

Liquefaction Mitigation Study using Bio-remediation

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Oregon Seismic Safety Policy Advisory Commission (OSSPAC) meeting
Salem, Oregon (July 9, 2019)

Research Team



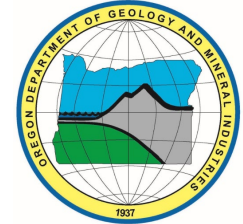
Dr. Arash Khosravifar,
Assistant Professor



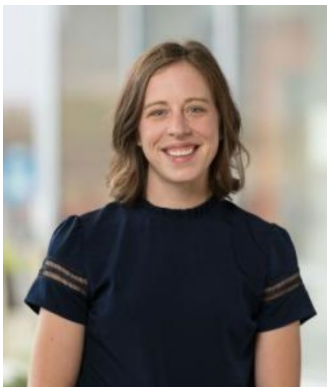
Dr. Ed Kavazanjian,
Professor



Dr. Ken Stokoe,
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(Advisor)



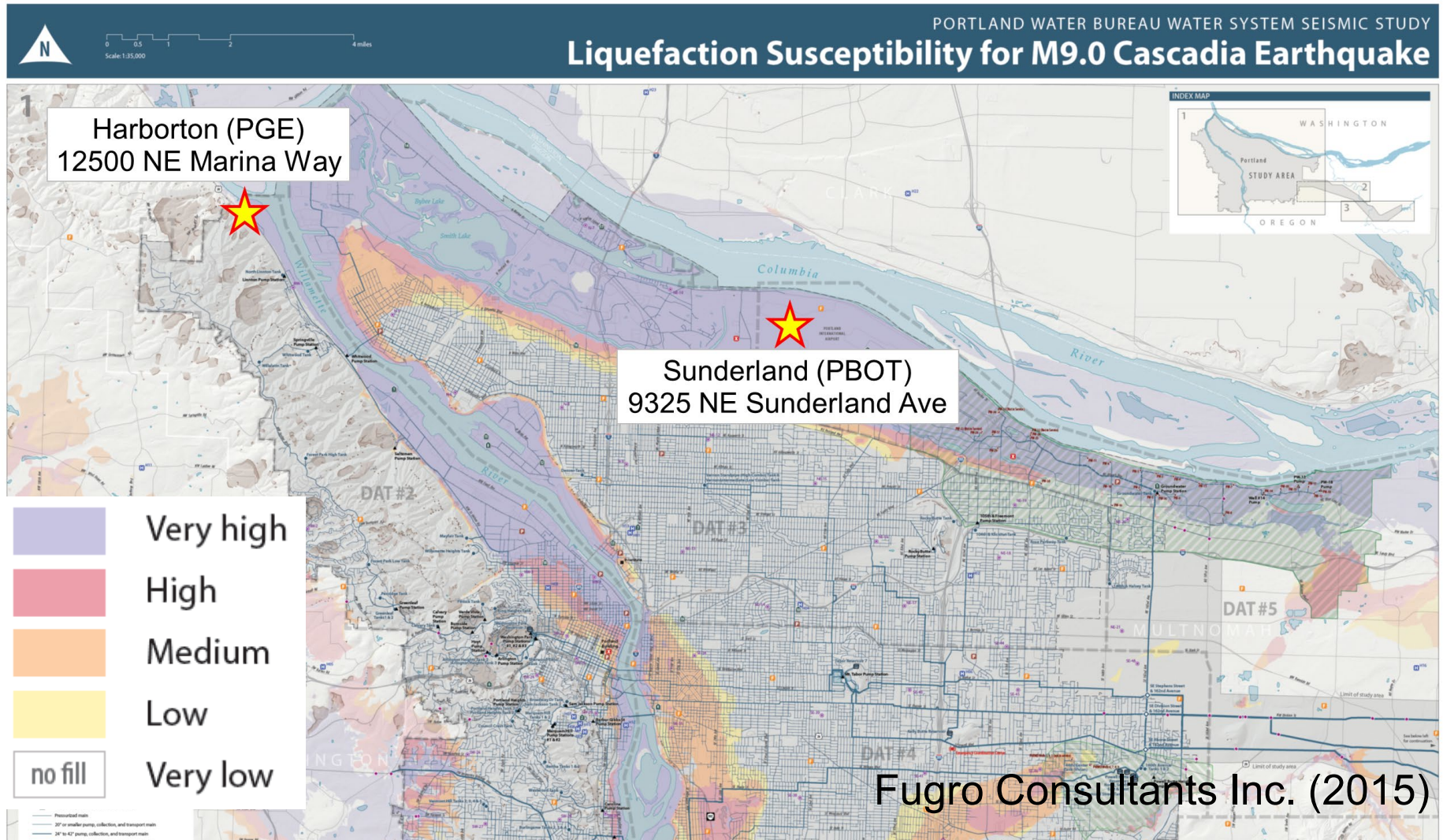
Dr. Diane Moug,
Assistant Professor



Dr. Leon van Paassen,
Associate Professor

Liquefaction Hazard in Portland

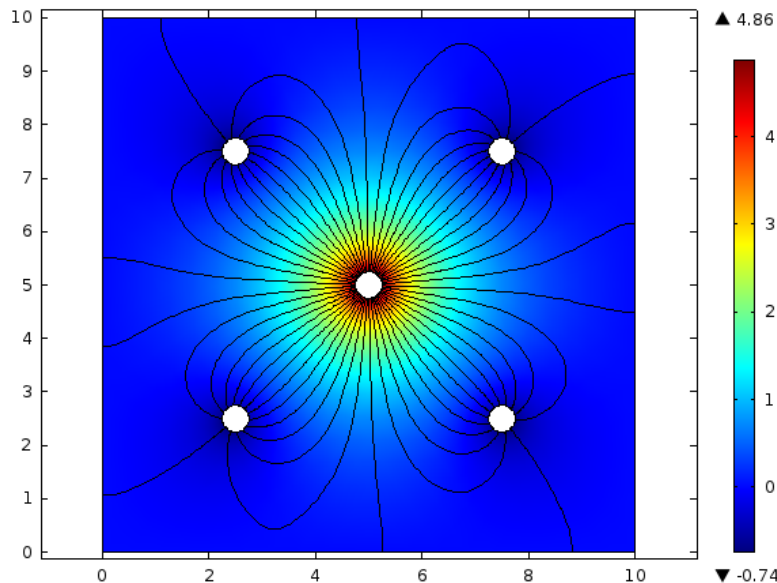
- Two sites selected for this study



Ground Treatment Method

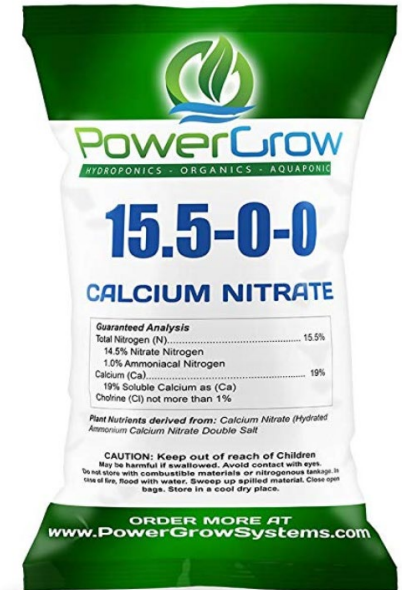
- Microbial Induced Desaturation and Precipitation (MIDP)
- Nutrients (treatment substrates) are injected to the ground from a central well and extracted from perimeter wells
- Denitrification results in nitrogen gas which desaturates the soil (unsaturated soil is not liquefiable)

Q=5.7870E-5, K=1.0000E-6 Time=1.7280E5 s Streamline: Darcy's velocity field
Surface: Hydraulic head (m)



Ground Treatment Method (MIDP)

- Advantages over other mitigation methods
 - Suitable for silts (e.g. Willamette Silt)
 - Non-invasive, suitable for existing structures sensitive to vibration (e.g. fuel tanks in CEI hub)
 - Nutrients are calcium nitrate (fertilizer) and calcium acetate (food grade), byproducts (nitrogen gas and carbon dioxide) are environmentally benign.



Ground Treatment Method (MIDP)

O'Donnell et al. (2017)

- Previous tests
 - Lab scale tests and centrifuge tests showed effectiveness
 - Field tests in Japan showed that the effect lasts for decades
 - Field tests are ongoing (Toronto ON, Richmond BC, and Portland)



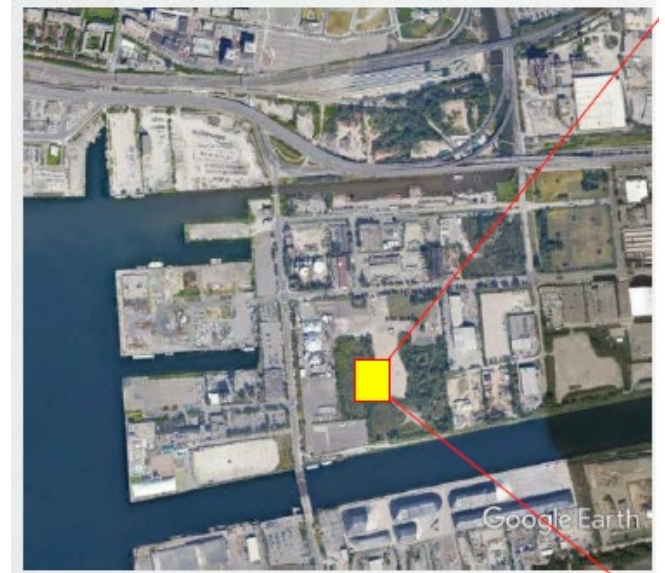
Day 1



Day 7



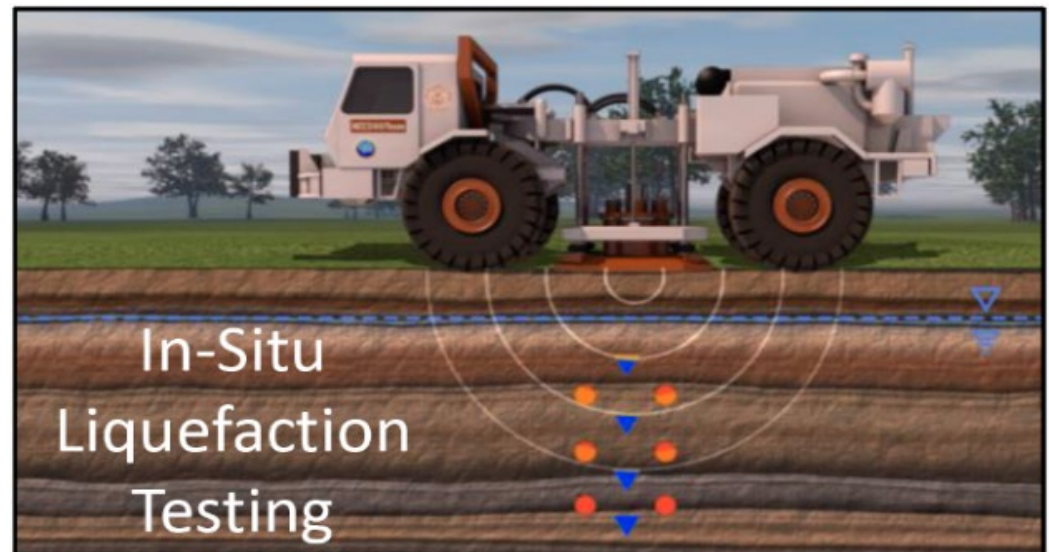
Day 17



Pilot site Toronto
Courtesy of Leon van Paassen

Scope of Tests in Portland

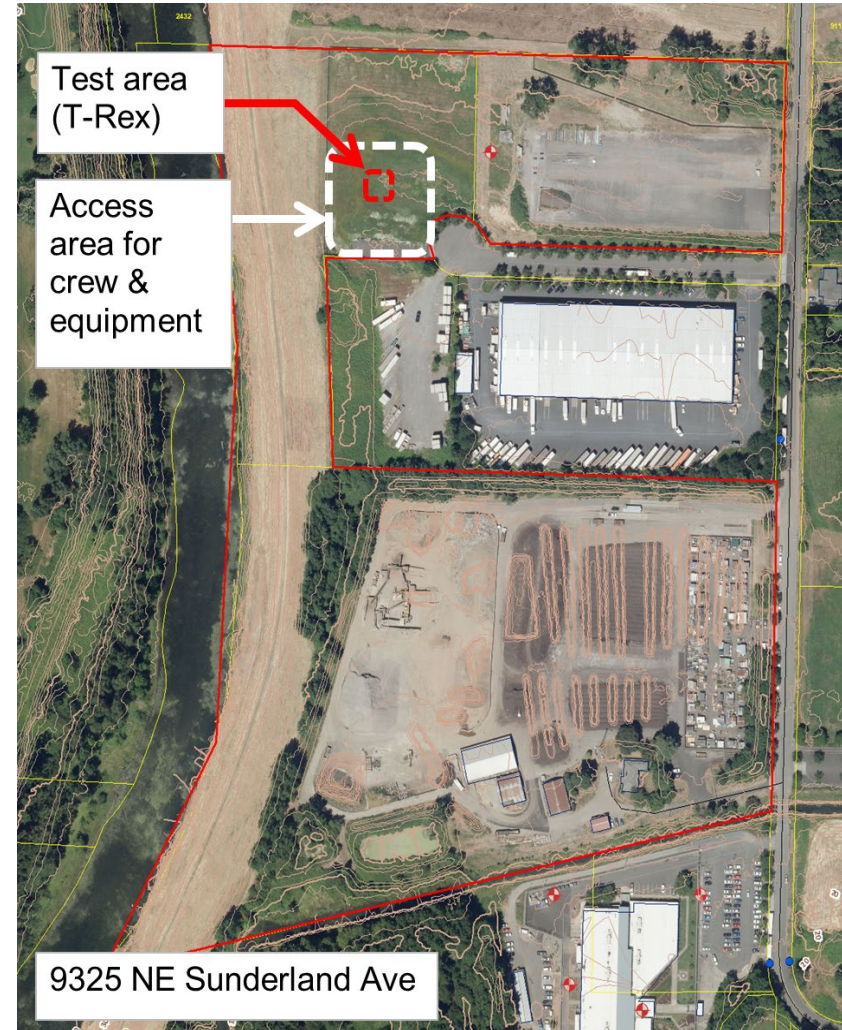
- Apply ground treatment (2 weeks of injection)
- Evaluate effectiveness using large mobile shaker (T-Rex) from the University of Texas NHERI equipment
- Monitor long-term effectiveness for 3 to 5 years using embedded sensors in the ground



NHERI@UTexas

Testing Schedule

- T-Rex at untreated site: Week of July 22
 - Ground treatment: July through August
 - T-Rex at treated site: Week of September 9
-
- Workshop (PSU/UT/ASU) on September 11, 2019, 1-5pm at PSU
 - Field demo on September 12, 2019, 9-11am at Sunderland



Sponsors and Partners

- National Science Foundation
- Center for Bio-mediated and Bio-inspired Geotechnics (CBBG)
- NHERI@UTexas
- City of Portland
- Portland General Electric
- ConeTec
- Condon-Johnson & Associates



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