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Improving Geotechnical Characterization for Constructability and Construction Decisions

A-GaME Summer Super Sessions – Take-Aways & Outcomes

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What are the Advanced Geotechnical Methods in Exploration?

The A-GaME is a toolbox of underutilized subsurface exploration tools that will assist with:

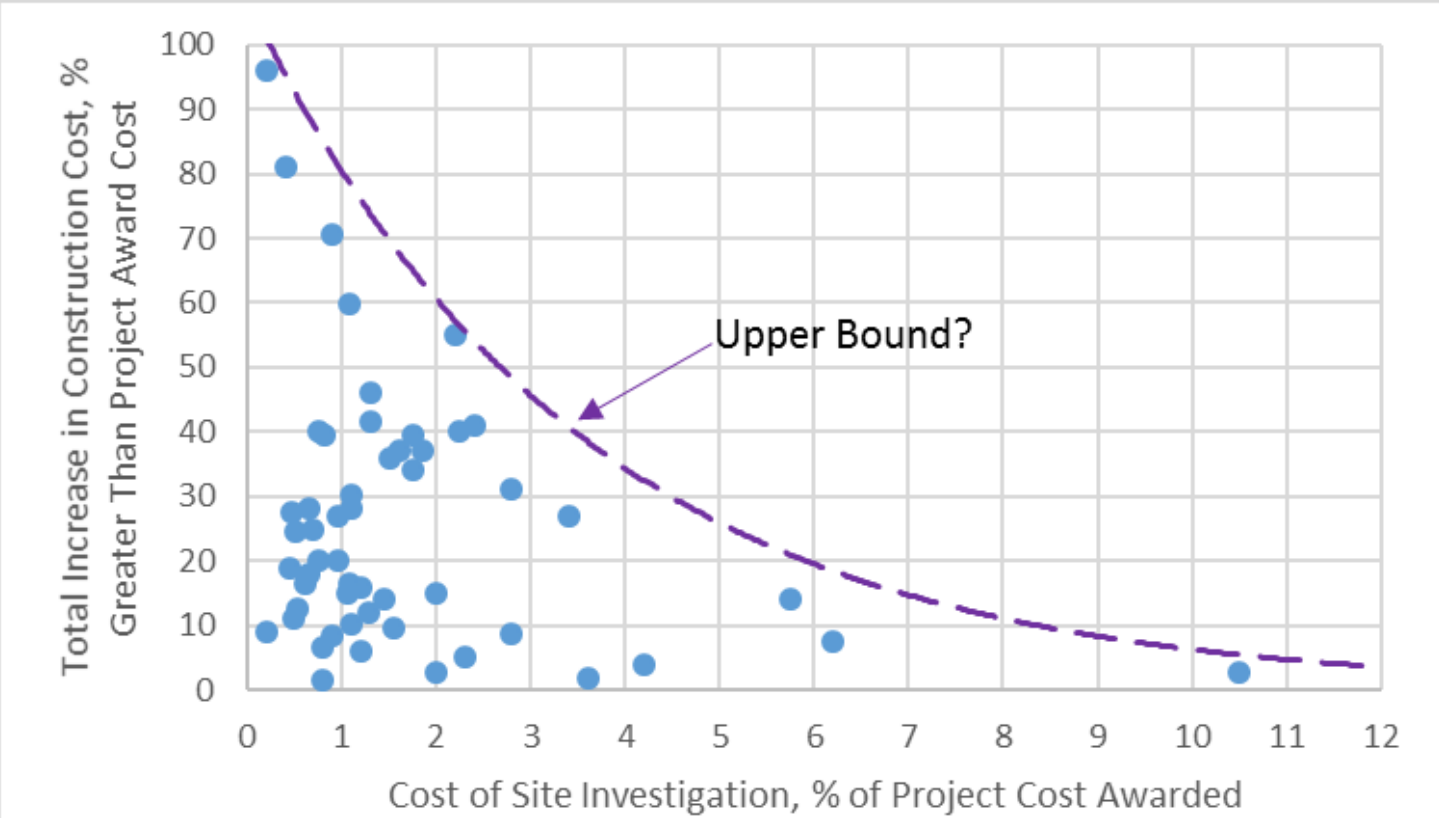
- Assessing risk and variability in site characterization
- Optimizing subsurface exploration programs
- Maximizing return on investment in project delivery

The A-GaME: Mainstreaming Underutilized Methods

- **CPT - Cone Penetration Test**
- **SCPT - Seismic Cone Penetration Test**
- **ER - Electrical Resistivity**
- **IP - Induced Polarization**
- **SP - Self Potential**
- **MWD - Measurement While Drilling**
- **Seismic: Refraction**
- **Seismic: Reflection**
- **Seismic: FWI - Full Waveform Inversion**
- **Seismic: MASW/SASW - Analyses of Surface Waves**
- **Seismic: Tomography**
- **Seismic: Downhole**
- **Seismic: Crosshole**
- **Seismic: P-S Suspension Logging**
- TDEM - Time-Domain Electromagnetic
- FDEM - Frequency-Domain Electromagnetic
- VLFEM - Very Low Frequency Electromagnetic
- **OTV - Optical Televiewers**
- **ACT - Acoustic Televiewers**
- GPR - Ground Penetrating Radar
- MicroGravity
- PMT - Pressuremeter Test
- DMT - Flat Plate Dilatometer Test
- VST - Vane-Shear Test
- Rock Discontinuities from Photogrammetry
- Pore-water pressure from Field Piezometers

The A-GaME & Site Investigation Investment

Costs spent on investigations for transportation projects are commonly 1% - 3% of total cost.



Source: NCHRP Synthesis 484 - Influence of Geotechnical Investigation and Subsurface Conditions on Claims, Change Orders, and Overruns (After Figure 1)

Improve Geotechnical Site Characterization for:

- Excavation/Blasting
- Depth to Rock
- Condition of Rock
- Dewatering and Groundwater Management
- Bad-Actors
- Site Variability
- Ground Improvement
- Drilled Shaft & ACIP Side-Resistance Verification
- Anchored Systems
- Visualization
- Bidding

Source: Harry Moore (Retired TN DOT)

A-GaME Summer Super Sessions
Focus: Constructability and Construction Decisions

- Session 1 – **Step into the Contractor's Boots** – June 22, recorded
- Session 2 – **Manage Risk: Reduce Geotechnical Uncertainties Before Construction** – July 20, recorded
- Session 3 – **Bridge the Gap: Communicating Subsurface Conditions for Construction** – August 17, recorded
- Session 4 – **Making it Happen: Improving Site Characterization for Constructability and Construction Decisions** – August 24, plenary/report-outs recorded

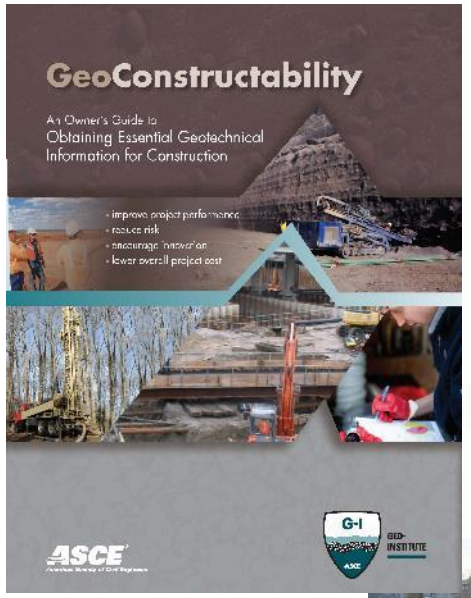


Image (above): ASCE GI

Image (below): FHWA

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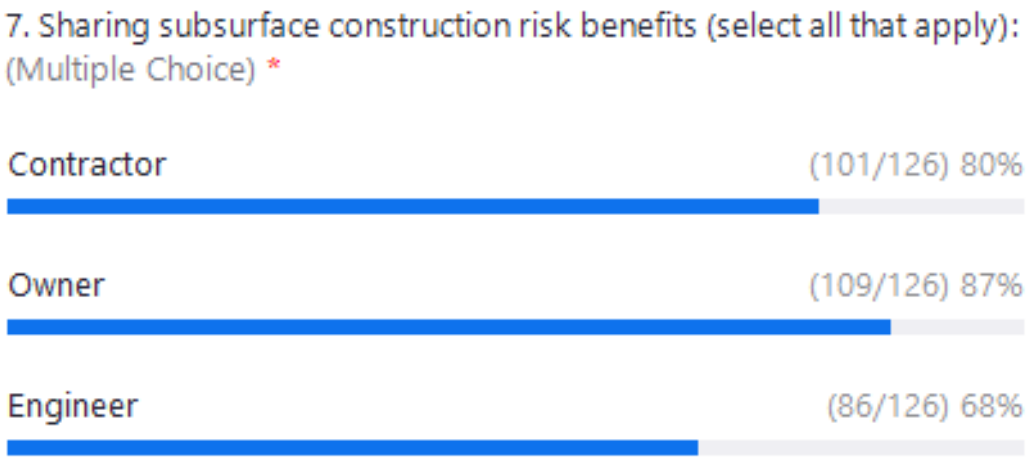
Session 1: Step into the Contractor's Boots Key Topics

- **The Contractor's perspective on geotechnical site characterization and subsurface data**
- **Risk and decisions during bidding and construction**
- **Risk reduction versus risk transfer**
- **The value of Contractors' experience and insight**

Photo: FHWA

Session 1: Step Into the Contractor's Boots Key Takeaways

- **Geotechnical risk is best managed when all parties are engaged in solving problems upfront**
- **Better project outcomes result when owners have a risk sharing rather than a risk transfer mindset**
- **Engaging contractors early in the design process can help manage risk**



Session 2: Manage Risk – Reduce Geotechnical Uncertainties Before Construction
Key Topics

- **The types of problems we encounter during construction as a result of geotechnical uncertainty**
- **Problem-solving applications of a range of A-GaME technologies**
- **Case histories that illustrate how A-GaME technologies can address these problems at any stage of a project**

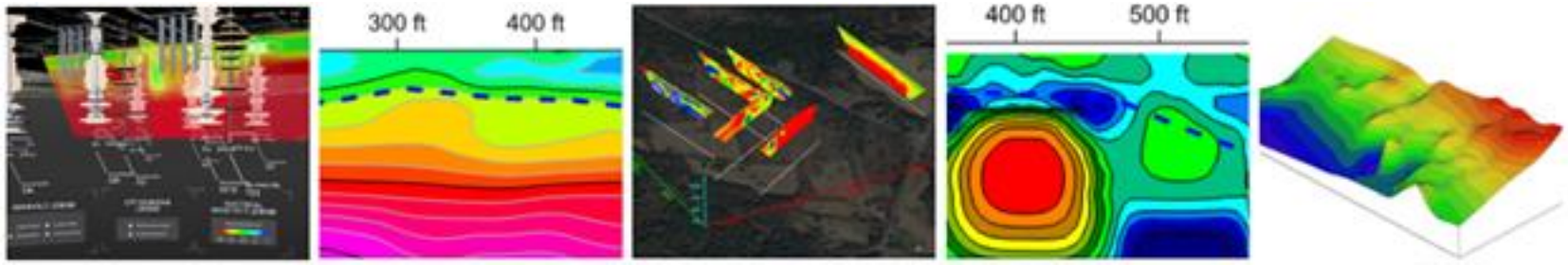


Photo: FHWA

Session 2: Manage Risk
Key Takeaways

- **Phased geotechnical investigations can be extremely valuable in reducing uncertainties, but schedule, cost and standard agency procedures can present roadblocks to implementation**
- **Geotechnical uncertainties such as challenges with foundation length, groundwater and site variability typically have moderate to significant impacts on project budget and schedule**
- **A-GaME technologies such as geophysics, CPT and MWD can be a critical part of investigations, specifically phased investigations, and can reduce these costly uncertainties.**

Source: LADOTD

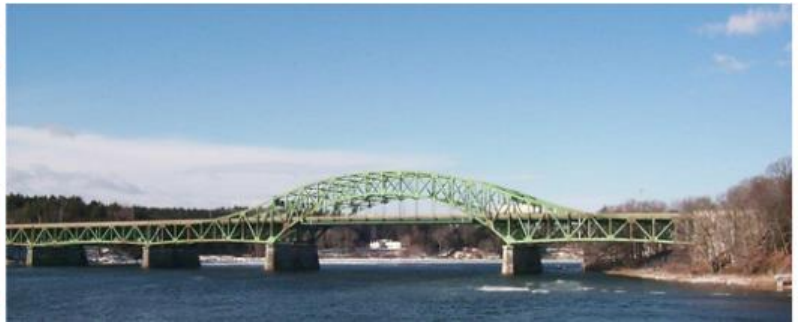
Source: ALDOT

Source: FHWA

Session 3: Bridge the Gap – Communicating Subsurface Conditions for Construction
Key Topics

- **Introduction to a valuable underutilized resource on Geoconstructability**
- **Communication mechanisms, geotechnical baseline reports**
- **Digital Transfer of Geotechnical Data**
- **Improving understanding of subsurface conditions during construction**
- **Digital Visualization and Integration**





Photos (left to right: MassDOT, MNDOT, MassDOT

Session 3: Bridge the Gap
Key Takeaways

- **The ASCE GeoConstructability Report is a helpful resource – Use it! Share it!**
- **Geotechnical baseline reports, digital data transfer, and subsurface visualization tools are valuable but underutilized means of communication for geotechnical data**
- **Digital data transfer using a schema such as DIGGS is gaining traction among software developers, and has the potential to improve efficiency and accuracy in organizations that move to this method**
- **With improved technology during foundation installation, much can be learned about the subsurface even during construction, allowing for adaptability of design through a project**

A-GaME Summer Super Session #4: Making it Happen

12 Breakout Discussion Topic Sessions

- **Topic 1: Local Agency Challenges**
- **Topic 2: Phased Investigations**
- **Topic 3: Data Exchange**
- **Topic 4: Communication of Subsurface Conditions**
- **Topic 5: Improving Geotechnical Plans and Specifications**
- **Topic 6: Baseline Reports**
- **Topic 7: Handling Risk**
- **Topic 8: Promoting use of Other Site Characterization Tools**
- **Topic 9: Investigation Planning**
- **Topic 10: Capturing the Value of the A-GaME**
- **Topic 11: Pay Items**
- **Topic 12: Constructability**

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A-GaME Summer Super Session #4: Making it Happen

Takeaways, Outcomes & Actions

- **Communication is Key!**
  - **"Geotechs/Geologists are middle persons"**
  - **Applies to all project delivery stakeholders**
    - On value of better site characterization
    - On value of using multiple methods
    - On expectations
    - On limitations of methods
    - On geotechnical risks
    - On subsurface conditions
    - On design considerations
    - On constructability
    - On quality assurance
  - **Feedback loops needed**

- **Need to Educate Others – Resistance to performing geophysics**
  - Lack of understanding or want a tolerance you cannot provide
  - "Fuzzier" data, interpretation, loss of resolution and accuracy [with surface methods] with depth
  - Data report with "hard data" vs data that needs to be interpreted
  - Limitations of geophysical methods

- **Need buy-in from staff and from management**

A-GaME Summer Super Session #4: Making it Happen

Takeaways, Outcomes & Actions

- **Take proactive approaches during design to address constructability for contractor**
  - E.g. acid producing soils, water table readings over time to aid in design of support of excavation, cofferdam, etc.
  - More than one site visit may be needed
- **The more relevant information provided to the contractor, the better**
- **Construction Manager/General Contractor (CM/GC), Geotechnical Baseline Reports (GBRs), and Summaries of Geotechnical Conditions have been effective mechanisms for DOTs**
  - More familiarity is still needed
- **Risk registers, risk workshops and assessments of risk are being used to inform site characterization efforts!**
  - Look to WSDOT, UDOT, MNDOT and USACE for assistance and insights
- Use **"Site Characterization Planning Report"** during reconnaissance phase as mechanism to assess risks, identify methods and phases, and to justify a more comprehensive A-GaME approach. Adjust as necessary/Use as a "living document."
- **Form a Users Group for Data Management to share use-cases and applications**

A-GaME Summer Super Session #4: Making it Happen

Takeaways, Outcomes & Actions

- Blasting requirements – historical guidance from the mining industry. Controls were not written for transportation project needs. Refer to FTA Noise and Vibration Assessment Manual for better guidance (per Alex D., Ohio DOT)
- UAS or terrestrial lidar or photogrammetry, in may provide a more accurate method for determining in-place material quantities
- What improved bid/pay-item structures could be improved leveraging shear-wave velocity measures, MWD drillability parameters, material variation determinations (interpreted from geophysical methods), down-hole logging techniques, geohydrologic mapping, groundwater flow testing and probable groundwater characteristics, etc.?

A-GaME Summer Super Session #4: Making it Happen

Takeaways, Outcomes & Actions

Local Agency Challenges

- **Risk profile looks different**
  - Small budgets vs. project costs
  - Often looking for alternative approaches – typically not conventional or to same standards as AASHTO
  - Standards and criteria vary or can be ambiguous
- **Local "organizations" vary greatly**
  - Rural contacts may be local landowner(s)/farmers(s) for community
  - May depend on multiple partner agencies (including State DOTs) for assistance.
  - Often do not have technical staff, let alone geotechnical staff
- **Remoteness or difficult access**

Recommended Actions

- **State DOTs and FHWA work with LTAP centers to provide training and resources**
  - To evaluate geotechnical risks relative to project risks
  - Provide basic training and fundamental expectations
  - Investigation approaches and leveraging available information
- **State DOTs, FHWA and Geo-Industry coordinate outreach to Universities**
  - Local agency needs (Note: there are many other topics that should be coordinated for university outreach).

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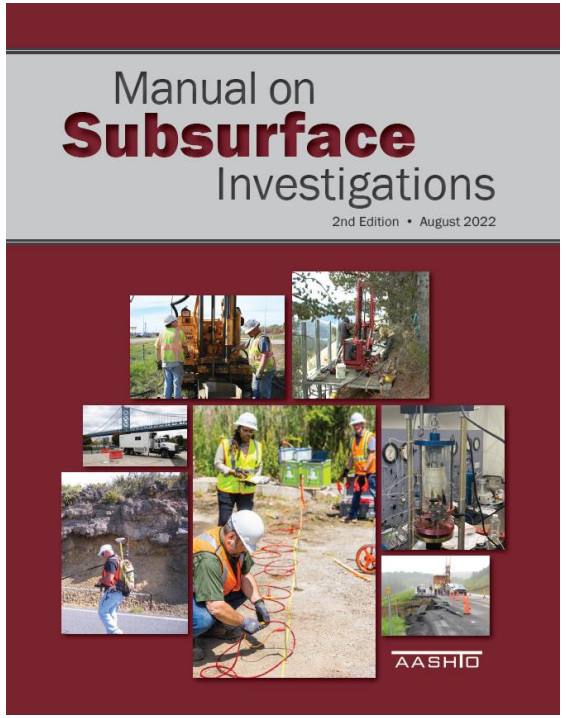
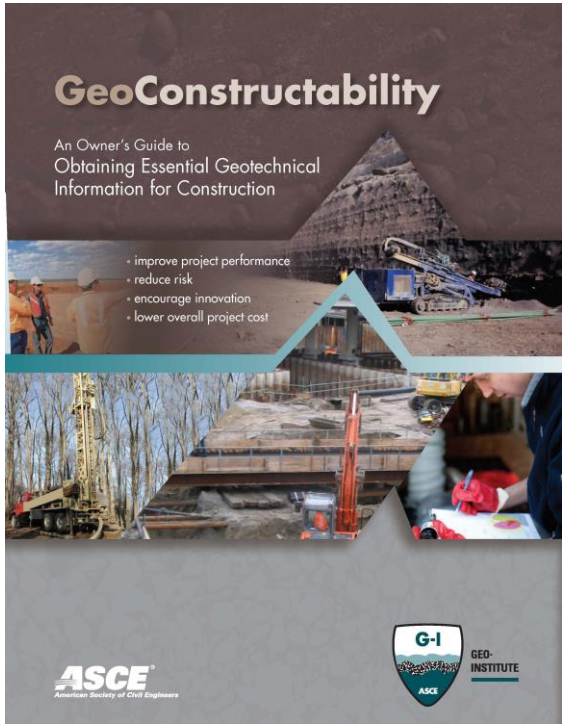
References and Resources

- AASHTO Manual on Subsurface Investigations, 2nd Edition, September 2022 (MSI-2) – Available Now!
- GI GeoConstructability
- FHWA A-GaME Webpage
- ASCE GBR Gold Book
- DFI Site Characterization Committee
  - A-GaME Winter Webinar Series
  - A-GaME Summer Super Sessions – Coming Soon!
  - Geophysics Web Tool: Applications to Geophysical Methods to Highway Related Problems
  - CPT Users Group
  - MWD Users Group
  - Geophysics Users Group
- DIGGS Website



Source: AASHTO



Source: ASCE GI

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