





Underground Lessons Learned: Unlocking the Benefits of Geotechnical Baseline Reports

Rick Smith, P.E. / March 19, 2025

Schnabel ENGINEERING

Build Better. Together.

No construction project is risk free. Risk can be managed, minimized, shared, transferred or accepted. It cannot be ignored.

Sir Michael Latham, 1994

Introduction

- What is a Geotechnical Baseline Report
- Benefits of Geotechnical Baseline Reports
- Key Elements of Geotechnical Baseline Reports
- Case Histories
- Lessons Learned
- Future Trends





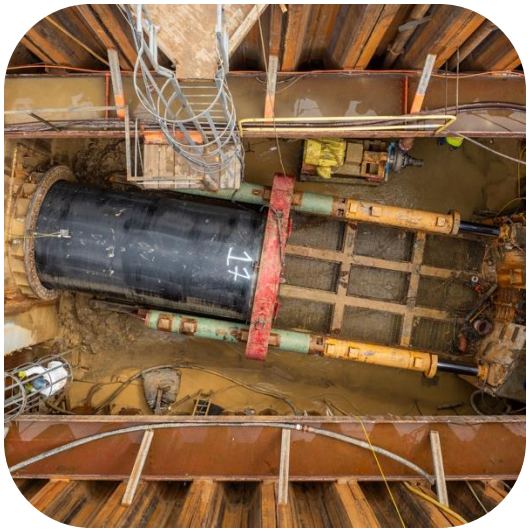
What is a Geotechnical Baseline Report?

The Geotechnical Baseline Report is the contract vehicle to tell the Contractor everything they need to know about the existing ground conditions and behaviors to be successful at building the job, for no more cost, and in no more time, than necessary.

Dr. Gary S. Brierley

What is a Geotechnical Baseline Report?

- A Contract Document
- An interpretation of subsurface conditions that are contractually binding
- A document that bidders can rely on to select means and methods, and set a price and schedule
- A risk allocation document





What is a Geotechnical Baseline Report?

- An aid to resolving differing site condition claims
- An explanation of requirements/constraints of the Project (at least as they relate to ground conditions)
- GBR shall lie high in the Order of Precedence
  - Contract/General Conditions & Addenda
  - Specifications
  - Drawings
  - GBR
  - Geotechnical Data Report (Factual data only!)



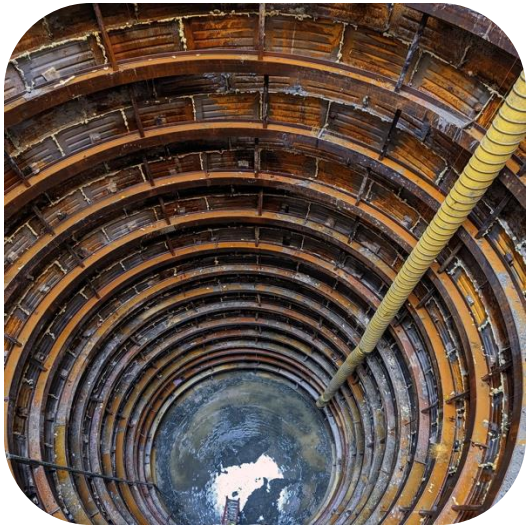


What is a Geotechnical Baseline Report?

A GBR is NOT

- A geotechnical engineering report
- A warranty that baseline conditions will be encountered
- A means to unfairly allocate risk

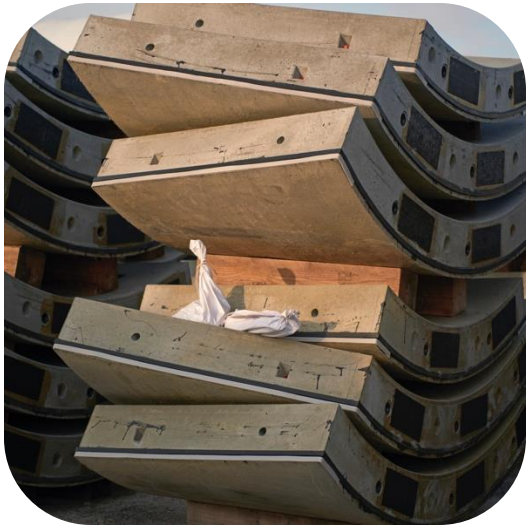




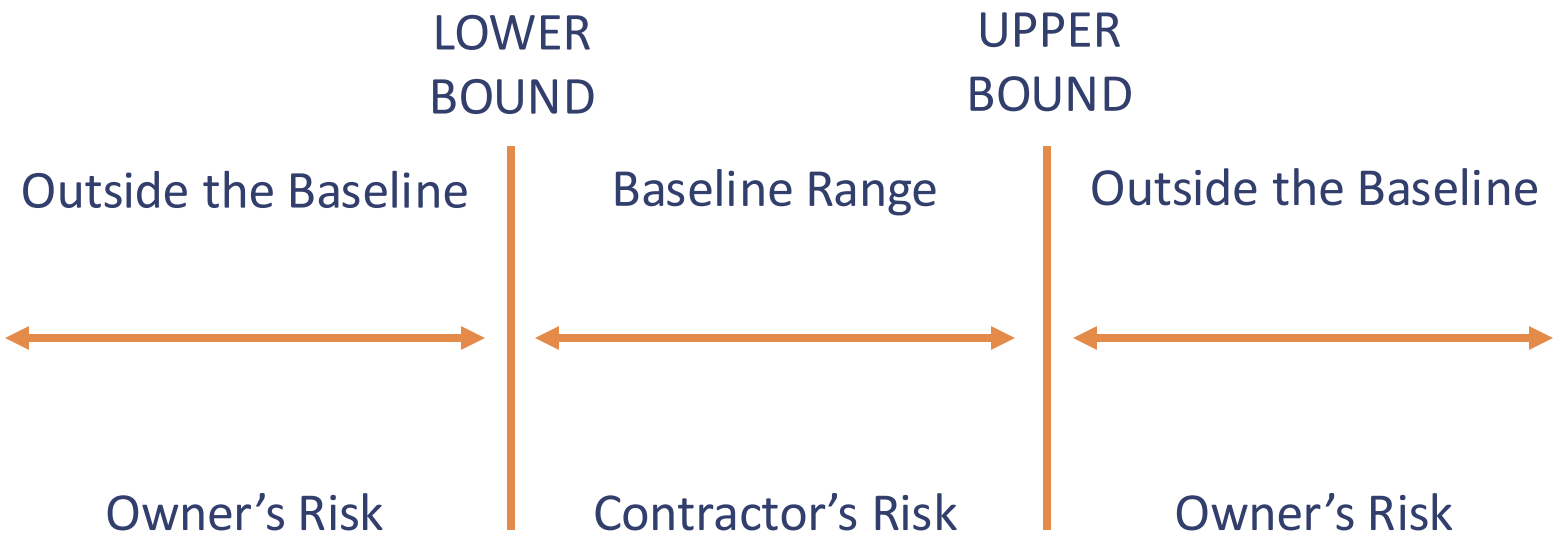
Benefits of Geotechnical Baseline Reports

- Promotes collaborative approach to contracting
- Provides cost control
- Encourages communication between Owner, Contractor, Engineer and Construction Manager





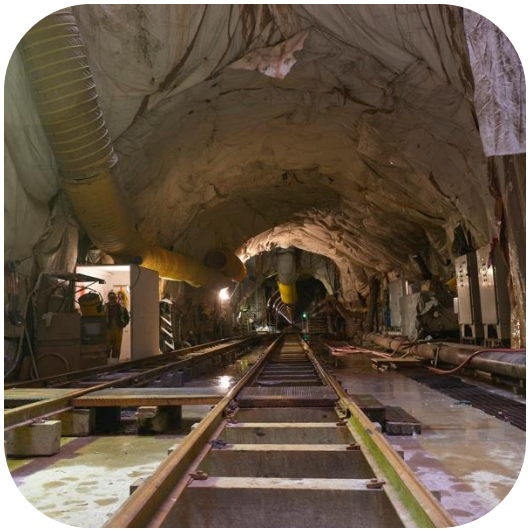
Benefits of Geotechnical Baseline Reports



- If conditions are outside the baseline range
  - The Owner owns the ground and risks beyond baseline
  - The Differing Site Condition clause provides a means to make the Contractor whole
- Owner's risk allocation preferences need to be understood and considered
  - Conservative Baselines = increased bid prices; lower DSC risk
  - Unconservative Baselines = lower bid prices; higher DSC risk

Benefits of Geotechnical Baseline Reports

- Benefits to the Owner
  - Contractors are bidding on the same interpretation of subsurface conditions; likely more uniform bids
  - Reduced risk-based contingencies; likely lower bids
  - Contractual basis to evaluate and resolve DSCs
  - Attract experienced, reputable Contractors





Benefits of Geotechnical Baseline Reports

- Benefits to the Contractor
  - The GBR describes all the key subsurface details/risks
  - GBR levels the playing field
  - Baselines are thresholds for DSCs, need only to bid on the baseline conditions
  - Overly conservative GBRs
    - Potential additional revenue if conditions encountered are below the baselines (from unspent risk contingencies)
    - Bid advantage for Contractors with local subsurface experience





Key Elements of Geotechnical Baseline Reports

- **Interpreted Subsurface Profile**
- Descriptions of subsurface conditions expected to be encountered during excavation
- Describe how these conditions have influenced design
- Describe how these conditions could influence construction
- Describe key risks on the Project





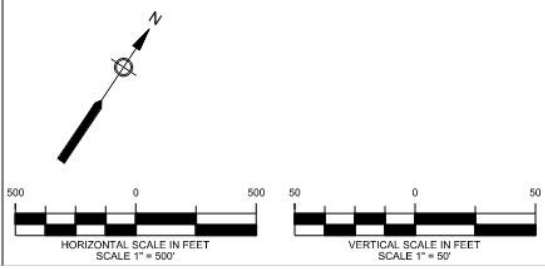
Interpreted Subsurface Profile - Tunnel

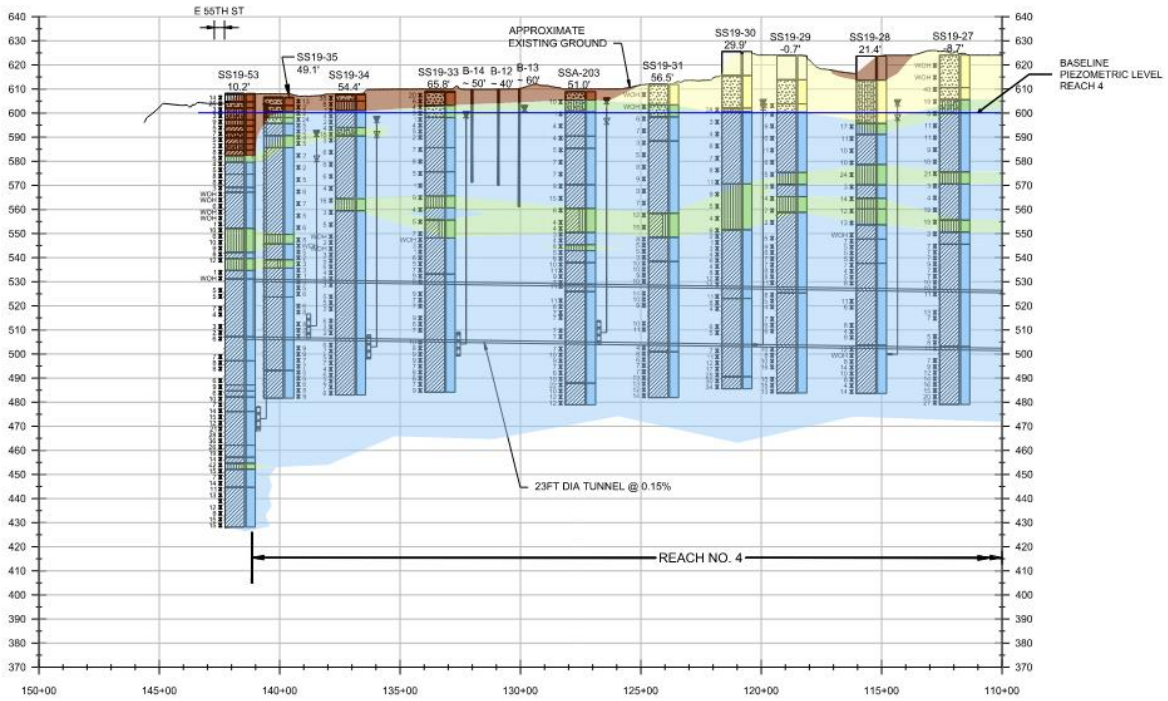


STRATIGRAPHIC LEGEND:

- FILL (FIL)
- RECENT GRANULAR DEPOSITS (RGD)
- PLASTIC CLAYS AND SILTS (PCS)*
- NON-PLASTIC SILT AND FINE SAND (NSF)*
- NON-PLASTIC SAND AND GRAVELS (NSG)
- TILL AND TILL LIKE DEPOSITS (TLD)
- SHALE (SHL)

*PCS AND NSF ARE INTERLAYERED AND TRANSITIONAL TO EACH OTHER. THE STRATIGRAPHY OF THESE ENGINEERING SOIL UNITS (ESU) AS DEPICTED ON THE PROFILES IS BASED ON THE PREDOMINANT ESU ANTICIPATED TO BE PRESENT. LAYERS OF THE NSF LESS THAN 2 FEET THICK CAN OCCUR WHERE PCS STRATIGRAPGY IS SHOWN. LAYERS OF THE PCS LESS THAN 2 FEET THICK CAN OCCUR WHERE NSF STRATIGRAPGY IS SHOWN.



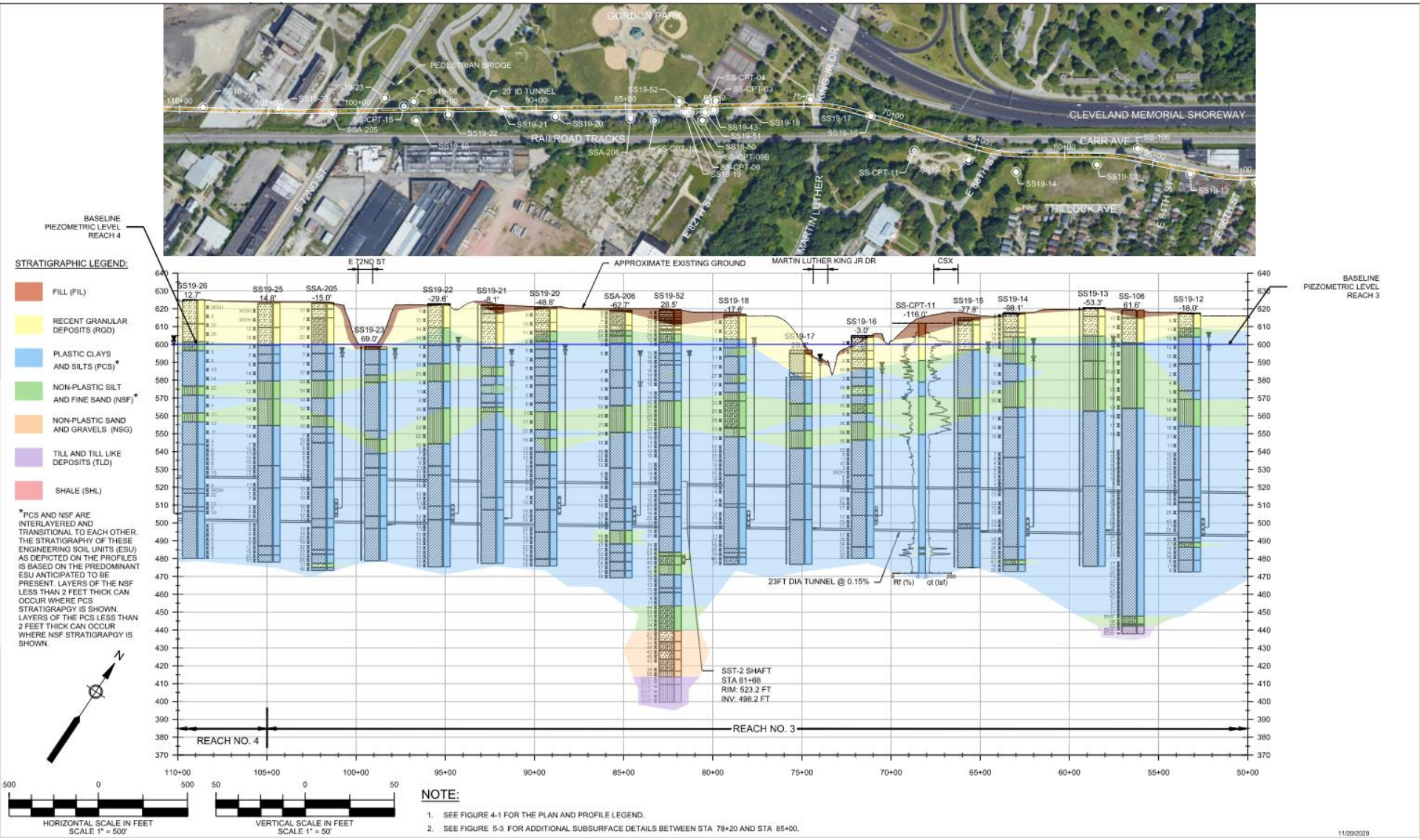


NOTE:

1. SEE FIGURE 4-1 FOR THE PLAN AND PROFILE LEGEND.
2. SEE FIGURE 5-5 FOR ADDITIONAL SUBSURFACE DETAILS BETWEEN STA 142+00 AND STA 140+00.

11/20/2020

Interpreted Subsurface Profile - Tunnel

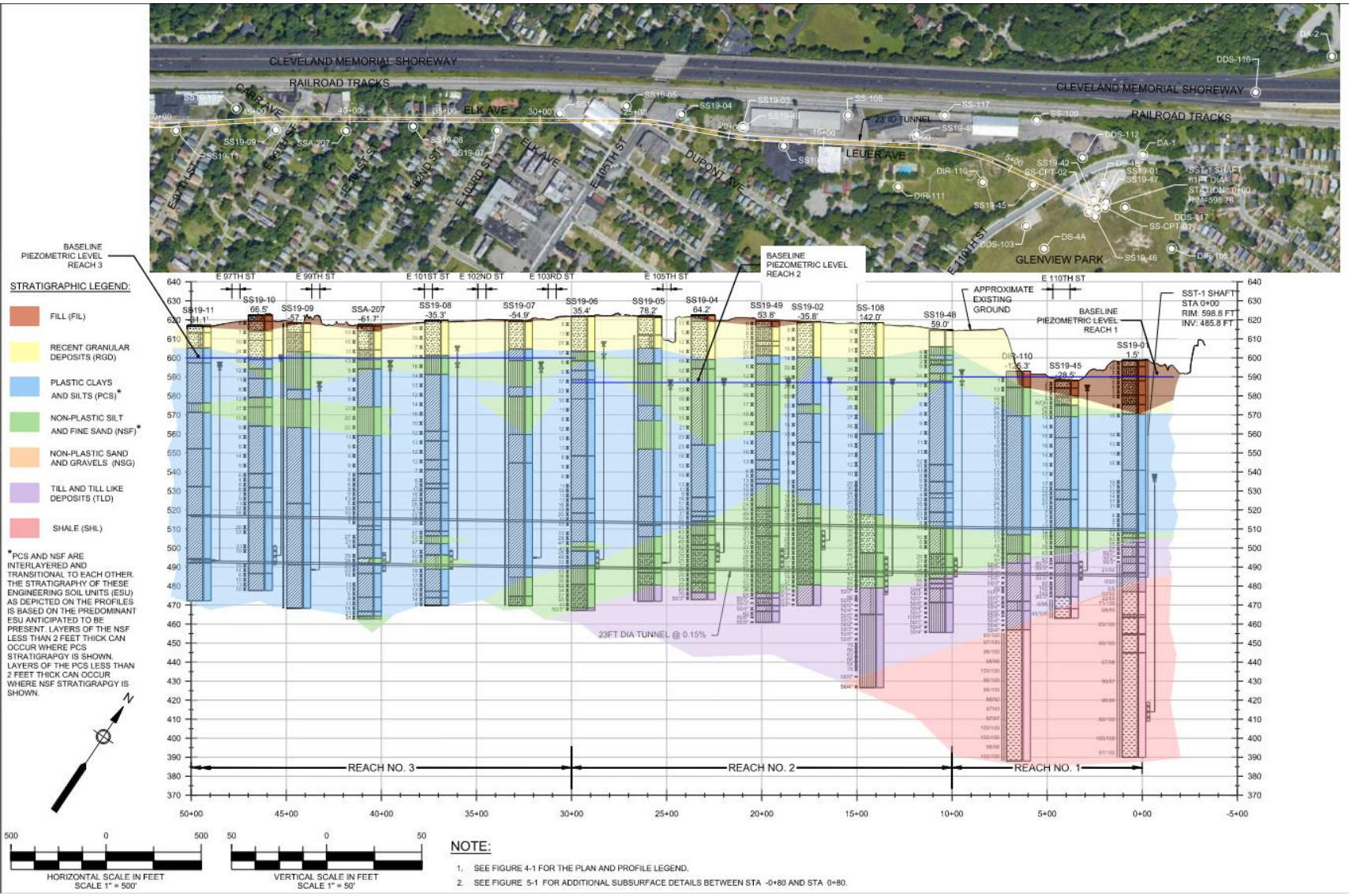


NOTE:

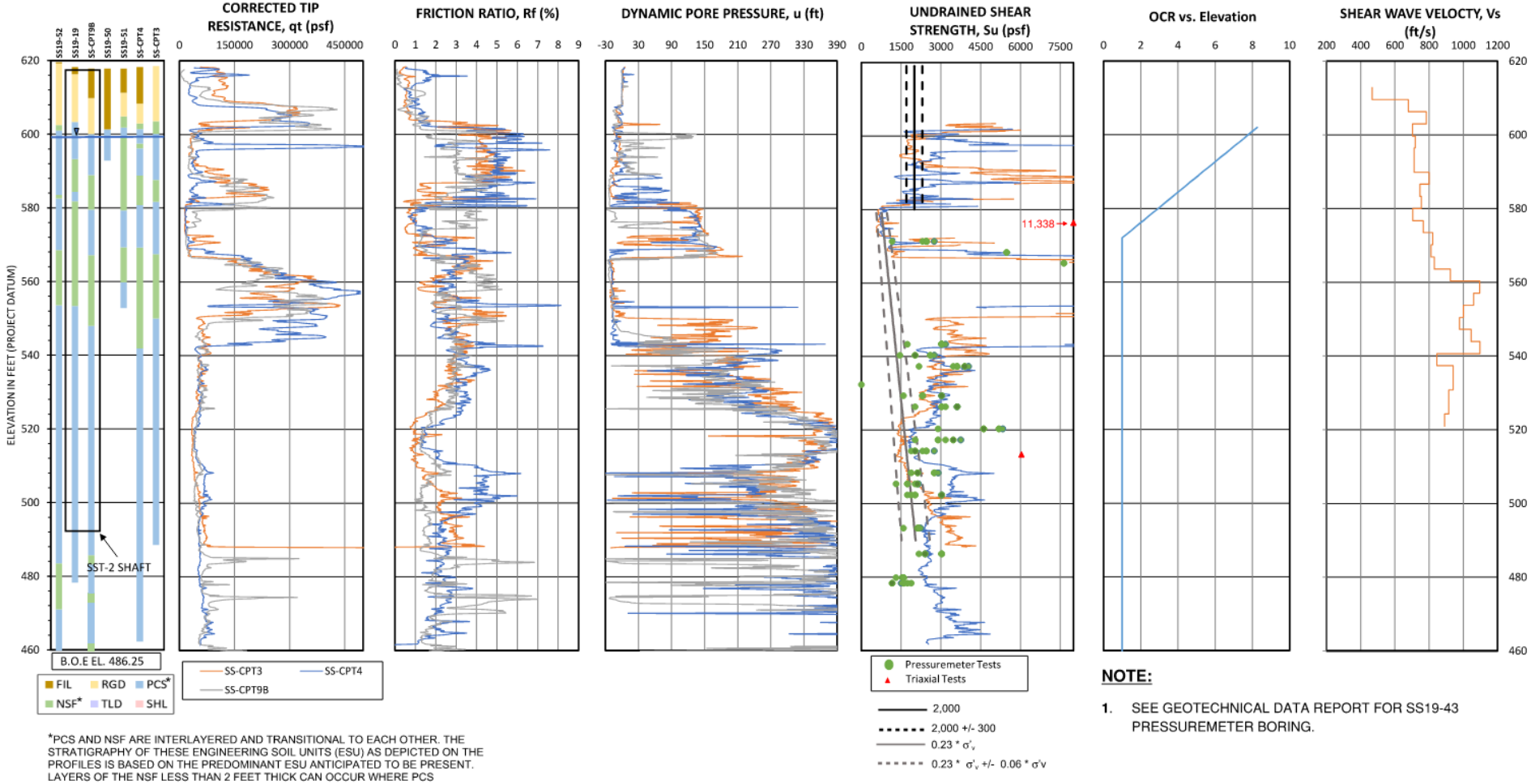
1. SEE FIGURE 4-1 FOR THE PLAN AND PROFILE LEGEND.
2. SEE FIGURE 5-3 FOR ADDITIONAL SUBSURFACE DETAILS BETWEEN STA 78+20 AND STA 85+00.

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Interpreted Subsurface Profile - Tunnel



Interpreted Subsurface Profile - Shaft



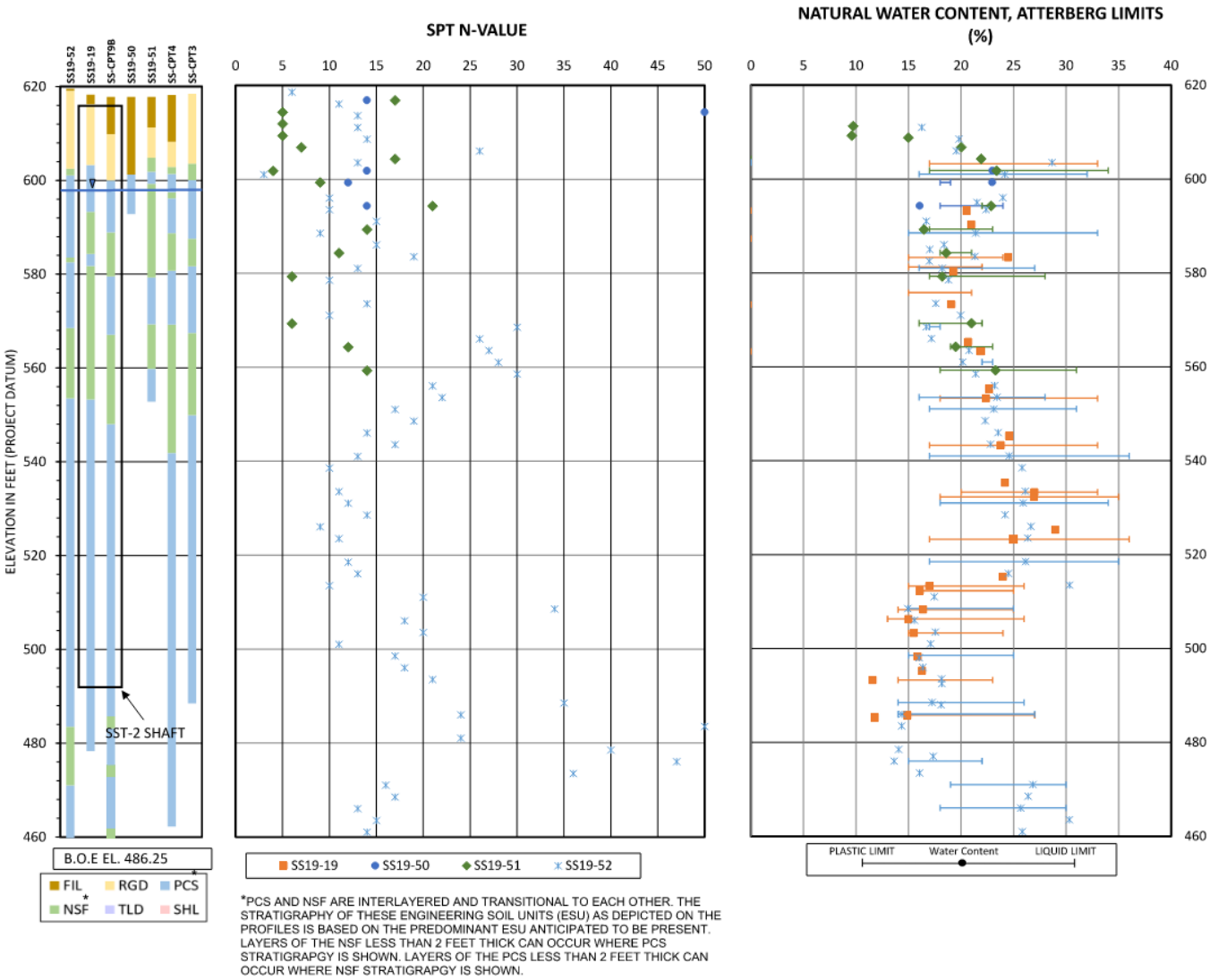
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NOTE:

1. SEE GEOTECHNICAL DATA REPORT FOR SS19-43 PRESSUREMETER BORING.

01/11/2021

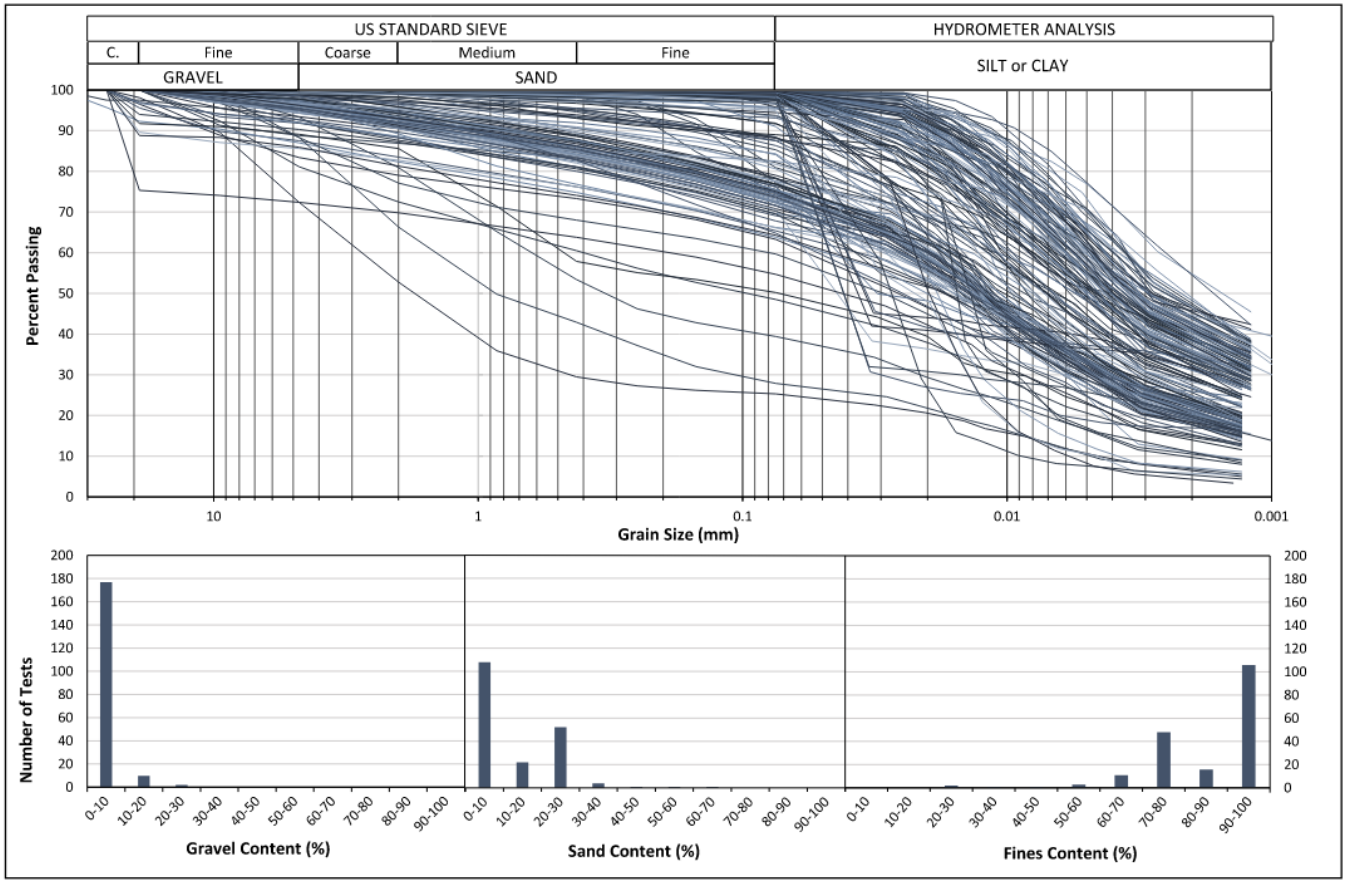
Interpreted Subsurface Profile - Shaft

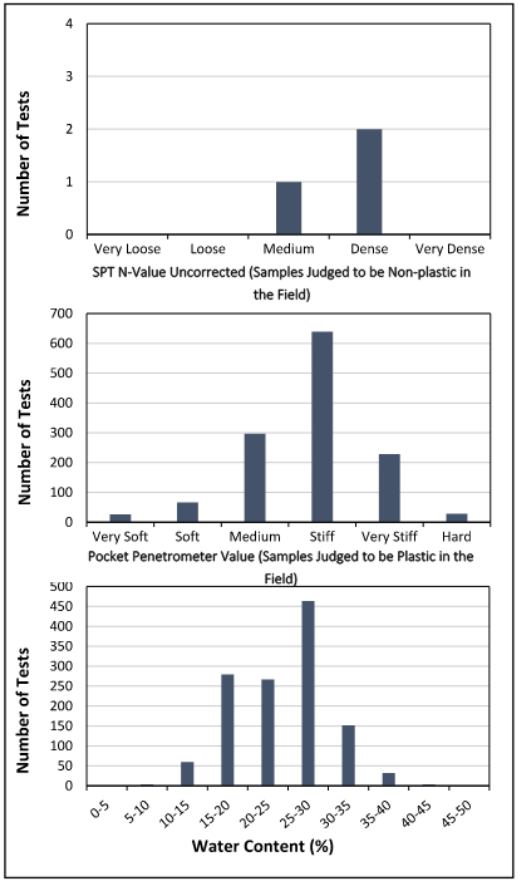


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01/11/2021

Material Property Summary



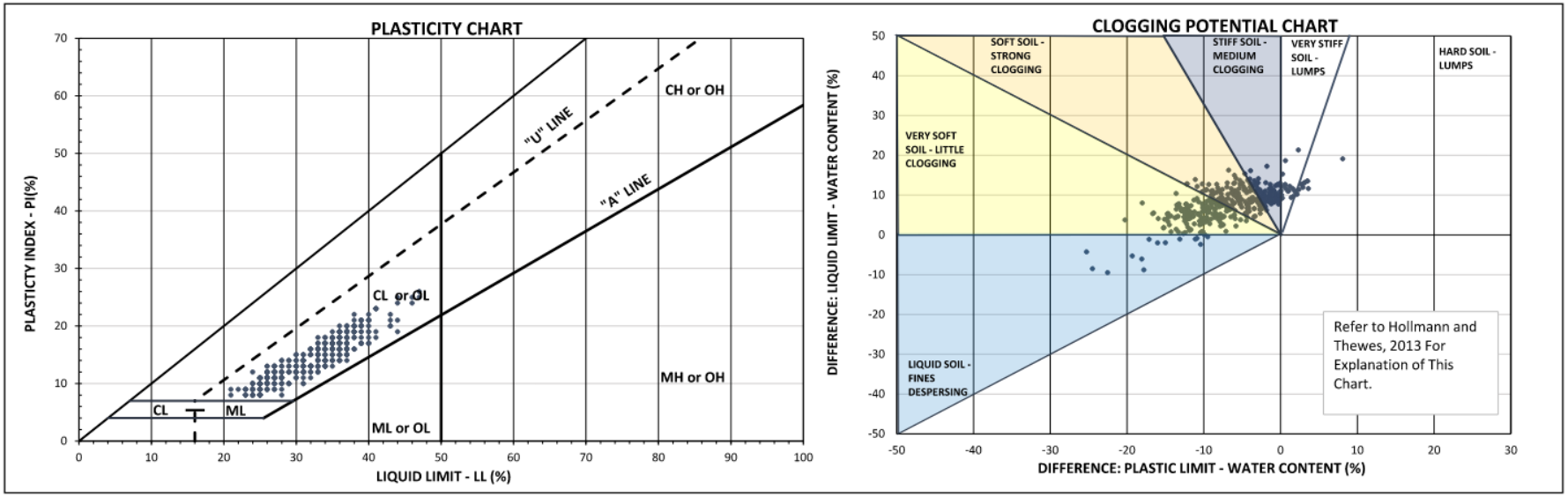


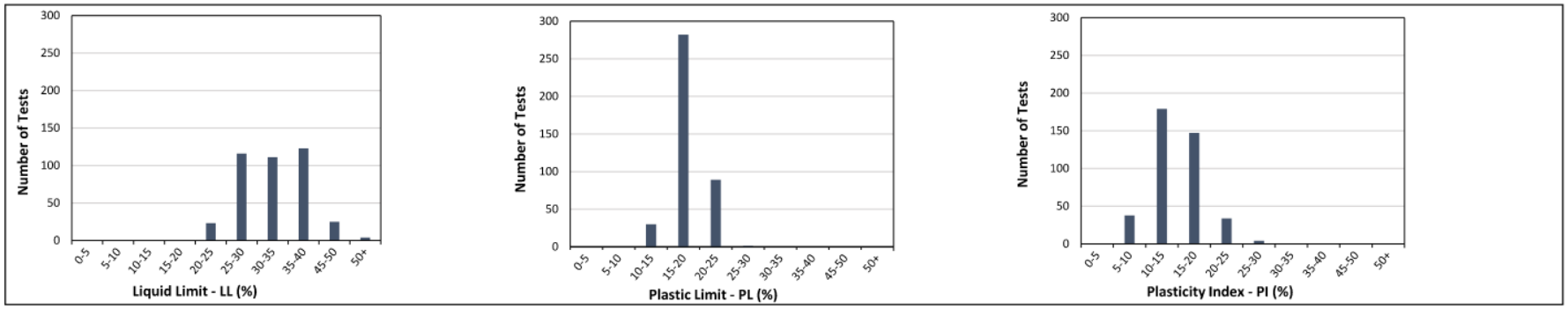
NOTE:

1. REFER TO APPENDIX A FOR DEFINITION OF TERMS USED ON THIS FIGURE.
2. THE DATA SUMMARY PROVIDED ARE BASED ON SSA- BORINGS (EXCLUDING SSA-201), ALL SS19- BORINGS, DIR-110, DS-4E, SS-106, AND SS-108 WHICH ARE AVAILABLE IN THE GEOTECHNICAL DATA REPORT.

12/02/2020

Material Property Summary





NOTE:

1. REFER TO APPENDIX A FOR DEFINITION OF TERMS USED ON THIS FIGURE.
2. THE DATA SUMMARY PROVIDED ARE BASED ON SSA- BORINGS (EXCLUDING SSA-201), ALL SS19- BORINGS, DIR-110, DS-4E, SS-106, AND SS-108 WHICH ARE AVAILABLE IN THE GEOTECHNICAL DATA REPORT.

12/02/2020

Case History – Shoreline Storage Tunnel (Cleveland, OH)

- NEORSD (Owner)
  - Provided sufficient funding for exploration, testing and design
  - Understands that Owner, Contractor, Engineer, and Construction Manager must work as a team for Project success
  - Committed to fair risk allocation
  - Set aside appropriate financial reserve for changes, and any valid DSCs
  - Provided a GBR with baselines consistent with the geotechnical data
  - General Conditions included a Dispute Resolution Process (Dispute Review Board)
- Project completed with reasonable claims

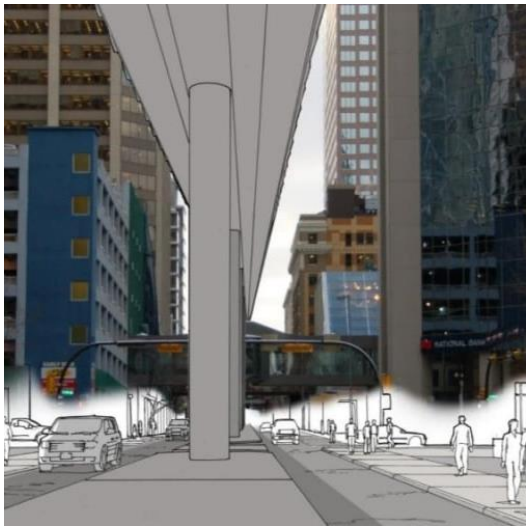




Case History – Calgary Green Line

- City of Calgary (Owner)
  - Provided sufficient funding for exploration, testing and design
  - Developed and maintained hostile relationship with Contractor
  - Allocated ALL risk to Contractor
  - Demanded the lowest-possible price (despite allocating all risk to Contractor)
  - Gave elevated significance to certain baseline statements
- Project cancelled before design was complete.





GBR Lessons Learned

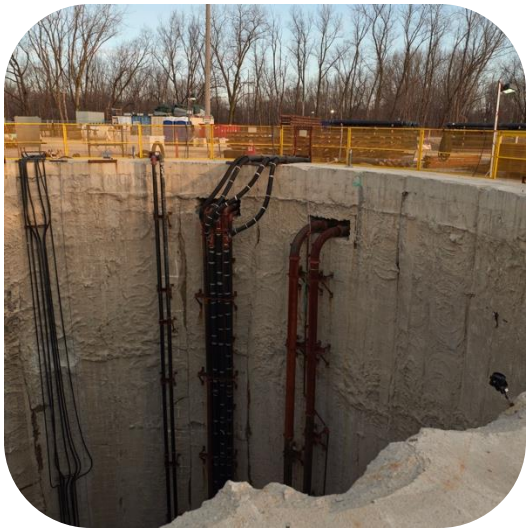
- Clear
  - Avoid ambiguous words (“could” “may” “might”)
  - Avoid Qualitative words (high, low, frequent, short)
  - Avoid Superlatives
- Concise
  - Baselines should be short, declarative sentences
  - Avoid repetition/redundancy
- Consistent with the Contract Documents
  - General Conditions
  - Specifications
  - Drawings
  - Payment Provisions
  - GDR

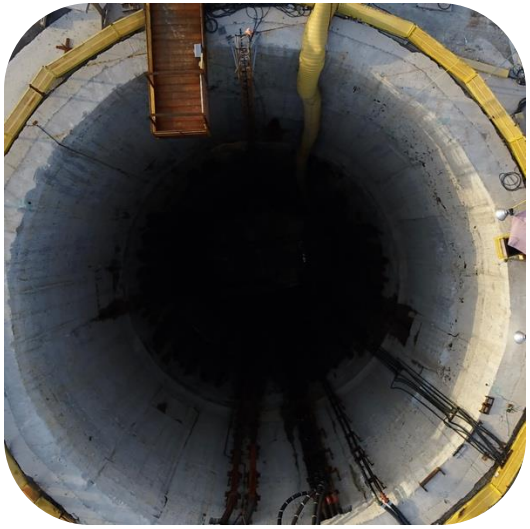




GBR Lessons Learned

- Set baselines using quantitative terms that can be measured and verified in the field.
  - ~~PCS will have short stand-up time.~~
  - The stand-up time of PCS will be less than 30 minutes.
- Avoid setting baselines that depend on the entire tunnel excavation. For example,
  - ~~For baseline purposes, PCS will be encountered in 42% of the tunnel excavation.~~
  - For baseline purposes, PCS will be encountered through 1,200 feet of tunnel excavation.





GBR Lessons Learned

- Baseline ranges instead of singular values
  - ~~The friction angle of PCS is 32 degrees.~~
  - The friction angle of PCS ranges from 30 to 34 degrees.

Table 5-3 Baseline PCS Undrained Shear Strength at SST-2 Shaft Site

Elevation (feet)	Undrained Shear Strength (psf)
Above 580	2,000 +/- 300
Below 580	$0.23 * \sigma'_v{}^{+}$ +/- $0.06 * \sigma'_v$

$\sigma'_{v=}$ vertical effective stress (psf)

- Baseline ranges should be reasonable
  - ~~The friction angle of PCS ranges from 24 to 38 degrees.~~
  - The entire data range is not a baseline.
  - Apply engineering judgment and project experience.

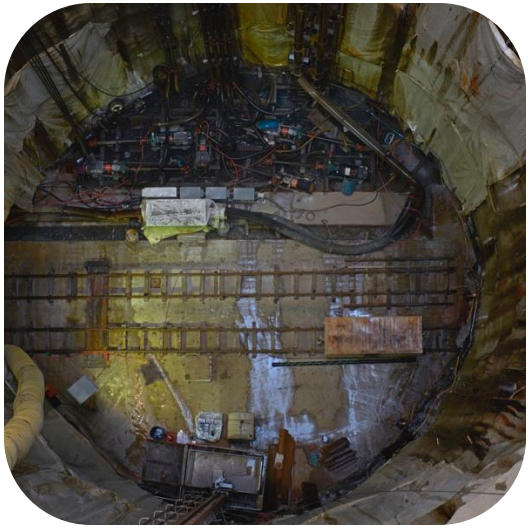




GBR Lessons Learned

- Do not include GBA's Important Information about Your Geotechnical Engineering Report.
  - The risk being allocated through the GBR is the Owner's risk; not the geotechnical engineers.
- Avoid lengthy Limitation discussion
  - Limitations should be related to the GBR and applicability of GBR to the Project





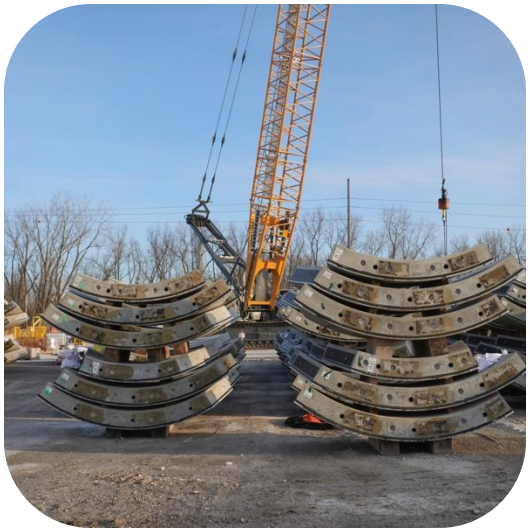
1.2 Limitations

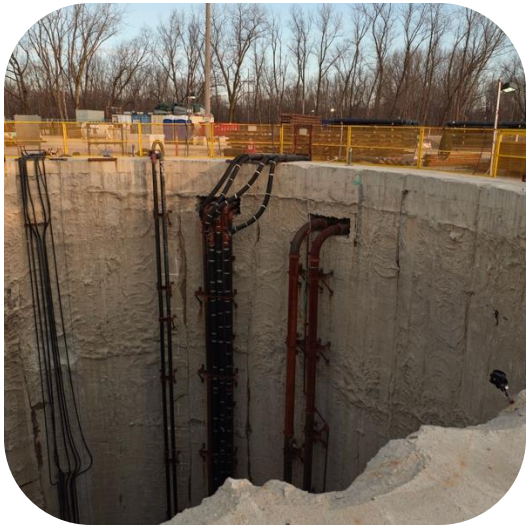
This GBR is a representation of the range of conditions to be assumed for bidding purposes, and for which the Contractor is responsible. The geotechnical baselines presented in this report are not a warranty that these conditions will, in fact, be encountered. The baselines do, however, represent a Contractual standard that the Owner and Contractor will agree to use when interpreting the Unforeseen Condition clause of the Contract. Ground behavior will be influenced by the means and methods, and construction sequencing employed by the Contractor, as well as the Contractor's workmanship. The GBR is prepared assuming that the construction methods and level of workmanship that is normally expected from an experienced and qualified Contractor operating in similar conditions and environments will be employed on the SST Project.

This GBR contains baselines with respect to certain subsurface conditions that are expected to be encountered during the performance of the work of the tunnel, shafts, and NSSs. The baselines are based on geotechnical information and data gathered through widely spaced explorations, in situ and laboratory testing, and other data as presented in the GDR; analyses, evaluations, and professional opinions; and other factors such as local construction experience.

GBR Lessons Learned

- A GBR should be written by a committee that includes
  - Owner – to inform the committee on their risk allocation preferences; understand how risk is allocated through the baselines; understand the consequences of baselines.
  - Engineer – They understand the design, the design requirements, constraints, opportunities
  - Construction Managers – they will manage the construction process for the Owner

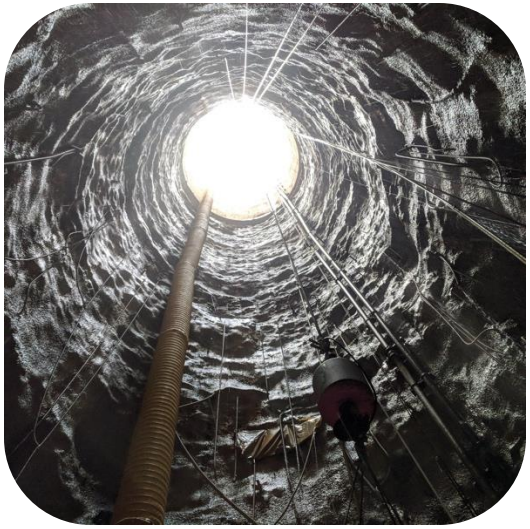




GBR Lessons Learned

- A fair and reasonable risk allocation is best for the project
- Consider Functional Baselines
  - A baseline of an operational result (i.e., advance rate, intervention time)
  - Should be some relationship between subsurface conditions and constructability
  - Should encourage “good behavior”
  - Should be easily understood and measurable
- GBRs should be short. Maximum of 30 pages.
- GBR should be written by experienced personnel that understand engineering geology, design and construction of underground structures. The GRB team includes the Owner (after all, it is their risk that is allocated through the GBR)
- Risk Allocation Memo to document the decisions made regarding risk allocation, setting of baselines, and the consequences of baselines





GBR Lessons Learned

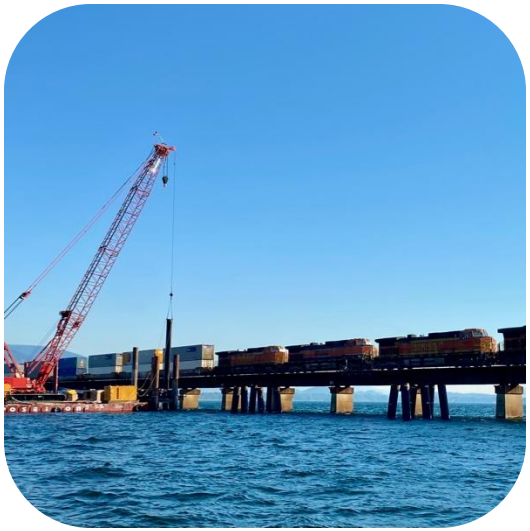
- Baseline statements should honor the data; but they don't have to
  - Engineering Judgment
  - Previous Construction Experience
  - Explain why baselines differ from the data
  - Avoid gratuitous baselines
- Avoid giving elevated significance to (certain) baseline statements
  - **{This is a contractually binding baseline.}**
  - This is not a contractually binding baseline.

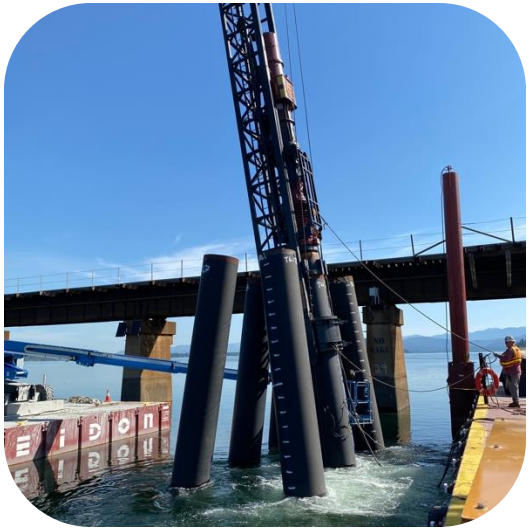




Future Trends

- GBRs for Surface Projects
  - Foundation construction may be a small part of construction, but can involve risk to schedule delays
  - Geotechnical risk is related to subsurface conditions and ground behavior
  - Concepts of Risk Sharing applicable to all types of projects
  - Equitable risk allocation in project's best interest





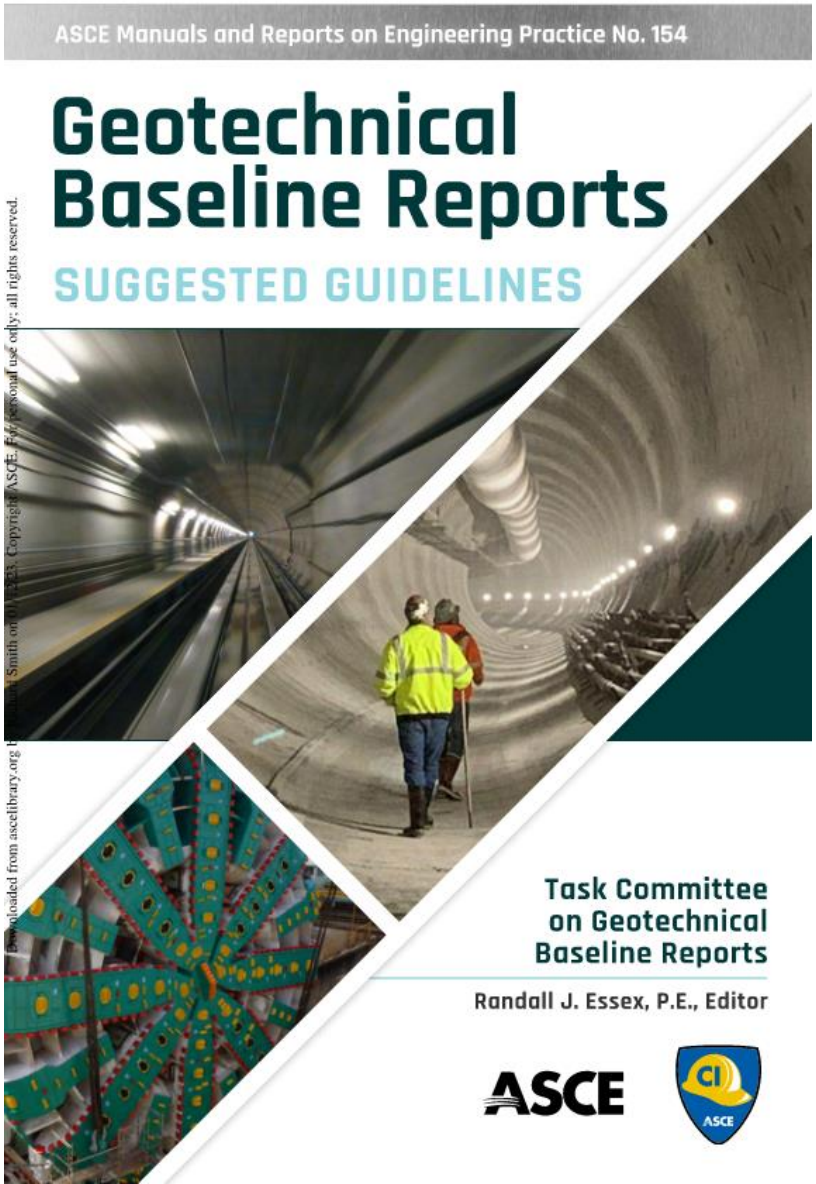
Summary

- A GBR is part of a robust, mindful risk management for heavy civil construction.
- A well-written GBR requires staff experienced with geology, design, and construction of underground projects, including the Owner.
- GBR must be consistent/compatible with the other contract documents.
- It is Project's best interest to allocate risks fairly and equitably
- Realistic baselines and clear contract provisions can increase bidder interest





Suggested Guidelines



THANK YOU!

QUESTIONS?