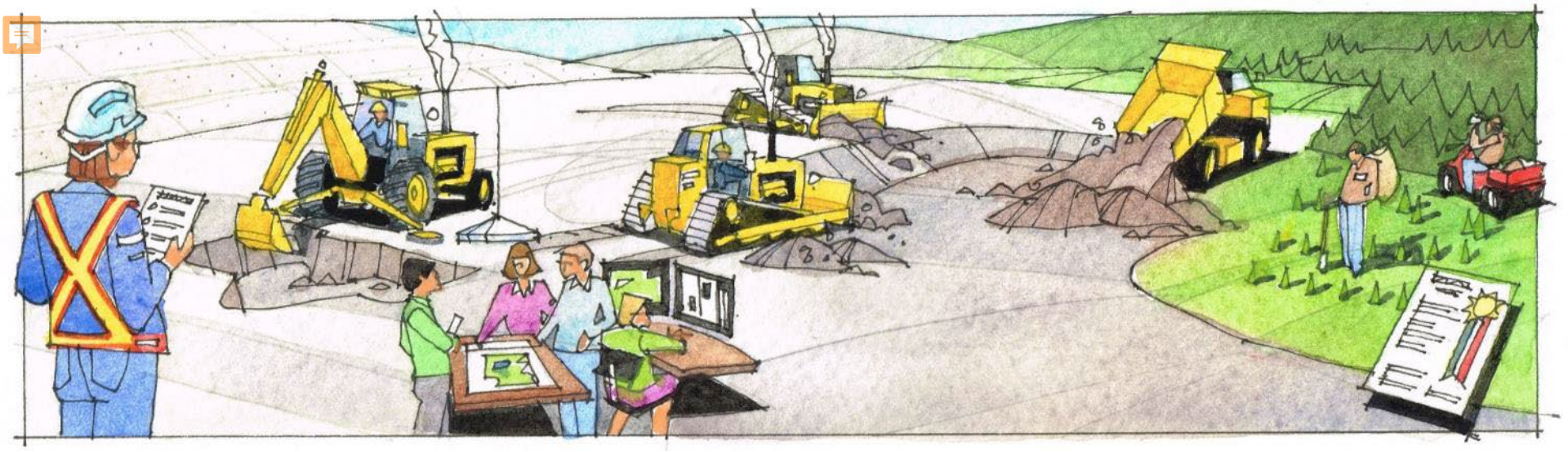

Landform design

Mining with the End in Mind

LANDFORM DESIGN INSTITUTE

Landform Design Institute
Orphaned and Abandoned Mines
October 11, 2023

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McKenna Geotechnical, LDI Chair
www.landformdesign.com

Objective of the presentation

Highlight the importance of establishing

clear goals

and involving all

relevant partners

in OAM planning and provide an overview and

examples of landform design

as a method of implementing it at OAM sites.

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To make landform design routine in the mining industry worldwide by 2030.

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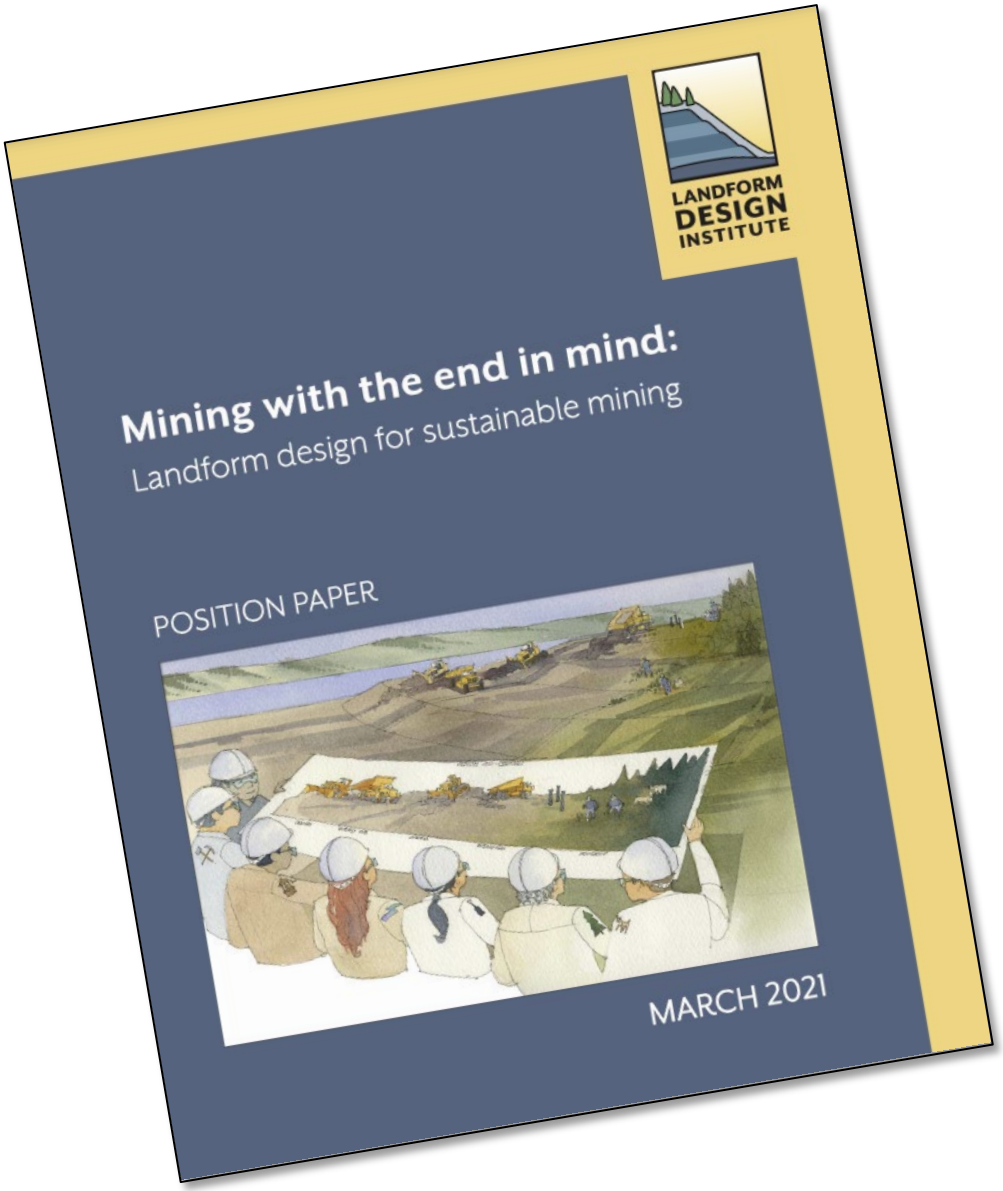
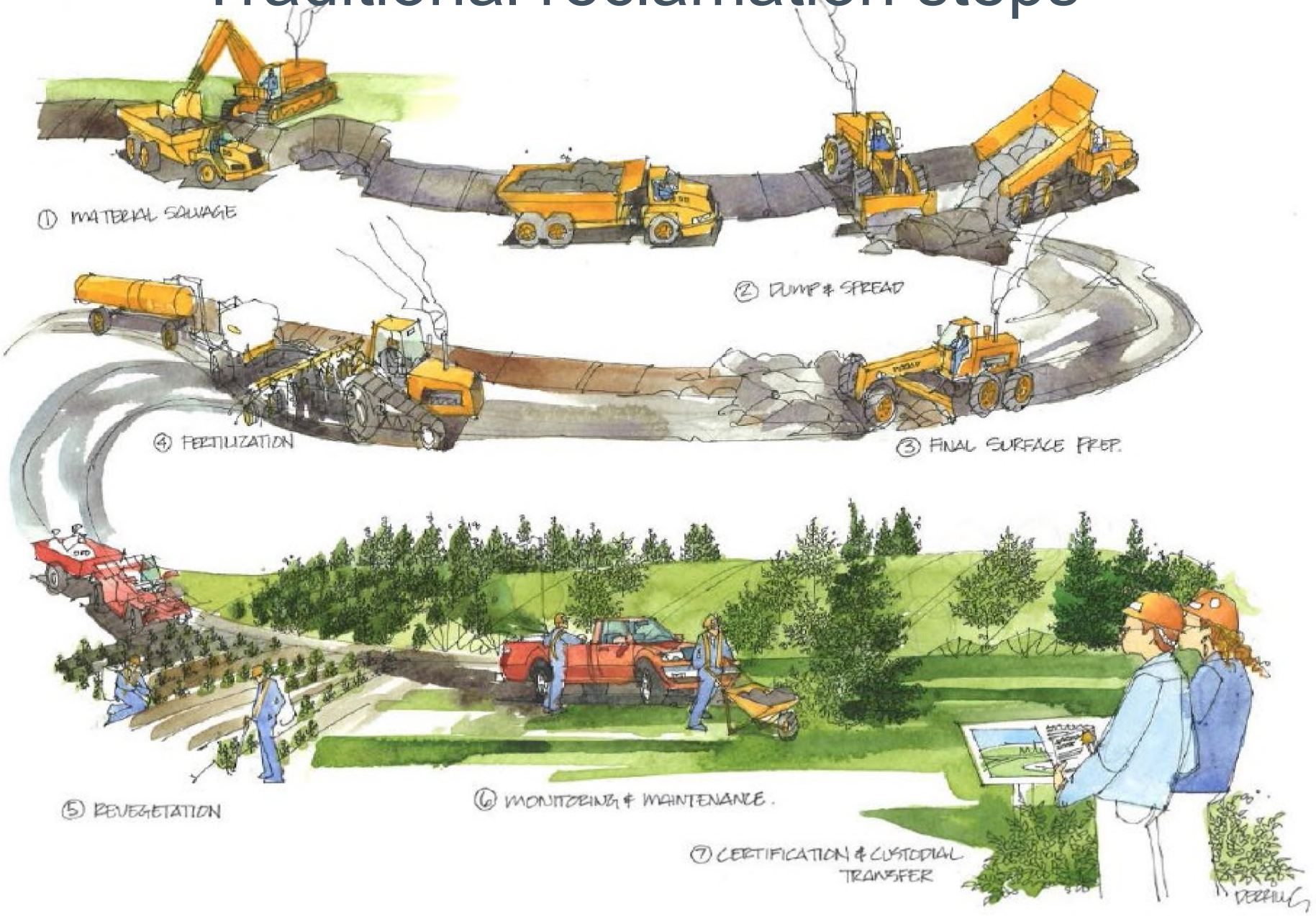


Traditional reclamation steps



Brenda Mine, BC

Lesson: Classic example of 70% reclaimed land

Lesson: Sand slopes behaving in practice but not in theory

Lesson: Plateau being re-reclaimed by new people with new ideas (stick to your DBM)

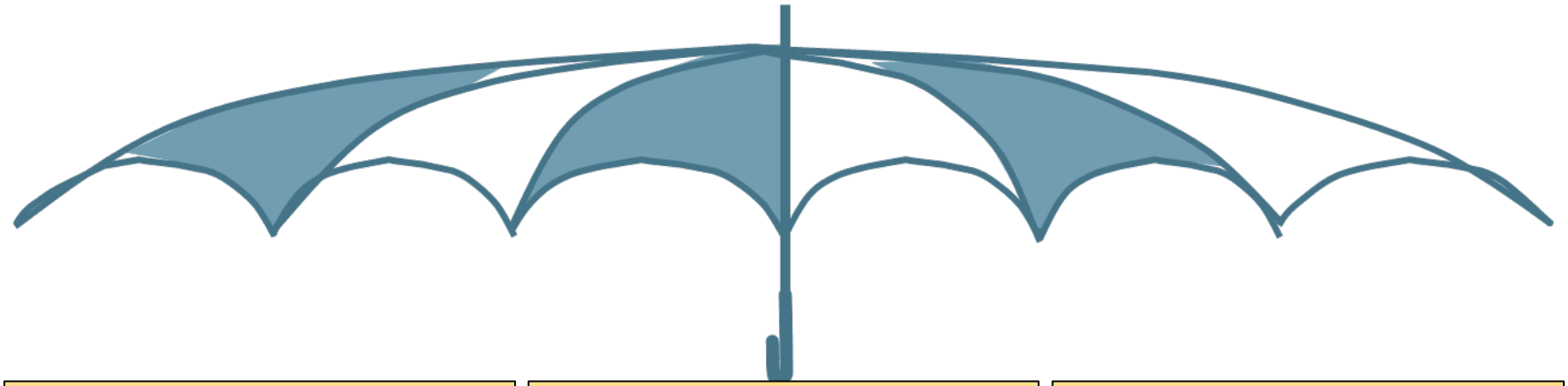
What is landform design?

Landform design is an emerging, integrated, multidisciplinary process to successfully reconstruct mine land.

It allows industry, regulators, and communities to work together to manage costs and risks, minimize liability, and produce progressively reclaimed landscapes with confidence and pride.

Done well, landform design leads to a positive mining legacy — it is a pillar of sustainable mining.

Successful reclamation



Integrated community

- Collaboration with Aboriginal and local communities
- A business / finance framework for reclamation and closure
- Avoiding and mitigating social impacts of mine closure

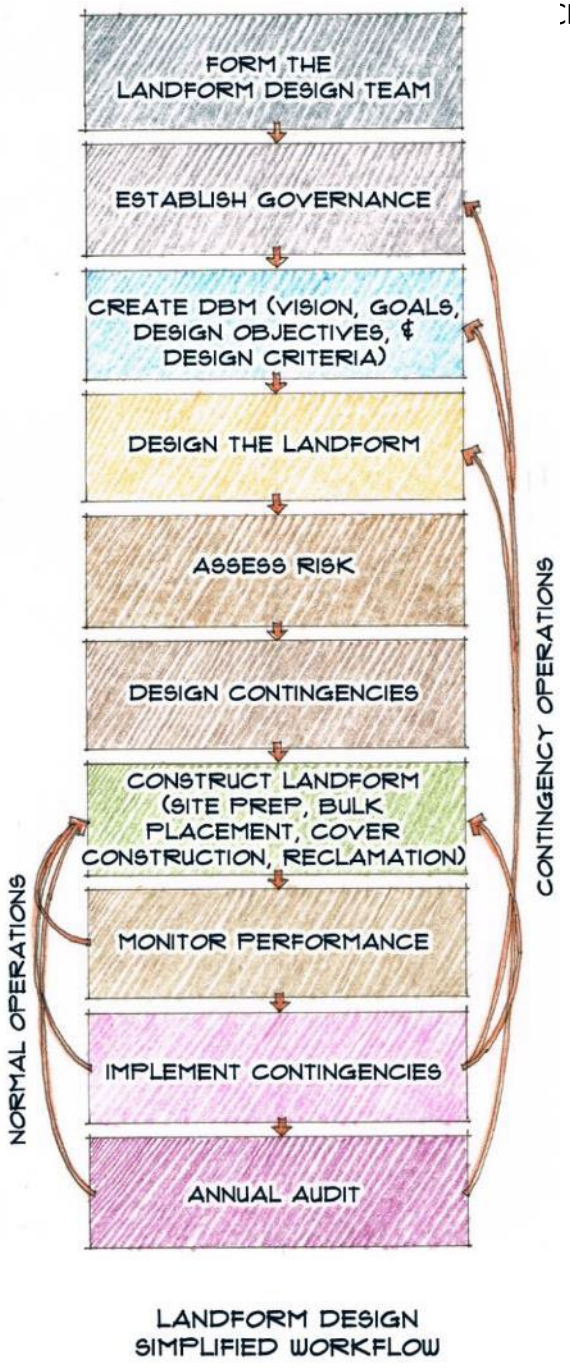
Shared governance

- Land use for mining landscapes
- Stewardship & governance
- Minesite / landscape scale (closure planning)

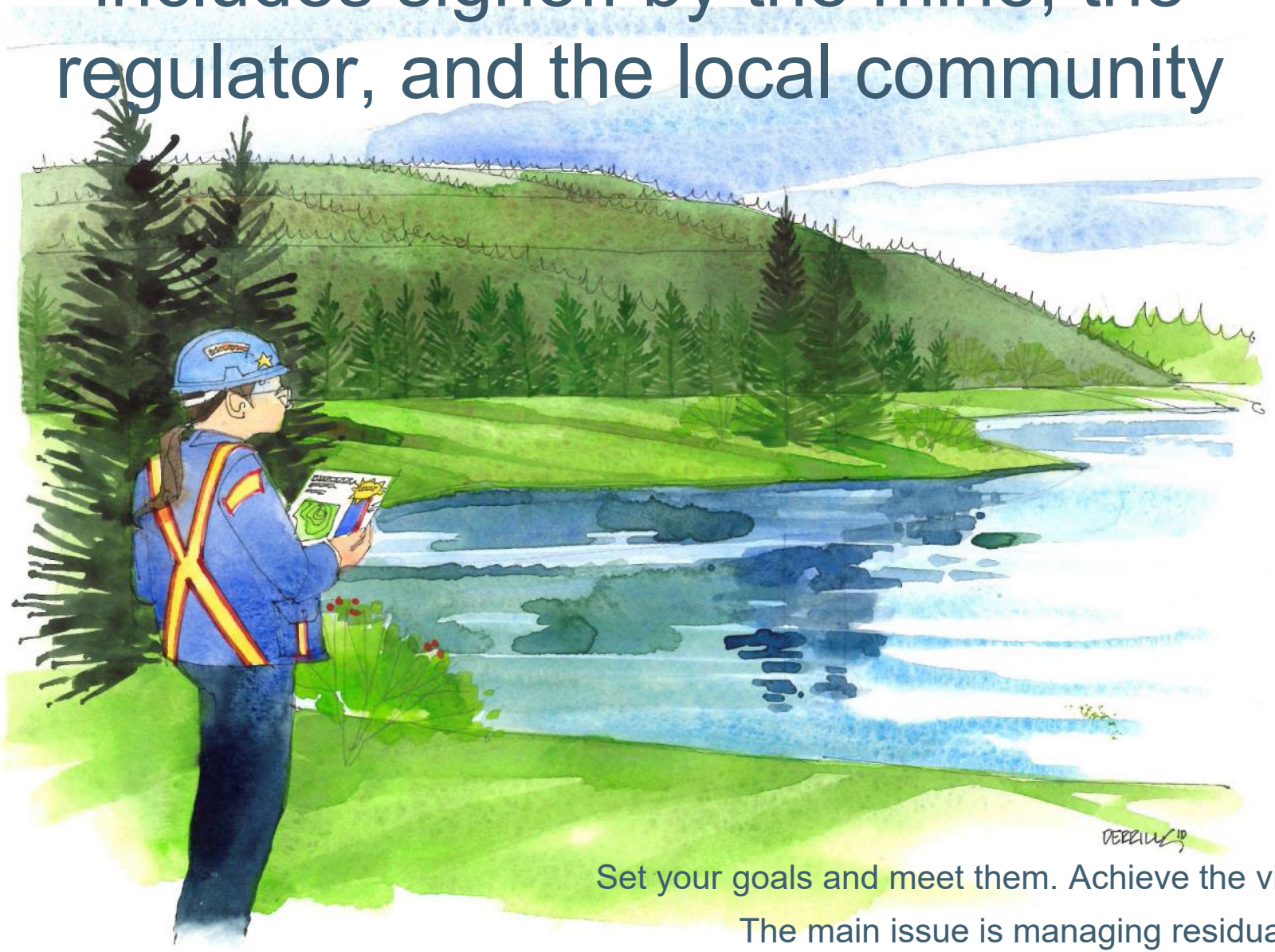
Multidisciplinary landform design

- Regional scale
- Landform scale
- Element scale

LFD is a decadal-long process…



What does success look like: it includes signoff by the mine, the regulator, and the local community



Set your goals and meet them. Achieve the vision.

The main issue is managing residual risk

Traditional definition of a landform…

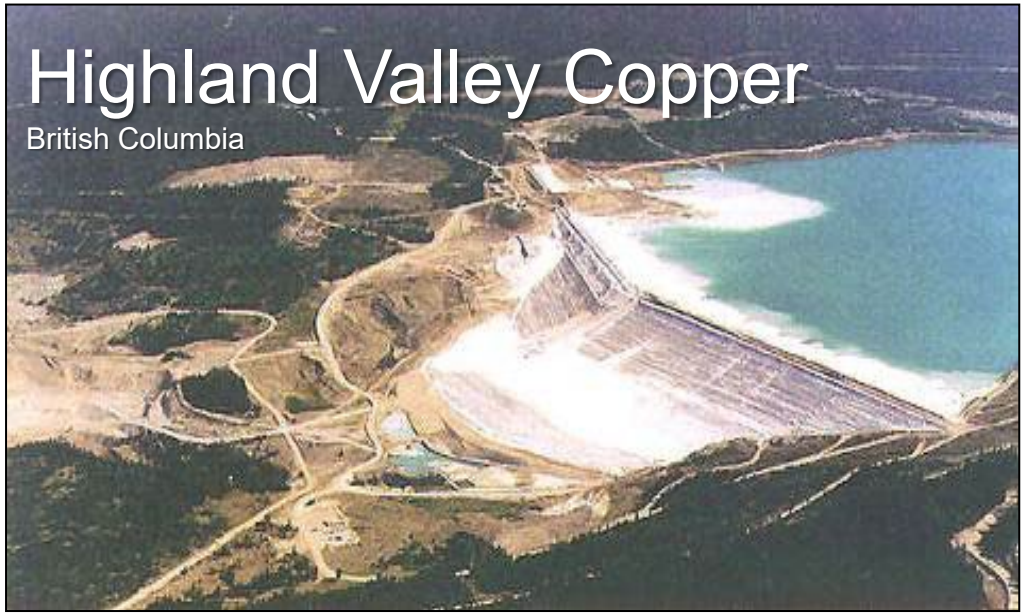
A distinctive topographic feature created by natural or artificial processes.

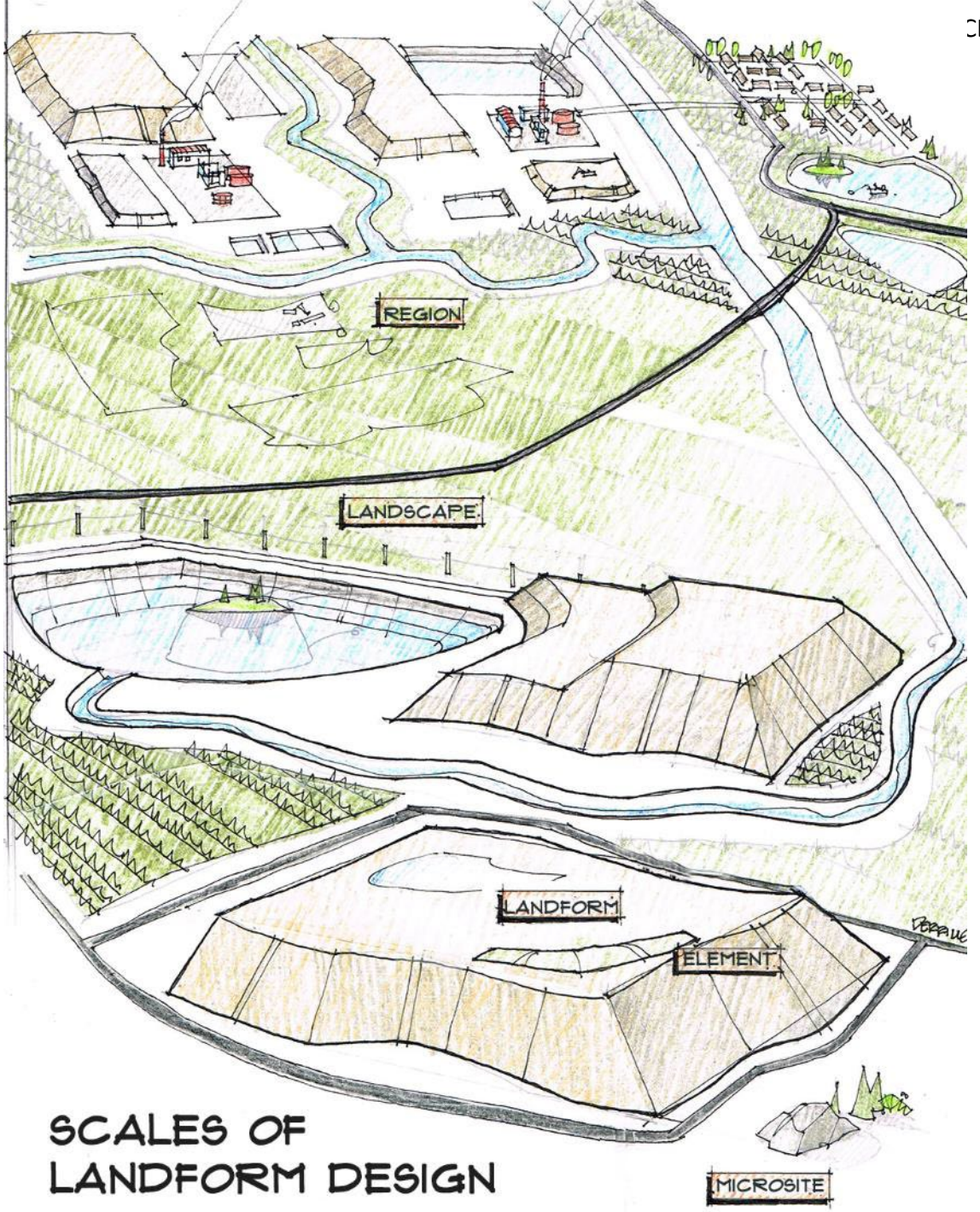
Taken together landforms make up the surface of the earth.

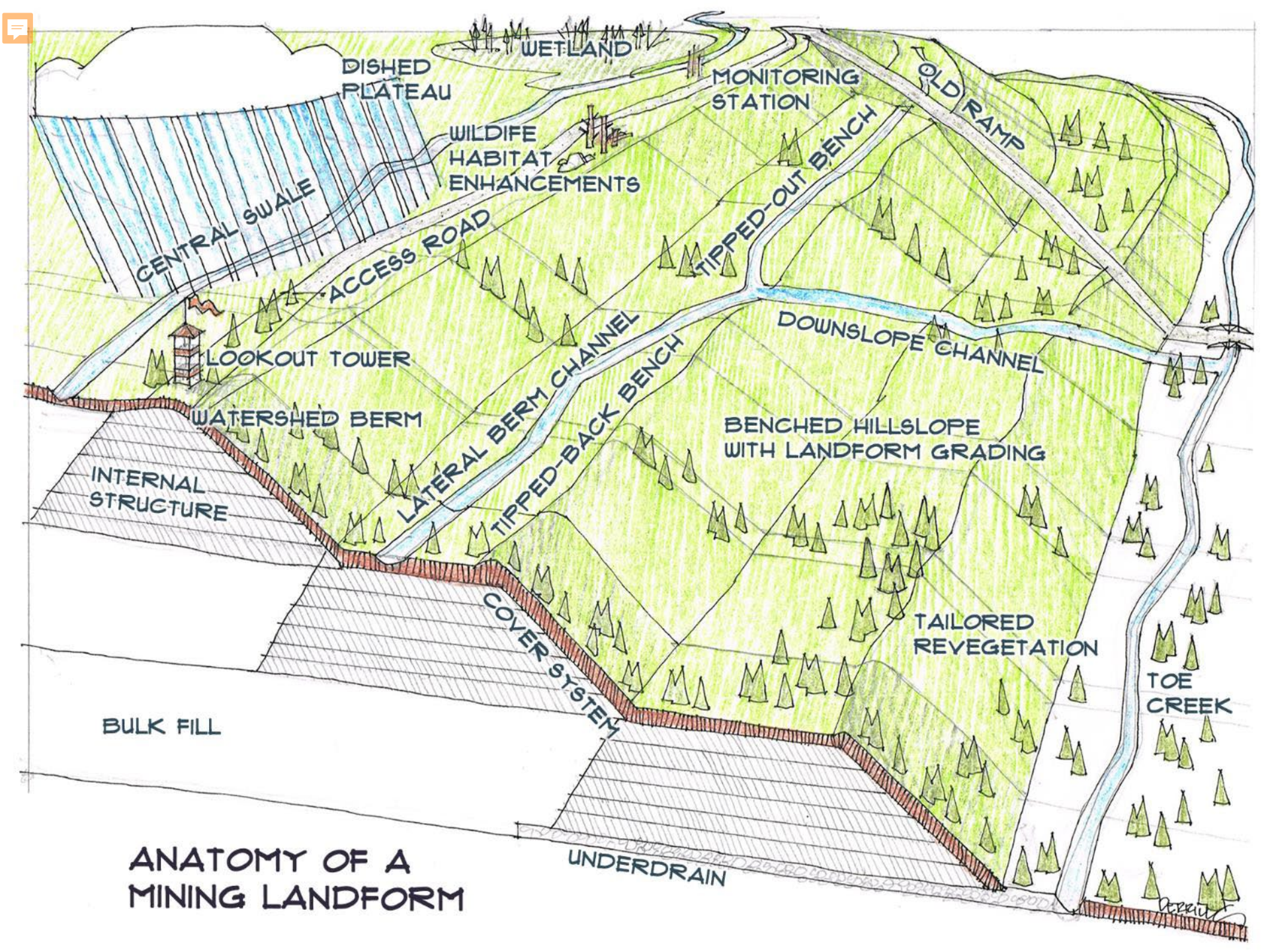
Capulin Volcano

New Mexico

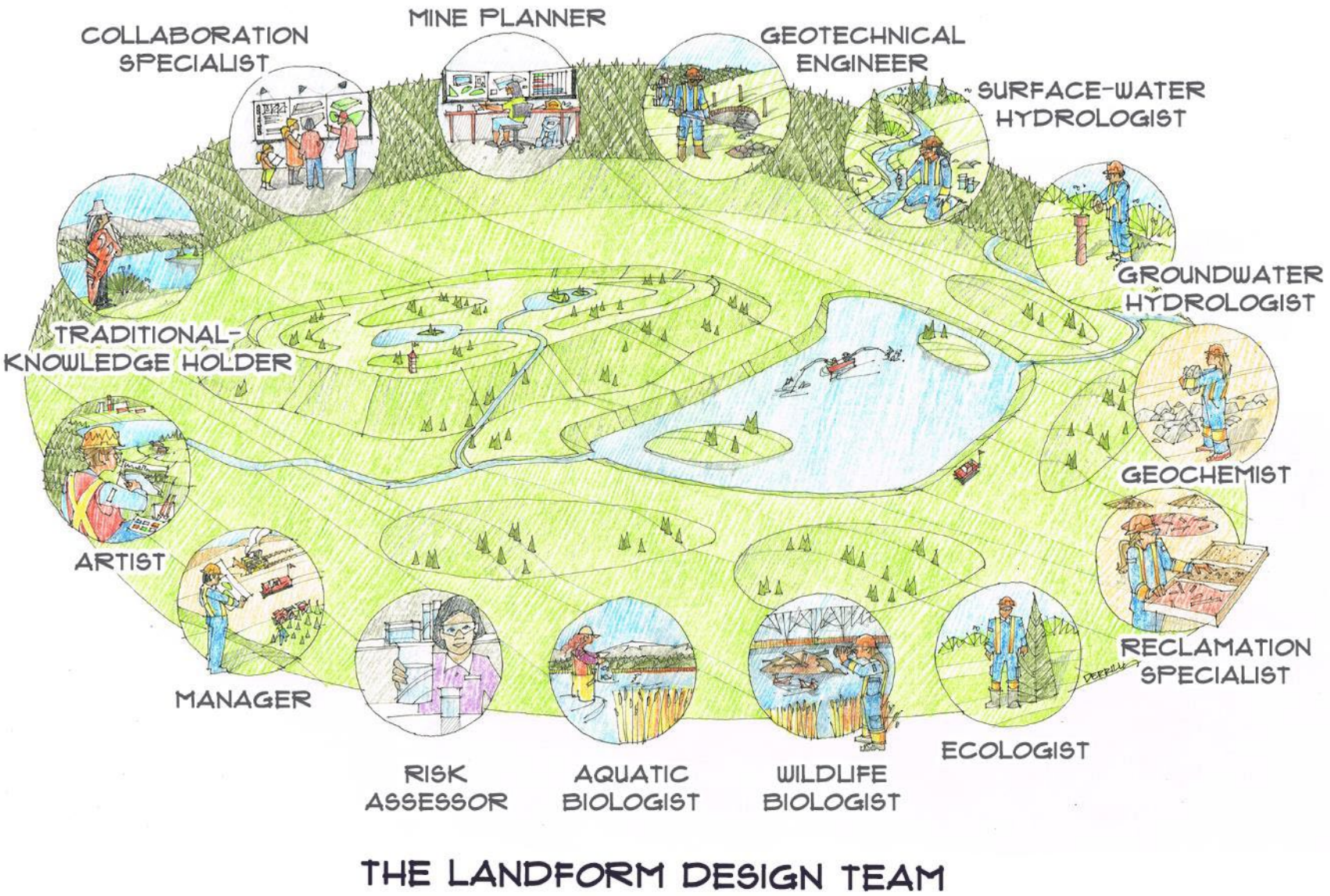
Mining landforms




REGION
LANDSCAPE
LANDFORM
ELEMENT
MICROSITE
SCALES OF
LANDFORM DESIGN

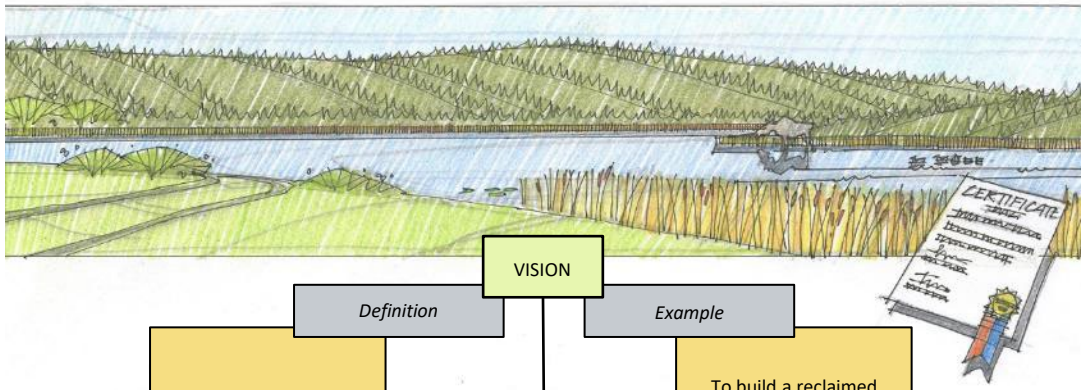

WETLAND
DISHED PLATEAU
MONITORING STATION
OLD RAMP
WILDIFE HABITAT ENHANCEMENTS
CENTRAL SWALE
ACCESS ROAD
TIPPED-OUT BENCH
LOOKOUT TOWER
DOWNSLOPE CHANNEL
LATERAL BERM CHANNEL
TIPPED-BACK BENCH
WATERSHED BERM
BENCHED HILLSLOPE WITH LANDFORM GRADING
INTERNAL STRUCTURE
COVER SYSTEM
TAILORED REVEGETATION
TOE CREEK
BULK FILL
UNDERDRAIN
ANATOMY OF A MINING LANDFORM

Form the landform design team



Working with local communities (co-reclamation)

Nested hierarchy: vision, goals, objectives, criteria



VISION

Definition

Vision:
big picture of what is to be achieved. Usually relates to land use.

Goal:
overarching design or performance requirement in support of the vision.

Design objective:
a design requirement in support of the goal

Design criteria:
a specific and measurable criteria required to fulfill an aspect of the design objective

Example

To build a reclaimed landscape such that reclaimed soils and landforms can support a self-sustaining, locally common boreal forest.

Landform slopes are geotechnically stable.

Avoid ponded water near slopes.

Prevent water from ponding within the geotechnical buffer zone during a 1 in 100-year return period flood event.

Goal #1	Goal #2	Goal #3
Design objective #1	Design objective #2	Design objective #3
Design criteria #1	Design criteria #2	Design criteria #3

The start of a DBM table

Goal	Objective	Criteria
Establish boreal forest upland and lowland communities	Upland areas reclaimed with native trees and shrubs	Nurse crop of wild oats planted in the year of reclamation material placement at a rate of 60 kg/ha.
		Planted with 2000 stems/ha white spruce and aspen and 1200 stems per hectare wild rose one year after reclamation material placed
	Low land areas reclaimed to marsh wetlands with natural invasion of wetland vegetation and benthic invertebrates	Water depth <1.5 m Watershed to surface area >10 Water salinity <2000 mg/L
Streamline reclamation operations	Provide access for two-way traffic for haul trucks	For 100 tonne trucks, haulroads 20m wide
May lump under specialties: geotechnical, surface water, groundwater, geochemistry, soils, vegetation, wildlife, land use, etc.…		

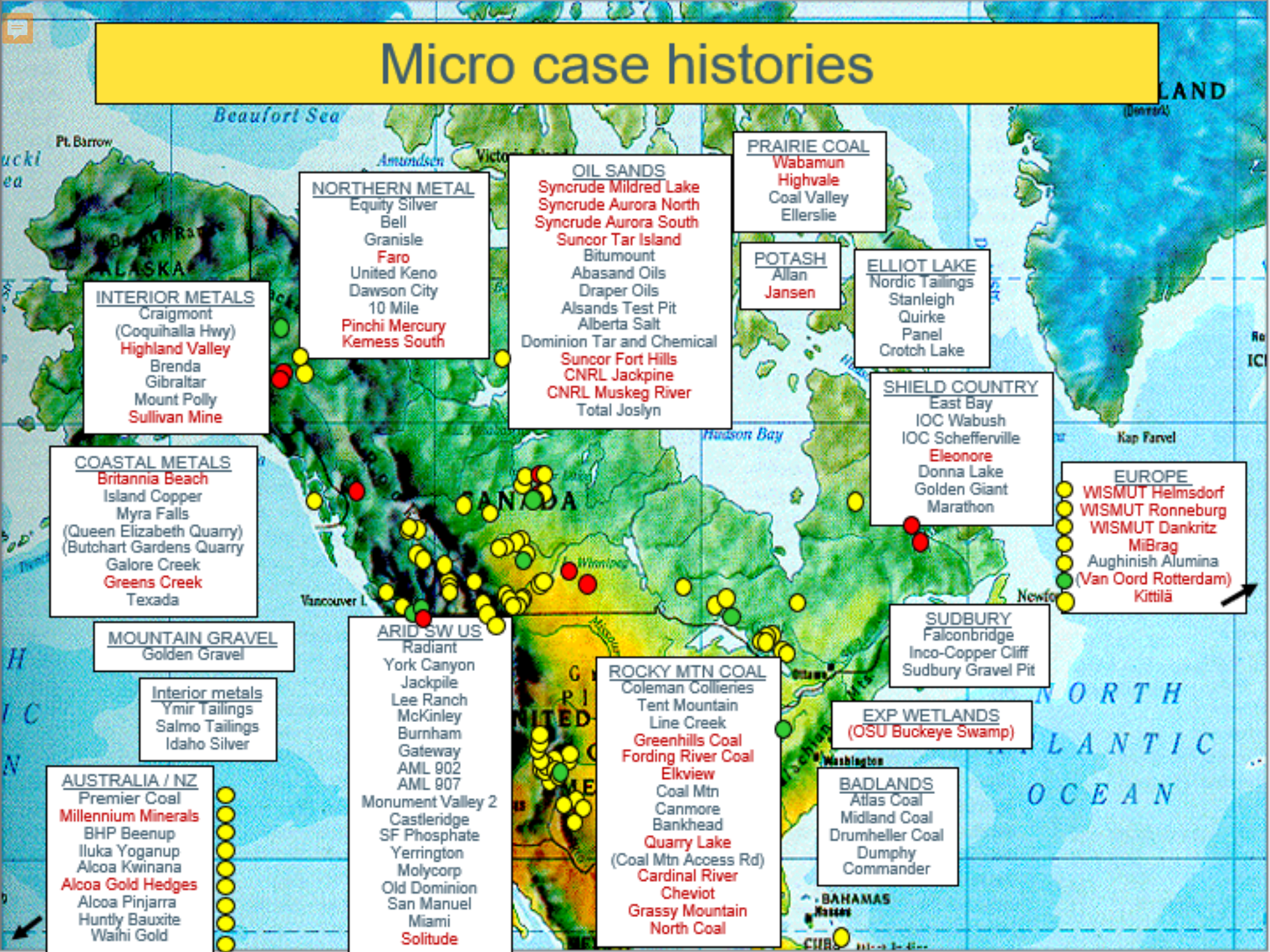
Quarry Lake, AB

Lesson: Simple sites can be a tremendous asset to the local community.

Landform design for abandoned mines

- **Same as for planned mines, mines in production, closed mines**
- **More compromise, since the mine has been built, lack of good records, probably built without closure plan for landform design**
- **Often remote**
- **Funding is usually a problem**
- **ALL THE MORE REASON for landform design**

Micro case histories



Suncor Pond 1 – Wapisiw Lookout

Lesson: The landform design process works


Draft

Queen Elizabeth Park, BC

Lesson: Can reclaim to better than it was before

Lesson: It often comes down to one person

Island Copper, BC

Lesson: Pit lake dynamics are complex

Pinchi Mercury Mine, BC

Lesson: Even highwalls can be reclaimed.

Equity Silver, BC

Lesson: If allowed, reclaimed mines can be very maintenance intensive.

Craigmont Mine, BC

Lesson: Spillways in bedrock are great.

Wismut Waste Rock, Germany

Lesson: Simple reclamation is best, but best done right.

Vale – near Belo Brazil

Lesson: Visual aspects matter

Premier Coal, Western Australia

Lesson: Don’t rely on complex numerical models

Huntly Bauxite, Western Australia

Lesson: Some mines have it all together – good management

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