16th Annual Technical Forum for Geohazards Impacting Transportation in the Appalachian Region

Dismantling the Tallest Reinforced Fill in North America – The Observational Method Applied at the Yeager Airport

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3 August 2016

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SETTING

- Rugged mountains of West Virginia
- Yeager Airport and runways on top of mountain in Charleston
- Variable sedimentary rock
- Fill, colluvium, and thin natural soil

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ORIGINAL PROJECT

- FAA directed safety zone at end of runway with length of 500’
- Engineered Materials Arresting System (EMAS)
- To support the EMAS, *“The tallest known geosynthetic reinforced 1H:1V slope in North America”* was constructed

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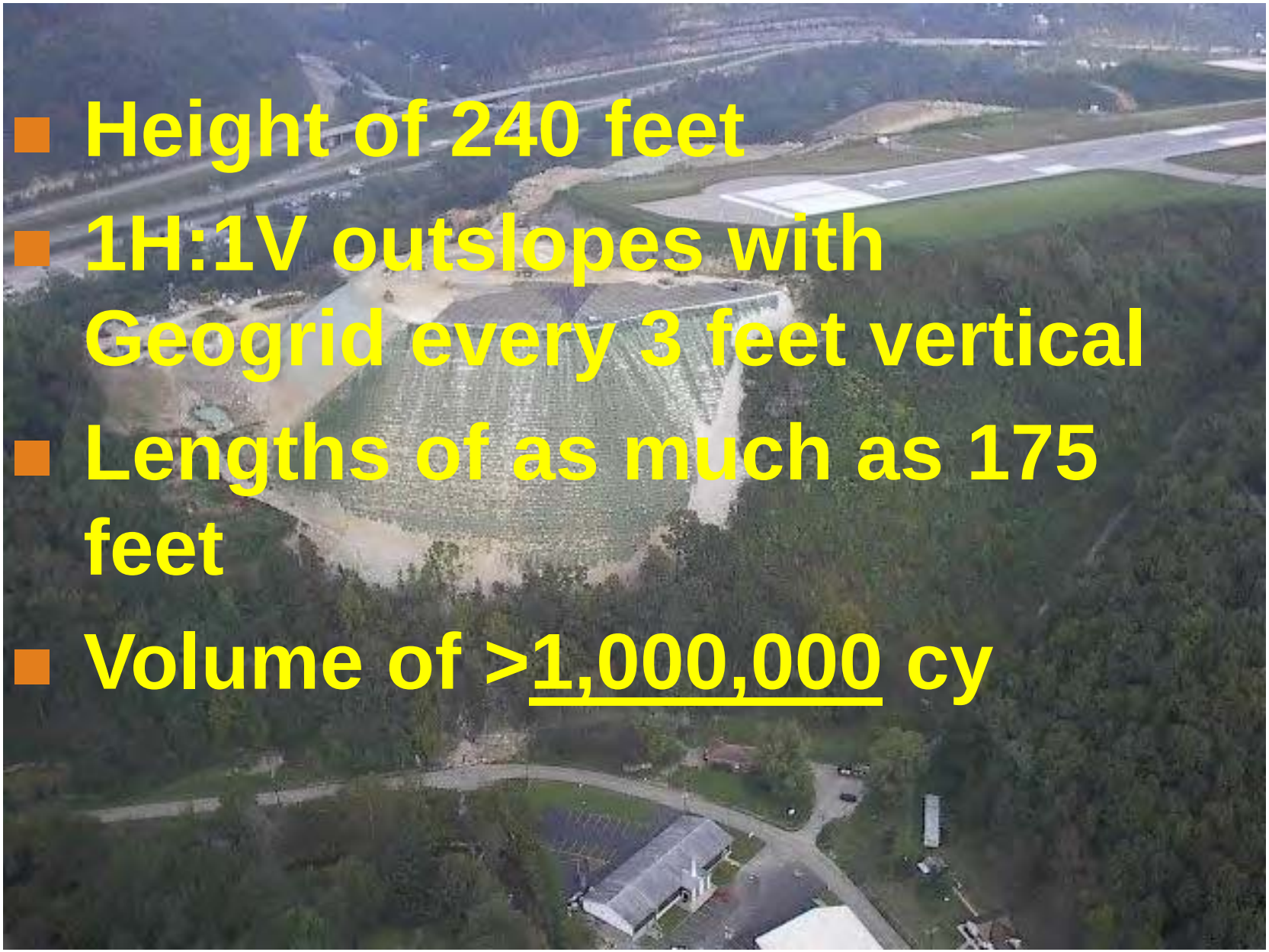
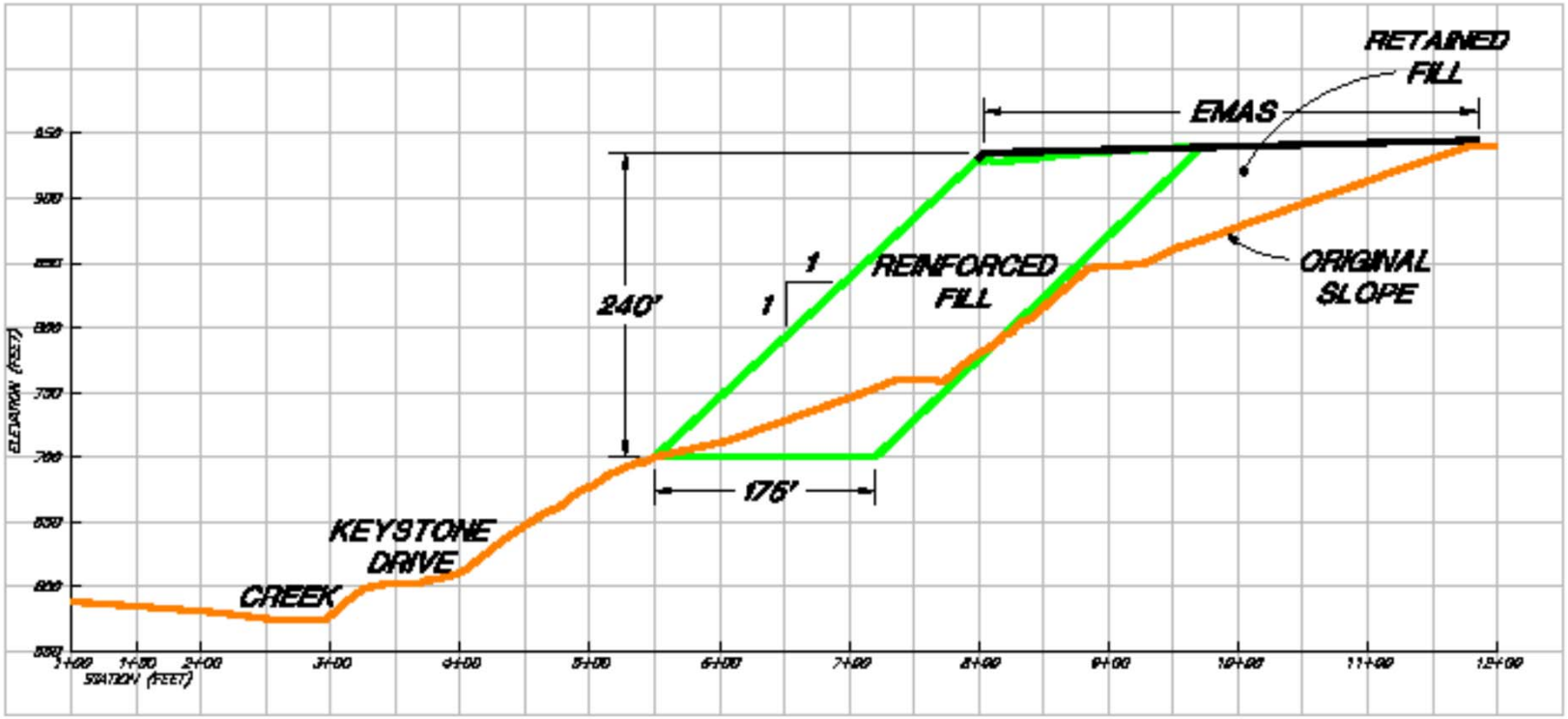
FILL STATS



- Height of 240 feet
- 1H:1V outslopes with Geogrid every 3 feet vertical
- Lengths of as much as 175 feet
- Volume of >1,000,000 cy


RETAINED FILL
EMAS
1
1
REINFORCED FILL
240'
176'
ORIGINAL SLOPE
KEYSTONE DRIVE
CREEK
ELEVATION (FEET)
STATION (FEET)
1+00
1+50
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00

SECTION A-A

EMAS co

CHALLENGES

Schedule

- *Mitigation plan*
- *Bid package*
- *Contractor selection*

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CHALLENGES

Available data limitations, unknowns

- Materials used
- In-place density and strength
- Water
- Grid limits
- Failure mechanism

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CHALLENGES

Safety

- No one gets hurt
- 140 feet high vertical face below runway
- Massive, creeping debris field below vertical face

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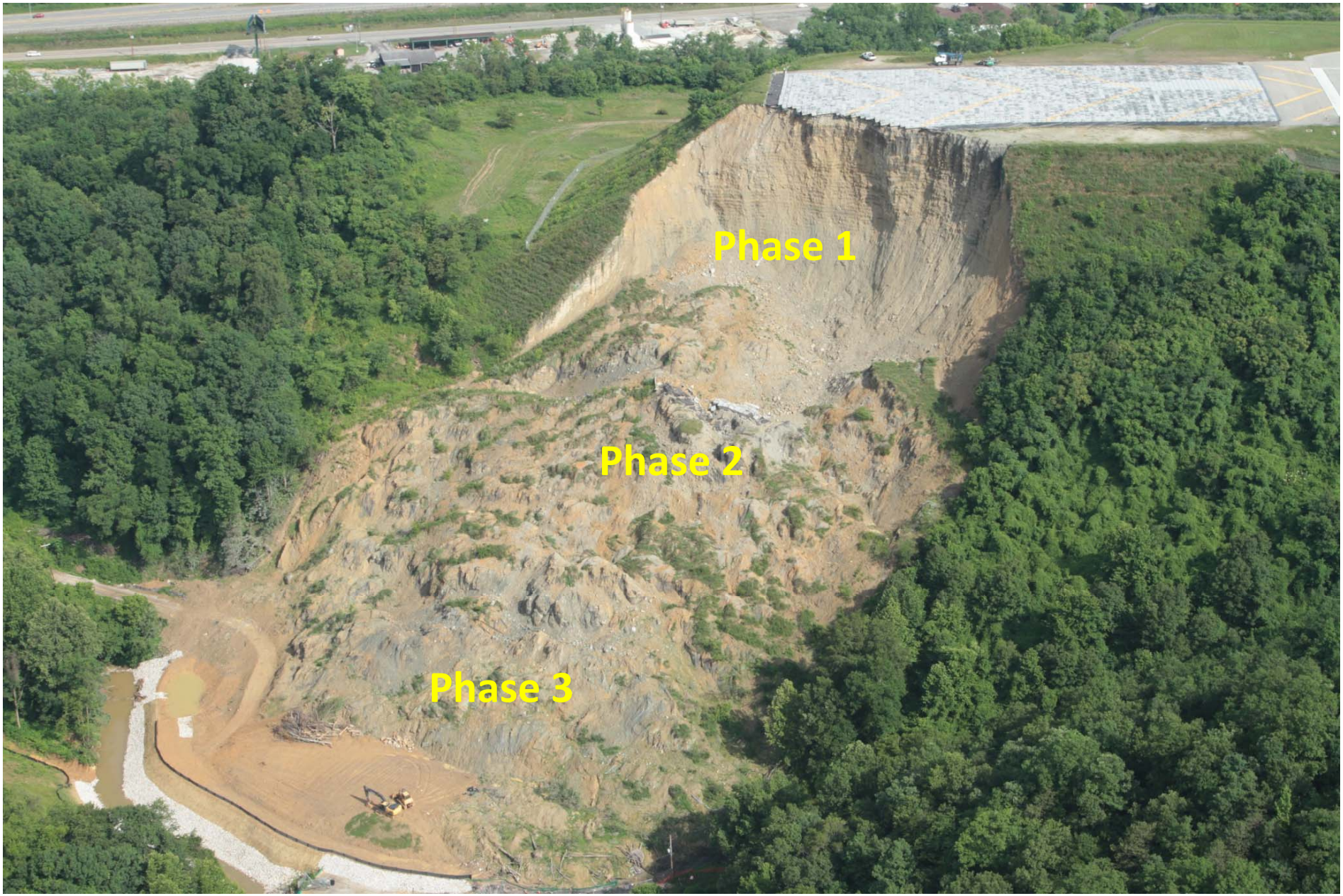
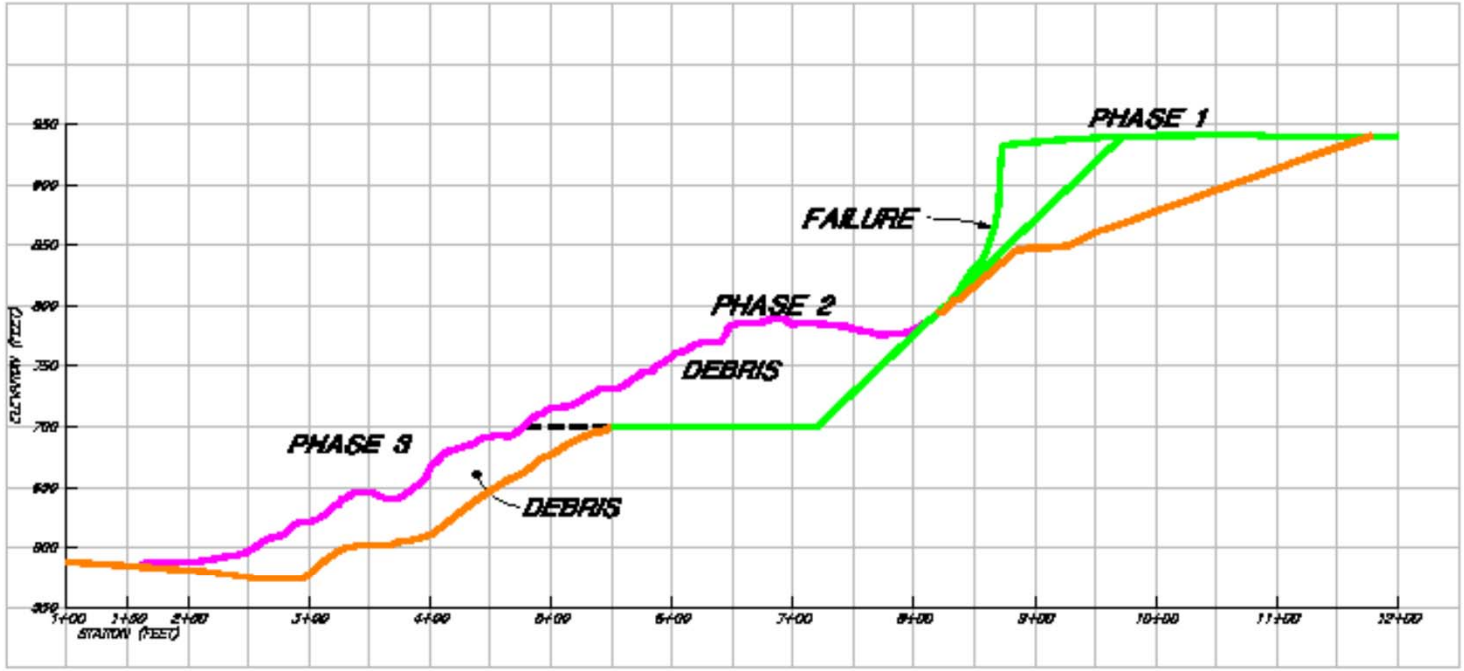

Phase 1
Phase 2
Phase 3



SECTION A-A

DESIGN

- Temporary cut slopes to be left in place
- Removal of hanging wedge/vertical face

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TEMPORARY CUT SLOPES

- Balance safety factor with minimizing removal of remaining fill
- Based on perceived nature of material, used cut slopes of 1.5H:1.0V with benches approximately 50 feet vertical

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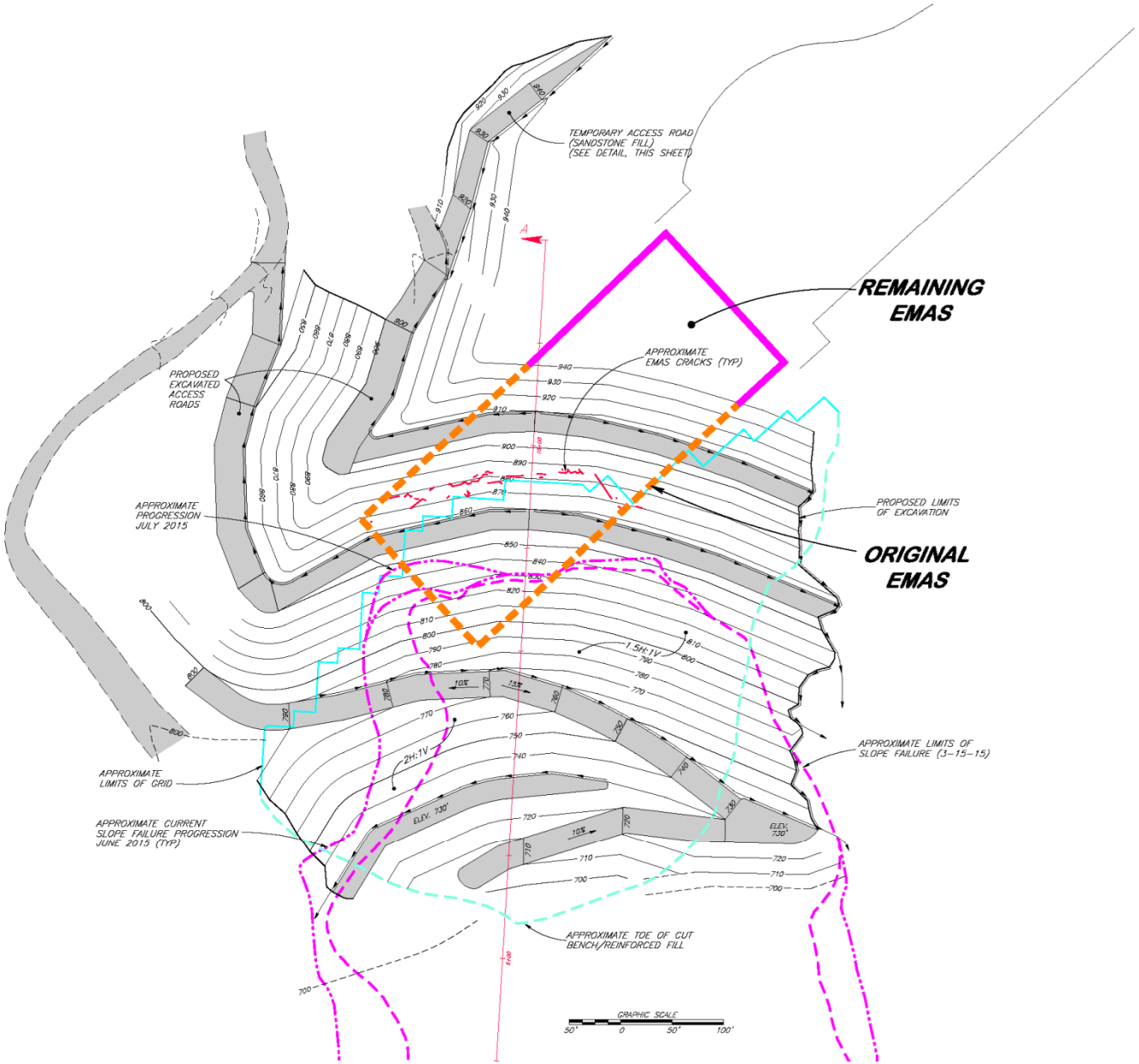
TEMPORARY ACCESS ROAD
(SANDSTONE FILL)
(SEE DETAIL, THIS SHEET)
REMAINING
EMAS
APPROXIMATE
EMAS CRACKS (TYP)
PROPOSED
EXCAVATED
ACCESS
ROADS
PROPOSED LIMITS
OF EXCAVATION
ORIGINAL
EMAS
APPROXIMATE
PROGRESSION
JULY 2015
1.5H:1V
2H:1V
10%
15%
APPROXIMATE
LIMITS OF GRID
APPROXIMATE LIMITS OF
SLOPE FAILURE (3-15-15)
APPROXIMATE CURRENT
SLOPE FAILURE PROGRESSION
JUNE 2015 (TYP)
ELEV. 730'
APPROXIMATE TOE OF CUT
BENCH/REINFORCED FILL
GRAPHIC SCALE
50' 0 50' 100'

REMOVAL OF HANGING WEDGE/VERTICAL FACE

- Not easily explained
- Remaining sheared grid was a benefit
- Concerns about equipment/personnel safety
- Practical limitations of equipment reach vs. oomph

OBSERVATIONAL APPROACH

- Excavate enough material to balance weight of equipment

- Monitor/restrict access in front of known cracks in remnant fill

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OBSERVATIONAL APPROACH

- Survey points on outer edge of face with continuous monitoring

- Visual observations

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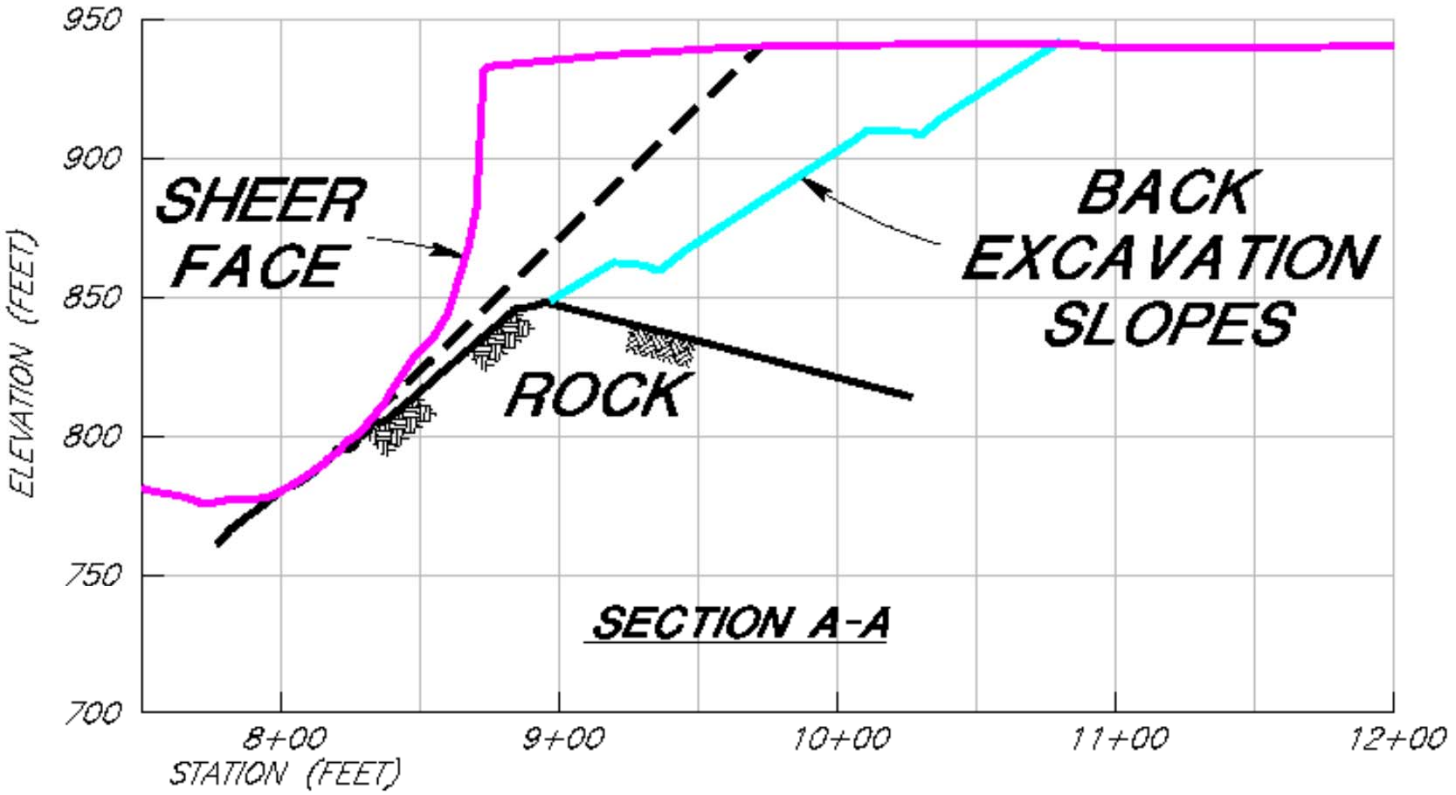

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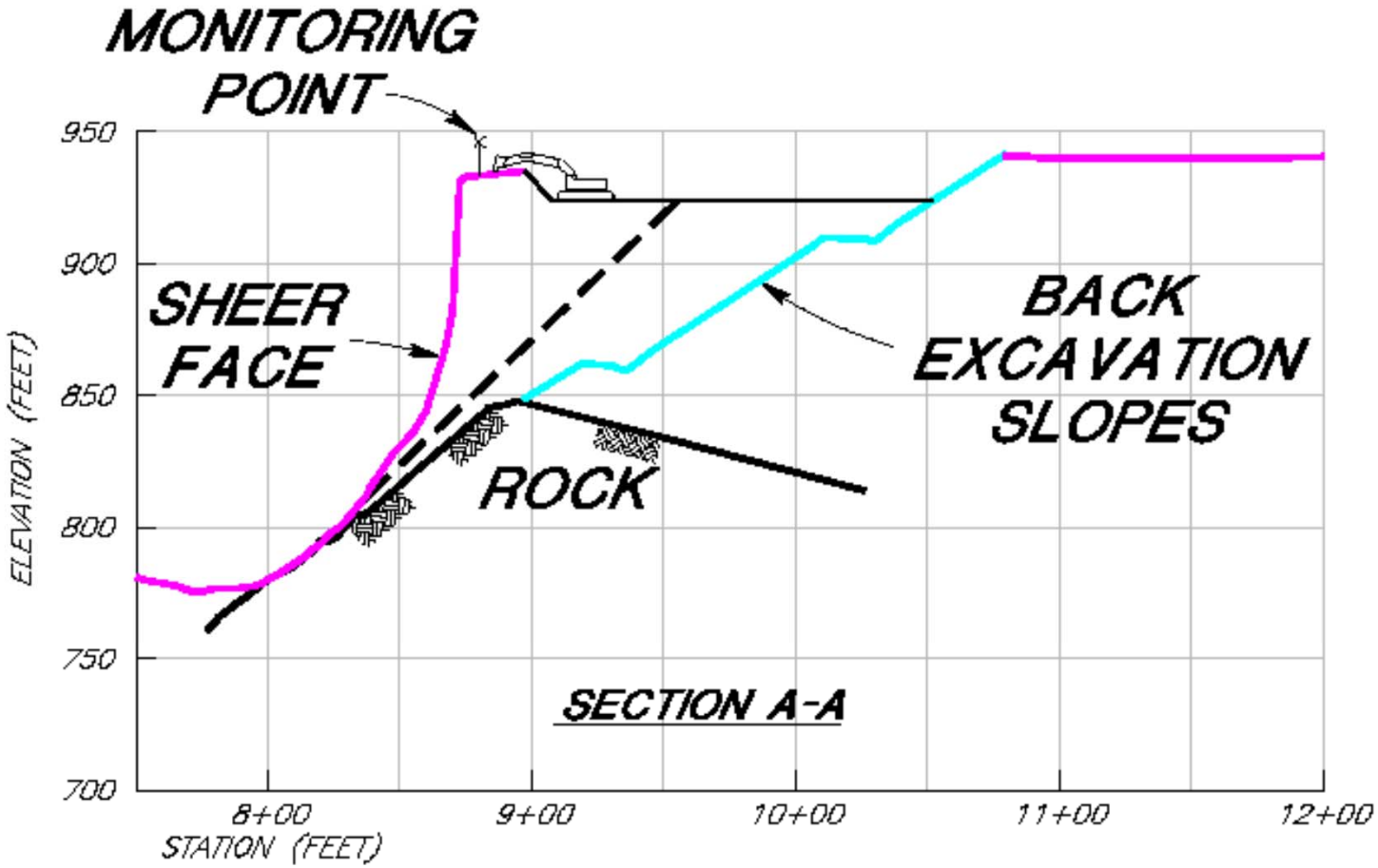

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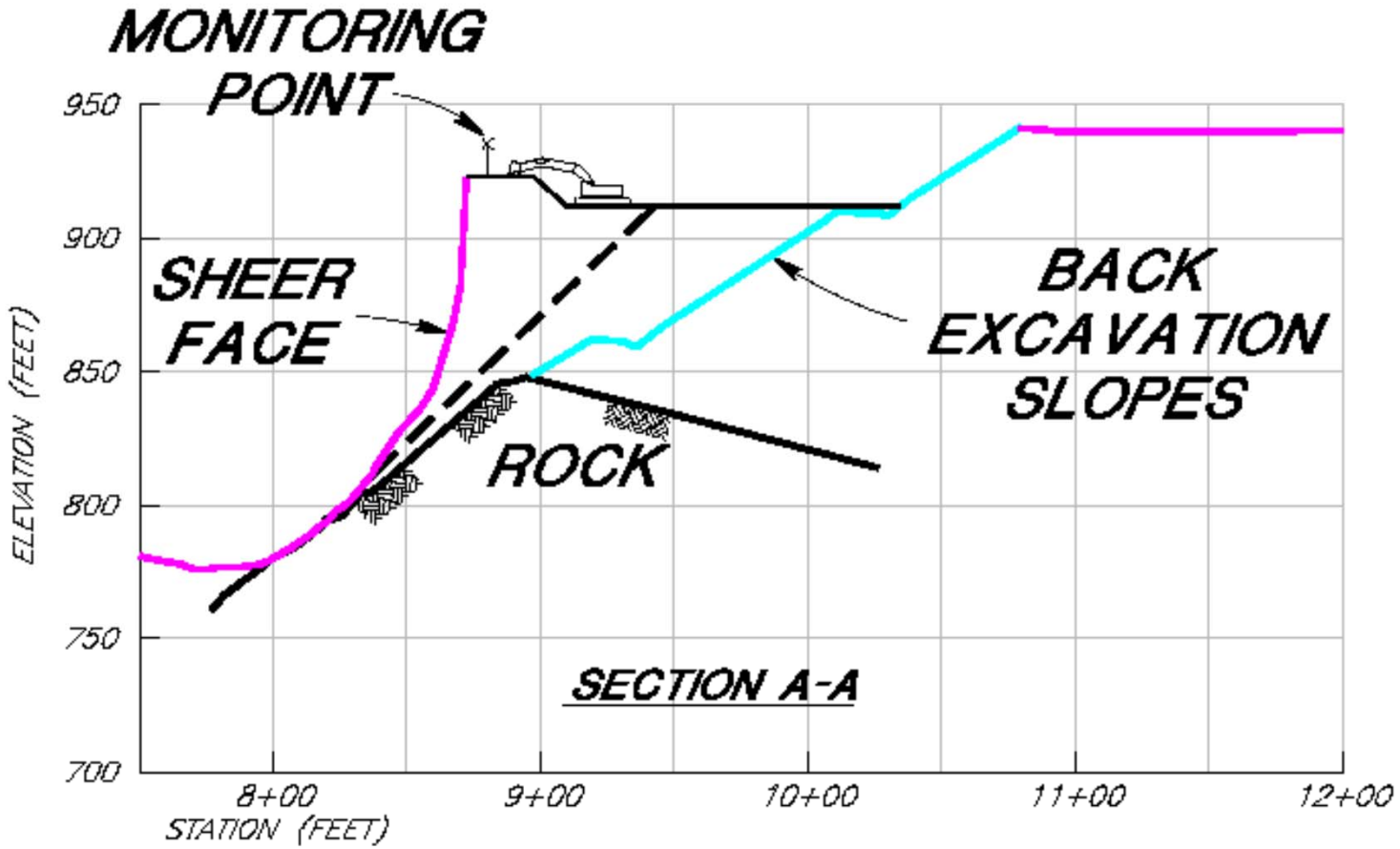

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DEERE


KOMATSU
PC 400 LC
EX002
KOMATSU


CAT
CAT


Waste Storage Fill
Active Runway 5
Slope mitigation area
Airport Rd
Keystone Dr
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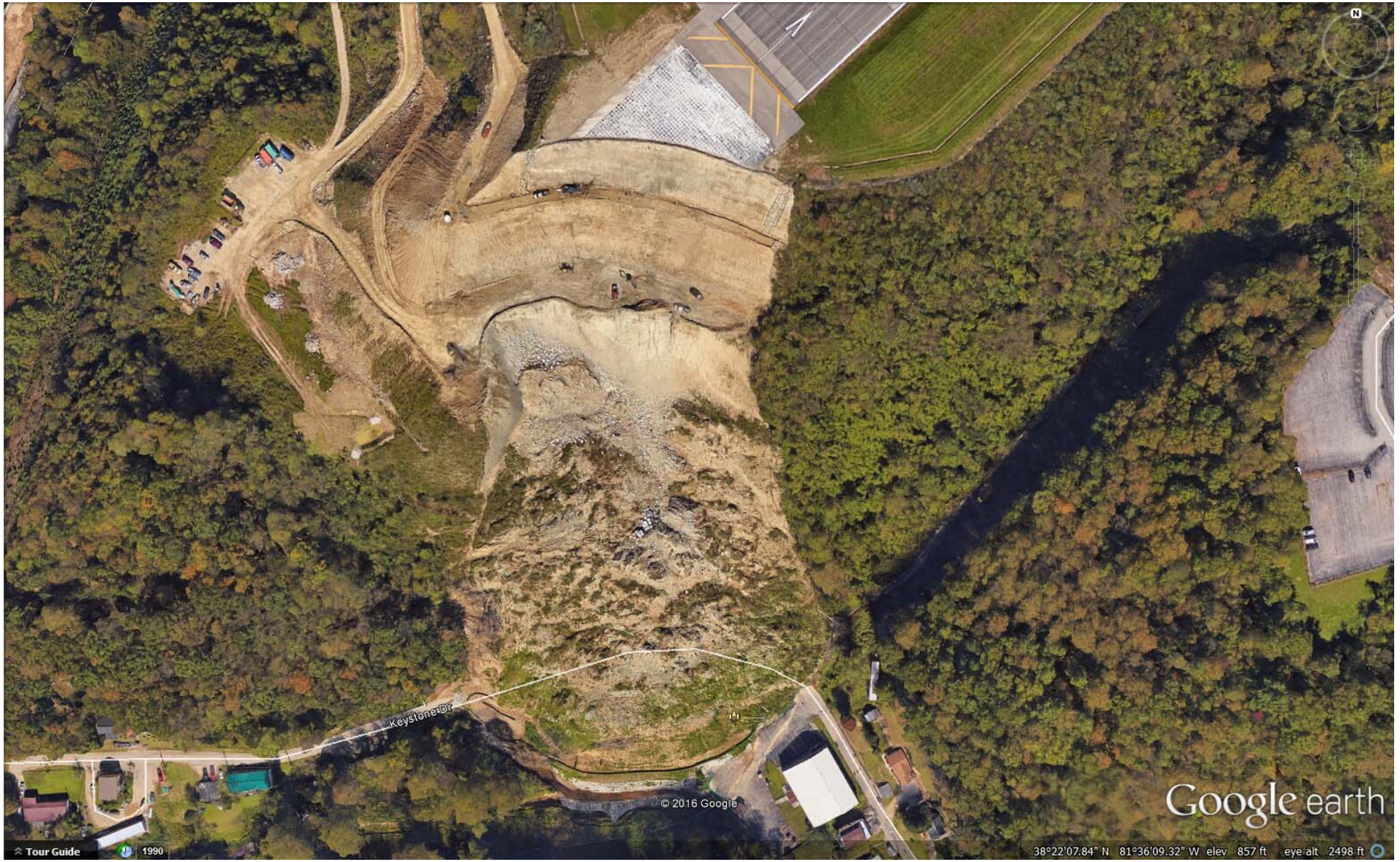
Google earth
Tour Guide
38°22'11.73" N 81°35'46.58" W elev 948 ft eye alt 3878 ft


Keystone Dr
© 2016 Google
Google earth
Tour Guide
1990
38°22'07.84" N 81°36'09.32" W elev 857 ft eye alt 2498 ft

Phase 2 is complete

Phase 3 started July 5 – in progress

Permanent Repair Design and Construction in the future?