Development of Sinkhole Risk Evaluation Program

(BDV24 TWO 977-17)

Presented by:

UCF Sinkhole Research Team

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University of Central Florida

Presented to:

FDOT GRIP Meeting

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Presentation Outline

- Introduction
- Task 1 – In-situ groundwater monitoring experiment
- Task 2 – High-resolution groundwater recharge map
- Task 3 – Improved identification method for detecting raveled zone
- Task 4 – Develop the sinkhole stability analysis
- Future work plan

Introduction

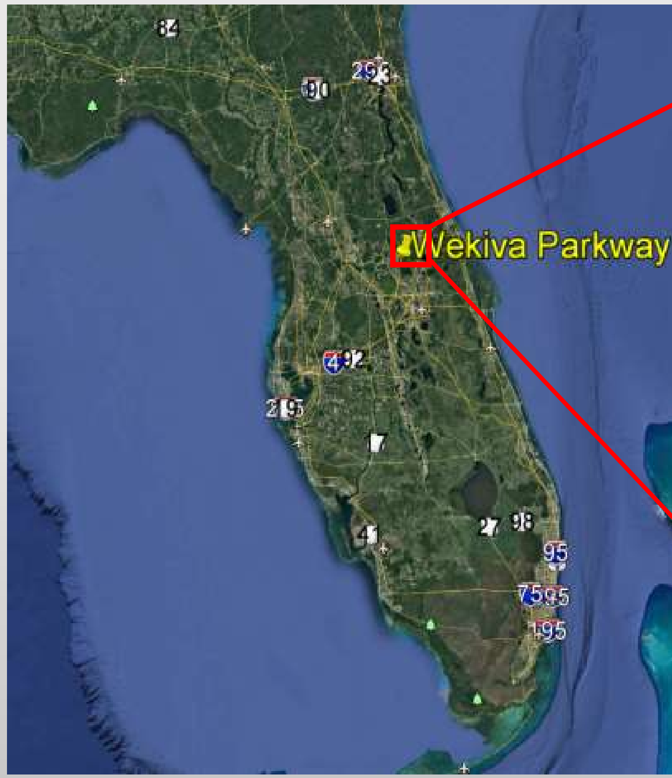
- **Research objective:**
  - to develop a high-resolution recharge map
  - to explore in-situ groundwater sensing/monitoring
  - to develop a procedure to evaluate the level of sinkhole vulnerability based on in-situ CPT

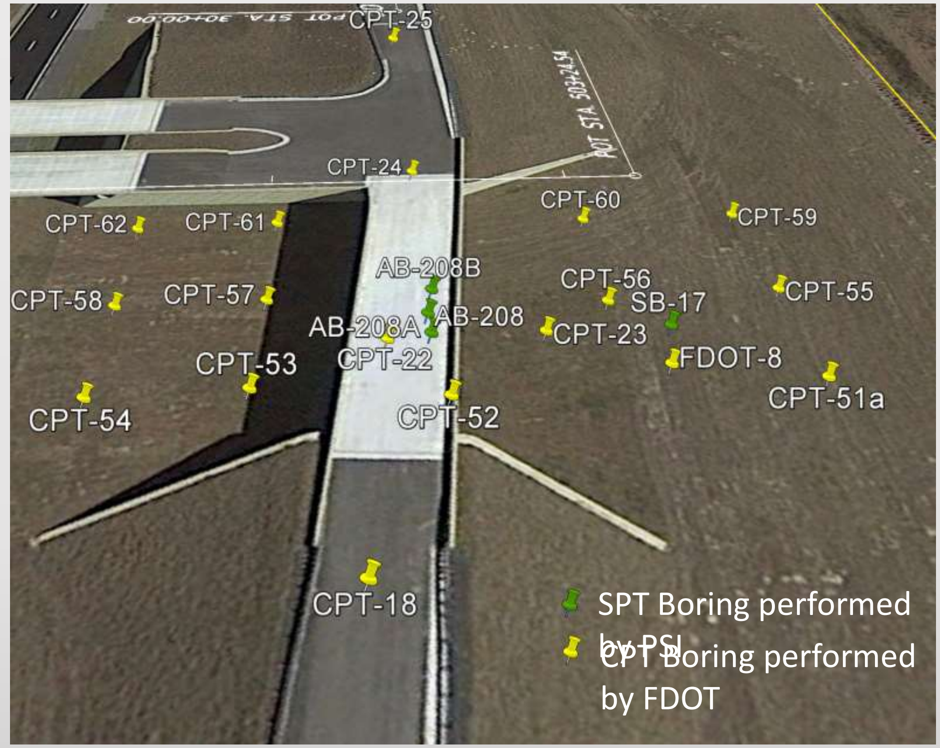
- **Research methodology:**
  - In-situ subsurface tests (SPT, CPT, etc.)
  - Piezometer sensor installation
  - FD based numerical analysis => groundwater recharge modeling
  - FE based numerical analaysis => sinkhole stability modeling

Task 1. In-situ groundwater monitoring experiment

Wekiva Parkway Project – Site Description

- Lake County
- About 40 minutes North of Downtown Orlando.
- Focus Section: North end of SR 46 to Mt. Plymouth Rd connector toll road.
- Located north of wekiva springs and south of Seminole springs. Numerous relic sinkholes.
- Interchange consists of 3 bridges, 4 earth-embankment ramps



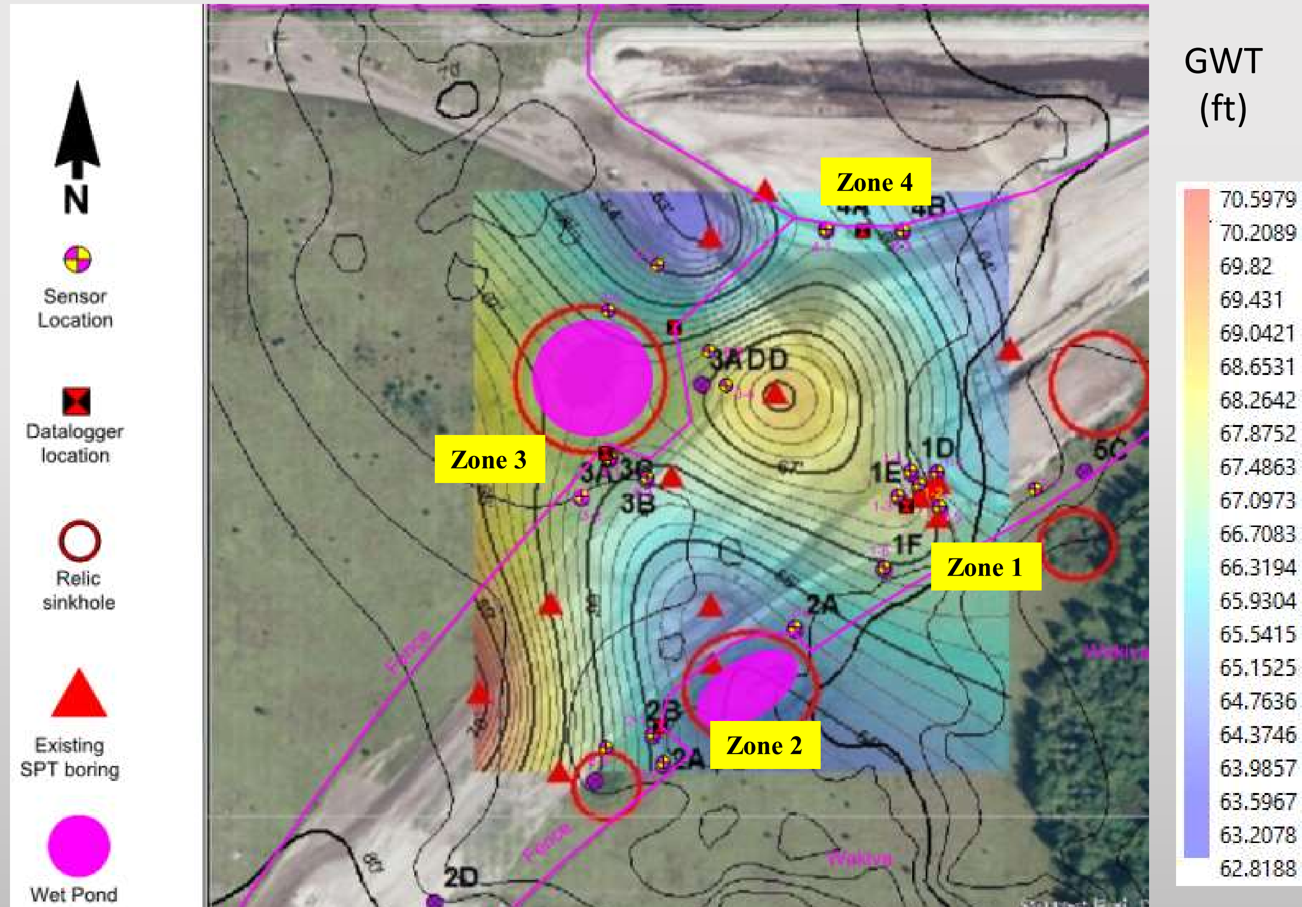


Field investigation performed by FDOT and Professional Services Inc.

- 74 CPT soundings performed till refusal
- 14 SPT borings through performed till
- Depth to Limestone varies from 60 to 130 feet.
- Borings show very loose soil (WH/WR & Tip resistance < 10 TSF) directly above the limestone bedrock.

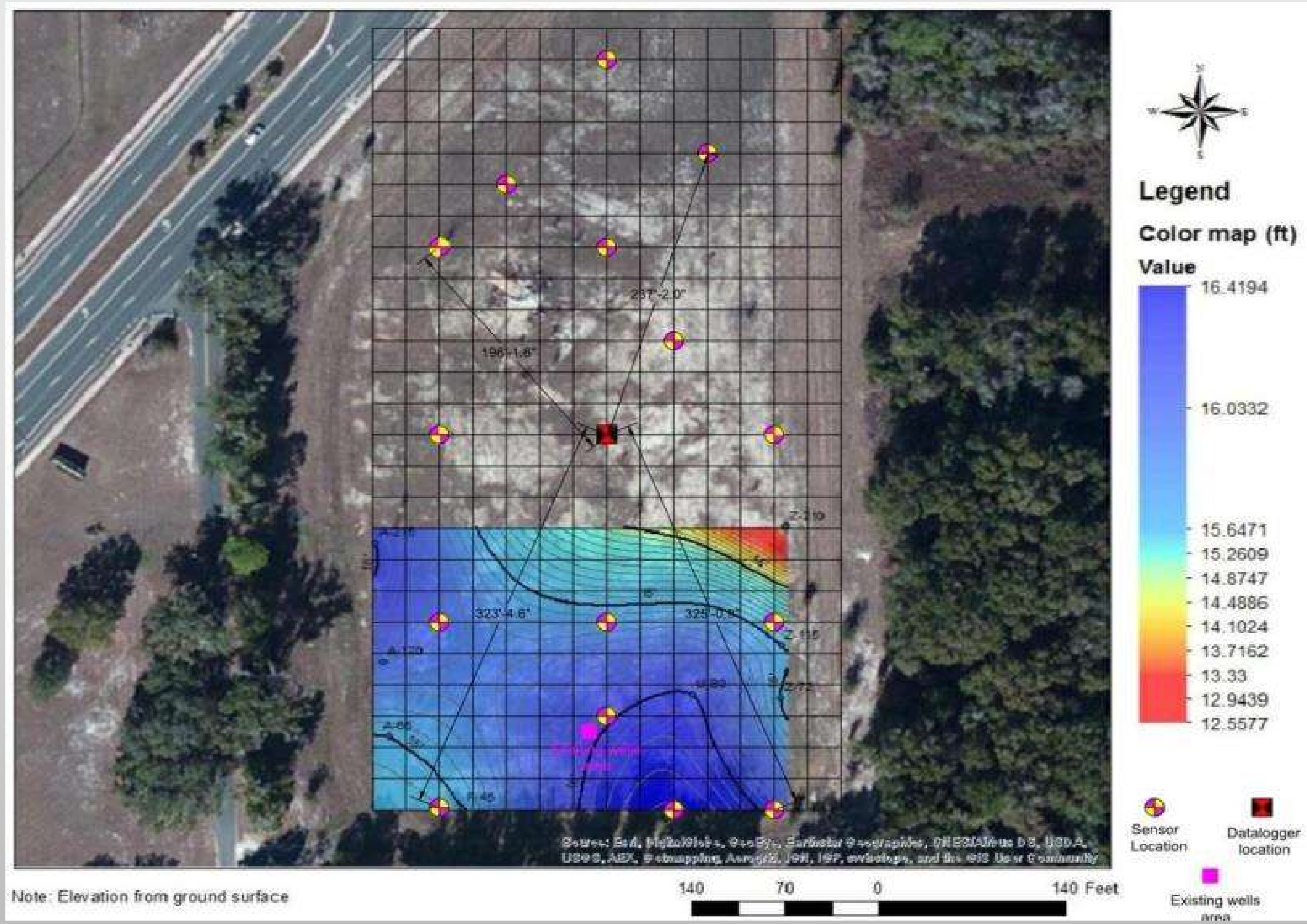
Sensor layout for Wekiva pkwy

- Ground water table from MSL
  - Low: 63 feet
  - High: 70.5 feet
- Number of Zone: 4
  - No. of sensor in zone 1: 7
  - No. of sensor in zone 2: 4
  - No. of sensor in zone 3: 7
  - No. of sensor in zone 4: 2
- Type of sensor: 4500S-350kPa
- Number of Datalogger: 5
  - 4-channel datalogger: 4
  - 16-channel datalogger: 1



Sensor layout for fdot retention pond

- Ground water table
  - Low: 13.5 ft
  - High: 16 ft
- Number of sensor: 16
- Type of sensor: 4500S-350kPa
- Number of datalogger: 1
- Type of datalogger: 16-channel



Equipment

- Piezometer sensor
- Make: Geokon
- Model: 4500S-350kPa
- Resolution: 0.025% F.S
- Accuracy:
  ±0.1% F.S.

- 4-Channel datalogger
- Make: Geokon
- Measurement Accuracy: ±0.05% F.S.
- Data Memory: 320K EEPROM
- Storage capacity: 10666 arrays

- 16-Channel datalogger
- Make: Geokon
- Measurement Accuracy: ±0.05% F.S.
- Data Memory: 320K EEPROM
- Storage capacity: 3555 arrays

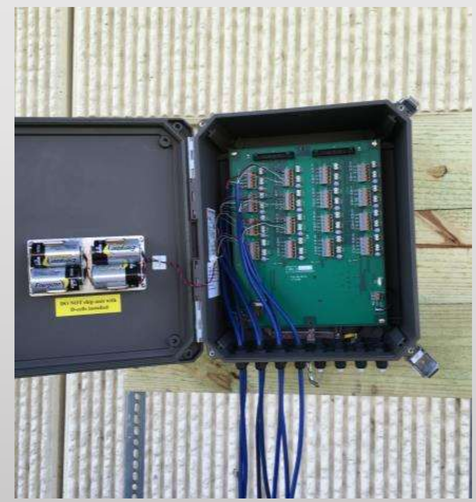
Sensor preparation and installation

Step 1: Checking sensors and dataloggers in lab

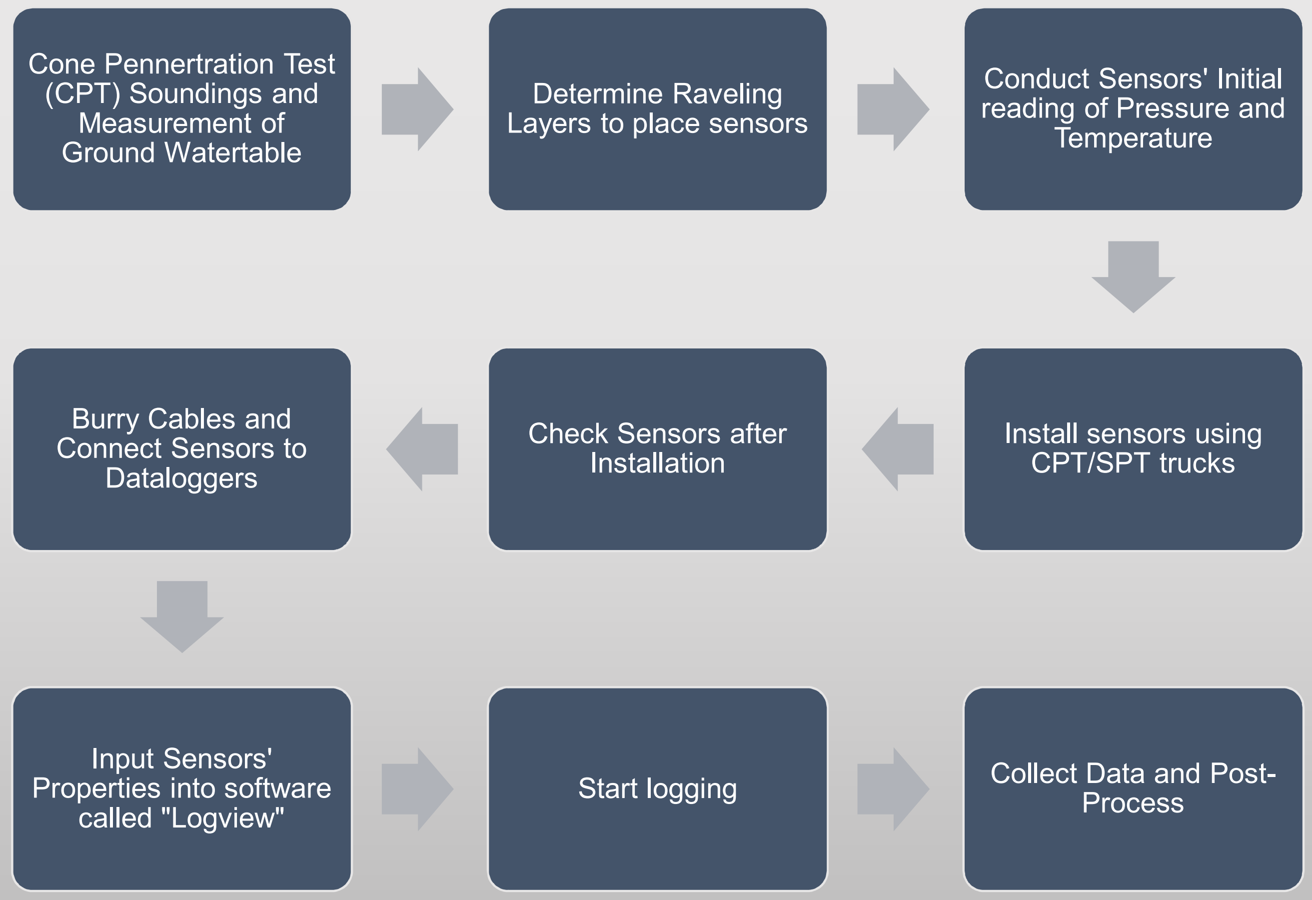
Step 2: Install sensor using CPT/SPT trucks

Step 3: Install sensor using CPT/SPT trucks

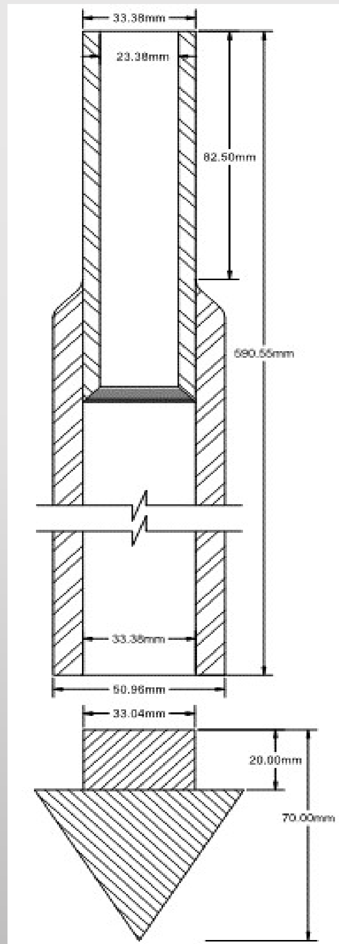
Step 4: Connect sensors to datalogger and start logging

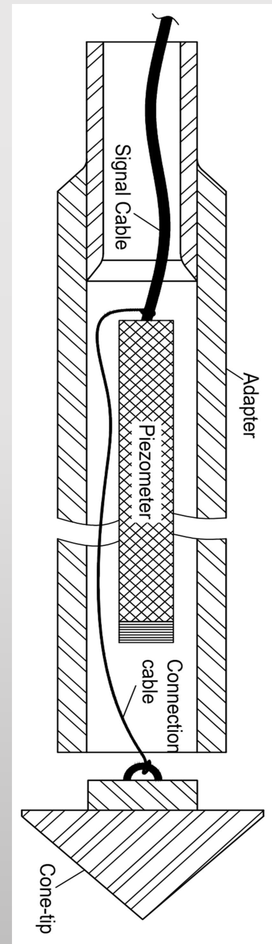


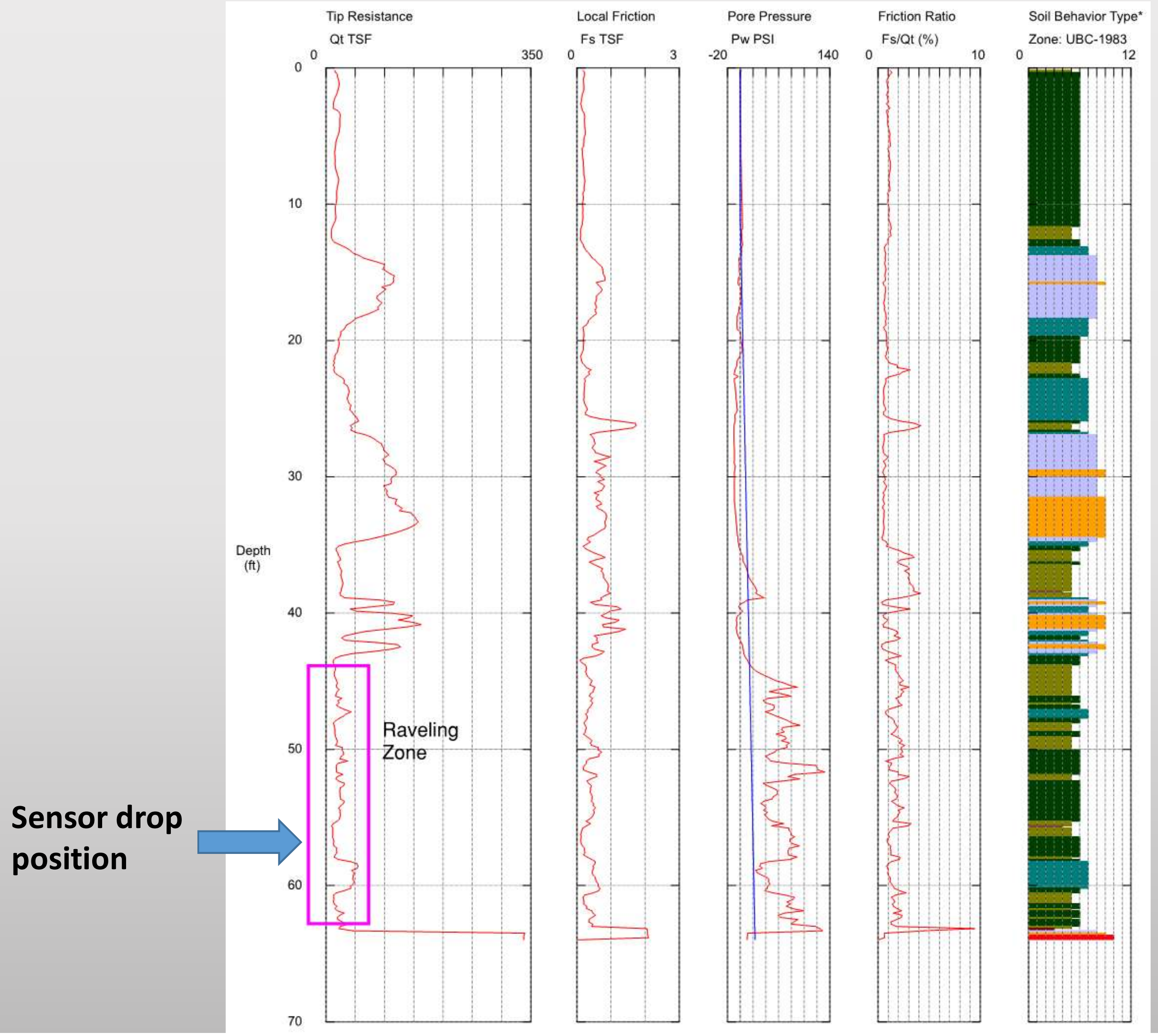
Process of sensor Installation



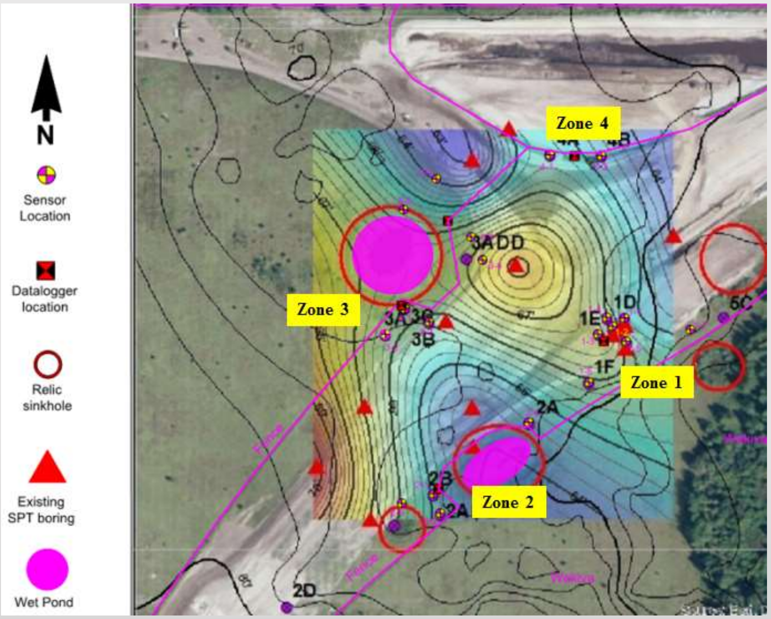
Adapter and Sacrificial cone-tip

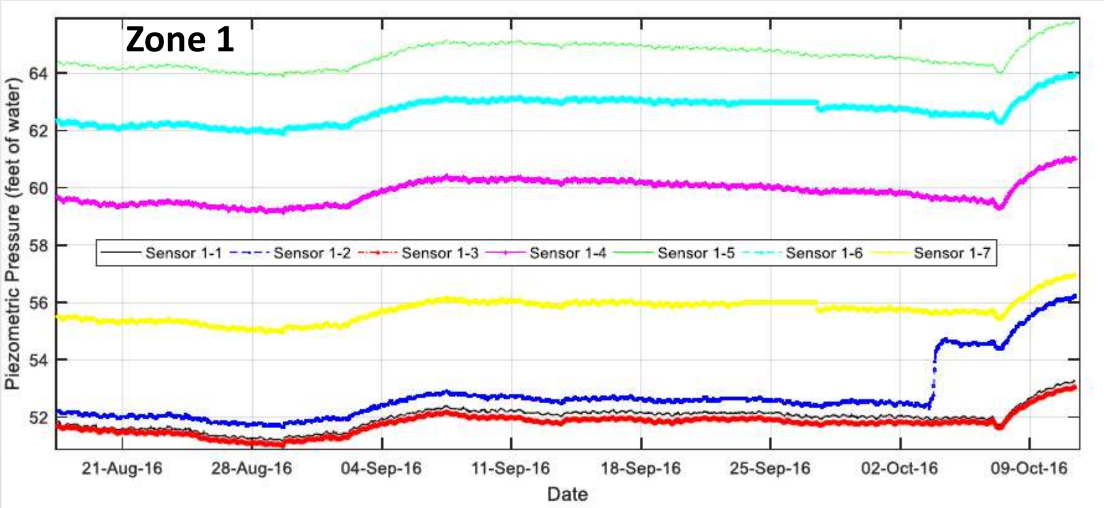


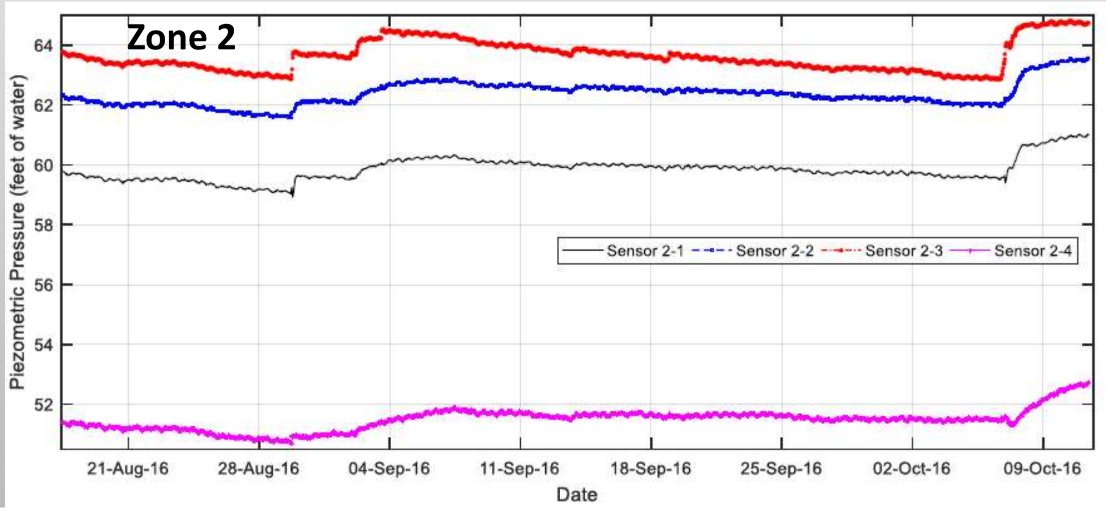



Tip Resistance
Qt TSF
Local Friction
Fs TSF
Pore Pressure
Pw PSI
Friction Ratio
Fs/Qt (%)
Soil Behavior Type*
Zone: UBC-1983
Depth
(ft)
Raveling
Zone
Sensor drop
position

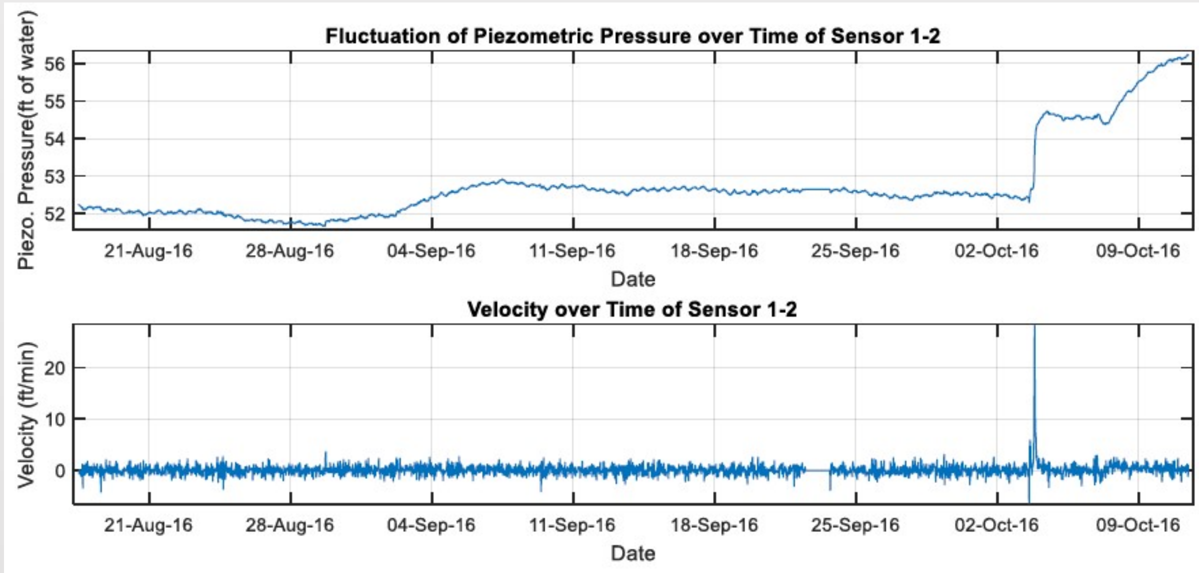
Example of piezometer data monitoring

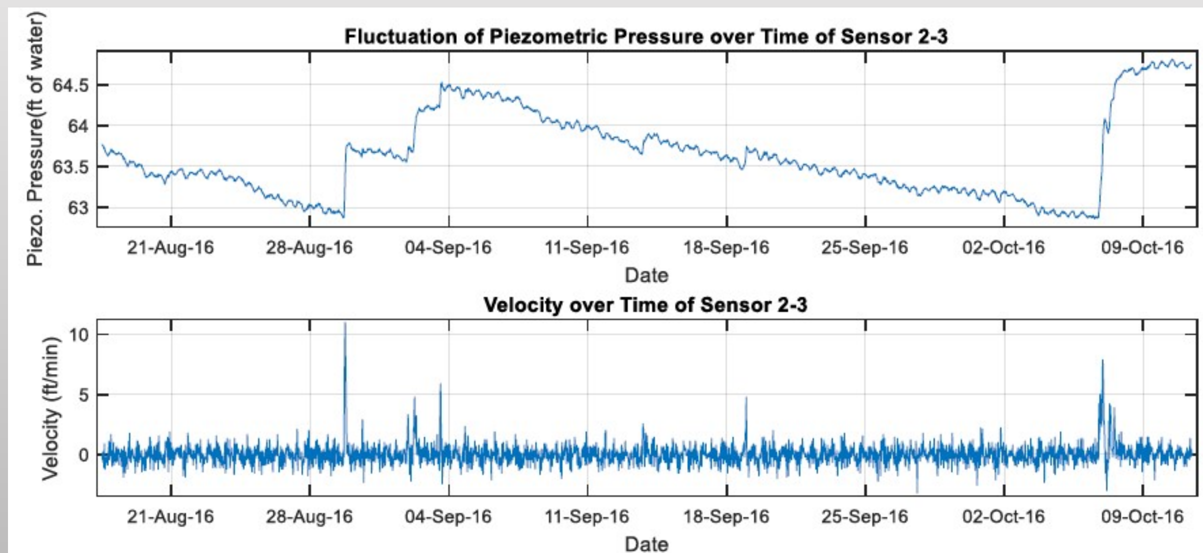




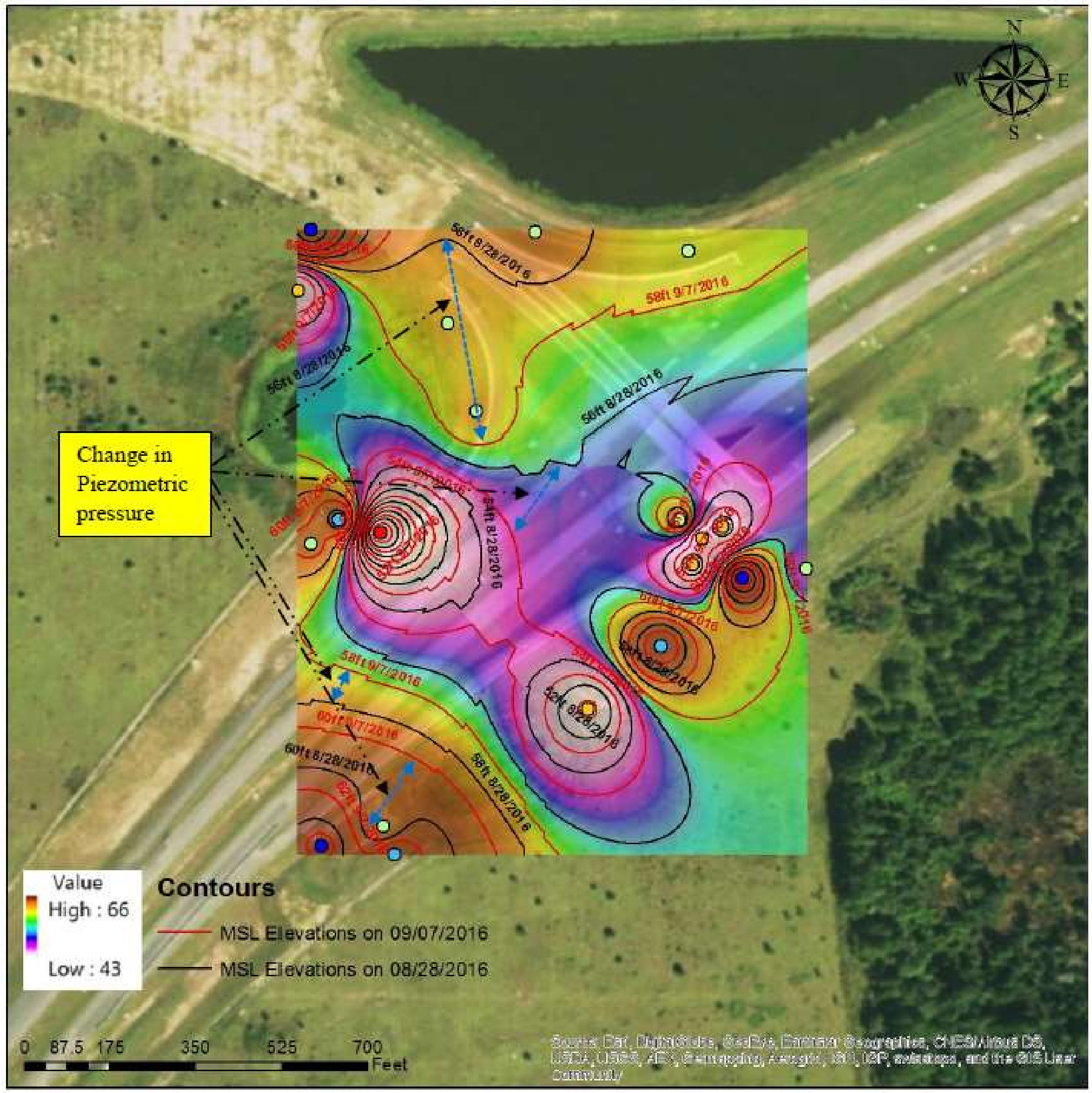


(Tu 2016)


Fluctuation of Piezometric Pressure over Time of Sensor 1-2
Piezo. Pressure(ft of water)
56
55
54
53
52
21-Aug-16
28-Aug-16
04-Sep-16
11-Sep-16
18-Sep-16
25-Sep-16
02-Oct-16
09-Oct-16
Date
Velocity over Time of Sensor 1-2
Velocity (ft/min)
20
10
0
21-Aug-16
28-Aug-16
04-Sep-16
11-Sep-16
18-Sep-16
25-Sep-16
02-Oct-16
09-Oct-16
Date

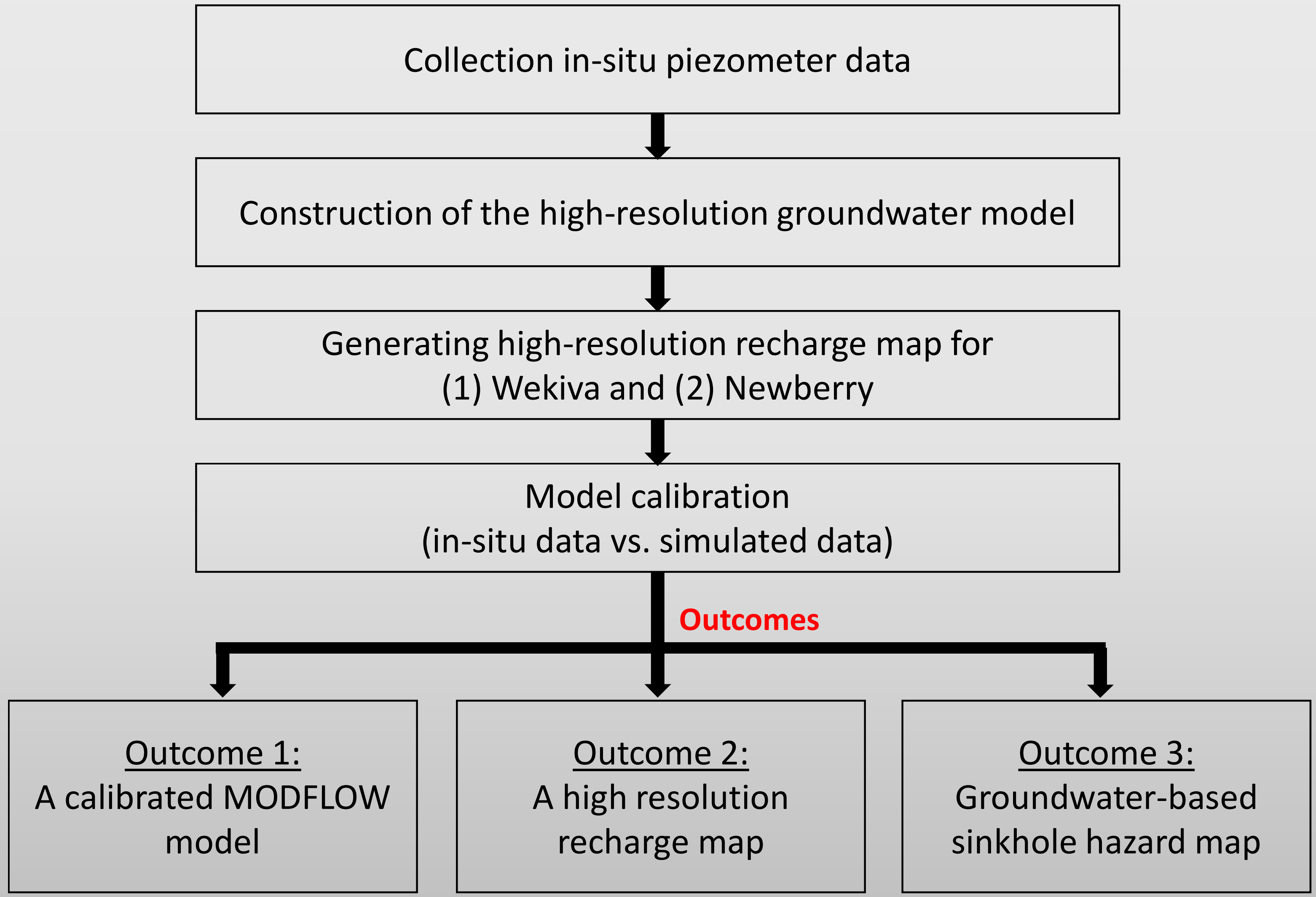

Fluctuation of Piezometric Pressure over Time of Sensor 2-3
Piezo. Pressure(ft of water)
64.5
64
63.5
63
21-Aug-16
28-Aug-16
04-Sep-16
11-Sep-16
18-Sep-16
25-Sep-16
02-Oct-16
09-Oct-16
Date
Velocity over Time of Sensor 2-3
Velocity (ft/min)
10
5
0
21-Aug-16
28-Aug-16
04-Sep-16
11-Sep-16
18-Sep-16
25-Sep-16
02-Oct-16
09-Oct-16
Date

(Tu 2016)


Change in Piezometric pressure
Value
High : 66
Low : 43
Contours
MSL Elevations on 09/07/2016
MSL Elevations on 08/28/2016
0 87.5 175 350 525 700 Feet
N
S
W
E
58ft 8/28/2016
58ft 9/7/2016
56ft 8/28/2016
58ft 9/7/2016
60ft 9/7/2016
60ft 8/28/2016
58ft 8/28/2016

(Tu 2016)

Task 2. High-resolution groundwater recharge map


Collection in-situ piezometer data
Construction of the high-resolution groundwater model
Generating high-resolution recharge map for
(1) Wekiva and (2) Newberry
Model calibration
(in-situ data vs. simulated data)
Outcomes
Outcome 1:
A calibrated MODFLOW model
Outcome 2:
A high resolution recharge map
Outcome 3:
Groundwater-based sinkhole hazard map

Procedures of High Resolution Groundwater Modeling

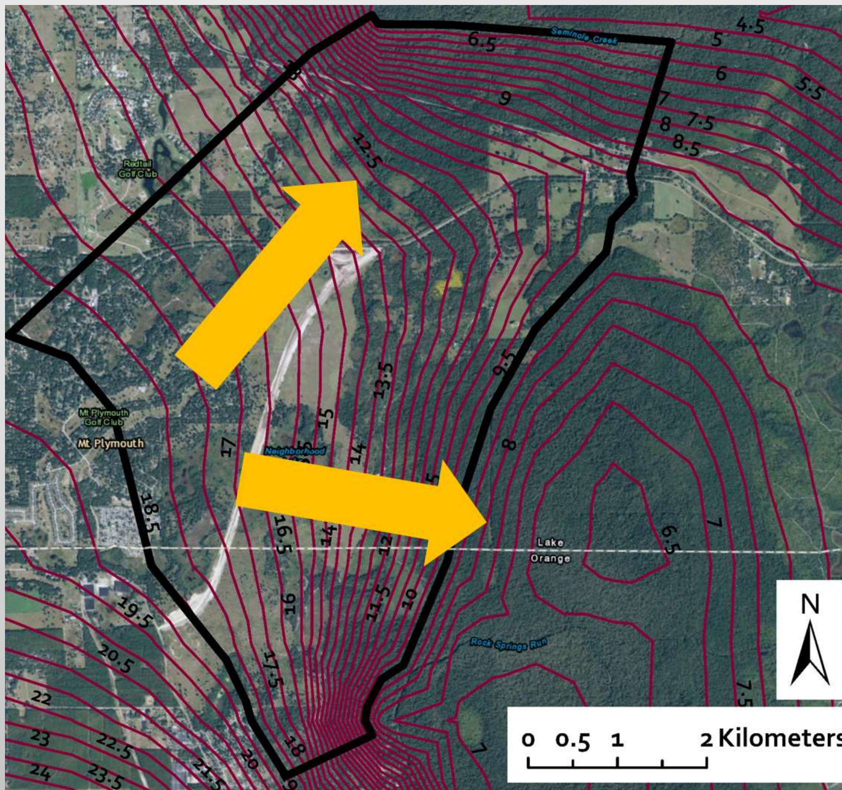
- Step 1 – Selection of study area
- Step 2 – Model domain identification
- Step 3 – Discretization
  - Horizontal
  - Vertical
- Step 4 – Boundary condition
- Step 5 – Local-scale model setup
  - Same procedure from Steps 1 through 4 for the local-scale model
- Step 6 – Calibration of numerical model
- Step 7 – Recharge map generation

Step 1 – Study Area

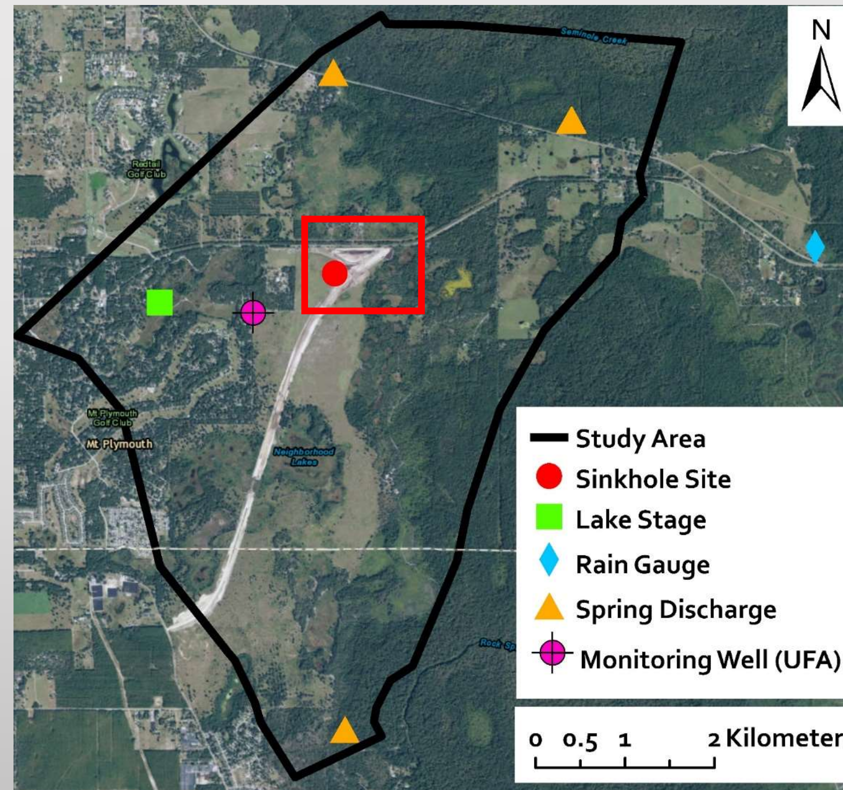
- Construction site located at the Wekiva Parkway Bridge at Mt. Plymouth, Florida **Site 1**

- FDOT drain basin site located at the detention pond at Newberry, Florida **Site 2**

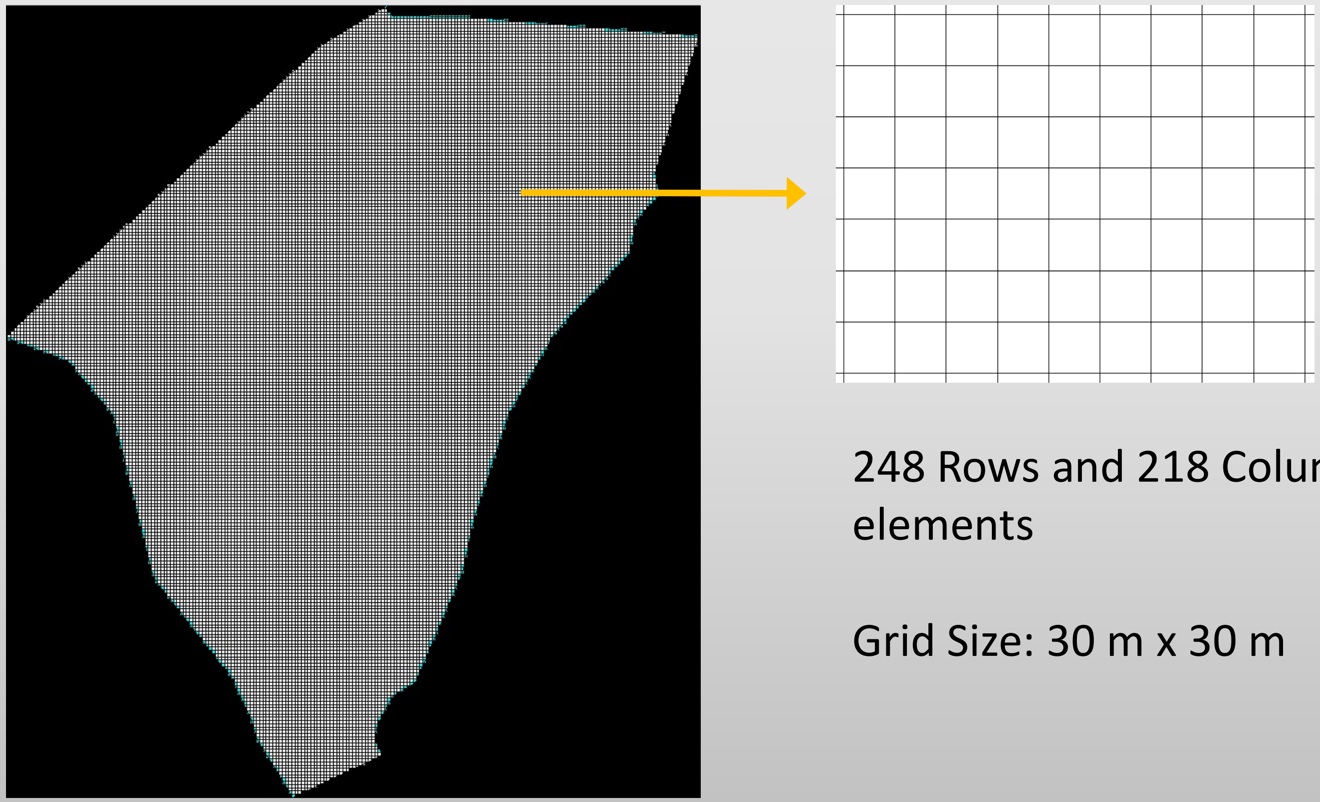
Step 2 - Model Domain Identification



Water Table Contour 2010
(SJRWMD Special Publication SJ95-SP7)



Step 3 – Model Horizontal Discretization



248 Rows and 218 Columns => 54,064 elements

Grid Size: 30 m x 30 m

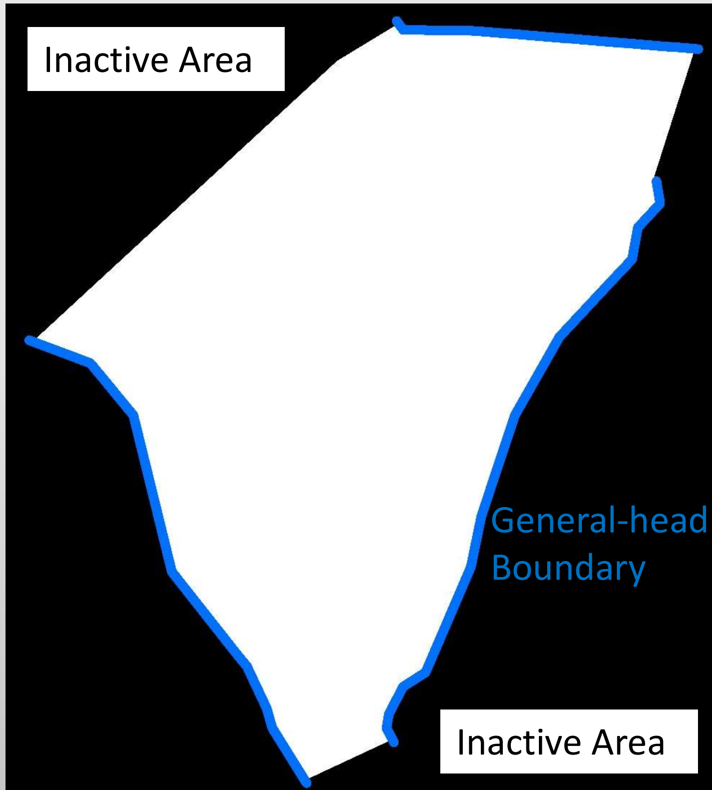
Step 3 – Model Vertical Discretization

Surficial Layer (Surficial Aquifer)
Primarily composed of sand

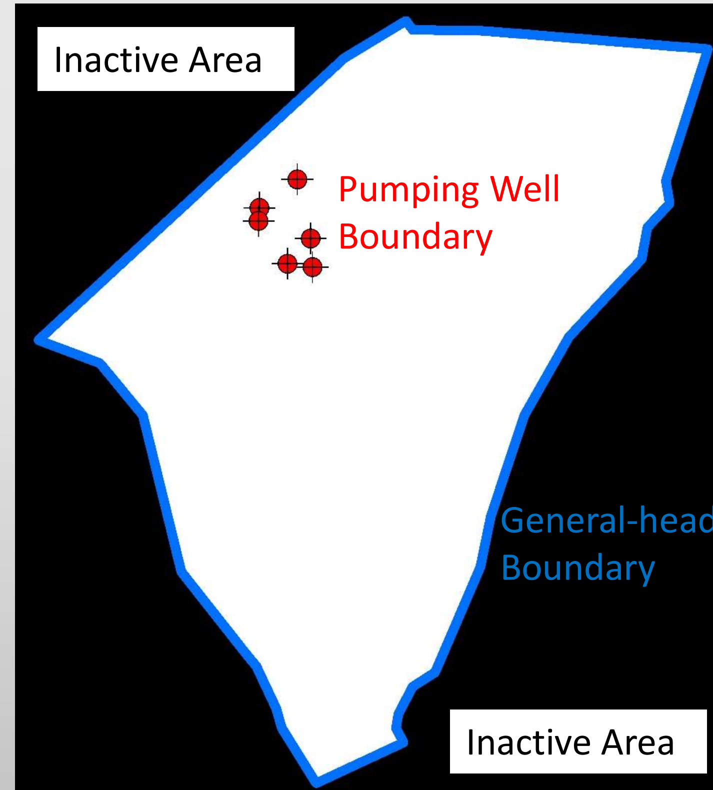
Clay Layer (Upper Confining Unit)
Primarily composed of clay

Limestone Layer (Floridan aquifer)
Primarily composed of limestone and dolostone

Step 4 – Boundary conditions



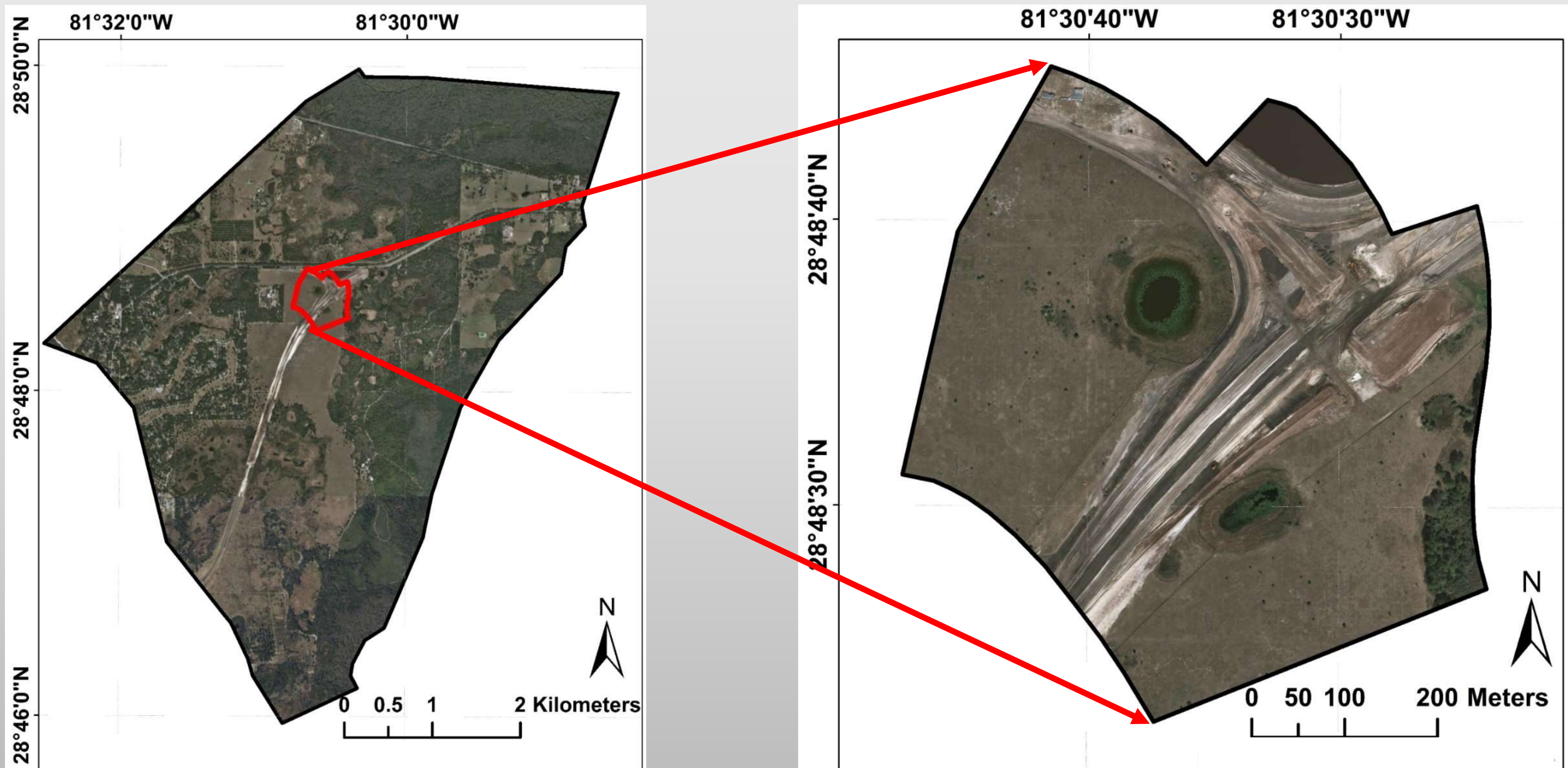
Surficial Layer



Limestone Layer

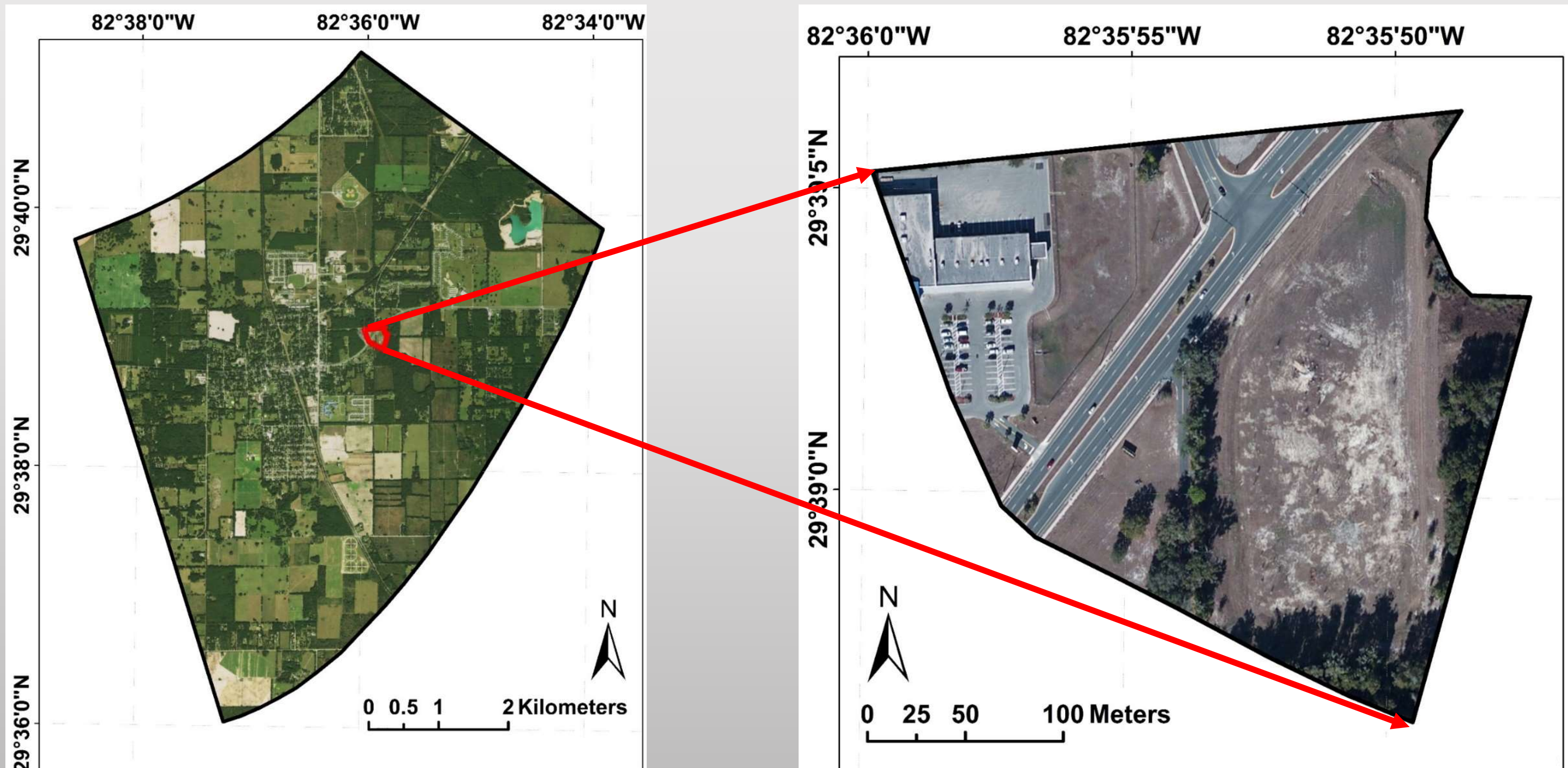
Step 5 – Local-scale model setup (Wekiva Site)

Substep 5.1 – model domain for the local-scale model



Step 5 – Local-scale model setup (Newberry Site)

Substep 5.1 – model domain for the local-scale model



Step 5 - Local-scale model setup (Example)

Substep 5.2 - Discretization

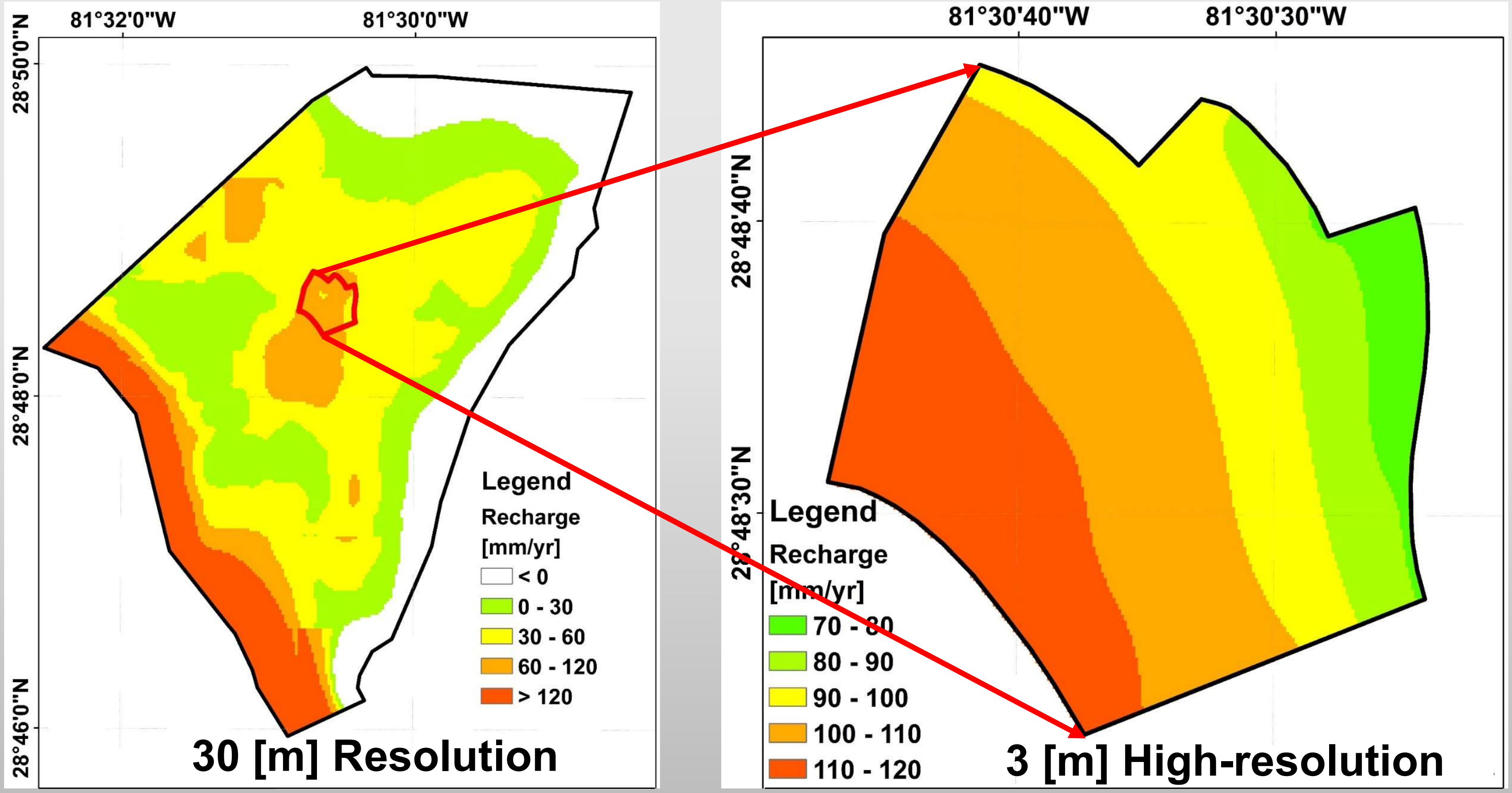
- Site 1 (Construction site at the Wekiva Parkway Bridge)

  - **Fine Sand**
  - **Silty Fine Sand**
  - **Clayed Fine Sand and Clay**
  - **Silty fine sand and clayed fine sand**
  - **Weathered Limestone**

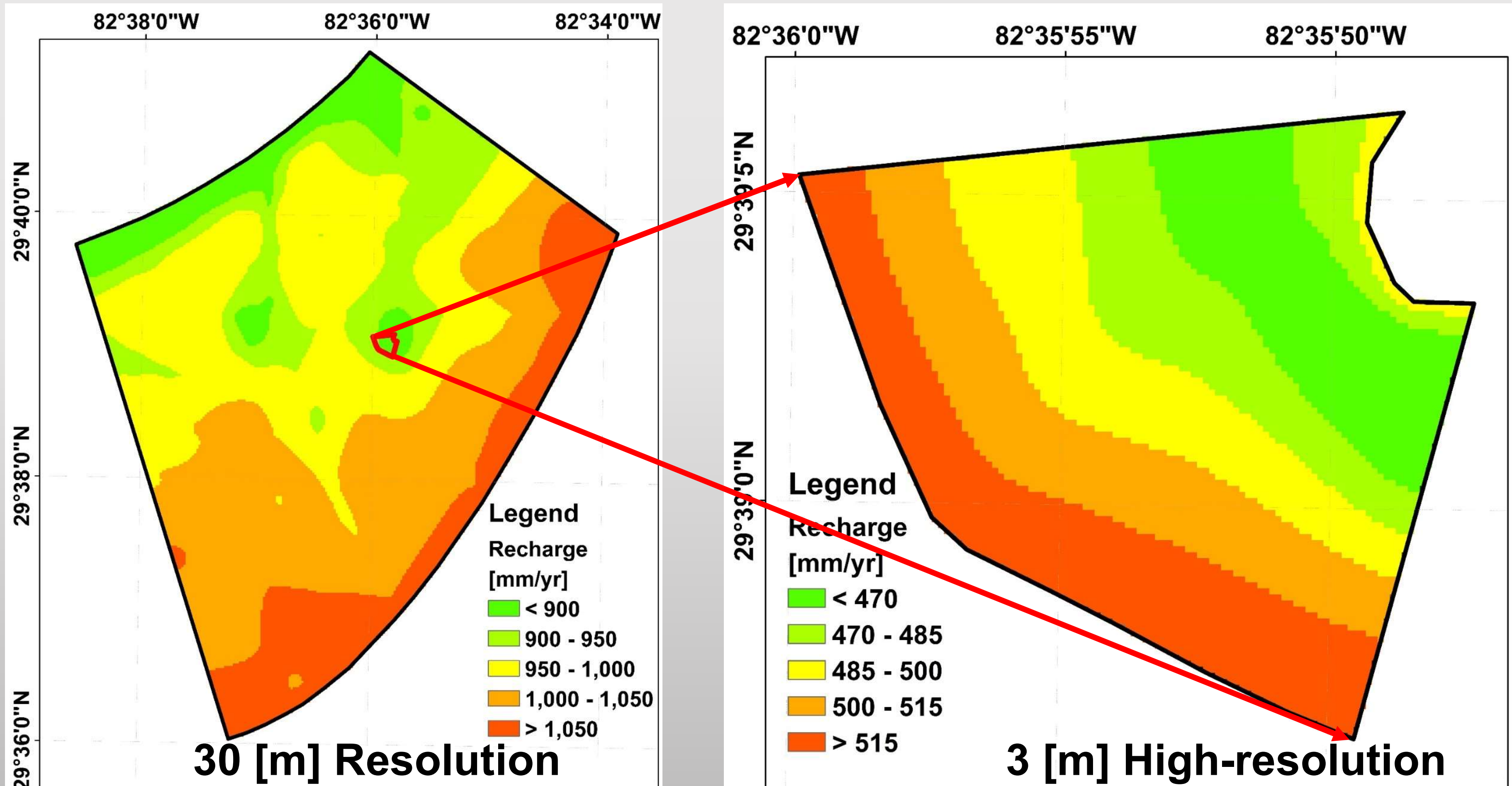
- Site 2 (Drain basin site at the detention pond)

  - **Sand, Sandy Clay, Clay**
  - **Soft to Medium Dense Limestone**

Preliminary result – Wekiva Pkwy site



Preliminary result – Newberry Pond site

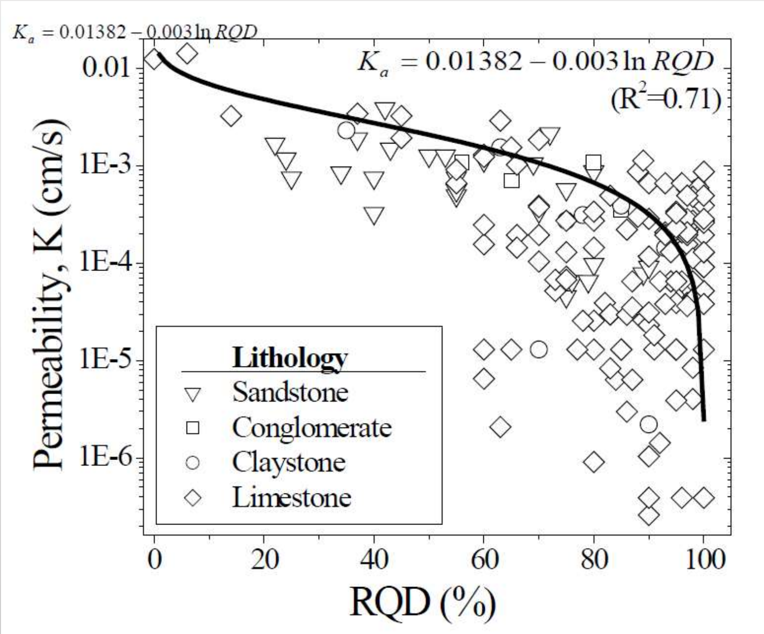


Model Calibration

- Methodology:
  - Hydraulic conductivity of each layer (including soil layers and limestone layer) is adjusted and the groundwater levels are simulated accordingly
  - A trial-and-error method is used to compare the simulated groundwater levels and the observed groundwater levels and determine the difference between them
- Range of *K:*
  - Fine sand: 0.02 - 20 m/d
  - Silty fine sand: 0.001 – 0.5 m/d
  - Clayed fine sand: 0.0005 - 0.5 m/d
  - Clay: 0.000001 - 0.0005 m/d

Range of Hydraulic Conductivity (K)

- Limestone layers
  - The hydraulic conductivity of each type of limestone is estimated based on the RQD (Rock Quality Designation)
  - The hydraulic conductivity of limestone decreases with an increase in the RQD



Qureshi et al. 2014

Range of Hydraulic Conductivity (K)

<u>Site 2: Newberry Pond</u>

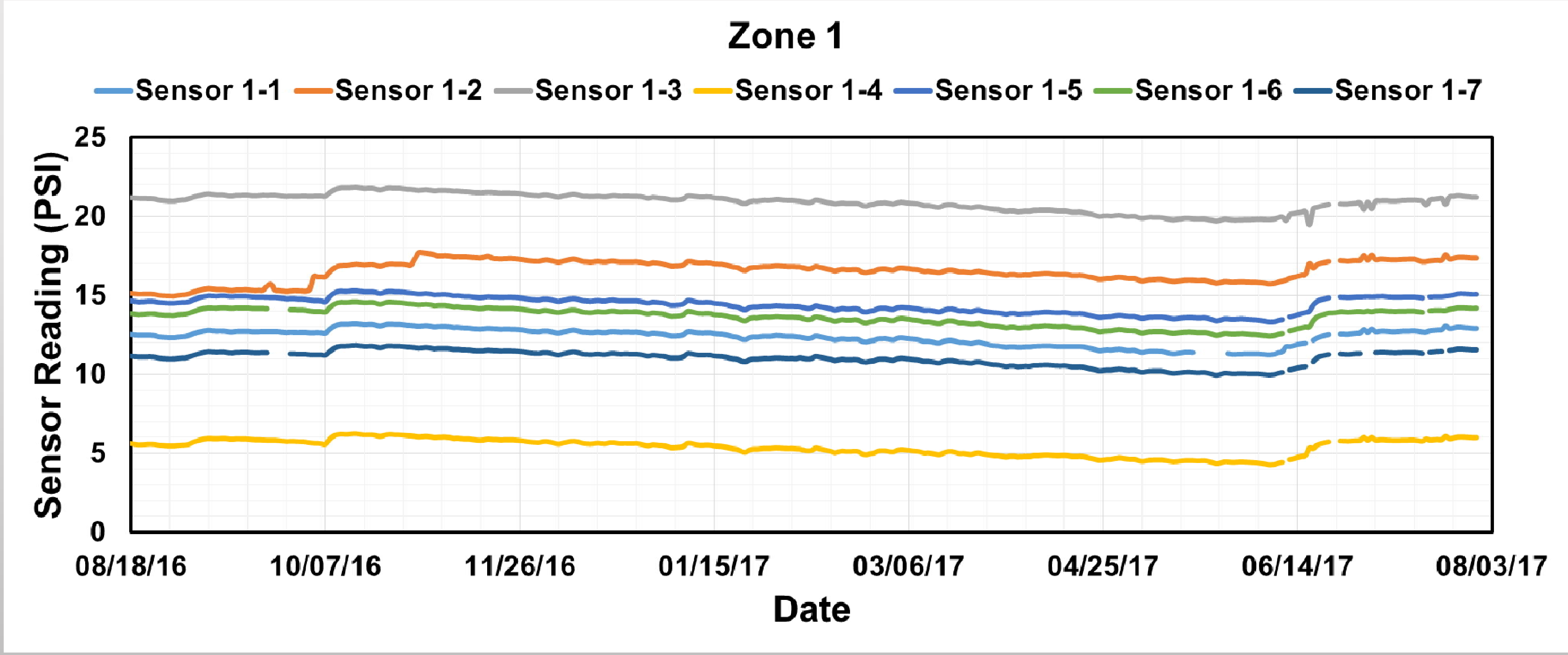
- The limestone is classified into four categories based on the RQD
  - Very soft limestone
    - 10 – 50% RQD
    - Hydraulic conductivity: 0.002 – 0.007 cm/s
  - Soft limestone
    - 40 – 50% RQD
    - Hydraulic conductivity: 0.002 – 0.003 cm/s
  - Medium dense limestone
    - 50 – 80% RQD
    - Hydraulic conductivity: 0.0005 – 0.002 cm/s
  - Dense limestone
    - 90 – 100 % RQD
    - Hydraulic conductivity: 0.00001 – 0.0004 cm/s

Range of Hydraulic Conductivity

Site 1: Wekiva Pkwy

- The limestone is soft to medium dense limestone, but no RQD value available
- The hydraulic conductivity varies from 0.0005 – 0.002 cm/s
- The N values of the limestone are recorded as 50/1”, 50/2”, and 50/3”, indicating that the stiffness is varied
  - Limestone with N value of 50/1”
    - Hydraulic conductivity: 0.0005 – 0.001 cm/s
  - Limestone with N value of 50/2”
    - Hydraulic conductivity: 0.001 – 0.0015 cm/s
  - Limestone with N value of 50/3”
    - Hydraulic conductivity: 0.0015 – 0.002 cm/s

Monitored Data for the Model Calibration (Site 1 – Zone 1)



Task 3. Improved identification method for detecting raveled soil zone

3.1 Raveling identification and criteria in CPT data

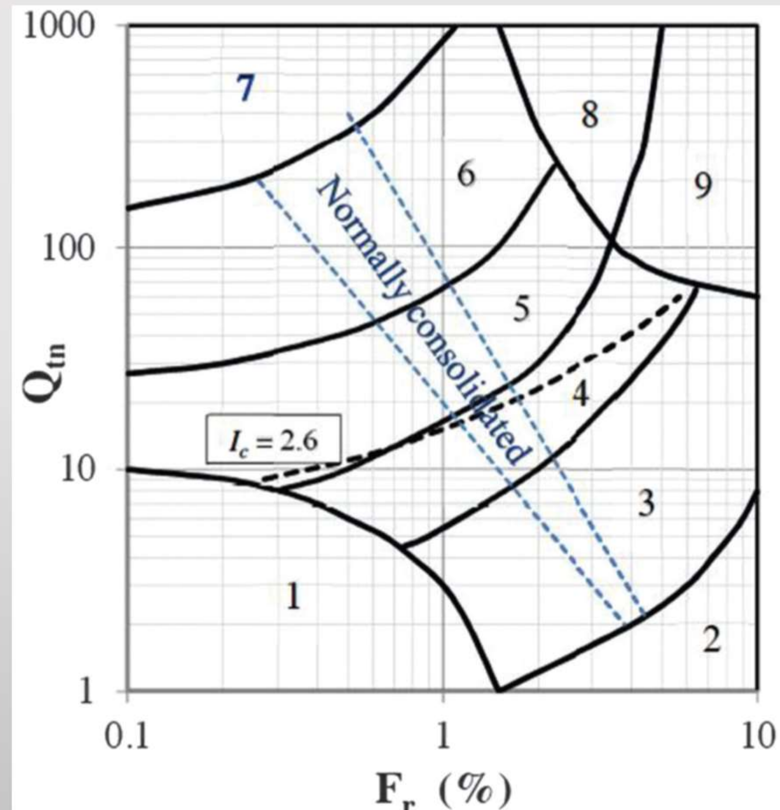
3.2 Assessment of sinkhole hazard by CPT

Cone Penetration Testing

<u>Correlations</u>:

- Newest Correlation Chart (Robertson 2016)

- Commercially available software applies the chart to measured CPT data “real-time” providing estimated soil stratigraphy from each test

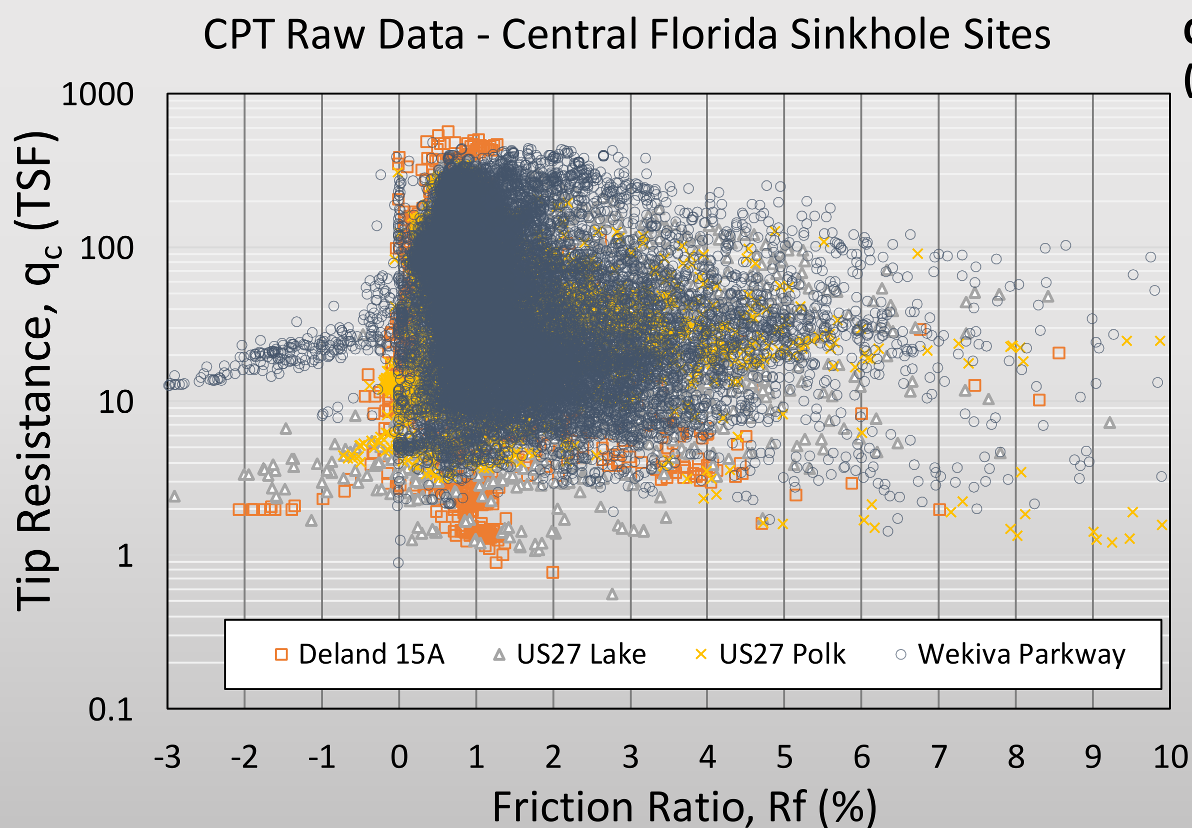


1 Sensitive fine-grained
2 Organic
3 Clay
4 Silt-mixtures
5 Sand-mixtures
6 Sand
7 Gravelly sand to sand
8 Very stiff sand to clayey sand
9 Very stiff fine-grained

$$Q_{tn} = \frac{q_c - \sigma_{vo}}{\sigma'_{vo}}$$

$$F_r = \left[\frac{f_s}{q_c - \sigma_{vo}}\right] * 100\%$$

3.1 Raveling identification and criteria in CPT data



Central Florida sites:
(Cypress head formation): 125 CPTs

25 CPTs performed near **collapsed sinkholes** (verified).

78 performed showing signs of **suspected** raveling

22 Similar strata but no other signs of sinkhole formation deemed **"safe"** CPTs.

Too messy…

Must Filter data!

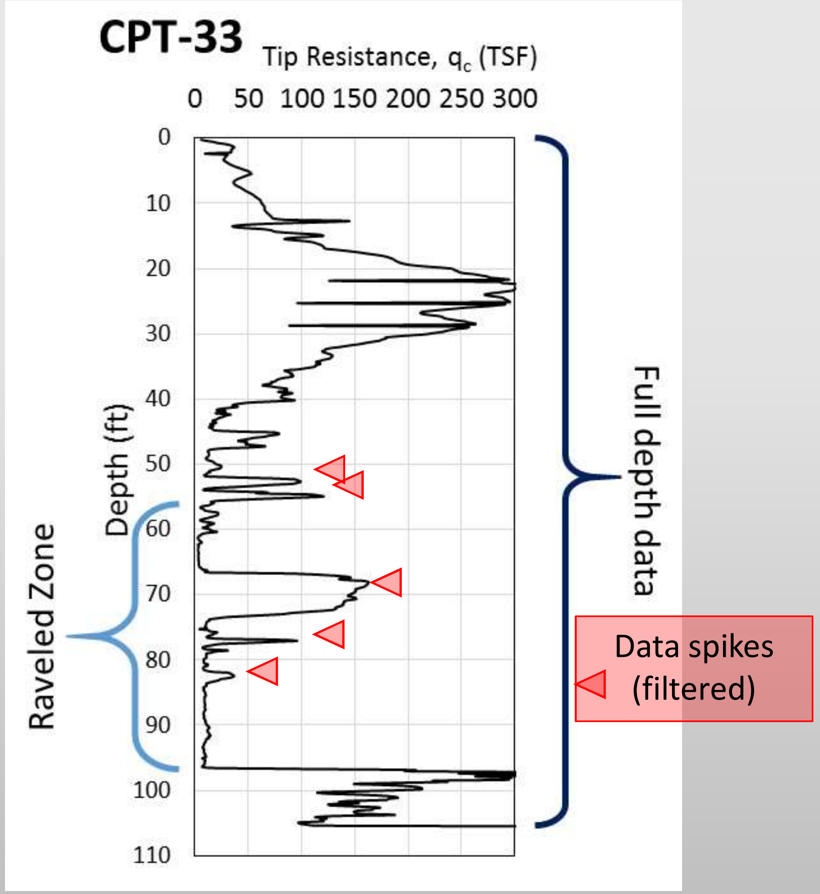
Central Florida sites: Data Preparation

Filtering Data: 2 stages

- Even when normalized, full depth data not needed

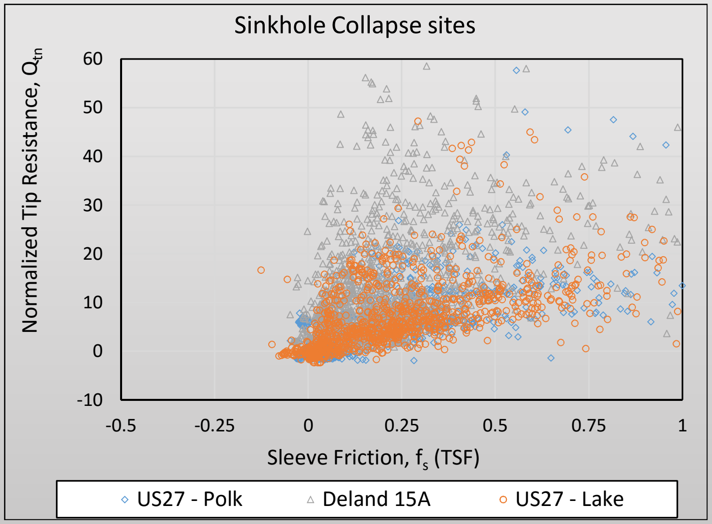
1) Filtered out residual soil data
   - Raveling depths only
   - Verified by nearby SPTs

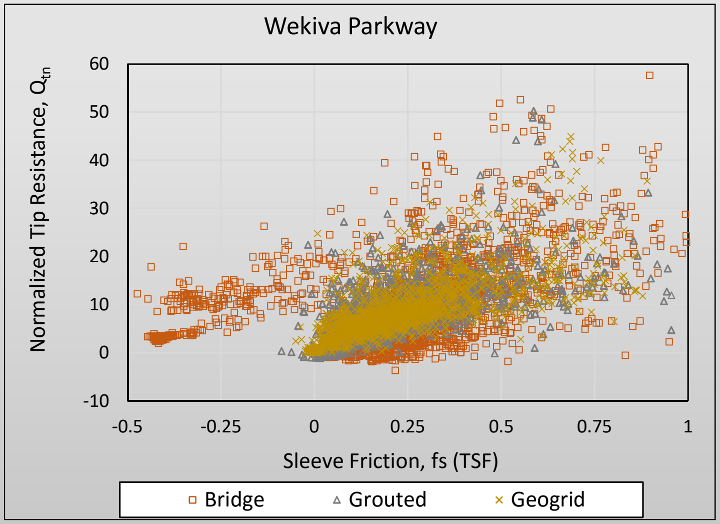
2) Abnormal Spikes of q_c within Raveled zone
   - Caused by phosphates, or isolated pockets of stiffer material
   - May affect "severity" of raveling, but not needed in criteria development



Results

- After filtering and normalization strong similarities between verified raveled material (collapsed sites) and suspected raveling soil (mitigated sites) were identified

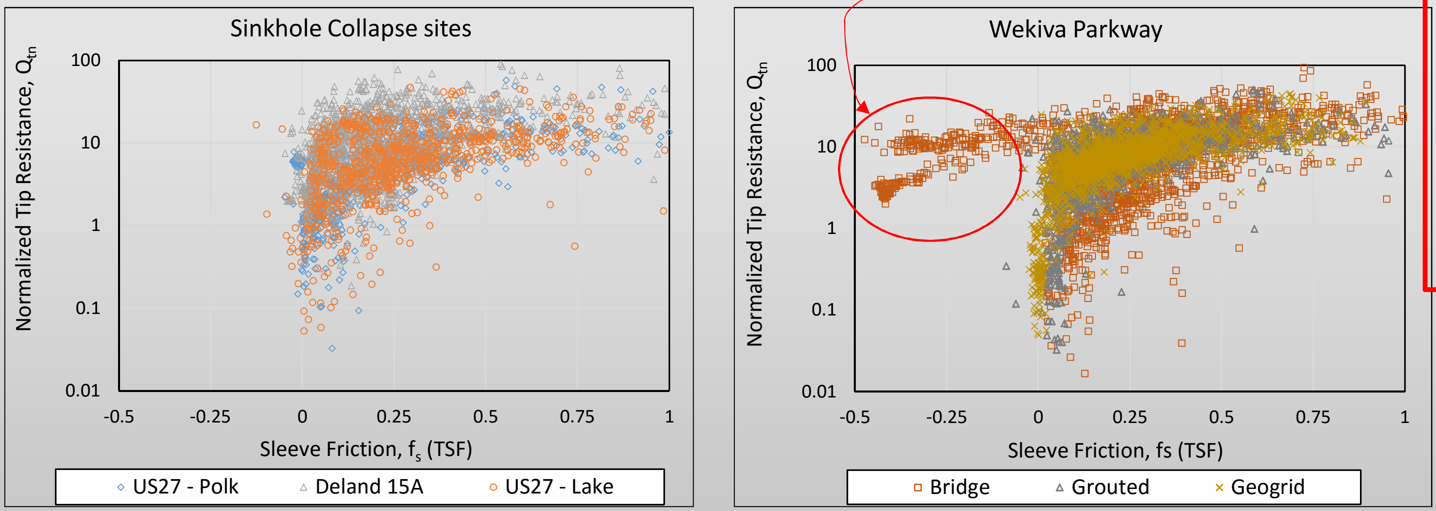




Results

- After filtering and normalization, strong similarities between verified raveled material (collapsed sites) and suspected raveling soil (mitigated sites) were identified

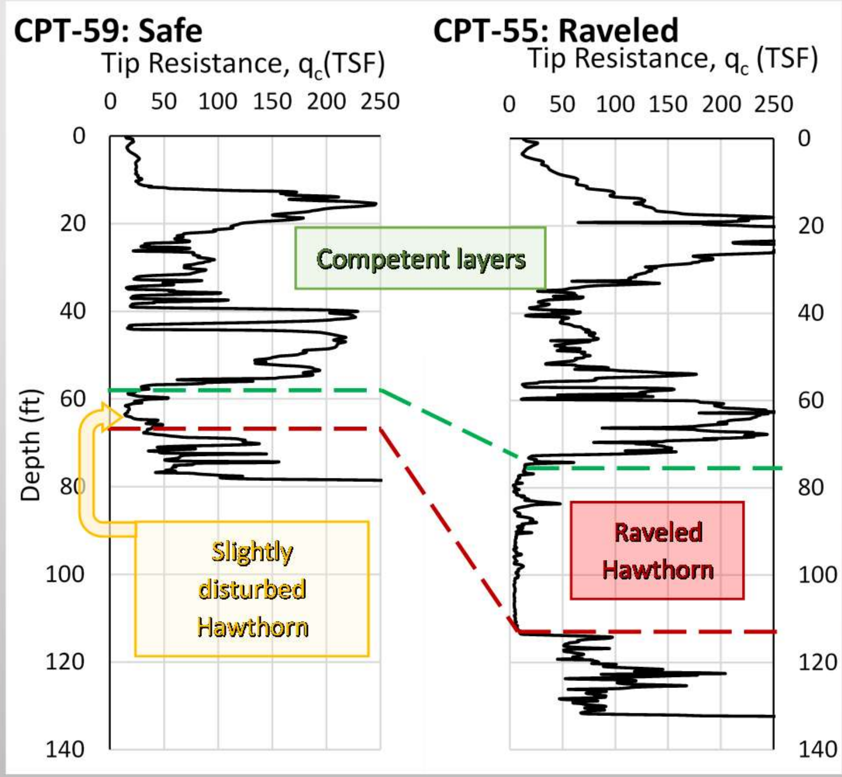
Negative sleeve friction encountered directly below 100% loss of circulation from SPT in two cases, and WR occurs.
Possible indication of sinkhole?



- Log scale for Q_{tn} since majority of data is between 0.1 and 20.

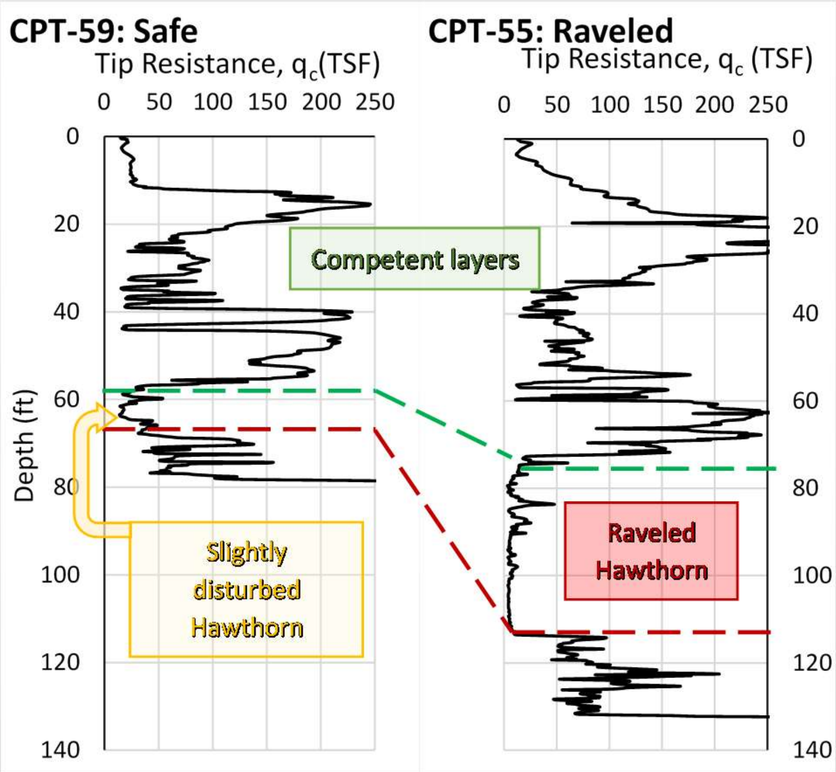
Results

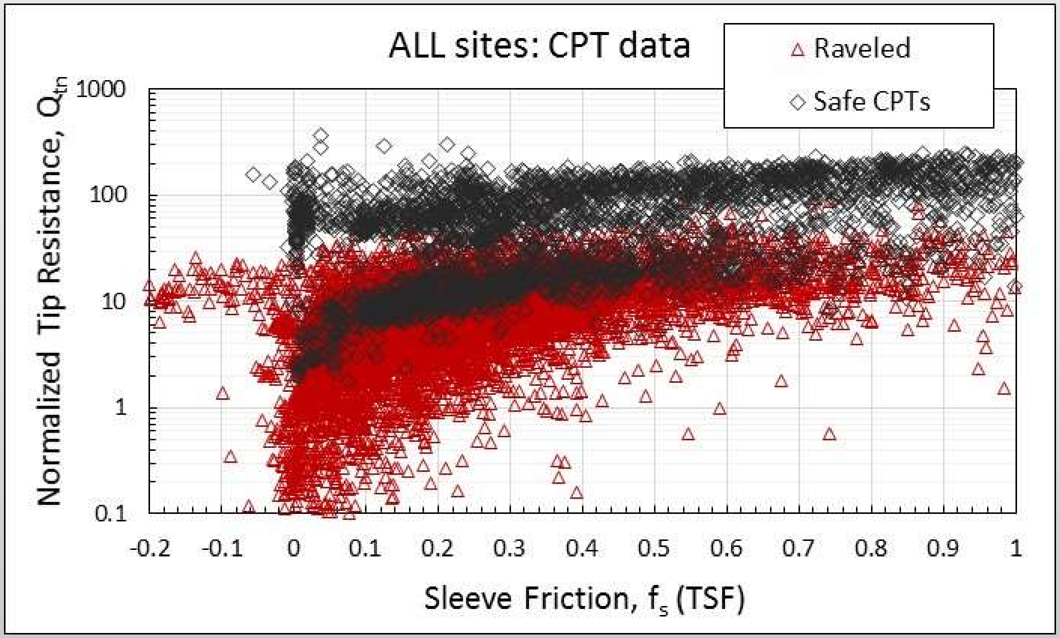
- Comparison between "safe" and "Raveled" CPT data



Results

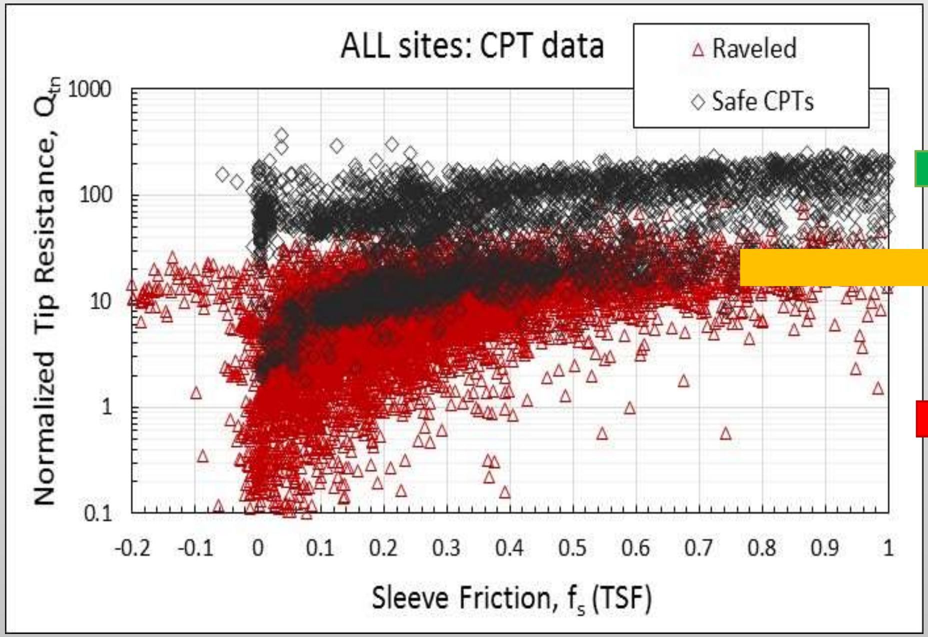
- Comparison between "safe" and "Raveled" CPTs' data





Results

- Comparison between “safe” and “Raveled” CPTs’ data



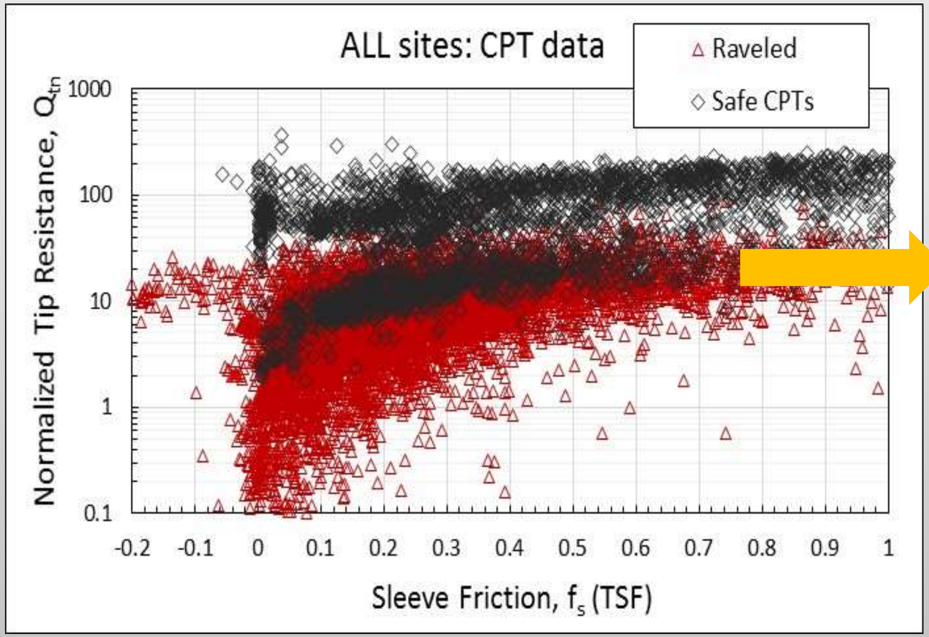
“Safe” Hawthorne soils

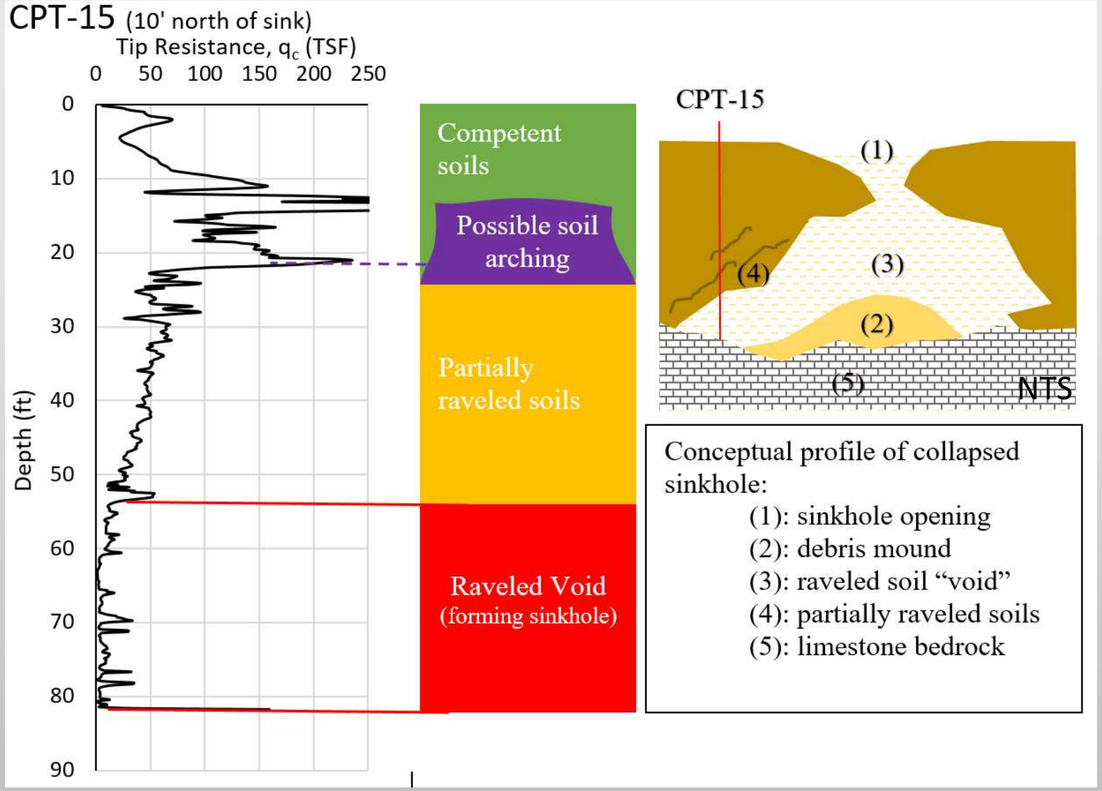
?? Overlap

“Raveled” Hawthorne soils

Results

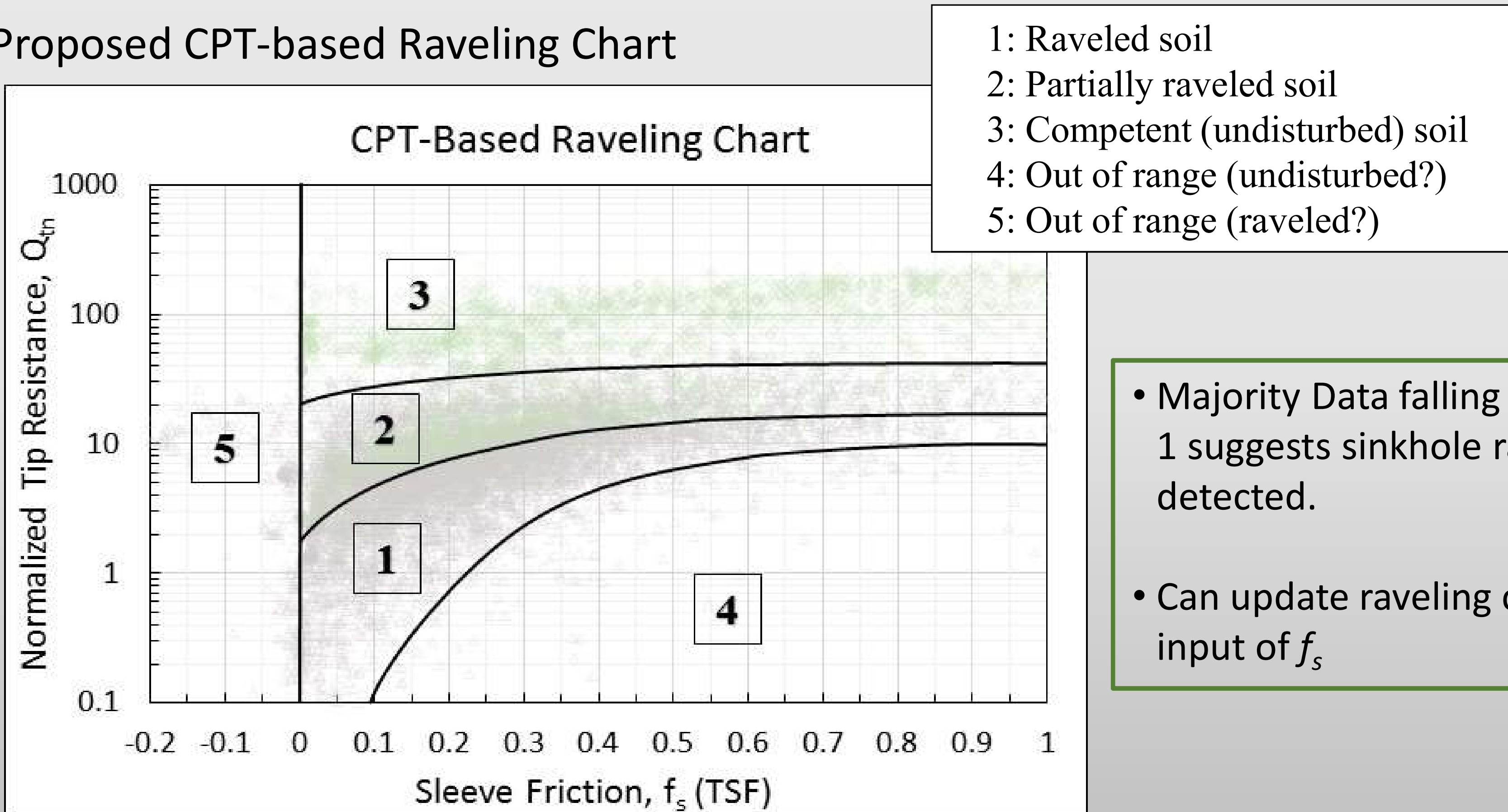
- Comparison between "safe" and "Raveled" CPTs' data





Results

- Proposed CPT-based Raveling Chart



- Majority Data falling within zone 1 suggests sinkhole raveling detected.
- Can update raveling criteria with input of f_s

Results

- Proposed Updated CPT raveling detection Criteria

Source:	Region	Measured cone resistance, q_c	Normalized Cone Resistance, Q_{tn}	Measured sleeve friction, f_s
Gray & Bixler (1994)	Karst Central Florida	$\leq$ 10 TSF	-	-
This study	Karst Central Florida (Cypress head formation)	-	$\leq$ 26	$\leq$1.2 TSF

Through analysis of CPTs performed at Sinkhole collapsed sites, raveled soils indicative of sinkhole formation may be identified by readings of:

$$Q_{tn} \leq 26 \quad \& \quad f_s \leq 1.2 \text{ TSF}$$

Generally, $Q_{tn} < q_c$ at depths where raveling occurs. Suggesting the present criteria may be too lenient.

3.2 Assessment of Sinkhole Hazard by CPT

- This chapter presents techniques used as tools for assessing potential Sinkhole hazards during site characterization.

1. Point-based method (single test)
2. Surface plot area-based methods
   - Current Raveling Index (RI)
   - Proposed Sinkhole Resistance Ratio (SRR)

Point-based Method

Correcting for vertical stress

(Robertson & Wride 1998)

Normalization equations:

Tip resistance,

$$Q_{tn} = \left(\frac{q_c - \sigma_v}{\sigma_v'}\right)^{0.65}$$

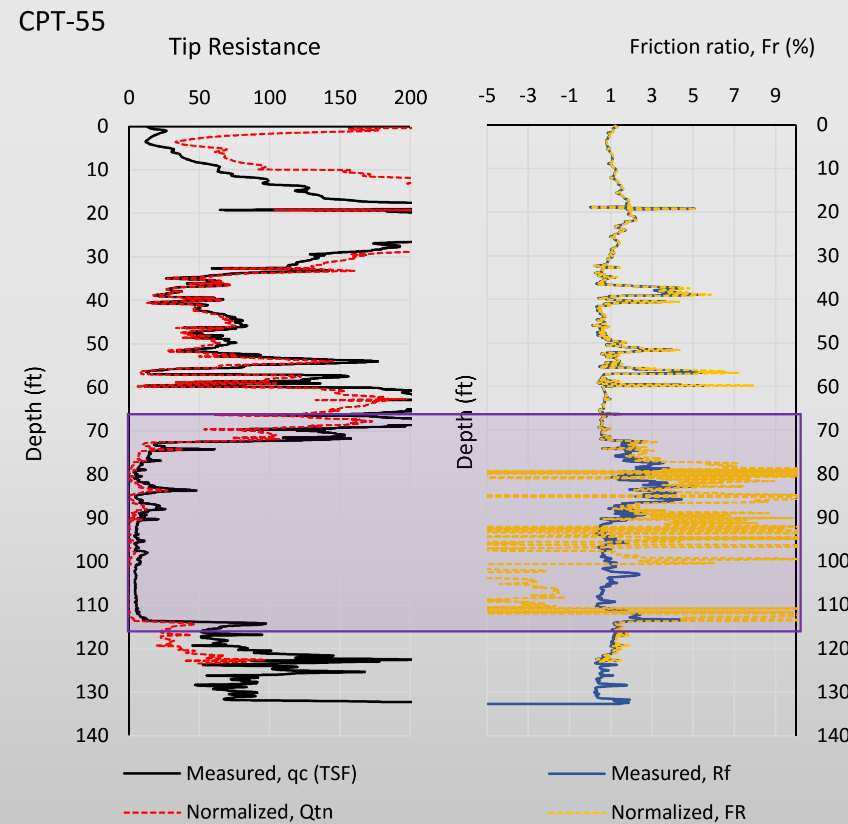
Friction ratio,

$$F_r = \left(\frac{f_s}{q_c - \sigma_v}\right) * 100$$

AS

$q_c \rightarrow \sigma_v : F_r \rightarrow \pm\infty$

$q_c < \sigma_v : Q_{tn} < 0$



Point-based Method

<u>Correcting for vertical stress</u>

Normalization equations:

Tip resistance,

$$Q_{tn} = \left(\frac{q_c - \sigma_v}{\sigma'_v}\right)^{0.65}$$

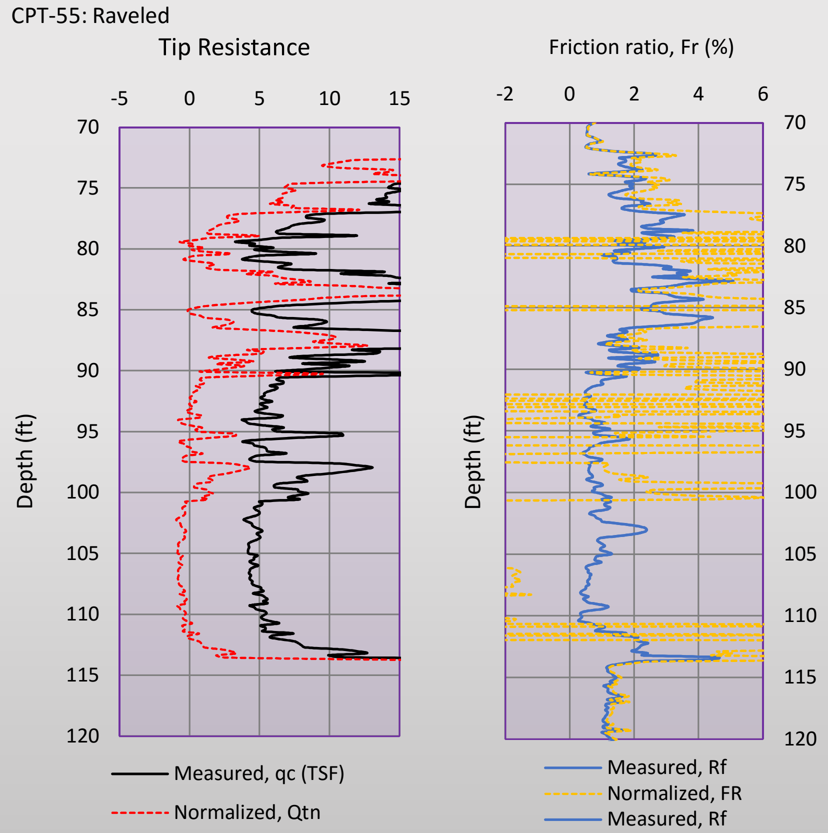
Friction ratio,

$$F_r = \left(\frac{f_s}{q_c - \sigma_v}\right) * 100$$

AS

$q_c \rightarrow \sigma_v$: $F_r \rightarrow \pm\infty$

$q_c < \sigma_v$: $Q_{tn} < 0$



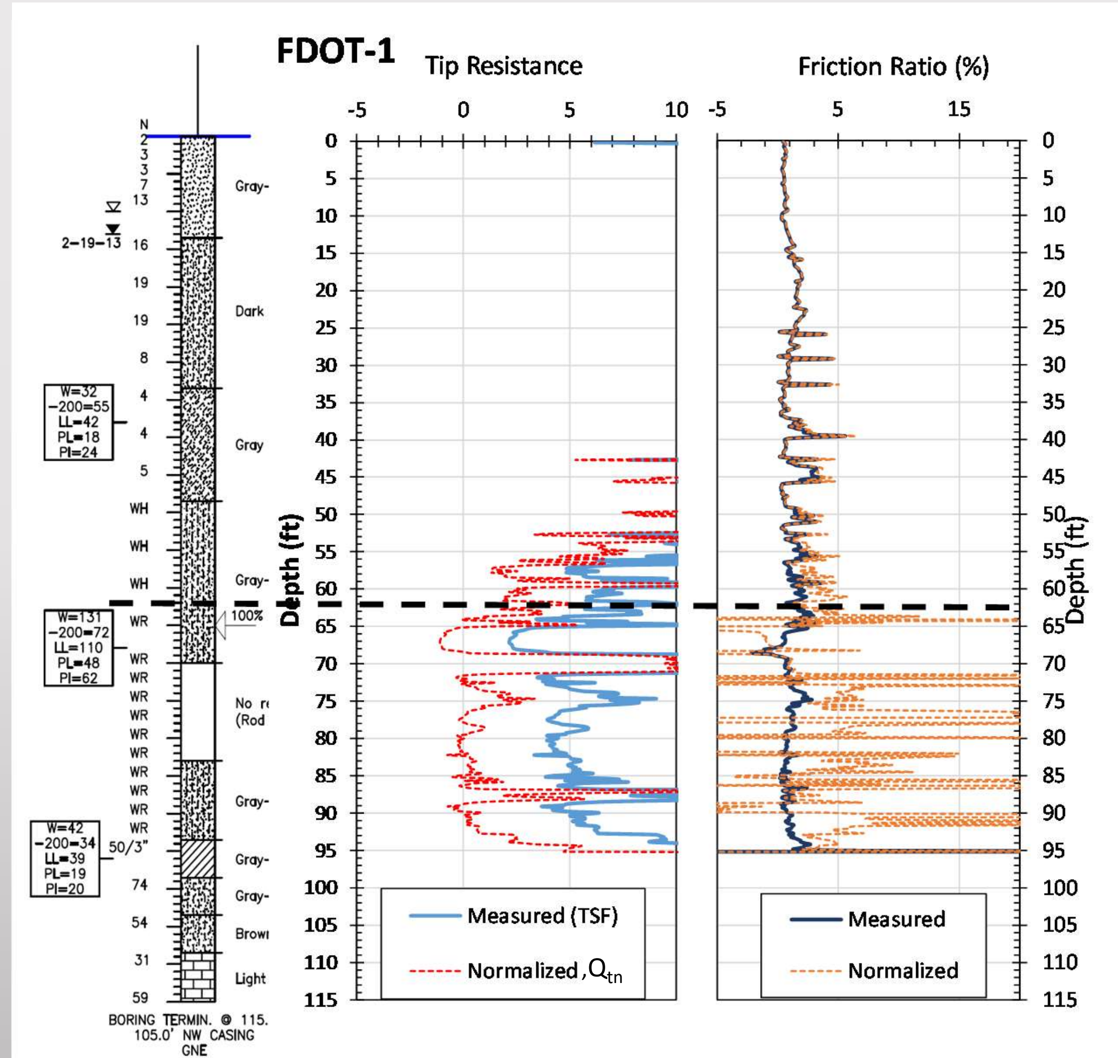
Even though CPT is recording resistance ($q_c \neq 0$), the overburden stresses may be transmitted through soil arching around that soft soil zone.

Point-based Method

Depths when $Q_{tn} < 0$ seem to correlate with WR conditions and 100% LOC occur.

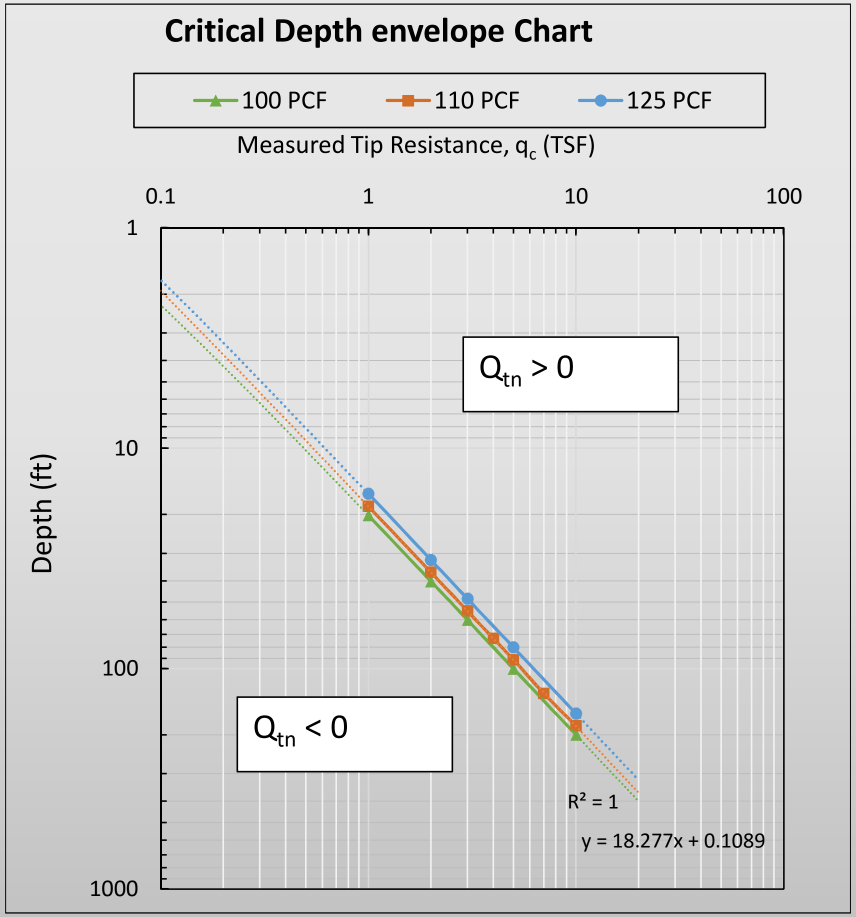
Suggests there must be a “critical depth” when q_c yields, $Q_{tn} < 0$ when corrected for overburden.

$Q_{tn} < 0$ indicates severely raveled soil lacking any strength characteristics to withstand overburden soil weight.



Point-based Method - Critical Depth Envelope Chart

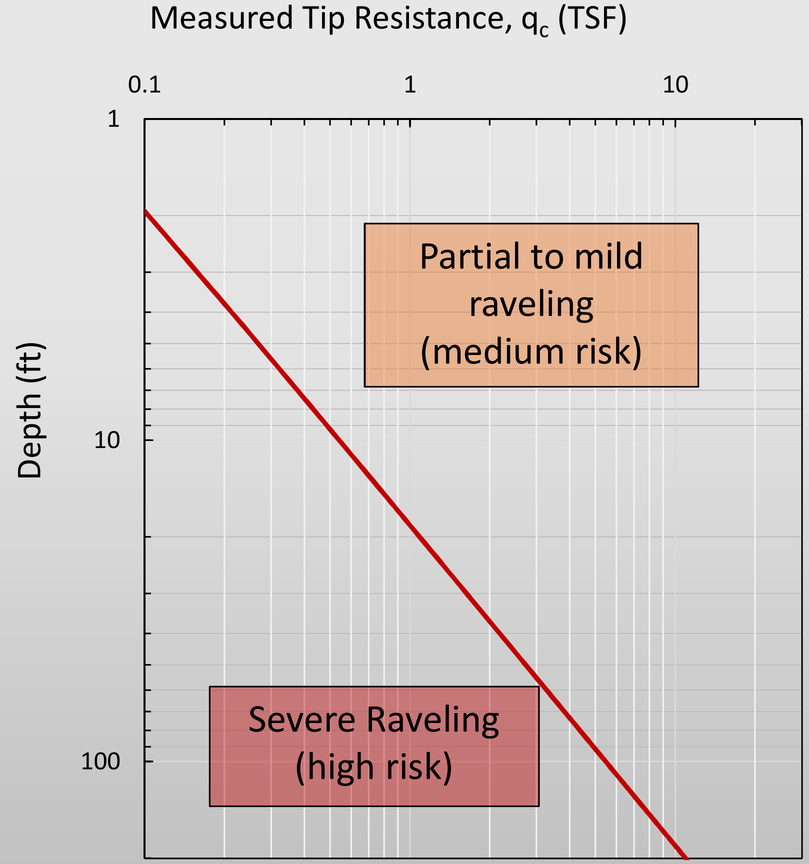
- Created to determine at what depth a specific q_c value will yield a negative Q_{tn} value.
- Varying assumed γ_{sat} typical of Florida's sandy soil.



Point-based Method - Critical Depth Envelope Chart

- Created to determine at what depth a specific q_c value will yield a negative Q_{tn} value.
- Varying assumed γ_{sat} typical of Florida's sandy soil.
- Extrapolating and consolidating trend lines to create Raveling severity chart based on same principle.

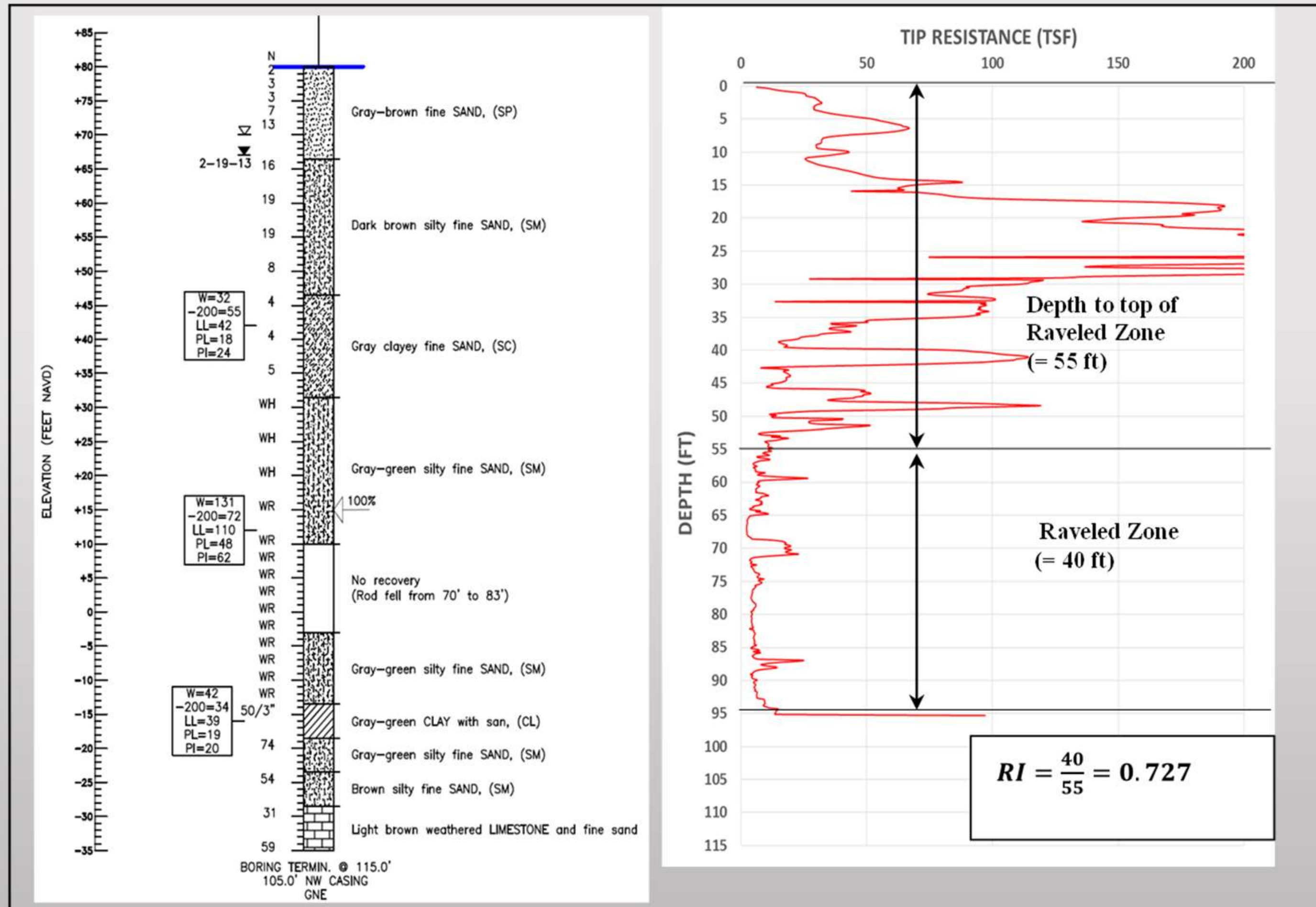
Raveling Severity Chart for CPT measured tip resistance, q_c



Raveling Index (RI) – existing method

- Proposed by Gray and Bixler, the raveling index is the ratio of thicknesses of raveled soil to harder "undisturbed" overburden soil. Best when calculated using CPT data because of high resolution of data.

$$RI = \frac{Thickness\ of\ raveled\ zone}{Depth\ to\ top\ of\ raveled\ zone}$$

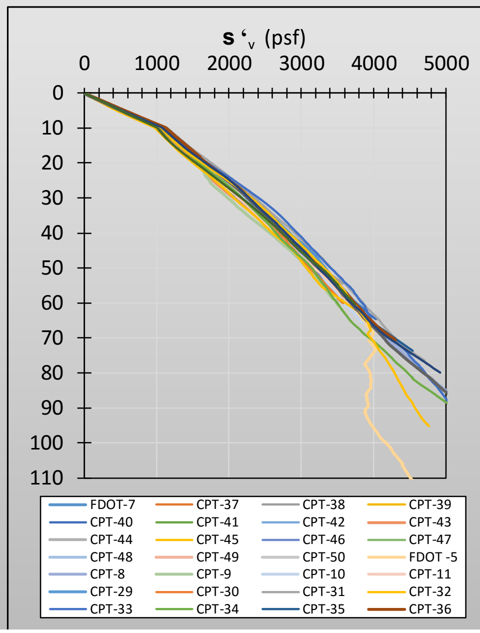


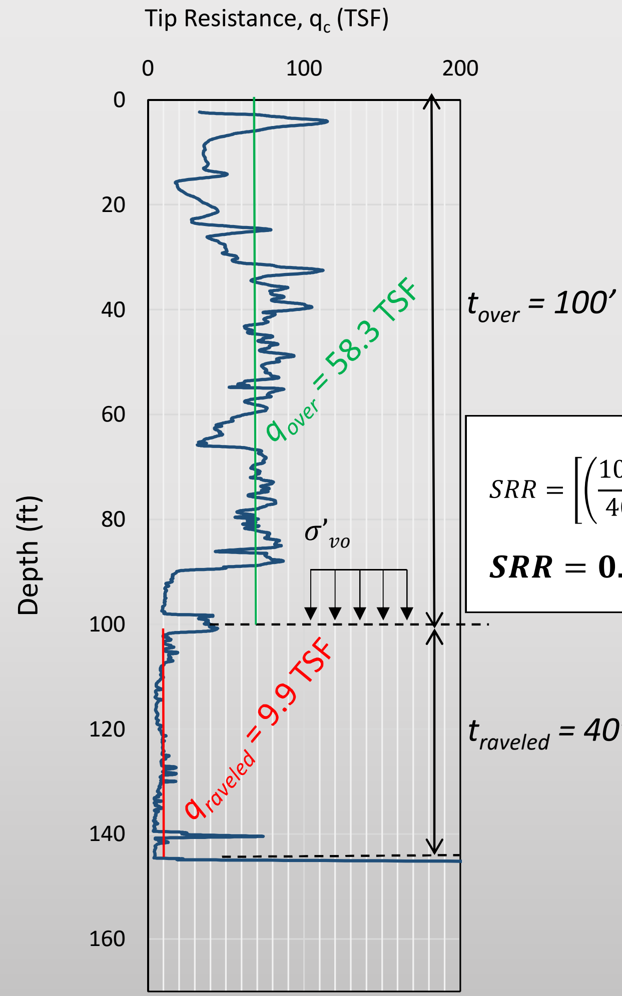
Sinkhole Resistance Ratio (SRR)

$$\mathrm{SRR} = \left(\frac{q_{over} + q_{ravel}}{100 * \sigma'_{vo}}\right)\left(\frac{t_{over}}{t_{ravel}}\right)$$

Effective stress calculated using estimated unit weight: (Robertson and Cabal 2010):

$$\gamma_{sat} = \gamma_w[0.27[\log(R_f)] + 0.36\left[\log\left(\frac{q_c}{P_a}\right)\right] + 1.236] * \frac{G_s}{2.65}$$





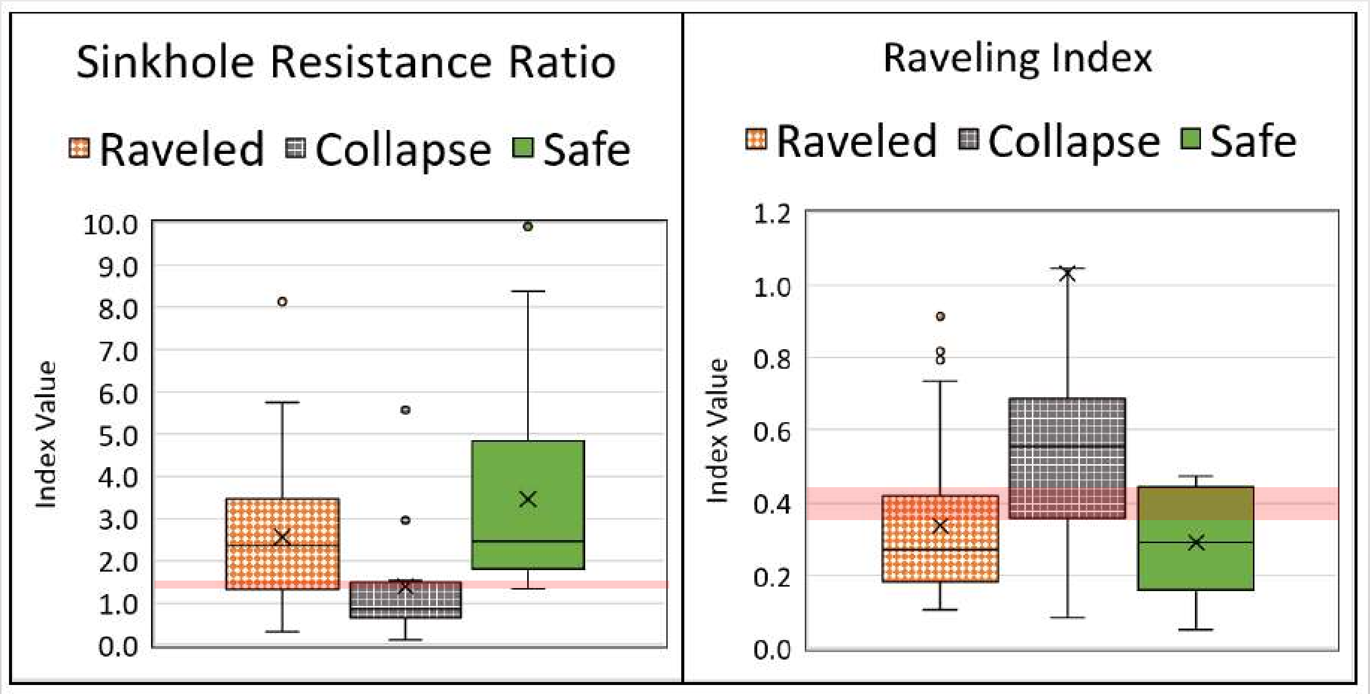
$$SRR = \left[\left(\frac{100'}{40'}\right) * \left(\frac{58.3 + 9.9}{2.74 * 100}\right)\right]$$

$$\boldsymbol{SRR = 0.622}$$

Index Comparison – Wekiva Pwky site

Zone 3 - Bridge Area	*Thickness (ft)*		*Measured q_c (TSF) average*		σ_v' *(TSF)*	RI [4]	SRR [5]
CPT	*Overburden*	*Raveled*	*Overburden*	*Raveled*			
CPT-51a	55.94	51.67	99.35	13.60	1.86	0.92	0.66
FDOT-8	68.41	54.46	134.51	25.84	2.14	0.80	0.94
CPT-23	67.42	46.26	129.55	14.13	2.17	0.69	0.96
CPT-55	72.83	40.69	121.94	9.60	2.41	0.56	0.98
CPT 1-1	44.78	21.82	133.22	21.22	1.37	0.49	2.31
CPT 1-2	51.67	21.66	82.42	19.79	1.73	0.42	1.41
CPT-62	37.73	14.93	128.55	16.62	1.40	0.40	2.62
CPT 1-4	43.14	16.74	165.77	26.43	1.34	0.39	3.70
CPT 1-6	43.80	15.26	86.73	13.72	1.36	0.35	2.12
CPT-24	42.32	13.95	112.70	18.80	1.34	0.33	2.98
CPT-53	48.72	14.60	95.80	8.01	1.65	0.30	2.11
CPT 1-3	54.30	16.24	115.59	33.92	1.74	0.30	2.87
CPT 1-7	35.76	9.68	119.11	17.17	1.42	0.27	3.55
CPT-58	37.57	9.35	112.64	17.72	1.33	0.25	3.95
CPT-54	39.21	9.51	122.96	21.39	1.43	0.24	4.15
CPT-61	42.65	10.01	104.91	10.93	1.48	0.23	3.32
CPT-52	58.23	12.31	104.48	14.68	1.95	0.21	2.88
CPT-18	50.52	9.68	80.84	24.81	1.69	0.19	3.26
CPT-56	65.94	12.14	129.68	25.32	2.23	0.18	3.78
CPT-22	52.49	7.71	88.80	27.30	1.70	0.15	4.64
CPT-60	51.02	7.21	115.04	17.54	1.73	0.14	5.42
CPT-57	42.32	4.76	123.07	13.62	1.49	0.11	8.13
CPT-59	58.23	6.40	100.86	22.35	1.94	0.11	5.77

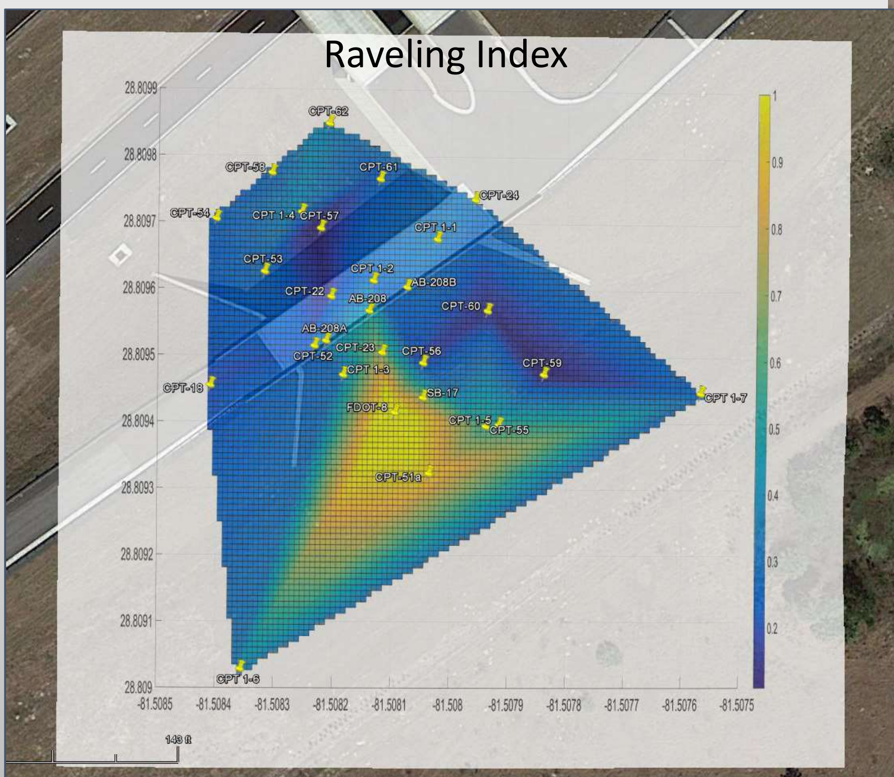
Index Comparison – SRR vs. RI

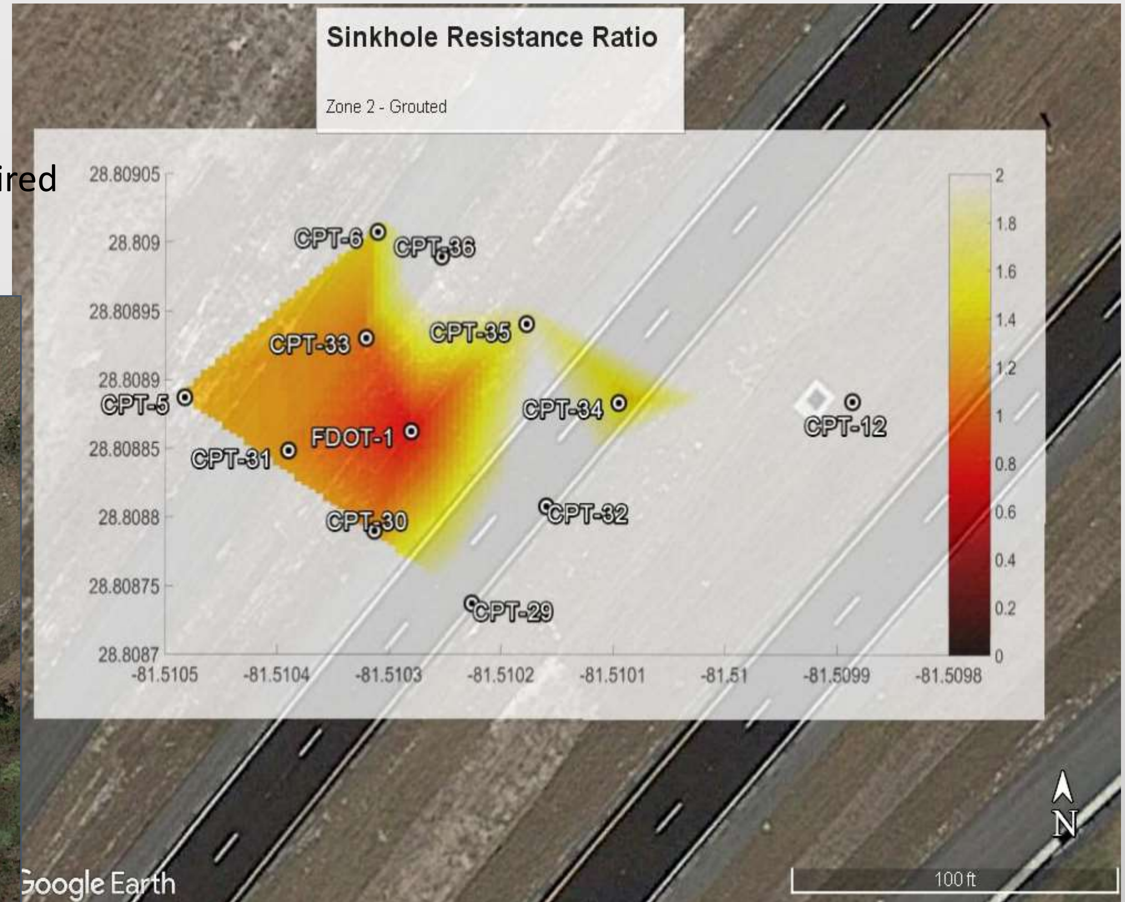


- RI has more overlap between index values => potential of false alarming
- SRR has much less overlap between *Raveled* and *Collapse*.

Index Contouring

Help estimate volume of mitigation technique required (grout or geogrid)





Linear interpolation between index values: looses accuracy with distance

Task 4 – Develop the sinkhole stability analysis

Background

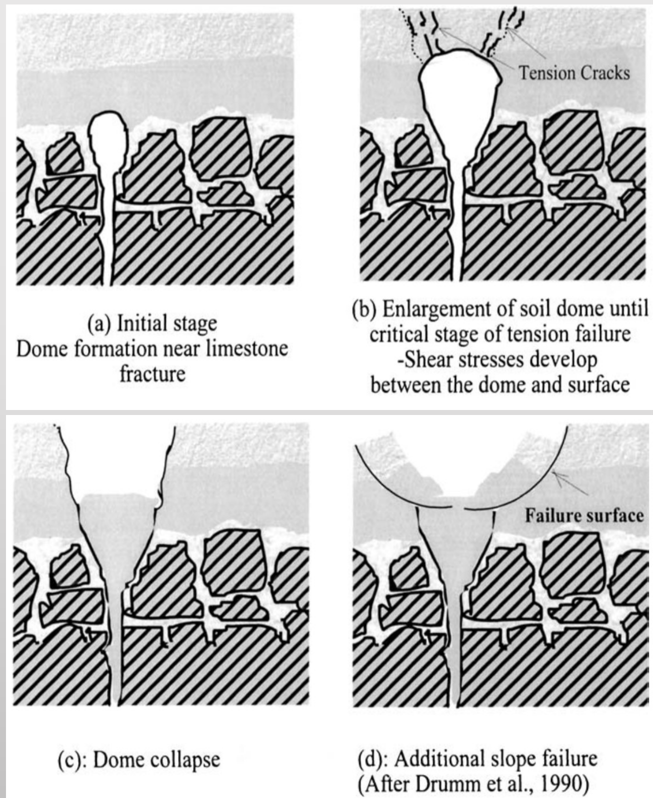
- Stability Analysis of sinkholes using numerical methods, in the literature, was conducted using two approaches:
  1. *Failure Mode Approach*

     Determining the depth required to maintain stability against sinkhole for a dome diameter at specific soil conditions.
  2. *Shear Strength Reduction (SSR) Approach*

     Determining the factor of safety against sinkholes for specific soil conditions and dome geometry.

Failure Mode Approach

Mode I (Cover-Collapse Sinkholes)



(a) Initial stage
Dome formation near limestone fracture

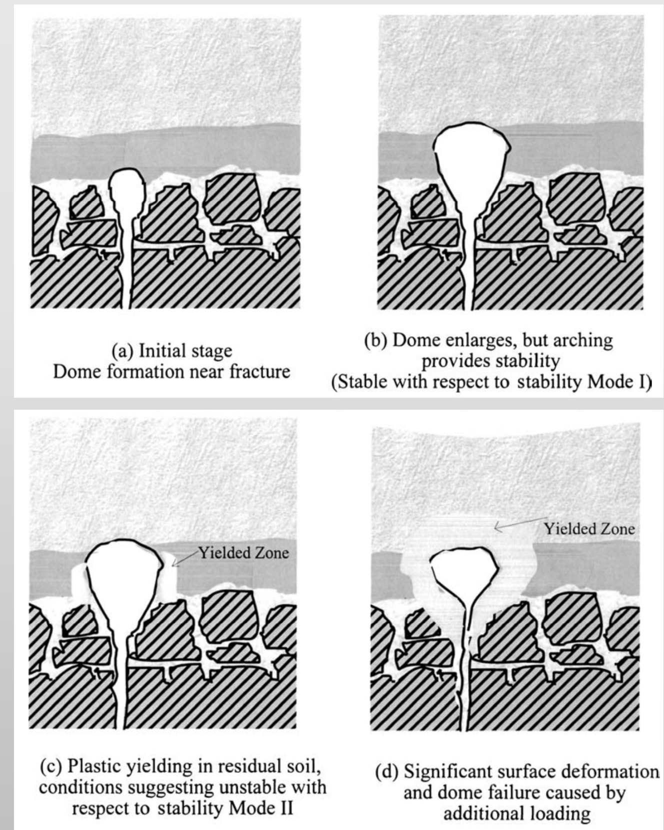
(b) Enlargement of soil dome until critical stage of tension failure
-Shear stresses develop between the dome and surface

(c): Dome collapse

(d): Additional slope failure
(After Drumm et al., 1990)

Drumm & Yang, 2002

Mode II (Cover-Subsidence Sinkholes)



(a) Initial stage
Dome formation near fracture

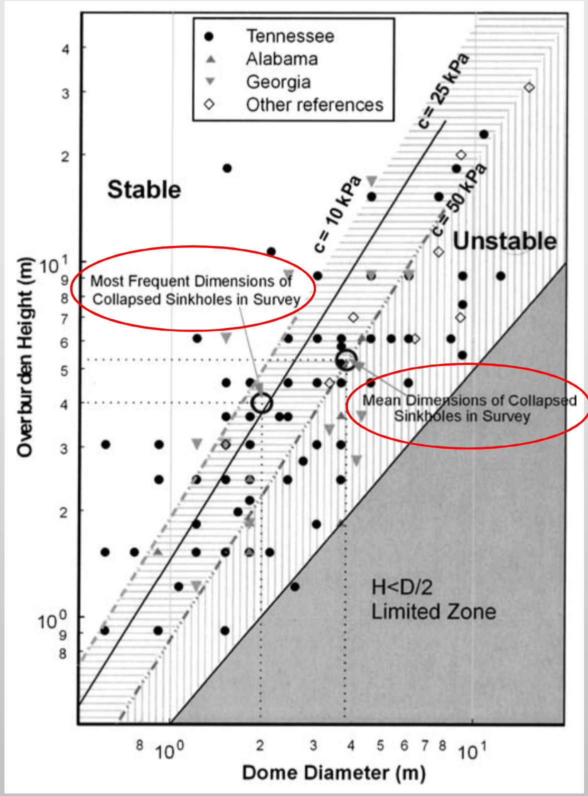
(b) Dome enlarges, but arching provides stability
(Stable with respect to stability Mode I)

(c) Plastic yielding in residual soil, conditions suggesting unstable with respect to stability Mode II

(d) Significant surface deformation and dome failure caused by additional loading

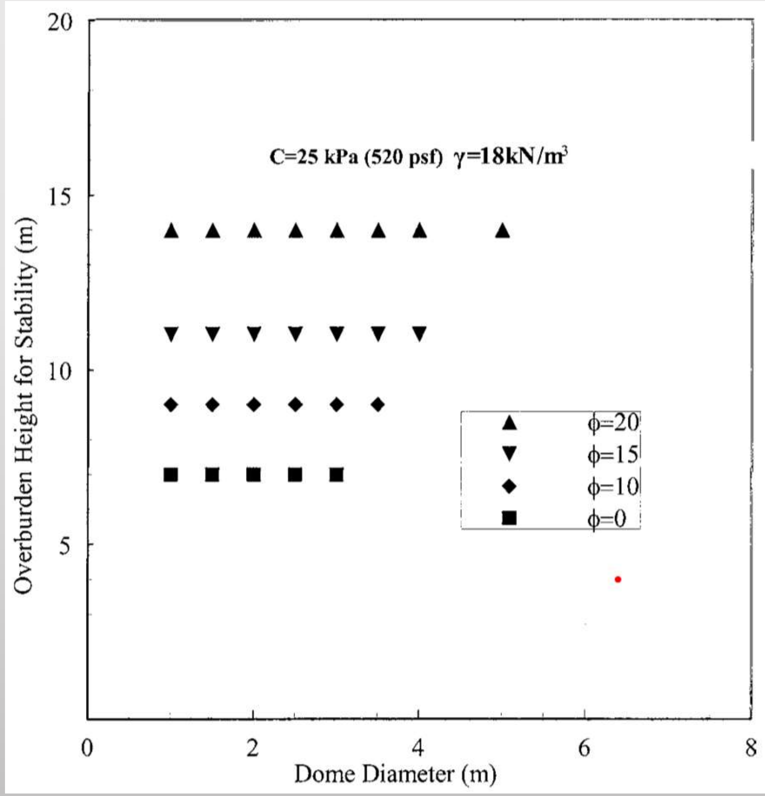
Failure Mode Approach

Mode I (Cover-Collapse Sinkholes)



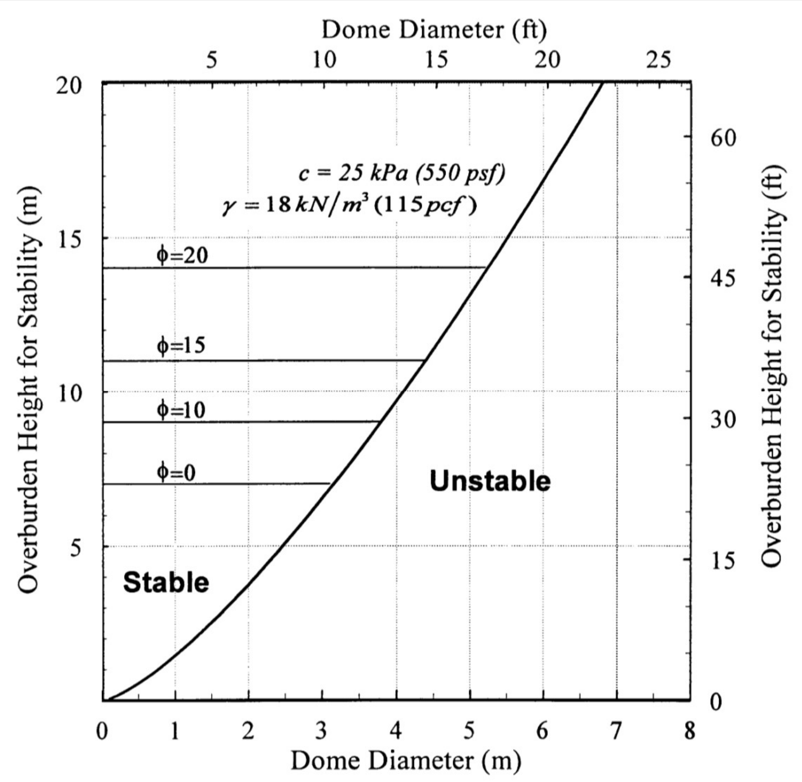
Surveyed sinkhole dimensions and Mode I stability relationships (Drumm & Yang, 2005)

Mode II (Cover-Subsidence Sinkholes)

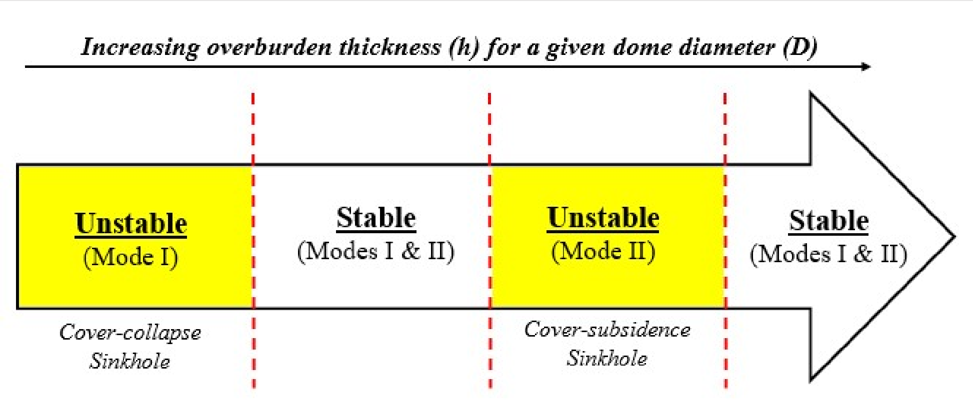


Upper bound of overburden thickness for dome stability (Mode II), c = 25 kPa (Drumm & Yang, 2002/2005)

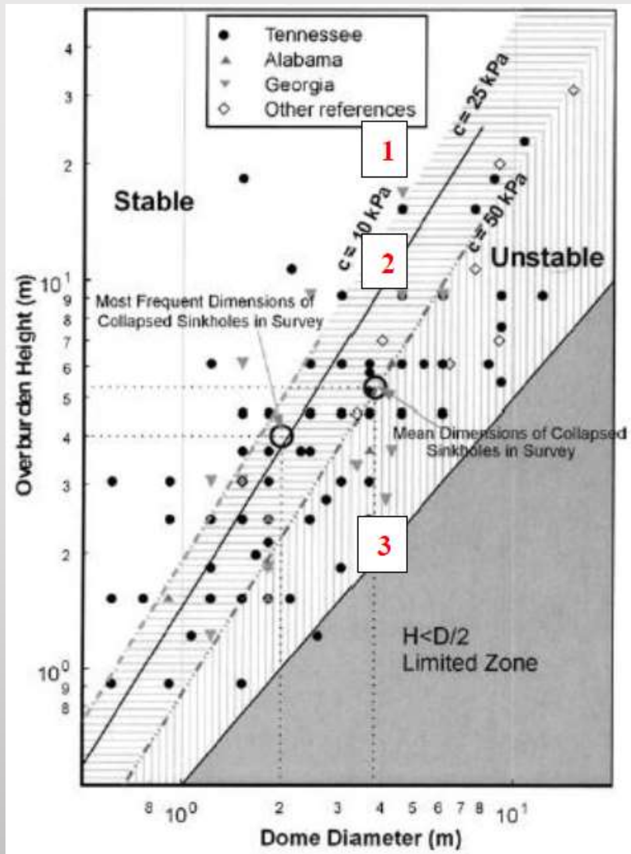
Failure Mode Approach



Karst Dome Stability Chart (Drumm & Yang, 2002/2005)

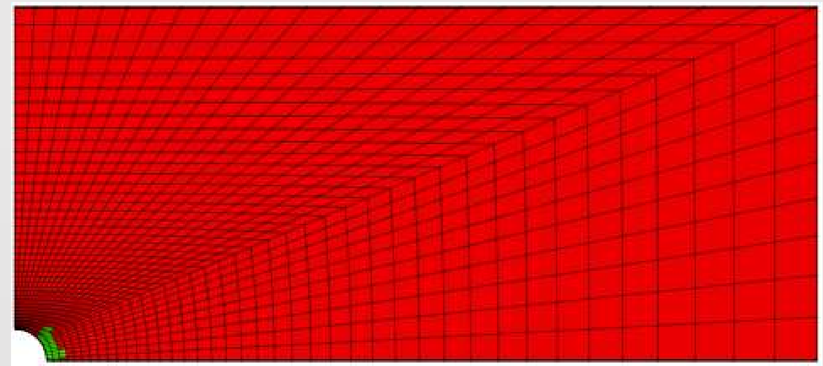


Failure Mode Approach

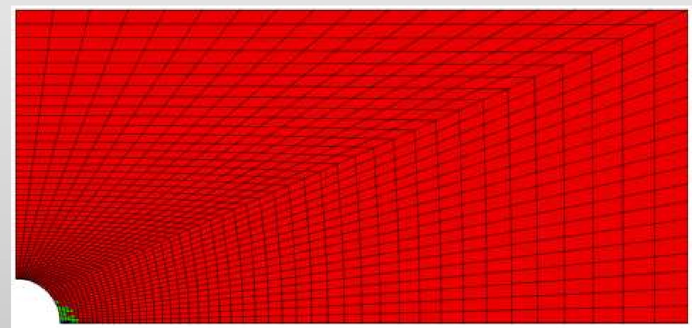


Surveyed sinkhole dimensions and Mode I stability relationships (Drumm & Yang, 2005)

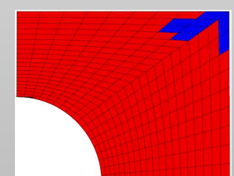
Case 1:
D=4m , h=20m



Case 2:
D=4m , h=12m

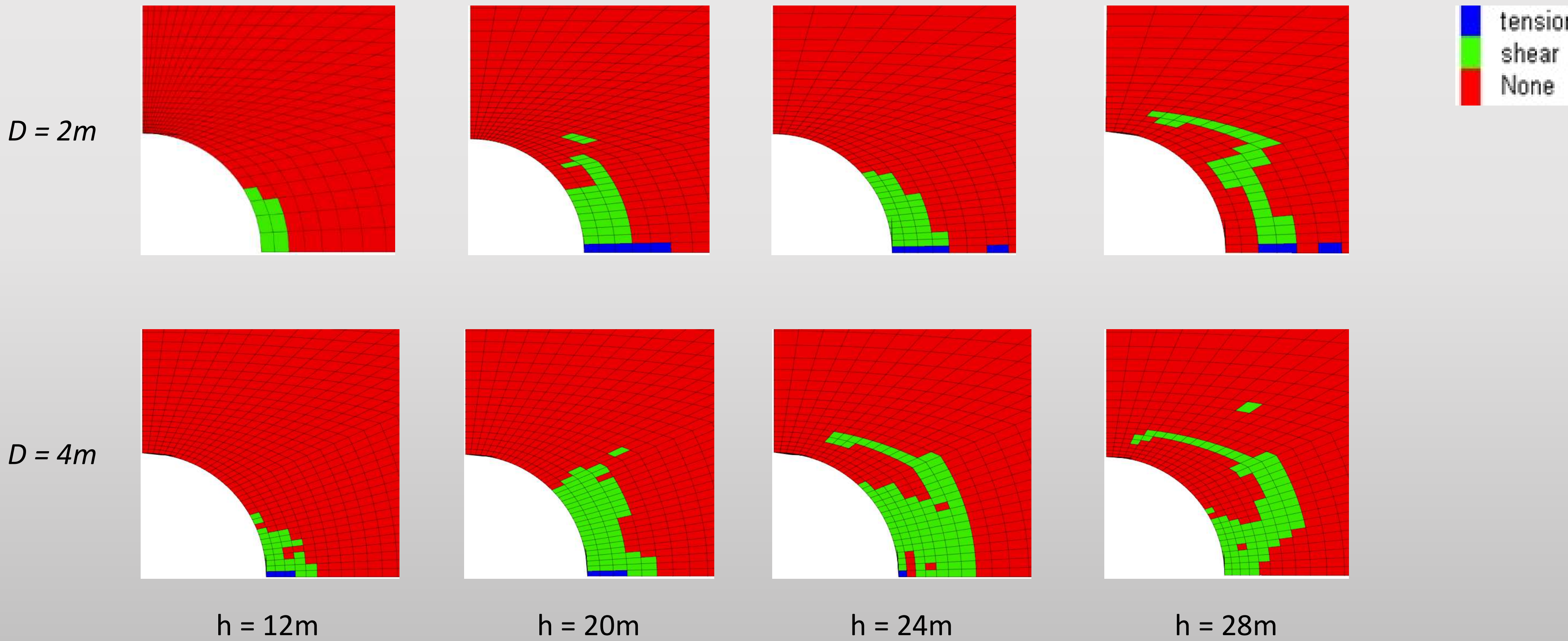


Case 3:
D=4m , h=4m



Yielding/Tension zones vs. overburden depth around a cavity (C=50 kPa)

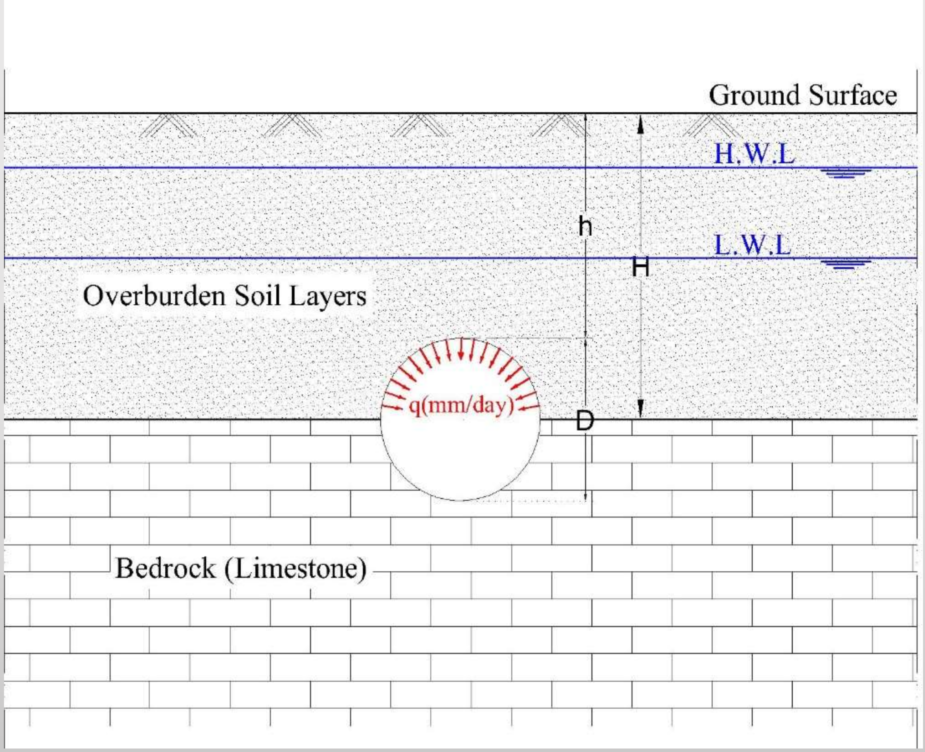
Failure Mode Approach



Growth of yielded zone with the overburden thickness

Future Works in Numerical Analysis

1. **Effective stress analysis**
   - Effect of groundwater table
   - Effect of water table change (e.g. seasonal change)
   - Raveled zone (loose soil zone)
2. **Seepage-stress coupled analysis**
   - Groundwater recharge (or seepage downward)
3. **Shear Strength Reduction (SRR) approach**



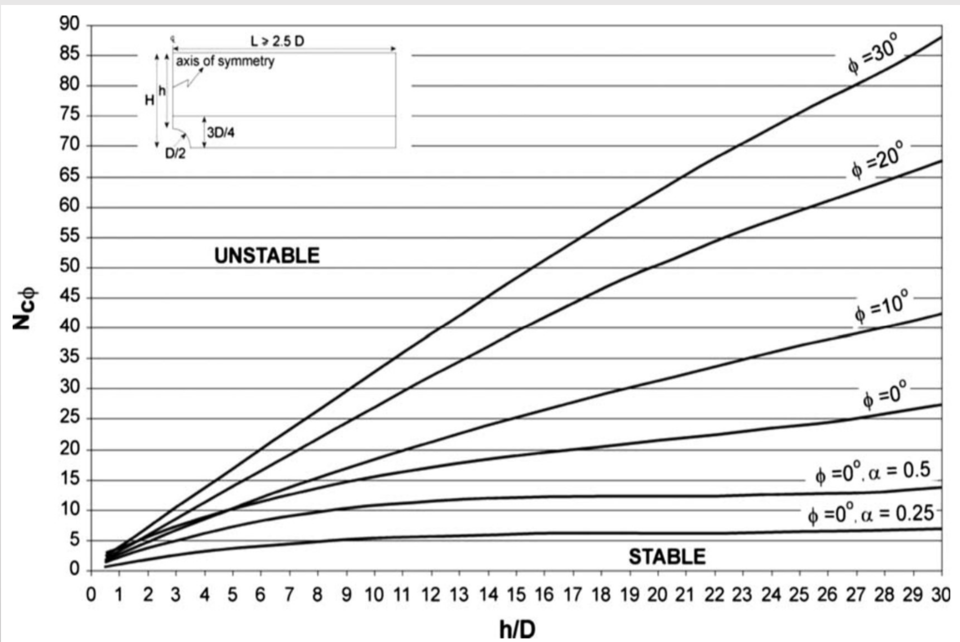
Shear Strength Reduction (SRR) Approach

- This approach is widely used in the stability of slopes and landslides where the factor of safety is obtained by weakening the soil in steps in an elastic-plastic finite element analysis until the slope "fails". *(Dawson et al., 1999; Griffiths and Lane, 1999)*
- Numerically, the failure occurs when it is no longer possible to obtain a converged solution (with a specified tolerance) → *The point at which the deformations become excessive (unacceptably large)*
- The resulting stability numbers are preferable to the stability chart proposed by Drumm and Yang in 2005, where failure was assumed based on an arbitrary size of the yielded zone. (Drumm et al., 2009)

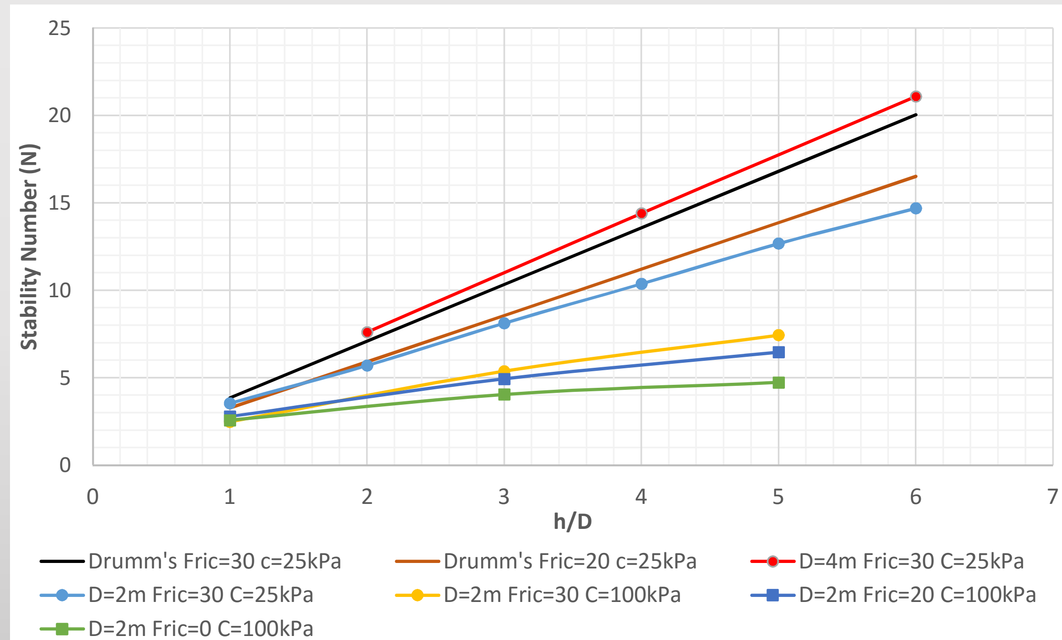
$$\boldsymbol{\tau = \frac{c' + \sigma'\tan\varphi'}{SRF} = \frac{c'}{SRF} + \frac{\sigma'\tan\varphi'}{SRF} = c'_f + \sigma'\tan\varphi_f}$$

Shear Strength Parameters at failure: $c'_f = \frac{c}{SRF}$, $\varphi'_f = \tan^{-1}(\tan\frac{\varphi}{SRF})$

Limitations of SSR Approach



Stability Curves from Drumm et al. (c = 25 kPa)



Stability Curves for different shear strength and geometry values

Future work plan

- Task 1: In-situ groundwater data
  - Continue to monitor the piezometer data
- Task 2: Groundwater recharge model
  - Model calibration based on in-situ piezometer data
  - Creating the high-resolution recharge map
- Task 4: Sinkhole stability analysis
  - Effective stress analysis
  - Seepage-stress coupled analysis
- Task 5: Develop the guideline for sinkhole risk evaluation

Acknowledgement:
Special Thanks to SMO and District 5 teams for all their drilling support thus far!

Thank you!
&
Questions?