Charles D. Baker, Governor
Karyn E. Polito, Lieutenant. Governor
Stephanie Pollack, MassDOT Secretary & CEO

massDOT
Massachusetts Department of Transportation

2021 RESEARCH PROJECT STATEMENT

Research Topic:
Massachusetts Depth to Bedrock Project

Research Budget and Timeline:
- $90,000-$115,000
- 16-21 months (of which final 3 months are for review)

Problem Statement and Objectives

Fundamental to any transportation planning and engineering activity is having a reasonable estimate of the thickness of the overburden. It affects project design, cost of construction as well as risk to structures due to ground shaking during an earthquake. Furthermore, estimates of the thickness of overburden, along with the type of overburden (glacial till, varved clay, sand and gravel) help determine the number of borings necessary as well as the best and most appropriate subsurface investigation technology to use during project planning, both of which affect costs and project delivery schedule.

Massachusetts has a number of existing data sets (MWRA project borings, MassDOT bridge borings, subsurface borings from the Big Dig collected by Tufts University, MassDEP private well completion reports, USGS NWIS database, among others) containing reliable soil thickness information (est. 100,000 records) that have never been assembled in one place and used to generate to 2D map of the thickness of overburden.

Accordingly, this research has the following objectives:

1) Identify, collect, assemble and apply the necessary data validation, quality control, attribution and processing to each of the existing data sources to unify the information for modeling soil thickness;

2) Combine soil thickness values with the constraints in the recently completed statewide surficial materials map (outcrops and shallow bedrock areas), LiDAR data (surface elevation) and other sources to model a continuous soil thickness raster along with a data quality confidence raster using appropriate geostatistical or other methods;

3) Use the soil thickness raster along with existing shear wave velocity data to generate a NEHRP soil classification map for Massachusetts. The main outcomes of this work will be resource maps in raster format showing the altitude of the top of bedrock and thickness of overburden that can be imported directly into MassDOT's Geographic

Information System (GIS) for use in helping plan and design any highway project in Massachusetts.

Anticipated Outcomes and Deliverables

1. Statewide 2-D raster of the thickness of overburden accompanied by a confidence map indicating the level of spatial uncertainty in the thickness estimate.

2. Statewide 2-D raster of the altitude of the surface of the bedrock accompanied by a confidence map indicating the level of spatial uncertainty in the altitude estimate.

3. A set of local, Massachusetts-specific calibration curves relating depth vs. fundamental site frequency for estimating depth to bedrock using the Horizontal to Vertical Spectral Ratio technique (passive seismic). These calibration curves will be used to estimate depth to bedrock in critical areas where borehole data is unavailable and to fill in data gaps in 1 and 2 above.

4. A reprocessing module or script that will automate updating the maps as new thickness of overburden point data are provided.

5. An improved statewide map showing National Earthquake Hazard Reduction Program (NEHRP) soil classifications augmented by the improved soil thickness data.

Final Deliverables:

1. GIS data layers for MassDOT GIS
2. Webinar – How to use the map layers
3. Final Presentation
4. Final Report