

# Realignment of Highway with One of the Largest Geogrid Reinforced Slope Projects Constructed in Minnesota

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## Acknowledgements

- Blue Earth County Public Works Department – Owner, Construction Inspection
- SRF Consulting Group Inc – Civil Engineer
- Mathiowetz Construction Company - Contractor



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## Background

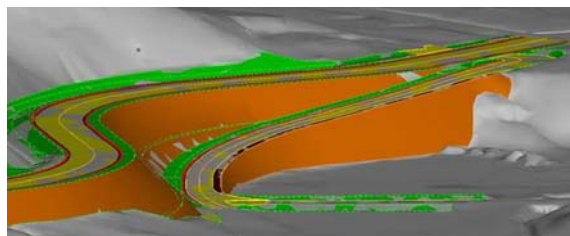
- Blue Earth County State-Aid Highway (CSAH) 1 was recently acquired from the Minnesota Department of Transportation
- A 2 mile portion of CSAH 1, exists at the edge of steep, 50-100ft tall Ravine
- The roadway had many issues including:
  - Sharp curves,
  - Limited sight distance,
  - Significant Hillside Erosion and Slope Failures
  - Supported by ad-hoc retaining structures
  - High annual maintenance Costs
- Roadway located in a semi-rural area just south of Mankato, MN with businesses and residences along the roadway and at base of the steep ravine



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## Proposed Construction

- Update Roadway to Current Design Standards
- Requires Roadway Embankment Widening over Steep Hillside Slopes
- 30-50ft tall Grade Separation Structures Would be Required to Minimize Impacts and ROW Acquisition
- Local Access Road to Base of Ravine Also to be Reconstructed
- 1H:1V (45 deg.) RSS and 1H:2.75V (70 deg.) RSS selected as Cost Effective Alternative



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## Site Geology

- Hillside – 15ft Soft Clays over Soft/Weathered Sandstone and Limestone Bedrock
- Pockets of Competent Limestone Bedrock
- Bottom of Ravine Consists of Soft Clay over a Stiff Clay

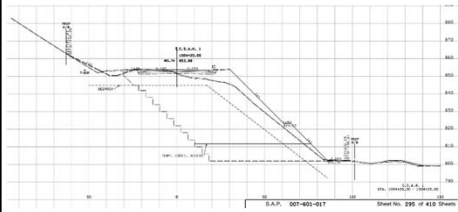


BORING NO. B-31		CLIENT	
Blue Earth County CSAH 1 (The 66 Turnback)		Blue Earth County Public Works Dept	
DEPTH	SOIL DESCRIPTION	DEPTH	SOIL TYPE
0.00	Surface in location, see 118	0.00	Surface
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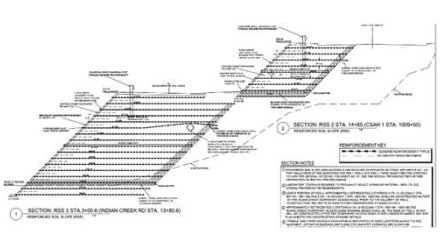
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## Proposed RSS Construction

- 1H:1V RSS – 1600ft Long, up to 50ft in Height
- A portion constructed as 2 Tiers to Support Local Access Road and new CSAH 1



1H:1V RSS, 50ft Tall Cross Section

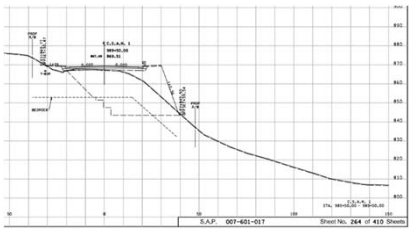


1H:1V RSS, Tiered Cross Section

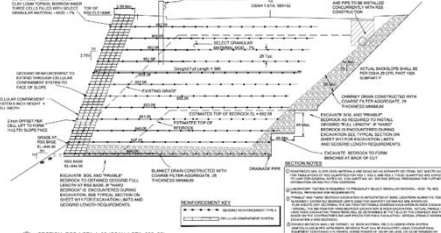
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## Proposed RSS Construction

- 1H:2.75V RSS – 900ft Long, up to 30ft in Height
- Constructed on Edge of Hillside Slope



1H:2.75V RSS Cross Section

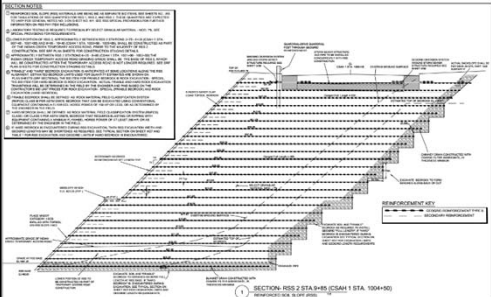


1H:2.75V RSS Cross Section


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## 1H:1V RSS Design


- 1H:1V RSS Components
  - Constructed with Planar Slope Face
  - Gravel Chimney & Blanket Drain
  - Select Granular Fill,  $\Phi > 35$  deg.
  - Primary Geogrid Reinforcement, Allowable Tensile Strength = 5000 lb/ft
  - Geogrid Lengths of 120% of Slope Height at 2ft Vertical Increments
  - Secondary Geogrid Reinforcement at Slope Face, 1ft Vertical Increments
  - 6 Inch Thick Specialized Topsoil/Seed Fertilizer Mix Placed at Slope Face
  - Temporary Straw Coconut Erosion Control Blanket at Slope Face



SECTION - RSS 2 STA 9445 (C&M) 1 STA. 1004-50  
REINFORCED SOIL SLOPE (P&E)

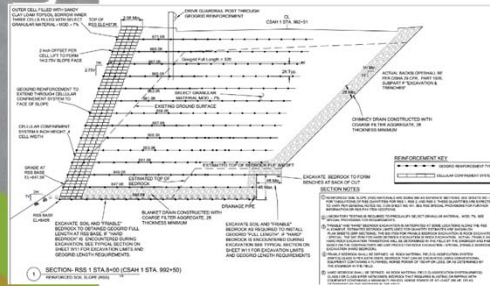



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## 1H:2.75V RSS Design

- 1H:2.75V RSS Components
  - Facing Constructed with Stacked Geocells
  - Gravel Chimney & Blanket Drain
  - Select Granular Fill,  $\Phi > 35$  deg.
  - Primary Geogrid Reinforcement, Allowable Tensile Strength = 2500 lb/ft
  - Geogrid Lengths of 120% of Slope Height at 2ft Vertical Increments
  - Outer Geocell Specialized Topsoil/Seed Fertilizer Mix Placed at Slope Face

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## CSAH 1 RSS Design Challenges

- Project Challenges
  - Hillside Excavation: Shallow Soft Bedrock with Hard Bedrock Pockets
  - Soft Clay Foundation Soils at Base of Ravine
  - Active Hillside Seepage
  - Construction Staging to maintain Local Access during Construction
  - Vegetation Establishment on Slope Face




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### CSAH 1 RSS Challenges

- Hillside Excavation
  - Shallow Soft Bedrock Excavated with Conventional Equipment
  - Harder Competent Bedrock Left in Place – Save \$
  - RSS Geogrid Length Adjusted Based on Encountered Bedrock
  - Construction Staging to maintain Local Access during Construction
  - Field Surveying of Excavated Bedrock Limits

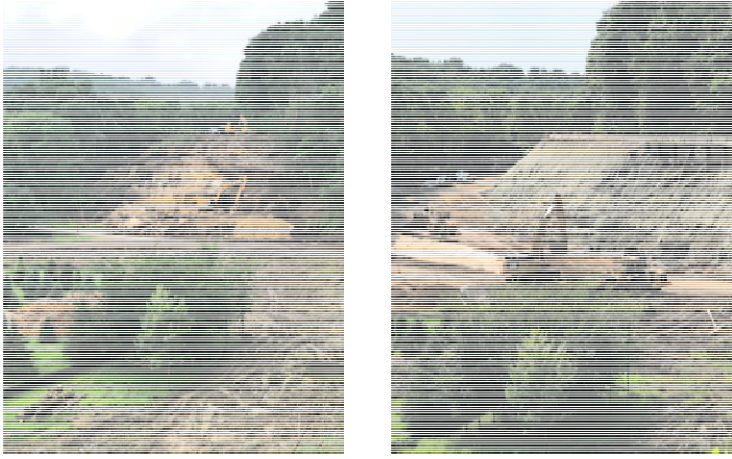


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### CSAH 1 RSS Challenges

- Hillside Excavation



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### CSAH 1 RSS Challenges

- **Soft Clay Foundation Soils**
  - Potholing during Construction to Determine Extent of Soft Clay
  - Excavate 5-10ft Soft Clay within RSS Footprint
  - Replace with Select Granular



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### CSAH 1 RSS Challenges

- **Active Hillside Seepage**
  - Install 2ft Thick Gravel Chimney & Blanket Drain at Back and Base of RSS Cut
  - Install 4 Inch Drain Tile at Outlet Pipes at Base of RSS



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### CSAH 1 RSS Challenges

- Active Hillside Seepage



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### CSAH 1 RSS Challenges

- Construction Staging:
  - Partial RSS Construction to Serve as Temp Access Road to Base of Ravine
  - Keep Old CSAH 1 Open During Construction



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### CSAH 1 RSS Construction

- Geogrid Reinforcement Placement:
  - Primary Reinforcement at 2ft Vertical Intervals, 1.2H Length
  - Secondary Geogrid Reinforcement, 1ft Vertical Intervals, 6ft Length



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### CSAH 1 RSS Construction

- Geogrid Reinforcement Placement:



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### CSAH 1 RSS Construction

- Stacked Geocell at 1H:2.75V RSS Face:
  - 6 Inch Geocell Height, 4ft Deployed Length
  - UV Stabilization, Peel Strength Specified
  - Outer Cell infilled with Topsoil/Seed, Fertilizer Mix




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### CSAH 1 RSS Construction

- Stacked Geocell at 1H:2.75V RSS Face:



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### CSAH 1 RSS Challenges

- Vegetation Establishment on RSS Face:
  - Significant Aspect of RSS
  - Reduce Future Maintenance due to Erosion
  - Increased Aesthetics



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### CSAH 1 RSS Challenges

- Vegetation Establishment Components:
  - Specialized Topsoil: Specify Organic Content, pH, Silt/Clay Content
  - Specialized Fertilizer/Seed Mix: Native Mix with Rapid Deployment
  - Premix Topsoil, Seed and Fertilizer prior to Placement on Slope Face



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### CSAH 1 RSS Challenges

- Vegetation Establishment Components:



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### CSAH 1 RSS Completion

- Construction Inspection was Significant Aspect of Project:
  - Bedrock Excavation
  - Geocell Placement
  - Geogrid Placement
  - Topsoil/Seed/Fertilizer Placement on RSS Face



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Questions?

