

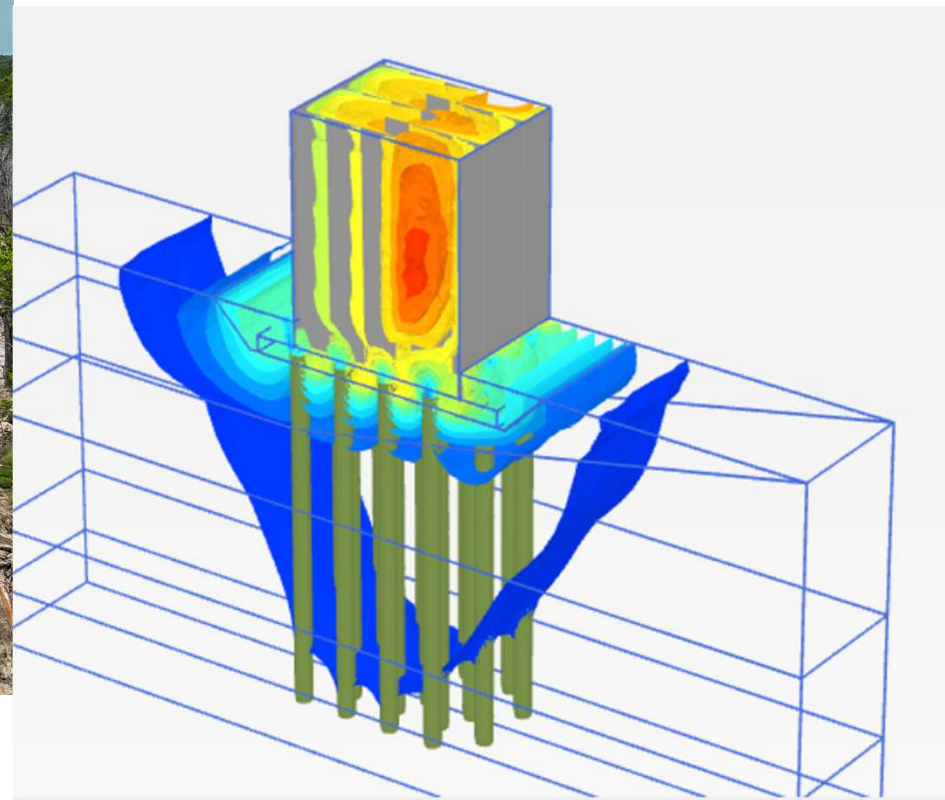
Rigid Inclusion Supported Rail Embankment on Soft Organics



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Venkata Muppana, P.E.
John Myers, P.E.







TRESTLE BRIDGE

WINONA DR

EVERGREEN AVE

CULVERTS

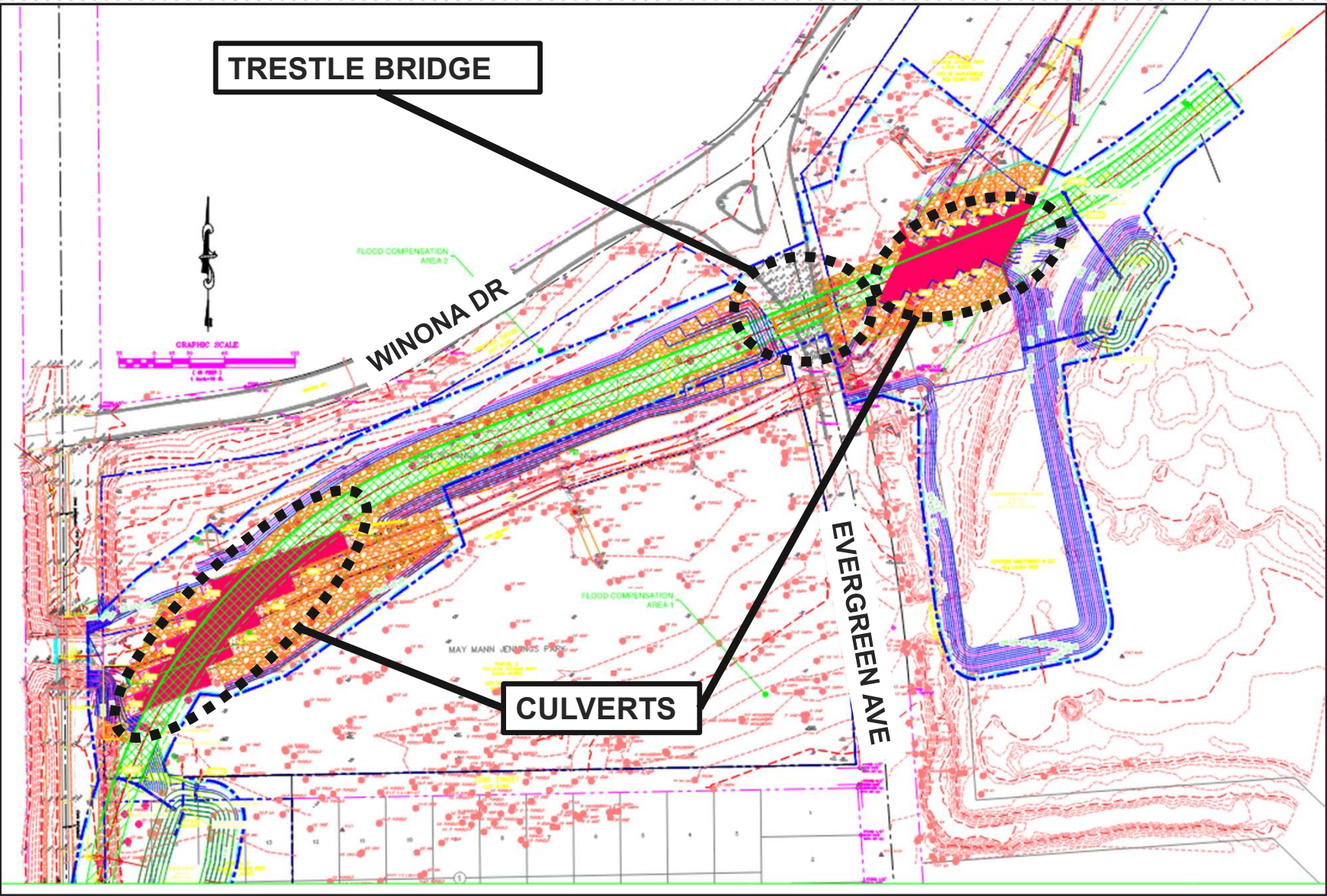
FLOOD COMPENSATION
AREA 2

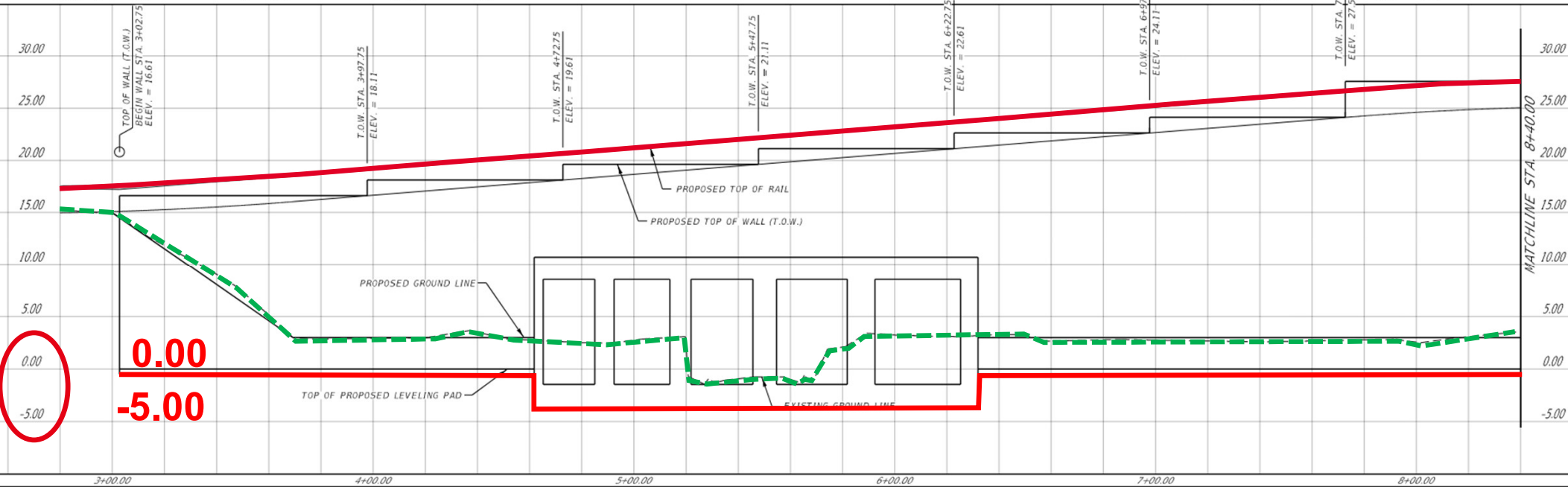
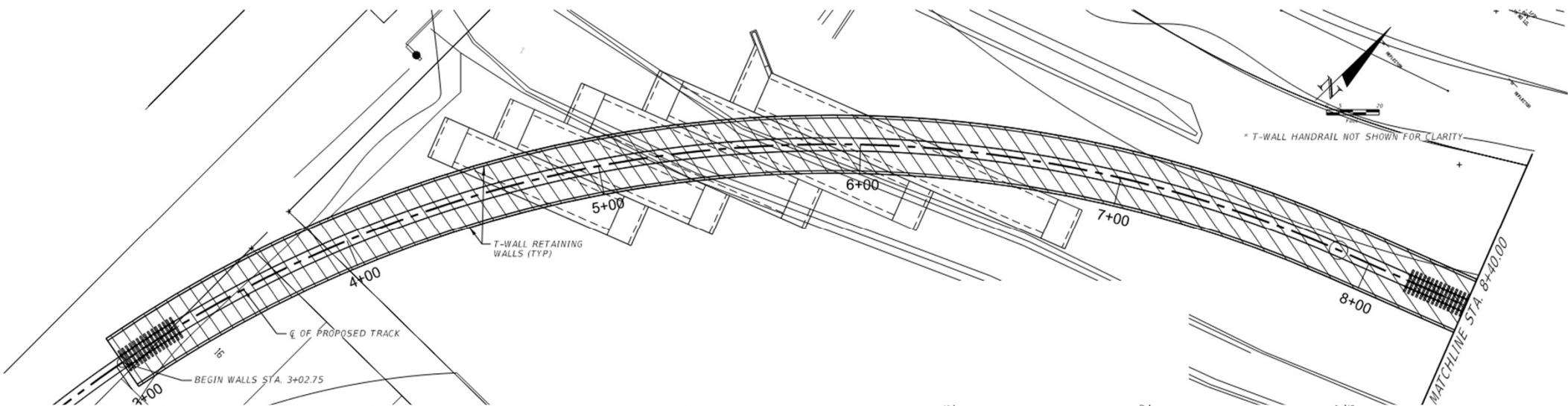
FLOOD COMPENSATION
AREA 1

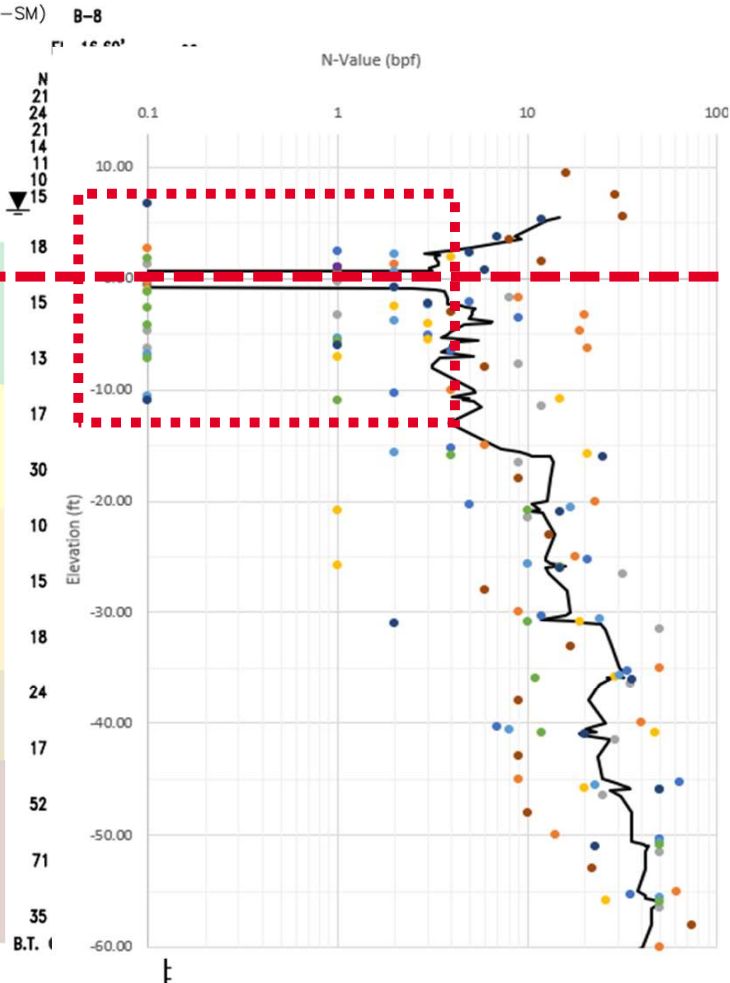
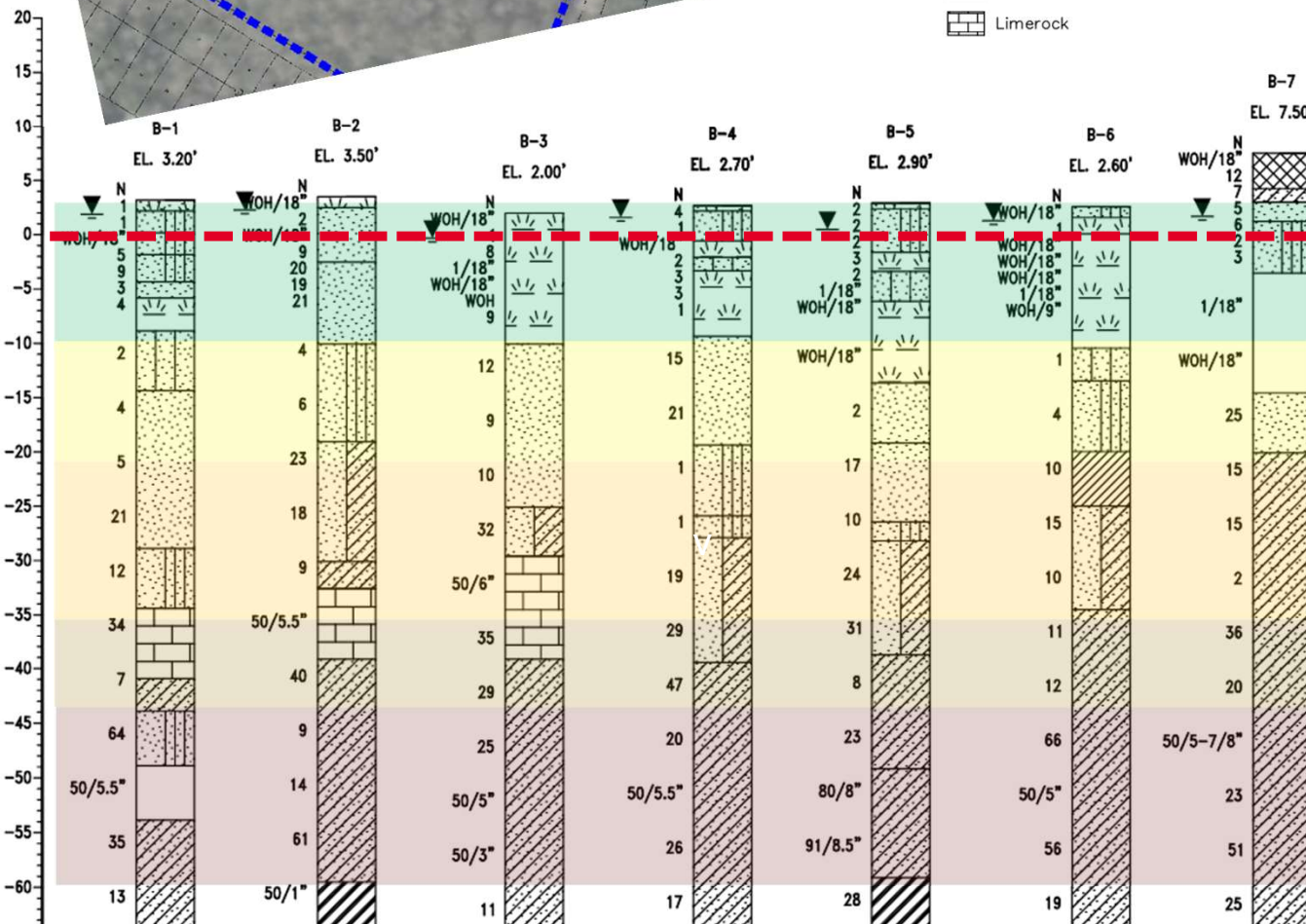
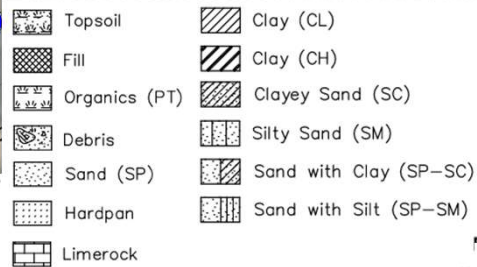
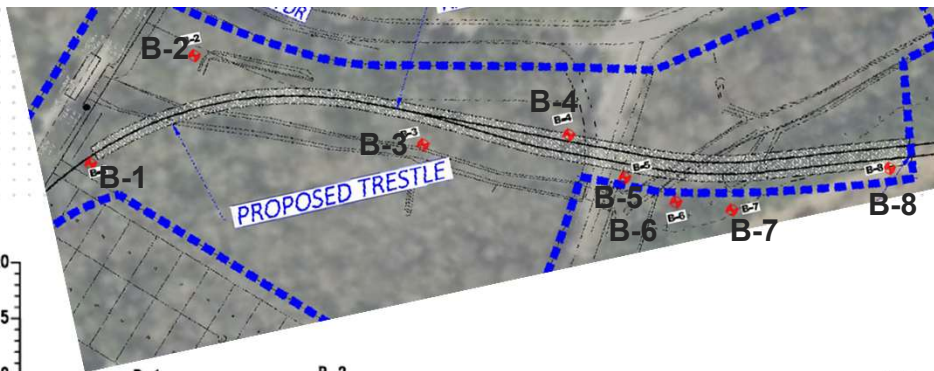
MAY MANN JENNINGS PARK

GRAPHIC SCALE

1" = 100' (H. 100')
1" = 100' (V. 100')







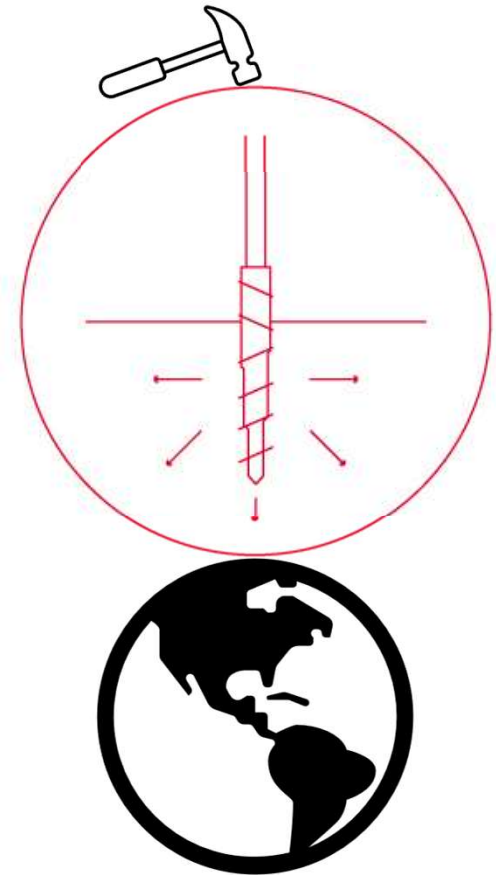
Controlled Modulus Columns*

*Rigid Inclusions



CMCs: Applications

- Very soft soils
- Very deep problematic soils
- Variable soil layers
- Can accommodate heavy loads
- Contaminated sites



CMCs – Applicable Soil Types



	V. SOFT CLAYS/ ORGANICS/PEAT	CLAYS/SILTS	SILTY SANDS/ SANDY SILTS/FILLS	SAND/GRAVEL
GROUND IMPROVEMENT TECHNIQUE	VERTICAL WICK DRAINS / VACUUM			
		STONE COLUMNS / AGGREGATE PIERS		
		DYNAMIC REPLACEMENT		
			DYNAMIC / RAPID IMPACT COMPACTION	
				VIBROCOMPACTION
				EQ DRAINS
		DEEP SOIL MIXING		
	CMC RIGID INCLUSIONS / BIMODULUS COLUMNS			

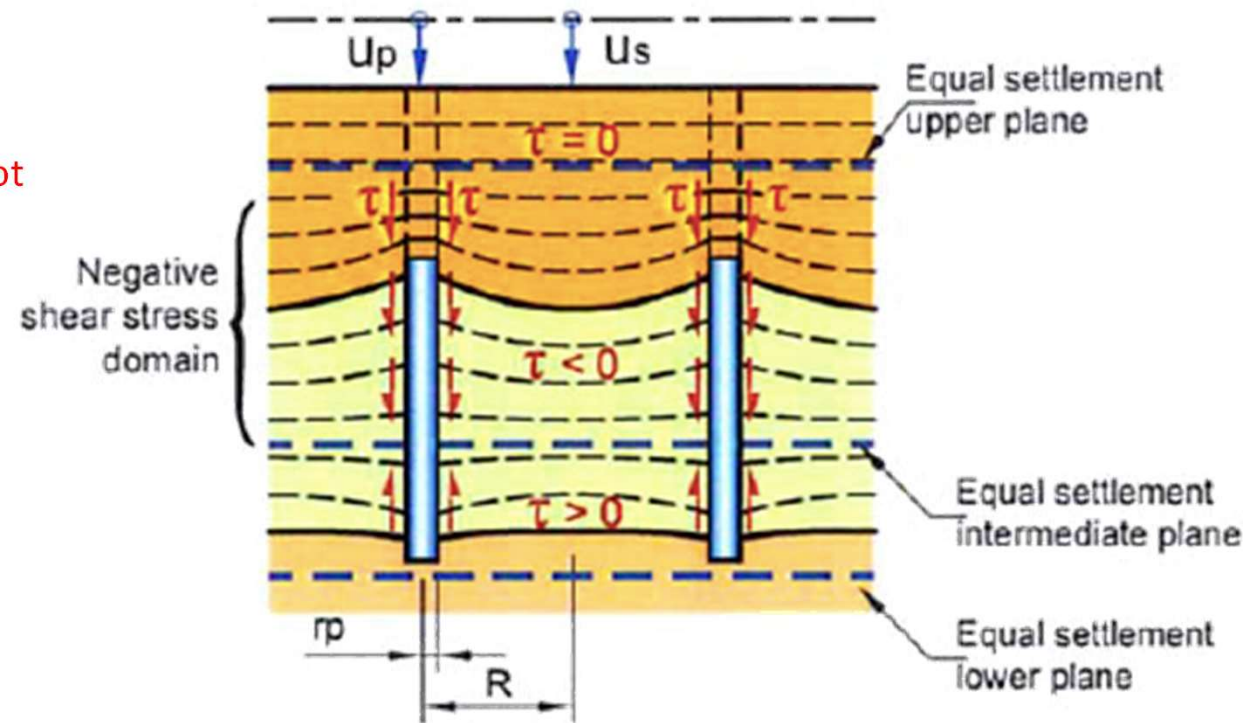


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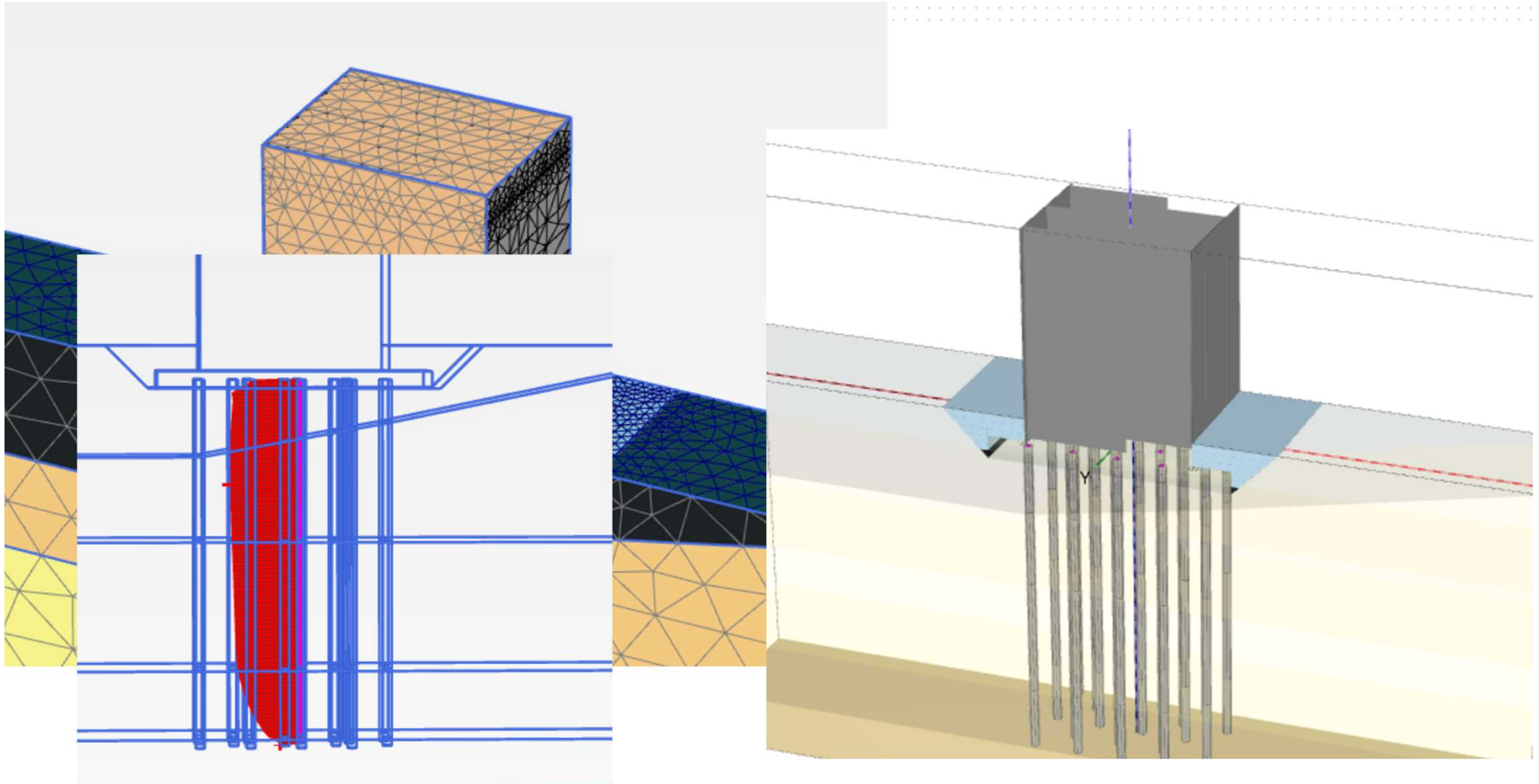
Controlled Modulus Column (CMC)TM – Rigid Inclusions

Why is it complex?

- The calculation of settlements for a structure supported by a network of rigid inclusions is not as straight-forward as the case of granular inclusion or simple, unimproved soil
- The ratio of moduli is several orders of magnitude different...
- No strain compatibility =>
 - Complex soil-structure interaction
- Service limit state calculations not easily completed by hand

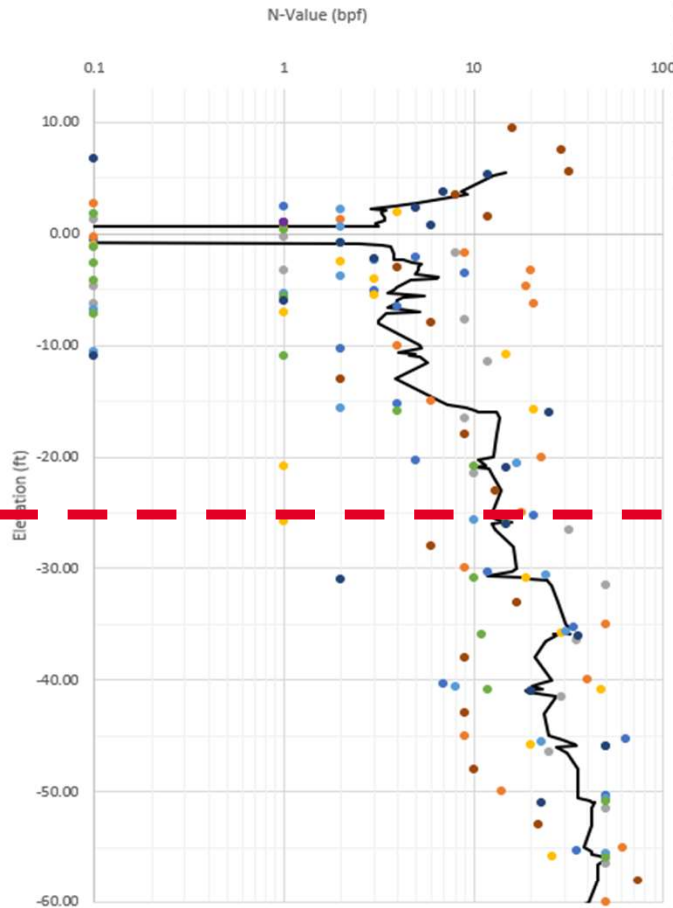


How do we analyze such a complex system?

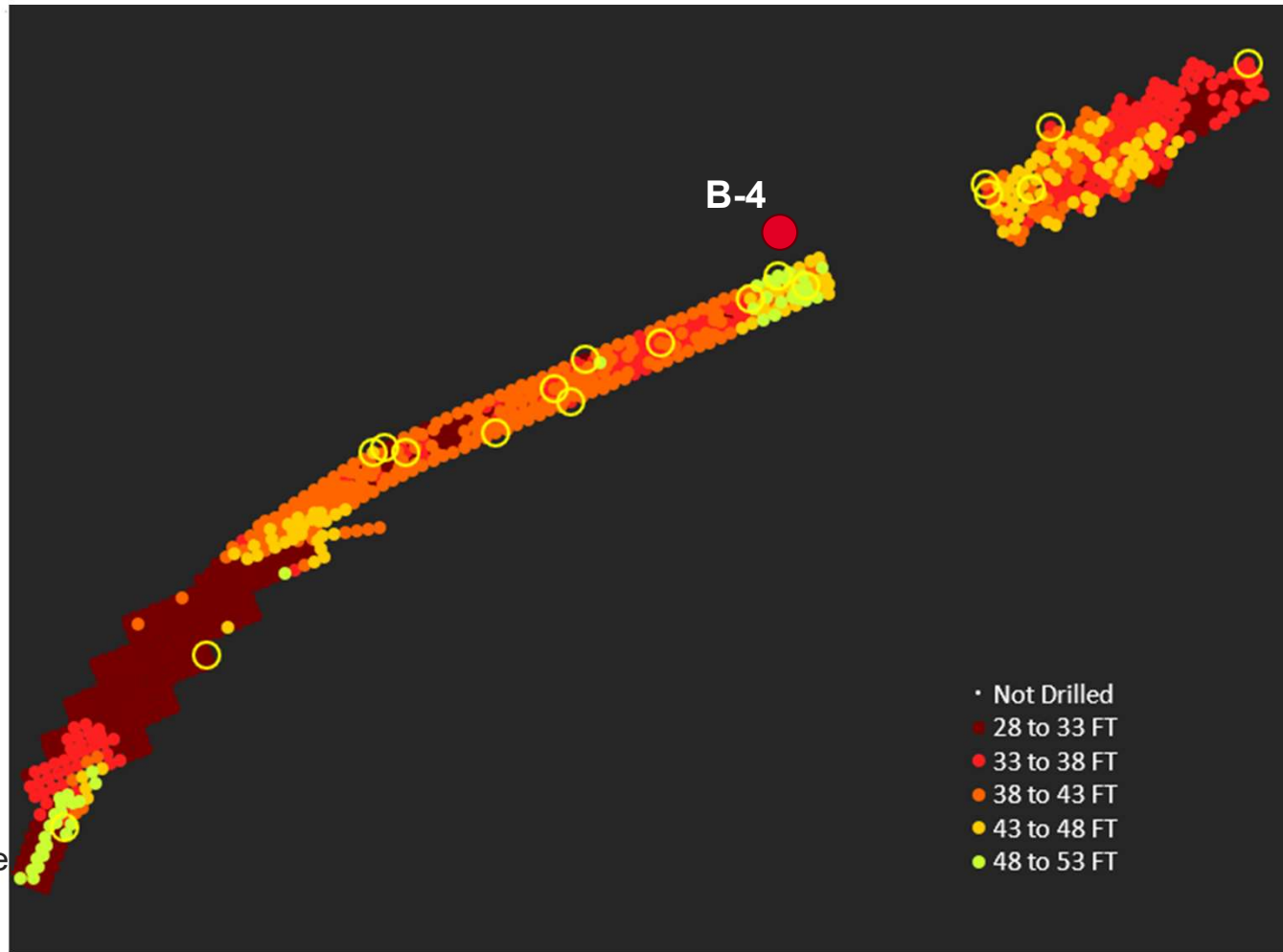




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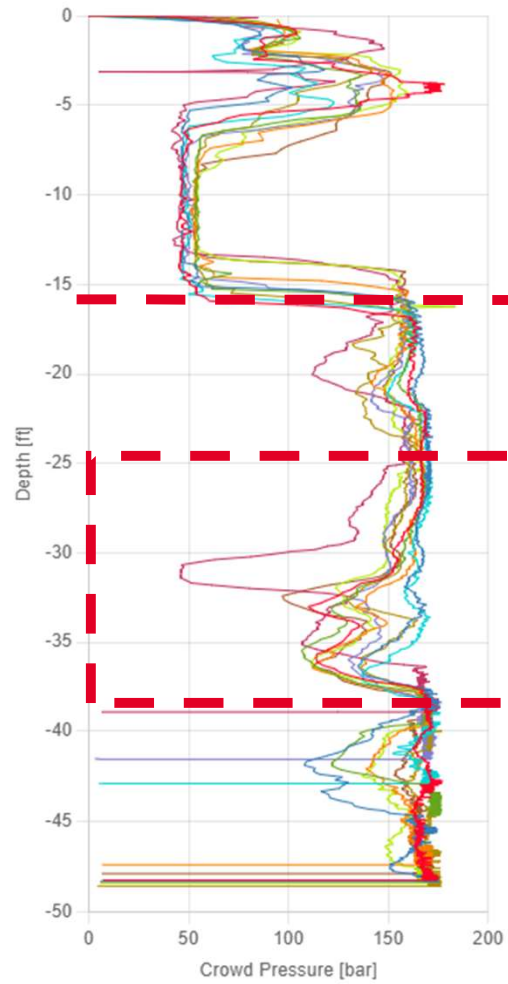


- Minimum depth of 30 ft
- 2 ft embedment of high rotary head pressure
- Every 10 columns, attempt to install deeper to verify no risk of “punching” through bearing layer

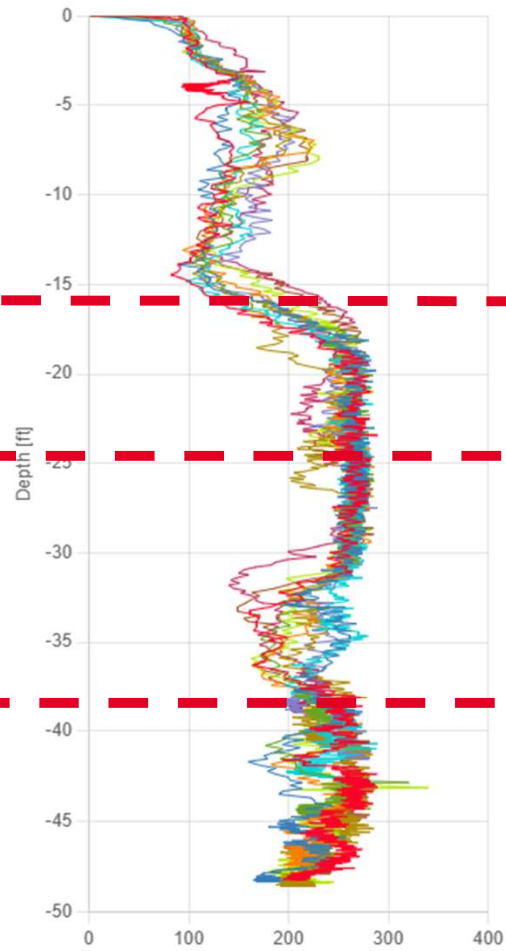




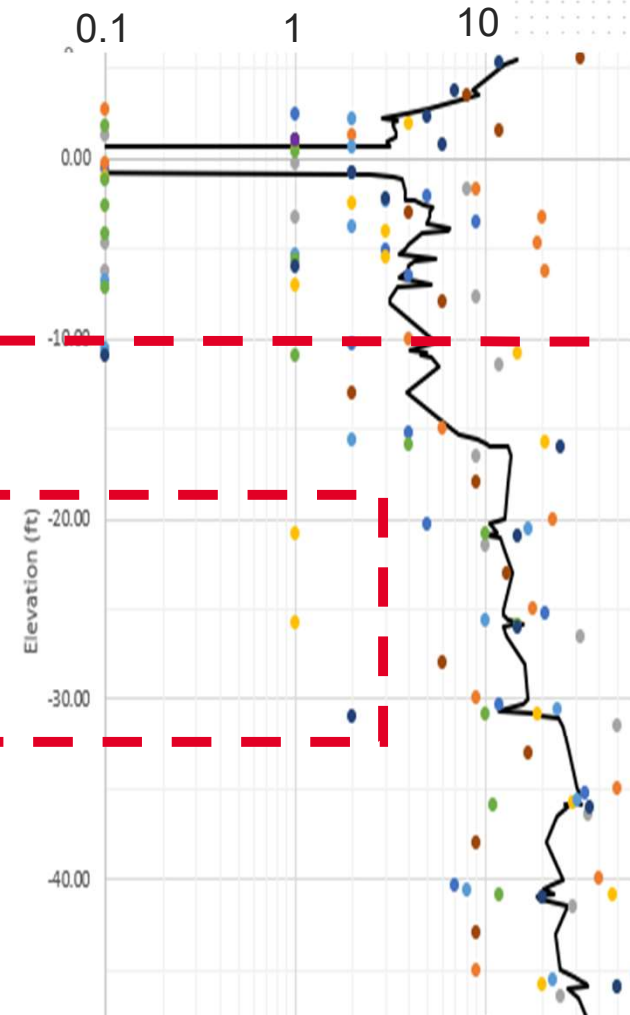
Crowd Pressure



Torque Pressure

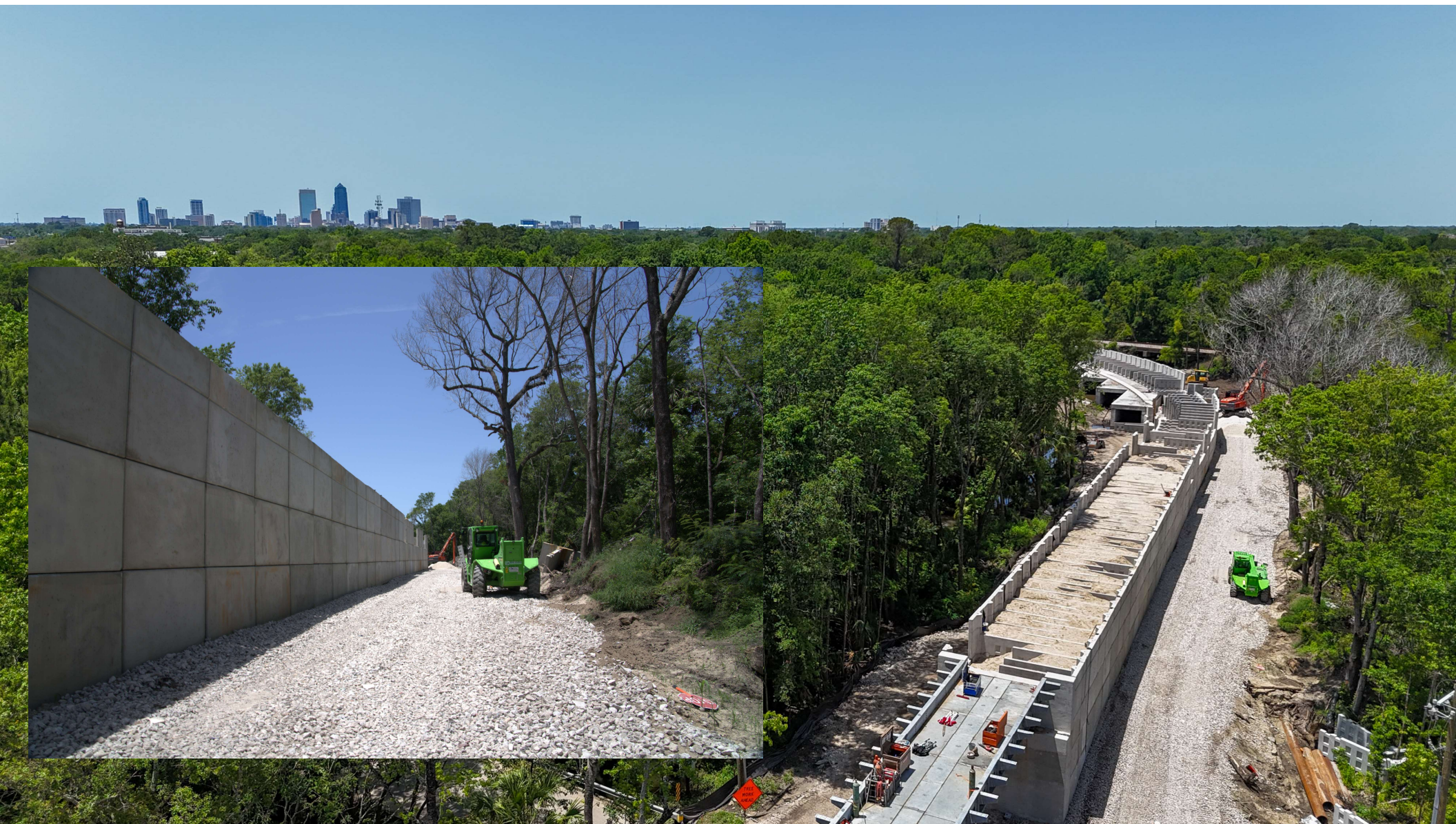


Blow Count, N60 (bpf)











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Wednesday, September 24, 2025

Last Call!

Limited Spots Remain!

Earn 5 PDH credits!



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