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Evolving Project Delivery with Advanced Geotechnical Data Management Practice with DIGGS Implementation

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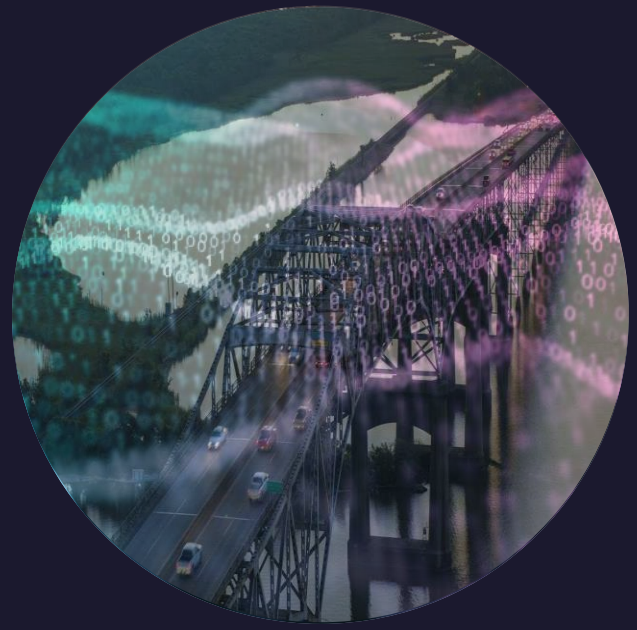
October 19, 2022

The 51st Annual Southeastern Transportation Geotechnical Engineering Conference (STGEC)

Outline

- Introduction
- Quick Recap
- General Workflow
- How Can DIGGS Help
- Showcases of DIGGS Implementation
- Final Thoughts



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Typical Geotechnical Practice

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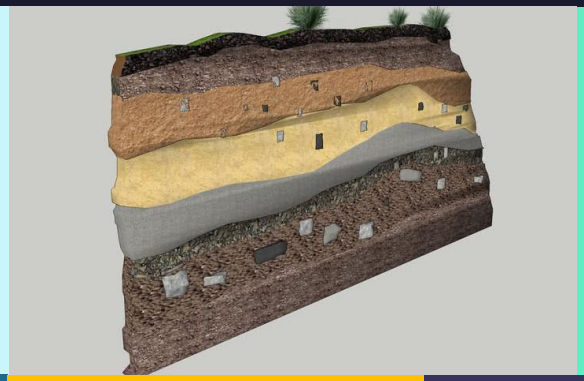
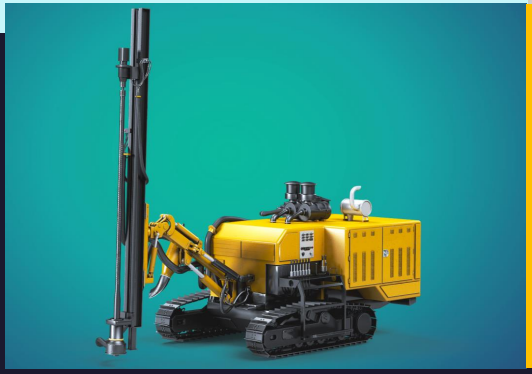
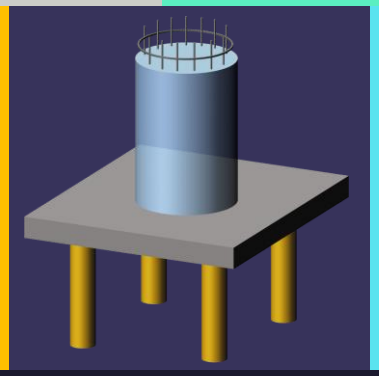
Investigation



Testing



Analysis/
Design



Construction
& Monitoring

Evolution of Geotechnical Practice - Investigation

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- SPT (hand logs)
- CPT (pdf record – image, digital)
- Geophysical testing – analog, digital
- MWD (performance monitoring and feedback)
- Data management and visualization, GIS, web-based tools, AR, VR)

Evolution of Geotechnical Practice - Testing

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- Proving rings, dial gauges, paper records
- Load cells, LVDTs, pressure transducers, analog output, A/D converters
- Data recorders
- Automated test equipment and feedback

Evolution of Geotechnical Practice - Analysis/Design

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- Hand calculations (e.g., slope stability)
- Fortran and punch cards
- PCs and computer software
- Finite element and finite difference methods
- Data analytics (e.g., big data with statistics, including AI and ML)

Evolution of Geotechnical Practice – Construction and Monitoring

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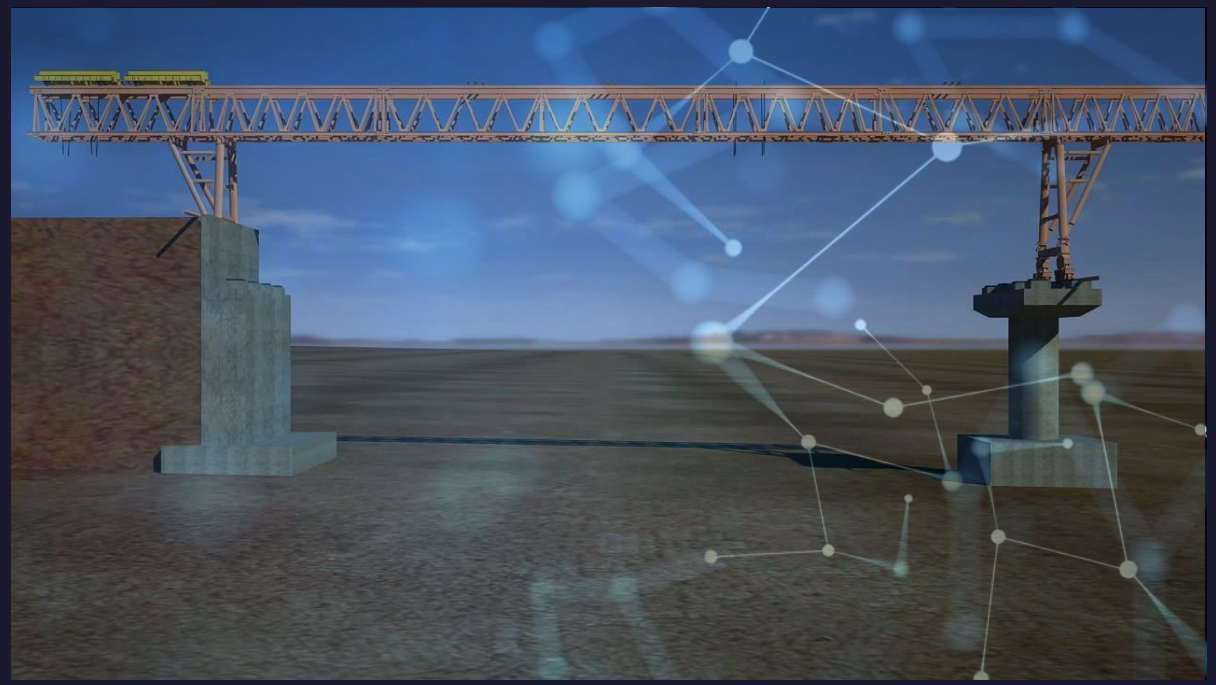
- Construction daily reports – paper
- Field instrumentation – by hand, electronic and wireless data recorders
- Information Management System (IMS)
- Building Information Modeling (BIM)
- Industrial Internet of Things (IIoT)
- Digital Twins



Motivation of the Evolution and Innovation

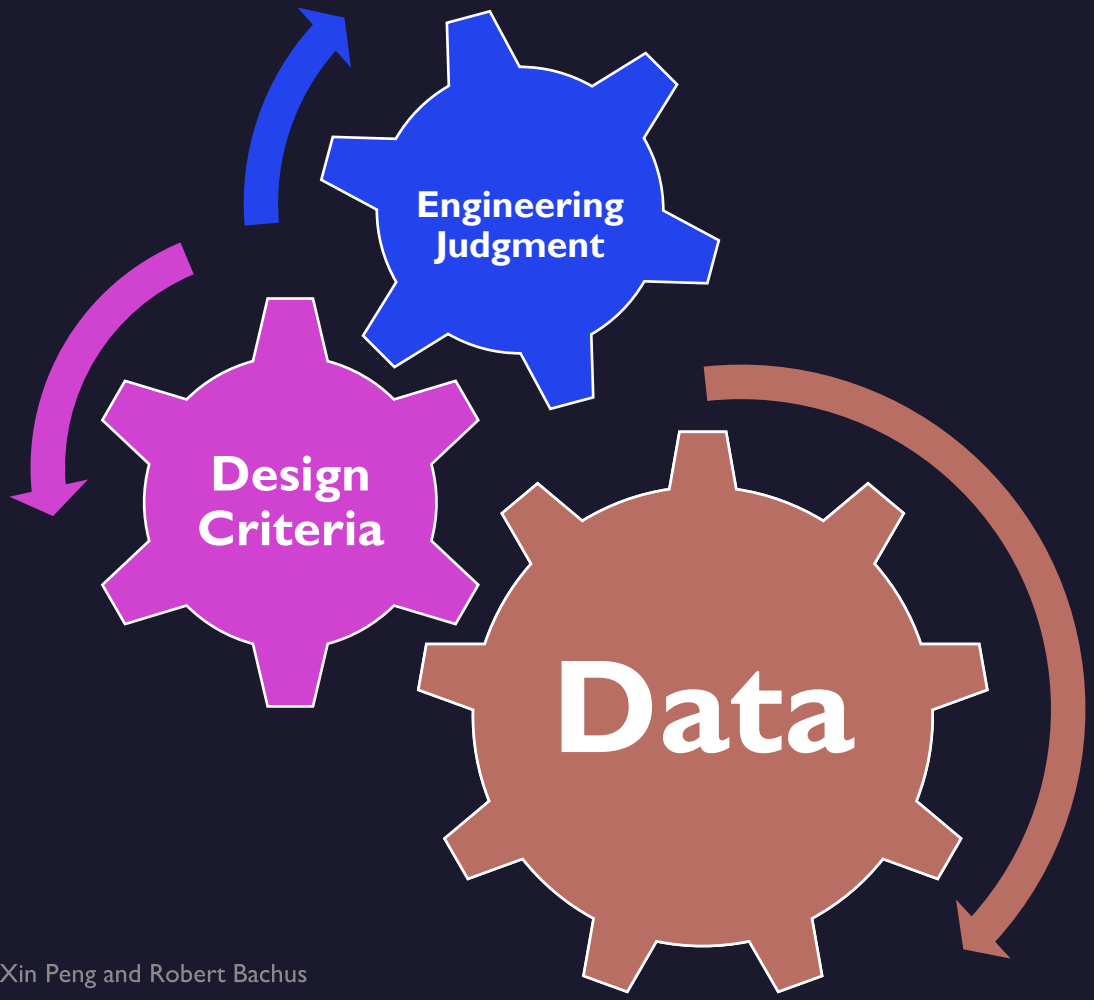
Identify Variability and Uncertainty

Reduce Costs

Increase Efficiency

Improve Quality

How data is involved in geotechnical practice



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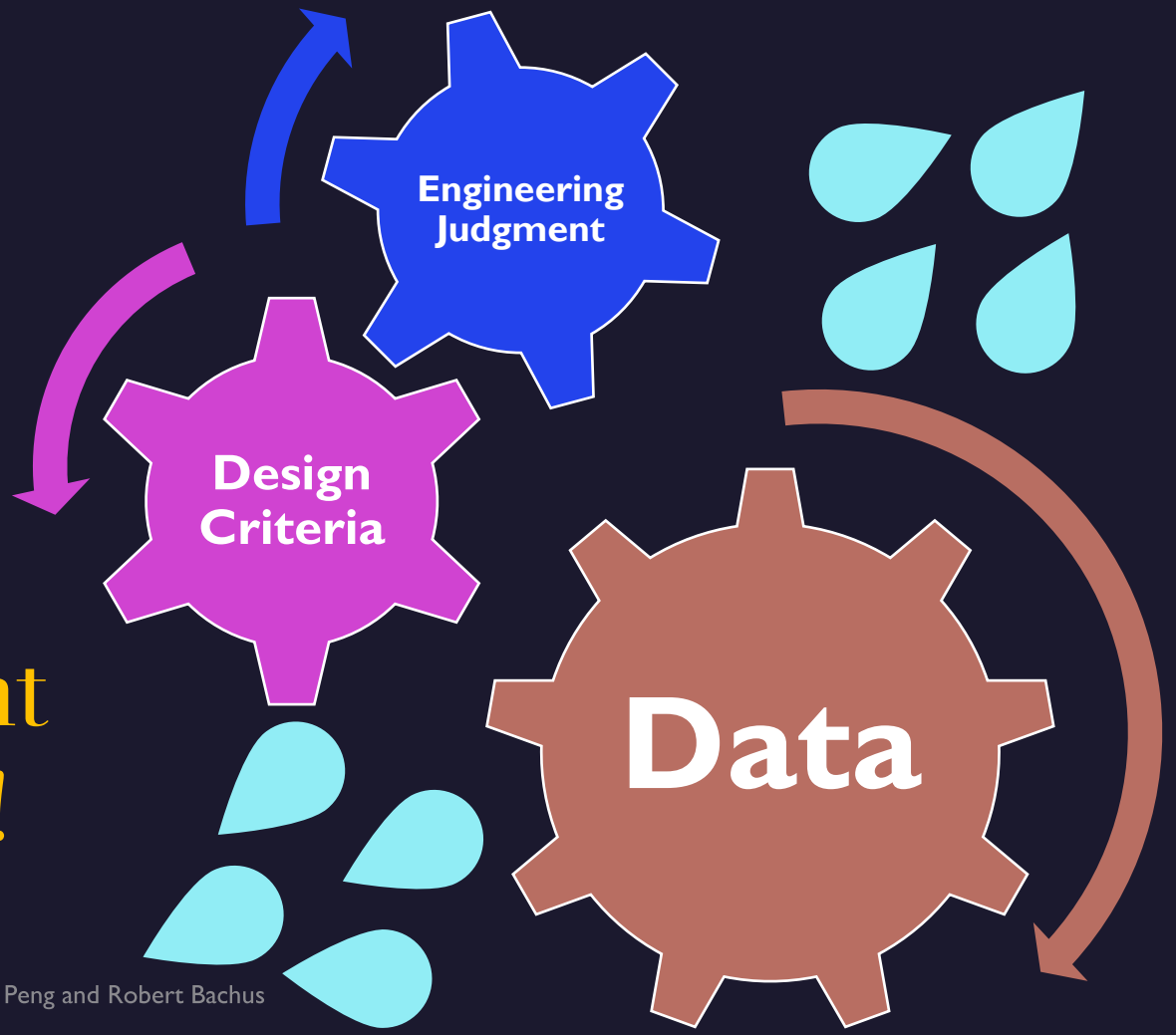
How to deliver your project in a more efficient and reliable manner?



Apply the proper "Lubricants"

More efficient and reliable!

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The Evolution of Project Delivery with Advanced Geotechnical Data Management Practice

- Geotechnical data transfer deliverables:
  - PDF summary data tables (project-specific);
  - Excel Spreadsheets (engineer-specific);
  - Borehole and CPT data in txt formats (organization-specific and/or contractor-specific);
  - Proprietary data formats (gINT *.gpj files);
  - Open-source data transfer formats, DIGGS in US and AGS in UK.
- Geotechnical data visualization and interpretation deliverables:
  - Hand-drawn Boring Logs;
  - PDF Boring Logs using gINT, Holebase, LogPlot, BorinGS, and Strater;
  - PDF fence diagrams using gINT, Holebase, LogPlot, BorinGS, and Strater;
  - Web-based geospatial and data-driven platforms to visualize and interpret geotechnical data.

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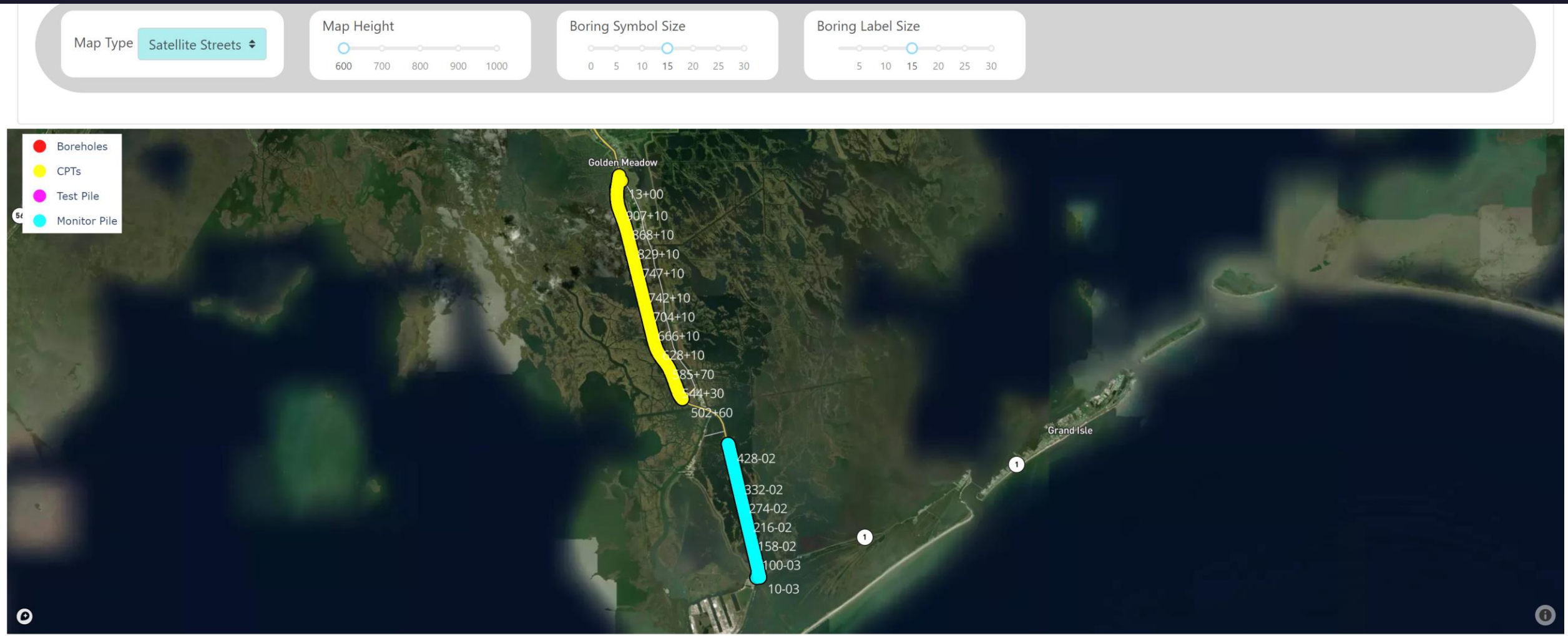
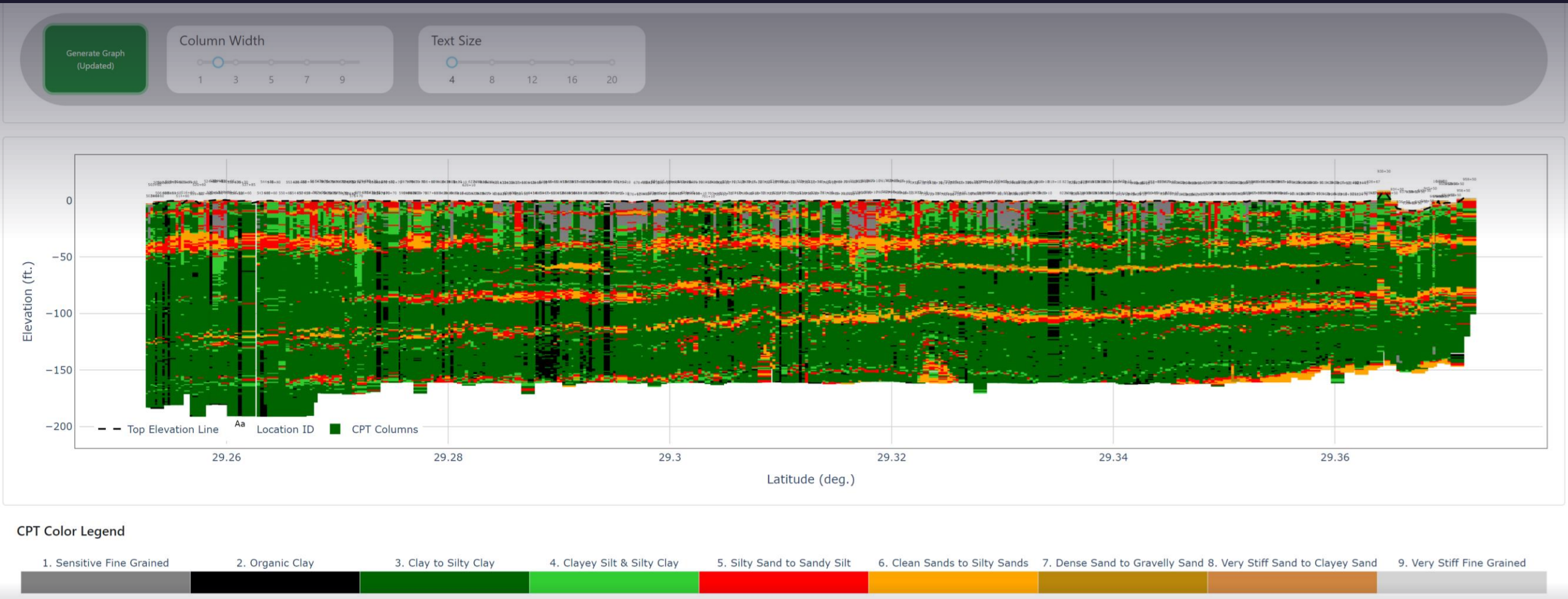
Quick Recap – Tailored Web-based geospatial and data-driven platforms to visualize and interpret geotechnical data for large projects in Louisiana

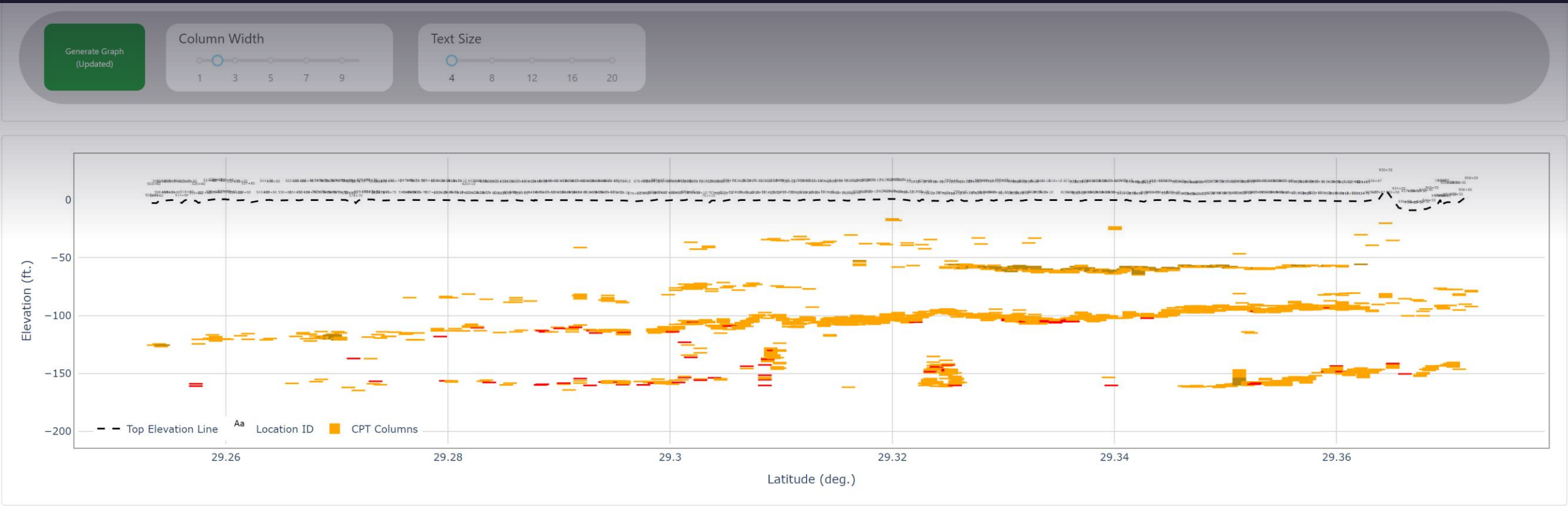
Interactive web-based map for borehole, CPT, and construction testing locations

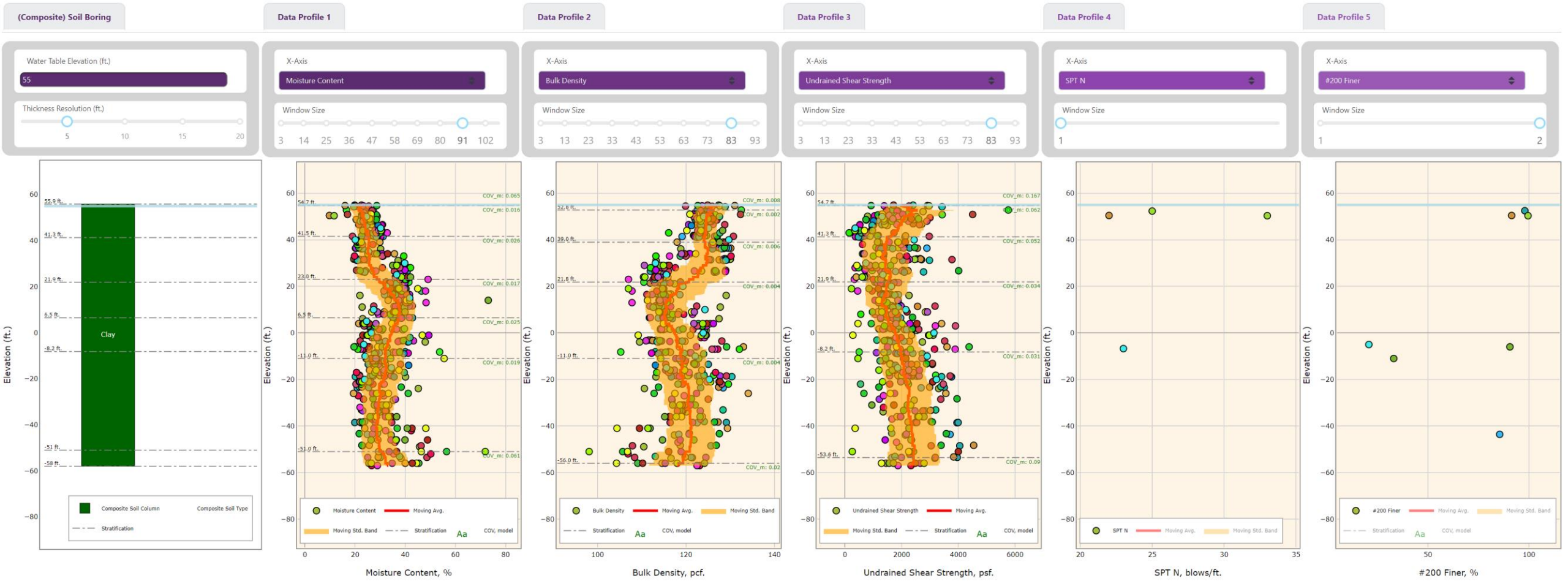


Generate a cross section with more than 300 CPTs in minutes



Implement user-defined rules to identify critical soil layers to facilitate design decisions





Develop data profiles with dynamically generated data statistical features and the independently generate soil stratigraphy boundary lines

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General Workflow

Compile different digital data source files

- •gINT *.gpj files
- •Standardized *.txt files
- •Standardized excel spreadsheets
- •Local and/or Cloud SQL and NoSQL databases
- •Open-source standardized data transfer files, e.g., DIGGS and AGS files

Standardize data formats for different data resources

- Borehole data
- CPT data
- Geophysical data
- Pile load testing data
- Other in-situ testing data
- Lidar data
- Any other data which is useful for projects

Deploy web-based geospatial and data-driven platforms to load and visualize all data

- A project-specific micro-database to host all data
- Simple and useful GIS features
- Simple and useful data visualization and data analytic features
- Standardized PDF reporting features

Implement tailored and project-specific features to fit the project needs in the web platforms

- Collaborate with engineering team to understand project-specific needs
- Implement tailored features to improve design efficiency and facilitate engineering decisions

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How Can DIGGS Help?

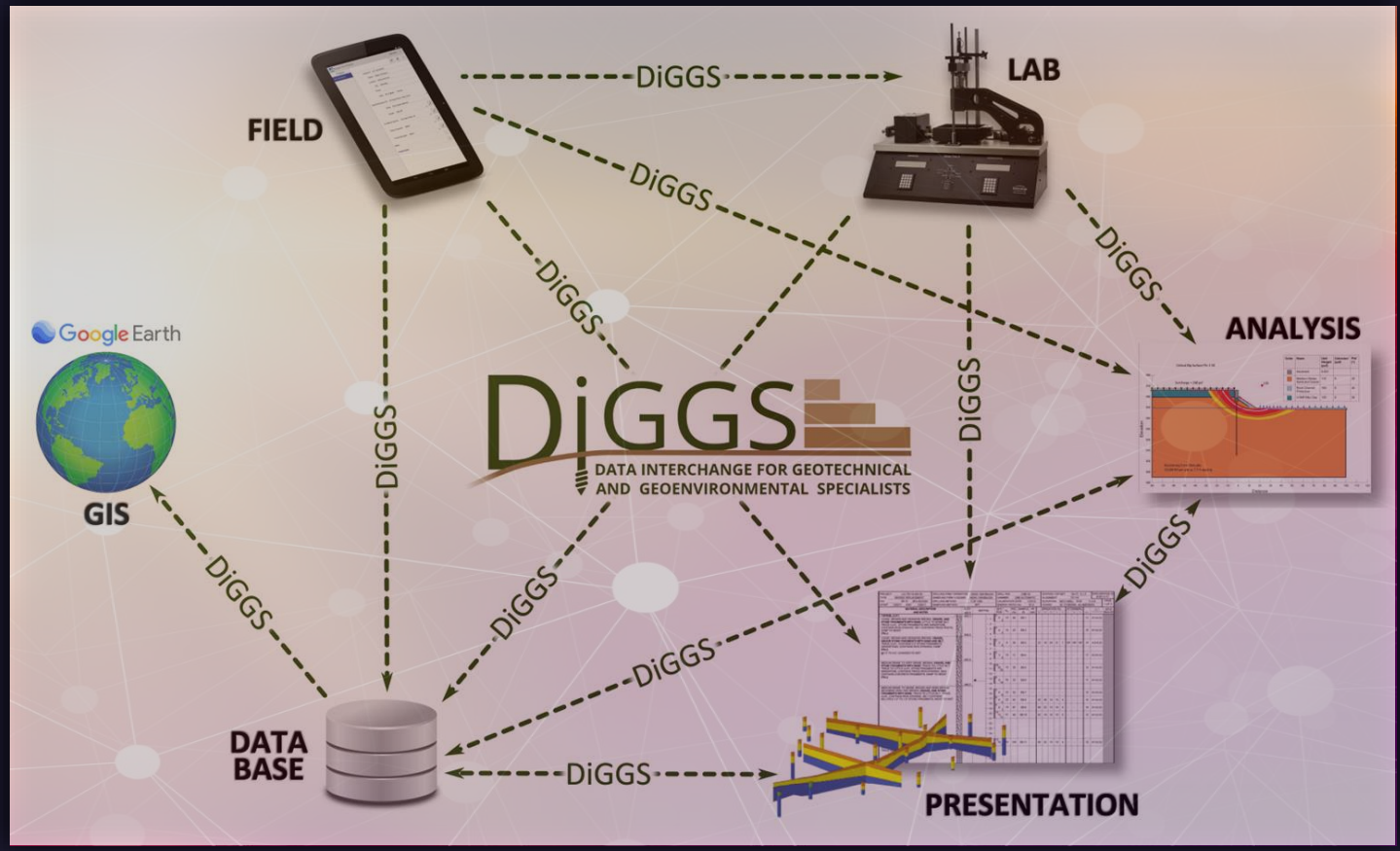
Data Interchange for Geotechnical and Geoenvironmental Specialists (DIGGS)

Standardized

Open-Source

Extensible

Data Exchange



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Showcases of DIGGS-Related Implementation

gINT (LADOTD) to DIGGS ...
DIGGS to tailored web-based platforms

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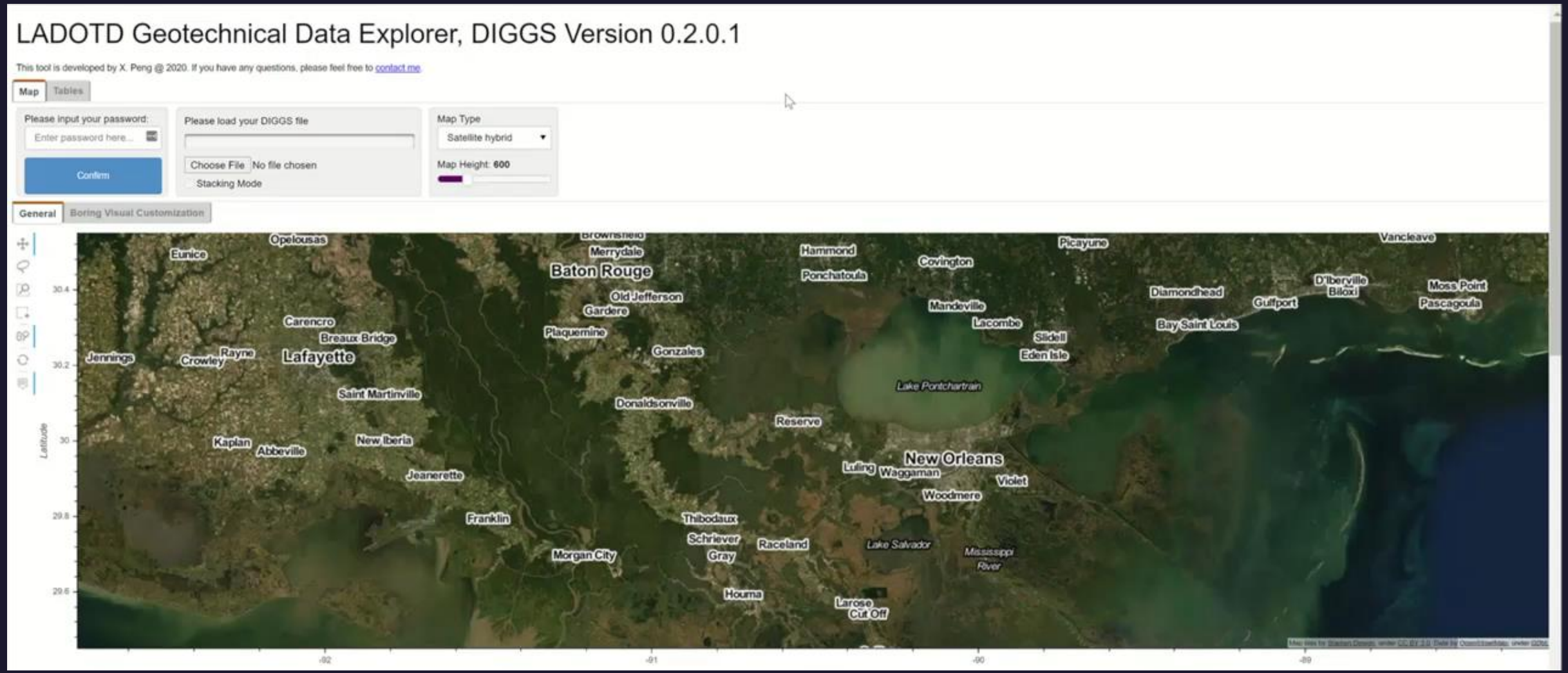
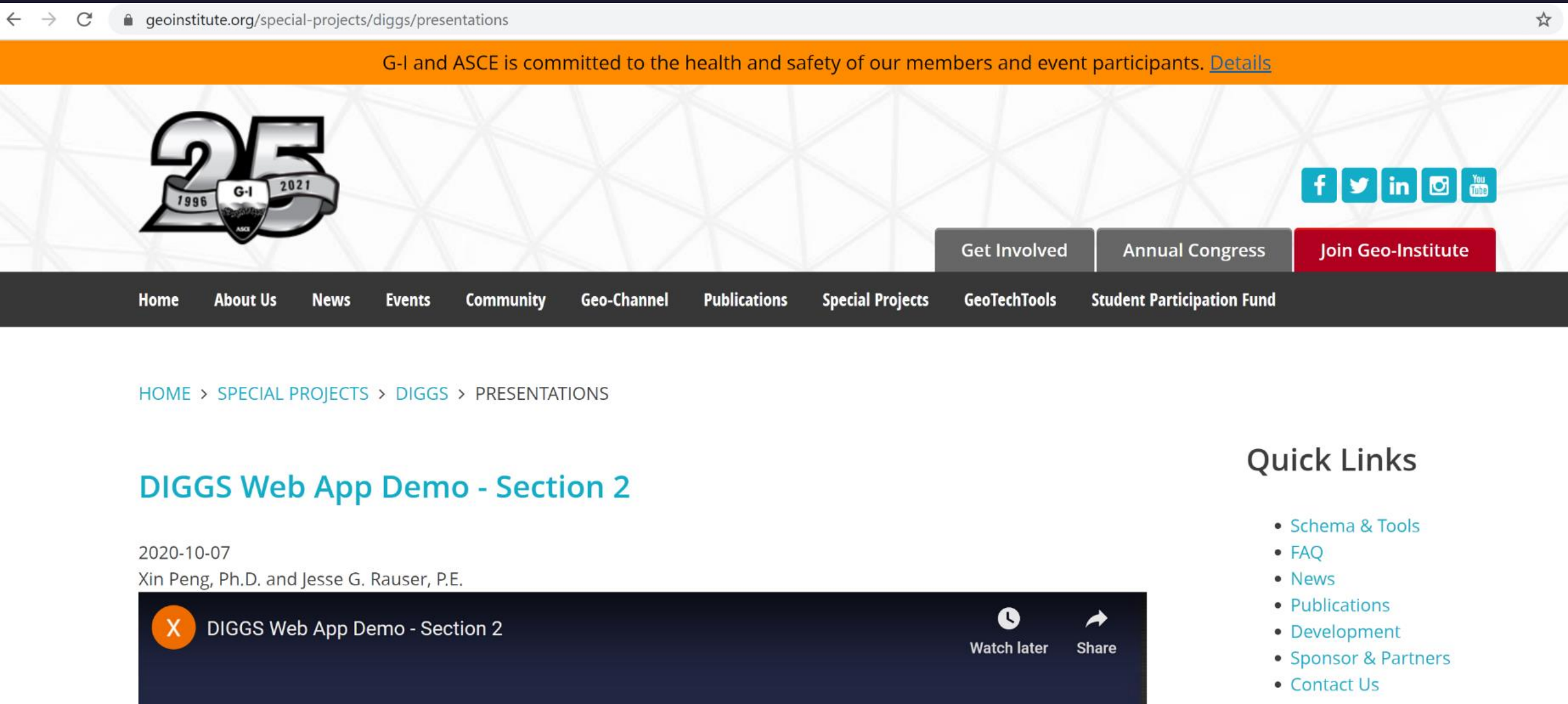


See complete demo videos on ASCE Geo-Institute's website:

https://www.geoinstitute.org/special-projects/diggs/presentations:



pyDIGGS – Open-Source Package to facilitate software vendors adopting DIGGS

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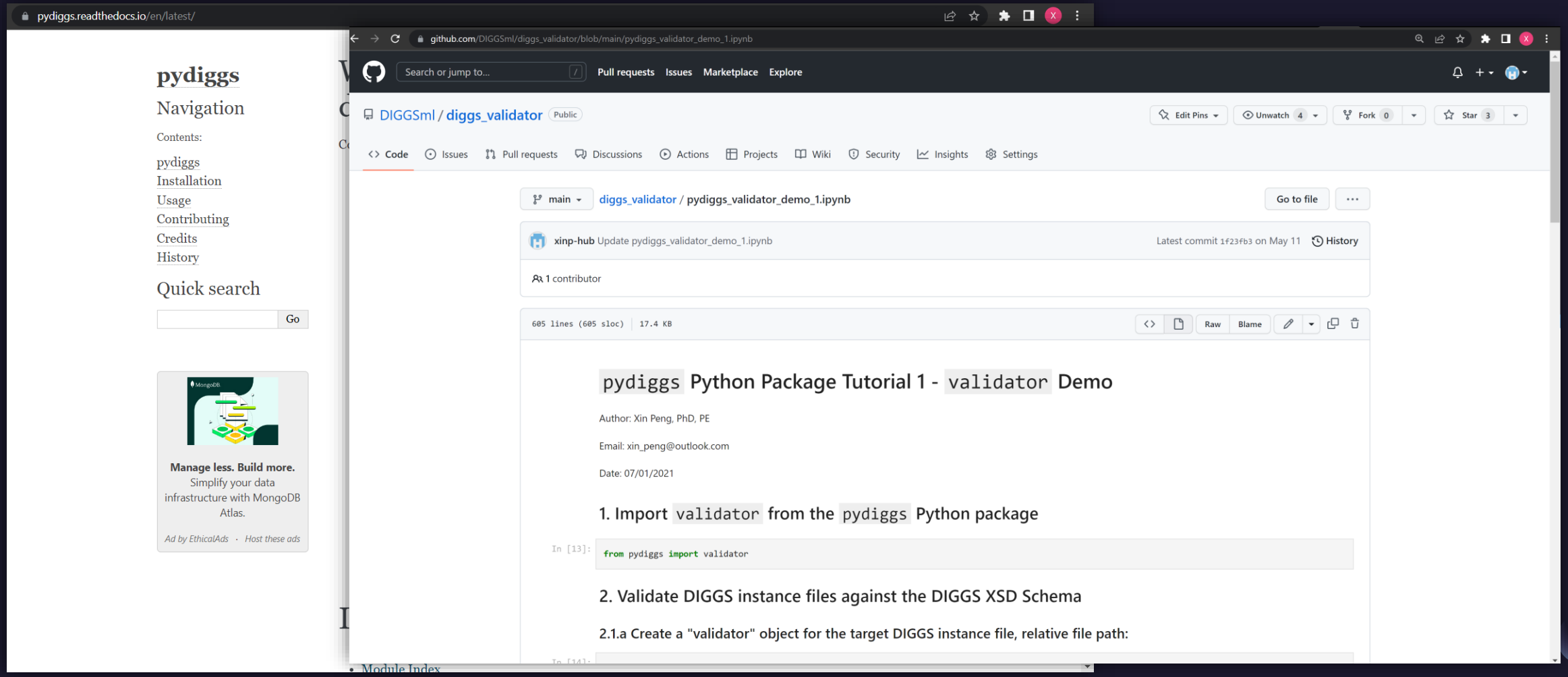

A Web Platform with a DIGGS Validation Feature (No Coding Experience required)

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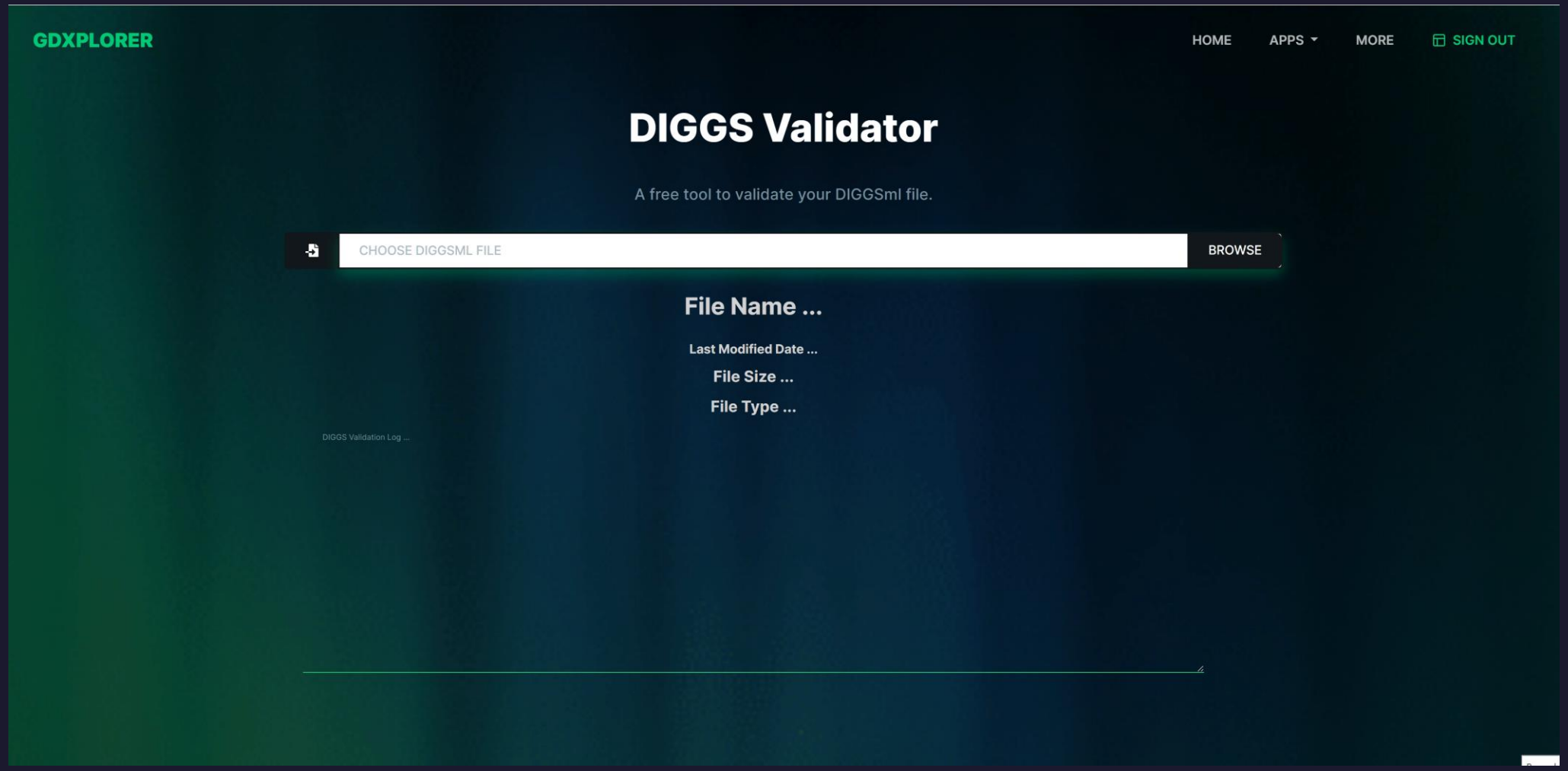

Additional Implementation

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10+ yrs

A design and construction project with coal combustion residuals (CCRs)

$$$$$

Geotechnical design and construction support

1000+ CPTs

Characterization of subsurface stratigraphy and soil design parameters

300+

Boreholes, and instruments for real-time construction monitoring

Additional Implementation - Project Needs

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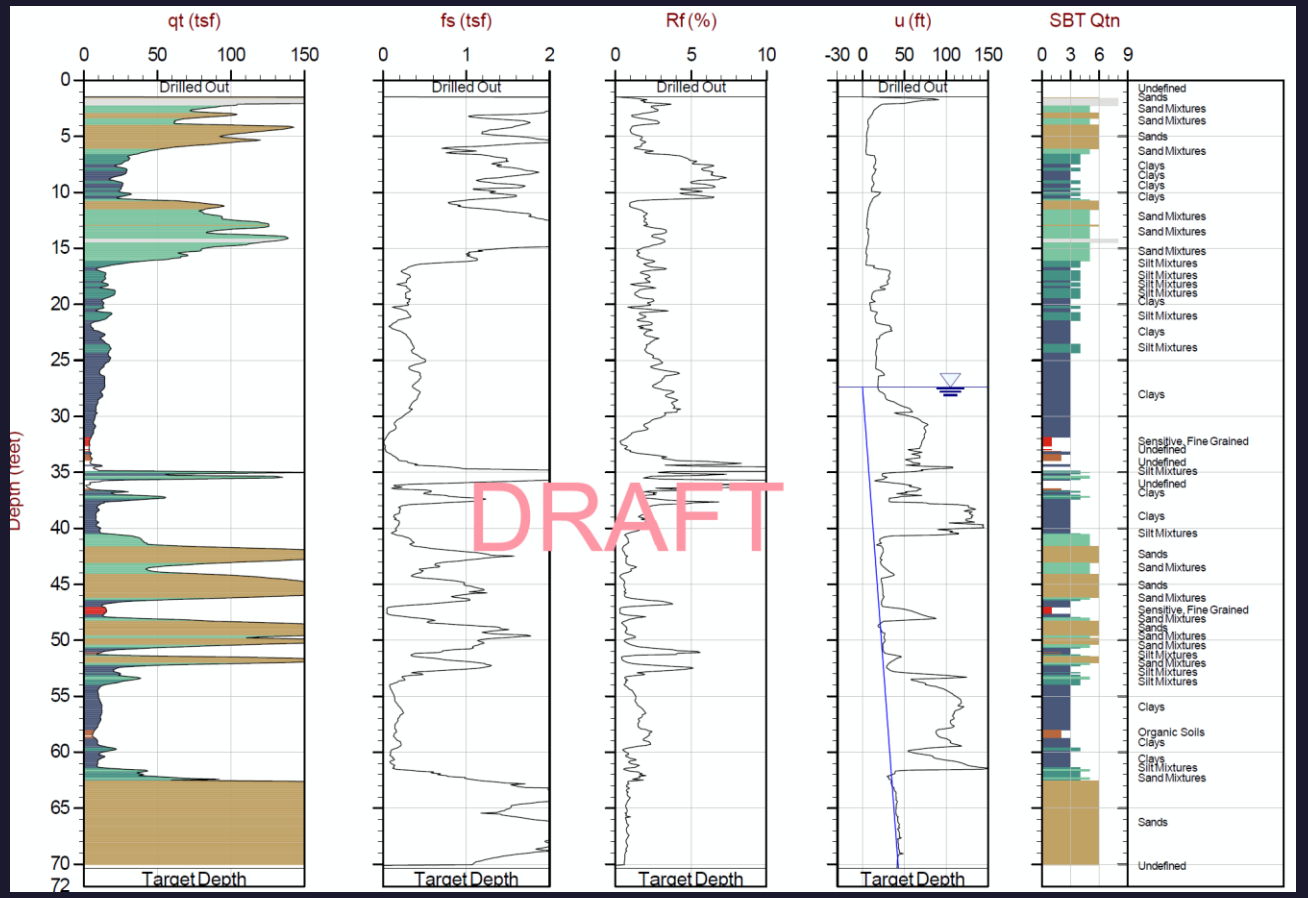
- Variable data source formats: Digital data files with different formats from CPT Contractors;
- Limited customization and inconsistency: The CPT interpretation from contractors/software vendors cannot be directly used for design;
- Project-specific needs: Project-specific CPT correlations and interpretations need to implemented;
- Inaccessibility: None of the existing tool can meet the project needs;
- Inefficiency: Developing excel spreadsheets to re-format and interpret CPT data is a tedious and inefficient work.



Additional Implementation - Solutions

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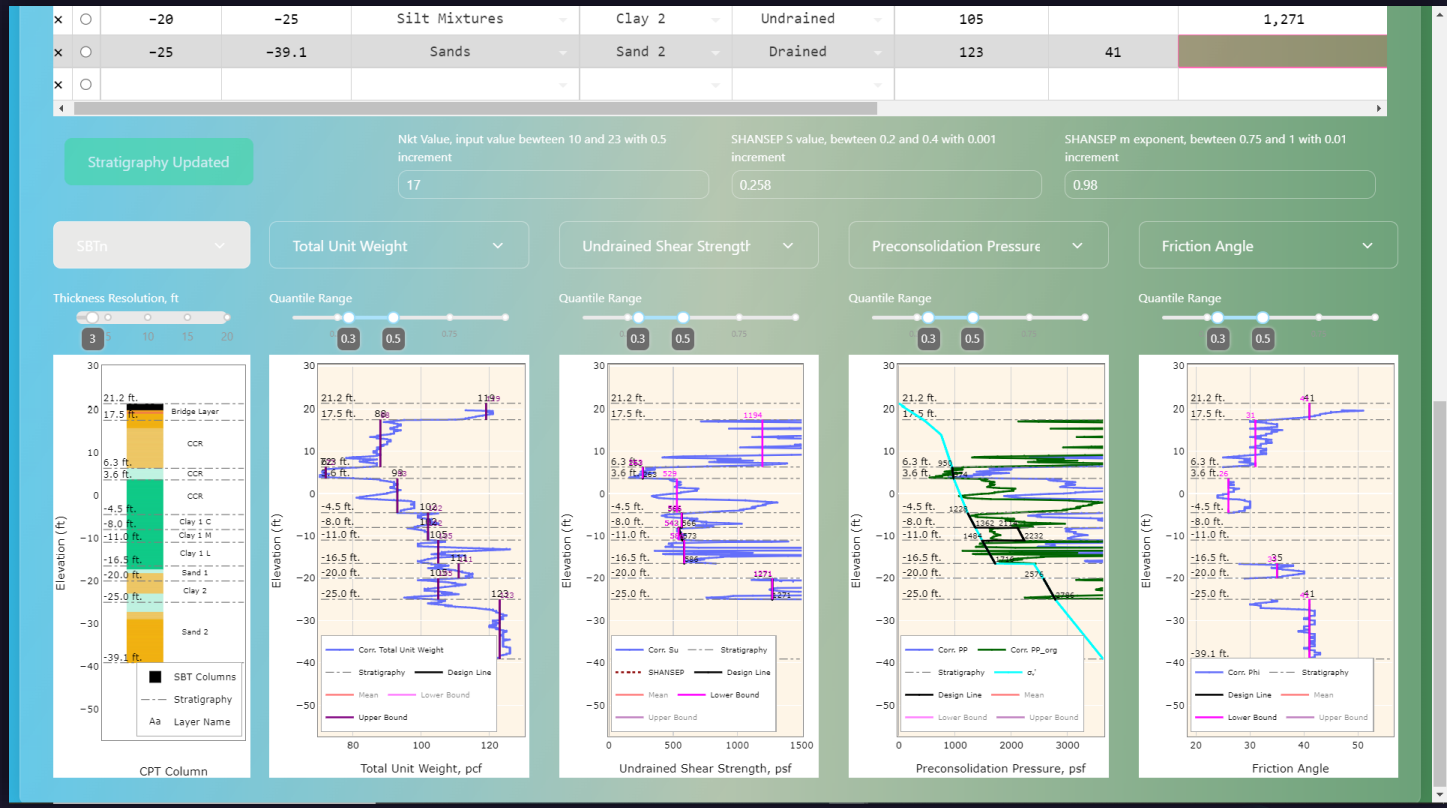
- A tailored web-based CPT platform: It is developed and customized to interpret CPTs to meet project needs;
- DIGGS compatible: This CPT tool can directly import DIGGS files and CPT data files from any CPT contractors;
- Improved efficiency: Engineers can save more than 50% of time to processing individual CPTs; (how much can be saved for processing 1000+ CPTs?)
- Quantifiable consistency: Consistent workflows with automated data statistics have been implemented to facilitate engineers developing soil design parameters.
- Flexibility to incorporate engineering judgement: Engineers can easily incorporate their own engineering judgement to finalize soil stratigraphy and the corresponding design parameters.



Additional Implementation
- Transition to Digital Transformation (DX)

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PDF CPT Log
(Review and Archive)

Digital Data File
(DX)

Local Staging
*.X File
(Revising CPT analysis)

A Project-Specific Web Platform

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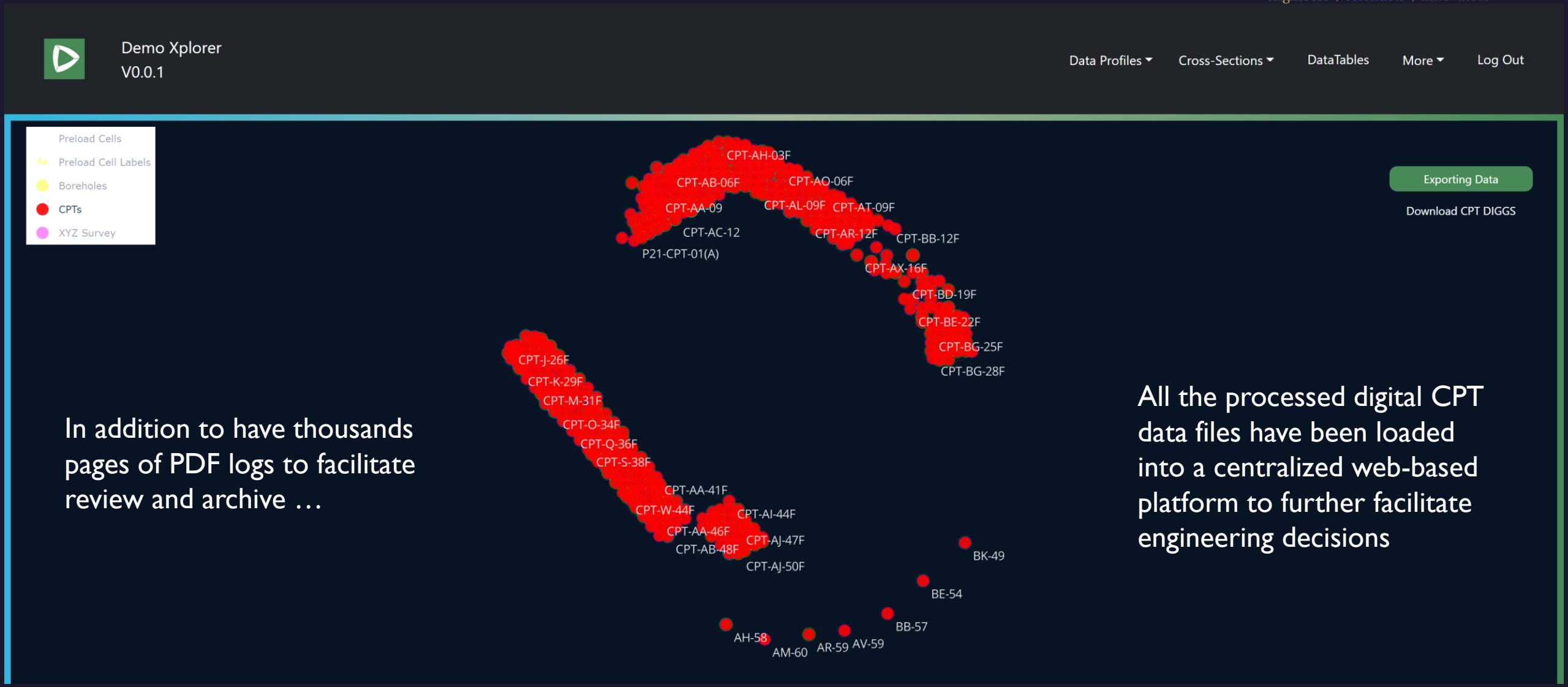

In addition to have thousands pages of PDF logs to facilitate review and archive …

All the processed digital CPT data files have been loaded into a centralized web-based platform to further facilitate engineering decisions

Dynamically estimating 2D and 3D soil stratigraphy between CPTs based on advanced statistic methods including kriging and machine learning (ML) algorithms.

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Generate Graph (Updated)

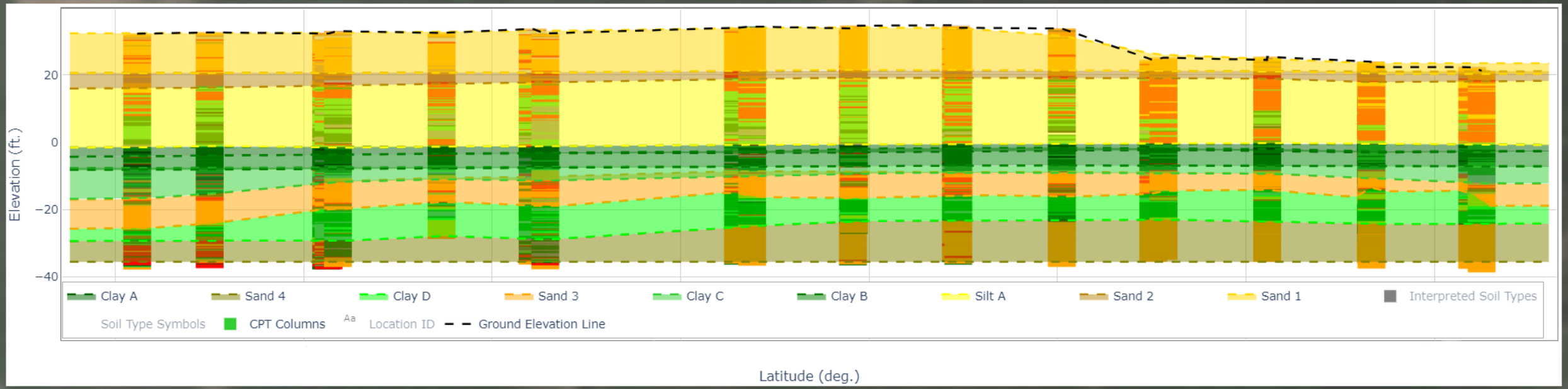
Column Width

Text Size

12

CPT Interpretation Method

SBTn, after 1990



CPT Color Legend

Final Thoughts

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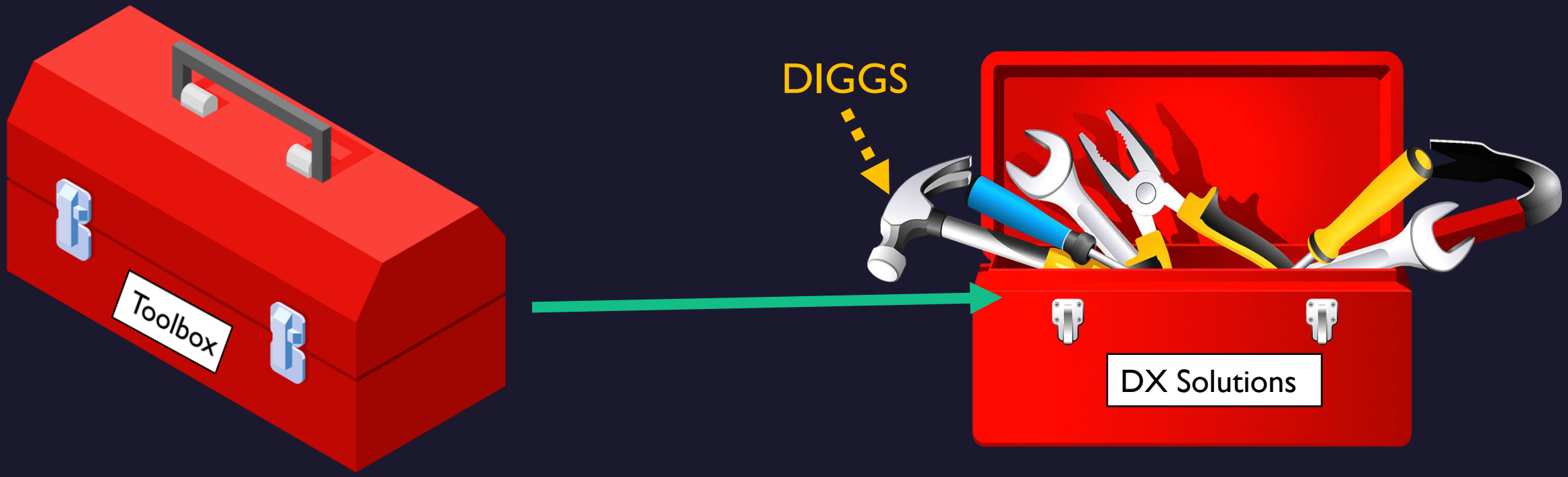

Toolbox = Digital Transformation (DX) solutions to enhance the value of data to reduce cost, improve efficiency, and facilitate engineering decisions

Final Thoughts

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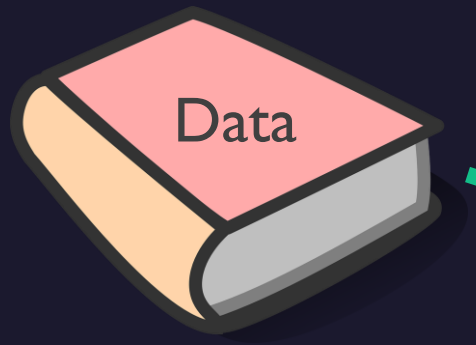

Data Management practice

Is this the goal?

http://www.pipa.sg/winners/winners-2021/photovivo-ptd-photo-travel-color/

http://www.pipa.sg/winners/winners-2021/photovivo-ptd-photo-travel-color/

How can we efficiently apply the "knowledge" from all the data to facilitate engineering practice?

A Free Live Webinar

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How Digital Transformation Will Advance Geotechnical Engineering in Your Data Management Practice … with and without gINT

10.26.2022

12 noon ET

by Xin Peng, Ph.D., P.E., and Robert Bachus, Ph.D., P.E., D.GE

Webinar Objectives:

- What is Digital Transformation (DX)?
- How DX can improve efficiency, reduce costs, and facilitate geotechnical engineering decisions.
- How DX can be implemented in your current and/or preferred data management workflows.
- DIGGS can help transition to DX.

Thank You

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