

Britannia Mine Remediation Project Project Overview

9th Annual ML/ARD Workshop

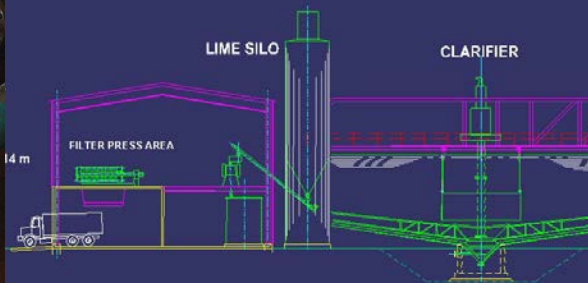
December 4, 2002

Gerry O'Hara, Project Manager

Golder Associates Ltd



Plant - Section

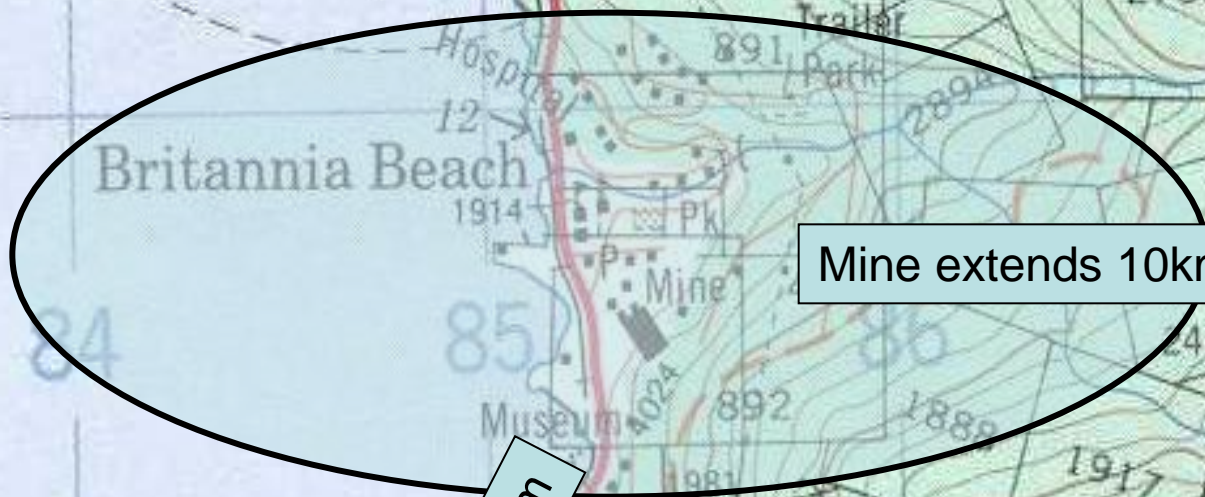


Britannia Mine Remediation Project Overview - Presentation Outline

- Environmental problems at Britannia
- Province's remedial concept
- Summary of work completed/ongoing
- Project status and schedule



Site Location



Mine extends 10km east

Vancouver 45km



Britannia Mine Background

- Britannia Mine often cited as the largest point source metal pollution source in North America discharging to a marine environment
- Impact to aquatic life in Howe Sound and local waterways (eg. Britannia Creek, Jane Creek)
- Naturally occurring metal sulphide orebody which has been exposed to air and water during (and subsequent to) seventy years of mining

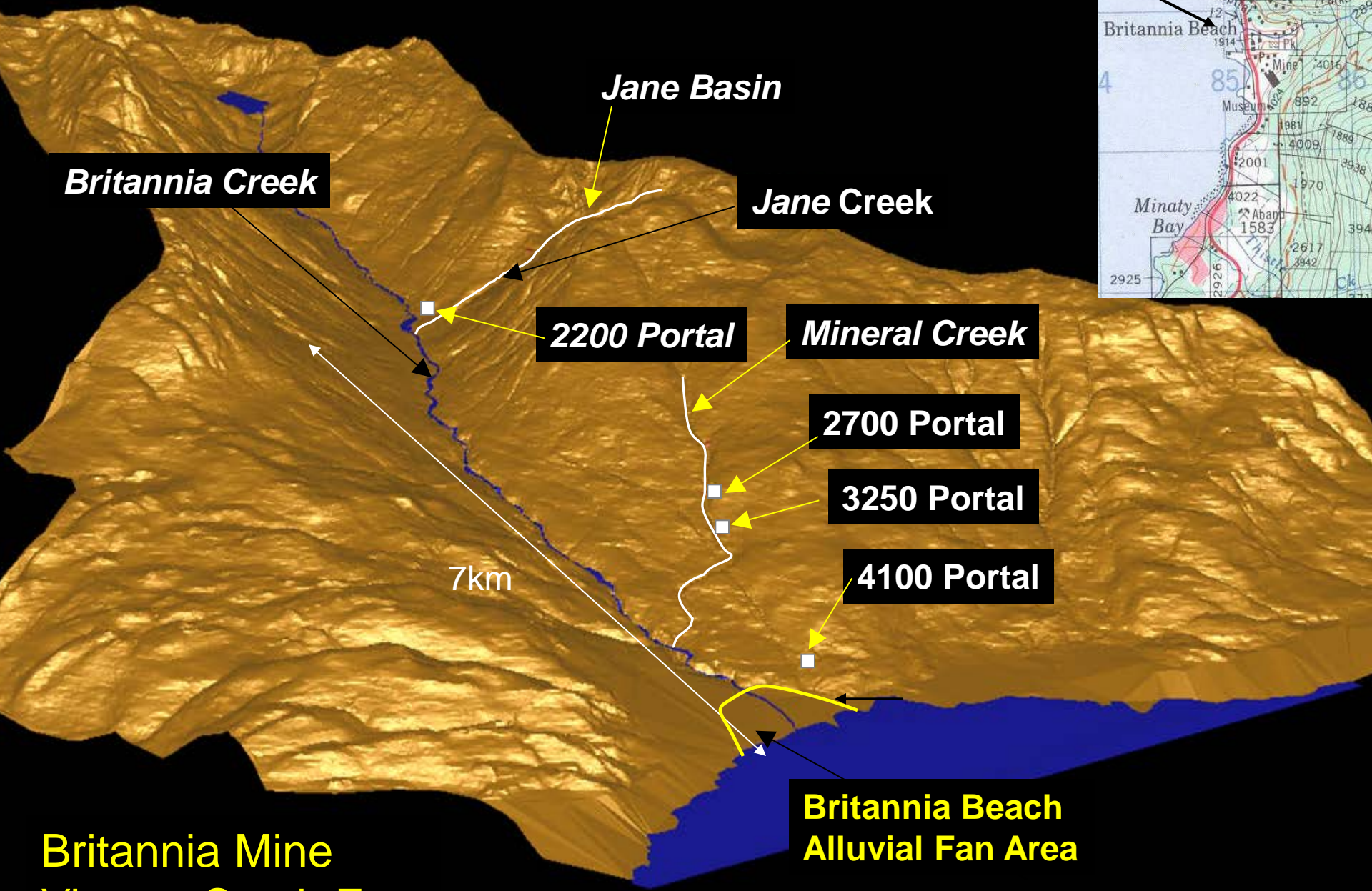
Mine History

- 1905 – mine began production
- 1920s – largest producing copper mine in the British Commonwealth
- 1974 – Mine owners ordered to collect and treat ARD discharge
- 1974 – Anaconda Canada Ltd. closed mine
- Post 1974:
 - Plug installed in 4100 Level – flow control
 - Dam installed in 2200 Level (later failed)
 - ARD discharge via ‘deep outfall’
 - Plug installed in 2200 Level – divert flow to 4100 Level

Why Now?

- On April 12, 2001 the Province and historical PRPs reach agreement indemnifying the historical PRPs in exchange for \$30 million
- The settlement requires the \$30 million be maintained in a trust fund
- Fund may only be spent on environmental remediation at the mine
- Funds to be committed within 5 years





Britannia Creek

Jane Basin

Jane Creek

2200 Portal

Mineral Creek

2700 Portal

3250 Portal

4100 Portal

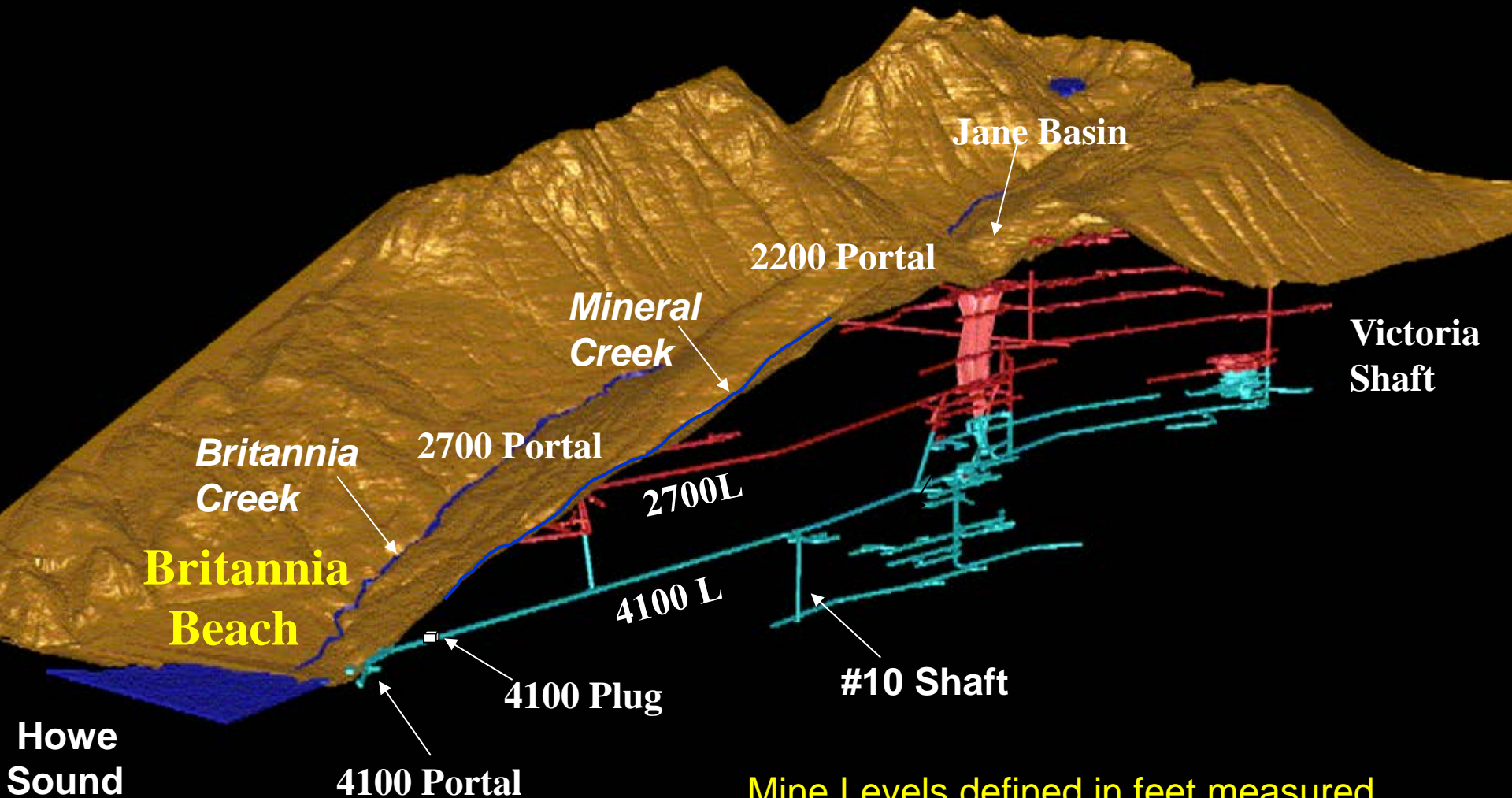
7km

**Britannia Beach
Alluvial Fan Area**

**Britannia Mine
View to South East**



3D Cutaway of Britannia Mine

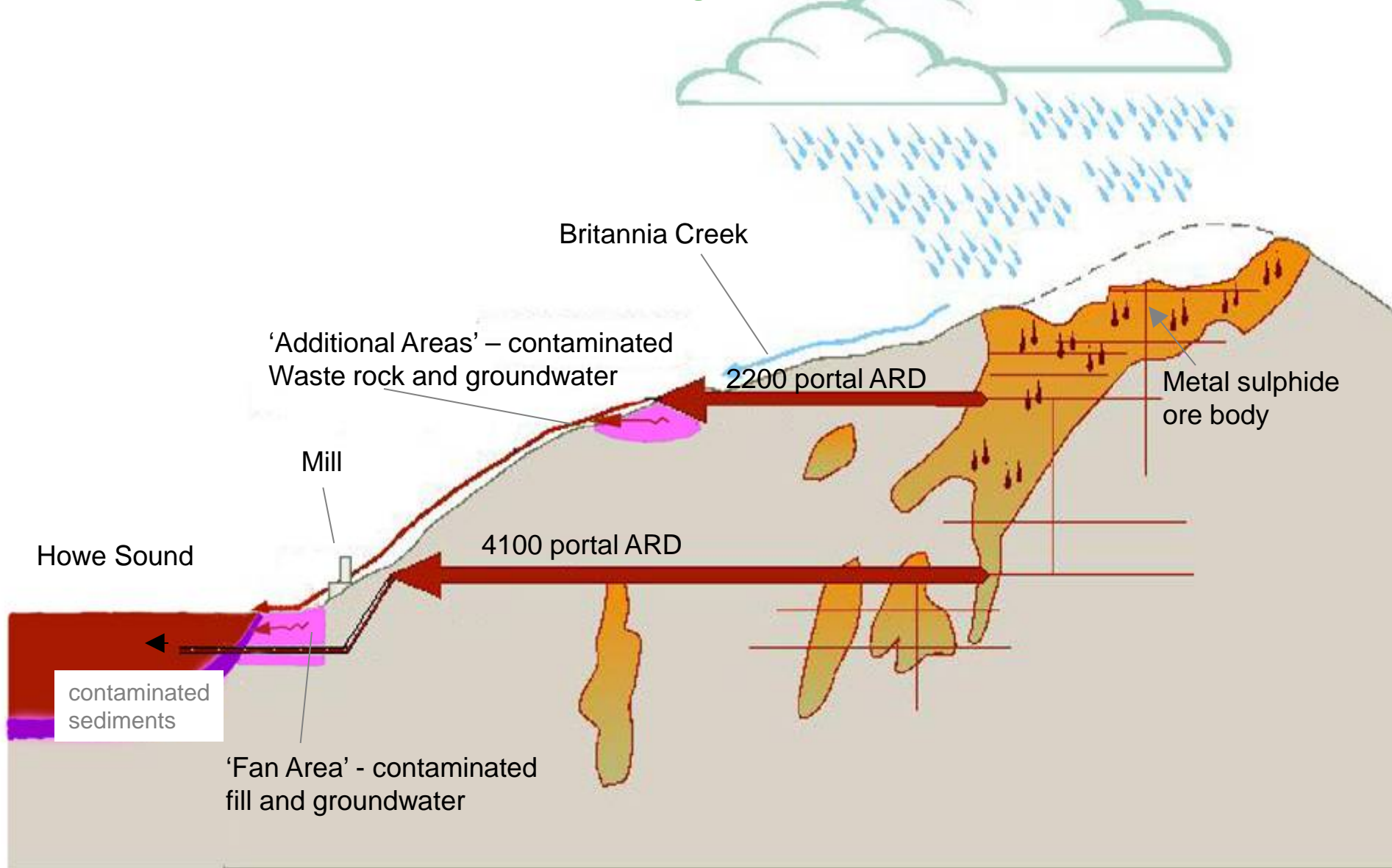


Mine Levels defined in feet measured downwards from highest elevation in mine




Summary of Environmental Problems

- Metals contaminated acidic (pH ~3) mine water from:
 - 2200 Level portal (now diverted to 4100 Level)
 - 4100 Level portal (deep discharge to Howe Sound via 4150 sub-level)
 - Other (minor discharges, e.g. seeps and other portals)
- Other contamination sources:
 - Mine infrastructure ('Fan Area & 'Additional Areas') e.g.
 - Processing/storage areas
 - Waste rock piles, launders, sediment ponds
 - Metals contaminated sediments in Howe Sound

Post-Mining Conditions



Estimated Daily Metals Loading

-  Bedrock
-  Alluvium and Fill
-  Contaminated sediments (tailings)

From additional areas – minor contribution

Mine Workings Total:
Copper and Zinc average around 300 kg/day each via outfall at 26m depth in Howe Sound

Mine water flow

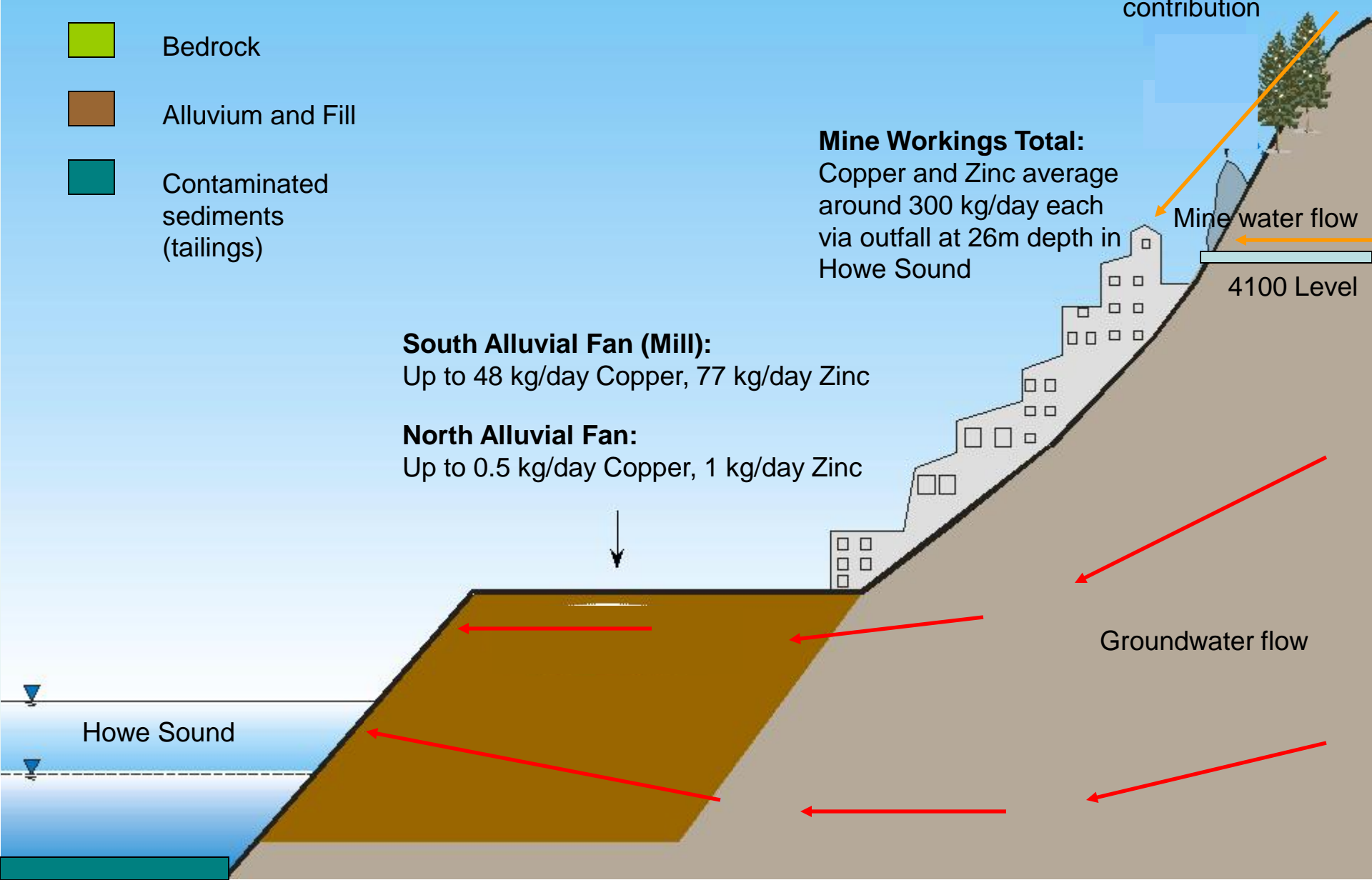
4100 Level

South Alluvial Fan (Mill):
Up to 48 kg/day Copper, 77 kg/day Zinc

North Alluvial Fan:
Up to 0.5 kg/day Copper, 1 kg/day Zinc

Groundwater flow

Howe Sound





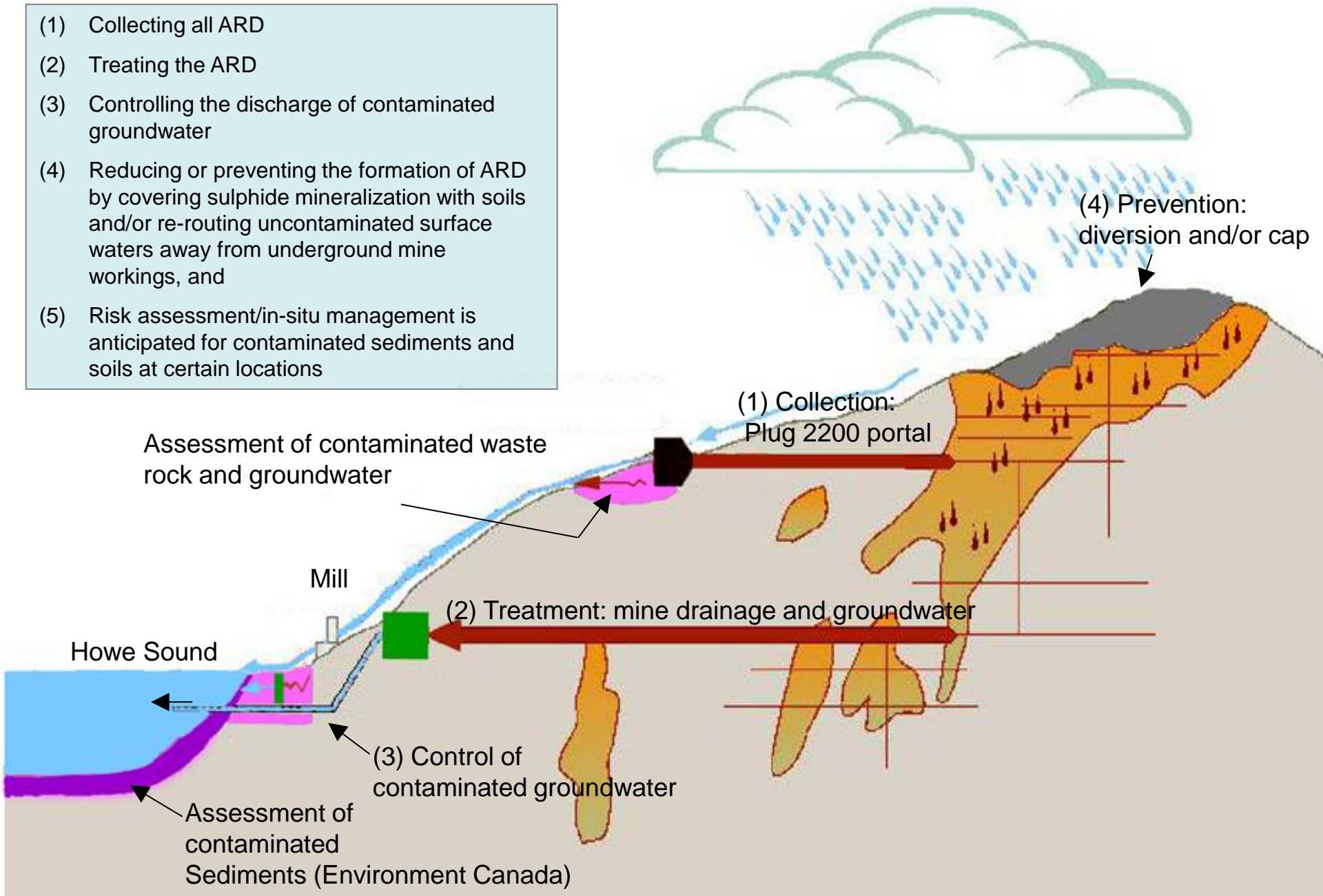
South 'Fan Area', Britannia Beach

Remediation Project Objectives

- *“Reduce environmental impact to fisheries....resulting from water and sediments originating from the mine site, by meeting site-specific risk-based provincial and federal requirements,*
- *Construct a water treatment plant and other works to treat drainages to meet site-specific provincial and federal requirements,*
- *Reduce contamination-related human health risks on, and emanating from, the mine site by meeting site-specific risk-based provincial requirements, and*
- *Consider future sustainable development, compatible with land use designations in SLRD’s OCP”*

Province's Remedial Concept

- (1) Collecting all ARD
- (2) Treating the ARD
- (3) Controlling the discharge of contaminated groundwater
- (4) Reducing or preventing the formation of ARD by covering sulphide mineralization with soils and/or re-routing uncontaminated surface waters away from underground mine workings, and
- (5) Risk assessment/in-situ management is anticipated for contaminated sediments and soils at certain locations



Assessment of contaminated waste rock and groundwater

(1) Collection:
Plug 2200 portal

(4) Prevention:
diversion and/or cap

Mill

(2) Treatment: mine drainage and groundwater

Howe Sound

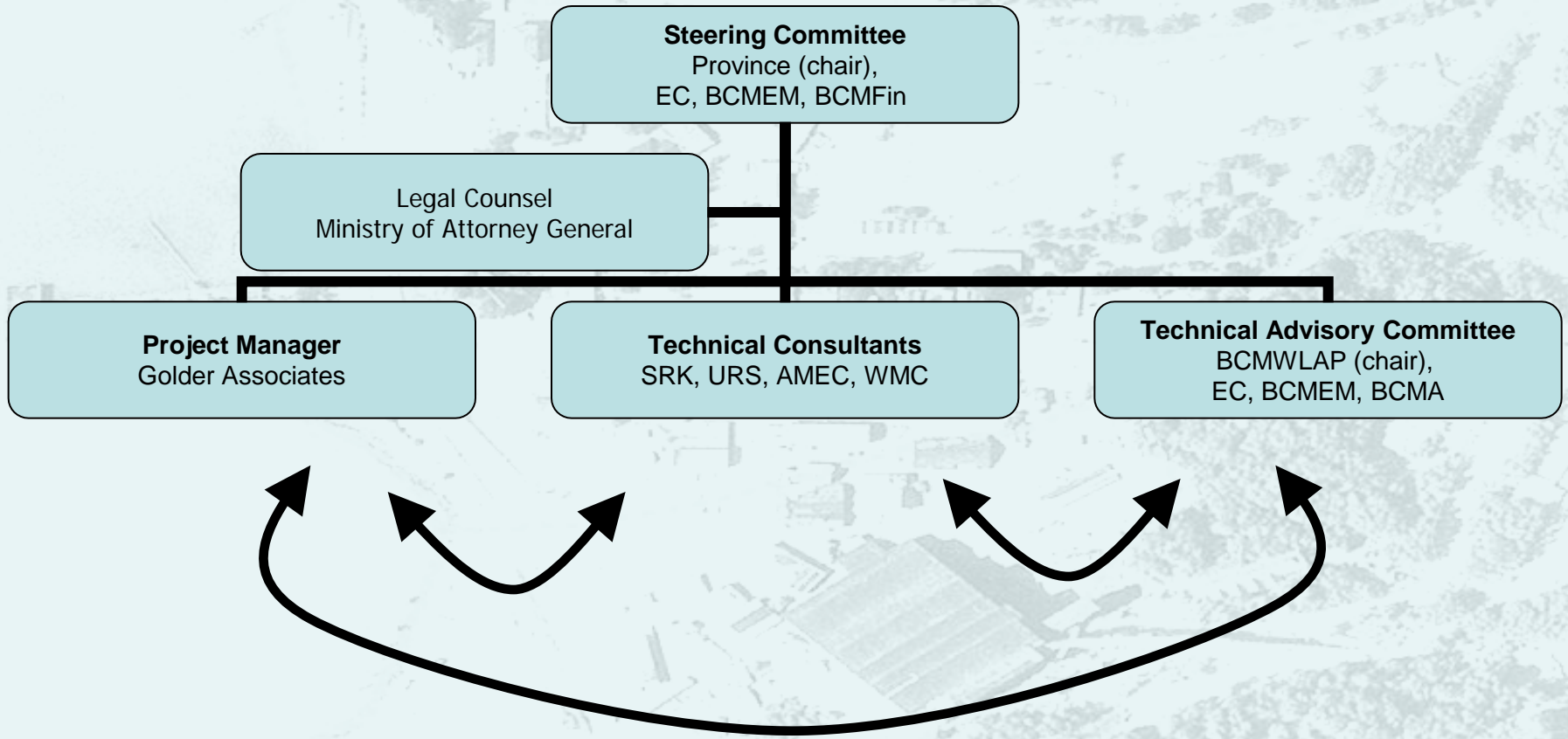
(3) Control of
contaminated groundwater

Assessment of
contaminated
Sediments (Environment Canada)

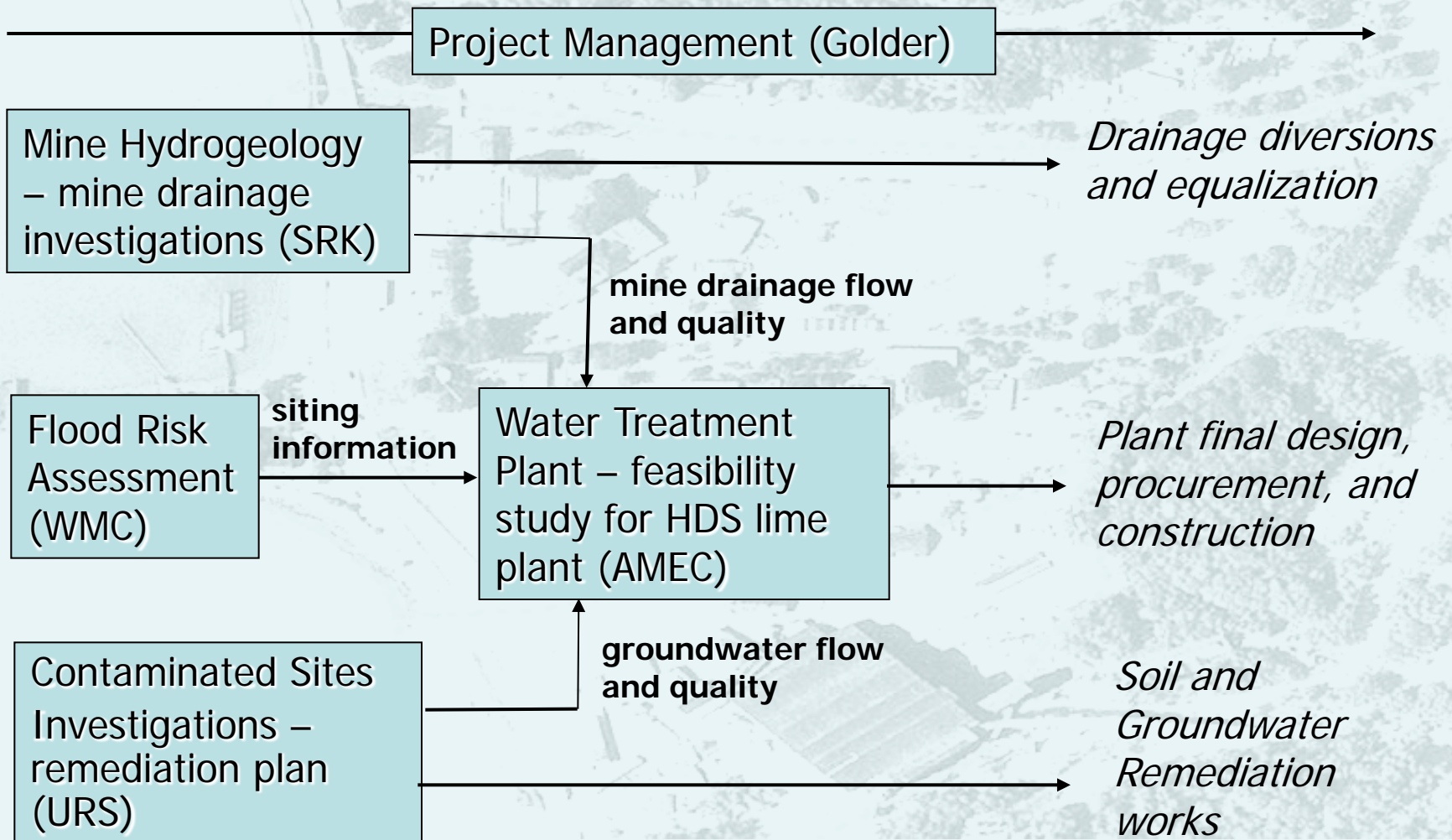
Project Components

- Golder Associates hired by Province in August, 2001 as Remediation Project Manager
- Technical contractors hired in fall, 2001:
 - Mining & Hydrogeology (SRK)
 - Water Treatment Plant (CH2MHill, AMEC & CEMI)
 - Contaminated Sites (URS)
 - Flood Risk Assessment (WMC)

Management Structure



Remediation Process



Mining and Hydrogeology Study - SRK

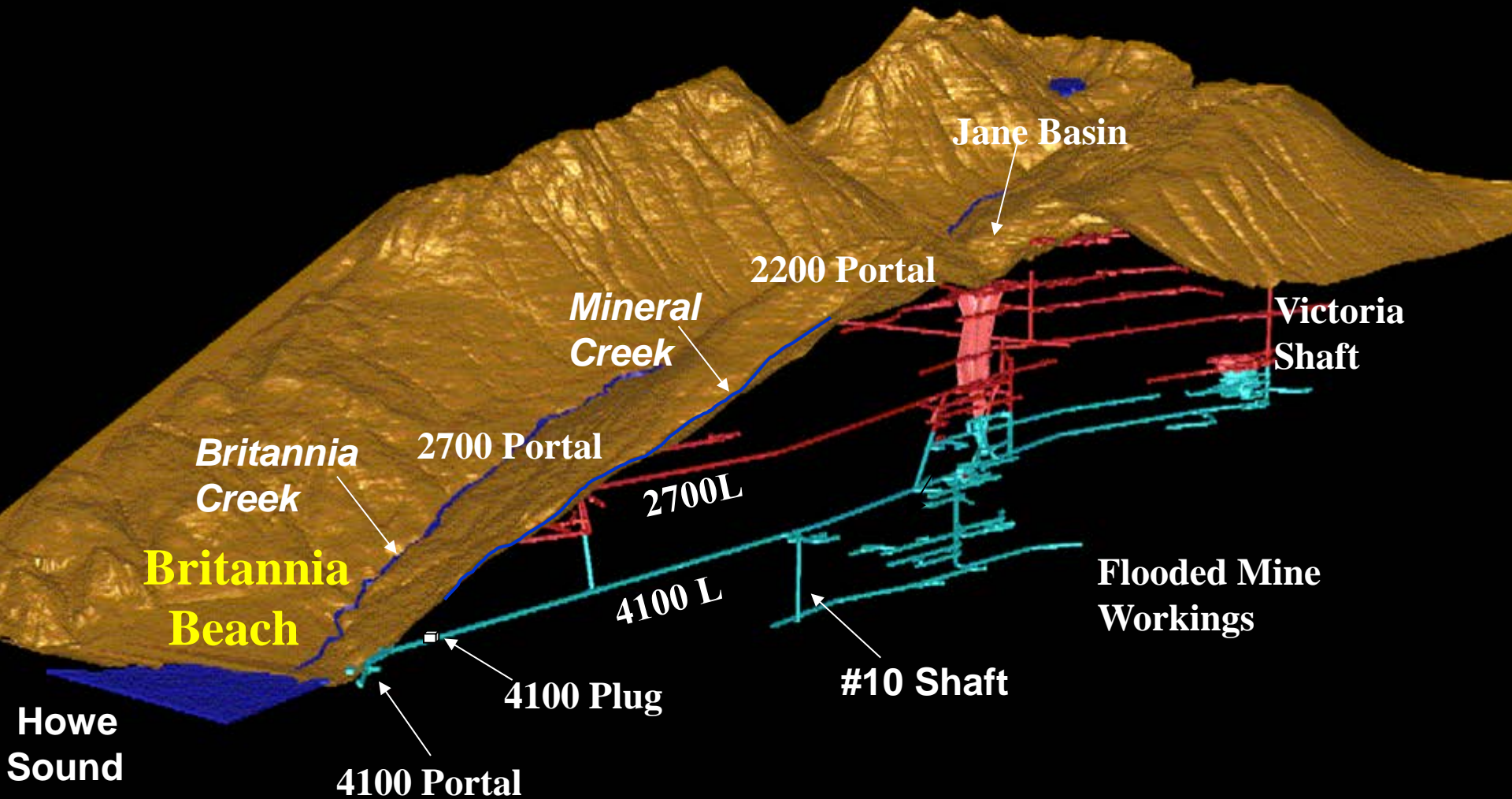
Evaluate mine as storage reservoir:

- Safety assessment & rehabilitation program
- Hydrology & hydrogeology studies¹
- Stability assessment of 4100 Level plug
- Tests to assess storage capacity of Mine
 - Assessment of mine water chemistry²
 - Determine elevation v. volume relationship
 - Evaluate mine hydraulics

1 Patrick Bryan & Graham Parkinson, 8:45

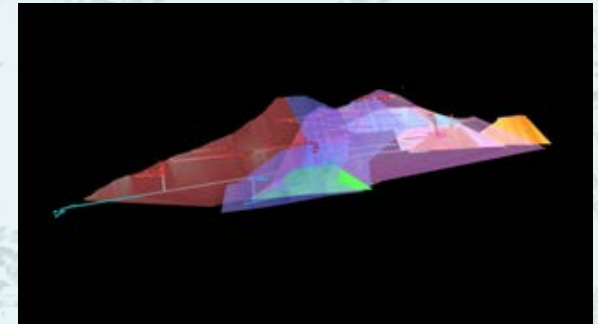
2 Kelly Sexsmith & Stephen Day, 9:15

3D Cutaway of Britannia Mine

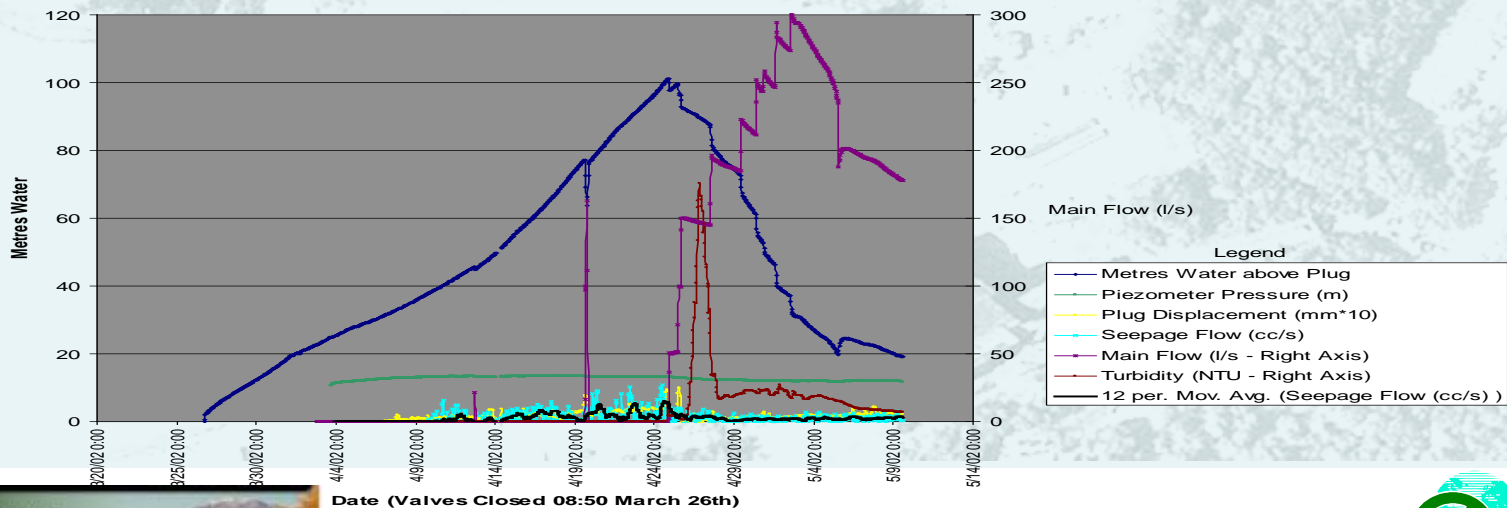


Mining and Hydrogeology Study - SRK

- 4100 Level Plug test completed
- Mine reservoir simulation model developed
- Jane Basin diversion study in progress
- Jane Basin stability assessment nearing completion
- Structural geology study completed



Metres Water Above 4100 Plug
and other hourly data logger channels



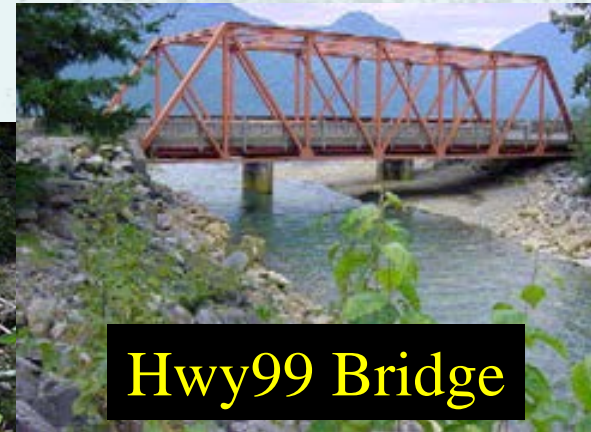
Flood Risk Assessment - WMC

Flood risk study required:

- Long history of flood and debris torrent events associated with Britannia Creek
- Dilapidated dams in watershed
- Some remedial works for Fan Area possibly located in flood plain



Tunnel Dam

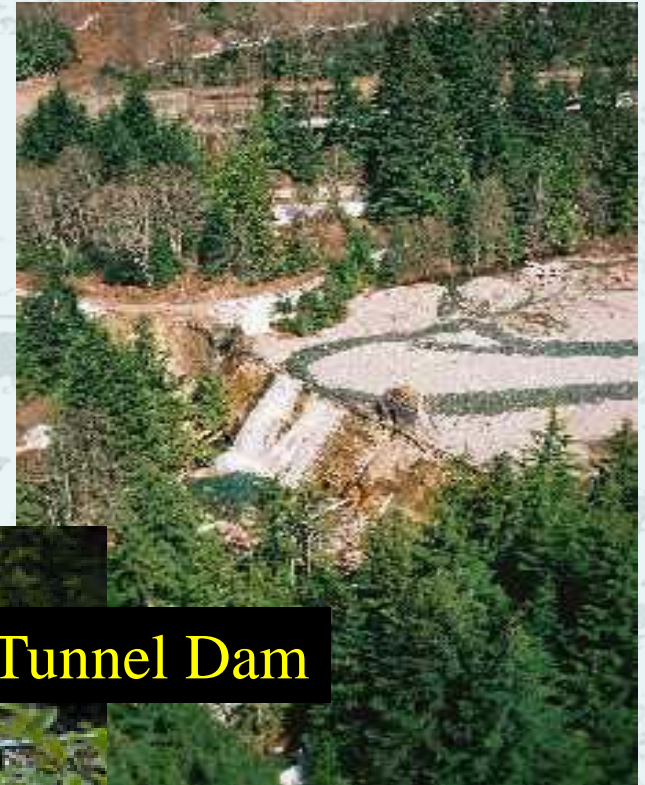


Hwy99 Bridge

Flood Risk Assessment - WMC

Determine flood risk and mitigation:

- Site surveys
- Maximum probable flood
- Debris flow analysis
- Sedimentation analysis
- Dam breach analysis
- Flood flow routing
- Modelling



Tunnel Dam

Contaminated Sites Investigation - URS

Assessment of secondary contamination sources by:

– Site Investigations in Fan Area and Additional Areas, including:

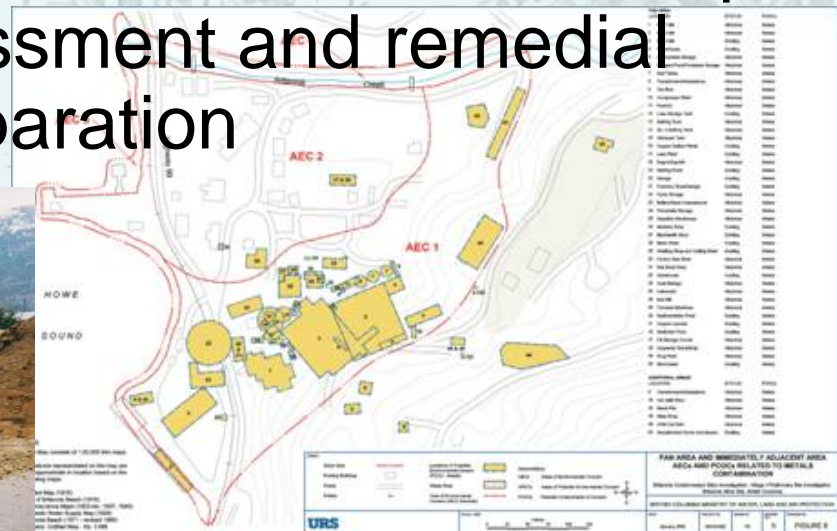
- historical information review
- risk assessments*
- boreholes, test pits, surficial sampling
- groundwater pumping tests & modelling
- storm water runoff sampling
- sediment & biota sampling

– Development of remediation plans



Contaminated Sites Investigation - URS

- Reports completed:
 - Fan Area PSI & DSI reports
 - Fan Area ecological risk assessment
 - Fan Area human health risk assessment
 - Fan Area remediation planning document
- Additional Areas - PSI and DSI fieldwork complete, investigation, risk assessment and remedial planning reports in preparation



Water Treatment - AMEC

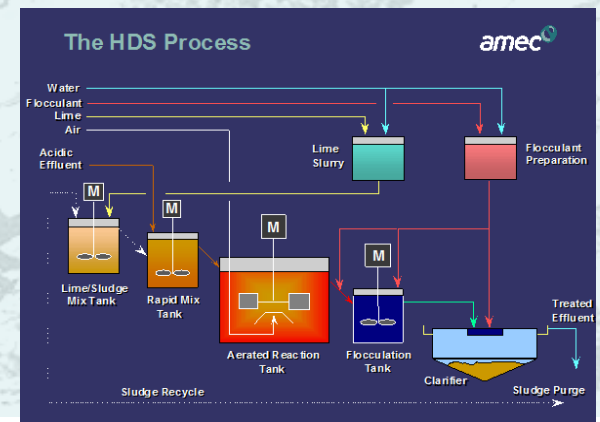
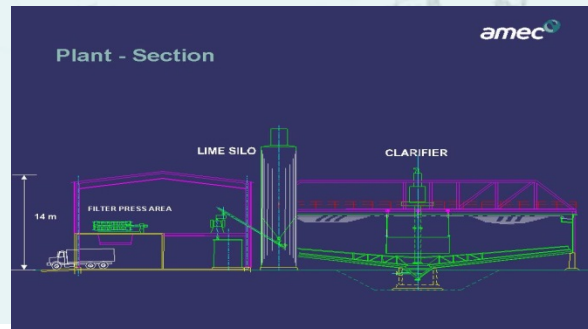
Determine Optimum Treatment Plant Design by:

- Pilot treatment program (CEMI):
 - High Density Sludge (HDS) program (lime addition)
 - Consider upstream metals removal (UMR)
- Plant feasibility study
 - Conceptual plant design
 - Plant siting and access
 - Sludge disposal study(s)
 - Outfall feasibility study



Water Treatment - AMEC

- Treatment plant pilot study report - completed
- Plant location stakeholder workshop held
- Site selection report - completed
- Preliminary sludge disposal option study/report – completed. Second phase study in progress
- Geotechnical investigation – completed
- Plant feasibility study issued (draft)*
- Outfall study in progress



Water Treatment – Plant Sizing

Plant sizing considerations:

- Nominal 1050m³/hr plant selected for feasibility study
 - Desktop hydrological/hydrology studies
 - Previous mine flooding records
 - Results of phase 1 of the 4100 Level Plug test
- SRK daily reservoir simulation model developed from plug test data - basis of assessing ability of plant to accommodate range of flows for previous 25 years
- Extension of the SRK model allows effects of operator decision rules to be simulated
- Will be used as input into permitting process

Water Treatment Plant Flow Modelling

Input

Design Capacity= **1050** m³/hr 292 L/s

Hydraulic Capacity= **1400** m³/hr 389 L/s

Plug Capacity= **4000** m³/hr 1111 L/s

Level I Criteria: Controlled discharge of untreated water

Increase flow of untreated water by a further **50** L/s 1. If the mine water level exceeds **150** m
 2. If the rate of increase of the mine water level exceeds **1** m/day

Decrease flow of untreated water by **25** L/s 1. If the rate of increase of the mine water level is less than **1** m/day

Level II Criteria: At high values of estimated Snowpack Water Equivalent (SWE)

If SWE exceeds **0** mm In April
 Increase the WTC flow by a further **50** m³/hr 1. If the mine water level exceeds **21** m
 2. If the rate of increase of the mine water level exceeds **2** m/day

Decrease the WTC flow by a further **50** m³/hr 1. If the rate of increase of the mine water level is less than **-1** m/day

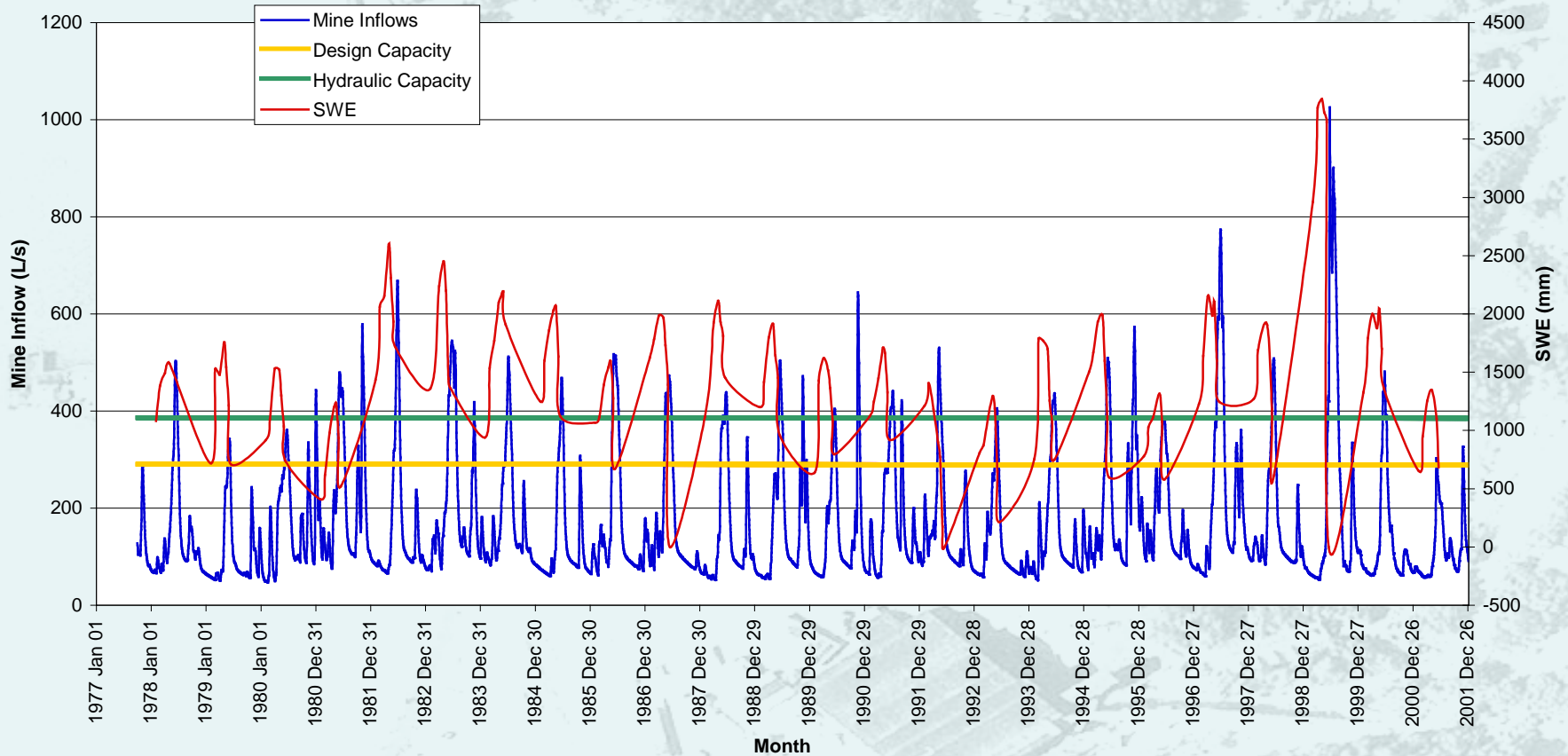
Output

Example: 1050m³/hr design capacity plant

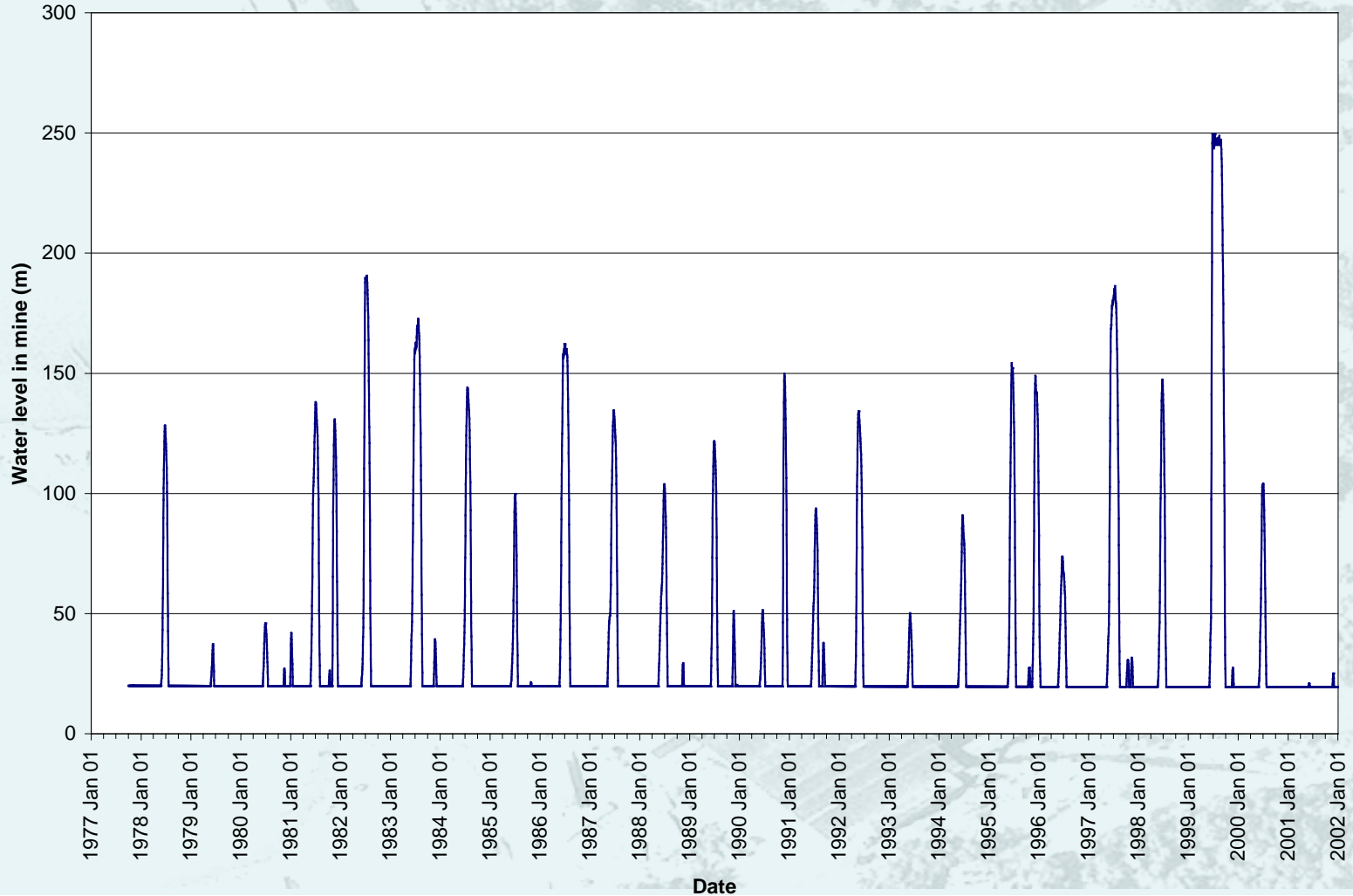
Percentage of water treated = 97.38266

Water Treatment Plant Flow Modelling

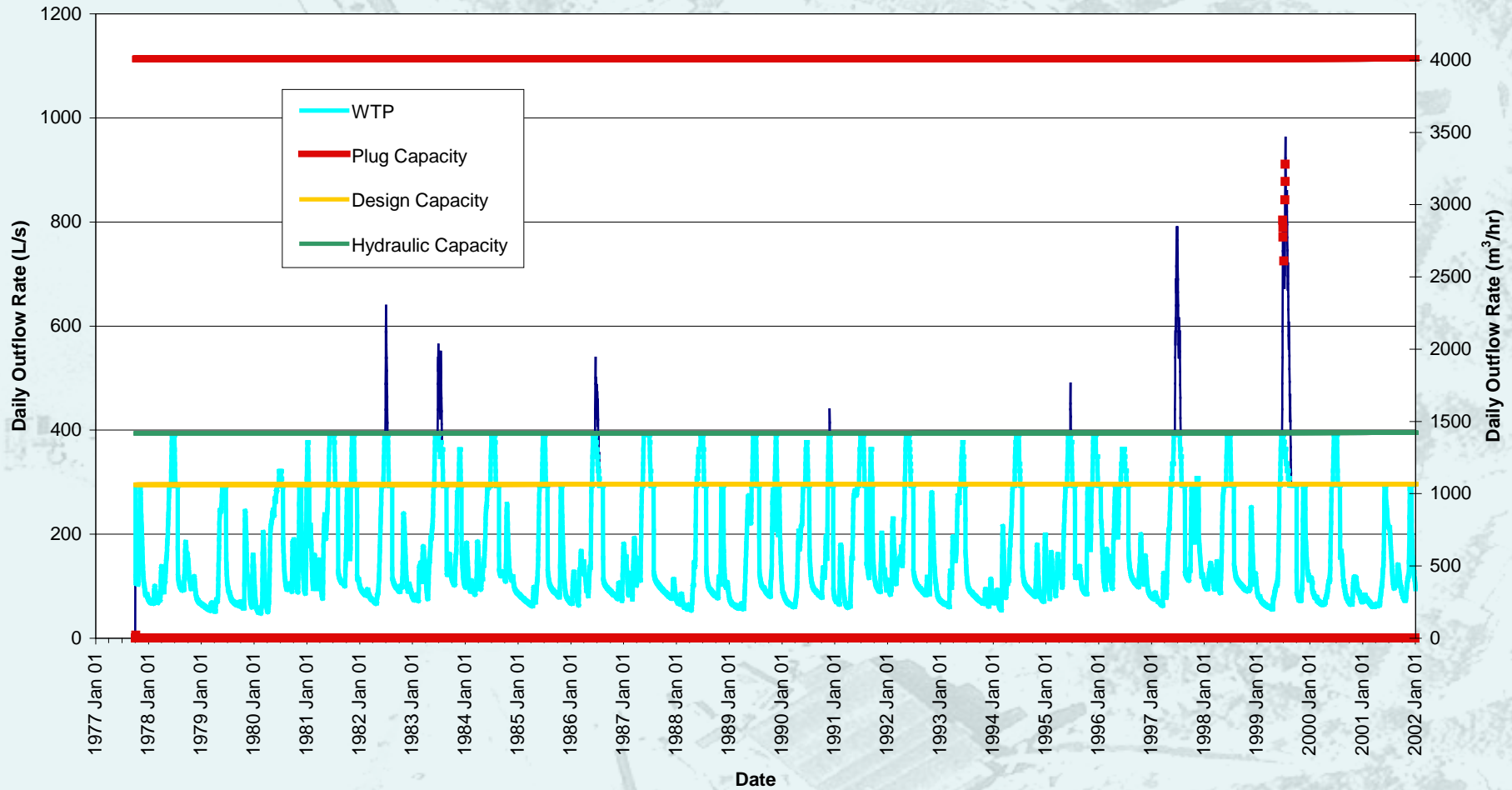
Estimated Total Inflows to Mine (including flows that reported to 2200 level)



Water Treatment Plant Flow Modelling



Water Treatment Plant Flow Modelling





Other Activities

- Site-Wide Monitoring Program:
 - integrates with scopes of Mining & Hydrogeology and Contaminated Sites investigations:
- Project Scheduling and Cost Control
- Permitting
- Database construction and maintenance
- Websites:
 - *britannia.golder.com*
 - *wlapwww.gov.bc.ca/sry/p2/britannia/index.htm*
- Newsletters, Reporting & Public Meetings

Project Schedule: Implementation

