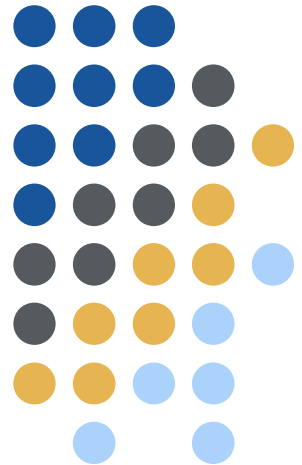
Geo-Statistical Deep Foundation Software

FDOT GRIP - Segment 2 - No. 10 - August 5, 2021



FDOT Project	BDV31 977-143
Project Manager	Rodrigo Herrera, PE
Institution	University of Florida
PI	Michael Davidson, PhD, PE
Co-PI	Michael Rodgers, PhD, PE
Co-PI	Gary Consolazio, PhD

BSI
Bridge Software Institute

Outline

- Introduction and background
- Project objective
- Project tasks and deliverables
- Implementation and deployment
- Project benefits
- Anticipated project timeline
- Closing discussion

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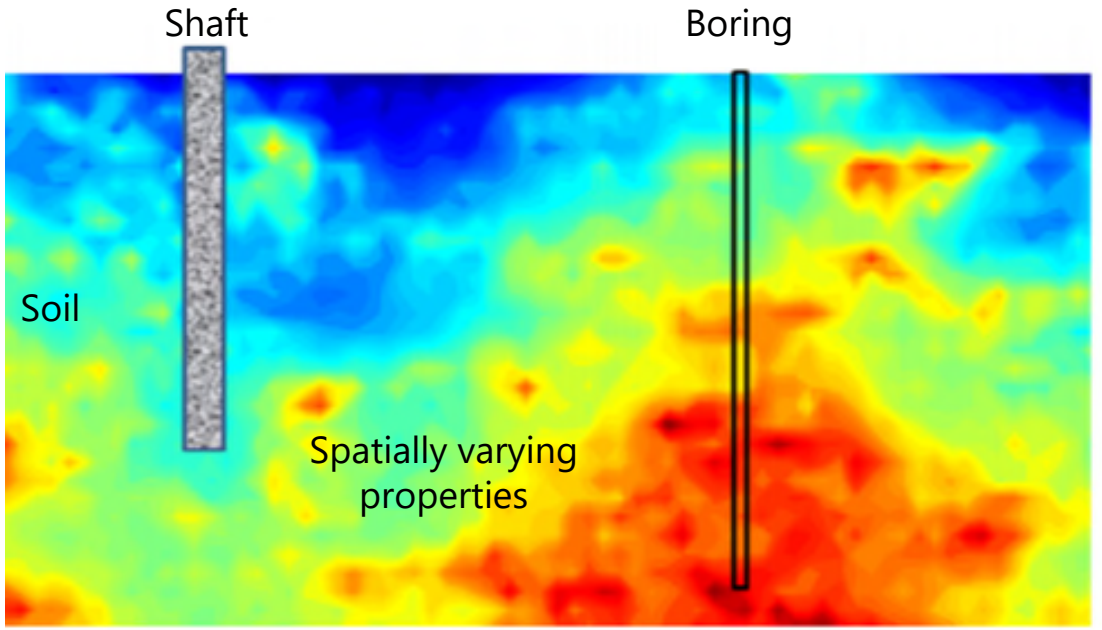
Introduction

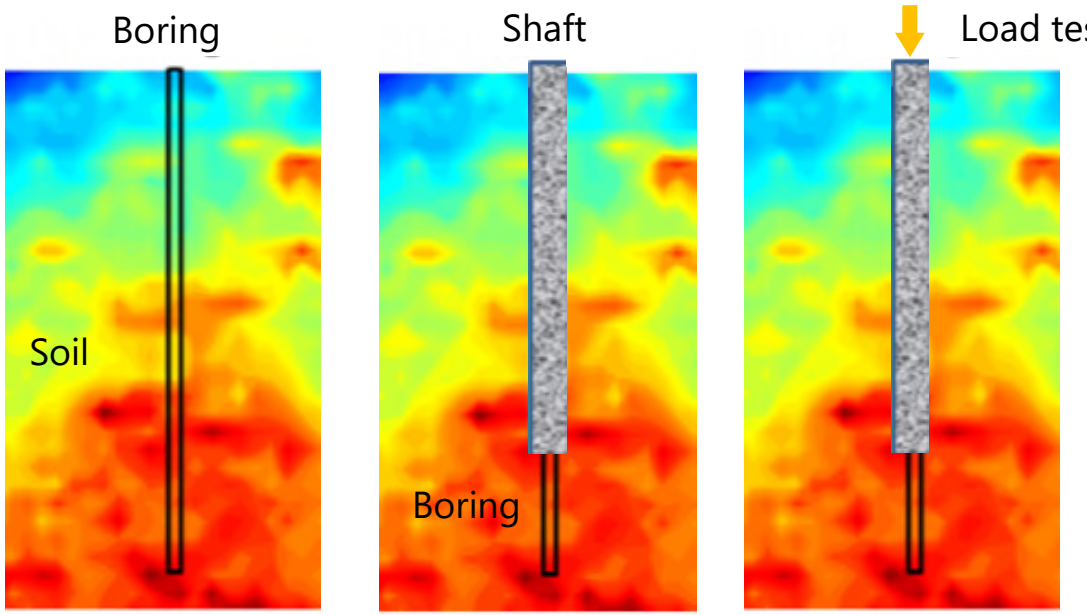
- Spatial variability
  - Horizontal
  - Vertical



Soil spatial variability (McVay et al. 2012)

Introduction

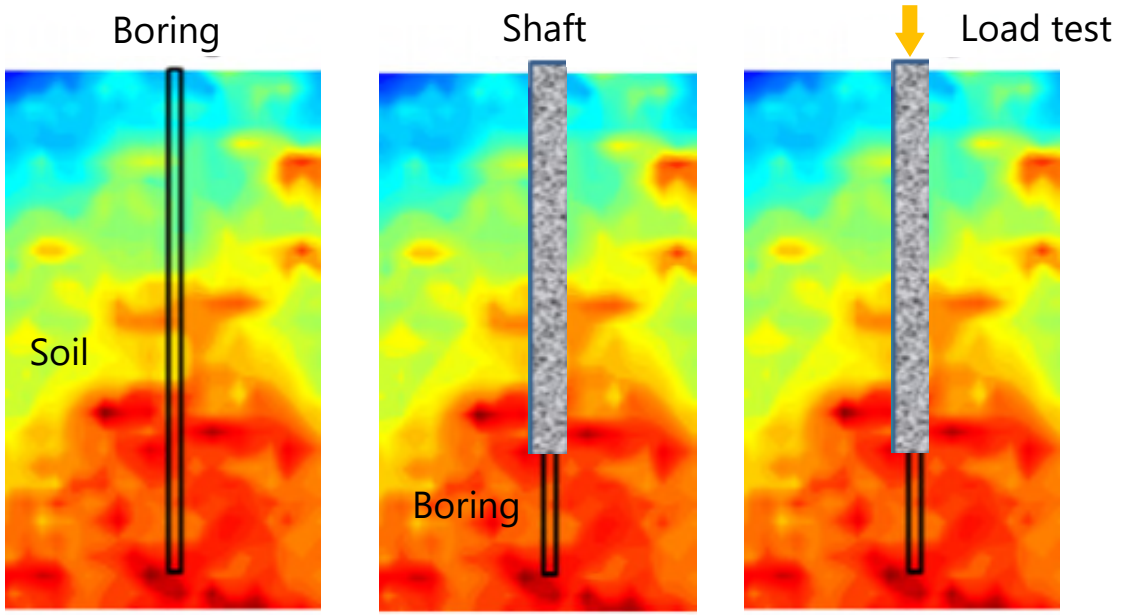
- Method error
  - Due to underlying assumptions in empirical methods
  - Correlation of measurement to unit resistance



Example: boring in footprint of shaft

Introduction

- Method error
  - Leads to uncertainty in computed capacities



Example: boring in footprint of shaft

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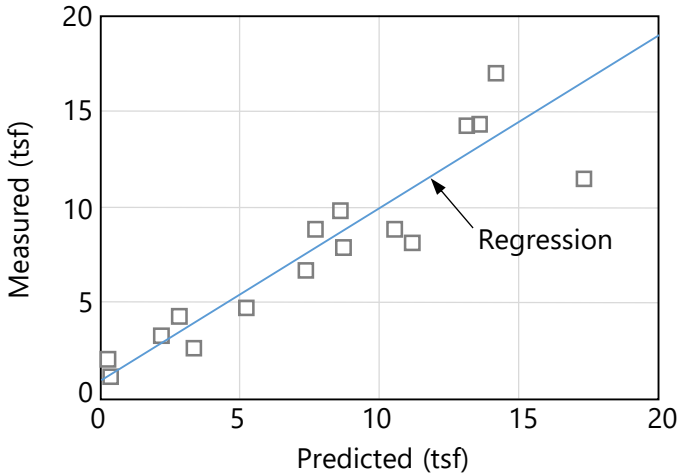
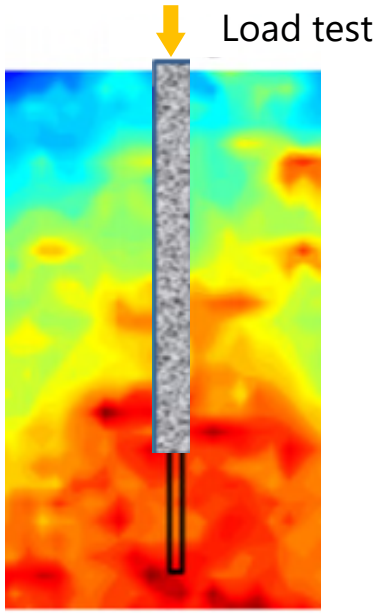


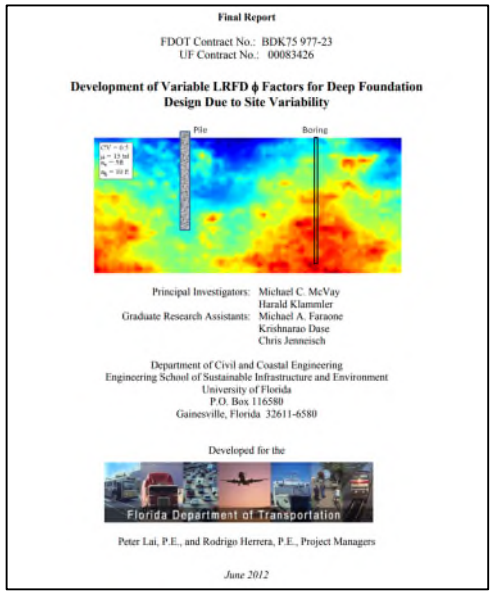
Predicted versus measured resistance



Example: boring in footprint of shaft

Background

- FDOT BDK 977-23 (McVay et al. 2012)
  - Developed geostatistical methodologies
  - Compiled method error data
  - Developed prototype tool


Final Report

FDOT Contract No.: BDK75 977-23
UF Contract No.: 00083426

Development of Variable LRFD ϕ Factors for Deep Foundation Design Due to Site Variability

Pile Boring

Principal Investigators: Michael C. McVay, Harald Klammler
Graduate Research Assistants: Michael A. Faraone, Krishnarao Dase, Chris Jenneisch

Department of Civil and Coastal Engineering
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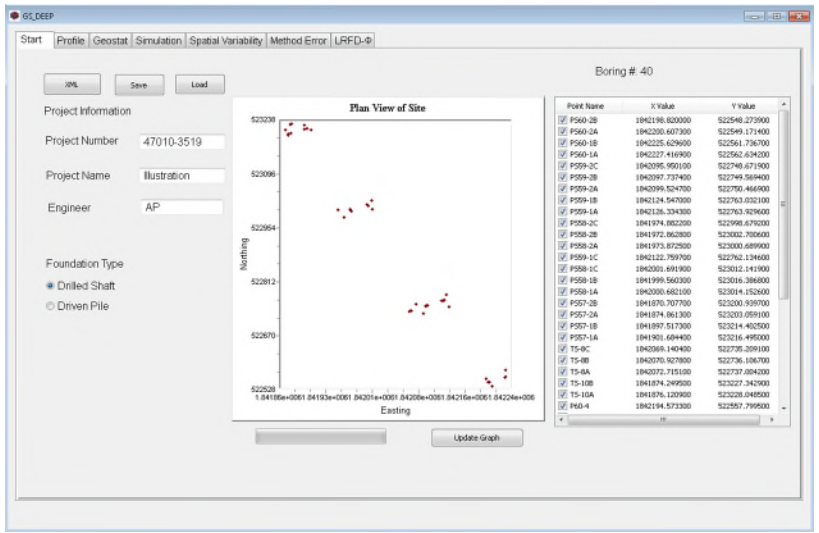
Developed for the

Florida Department of Transportation

Peter Lai, P.E., and Rodrigo Herrera, P.E., Project Managers

June 2012

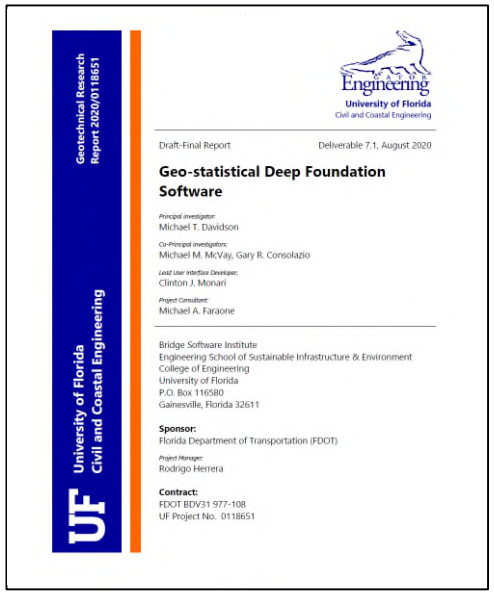
FDOT BDK75 977-23 final report



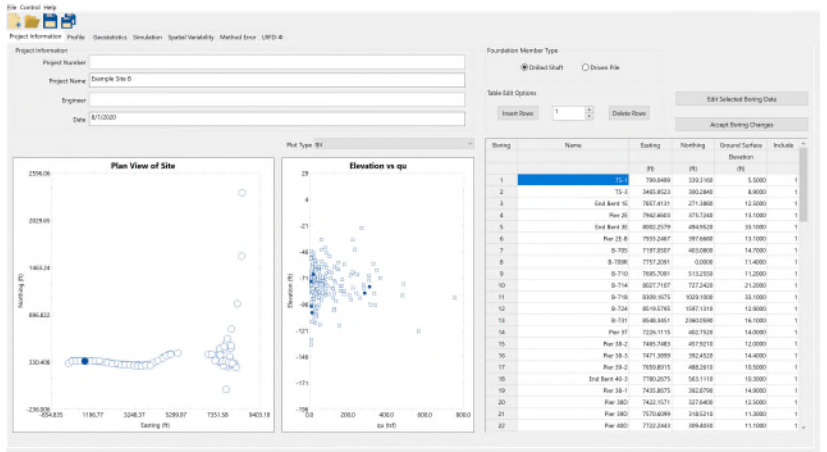
Prototype tool

Background

- FDOT BDV31 977-108 (Davidson et al. 2020)
  - Streamlined the prototype tool
  - Performed quality assurance and verification
  - Created help and technical manuals



FDOT BDV31 977-108 final report



Streamlined tool

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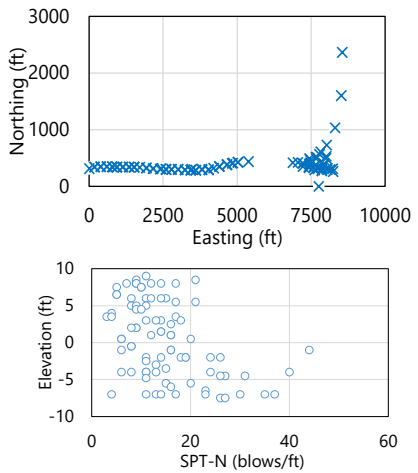
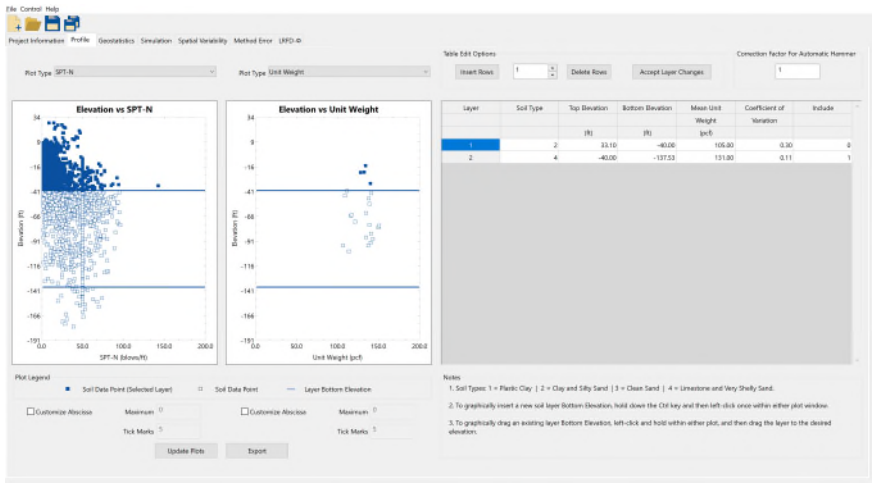
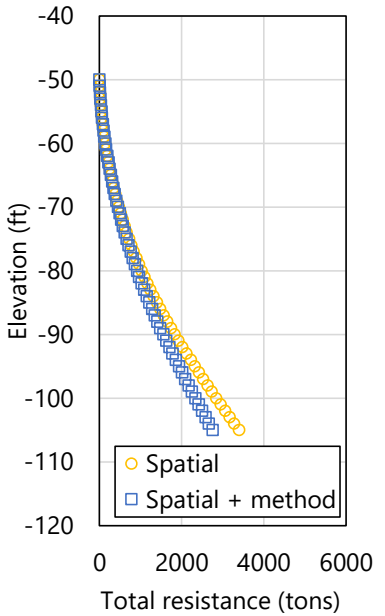
Objective

- Implement updates to streamlined geostatistical tool for use by practicing engineers
  - Leverage previous FDOT research
  - Compute axial design capacities of piles and shafts
  - Characterize uncertainty







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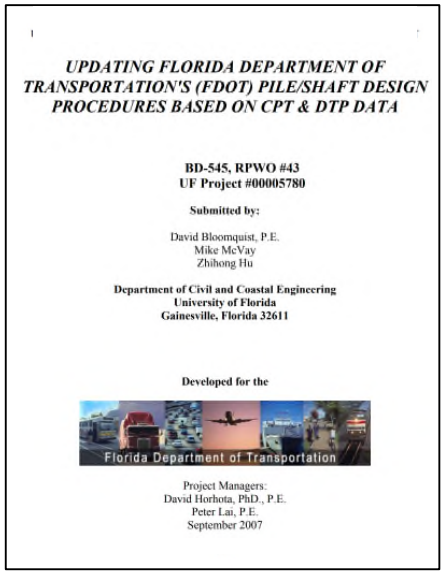
Project tasks and deliverables

- Task 1: Incorporate analysis of CPT data
  - Read-write of key variables
  - Generation of variograms
  - Population of analysis files for simulation
  - Identify method error regressions
  - Software manual documentation



UPDATING FLORIDA DEPARTMENT OF TRANSPORTATION'S (FDOT) PILE/SHAFT DESIGN PROCEDURES BASED ON CPT & DTP DATA

BD-545, RPWO #43
UF Project #00005780

Submitted by:

David Bloomquist, P.E.
Mike McVay
Zhihong Hu

Department of Civil and Coastal Engineering
University of Florida
Gainesville, Florida 32611

Developed for the

Florida Department of Transportation

Project Managers:
David Horhota, PhD., P.E.
Peter Lai, P.E.
September 2007

FDOT BD-545, RPWO #43 final report

Project tasks and deliverables

- Deliverable 1: Task 1 report
  - Input file format
  - User interface (UI) modifications
  - As-identified method error formulation

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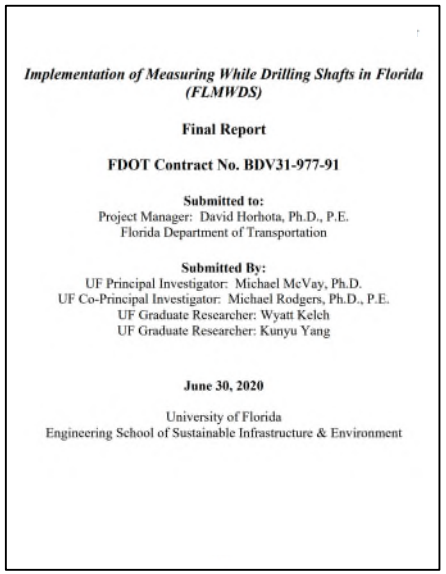
September 2007

FDOT BD-545, RPWO #43 final report

Project tasks and deliverables

- Task 2: Incorporate analysis of results from Measuring While Drilling (MWD)
  - Read-write of key variables
  - Generation of variograms
  - Population of analysis files for simulation
  - Identify method error regressions
  - Software manual documentation



Implementation of Measuring While Drilling Shafts in Florida (FLMWDS)

Final Report

FDOT Contract No. BDV31-977-91

Submitted to:
Project Manager: David Horhota, Ph.D., P.E.
Florida Department of Transportation

Submitted By:
UF Principal Investigator: Michael McVay, Ph.D.
UF Co-Principal Investigator: Michael Rodgers, Ph.D., P.E.
UF Graduate Researcher: Wyatt Kelch
UF Graduate Researcher: Kunyu Yang

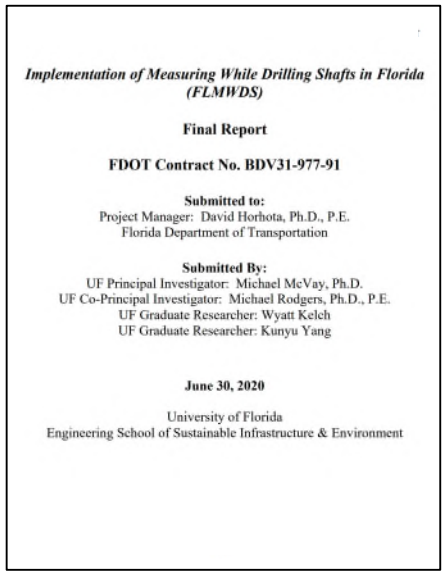
June 30, 2020

University of Florida
Engineering School of Sustainable Infrastructure & Environment

FDOT BDV31-977-31 final report

Project tasks and deliverables

- Deliverable 2: Task 2 report
  - Input file format
  - User interface (UI) modifications
  - As-identified method error formulation



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Submitted By:
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UF Graduate Researcher: Wyatt Kelch
UF Graduate Researcher: Kunyu Yang

June 30, 2020

University of Florida
Engineering School of Sustainable Infrastructure & Environment

FDOT BDV31-977-31 final report

FDOT BDV31-820-006

Project tasks and deliverables

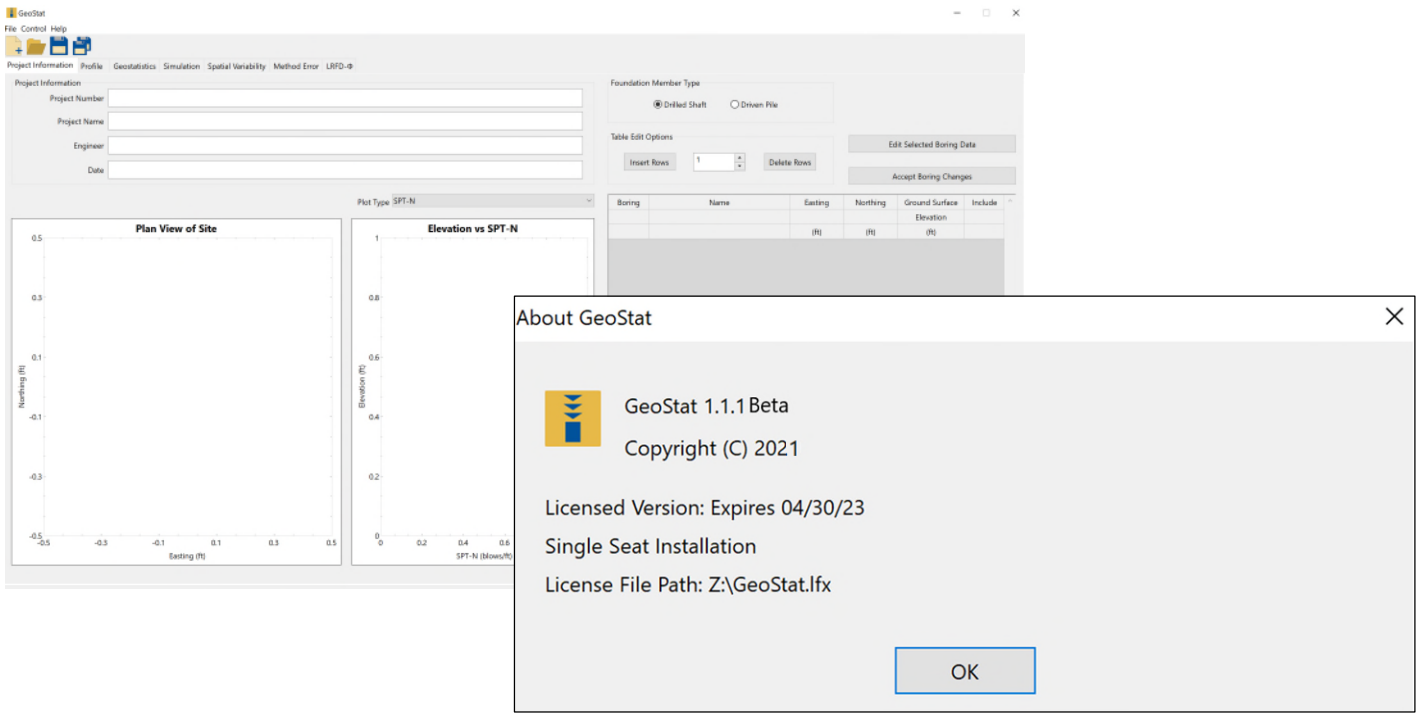
- Task 3: Conduct quality assurance (QA) testing
  - Develop test input sets
    - CPT
    - MWD
  - Add data validation checks
  - Ensure integrity of data writes to simulation files

Project tasks and deliverables

- Deliverable 3.1: Task 3 report
  - Input sets used for QA
  - Input and output processes
  - Summary of data validation checks
  - Listing of new program error messages

Project tasks and deliverables

- Deliverable 3.2: Beta version of GeoStat
  - Link to be provided to FDOT



Illustrative beta version dialogs

Project tasks and deliverables

- Task 4: Investigate methodology for effective radius
  - Assess GeoStat capabilities to produce estimates of zonal radius
    - Applicability of pile/shaft LRFD resistance factors
  - If identified as feasible:
    - Obtain site data from Project Manager
    - Build up illustration case
    - Add feature to visualize radius on plan-view plot within program

Project tasks and deliverables

- Deliverable 4: Task 4 report
  - Assess program capabilities
  - If feasible:
    - Key steps of methodology
    - Illustration case
  - If not feasible:
    - Document underlying reasons

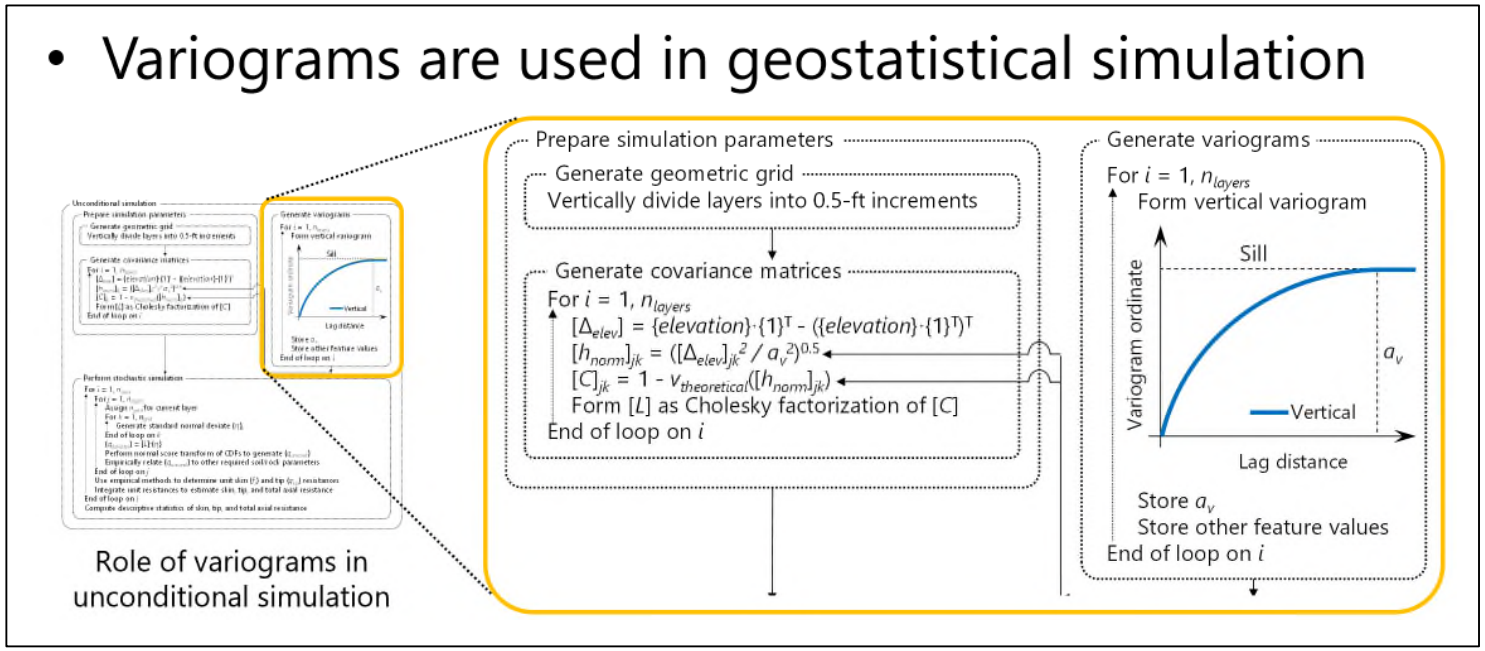
GeoStat Technical Manual

Project tasks and deliverables

- Task 5: Technology transfer
  - Leverage sample projects in FDOT BDV31-97-108
  - Web-based
  - Delivered to FDOT district engineers
  - Two sessions
    - Theoretical basis and driven pile sample project (2 hrs)
    - Drilled shaft sample project and Q&A (2 hrs)

Project tasks and deliverables

- Deliverable 5: Technology transfer materials
  - Zip-file package
    - Slides
    - Models



Illustrative technology transfer content for theoretical basis

Project tasks and deliverables

- Task 6: Draft final and closeout teleconference
  - Deliverable 6.1: draft final report
  - Deliverable 6.2: Closeout teleconference

- Task 7: Final report
  - Deliverable 7: Submission of final report

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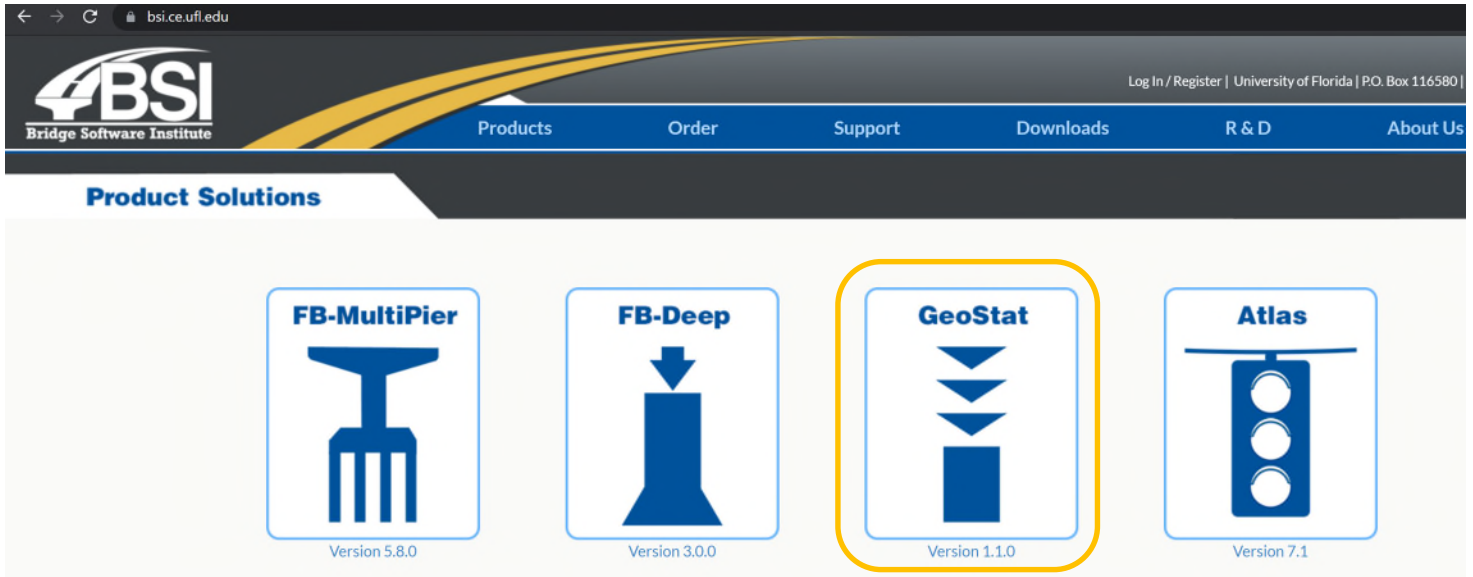
Implementation and deployment

- Licensed software made available to practicing engineers at bsi.ce.ufl.edu
- Maintained by BSI



Illustrative website layout

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Project benefits

- New methodologies for geostatistical analysis
  - CPT
  - MWD
  - Zonal radius visualization
- Technology transfer
  - Promotes use by FDOT engineers

Project benefits

- Quantitative:
  - How much variability is present in computed pile/shaft axial capacity?
  - How much uncertainty?
  - Are geological zones present?
- Qualitative:
  - Within a zone/site, what are representative layer definitions?
  - Do additional site data need to be gathered?

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- Introduction and background
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Anticipated project timeline

- Total duration: 18 months
  - Task 1 (Deliverable 1: Nov. 2021)
  - Task 2 (Deliverable 2: Mar. 2022)
  - Task 3 (Deliverable 3.1: Jun. 2022)
  - Task 3 (Deliverable 3.2: Jun. 2022)
  - Task 4 (Deliverable 4: Aug. 2022)
  - Task 5 (Deliverable 5: Sept. 2022)
  - Task 6 (Deliverable 6.1: Oct. 2022)
  - Task 6 (Deliverable 6.2: Dec. 2022)
  - Task 7 (Deliverable 7: Jan. 2023)

Anticipated project timeline: Where we are

- Total duration: 18 months
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  - Task 2 (Deliverable 2: Mar. 2022)
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  - Task 7 (Deliverable 7: Jan. 2023)

Where we are: preliminary progress

- Task 1: Incorporate analysis of CPT data
  - Read-write of key variables
    - Tip resistance, sleeve friction
  - Generation of variograms
    - Tip resistance w/ co-simulation
  - Population of analysis files for simulation
    - Draw upon existing FB-Deep syntax
  - Identify method error regressions
    - FDOT BD-545, RPWO #43 final report, Tables in Ch. 4

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Thank you