

Historic Renovation Micropiles Support New Red Rocks Canopy

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Creation Rock and Dinosaur Ridge



Birth of an Amphitheatre



Red Rocks Site



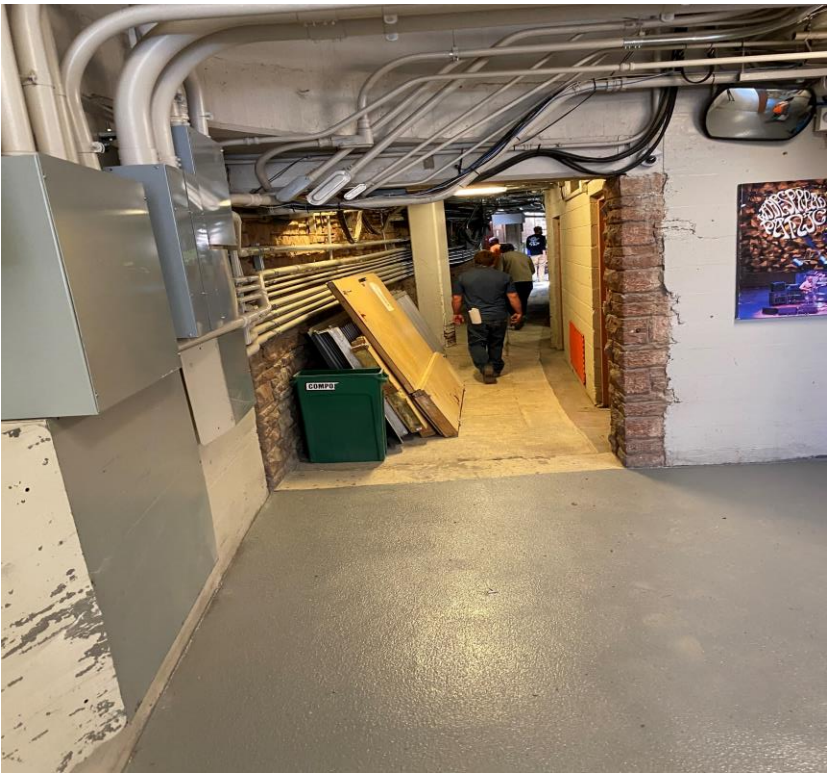
1988

Stage Roof

2021



Site Access



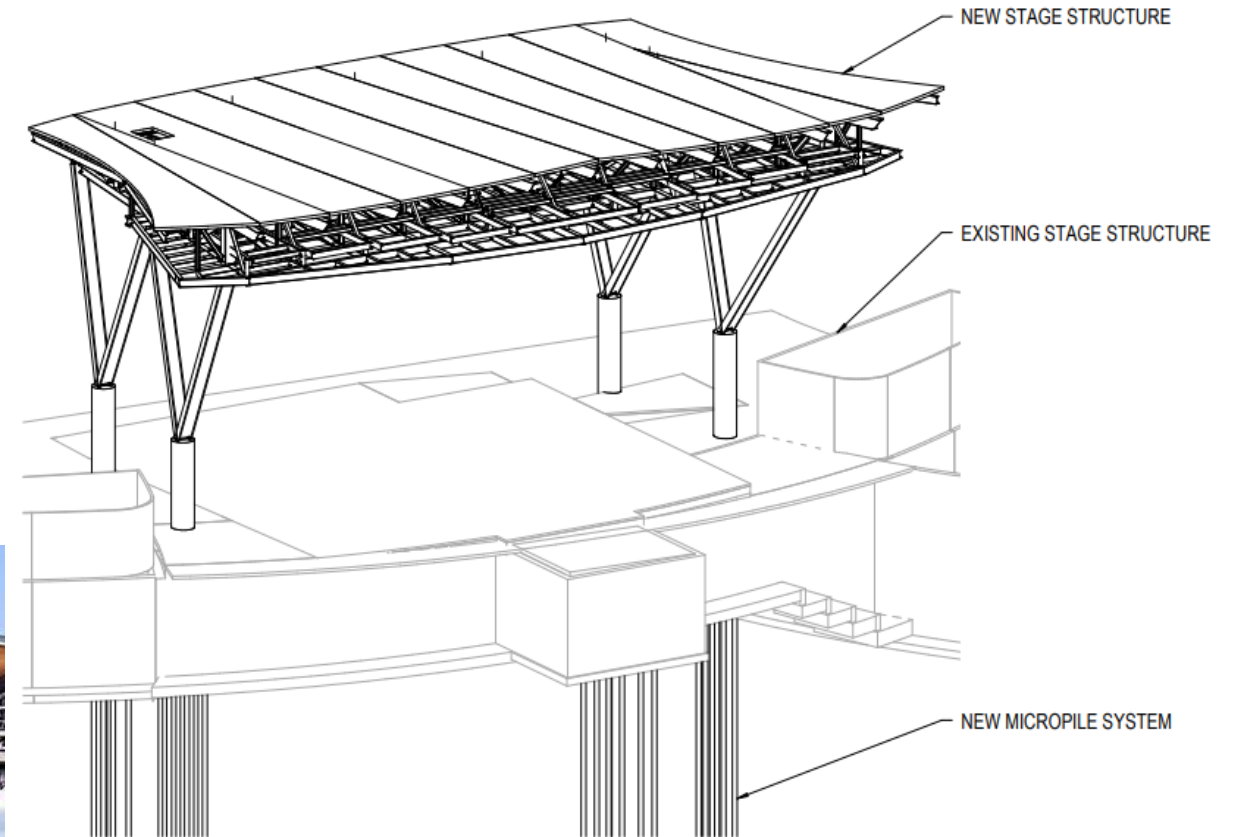
An architectural floor plan is shown with various drafting tools. A pair of compasses is on the left, and a grey pen with its cap off is on the right. Two markers, one orange and one green, are at the top. A ruler is partially visible. The drawing includes a large room with a dashed circle and the text 'malični prostor', a smaller room with a grid pattern and the text 'kafica amfiteatrov klub', and a staircase area. Dimensions and grid lines are also present.

Project Overview / Design

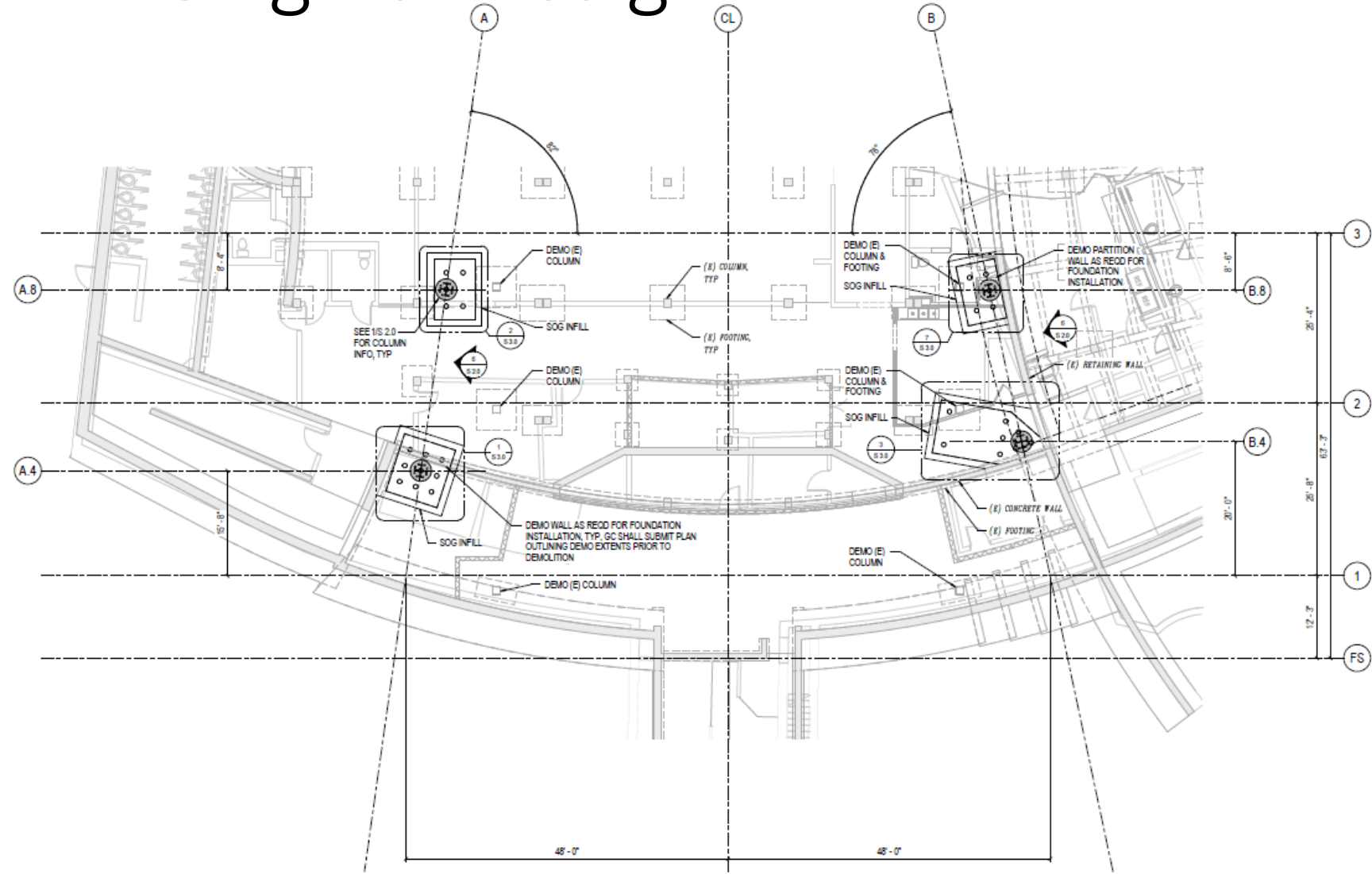
New Canopy Design



Photo courtesy of Colorado Construction & Design



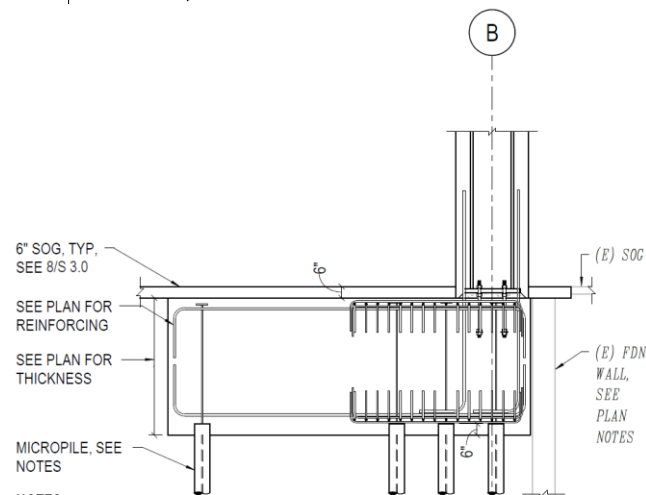
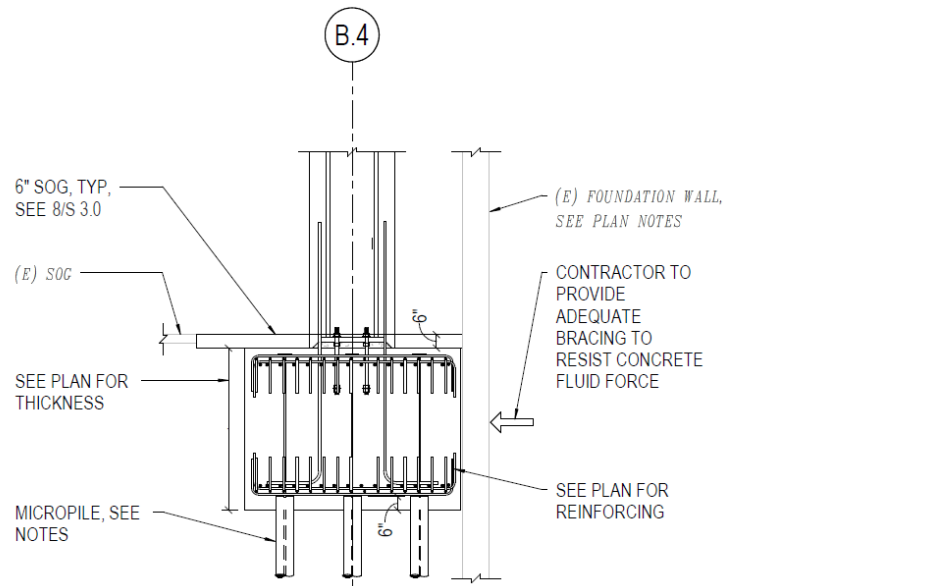
Original Design



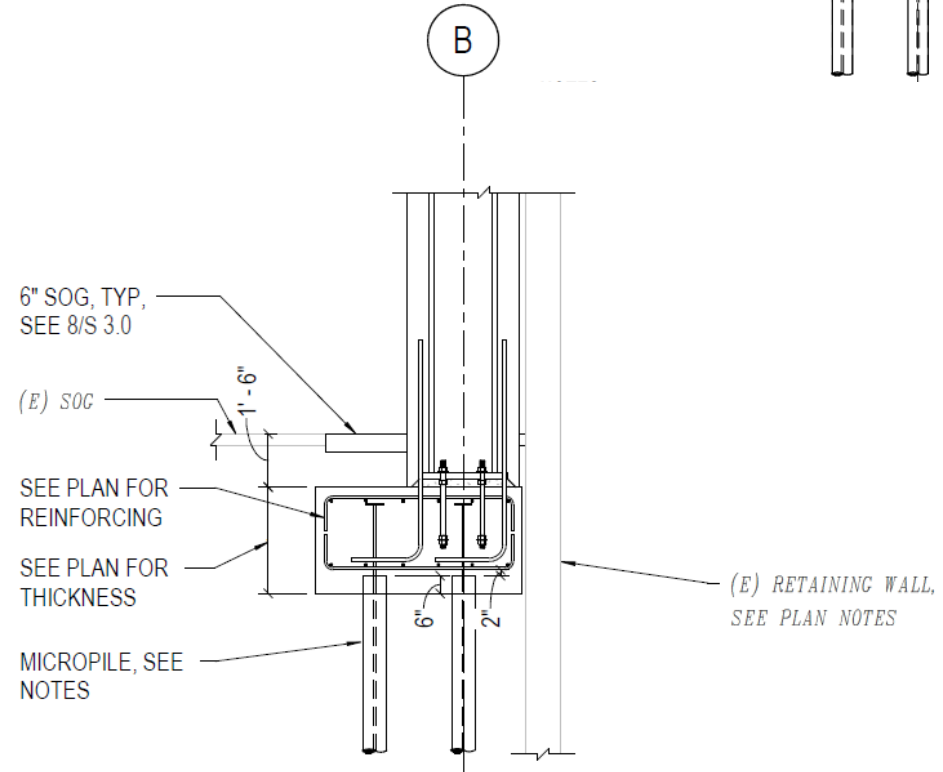
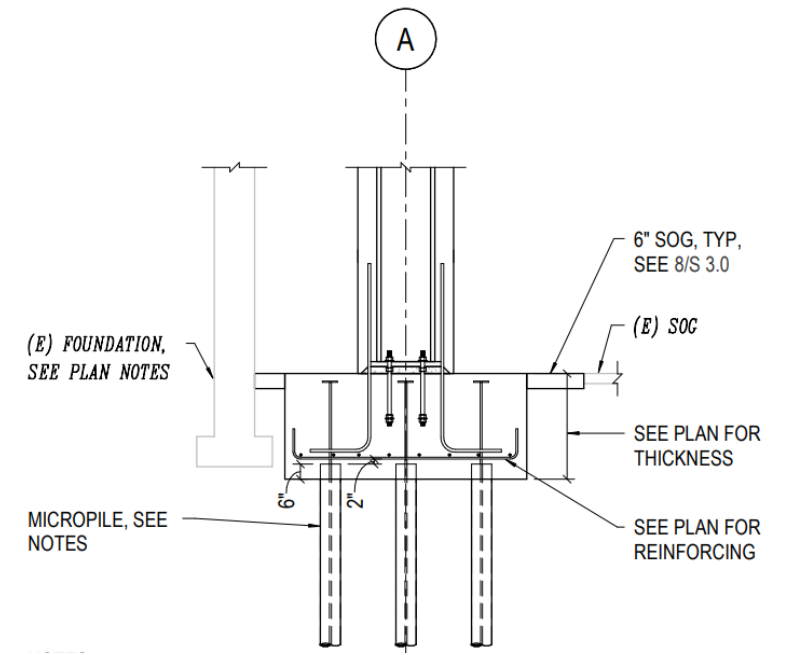
- Pile loads varied from:
 - Compression:
 - 90 kip – 160 kip
 - Tension:
 - 30 kip – 60 kip



Space Constraints



NOTES:
 1. MICROPILE DESIGN BY CONTRACTOR, MIN AXIAL COMPRESSIVE CAPACITY 160k SERVICE. MIN AXIAL TENSILE CAPACITY 60k SERVICE



Testing Requirements - Performance



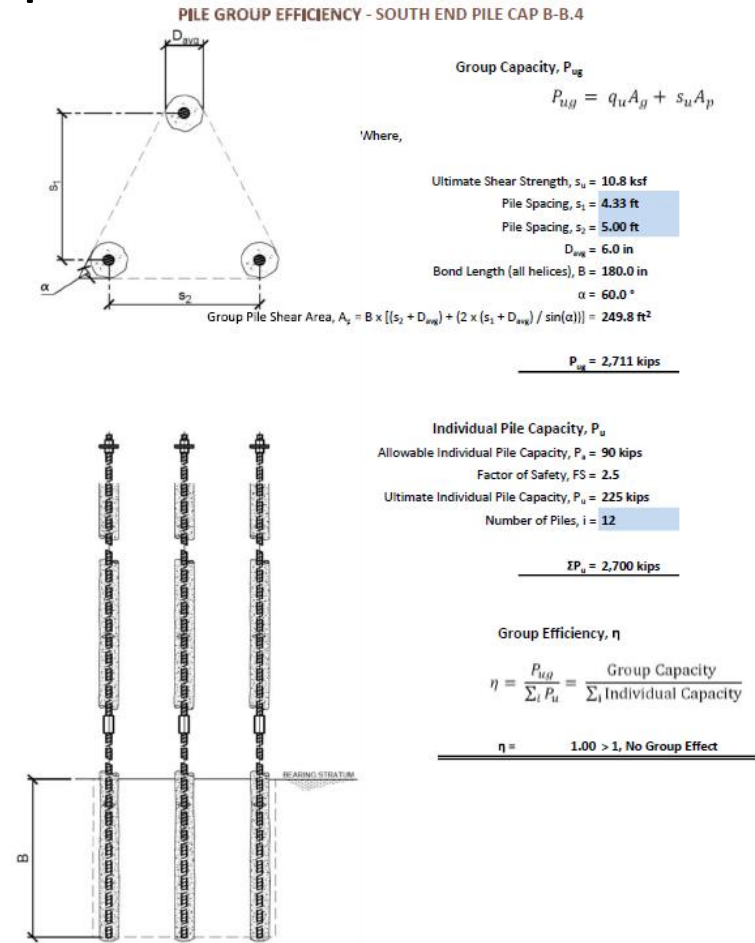
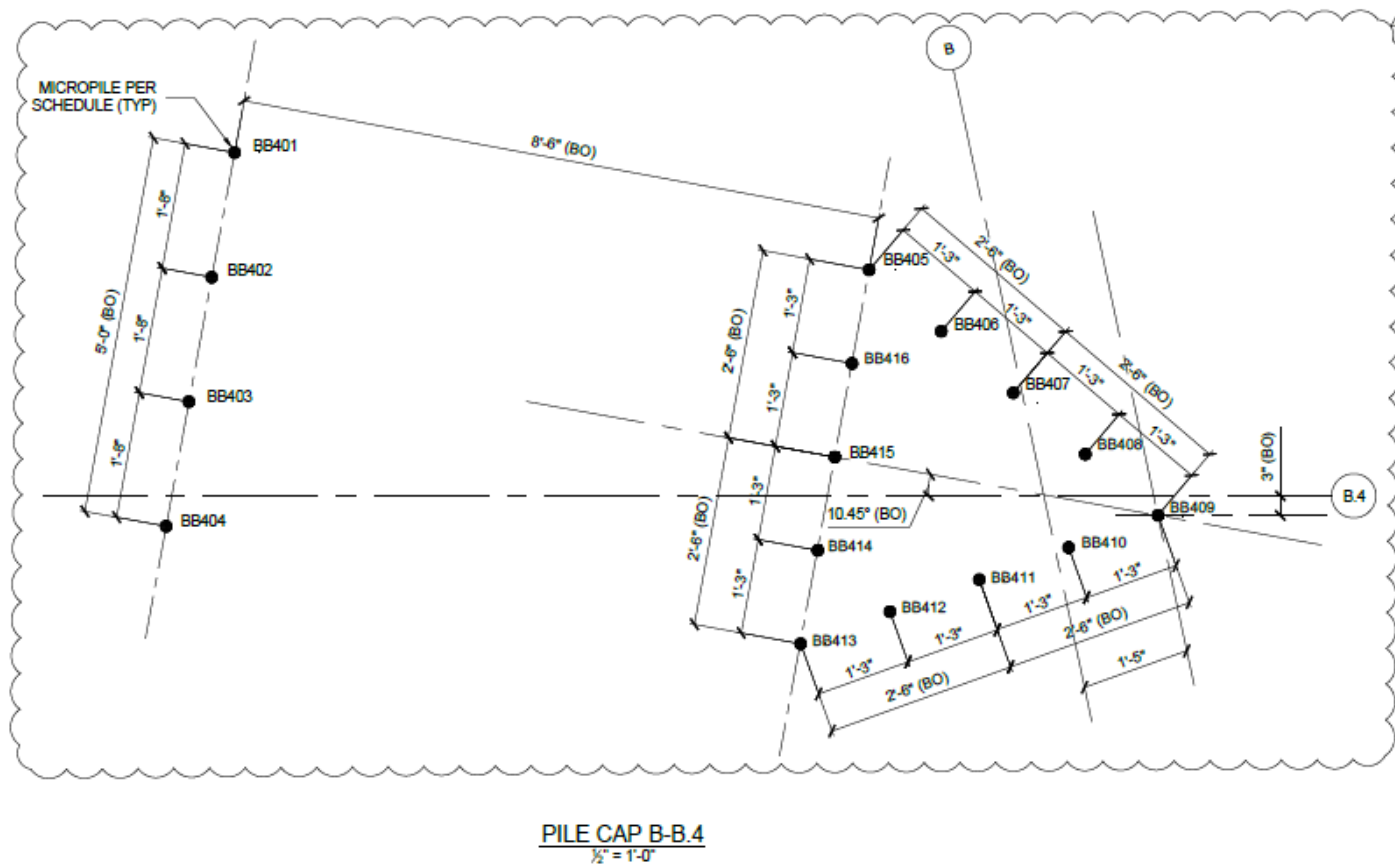
Testing Requirements - Proof

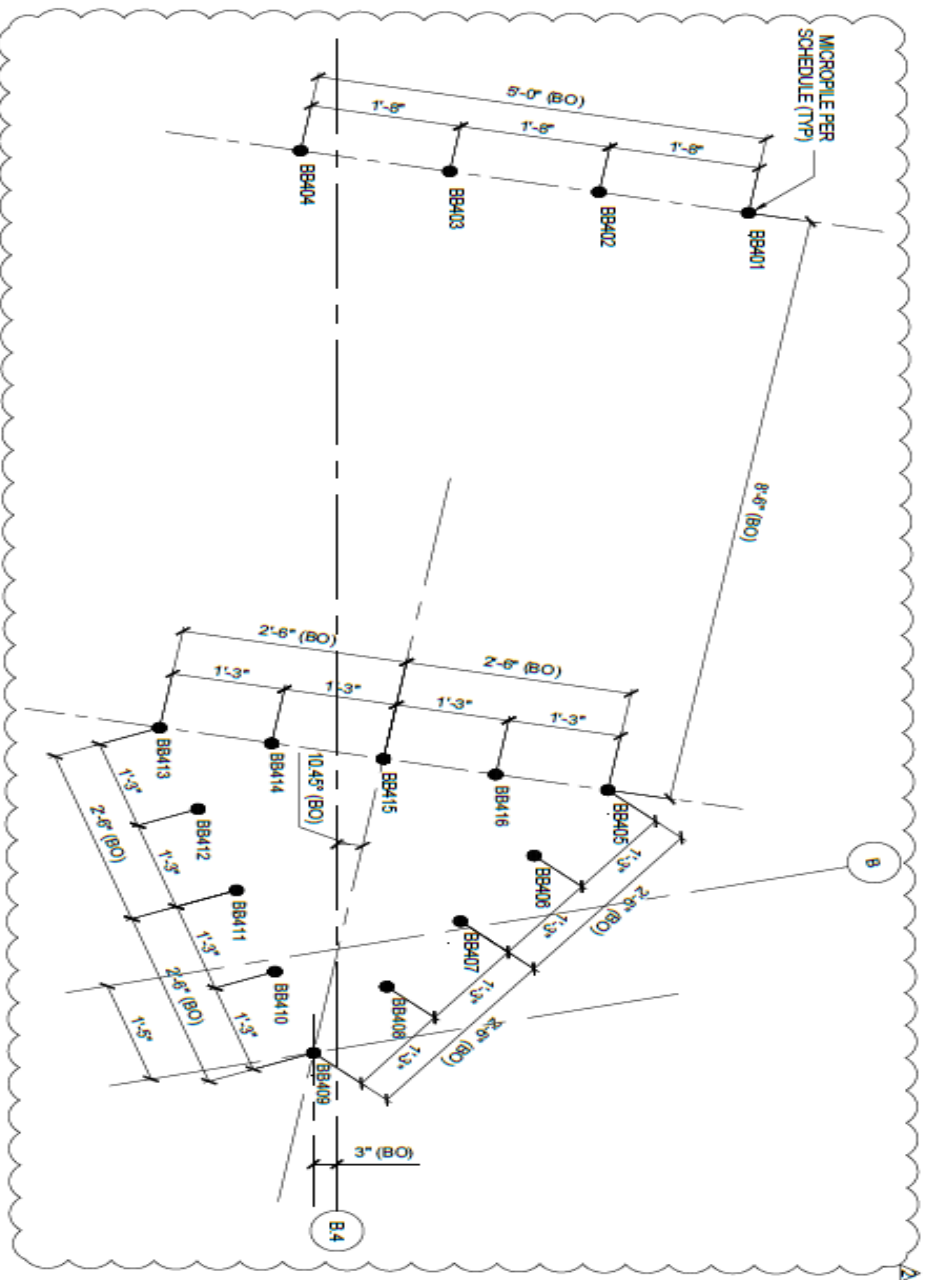
- Proof testing on production piles
 - Challenge to set up & manipulate beams in tight space
 - Limited beam size could be handled inside



Proposed One Lower Capacity Pile Type

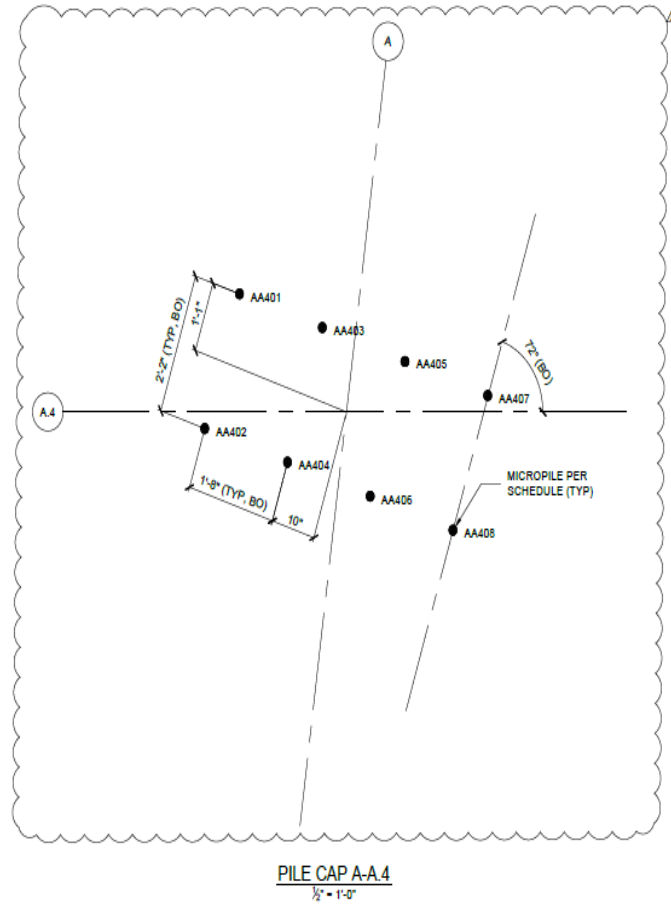
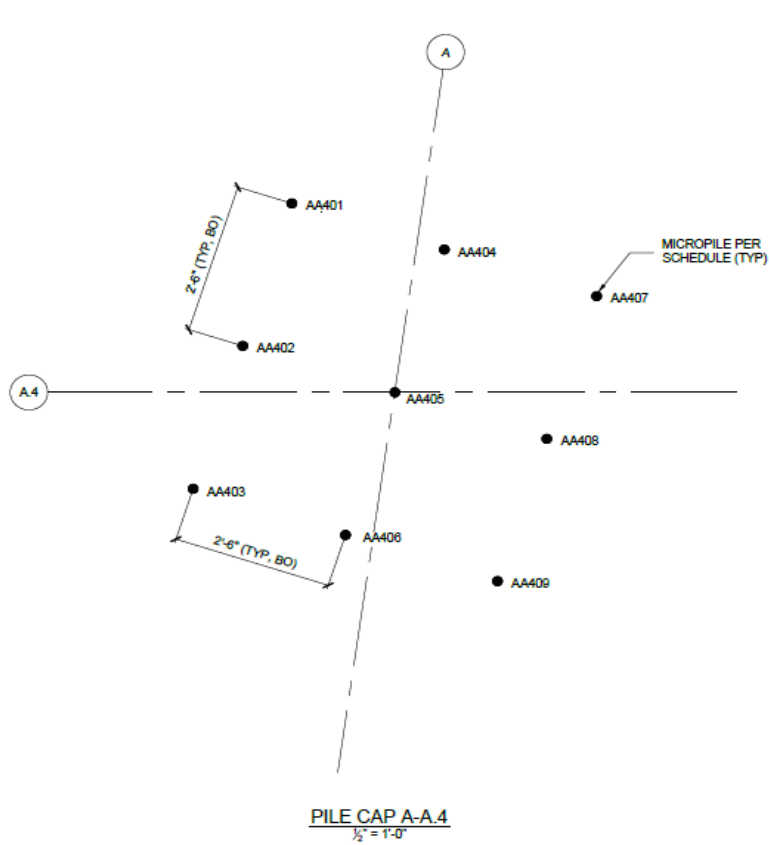
- Pile layout issues to fit enough lower capacity piles in original proposed footprint at higher loaded pile cap



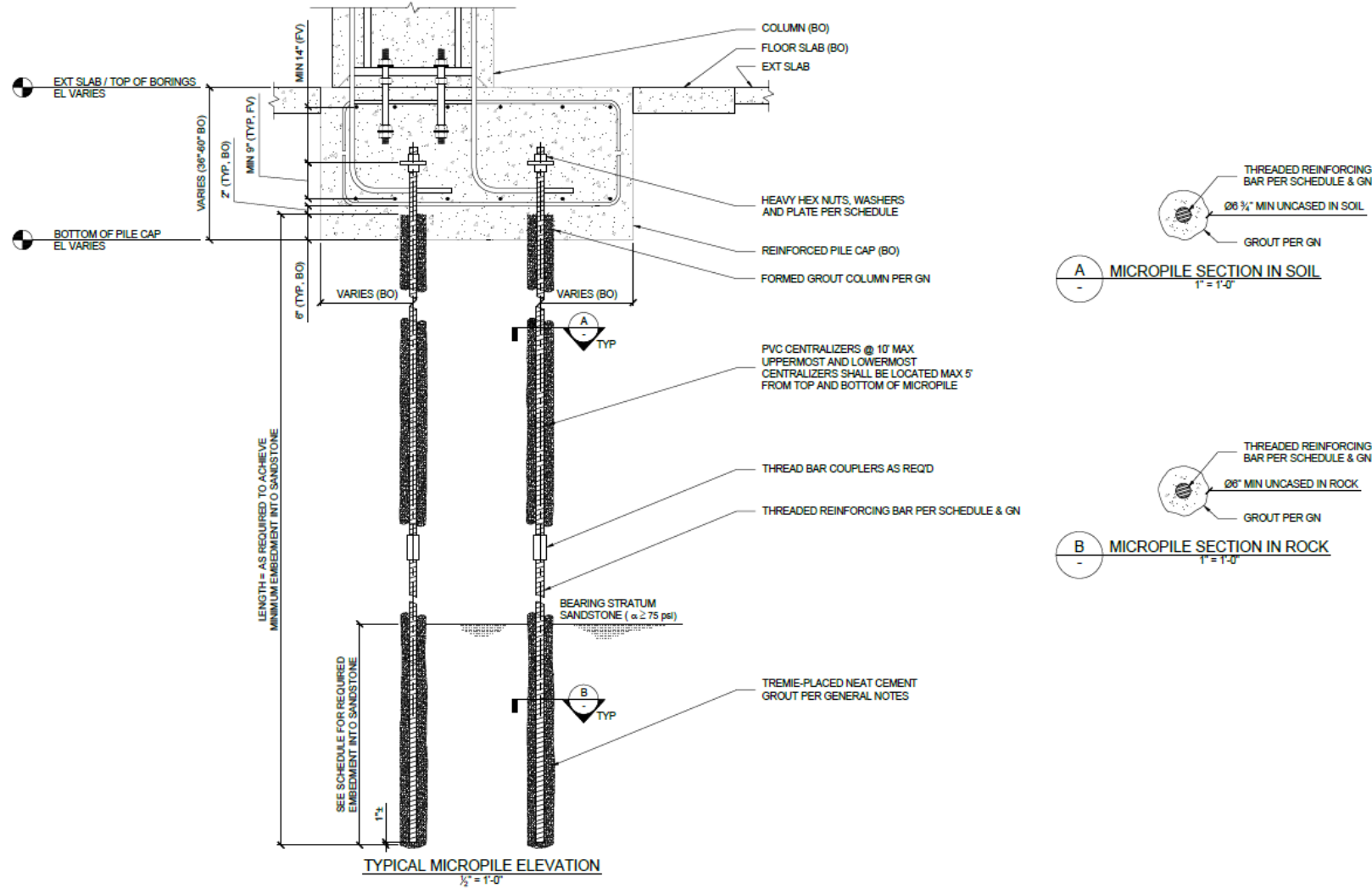


PILE CAP B-B4
1/2"=1'-0"

Existing Condition Challenges



Final Proposed Design

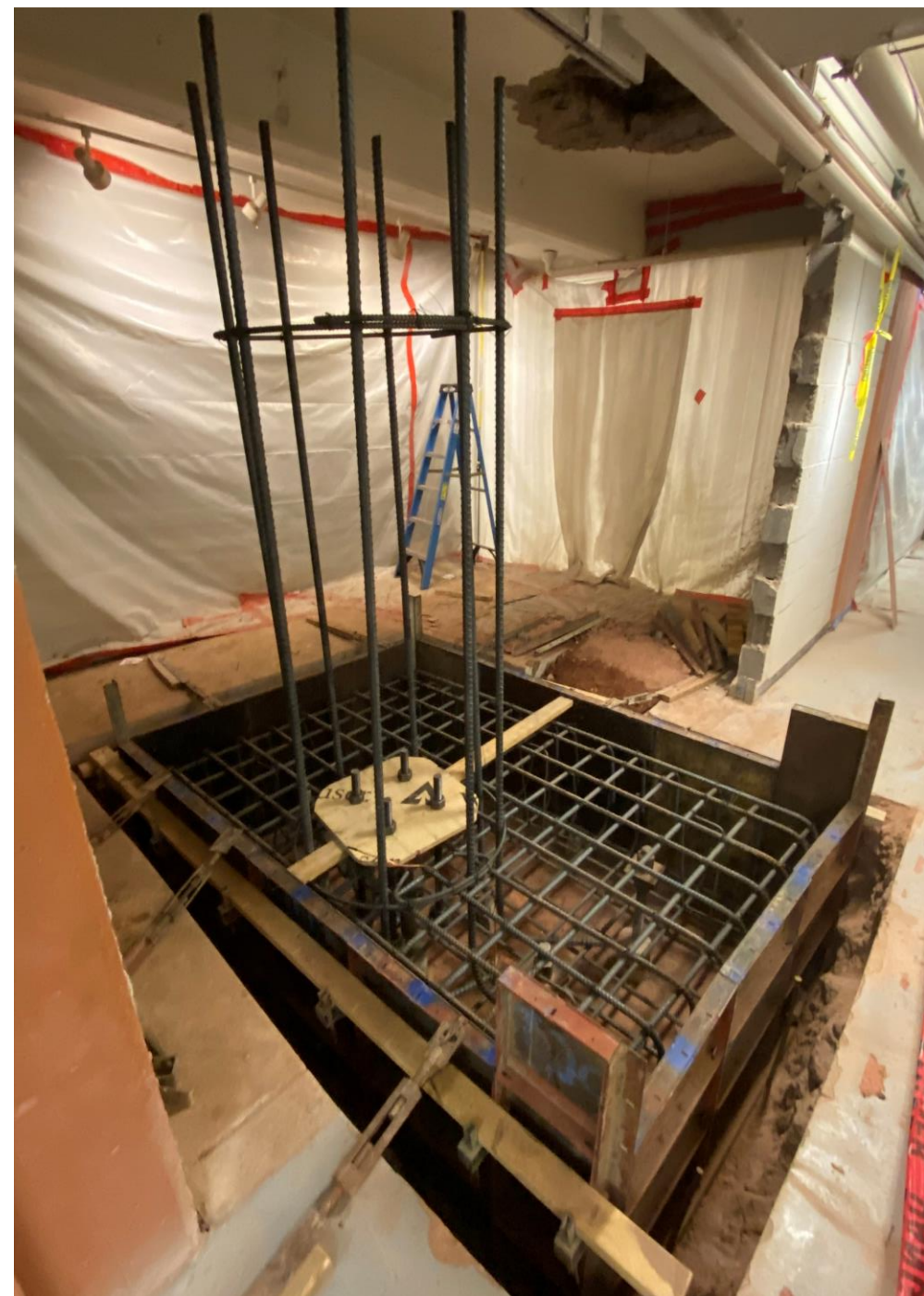


MICROPILE SCHEDULE

SYMBOL	PILE PROPERTIES		REQUIRED CAPACITY PER PILE		END PLATE & HARDWARE PROPERTIES		INSTALLATION CRITERIA	
	●	NUMBER OF PILES	34	COMPRESSION (kips)	90	DESIGNATION	PLATE	ANTICIPATED LENGTH (ft)
GROUT DIAMETER (in)		6 - 6.75	TENSION (kips)	30	DIMENSIONS (in)	6 X 6 X 1 - NG	MIN. EMBED. IN BEARING STRATUM (ft)	15
REINFORCING BAR		#14 GR 75 - NG	LATERAL (kips)	N.S.	NUTS & WASHERS	2 EA PER PILE	GROUT TAKE (ft ³ /ft)	0.18 - 0.23

Outcome

- Successful install
- Steel plates were right on per GC. Largest variance was 3/8 inch.
- Successful load testing & grout testing
- On schedule. Within Budget



Concrete Pile Cap





Micropile Installation Means and Methods



Micropile Installation Challenges

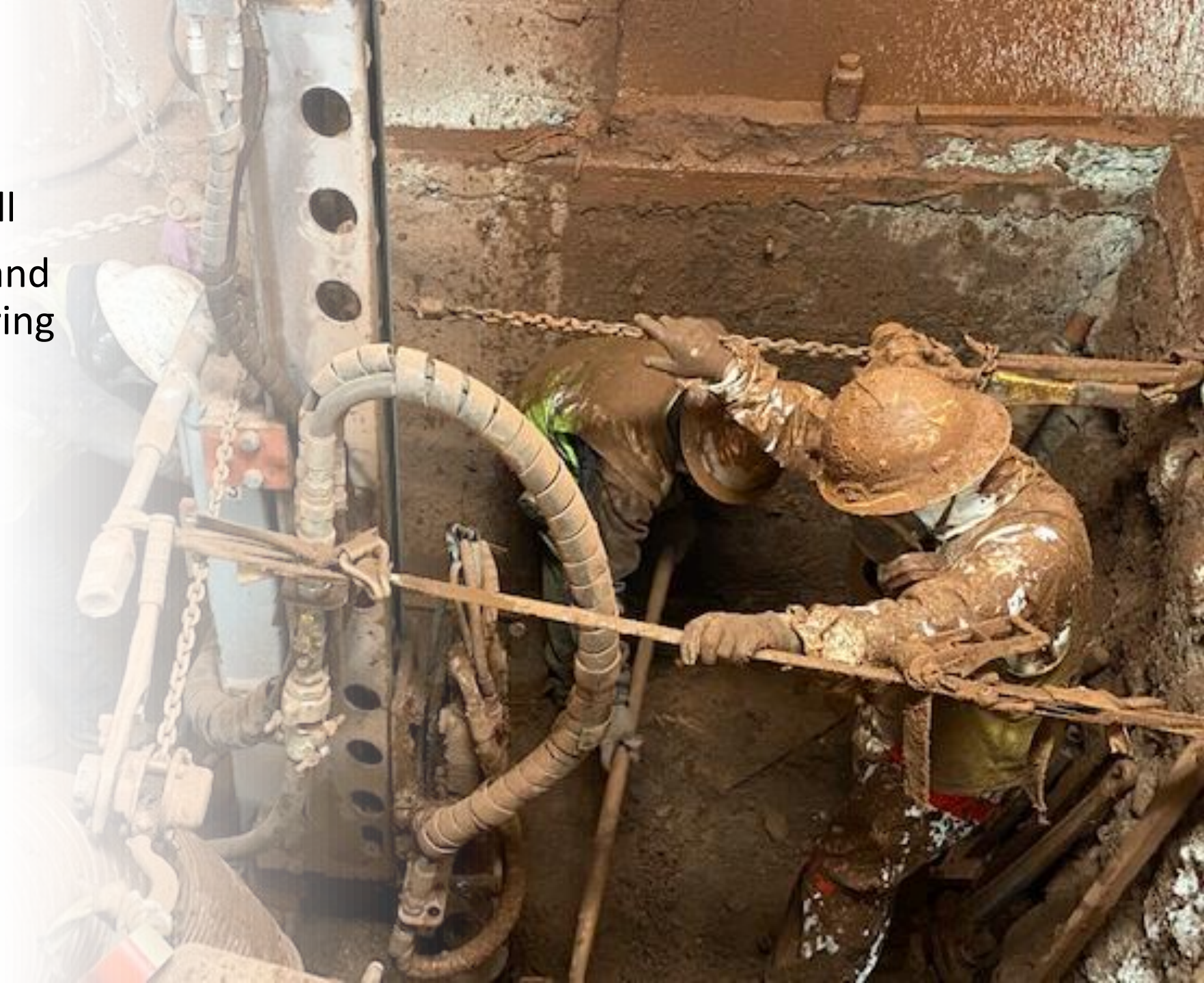
- Overhead clearance limits, narrow passages, tight corners
- Steep ramps with unknown capacity, at key access locations
- Air quality control
- Historic site protection and cleanliness
- Compressed schedule with concurrent contractors on site
- Covid environment
- Staging limitations for drill and grout, long distance hose routes
- Man portable equipment, no skid or lift
- Water and muck

Muck Management

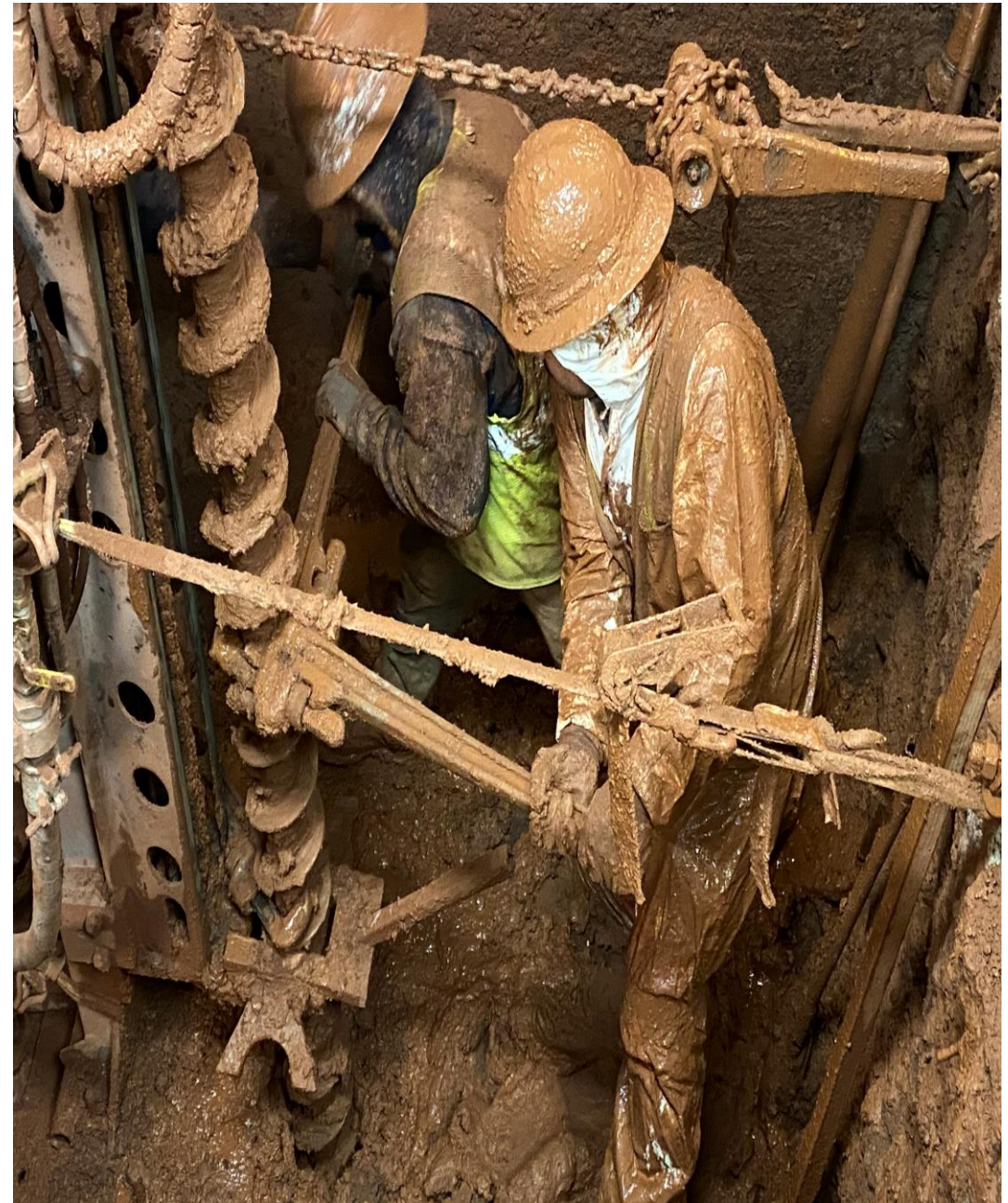
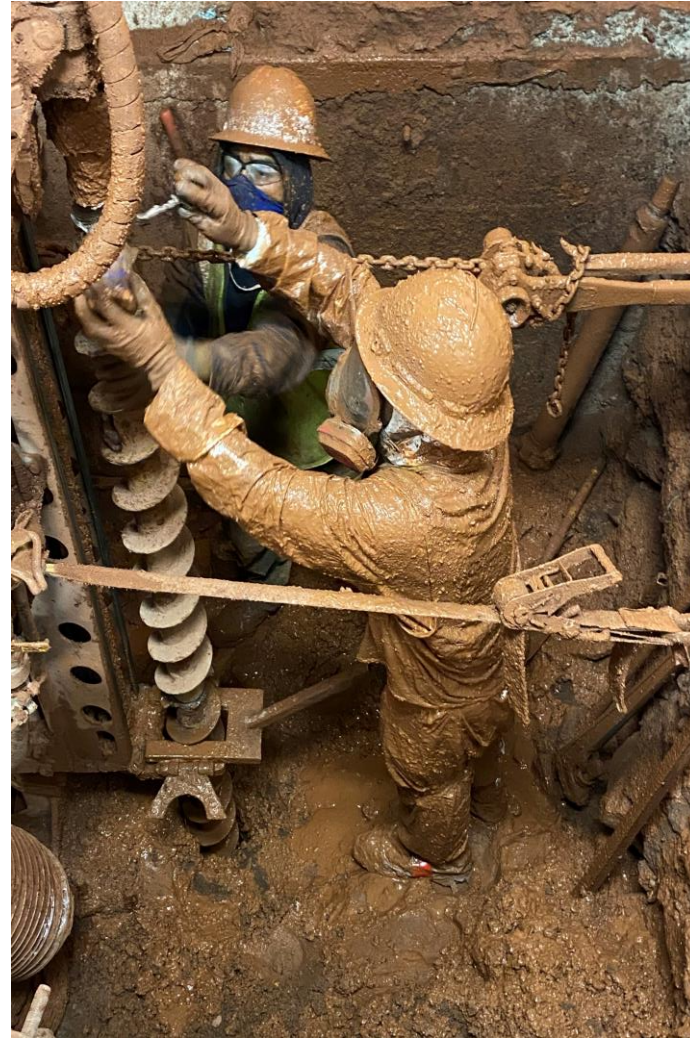


Pile Drilling

- TEI 350 with steel mast drill
- 6 inch piles; bit and auger and down hole hammer drill string
- Hole control
- Re drilling collapsed holes
- Drill spoils management
- Gantry crane
- Hoist
- Safety straps
- Crew Muscle and Attitude



Bit and Auger Drilling



Air Quality Controls and Drilling Site Protection



Red Rocks New Stage Roof Keys to Success



- Relationship between Engineering, Installer, General Contractor and Owner.
- Magnum GeoEngineering, Martin/Martin, Yeh & Assoc., Park Range Construction, GH Phipps, City of Denver
- Pre-Construction Planning
- Installation crew skill, creativity, and attitude
- Safety
- Equipment and tools

Thank You!

*Magnum GeoEngineering &
Park Range Construction
M/WBE, DBE & SBE Contractor*