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Assessing Maryland's Largest Highway Rock Cut Slope: Sideling Hill Rock Slope Hazard Study

2013 Geohazards Forum
July 31, 2013

Site Location

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I-68 Through Sideling Hill

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I-68 Through Sideling Hill

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Lithology and Structure

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Faulting

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Faulting

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Cut Slope Construction

- Construction completed in 1985
- Four benches on both sides
- Benches up to 80 ft high
- Bench slopes as steep as 0.25H:1V
- 20 ft wide benches
- Reverse sloped benches
- 38 ft wide catchment area
- Shallow V-shaped rockfall ditch

Background and Scope

- Existing geometry significantly different than as-built plans
- Tapered maintenance program
- History of small rockfalls
- Rock slope hazard study and mapping
- Develop design concepts for hazard mitigation

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Initial Site Visit: Hazardous Conditions

Highly Fractured, Loose Rock

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Loose Rock

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Thin Slabs at Face

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Raveling Bench Edge

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Raveling Bench Edge

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Raveling Bench Edge

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Overhanging Block

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Overhanging Block

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Differential Weathering

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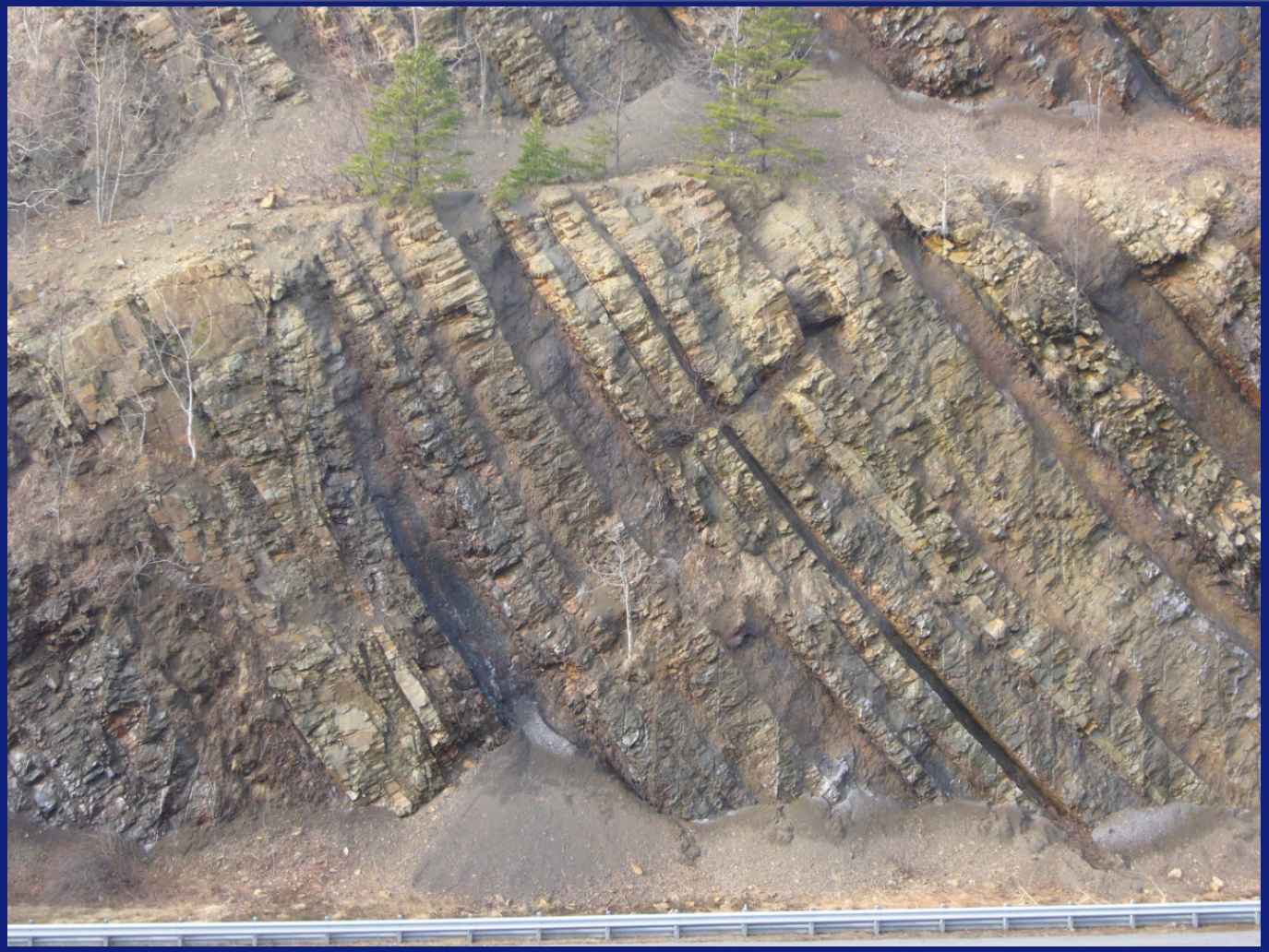
Differential Weathering



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Overhang

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Overhang

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Overhang and Raveling

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Overhangs

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Overhangs

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Debris Wedge

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Debris Wedge

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Debris Wedge

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Undermined Bench

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Wall above Undermined Bench

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Rockfall Catchment Area

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Vegetation

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Seepage

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Seepage Flow over Bench Edge

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Rock Slope Hazard Study

- LiDAR Survey
- Rock Structure Mapping
- Slope Stability Analysis
- Rockfall Hazard Analysis

LiDAR Survey

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Topographic Site Plan

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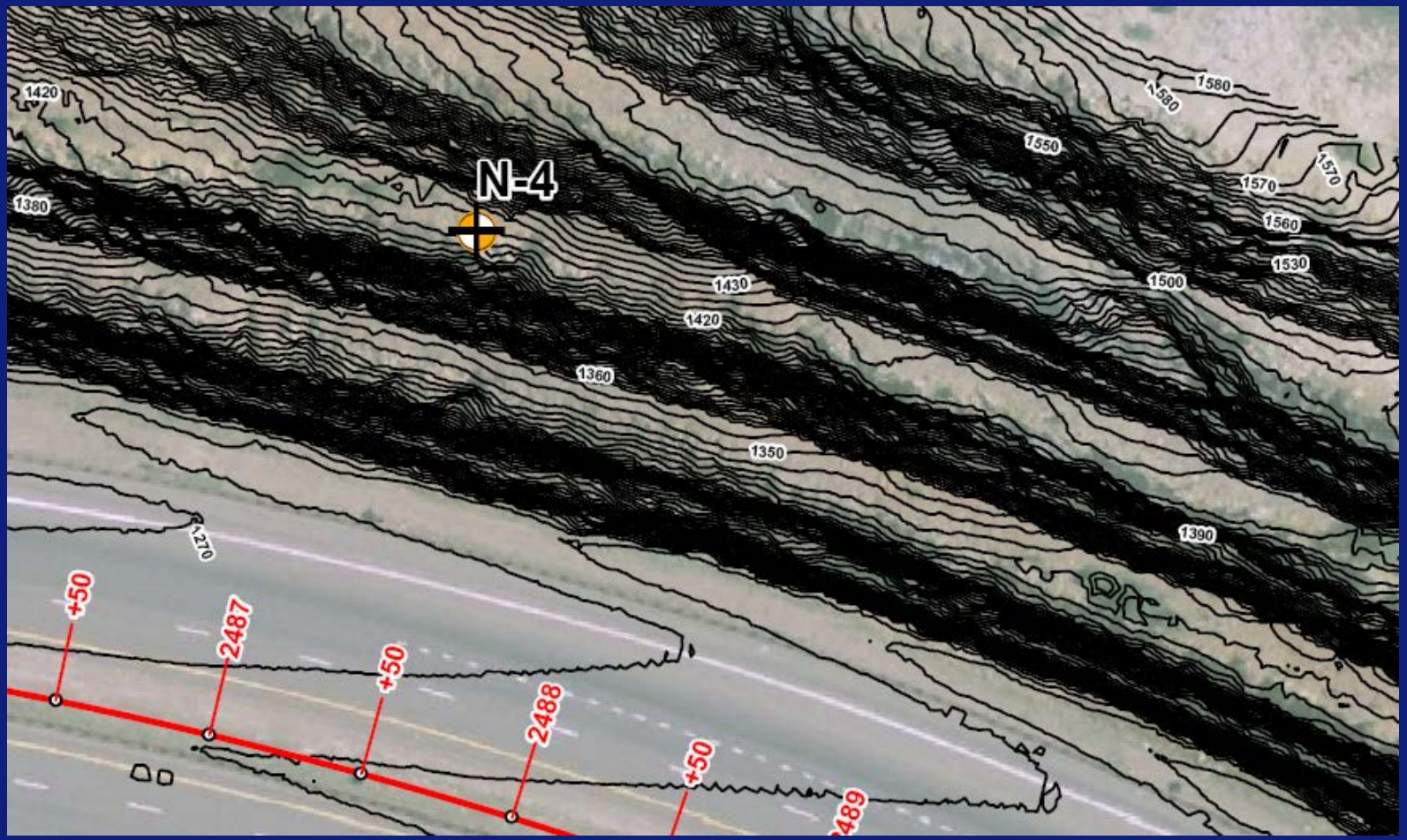
Topographic Site Plan



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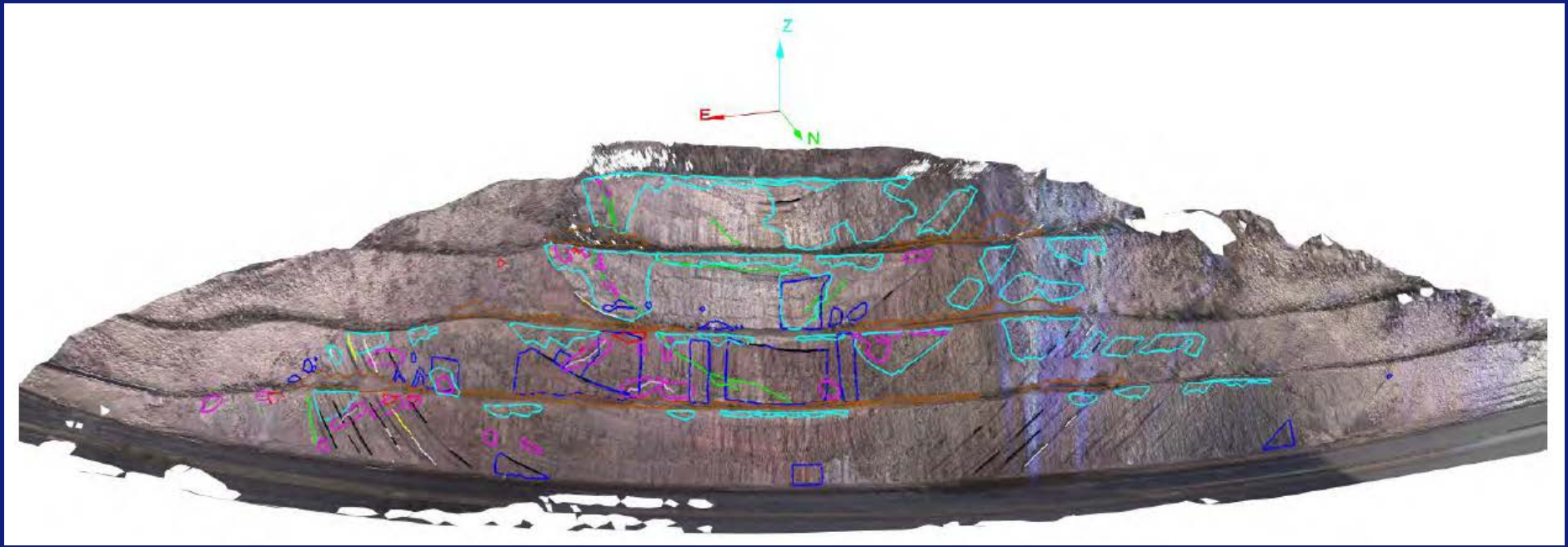
Field and Digital Mapping

	FIELD	DIGITAL
Lithology / Engineering Geology Units	X	X
Areas of Loose Rock	X	X
Overhangs (>2 ft)	X	X
“Pop-outs”	X	X
Rockfall Debris Accumulations	X	X
Major Joints	X	X
Major Fractures and Faults	X	X
Potentially Unstable Blocks	X	X
Seepage Areas	X	X

Rock Slope Hazard Map

South Face



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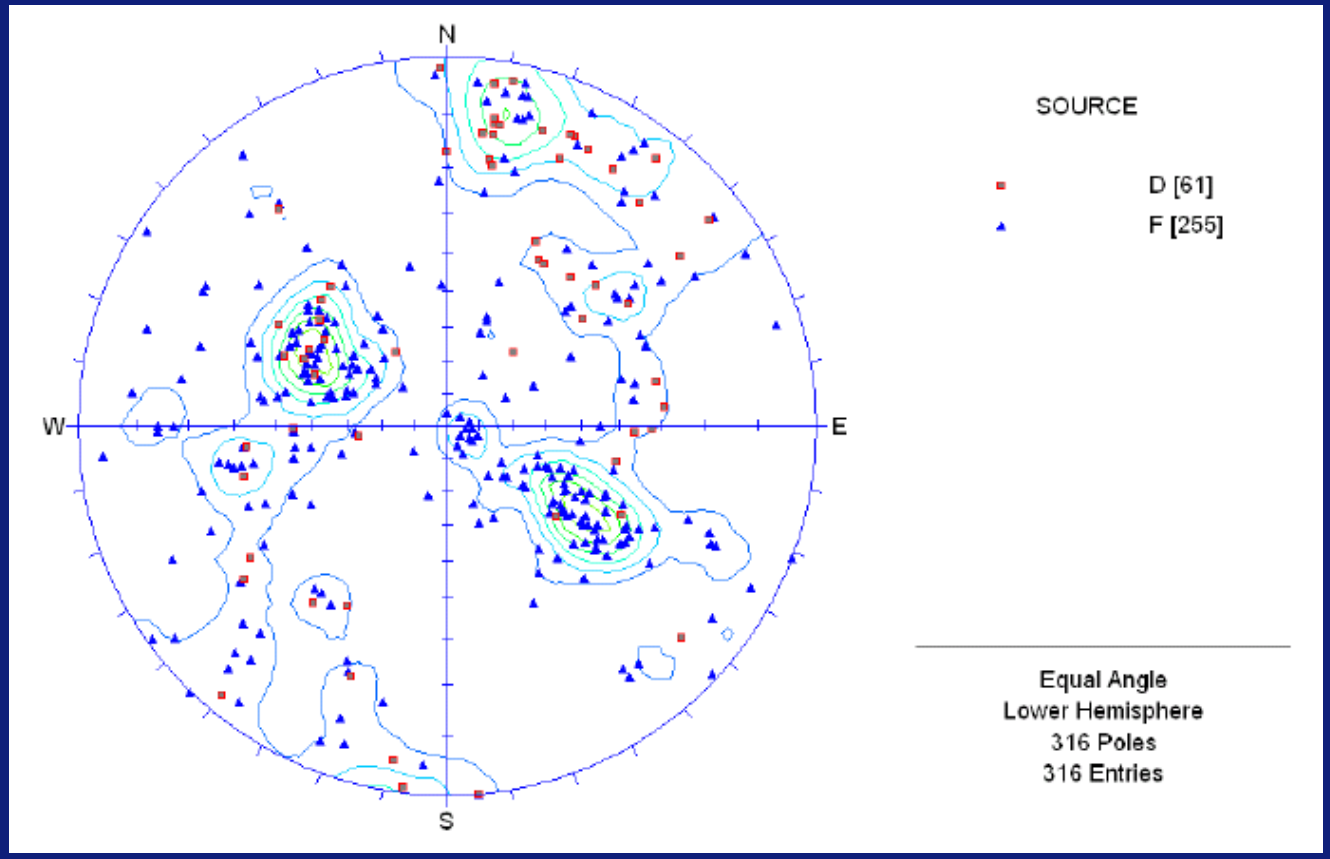
Rock Structure Mapping



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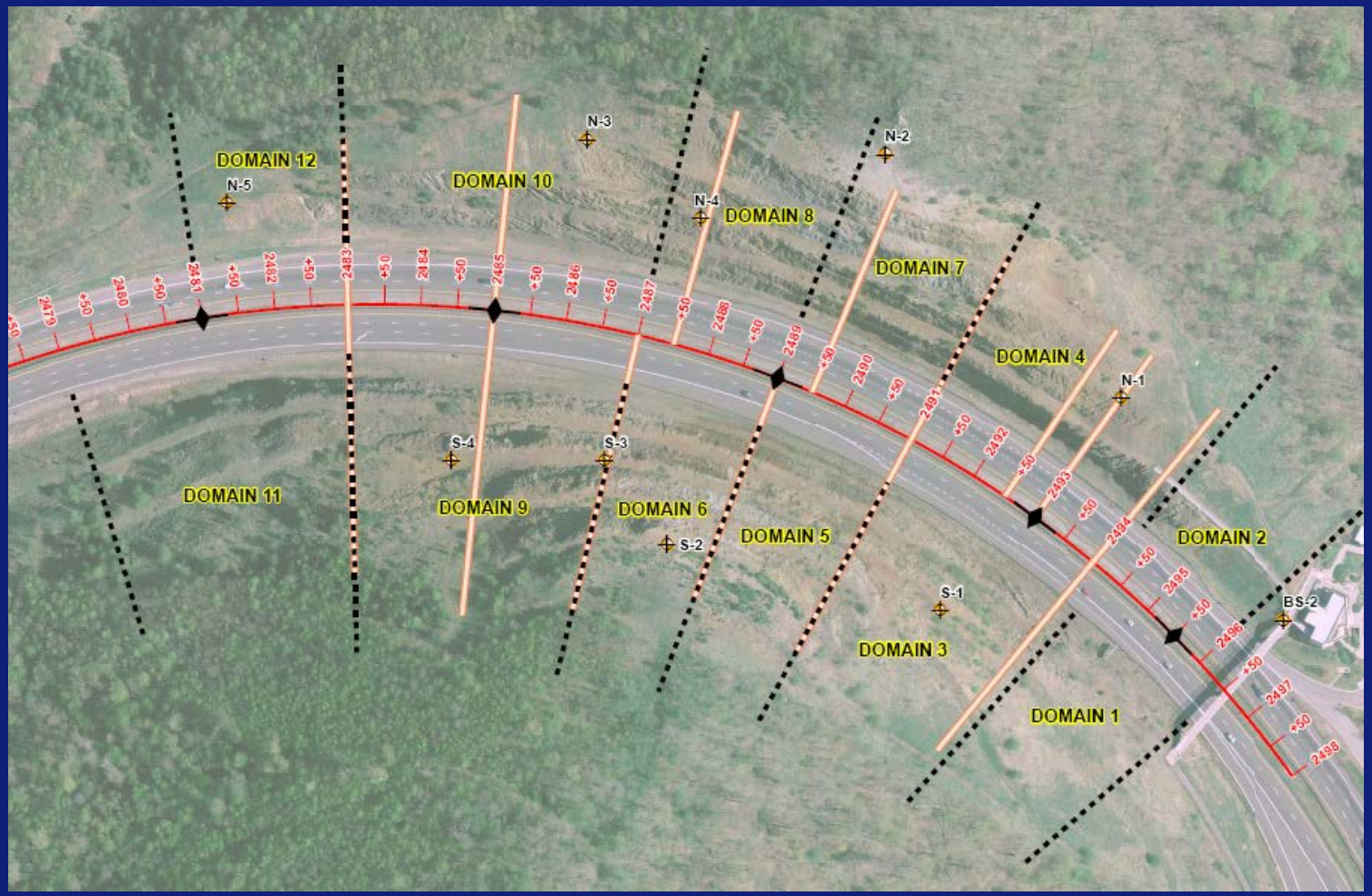
Kinematic Analysis



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Kinematic Analysis

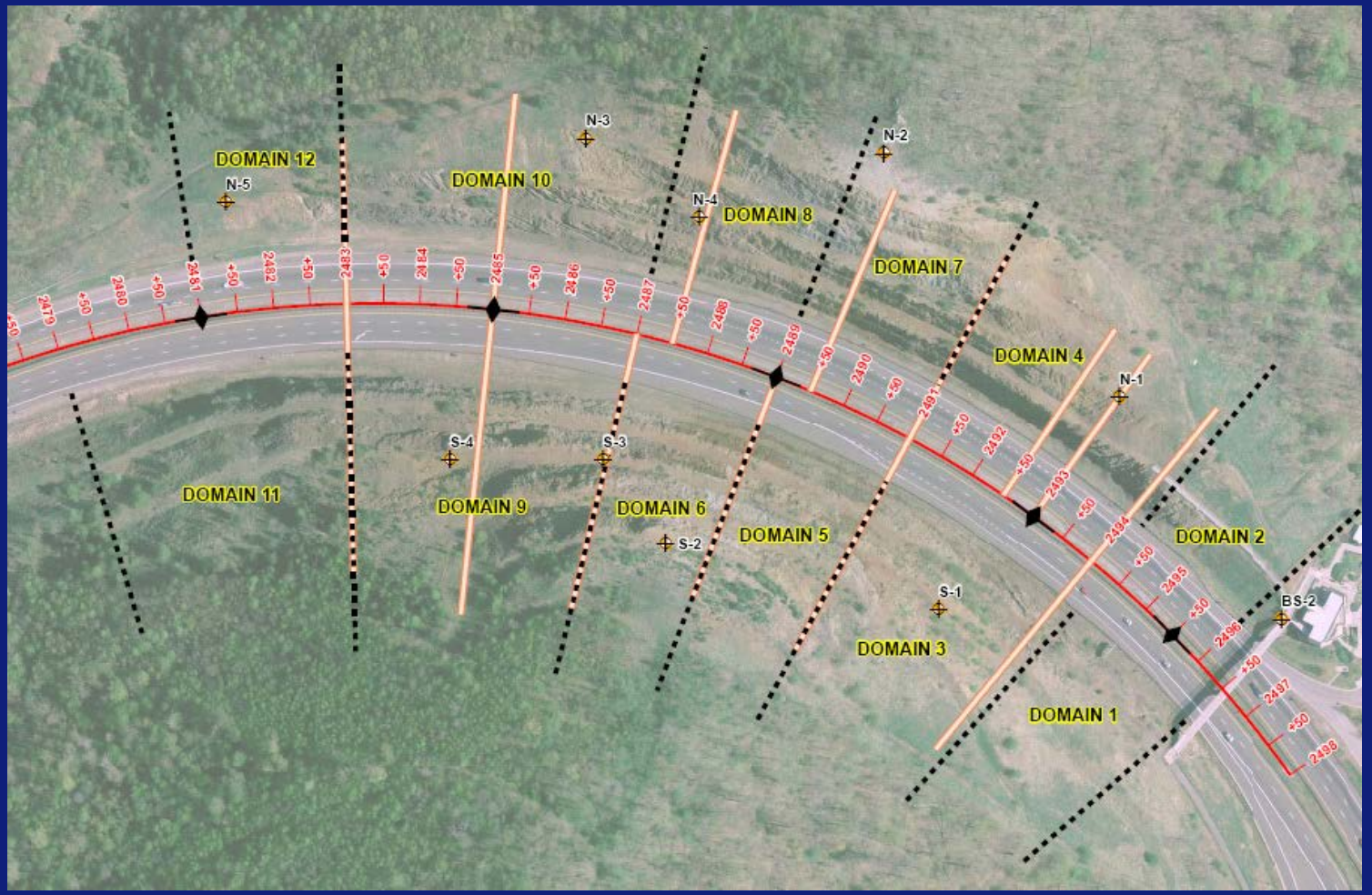
Summary

SLOPE	DOMAIN	FAILURE MODE
South	Domain 1	Planar Sliding (Major Joint)
North	Domain 8	Wedge Sliding (Bedding and Joint Set)
North	Domain 10	Planar Sliding (Major Joint)
North	Domain 12	Wedge Sliding (Bedding and Major Fracture)

Limit Equilibrium Analysis

- Safety factors all >1.5

Rockfall Hazard Analysis



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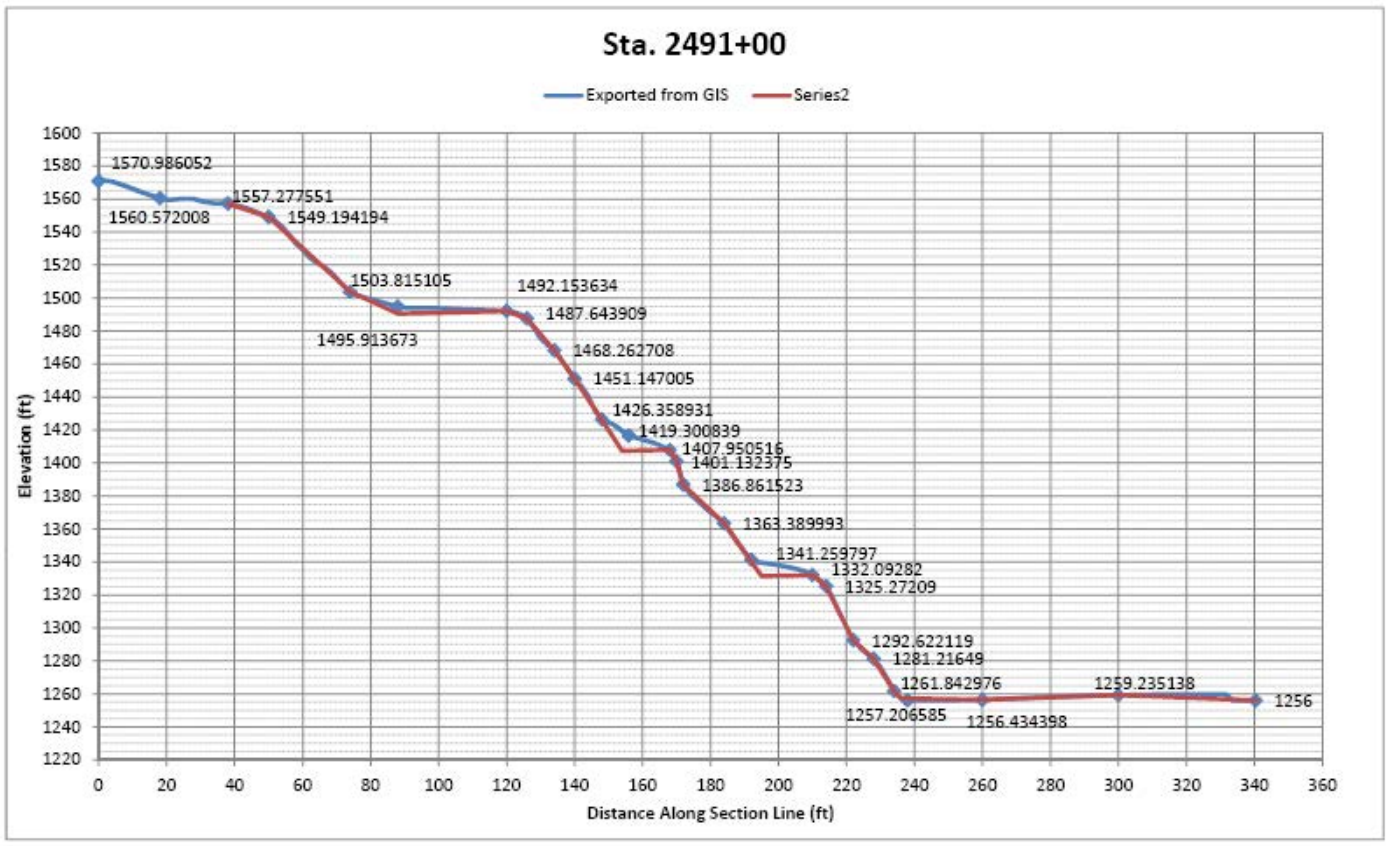
Rockfall Hazard Analysis



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Rockfall Hazard Analysis

- Inputs:
  - Profile (i.e., station)
  - Height (i.e., benches involved)
  - Debris on bench removed?
  - Block size (1ft, 3ft, 5ft)
  - Block shape
  - Analysis points

Rockfall Hazard Analysis

- Results:
  - Number passing
  - Percent passing
  - Maximum bounce height
  - Maximum energy

Conclusions from Hazard Study

- Emergency Action Not Required
- Bench-Scale Failures Not Indicated
- Small-Scale Rockfall Hazard
- Inadequate Catchment
- Debris Wedges
- Marginally-Stable Rock Blocks
- Overhanging Rock Ledges
- Vegetation

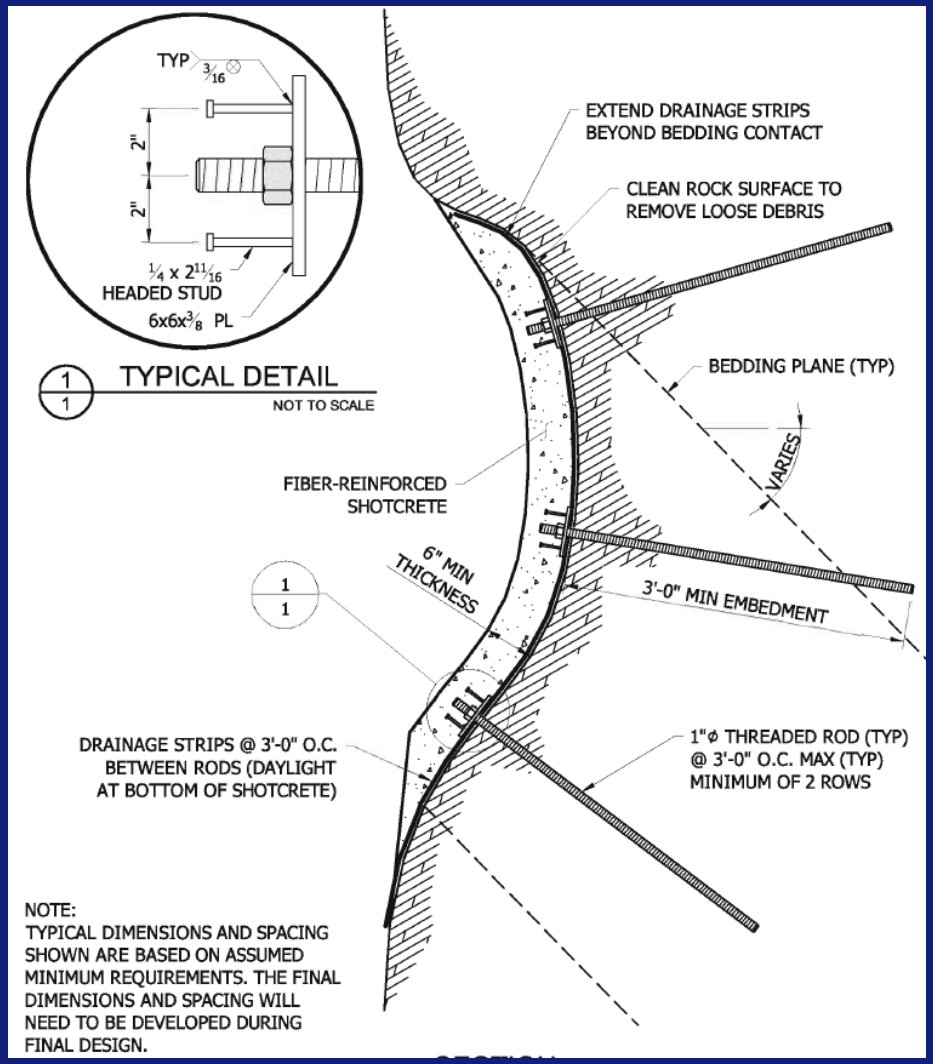
Mitigation Strategies

- Not to be considered:
  - Mass grading
  - Reconfiguration of the travel lanes
- Systematic approach to evaluate treatment options for each hazard

Option 1: Scaling and Bench Cleaning

- “Routine” scaling
- Debris removal from benches and/or reshaping
- Reverse grade benches
- Periodic follow-up
- Shotcrete Surface Protection
- Spot Bolting and Anchored Mesh

Shotcrete Surface Protection



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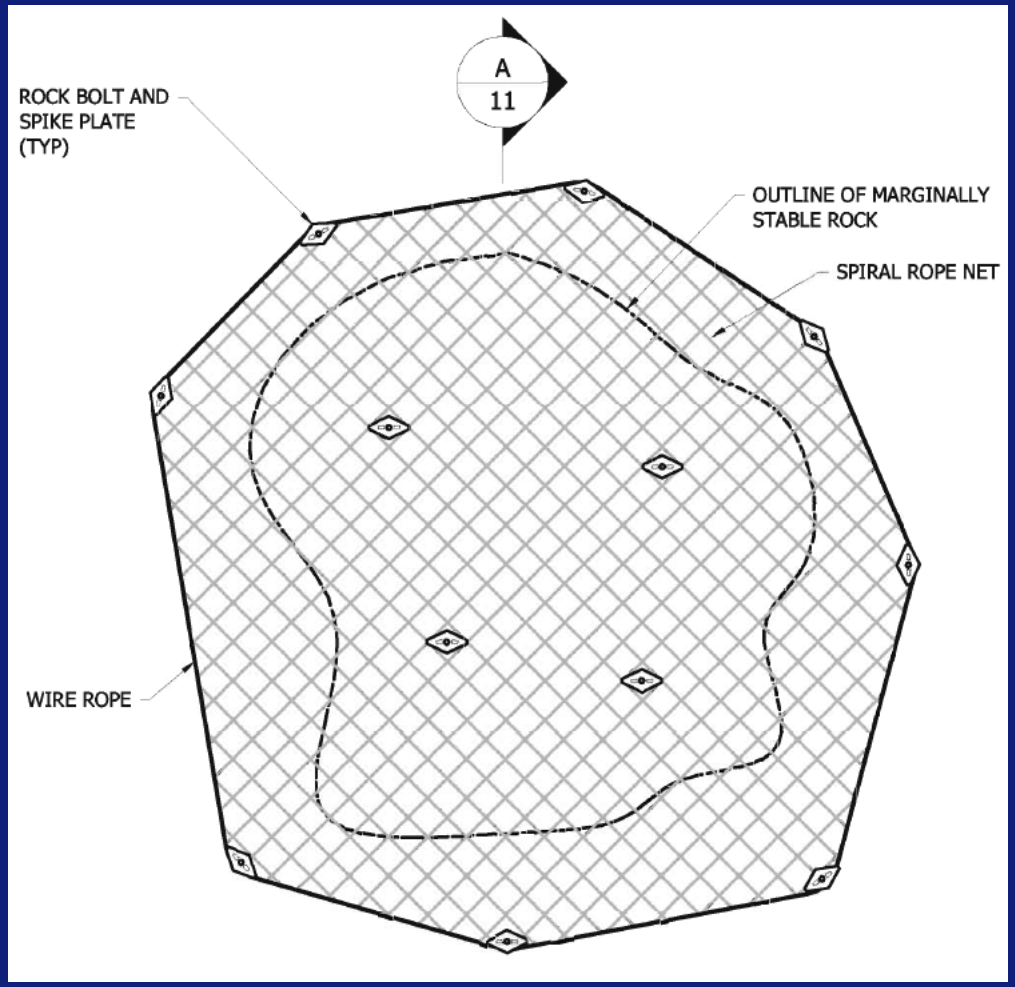
Spot Bolting and Anchored Mesh



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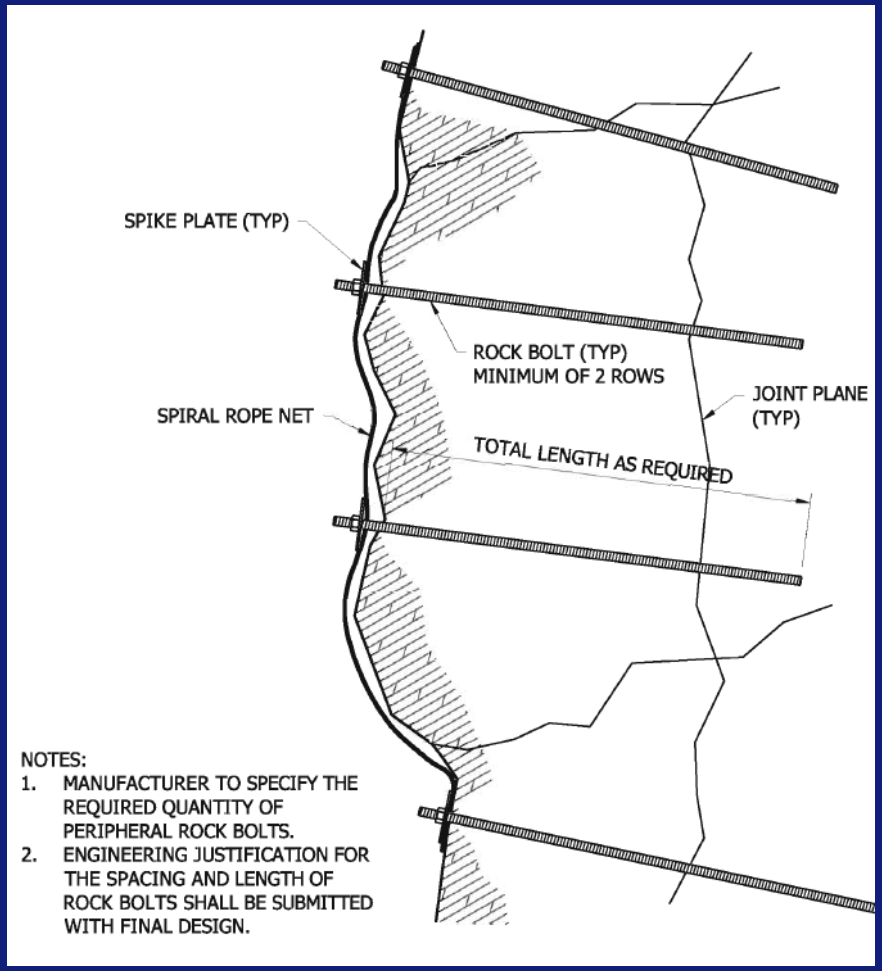

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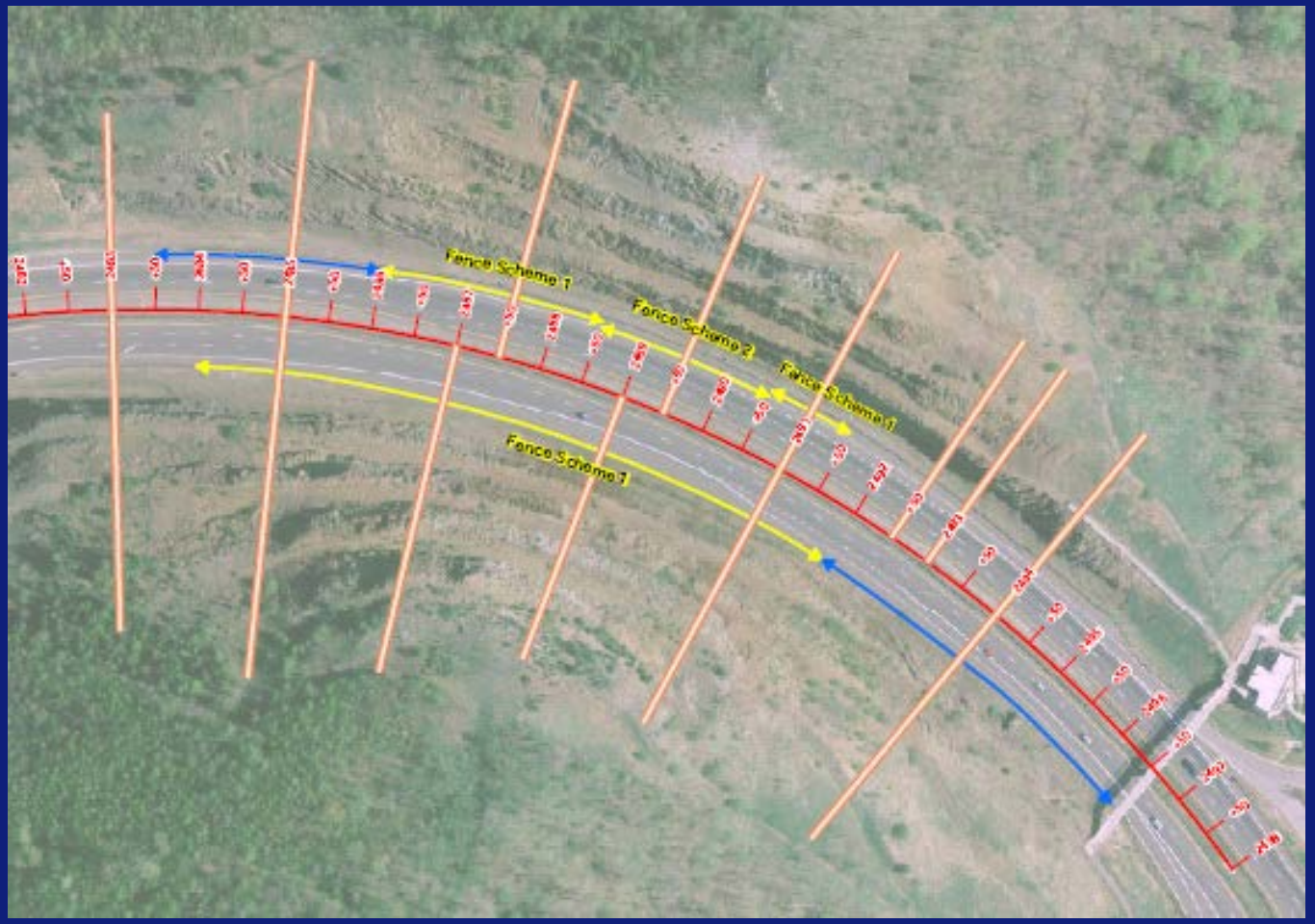
Option 2: Rockfall Barriers



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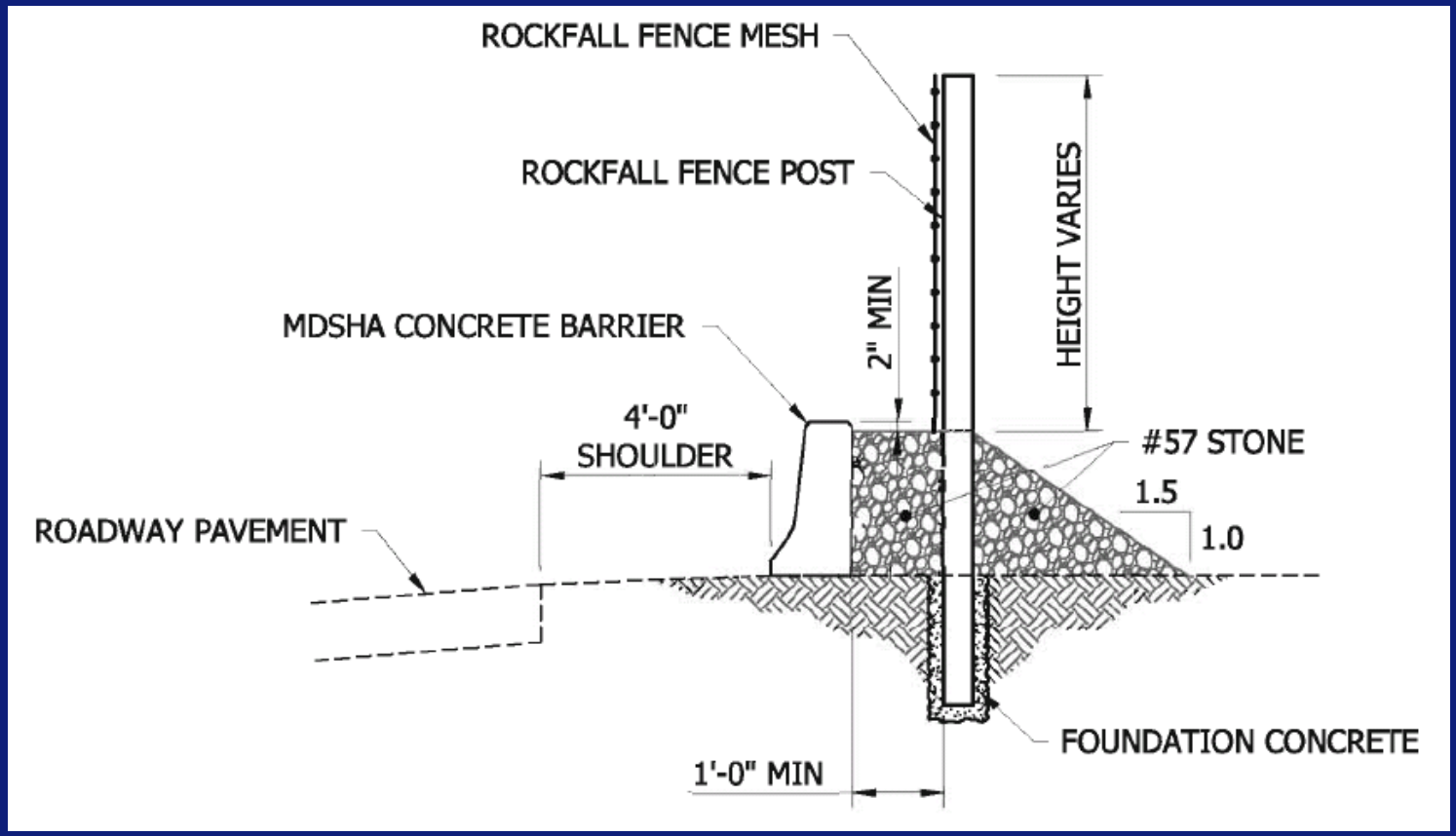

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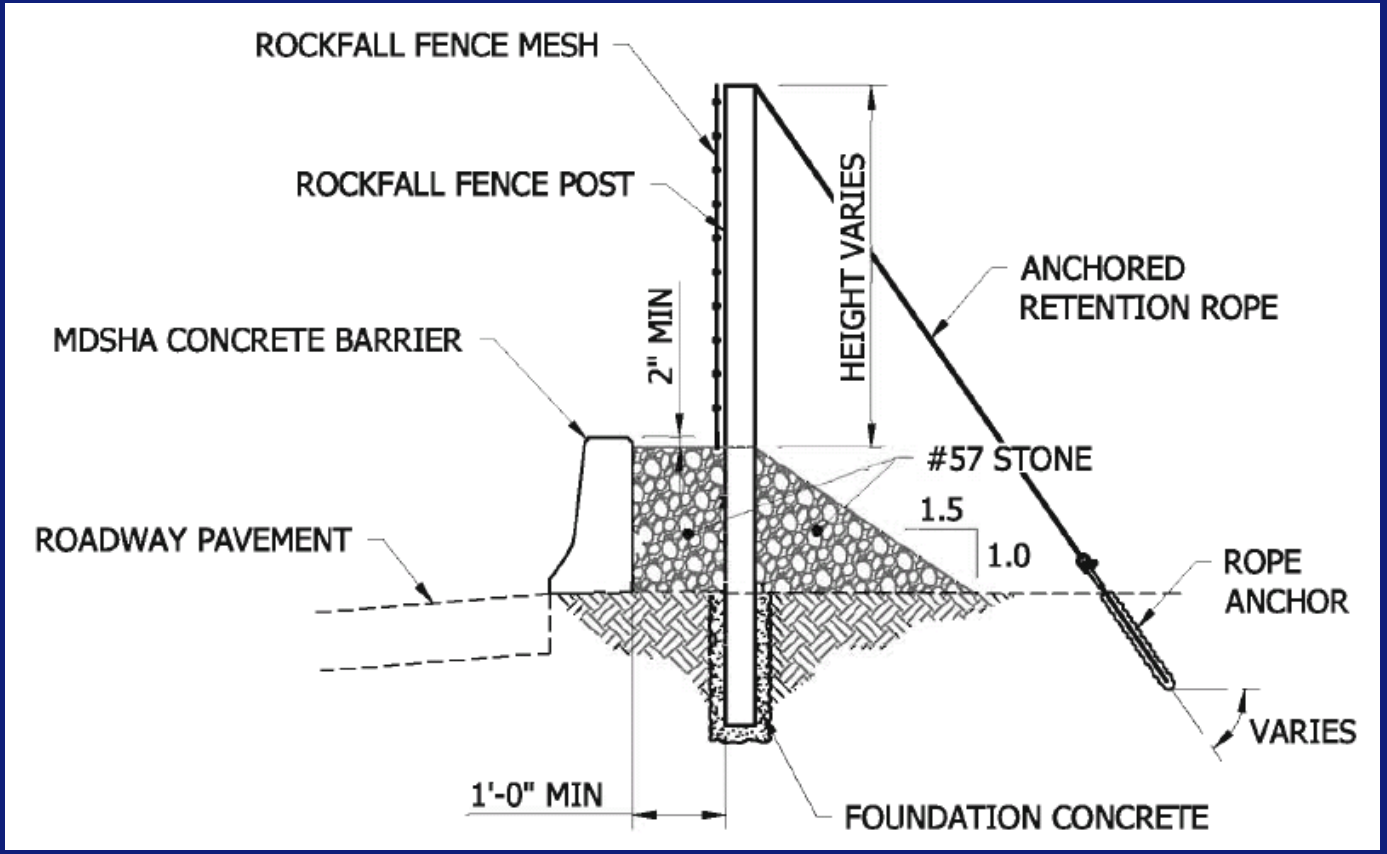

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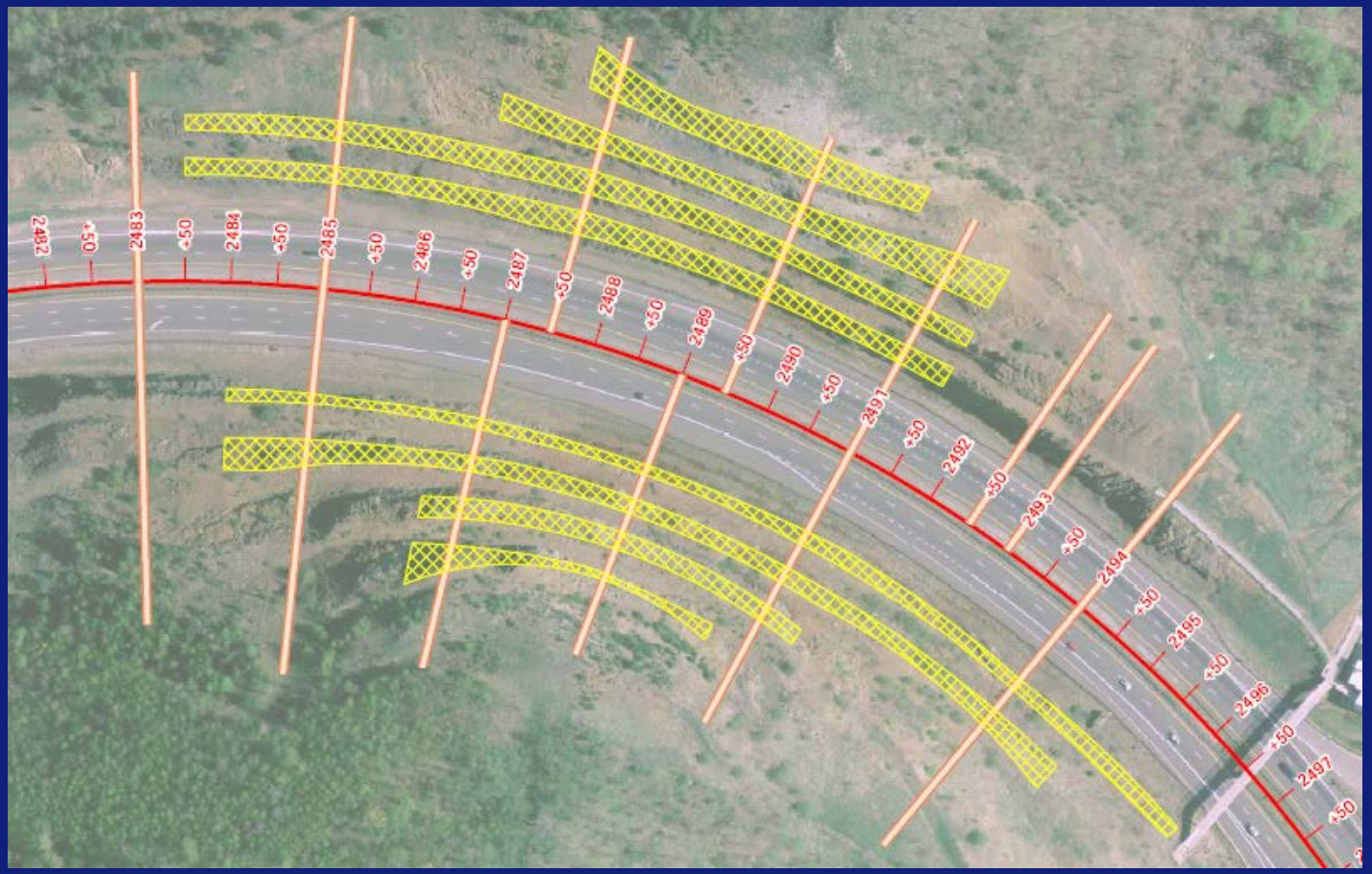
Option 3: Rockfall Drapery



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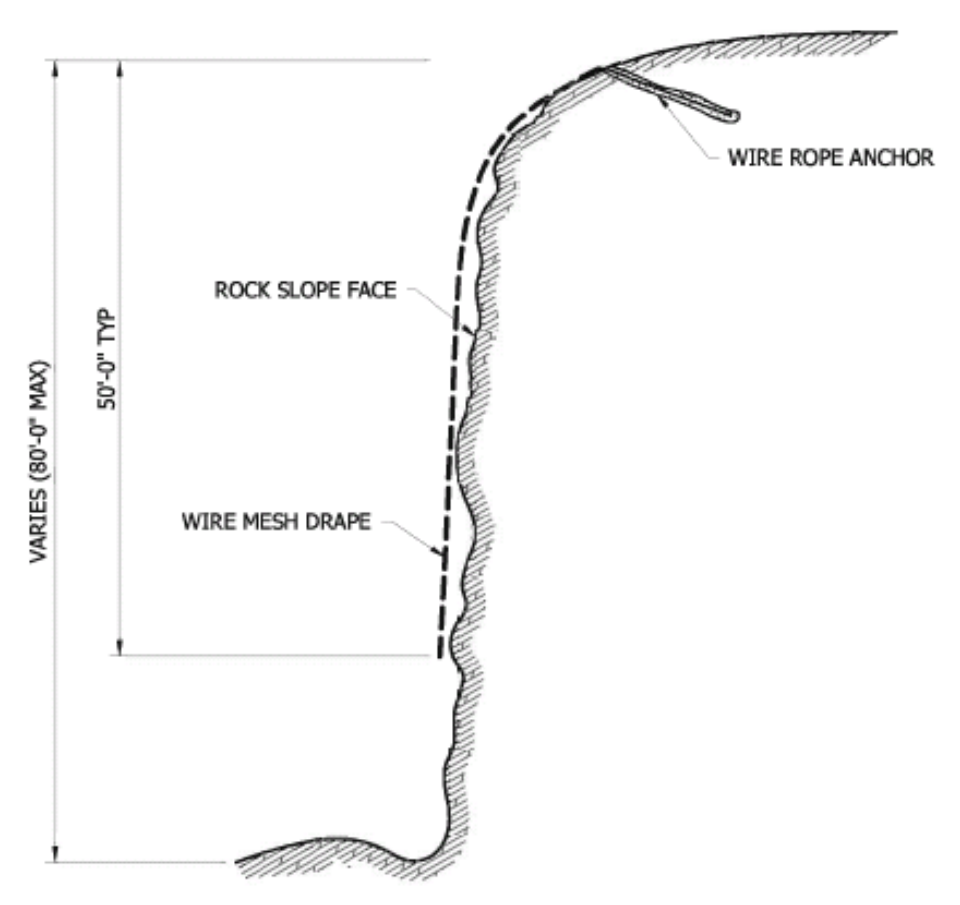

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Periodic Monitoring and Maintenance

- Debris removal (2 yrs.)
- LiDAR survey and engineering geologic evaluation (4 yrs.)
- Slope monitoring plan
- Qualified engineering geologist or geological engineer should be present during slope maintenance

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Thanks to:
Eric Dougherty & Karen Kalbaugh of MDSHA

Questions?