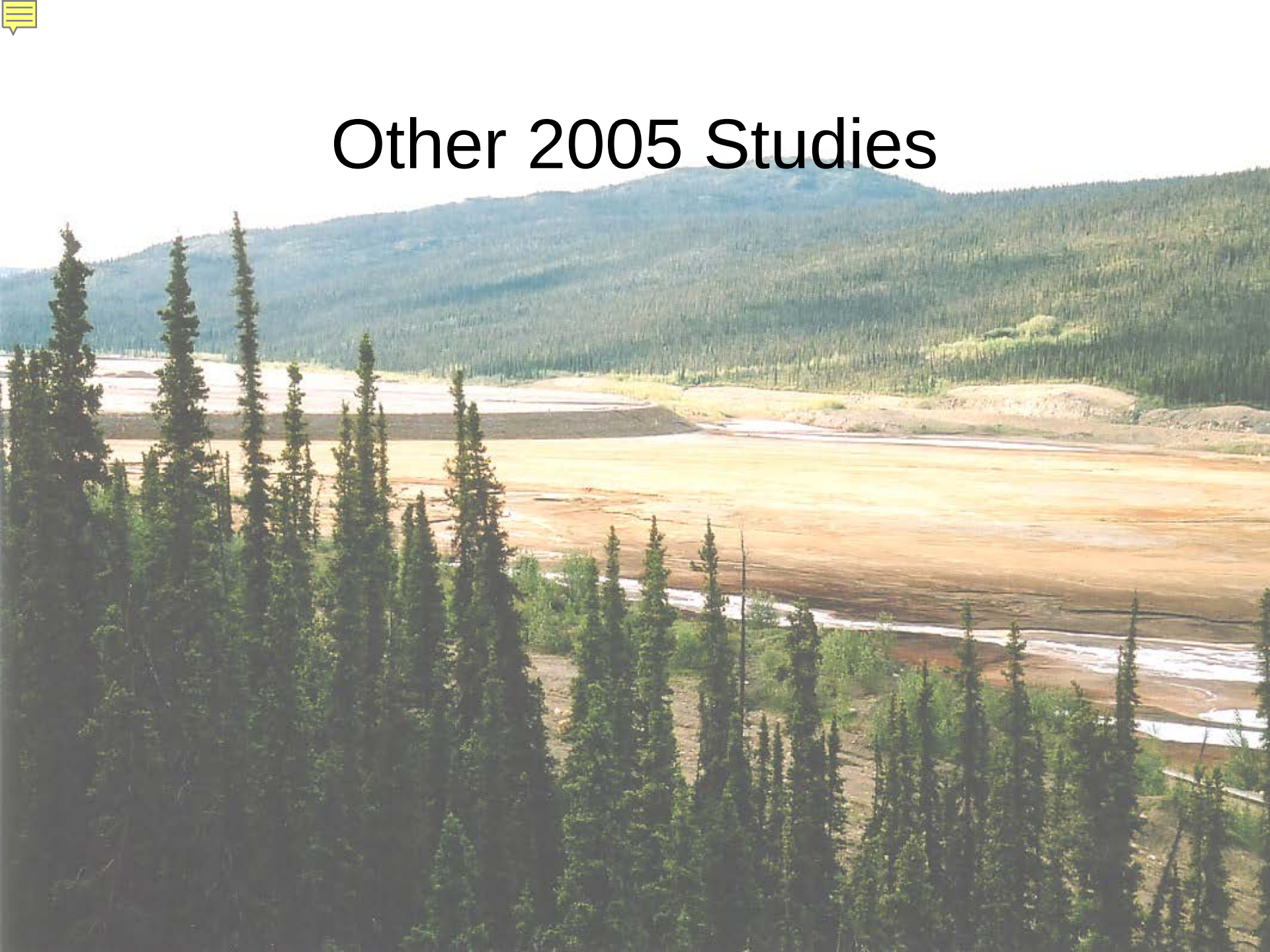
- Sampling includes:
  - Water
  - Sediment
  - Benthic Invertebrates
  - Fish and fish habitat

- The 2004 study also included assessment of the 1975 tailings spill. Further assessment is to be done in 2005

Environmental Assessment
Human Health and Ecological Risk Assessment

- A 2005 study is underway to better understand how the closed mine might affect the environment and people.
- This study uses the results of the terrestrial effects study, other monitoring programs and the overall site water balance.
- With these results, we hope to be able to predict how various alternatives might affect plants, animals and humans in the long-term.

Other 2005 Studies



2005/06 Technical Studies

- Overall Site Water Balance and Contaminant Loading Balance
- Cover trials and monitoring
- Further bioremediation testing in Faro Pit
- Design investigations for:
  - Plug Dam
  - Faro Pit outflow channel
  - Groundwater collection systems
- Contaminant attenuation
- Probable Maximum Flood
- Environmental Assessment studies
  - Water quality objectives
  - Terrestrial effects
  - Human health and ecological risk assessment
- Emergency Tailings Area
- Oxide Fines/Low Grade Ore

Next Steps

Closure Planning Next Steps

- Site has been divided into three large areas:
  - Faro Mine Area
  - Tailings Area
  - Vangorda/Grum Mine Area
- Closure concepts are being considered for all of these areas.
- Closure alternatives are being developed for each component on the site:
  - Where additional information is needed to define alternatives, that information is being collected.
  - Comparable costs are being developed for each of the alternatives.
  - Outstanding risks and uncertainties are being identified and evaluated for each alternative.

Closure Planning Next Steps

- Once the alternatives for the components have been developed, they will be presented to communities and First Nations for their consideration, comments and suggestions.
- The alternatives will be evaluated against the closure objectives.
- The comments and suggestions will be used in selecting which alternatives should receive further consideration in compiling overall closure options.
- Once the Oversight Committee selects appropriate alternatives for further consideration, overall closure options will be developed. These will be presented to communities for further discussion.

Alternatives Under Consideration Faro Mine Area

- Faro Pit
  - Flow-through pit
  - Isolated pit
  - Biological Treatment
  - Conventional Water Treatment
  - Plug Dam
- Waste Rock Dumps
  - Relocation
  - Low Infiltration Covers
  - Vegetation Covers
  - Seepage Collection and Treatment
- Faro Creek Diversion
  - Divert into pit
  - East Diversion
  - West Diversion

Alternatives Under Consideration Tailings Area

- Complete Relocation of Tailings to Faro Pit
  - All dams removed: some may remain in place for extended time while metals are removed from the area.
  - Rose Creek eventually returned to the valley: diversion maintained while metals are removed from the area.
- Soil Cover on Tailings
  - Dams and the Rose Creek Diversion must be upgraded to withstand severe earthquake and flood events.
- Partial Relocation of Tailings to Faro Pit
  - Some dams would be retained, and must be upgraded to withstand severe earthquake and flood events.
  - Part of the Rose Creek Diversion must be upgraded to withstand severe earthquake and flood events.
  - Part of Rose Creek would eventually be returned to the valley: the diversion would be maintained while metals in the valley are removed from the area.
- All three options would likely require some collection, pumping and treating for contaminated water.

Alternatives Under Consideration Vangorda/Grum Mine Area

- Vangorda Pit
  - Backfill with Waste Rock
  - Maintain as dirty water pit with water treatment.
- Grum Pit
  - Biological Treatment
- Waste Rock Dumps
  - Relocation
  - Low Infiltration Covers
  - Vegetation Covers
  - Contingency Seepage Collection and Treatment
- Vangorda Creek Diversion
  - Over backfilled pit
  - Close to current alignment
  - Dixon Creek





Faro Mine Closure Planning

Salmon Committee Meeting
September 2005