



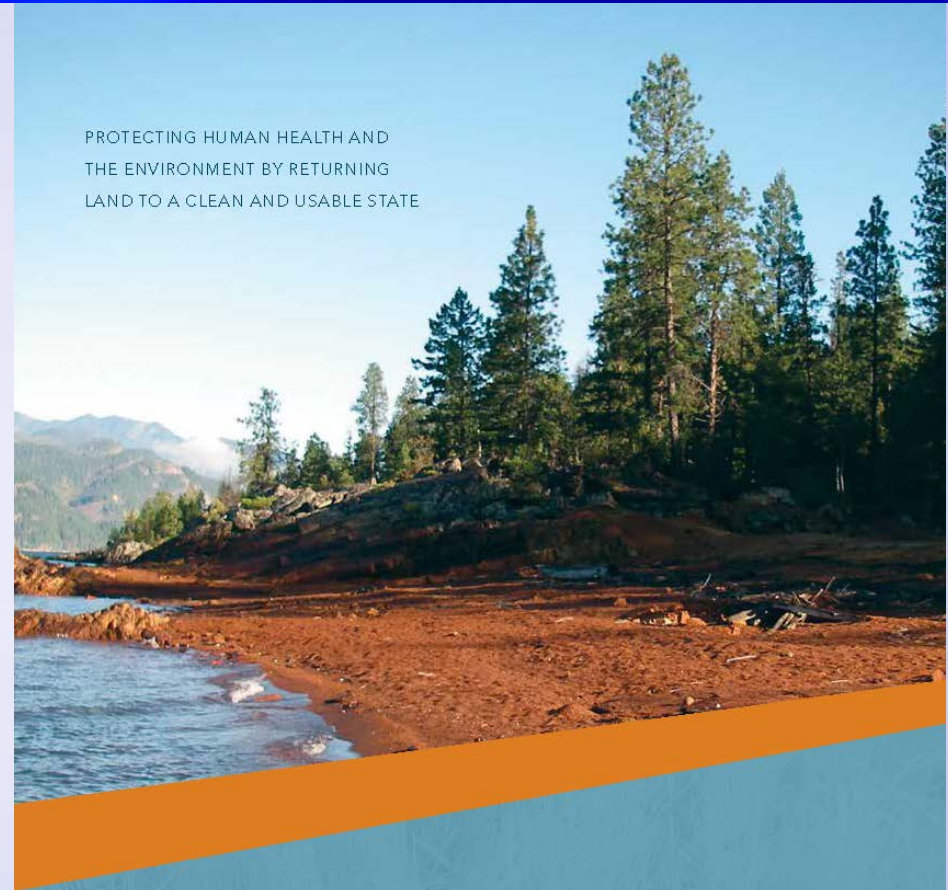
Ministry of **Forests, Lands, Natural Resource Operations**
and **Rural Development**

BC's Crown Contaminated Sites Program (CCSP) - Experiences Remediating Small, Old Mines

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**26th Annual MEND ML/ARD
Workshop
December 4, 2019
Vancouver, BC**

PROTECTING HUMAN HEALTH AND
THE ENVIRONMENT BY RETURNING
LAND TO A CLEAN AND USABLE STATE



CROWN CONTAMINATED SITES PROGRAM
Crown Land Opportunities and Restoration Branch
Ministry of Forests, Lands, Natural Resource Operations and Rural Development

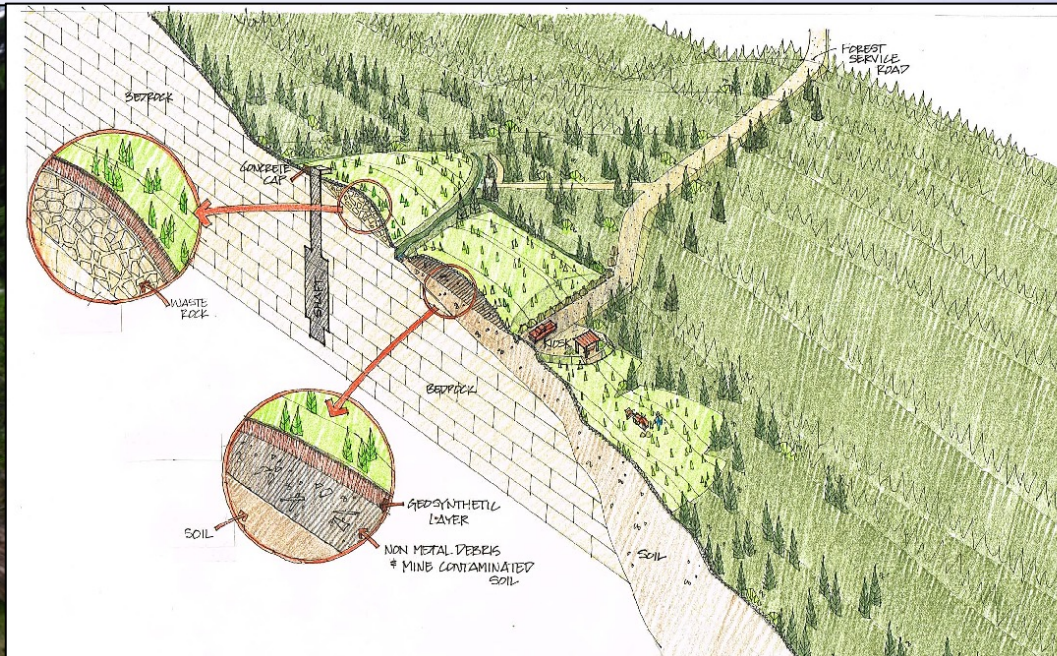




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Outline

- Program overview
- Types of sites
- Remedial approaches and experiences





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CCSP Overview

- Origin
- Key Principles
- Areas of Responsibility
- Site Prioritization

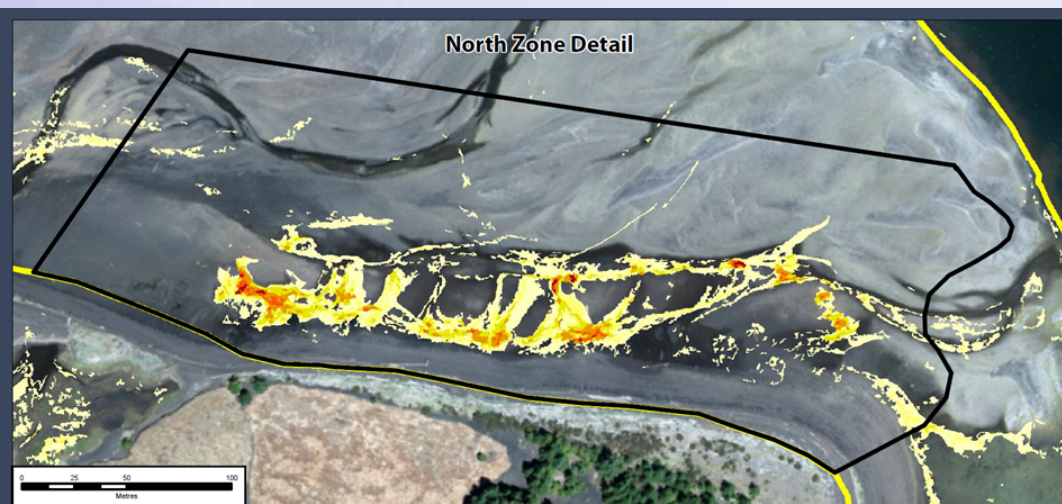




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CCSP resources and funding

- 8 full time staff + 1 shared
- Funded by the provincial government
- Province has committed > \$600 M since 2001;
- Spent ~\$11.5M/yr since 2005
- Shift in liability booking with 2015 Public Sector Accounting Standard for Contaminated Sites





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Biennial report

The Crown Contaminated Sites Program reporting responsibilities encompass annual financial reporting, a web-based presence, and a program biennial report.

CROWN CONTAMINATED SITES PROGRAM
2018 Biennial Report

2018 report available here:
https://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-remediation/docs/reports-and-presentations/ccsp_biennialreport2018.pdf

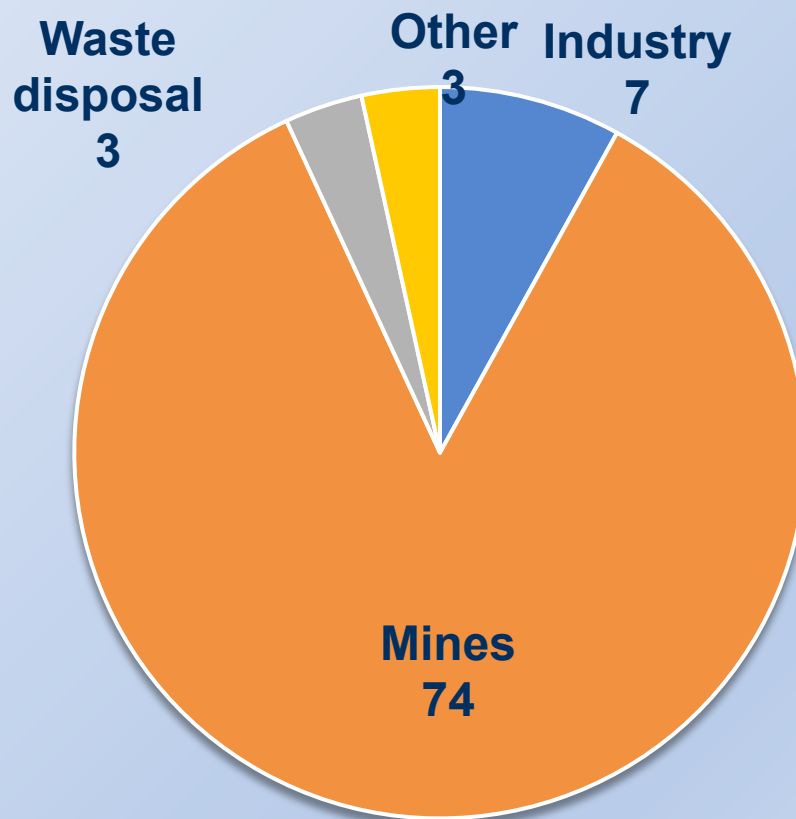
SUSTAINABLE BENEFITS
FOR BRITISH COLUMBIANS
THROUGH LAND RESTORATION



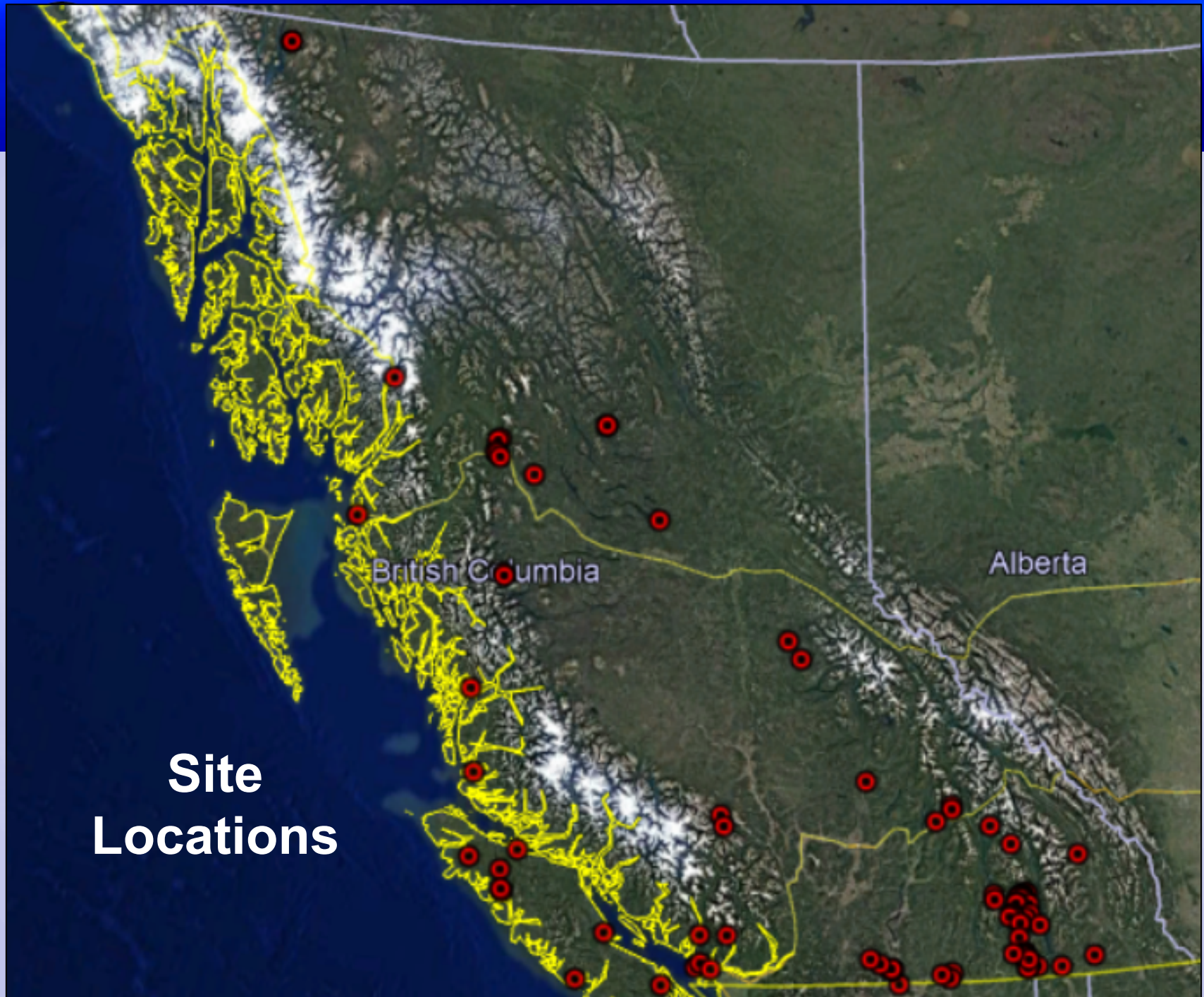


Site types and numbers

- 87 investigated
 - 74 mine-related
- 19 remediation completed
 - 9 mine-related (+1 transferred out of program)
- 18 current investigation / remediation
 - 15 mine-related



Site Locations





CCSP Site Characteristics

- Historic metal mine sites
- Operated prior to Health, Safety and Reclamation Code
- Small compared to modern mines.
- Waste discharged to the environment, limited or no containment
- Also, BC's unique due to:
 - rugged topography,
 - sulfidic deposits,
 - unceded lands,
 - regulatory framework





Statistics on 9 remediated mine sites

- 8 process areas, no extraction only sites
- 6 staked between 1897 and 1918, all prior to 1942
- On-site processing started as early as 1918 and not later than 1966





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Statistics on remediated mine sites (cont'd)

- 2 Hg mines (Bralorne-Takla and Mowson Pond)
 - No ARD but ML at both
- 7 Au, Ag, Pb, Zn, Cu (+) sites (Atlin Ruffner, Cork Province, Emerald Glacier, Howard, Teddy Glacier, Two Mile Creek, Yankee Girl)
 - 4 AG
 - 3 were non-PAG or uncertain
 - 7 (all) some ML



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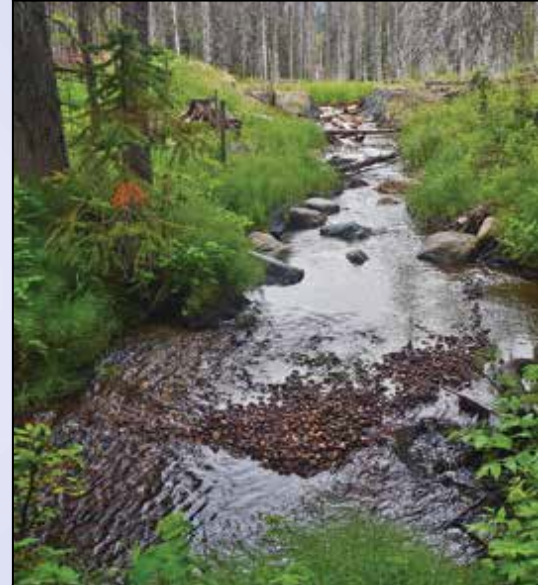
Remedial Option Scenarios and Cost Estimates – Example

Remedial Scenario	Scenario 1: On Site Standard	Scenario 2: On Site Upgrade	Scenario 3: On Site Deluxe	Scenario 4: Partial Offsite/ Stabilization	Scenario 5: Off-Site
Demolition and Debris Options	Option D1; Demolish, consolidate and cover all non-haz waste on Mill Building footprint	Option D1; Demolish, consolidate and cover all non-haz waste on Mill Building footprint	Option D1; Demolish, consolidate and cover all non-haz waste on Mill Building footprint	Option D2; Demolish, sort waste, burn wood, disposal of all remaining waste off site (including breaking and removing concrete)	Option D2; Demolish, sort waste, burn wood, disposal of all remaining waste off site (including breaking and removing concrete)
Tailings Options	Option T1a: Cover all tailings in place	Option T1a: Cover all tailings in place	Option T2a: Consolidate settling pond tailings into main tailings pond and cover	Option T3: On-site stabilisation of all tailings and sediment	Option T3: On-site stabilisation of all tailings and sediment
Contaminated Soil Options	Option S1a: Consolidate waste rock piles to mill footprint area facility and cover. Cap upper and lower pad soils in place.	Option S1b: Option 1 with geomembrane system incorporated into On-site Disposal Facility.	Option S1c: Option 1 with geomembrane system incorporated into On-site Disposal Facility, Lower Pad and Upper Pad.	Option S3: On-site stabilisation of Upper, Lower and Mill area soils through excavation, mixing and replacement to 1m depth.	Option S4: Excavate mill area, Lower and Upper pad soils and transport to commercial facility for stabilisation.
TOTAL Construction cost (including 20% contingency)	\$1,186,608	\$1,286,745	\$1,811,178	\$3,552,842	\$12,448,495



Remedial Solutions

- General preference of in-situ or on-site management
- 2 of 9 sites involved off-site disposal only, 7 involved cover system
- Building or structure decommission/demolition
- Waste consolidated in smaller footprint or new location
- Water management, risk management, revegetation
- Development of borrow source(s)



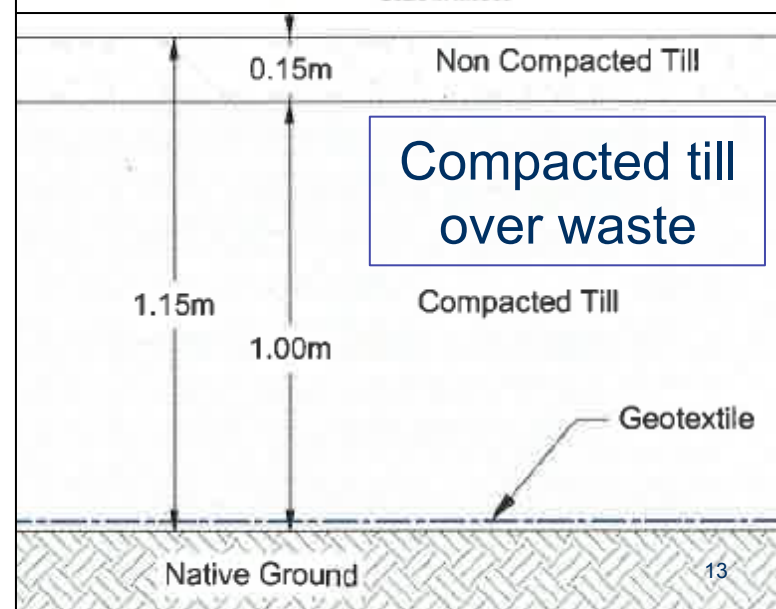
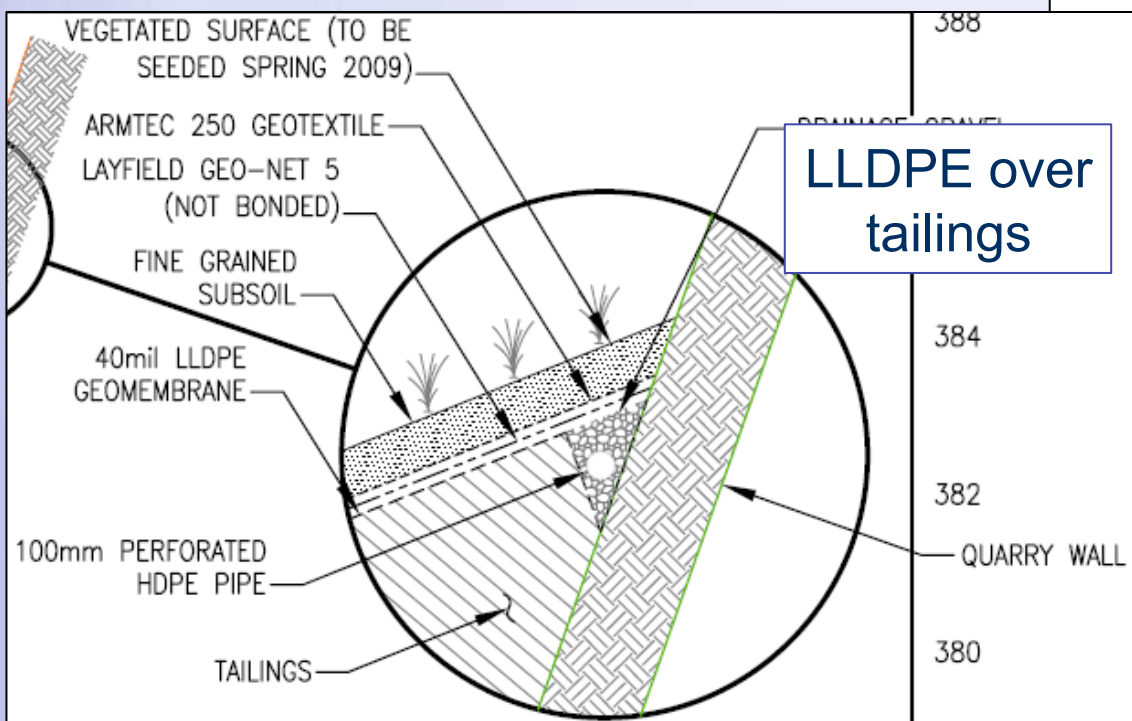
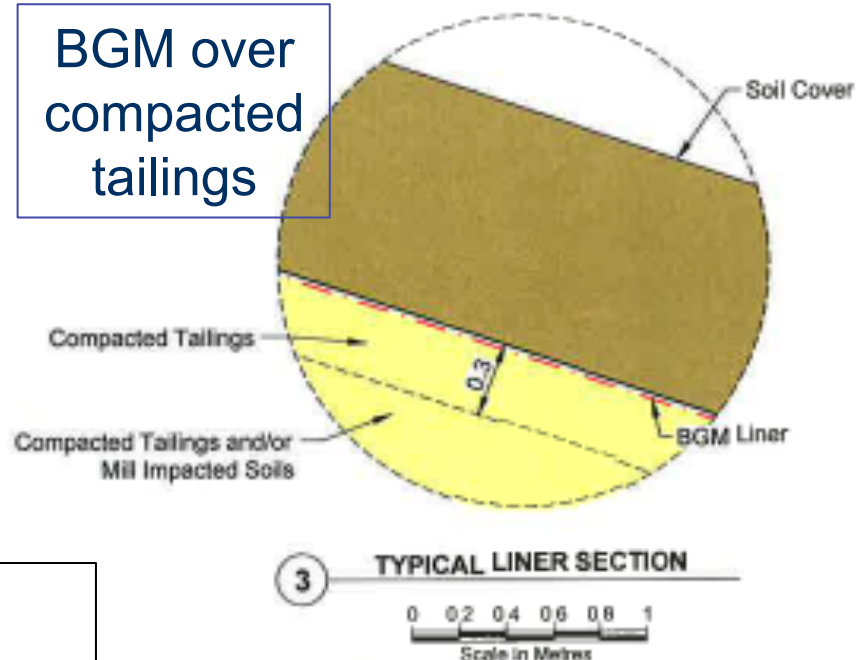


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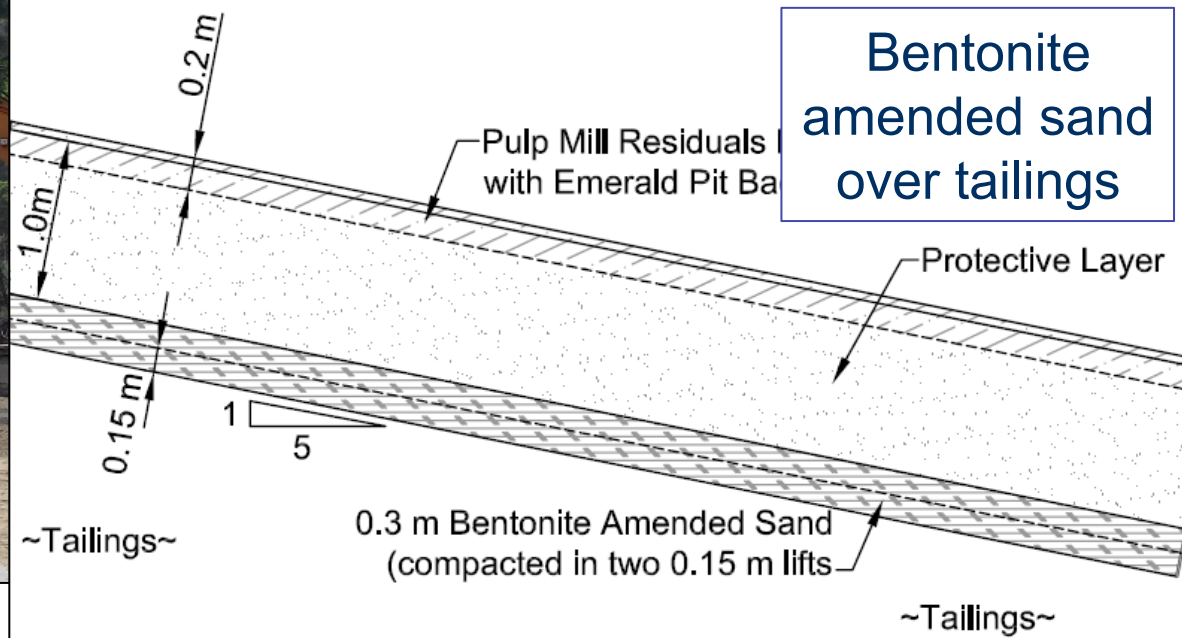
Cover Systems

- LLDPE, HDPE, soil, bentonite clay amended, till, BGM, combinations
- Areas of ~0.1 to ~2.2 ha

BGM over compacted tailings



Cover Systems



Bentonite amended sand over tailings

Existing Ground Surface @ Avg. 1.0% Grade (West)

BGM in gravel over tailings

BGM LINER @ Min 2.0% GRADE

1000mm

Drainage

Existing 1m Thick Gravel Cover Layer

Existing Geotextile Separation Layer

Tailings Material



Cover Systems cont'd

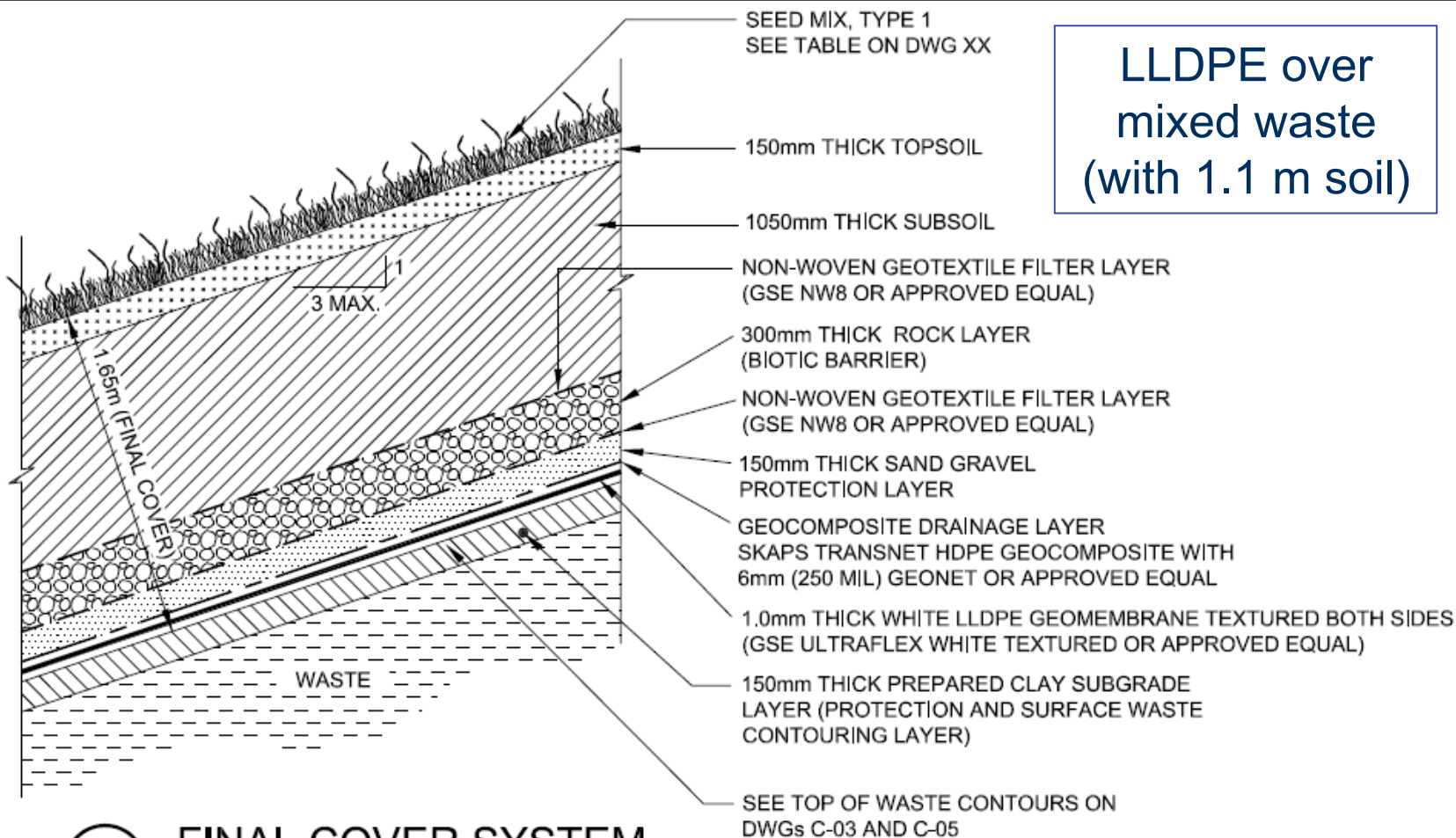
Borrow
over
tailings

0.15 m Topsoil

0.45 m Regular
Borrow Material

Tailings

LLDPE over
mixed waste
(with 1.1 m soil)



01 FINAL COVER SYSTEM



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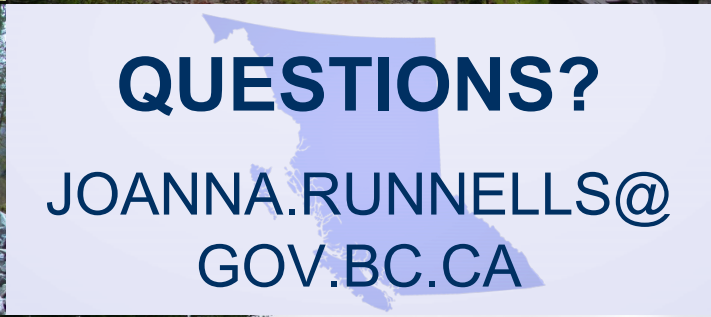
Remedial Option Performance

- Environmental – LTMM, reveg
- Physical – stability, integrity, flows
- Successes and challenges:
 - Polishing wetland
 - Changes in conditions and ML
 - Improvement rates
 - Water flow





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What does closure look like to you?



<https://youtu.be/wveuqfL1-c4>