

Debris Flow Mitigation at the East Gate Landslide

Glacier National Park

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Agenda

1. Site Background
2. Design Development
3. Implementation
4. Lessons Learned
5. Next Steps

Site Characteristics

British
Columbia

Alberta

Jasper
National Park

Yoho
National Park

Calgary

Kamloops

Mt. Revelstoke
National Park

Glacier
National Park

Kootenay
National Park

Banff
National Park





East Gate Landslide

Glacier
National Park

Km 0

Km 5

Km 10



Km 15

Km 20

Rogers Pass Monument

Km 25

Km 30

Km 35

Km 40

Km 44

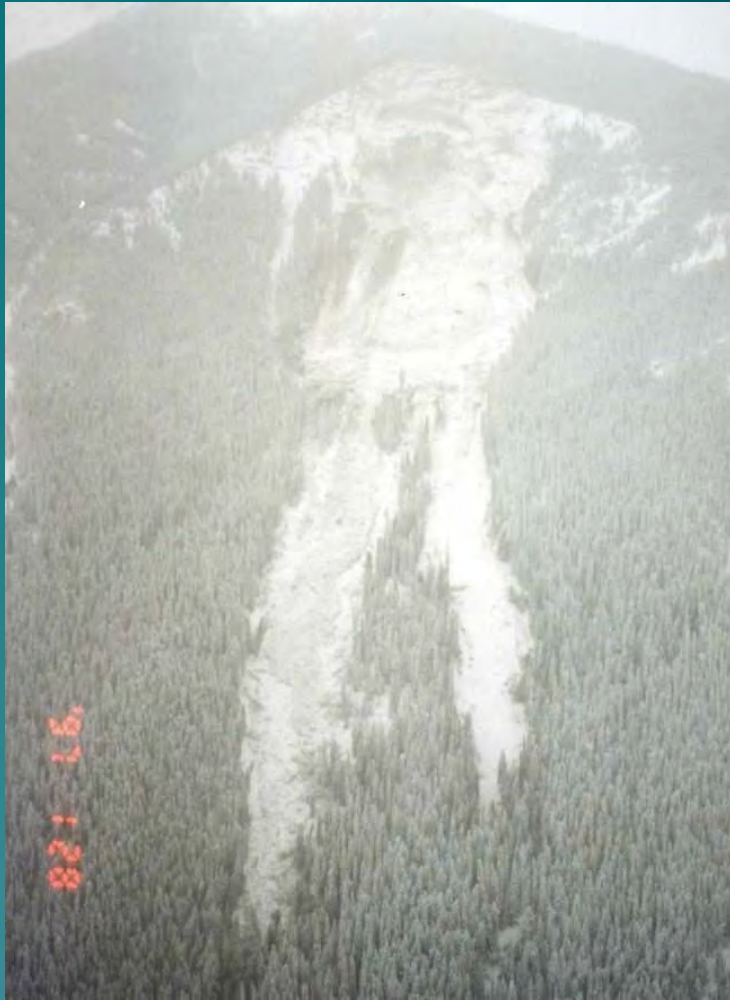


January 1997 reactivation
of ancient landslide –
2,000,000m³ failure



Photo by PCA, January 1997

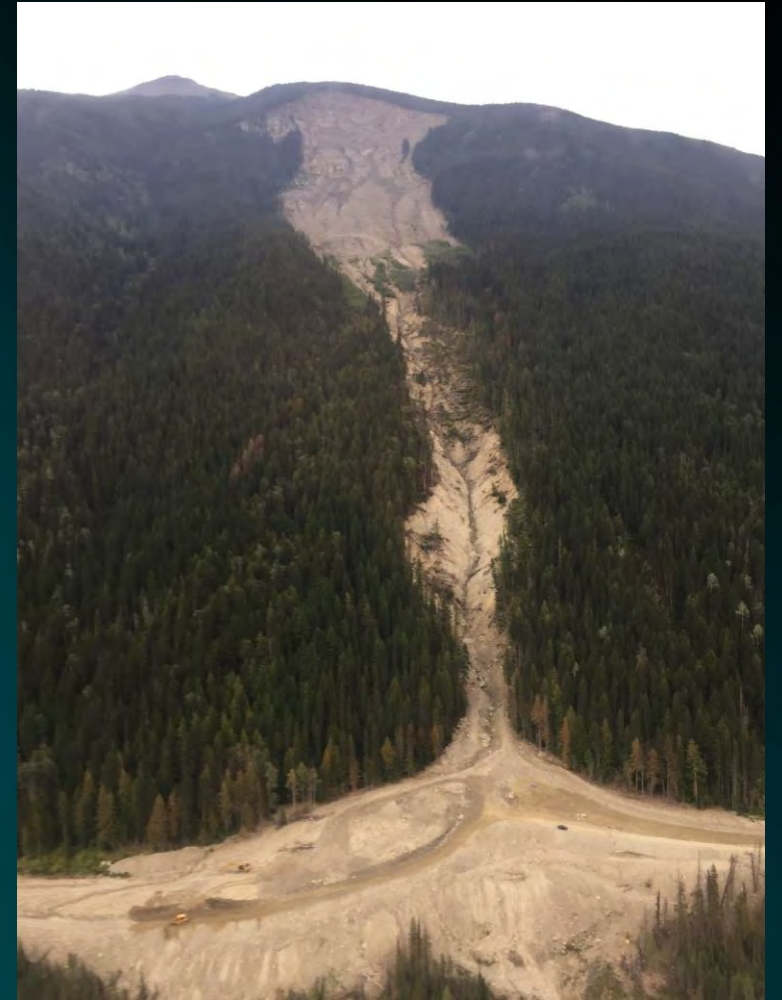
1997



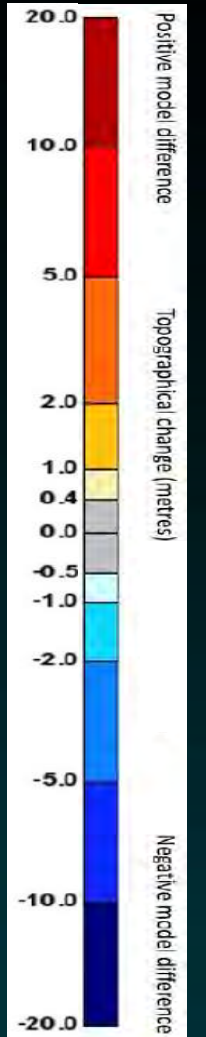
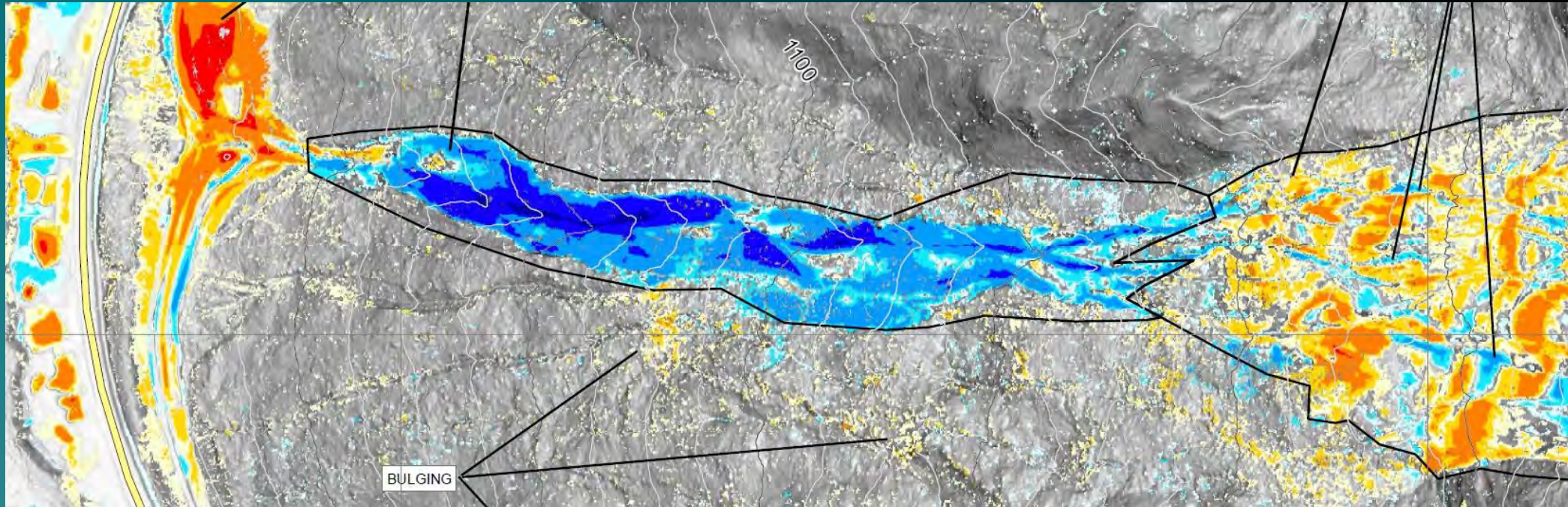
2003



2018



Gully Evolution: 2015 LiDAR vs. 2018 LiDAR







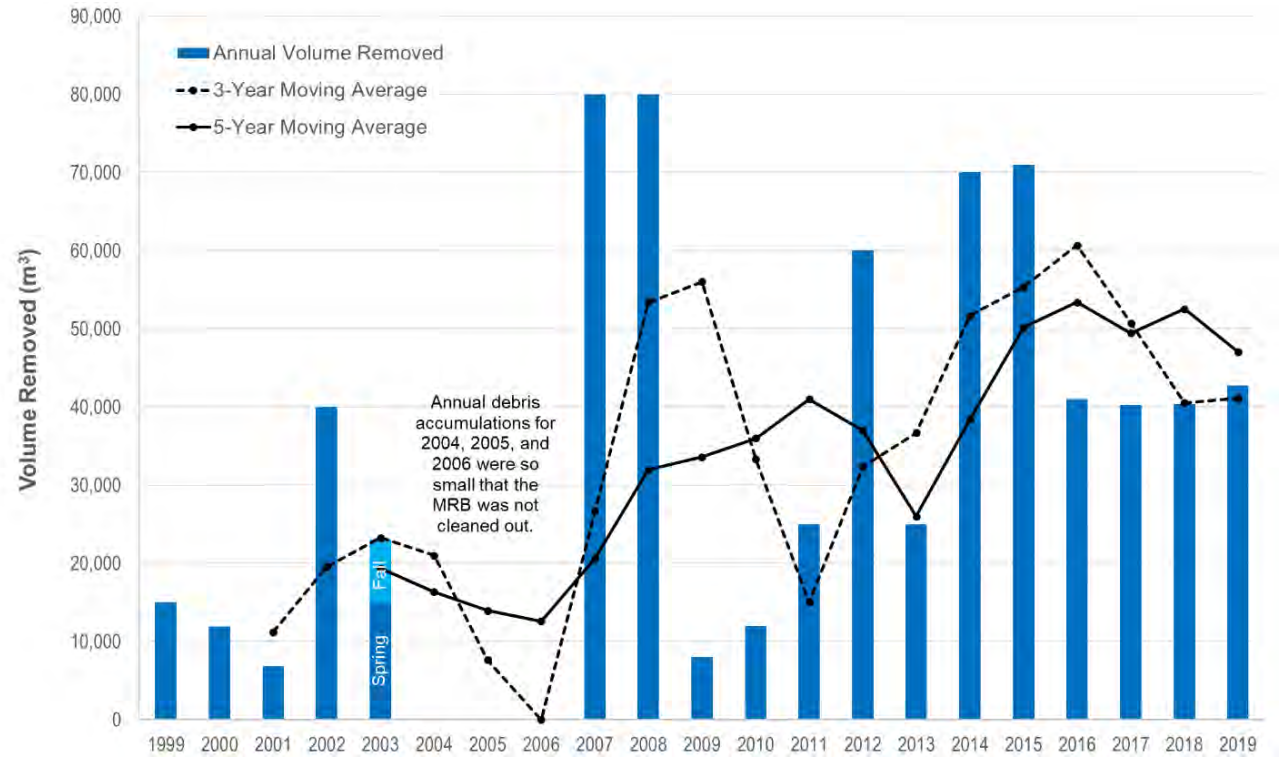
Previous Interventions





Debris Removal Volume (m³)¹

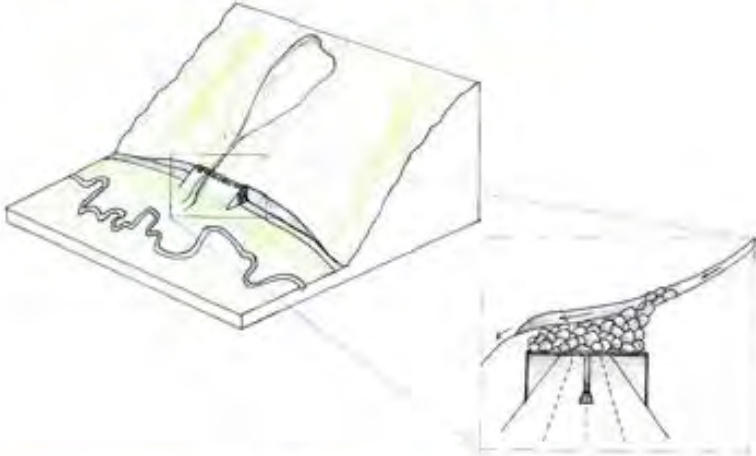
Minimum Annual	7,000
Median Annual	40,000
Maximum Annual	80,000
Total (1999 to 2019)	692,000



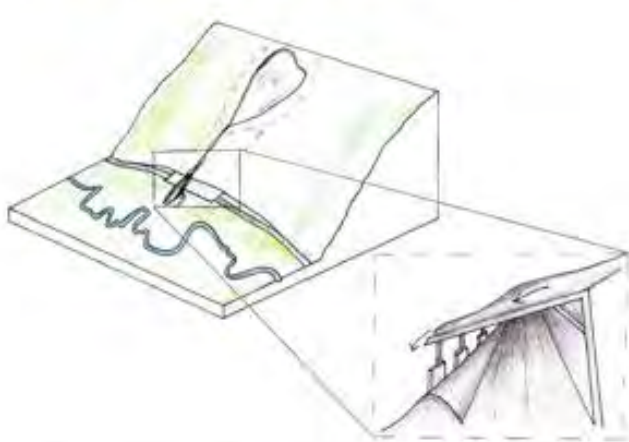
The background features several faint, light-colored line drawings. On the left and right sides, there are 3D perspective sketches of rectangular boxes with internal wavy lines, possibly representing cross-sections of materials or components. In the center, there are two smaller sketches: one showing a structure with a long, thin, curved element extending upwards, and another showing a more complex, multi-part assembly. The overall aesthetic is technical and minimalist.

Traditional Engineering Approaches

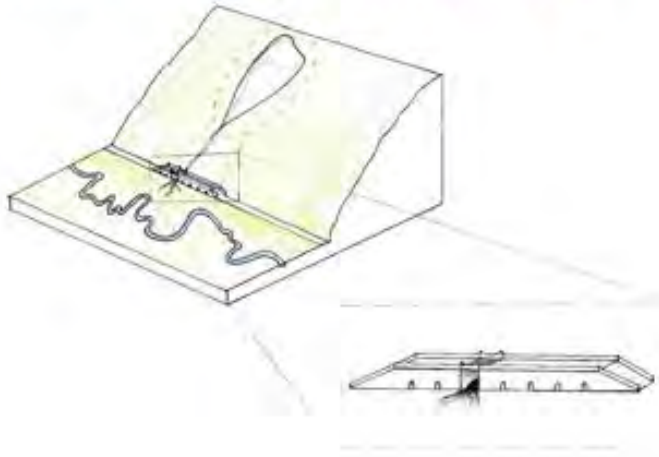
Cut and Cover Tunnel



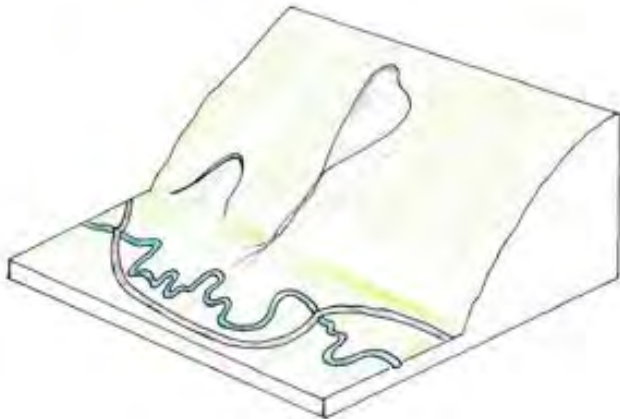
Shed Structure



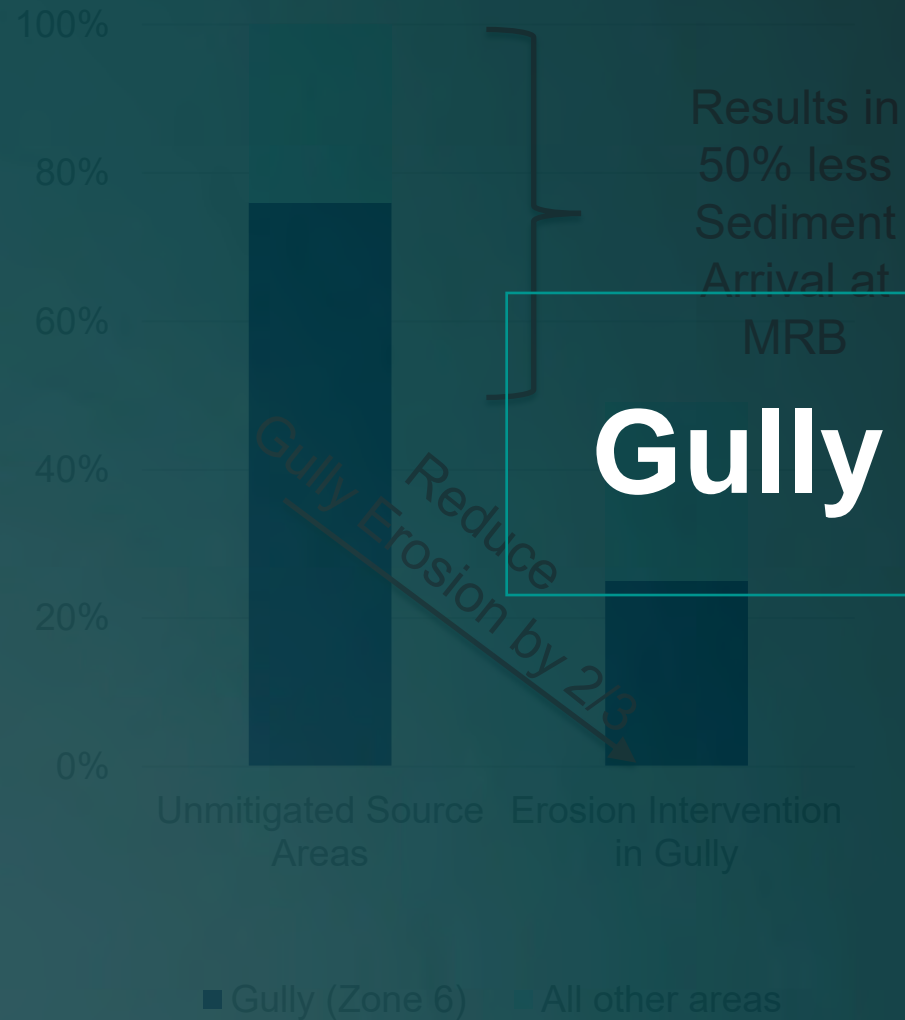
Berm-to-Bridge Structure



Highway Realignment



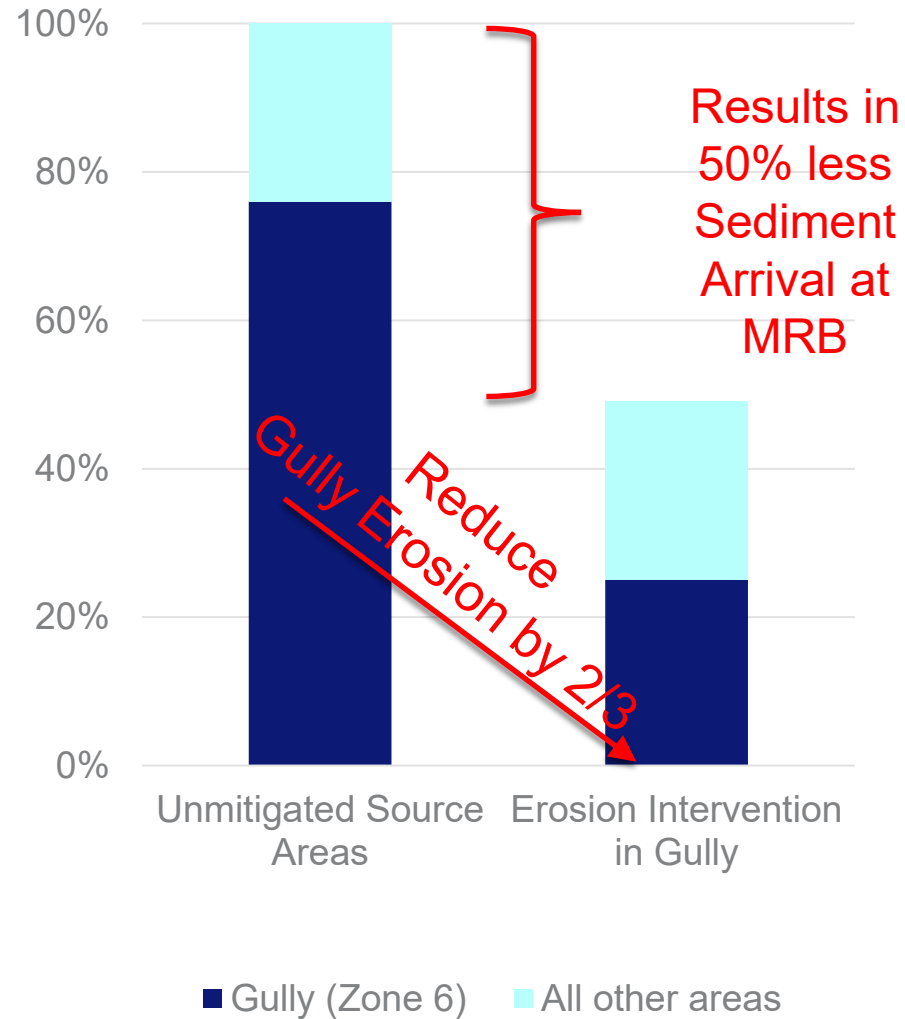
Sediment Arrival at Berm Apex



Gully Interventions

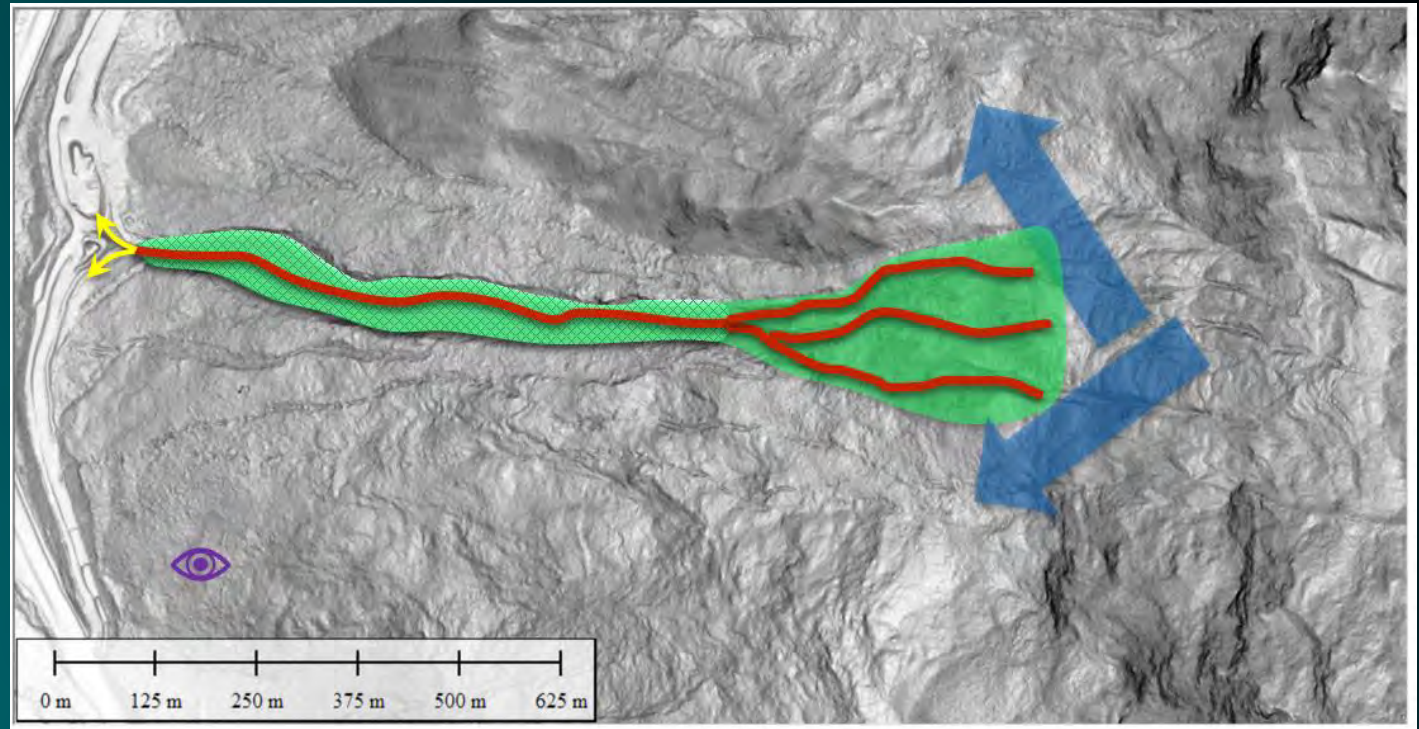
- 3/4 of debris is mobilized from Main Gully
- Recommended feasibility assessment
- Recommended intervention strategies:
 - Check dams
 - Water diversion
 - Revegetation

Sediment Arrival at Berm Apex



- $\frac{3}{4}$ of debris is mobilized from Main Gully
- Recommended feasibility assessment of gully erosion intervention strategies:
 - Check dams
 - Water diversion
 - Revegetation

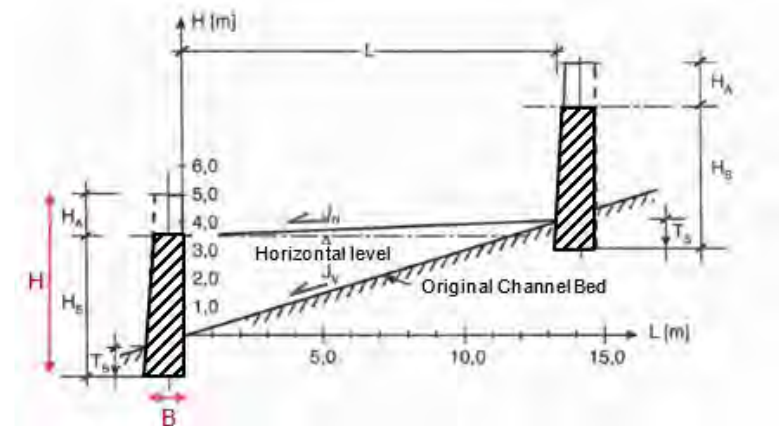
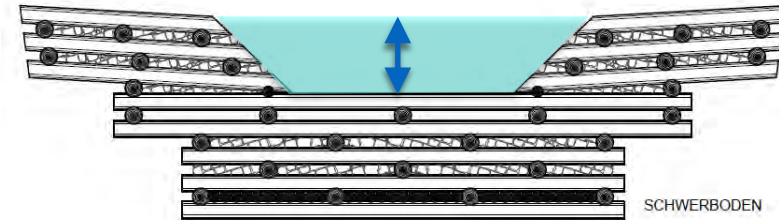
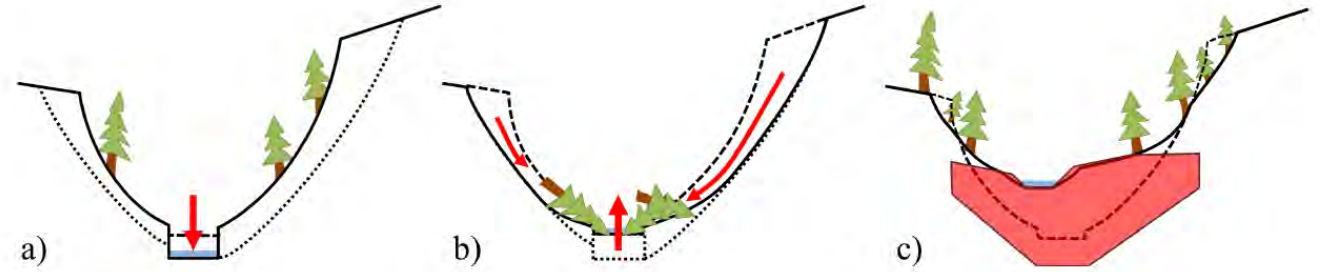
- Divert
- Prevent down-cutting
- Anticipate and adapt to gully side slope instability
- Improve surficial stability
- 👁 Monitor and adapt
- Guide gully discharge

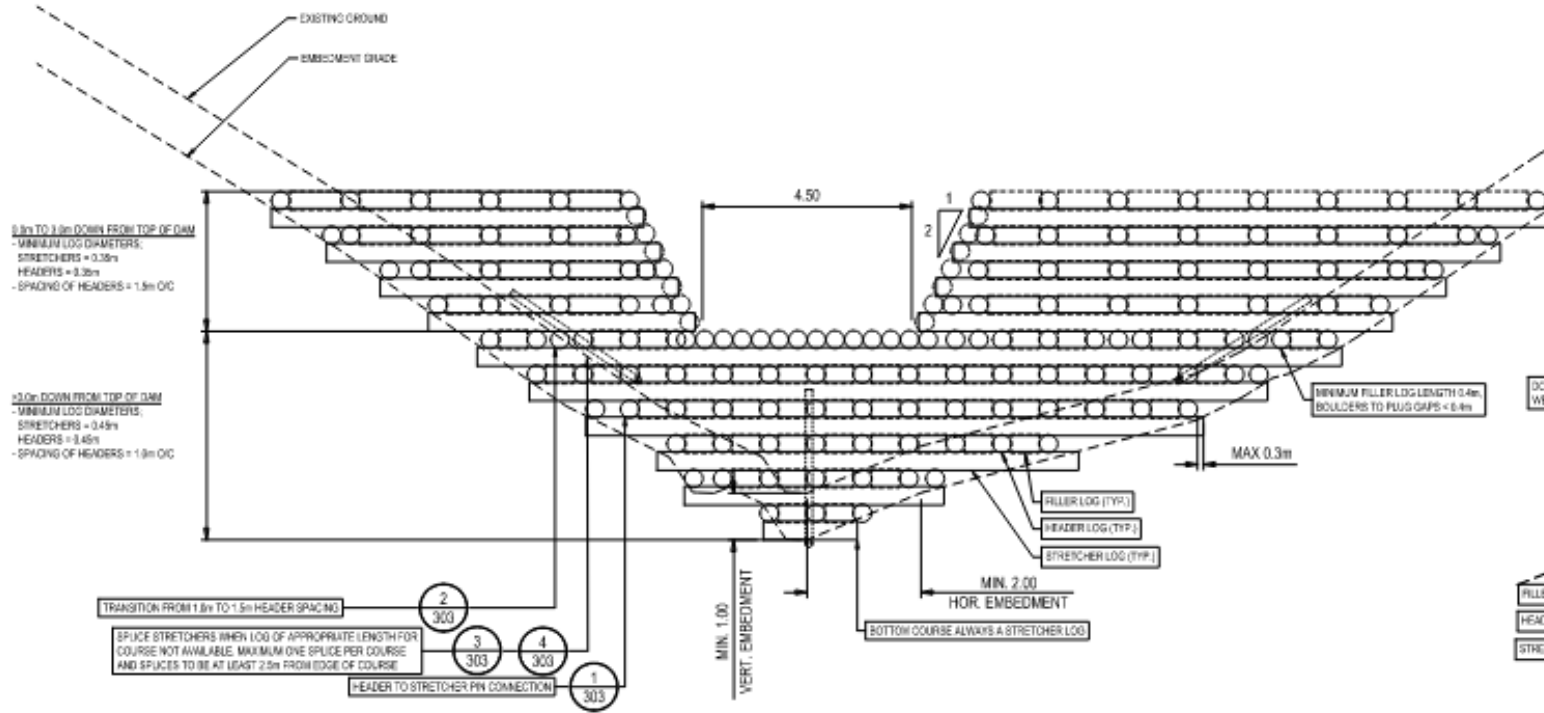


Check Dams

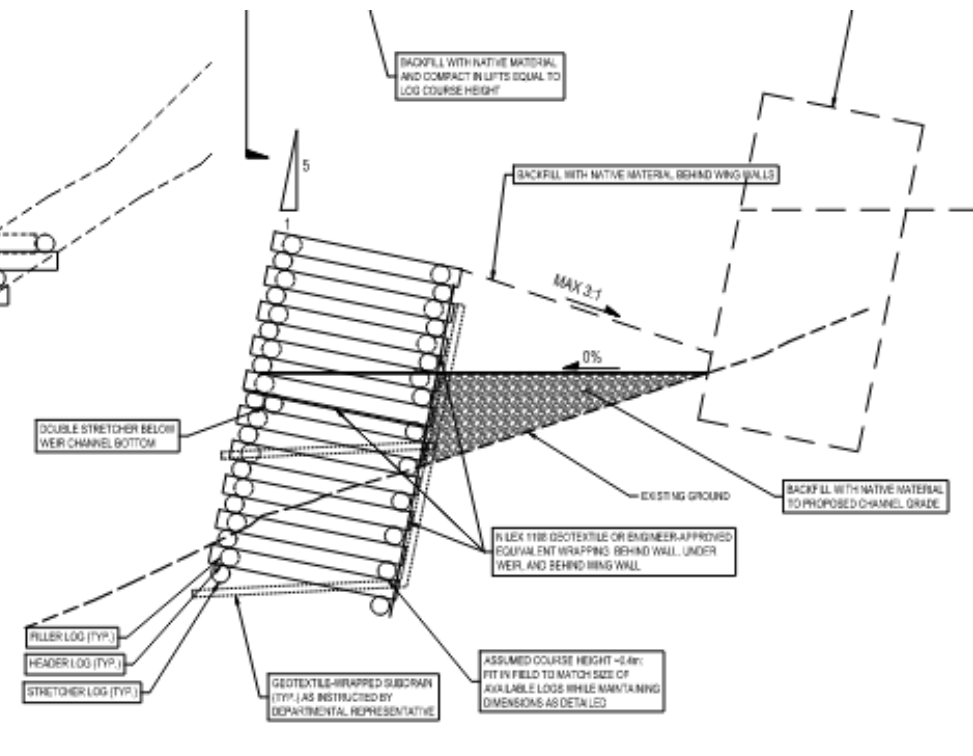


- Grade control -> Stops vertical incision
- Debris flow discharge is key parameter for sizing check dam weirs and defines height of wingwalls to prevent outflanking



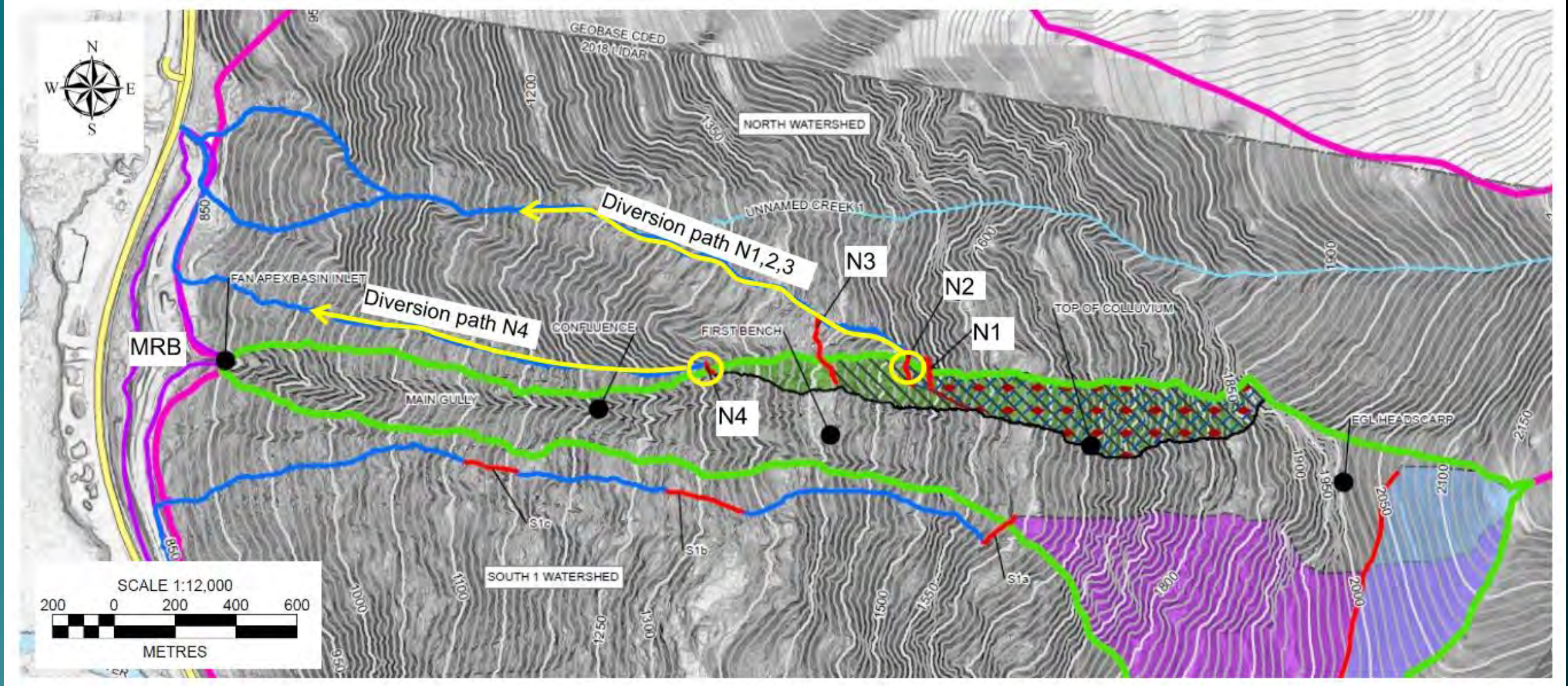


SECTION A-A



SECTION B-B

Diversions





Live Staking





Implementation











Continued Construction



6

5

4

3

2

1



Log Supply





Freshet!



The background image is a dark, teal-tinted photograph of a construction site. It shows a large area of sandbags arranged in rows, with a road or path cutting through them. In the center, there is a piece of equipment, possibly a pump or generator, with hoses connected to it. The overall scene suggests a flood control or erosion control project.

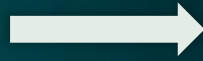
Wear & Tear



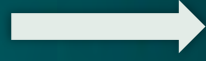
Front Face Abrasion



Corduroy Abrasion



Scour and Riprap Displacement



A topographic map showing a lateral landslide. The map features several contour lines representing elevation, with labels such as 0+360, 0+380, 0+400, 0+420, 0+440, 0+460, 0+480, 0+500, 0+520, 0+540, 0+560, 0+580, 0+600, 0+620, 0+640, and 0+660. A central text box with a white border contains the title "Lateral Landslide". The background is a dark teal color with a faint grid pattern.

Lateral Landslide

2022

2015

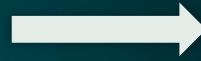


Football Field Landslide (FFL)

Football Field Landslide (FFL)



Check Dam Repairs



Thalweg Stabilization





Past, Present, Future







Special
Thanks



Parks
Canada

Parcs
Canada



Questions?



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