



2025 Spring Conference at Rocky Gap Resort
Flintstone, Maryland
**Protecting I-68 at Sideling Hill from Rockfall,
Washington County, Maryland**
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& Brian K. Banks, PG

May 09, 2025

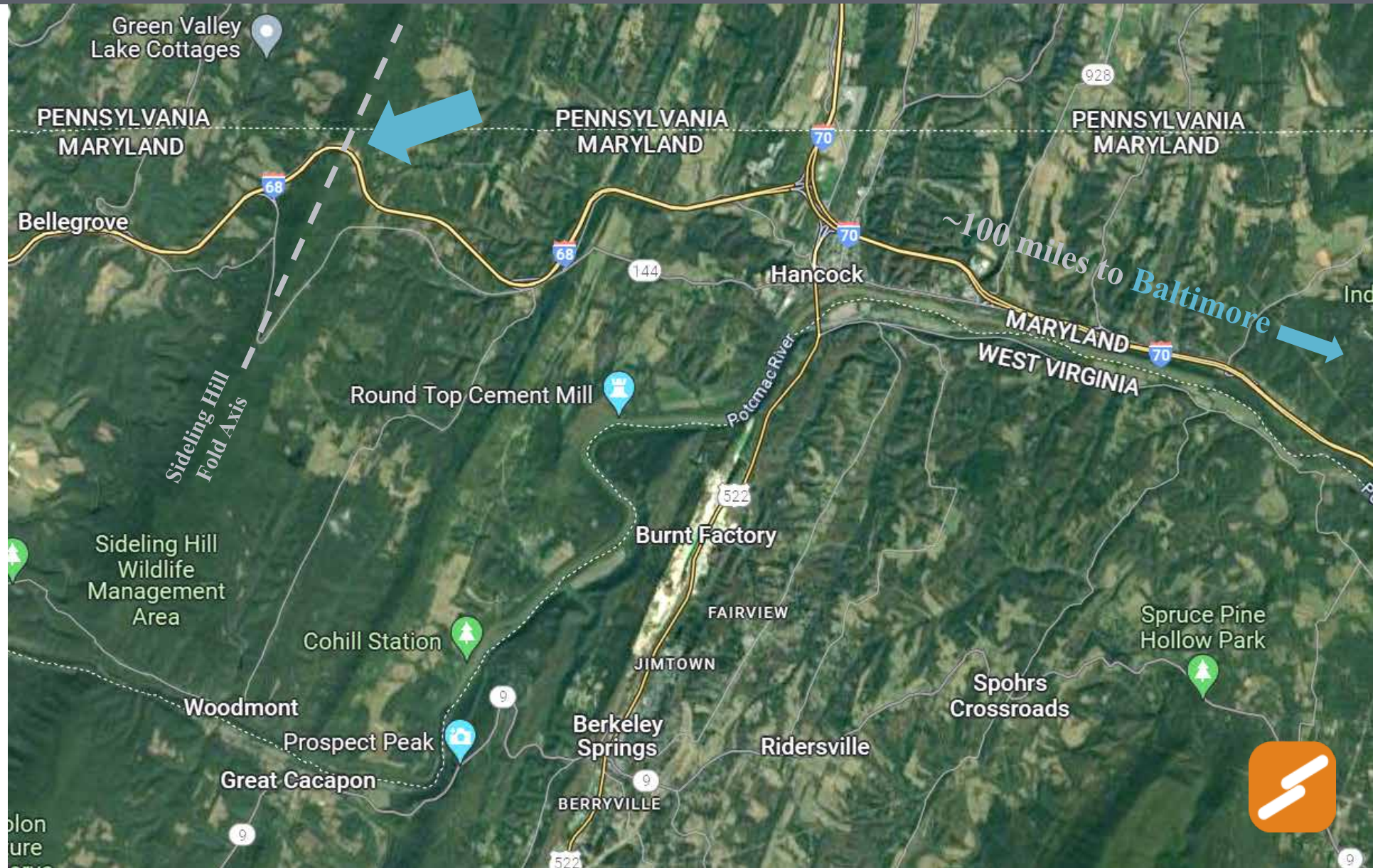
OUTLINE

Protecting I-68 at Sideling Hill from Rockfall, Washington County, Maryland

- § Overview of the I-68 Sideling Hill cut with opposite-facing rock walls rising 360 ft high above the road
 - § Generation of 3D digital terrain model (DTM) of the rock slopes using ground-based LiDAR technology
 - § Use of unmanned aerial vehicle (UAV) to produce a companion digital elevation model (DEM) similar to the DTMs developed through LiDAR.
 - § Rockfall hazard modeling using specialized software to simulate rockfall and estimates of the trajectories, bounce heights, energies, and roll out distances of rock blocks
 - § Custom designed to contain up to about 98% of expected rockfall for rock blocks with 800 kJ of kinetic energy.
 - § Design and construction of rockfall barrier with cantilevered posts and lateral anchors.
 - § Custom rockfall barrier reduces the risk of long-term, emergency closure of I-68, and promotes environmental sustainability by protecting the natural beauty of this iconic geologic wonder.
- § 1.0 PDH



Site Location





Sideling Hill Road Cut – circa 1986







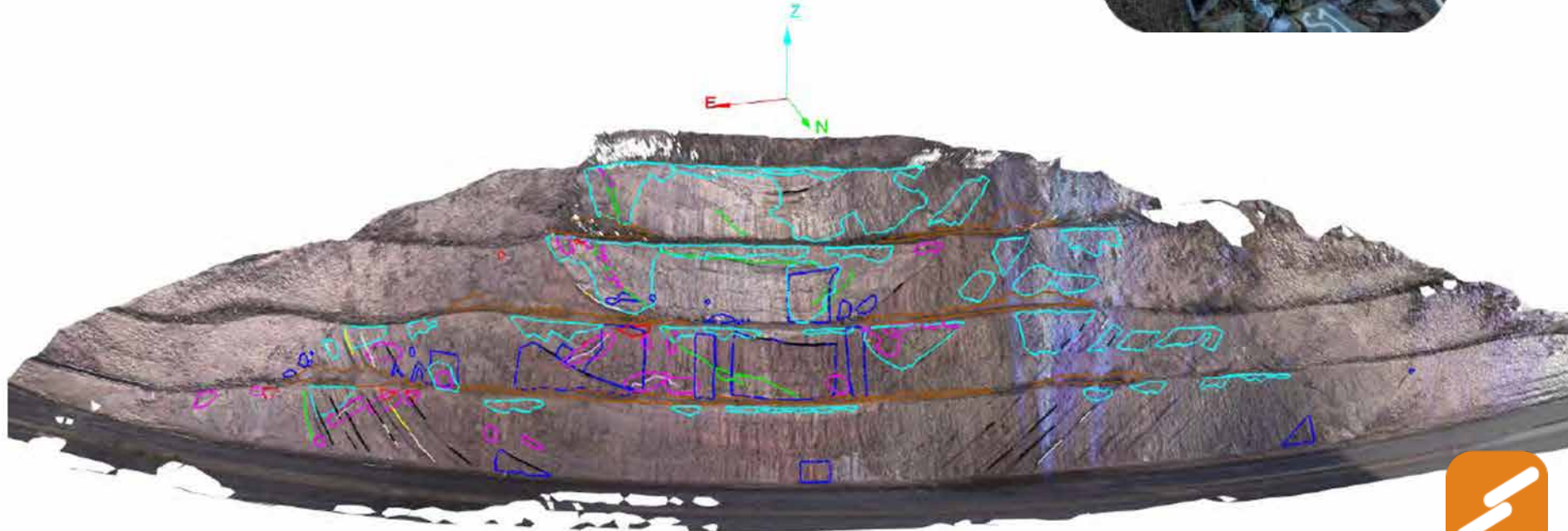






2012 Rock Slope Hazard Study

- § LiDAR Survey
- § Rock Structure Mapping
- § Slope Stability Analysis
- § Rockfall Modeling
- § Rock Slope Hazard Map
- § Rockfall Hazard Mitigation Concepts





2012 Slope Conditions





2012 Slope Conditions

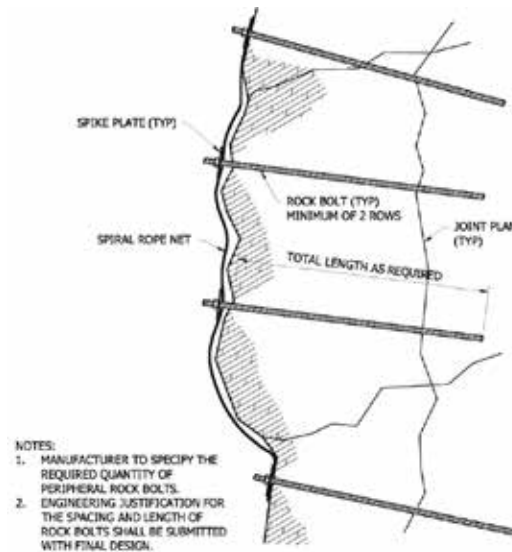
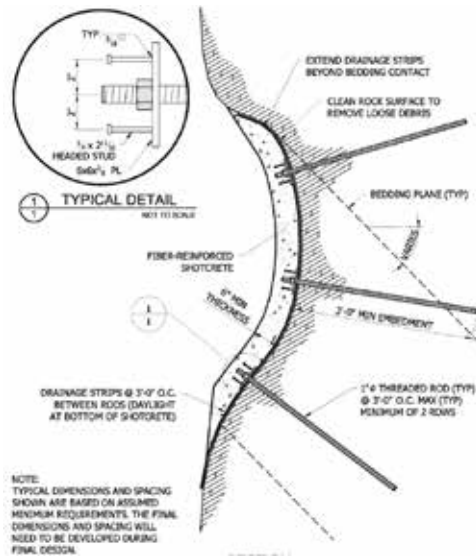
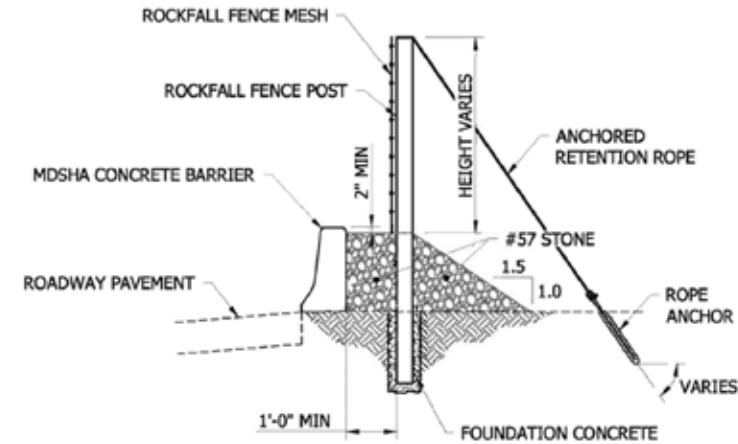






Rockfall Hazard Mitigation Concepts

- § Scaling and Bench Cleaning
- § Shotcrete Surface Protection
- § Spot Bolting and Anchored Mesh
- § Rockfall Barriers
- § Rockfall Drapery





Cancelled Solicitation for Scaling and Bench Cleaning – 2012





2017 Study

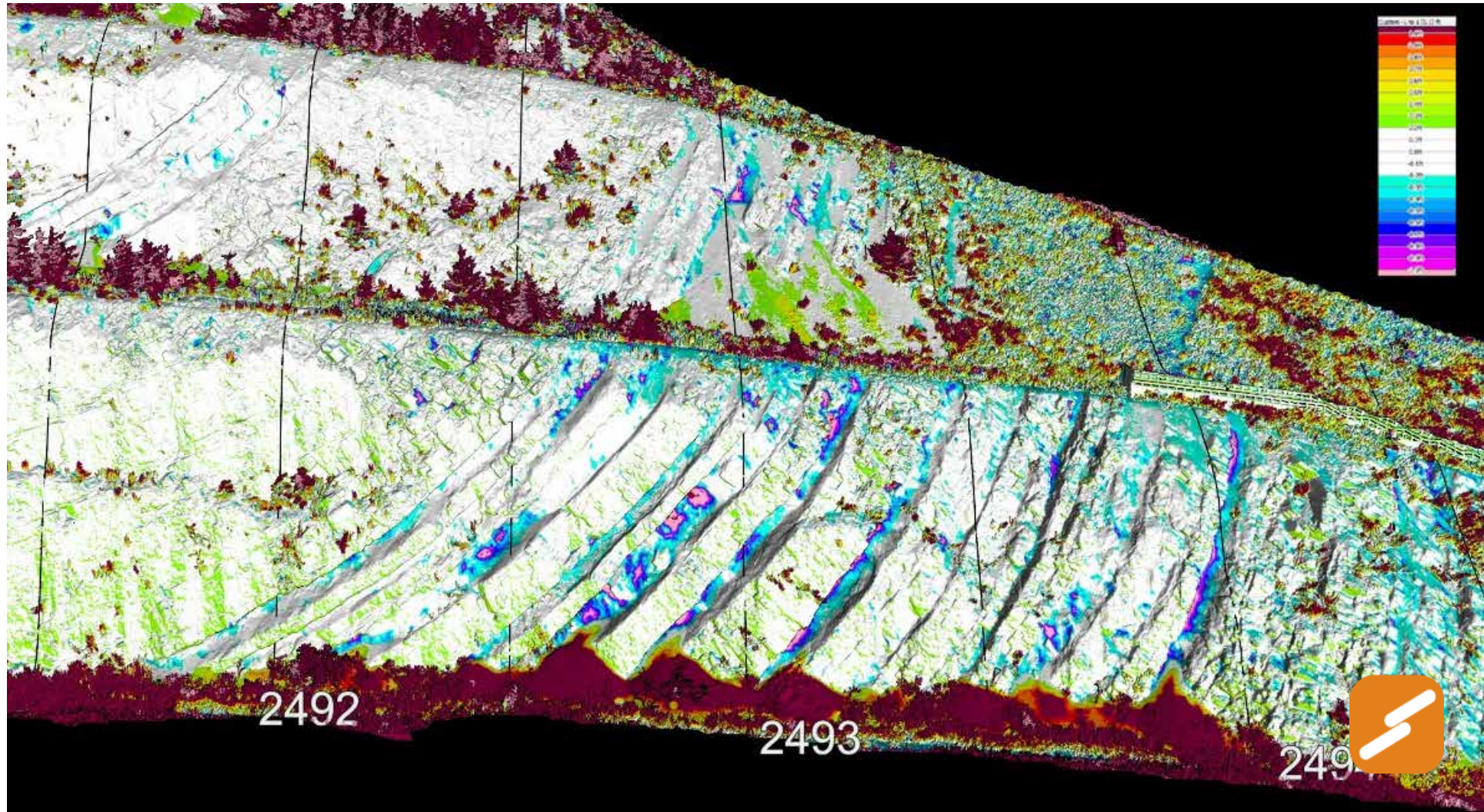
- § LiDAR Survey
- § Change Detection
- § Field Reconnaissance
- § Rockfall Hazard Analysis
- § Rockfall Fence Concepts





Change Detection

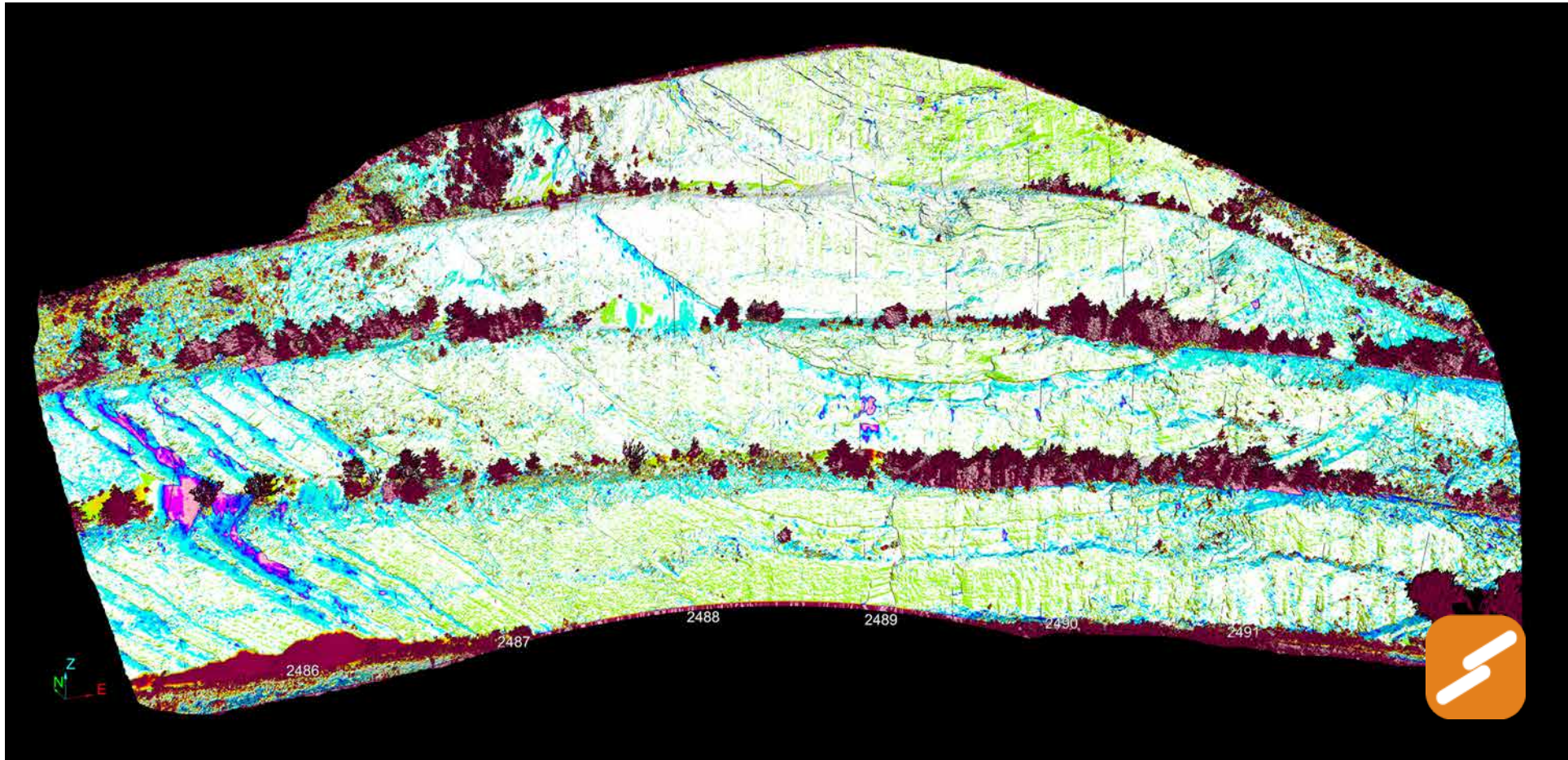
§ Material loss from differential weathering in the shale layers





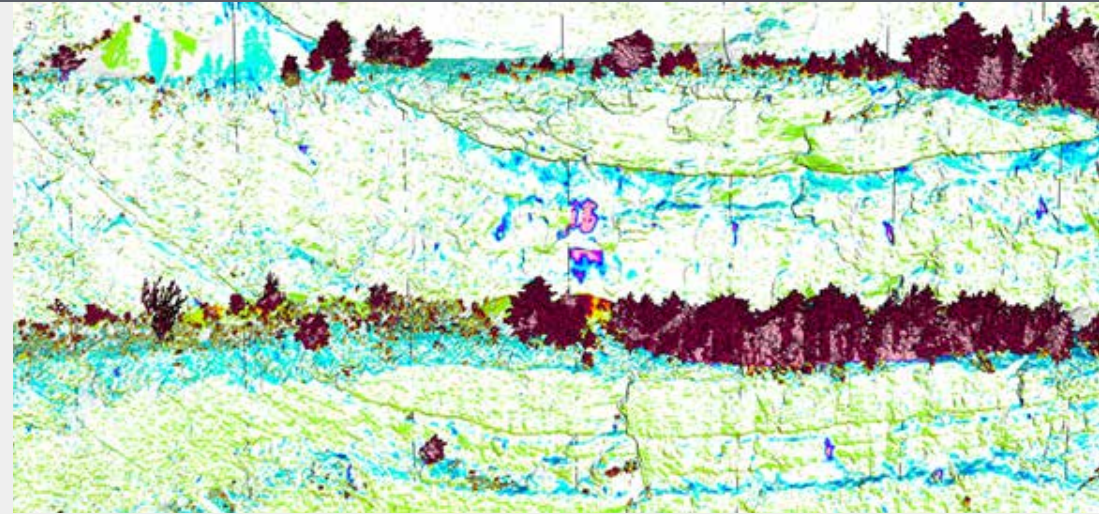
Change Detection

- § Relatively few source zones from the sandstone layers
- § Some raveling of bench edges
- § Loss of material below broad sandstone overhang



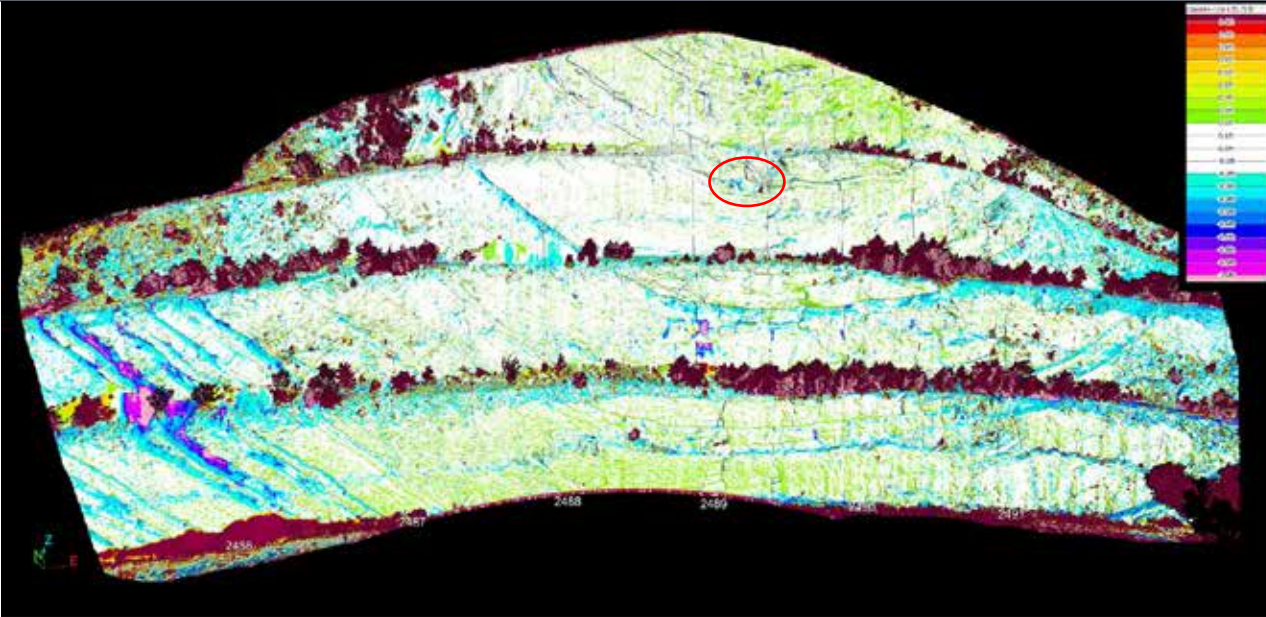


Rockfall Source and Debris – North Slope



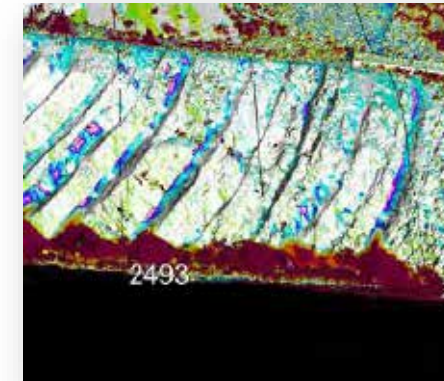
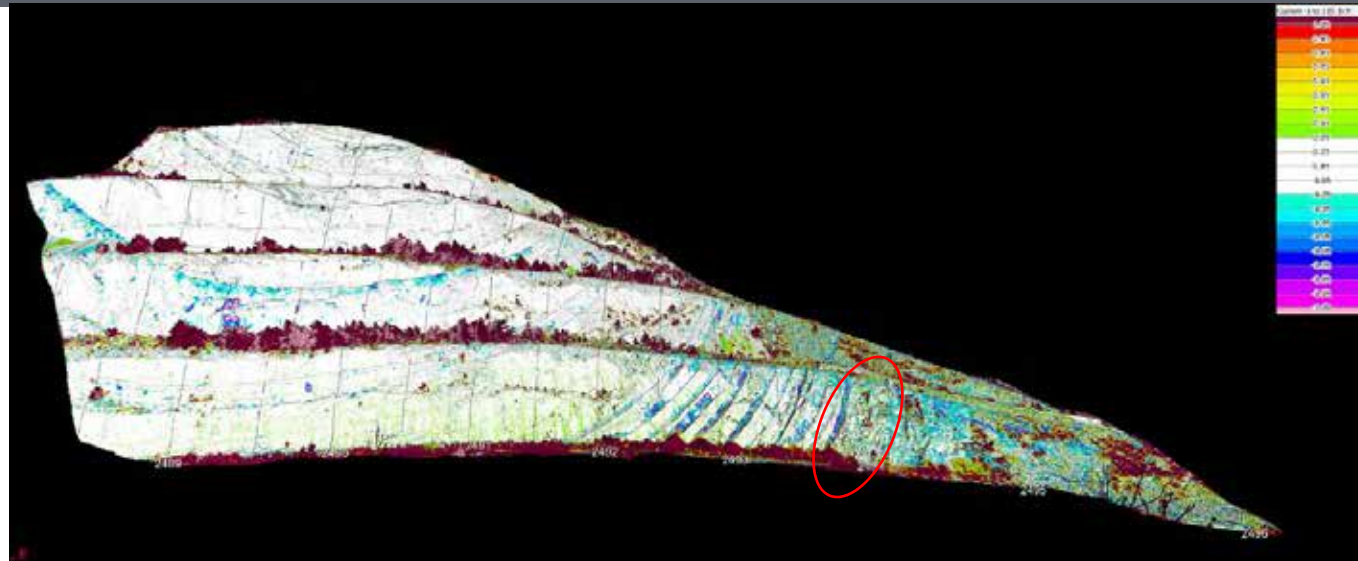


Rockfall Source – North Slope



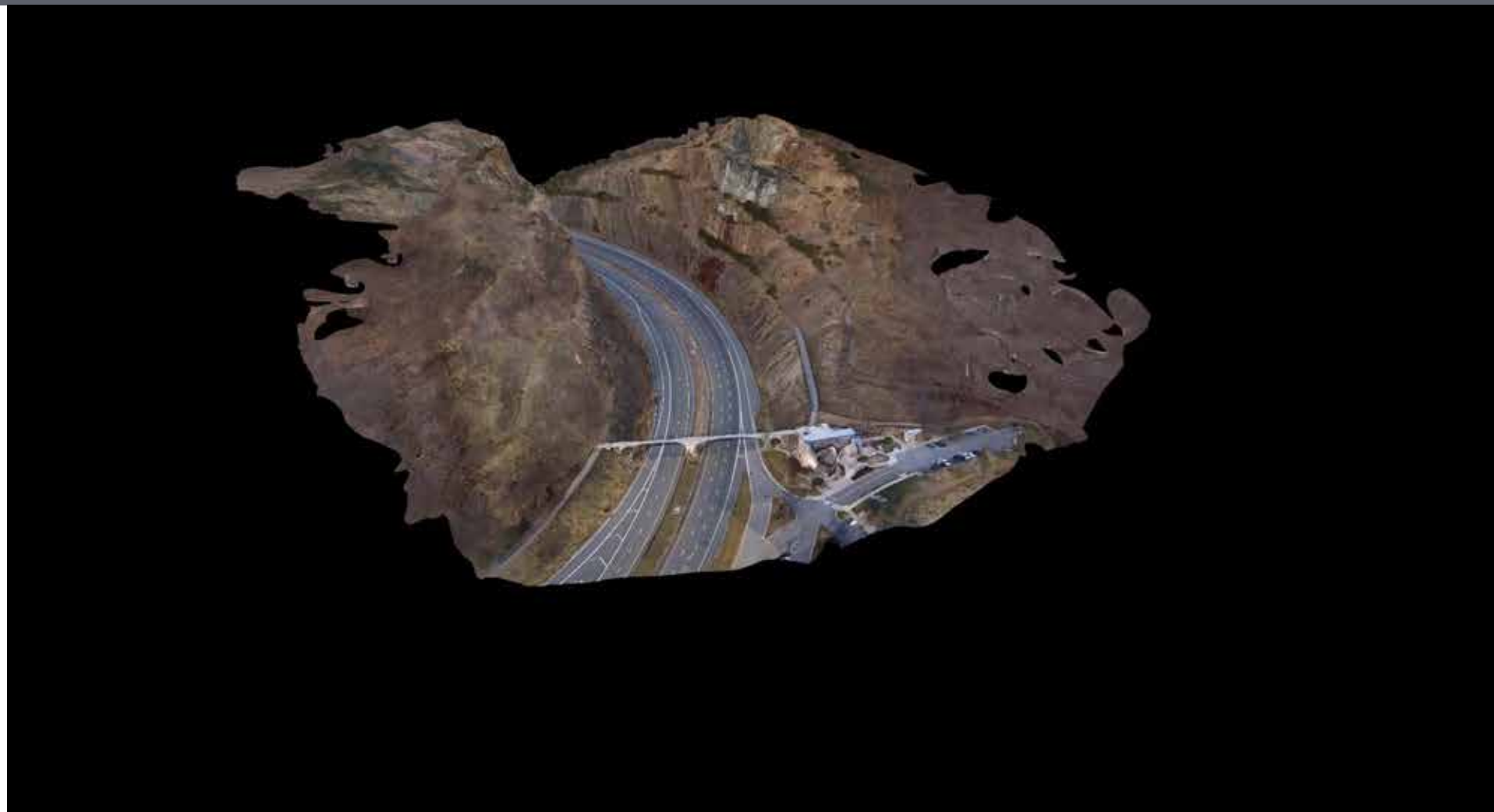


Rockfall Source and Debris – North Slope





UAV Drone Photogrammetry - Video



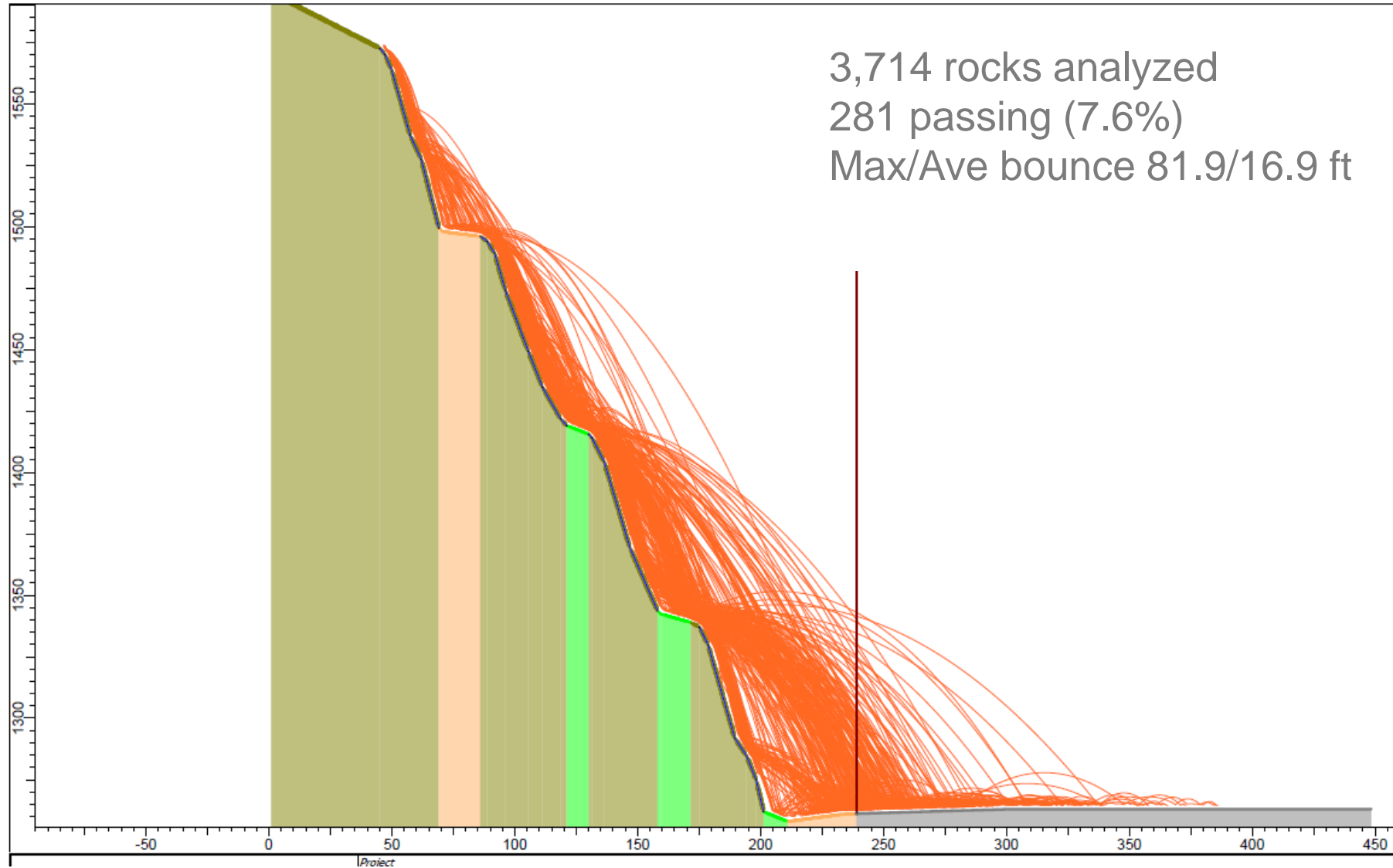


3D Mesh





Rockfall Simulation – South Sta. 2489+00





Rockfall Fence – SHA Design Criteria

- § Maintain 8 ft wide shoulder
- § Place fence 2 ft behind the W-beam
- § Fence mesh will be 1 ft off the ground
- § No tieback anchors





Fence Concept Alternatives

- § Fence Height (Options 1, 2 and 3)
- § Fence Type (Concept 1 and 2)

Station	Slope Height	Analysis Point Distance from Toe of Slope (ft)	Benches Involved	Analysis Point: Fence Location											
				No. Effectively Analyzed	No. Passing	% Passing	Bounce (ft)		Fence Height (ft)			Energy (kJ)			
							Max.	Ave.	90% Retained	95% Retained	97% Retained	Max.	Ave.	90% Percentile	95% Percentile
S2483+00	199	34	1, 2, 3	2,800	157	5.6%	51.6	8.1	-	1.8	2.9	720	186	582	622
S2485+00	266	39	1, 2, 3, 4	3,711	407	11.0%	61.2	12.2	2.1	7.1	18.1	1,018	306	648	705
S2487+00	307	34	1, 2, 3, 4	3,746	250	6.7%	61.0	15.3	-	2.5	10.3	1,141	325	623	773
S2489+00	322	38	1, 2, 3, 4	3,692	281	7.6%	81.9	16.9	-	4.1	13.0	1,502	341	819	1,019
S2491+00	303	27	1, 2, 3, 4	3,703	423	11.4%	72.0	10.9	2.0	4.6	10.4	1,155	232	705	790
S2493+00	201	29	1, 2, 3	2,793	370	13.2%	61.1	12.7	2.3	7.5	20.8	945	223	537	653
N2483+00	129	40	1, 2	1,885	35	1.9%	6.7	2.7	-	-	-	262	148	238	247
N2485+00	175	39	1, 2, 3	2,404	42	1.7%	29.4	7.5	-	-	-	641	176	555	603
N2487+00	268	28	1, 2, 3, 4	3,757	514	13.7%	62.2	10.6	2.3	7.8	17.9	1,001	260	647	716
N2489+00	310	26	1, 2, 3, 4	3,714	488	13.1%	84.2	15.9	2.4	11.9	31.3	1,539	321	800	1,019
N2491+00	216	26	1, 2, 3	2,775	140	5.0%	54.6	8.3	-	-	2.5	961	177	448	577
N2493+00	125	29	1, 2	1,836	79	4.3%	22.2	2.7	-	-	1.8	477	43	108	387

*800kJ energy capacity selected for concept-level design



Fence Height – Option 1

- § Guardrail only (“No-fence”) option
- § 90% retention based on bounce height
- § Rockfall hazard reduction for this option could be increased by:
 - § Strengthening guardrail by double-spacing the posts and overlapping/doubling the W-beams
 - § Add two rows of W-beams

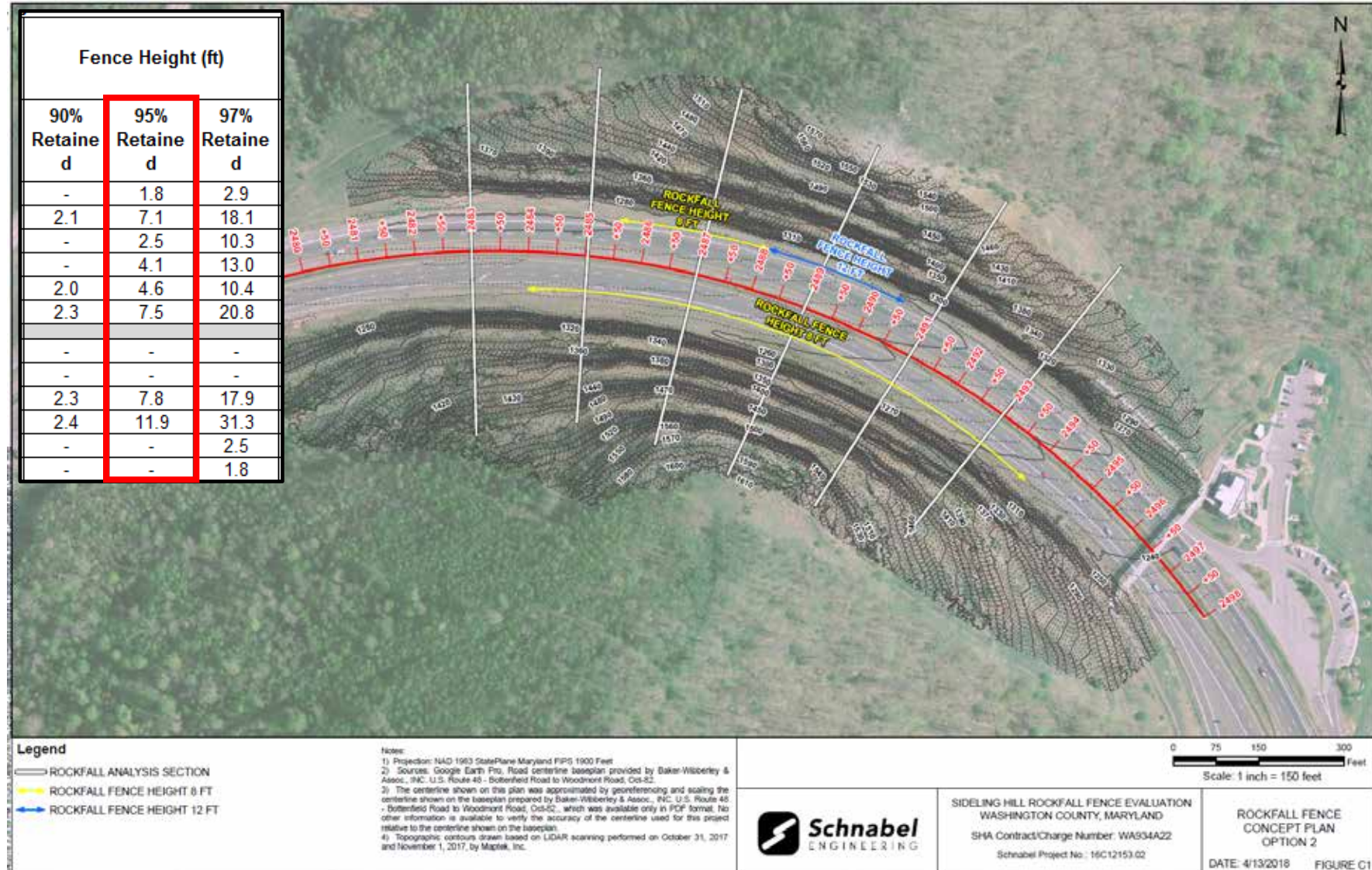


Fence Height (ft)		
90% Retained	95% Retained	97% Retained
-	1.8	2.9
2.1	7.1	18.1
-	2.5	10.3
-	4.1	13.0
2.0	4.6	10.4
2.3	7.5	20.8
-	-	-
-	-	-
2.3	7.8	17.9
2.4	11.9	31.3
-	-	2.5
-	-	1.8



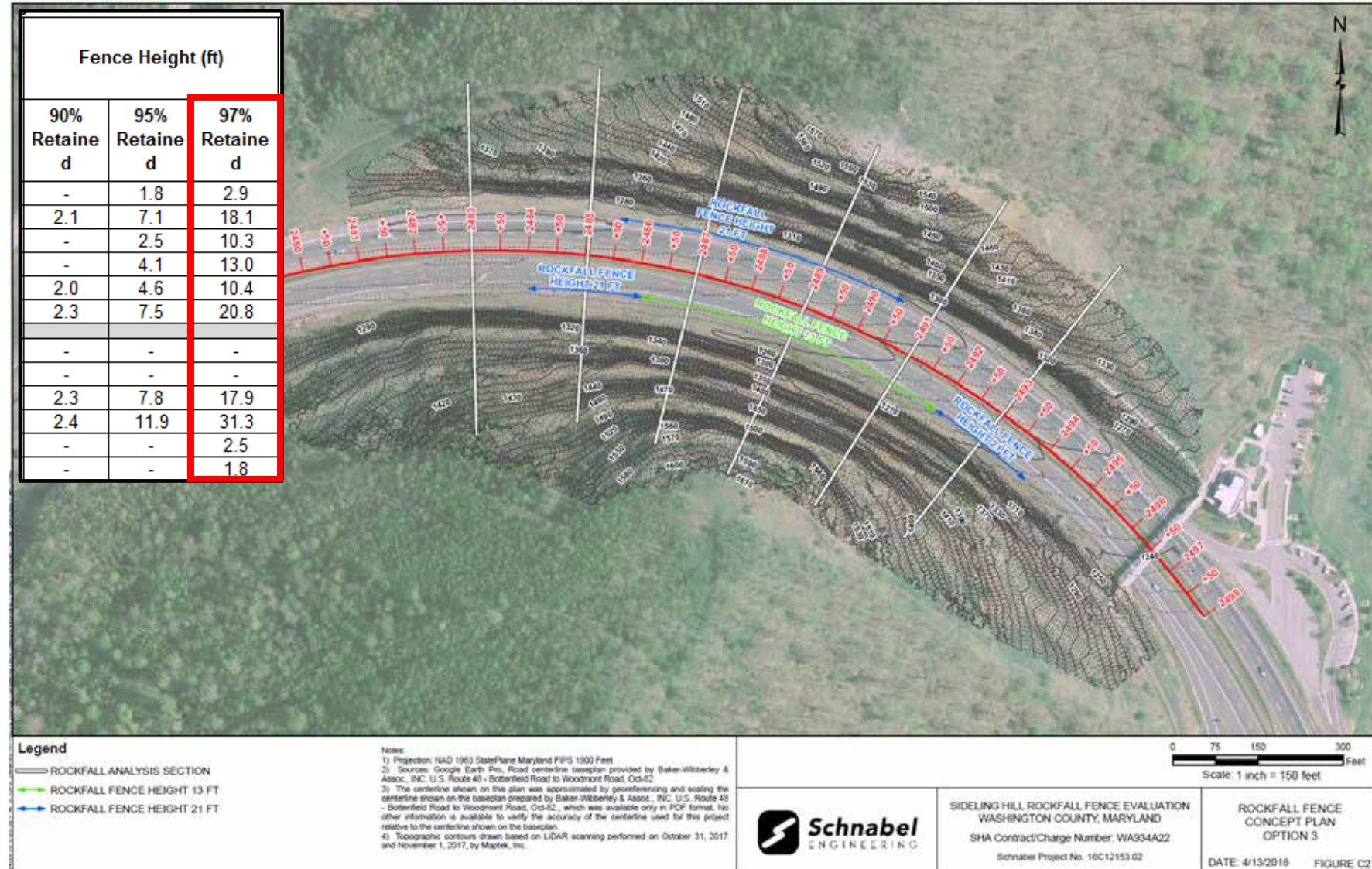


Fence Height – Option 2





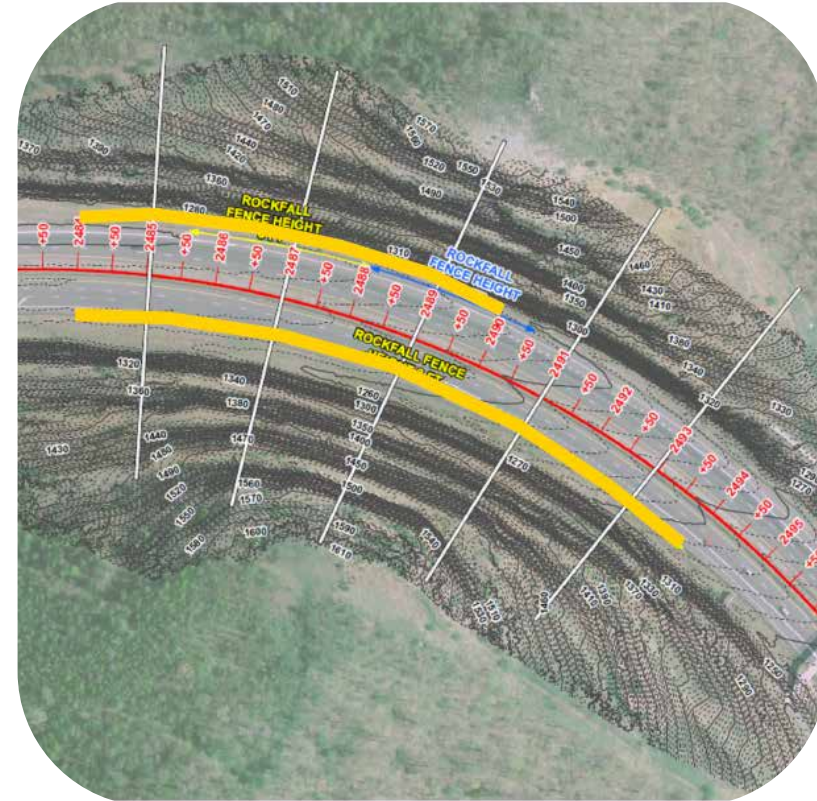
Fence Height – Option 3





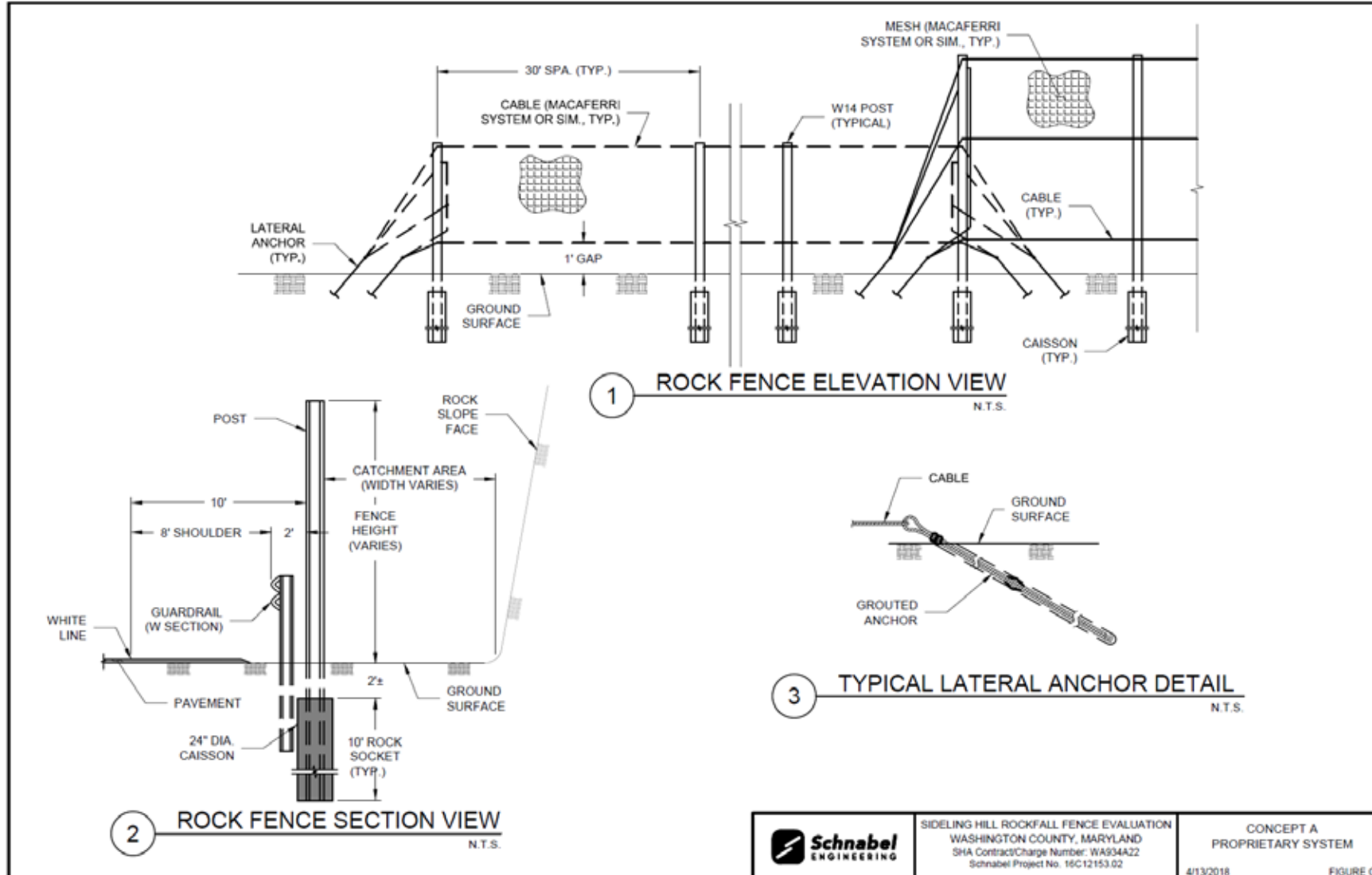
Option 2 - Fence Design Criteria

- ~956-ft on EB lane of I-68
- ~523-ft on WB lane of I-68
- 9-ft height with 1-ft gap
- 800kJ design energy capacity of rockfall fence.
- 11-ft maximum deformation at design energy
- No uphill/transverse rockfall fence anchors.





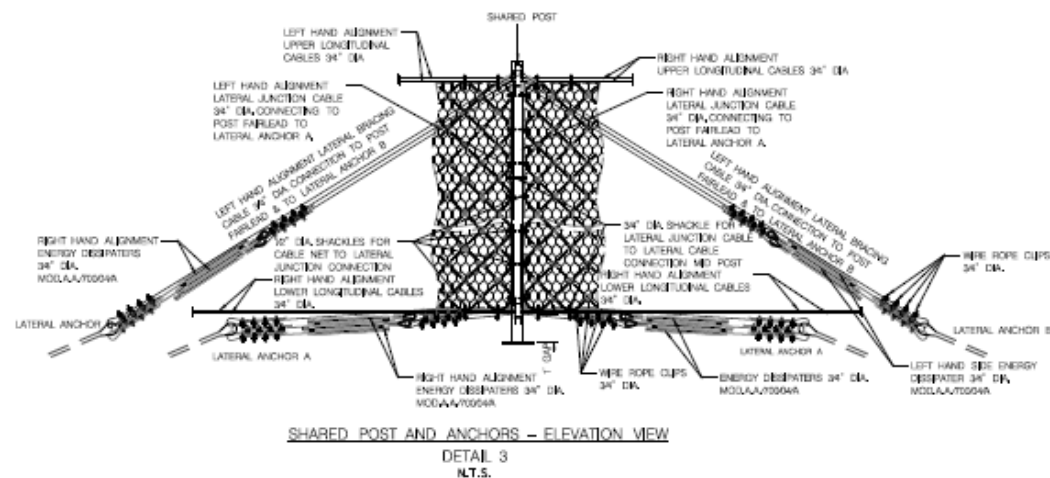
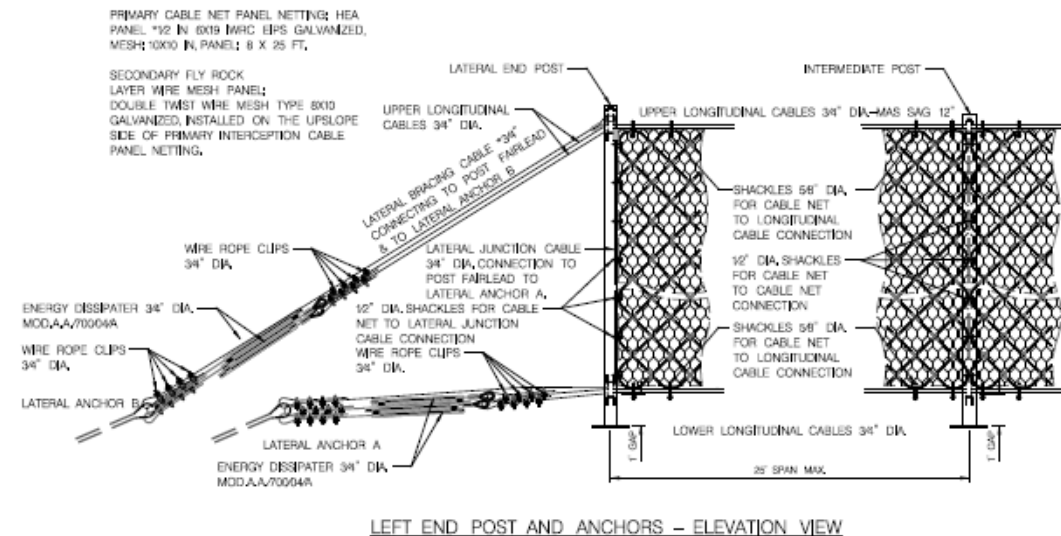
Fence Type Concept A – Proprietary System





Proprietary Fence System Components

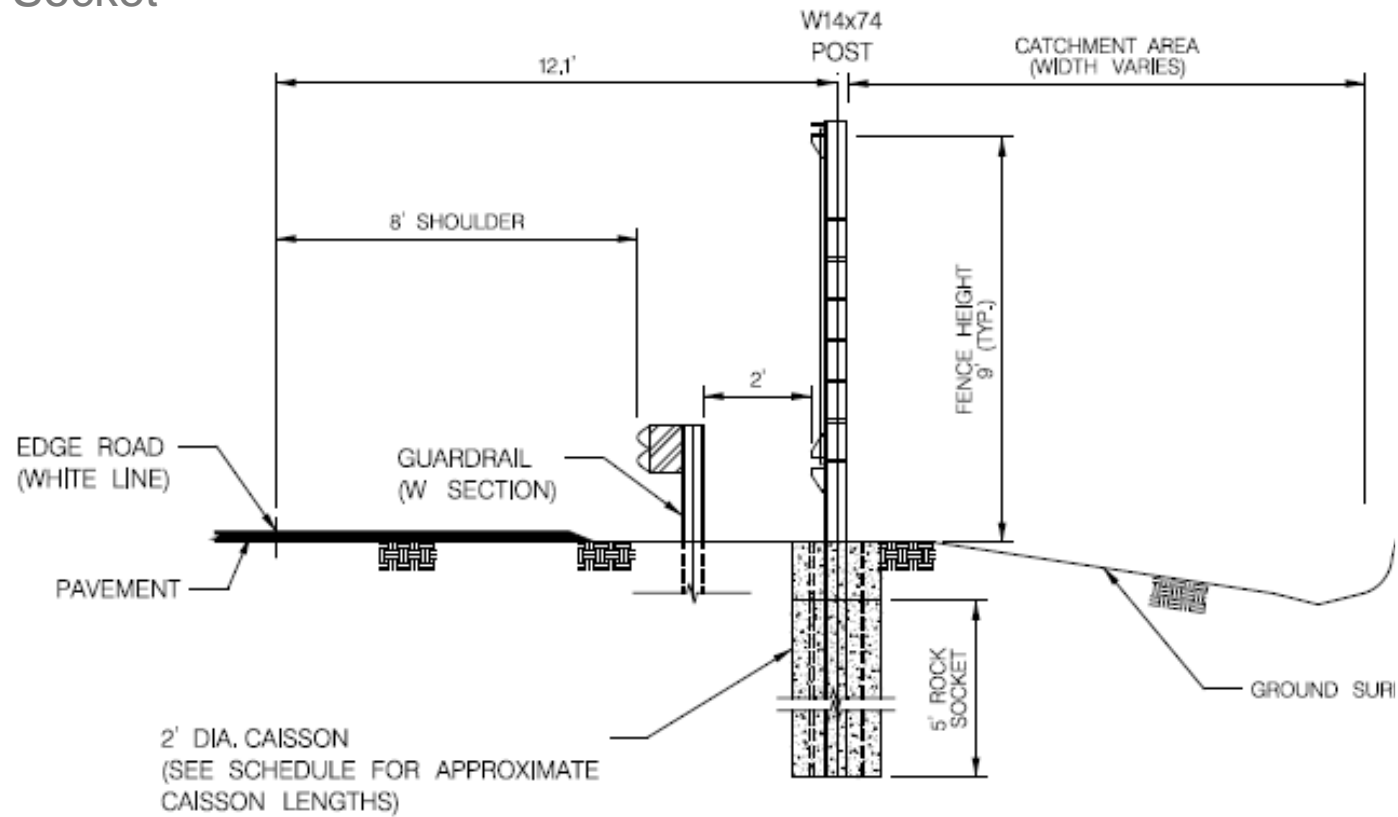
- Primary Rockfall Cable Net
- Secondary Rockfall Mesh
- Longitudinal and Lateral Bracing Cables
 - 3/4" Cables
- Separation rope supports
 - Shared Posts ~175-ft
- Energy Dissipaters





Custom Design Posts & Foundations

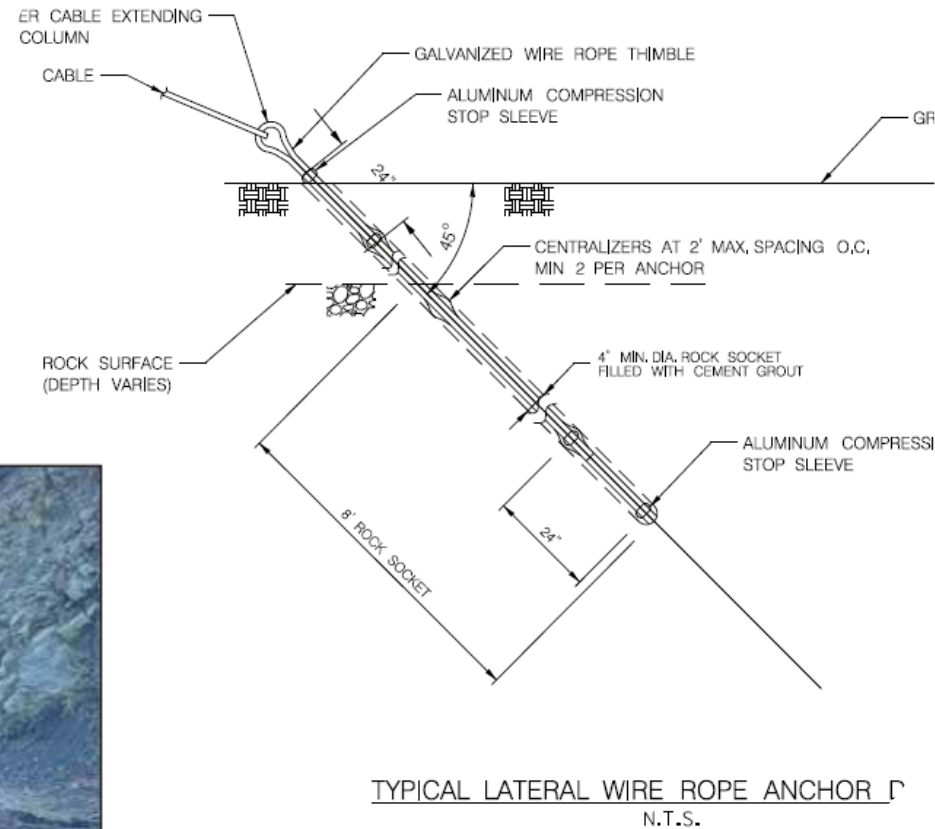
- W14x74 Posts spaced at 25-ft typ.
- 2-ft dia. Caisson with 5-ft min. Rock Socket





Custom Design Anchorage

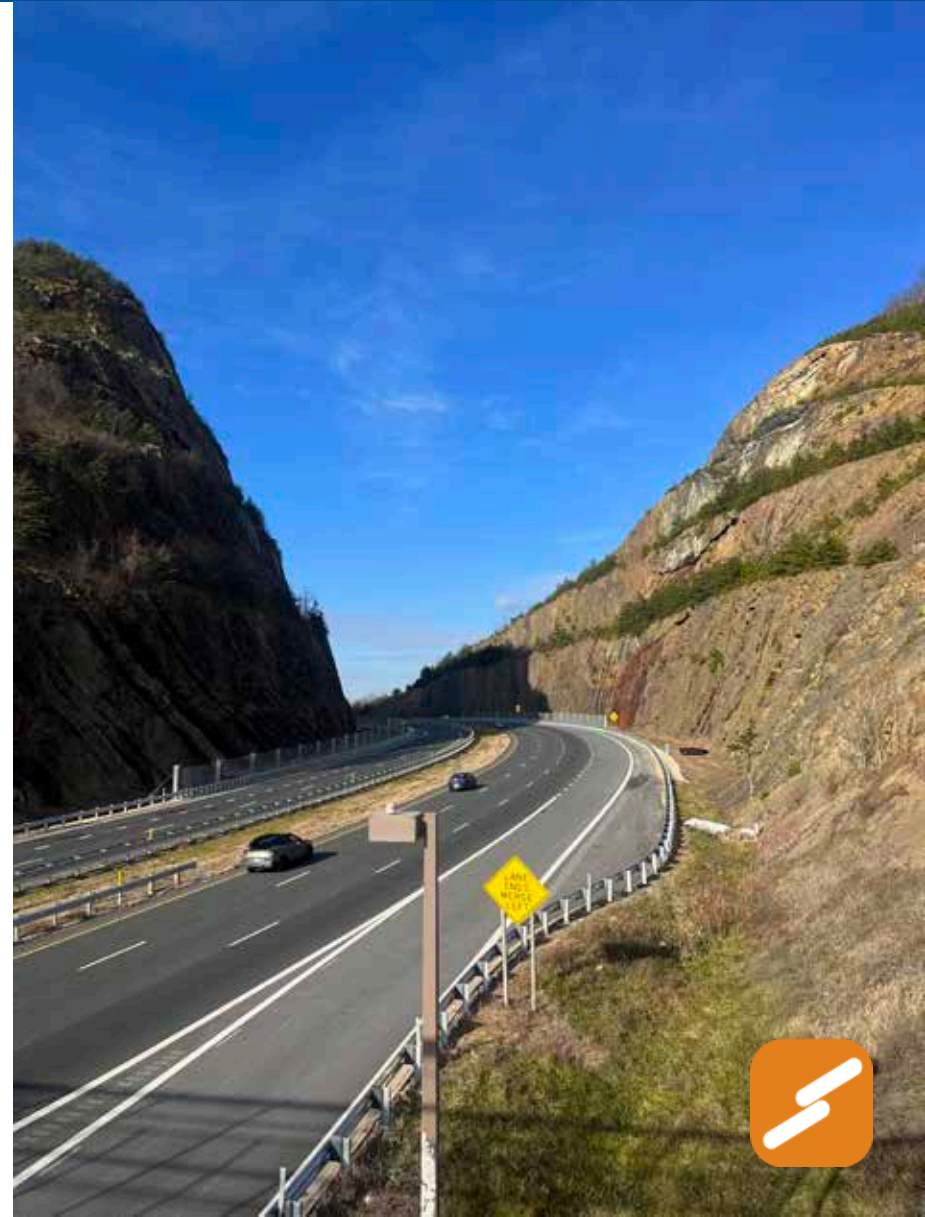
- Double Leg Wire Rope Anchor System
- 40-kips Min. geotechnical design pullout resistance
 - 4" Dia. Anchor
 - 8' Rock Socket





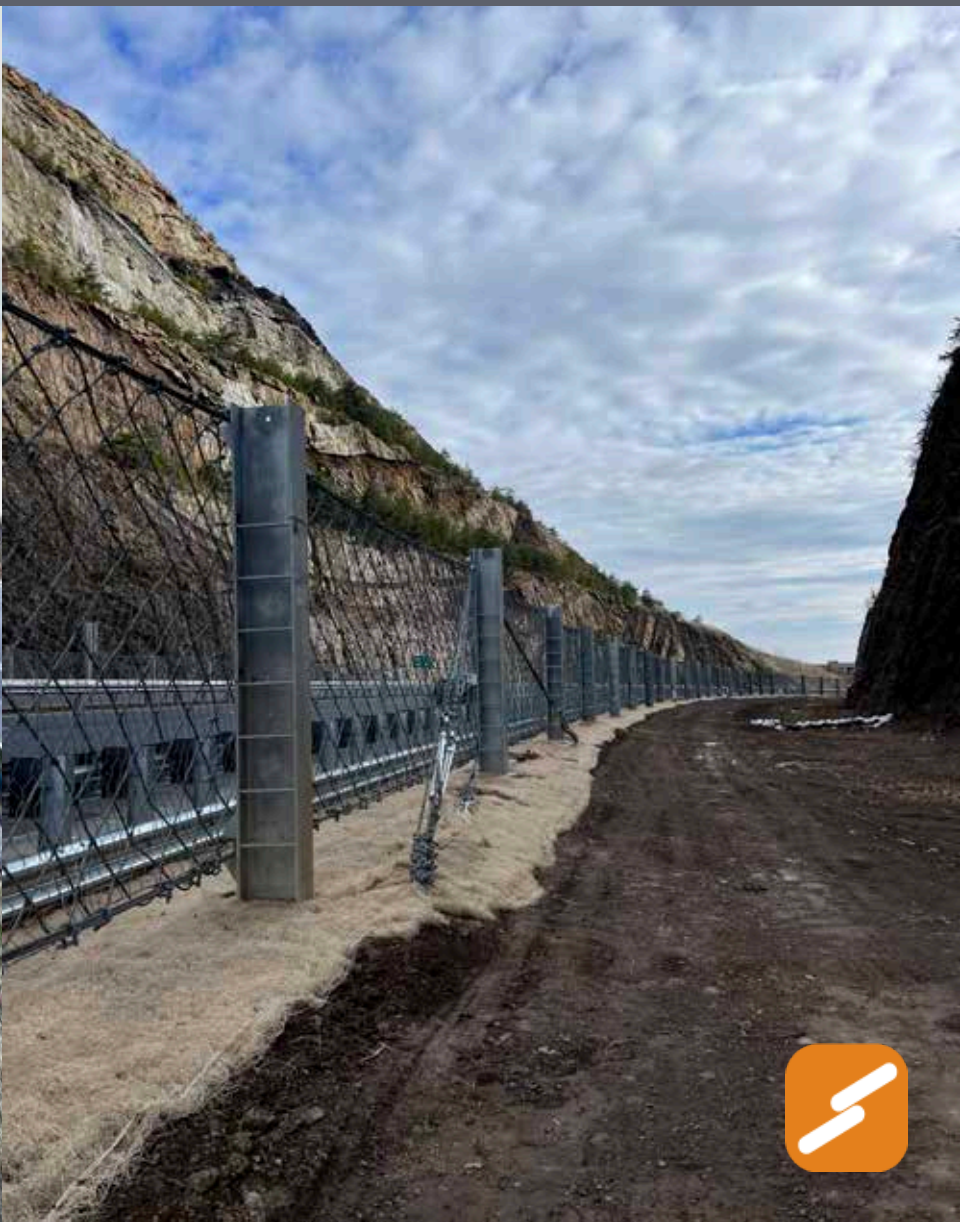
Contract Award

- Bid Results: \$3.1M to \$6.3M
- Carl Belt, Inc. was the winning bidder
 - Maccaferri system proposed
- NTP in April 2023
- Final Inspection December 2023





Completion





View of Rock Slope





QUESTIONS?

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