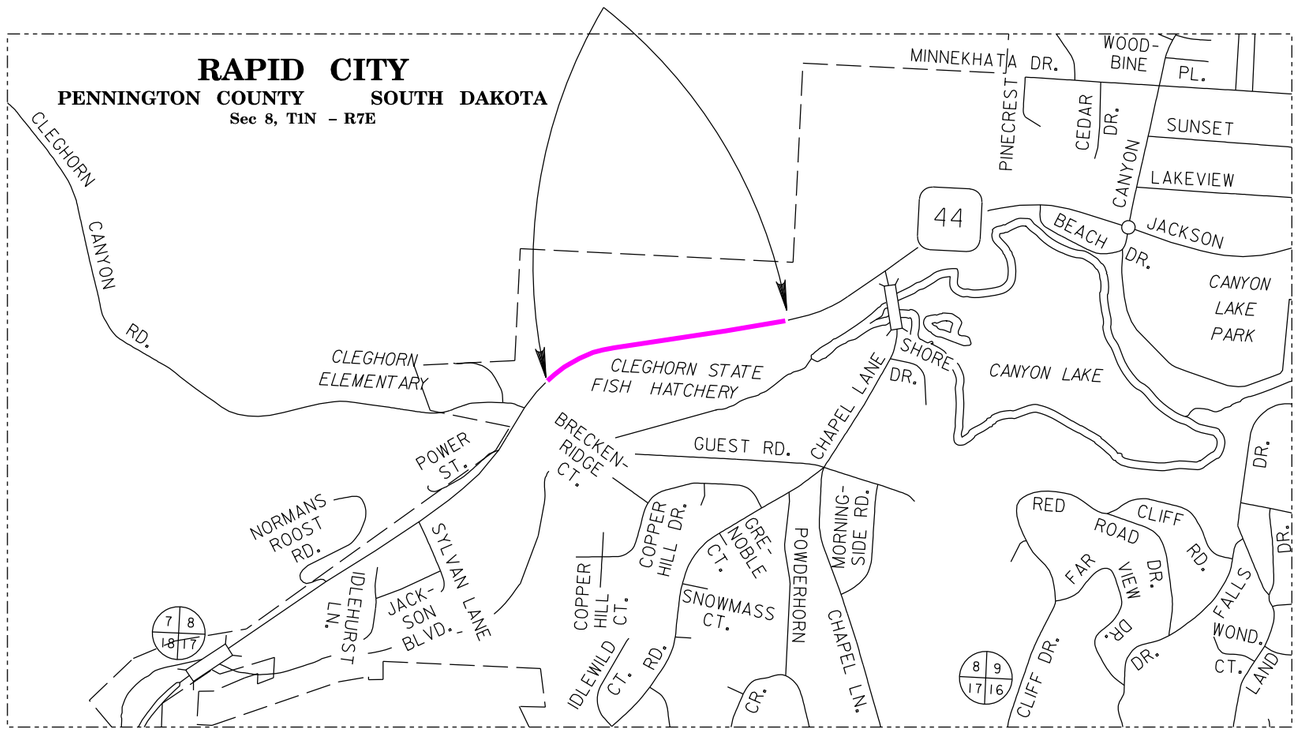
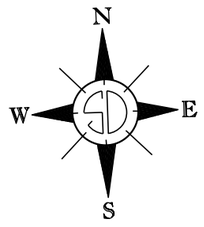
SECTION E: ROCKFALL STRUCTURE PLANS

INDEX OF SHEETS

PROJECT NH 0044(227)40
MRM 40.46 + 0.04 to MRM 40.46 + 0.34





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ROCKFALL FENCE AND SLOPE MESH
Estimate of Quantities

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STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E2	E8

Bid Item Number	Item	Quantity	Unit
420E0400	Structure Excavation, Miscellaneous	22	Cu Yd
530E0602	Soil Nail	1,155	Ft
530E1100	Slope Mesh	53,820	Sq Ft
530E1110	Slope Mesh Anchor	32	Each
620E8000	Rockfall Fence	963	Ft
900E6005	Concrete Foundation	33	Each
900E8950	Ground Anchors	1,360	Ft

Rockfall Fence Segment	Sta	to	Sta	Total Length (ft)	Appx. Post Spacing (ft)	Total Posts (Ea)	Total Ground Anchors
1	10+00		11+28	128	30.0	5	12
2	20+00		21+83	183	35.0	6	13
3	30+00	to	32+30	230	32.5	8	15
4	40+00		42+50	250	35.5	8	15
5	50+00		51+72	172	34.5	6	13

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ROCKFALL MITIGATION LOCATIONS
Plan View

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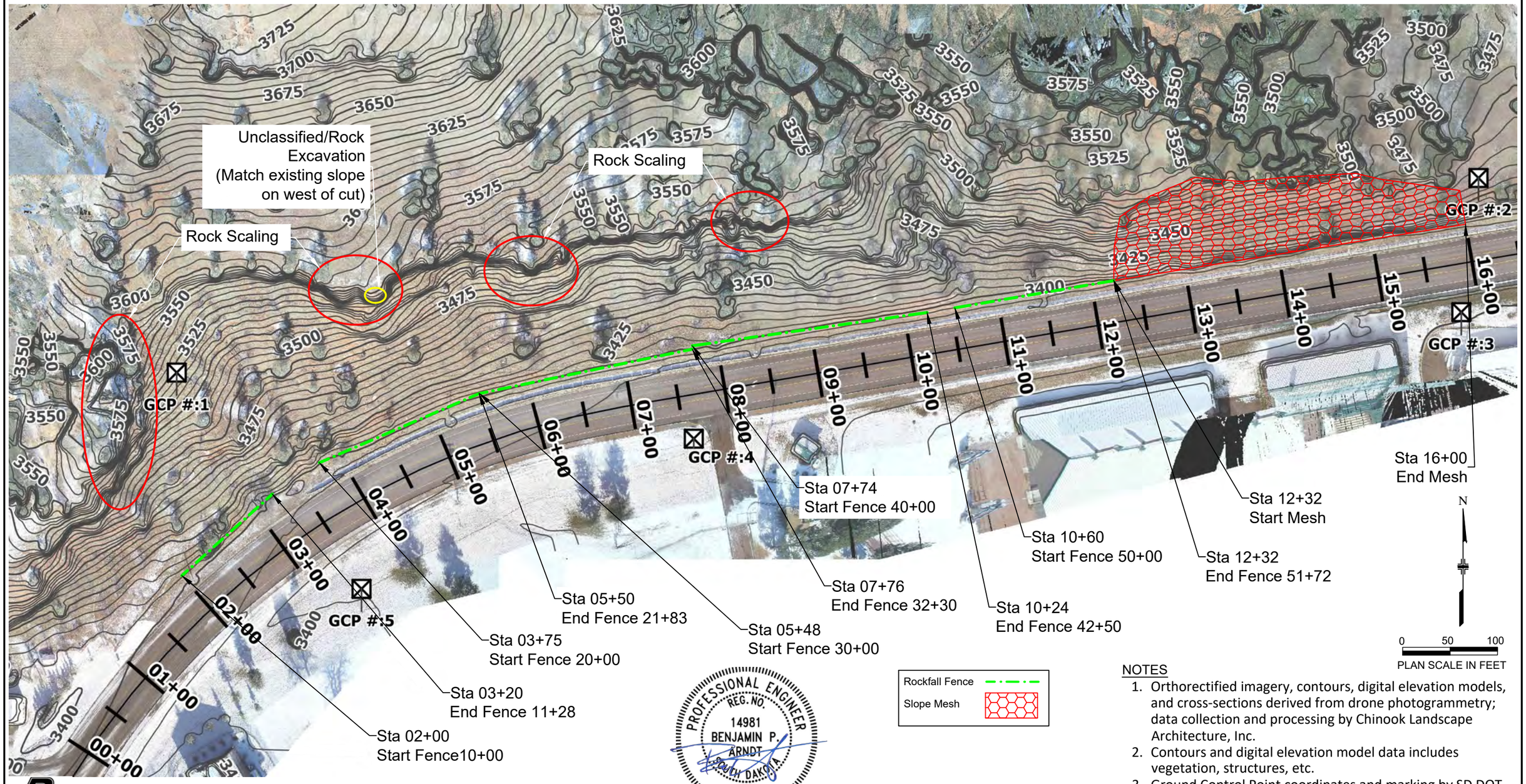
STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E3	E8



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Rockfall Fence
Slope Mesh

NOTES

1. Orthorectified imagery, contours, digital elevation models, and cross-sections derived from drone photogrammetry; data collection and processing by Chinook Landscape Architecture, Inc.
2. Contours and digital elevation model data includes vegetation, structures, etc.
3. Ground Control Point coordinates and marking by SD DOT.
4. NOT A LAND SURVEY.
5. The rockfall fence concrete foundation will need to be field fit for individual segments to avoid gullies and rocks.

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STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E4	E8

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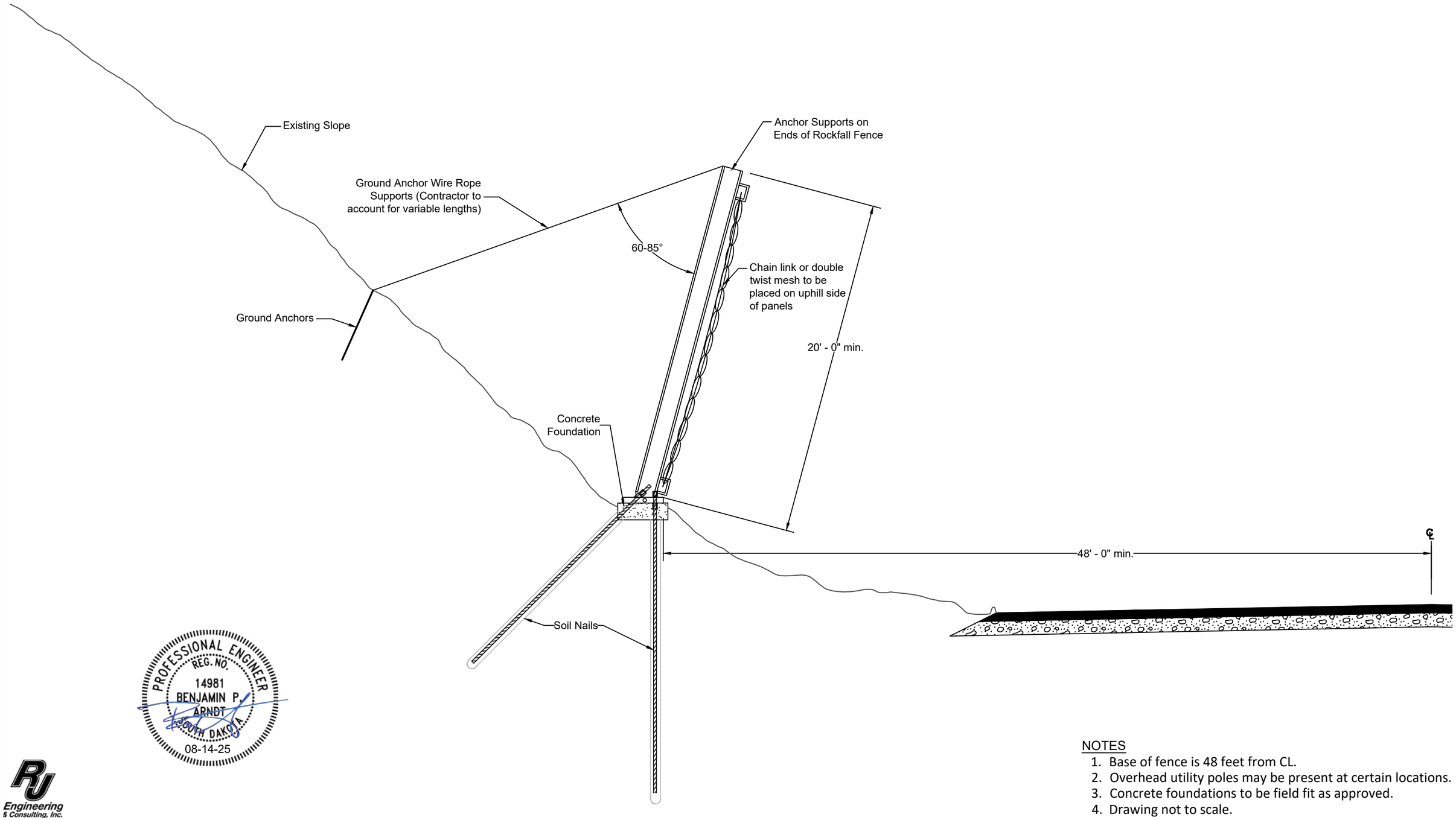
ROCKFALL FENCE
Typical Section



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NOTES
1. Base of fence is 48 feet from CL.
2. Overhead utility poles may be present at certain locations.
3. Concrete foundations to be field fit as approved.
4. Drawing not to scale.

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E5	E8

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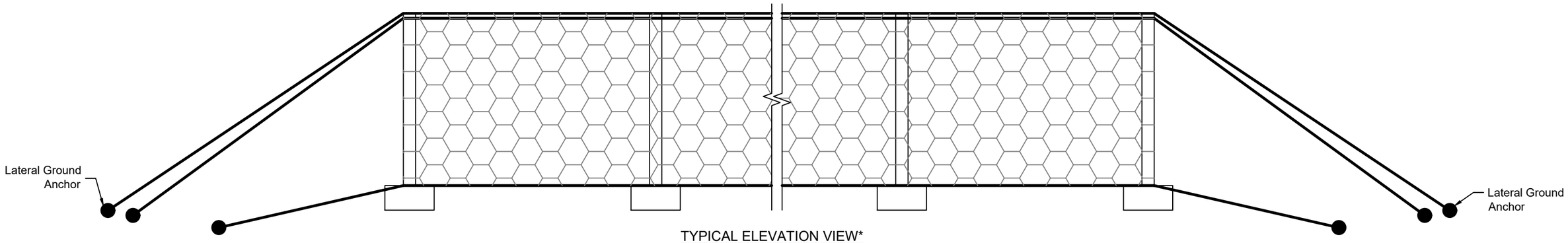
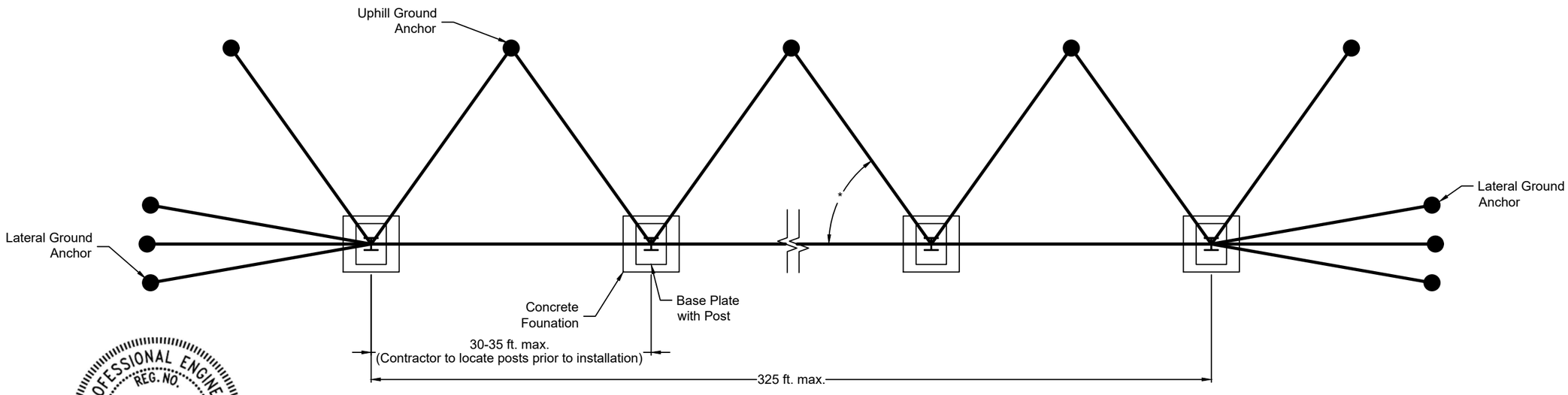
ROCKFALL FENCE
Typical Layout



TYPICAL ELEVATION VIEW*



TYPICAL PLAN VIEW*

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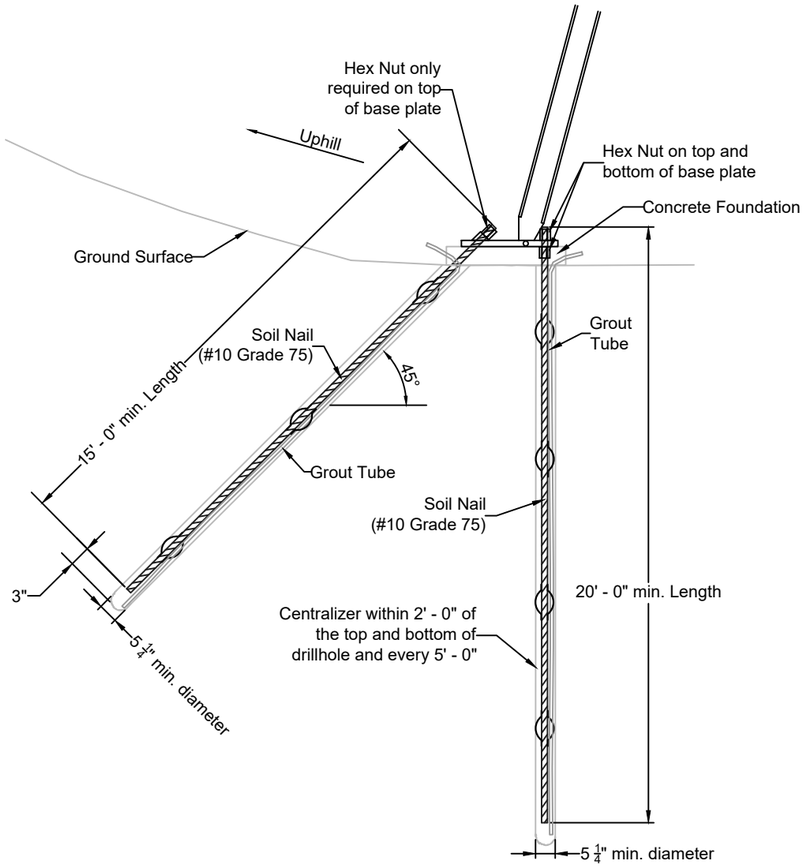
Note:
* Angles and lengths of wire anchor ropes per manufacturers recommendations to facilitate ground anchor locations but generally constructed as shown.
* System shown is general and is dependent on manufacture's tested system for number of anchors.

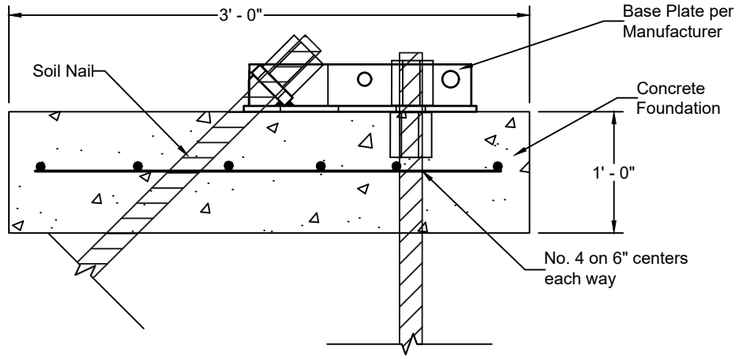
ROCKFALL FENCE
Details

FOR BIDDING PURPOSES ONLY

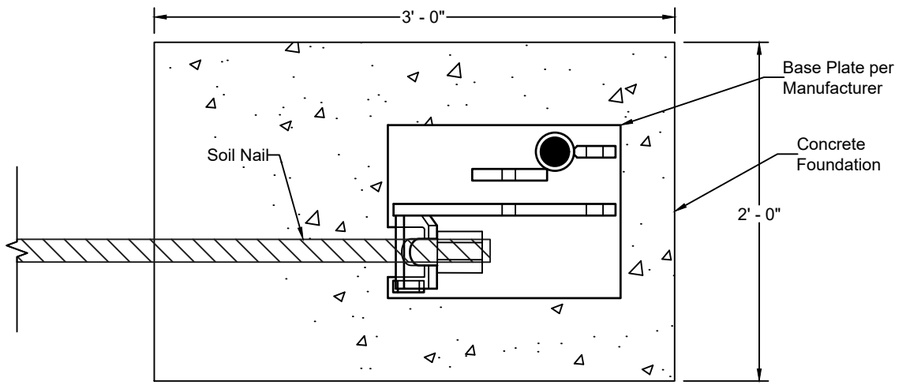
STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E6	E8



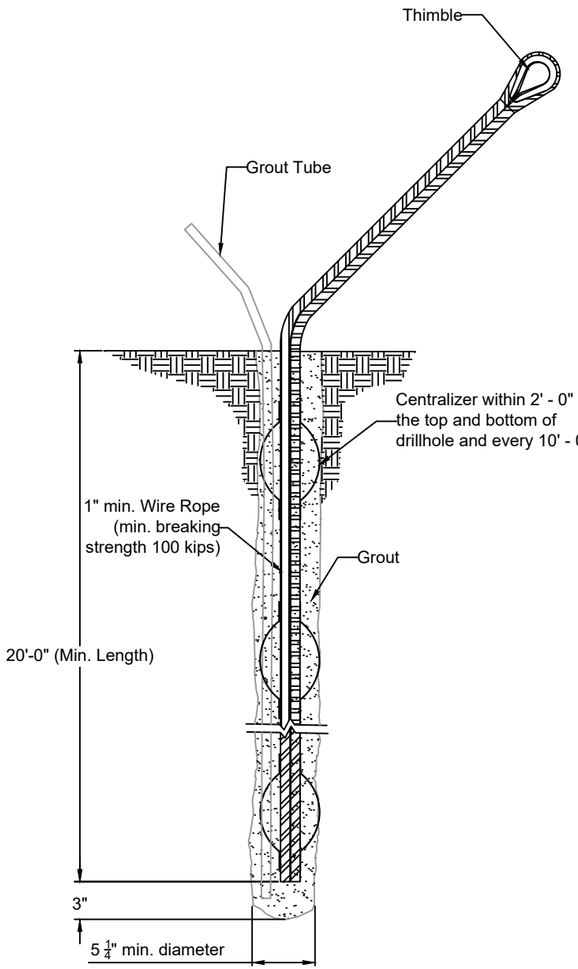
ROCKFALL FENCE
POST FOUNDATION DETAIL



CONCRETE FOUNDATION PAD
(SIDE VIEW)



CONCRETE FOUNDATION PAD
(TOP VIEW)



GROUND ANCHOR DETAIL

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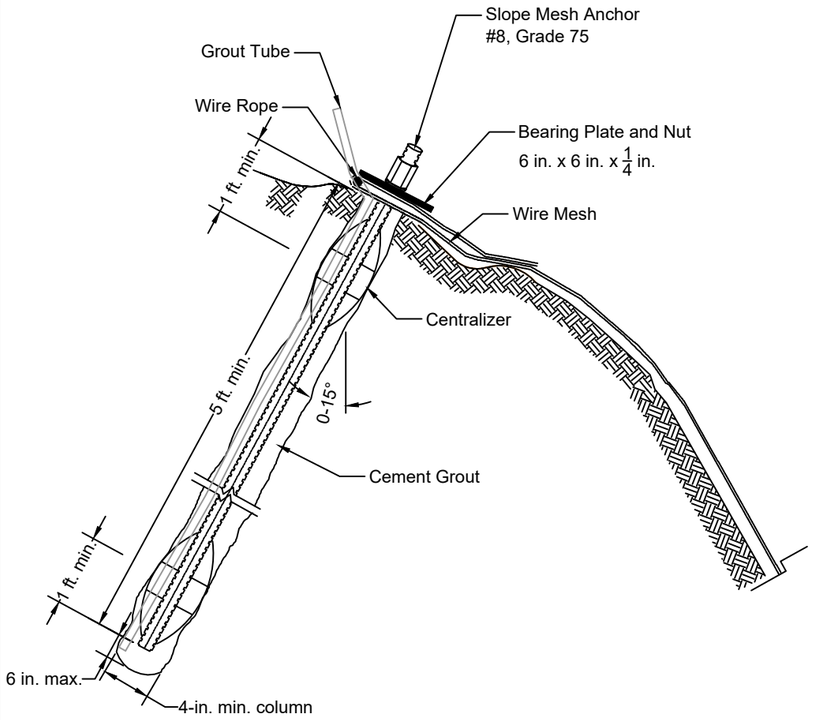
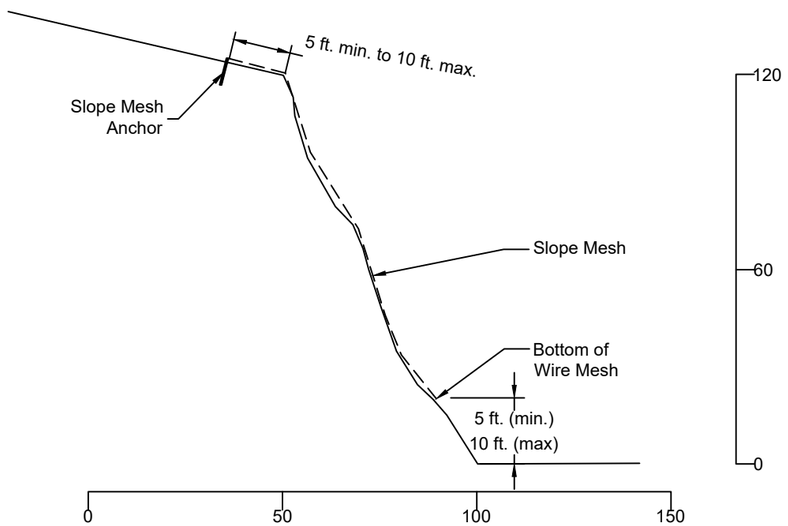
NOTES
1. See special provisions for corrosion protection requirements.

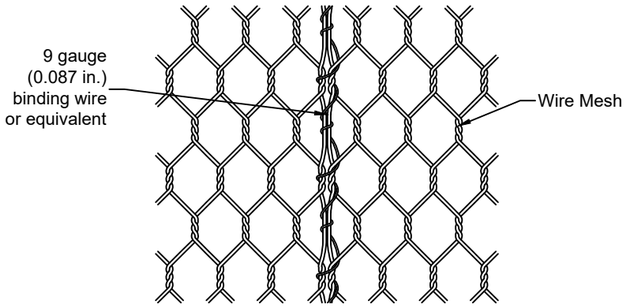
SLOPE MESH
Details

FOR BIDDING PURPOSES ONLY

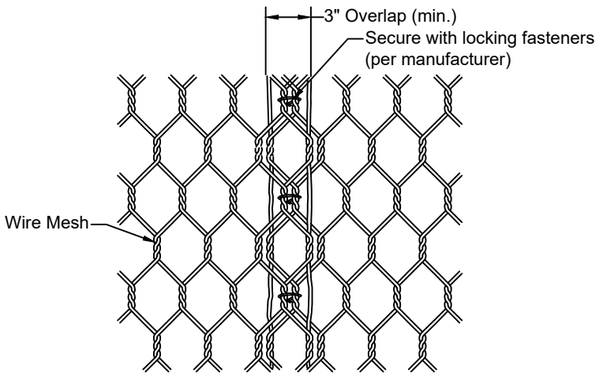
STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E7	E8







SLOPE MESH
OPTION 1: TYPICAL LACING DETAIL
NOT TO SCALE

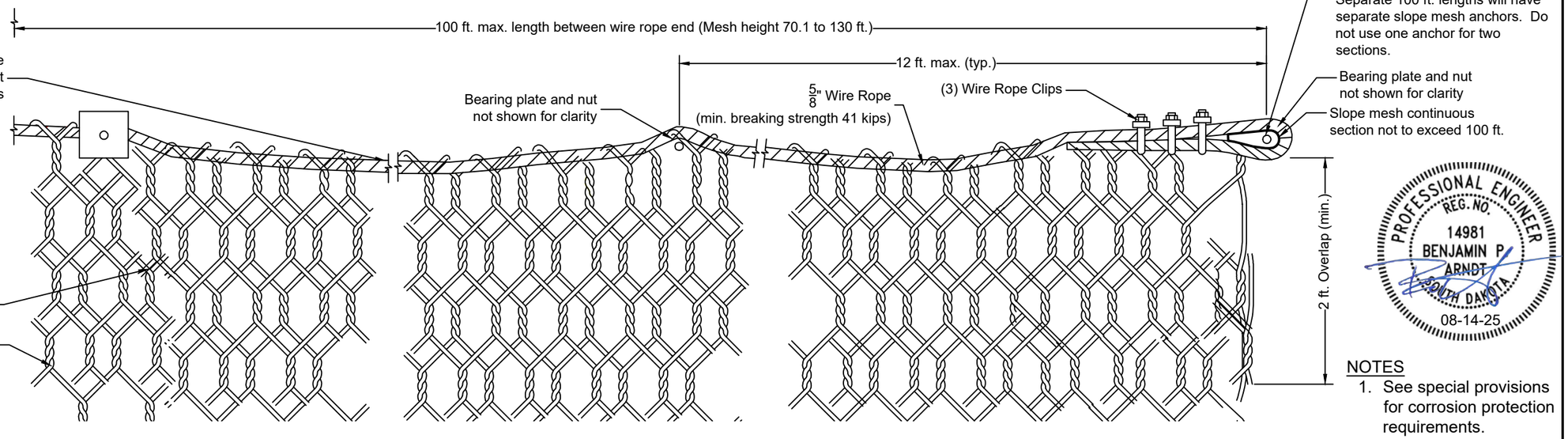


SLOPE MESH
OPTION 2: TYPICAL LACING DETAIL
NOT TO SCALE

SLOPE MESH ANCHOR DETAIL

* Note: Configure anchor wire rope as shown. Do not loop wire rope around anchors and avoid "kinking" wire rope and other sharp bends.

SLOPE MESH TYPICAL SECTION



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NOTES
1. See special provisions for corrosion protection requirements.

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ROCKFALL FENCE AND SLOPE MESH

FOR BIDDING PURPOSES ONLY

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	NH 0044(227)40	E8	E8

Notes

1 Rockfall Fence Requirements
- 1.1 Fence To Be Manufactured by Geobrugg, Maccaferri, or Approved Equivalent and will Meet Buy America Requirements,
- 1.2 Maximum Energy Level (MEL) Rating Of 2,000 KJ.
- 1.3 Panel Height of 20 Ft.
- 1.4 Maximum Elongation at MEL of 19 Ft.
- 1.5 See Special Provisions for submittal requirements.

2 Corrosion Protection and Color for Slope Mesh and Rockfall Barrier Fence
- 2.1 All bars nuts, washers, shackles, hardware etc to have epoxy or galvanization.
- 2.2 Color will be galvanization only.

3 Grout for Slope Mesh Anchors, Soil Nails, and Ground Anchors
- 3.1 The grout to be used for anchorage will consist of a pumpable mixture commercially available non-metallic, non-shrink grout, conforming to ASTM C1107 per Subsection 460.2 of the Standard Specifications. The grout may be neat or a sand cement mixture. Cement will be fresh and will not contain lumps or other indications of hydration. The grout will be capable of reaching a compressive strength of 1,500 psi in three days and 3,500 psi in seven days. The grout will have a water-cement ratio of 0.40 to 0.60. The grout will be free of lumps and un-dispersed cement.
- 3.2 f'c=1,500 psi min 3-day.
- 3.3 f'c=3,500 psi min 7-day.
- 3.4 See Special Provisions for specific requirements.

4 Testing of Soil Nail, Ground Anchor, and Slope Mesh Anchor
- 4.1 The Contractor will furnish at least one set of laboratory certified stressing equipment for use in conducting these tests. Testing equipment will include jack, pump, pressure gage, and a reaction frame.
- 4.2 Lift off/pullout testing will be performed on fully grouted anchors in rock or slope materials.
- 4.3 The lift off test assumes the bond zone is in sandy or bedrock material and the bond will not fail in creep. The Lift Off Test will be as shown in the plans or in accordance with manufacturer's recommendations assuming the anchor test is at or below 80% of soil nail or anchor yield strength unless otherwise approved.
- 4.4 The Engineer will monitor the pressure gauge to verify the anchor load is holding the load for 10 minutes at the Test Load. Adequate pressure will be maintained on the pressure gauge.
- 4.5 The Contractor or Subcontractor to submit all lift off testing results at the end of the day of the testing.

5 Slope Mesh Requirements
- 5.1 Slope Mesh will be 8x10 Double Twist wire.
- 5.2 Mesh will be placed on slope side of cable net during initial installation and folded over the top back down the slope.
- 5.3 Lift off load is 20 kips per anchor, perform testing of 20% of total anchors.
- 5.4 See Special Provisions for specific requirements.

6 Soil Nail Requirements
- 6.1 Soil Nails will be #10 all thread bar, Grade 75 conforming to ASTM A615.
- 6.2 Perform one lift off test on one vertical soil nail at each concrete foundation.
- 6.3 Lift off load is 70 kips per soil nail on vertical elements (not to exceed 80% of yield strength).
- 6.4 See Special Provisions for specific requirements.

7 Ground Anchor Requirements
- 7.1 Ground Anchor Wire Ropes will be galvanized per ASTM A475 and meet wire rope specifications per ASTM A1023/A.
- 7.2 Perform lift off tests on 25% of uphill ground anchors and 100% on lateral ground anchors.
- 7.3 Lift off load is 70 kips per ground anchor (not to exceed 80% of breaking strength).
- 7.4 See Special Provisions for specific requirements.

8 Design and Maintenance Assumptions
- 8.1 The Rockfall Fence System is based on the testing protocols of the European Assessment Document EAD 340059-00-0106 which replaced the previous guidelines of ETAG 27 and NCHRP 24-35.
- 8.2 The slope mesh design was based on "Design Guidelines for Wire Mesh Cable Net Slope Protection",WA-RD 612.2, April 2005. The systems were designed for a maximum rock diameter of 2.5 feet (1350 lbs) at a maximum rock impact velocity behind mesh of 10 fps to be contained in a catchment ditch.
- 8.3 Rockfall and rockfall events are sporadic and unpredictable. Causes can include but are not limited to factors such as animal, human, construction, environmental, weather, and/or earthquakes. Because of the multiplicity of factors affecting rockfall dynamics, rockfall prediction is not an exact science and the absolute safety of individuals and property cannot be guaranteed.
- 8.4 Periodic inspection and maintenance of rockfall mitigation systems are necessary to ensure the desired protection level is not degraded by impact damage which exceeds the design limits of the system, including but not limited to extremely wet snow avalanches or large debris flow events.

9 Special Notes for all Rockfall Mitigation Systems in Plans
- 9.1 The Contractor is responsible for job site safety during construction. Scaling and installation of mitigation systems is the responsibility of the Contractor to adhere to Federal and State Requirements.
- 9.2 Variable slope angles, obstructions, or other conditions can affect anchor placement conditions. The contractor is responsible for correctly locating wire rope anchors such that the locations are compatible with the rockfall mitigation system shown on the plans and so that proper bearing rope and retaining rope to anchor connections can be made.
- 9.3 Ground conditions may include soil, boulders, and bedrock.

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