

# Incorporating the CPT Into Mn/dot Site Investigations

Or, How We Replaced a Small Track  
Rig



# SPT Correlations

- Friction angle
- Undrained strength
- Relative density
- Bearing capacity
- Pile end bearing in sands

# SPT CORRELATIONS Cont.

- Pile skin friction in sands
- Pile end bearing in clays
- Pile skin friction in clays

# Do More Faster With Less

- Workload is increasing
- Workforce is decreasing
- Desired response time decreasing

# Small Worn-out Track Rig



# New Track



# Motivation for the “Cone”

- Speed of investigations, 5x-10x faster, lab work eliminated
- The fall of “N60” as sufficient information to predict all things
- Less labor intensive; 2-person field crew and less wear/tear on personnel
- Continuous soil profile
- Fast response and results for “discoveries” at time of construction

# Mn/dot's Experience With CPT

- Demo project (1999)
- Consultant projects (2000) (AET)
- Equipment purchasing & testing (2001)





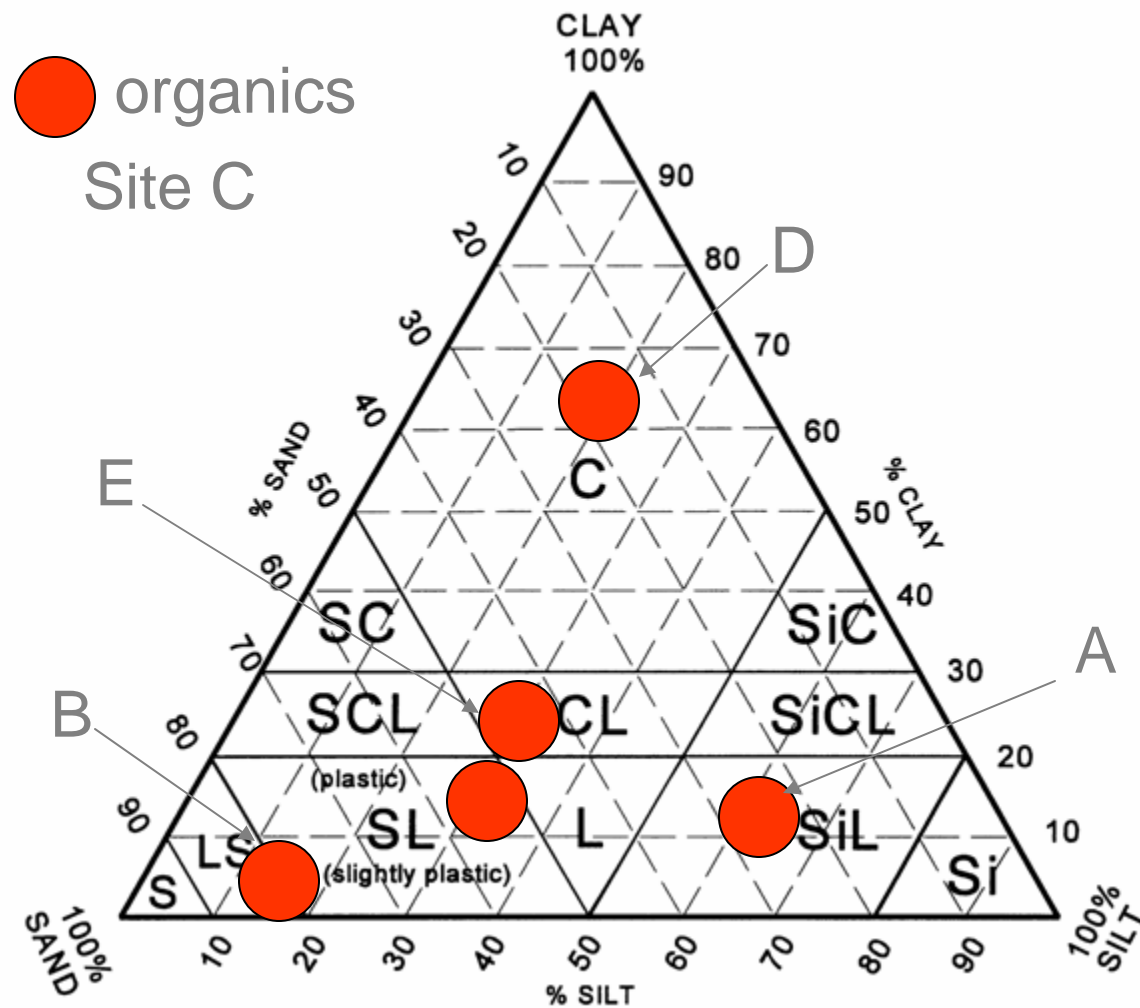
# Goals of Demo. Project

- Will CPT would work in Minnesota's glacial soils
- What are depth and relative density limitations of CPT
- How could we use CPT data
- What should we buy

# Plan

- Hire experienced CPT consultant
- Push CPT next to existing borings
- Evaluate equipment and data

# Soils for Demo Sites



# Push System



# Conclusions From Demo

- CPT works in Minnesota glacial soils
- Amount of data is overwhelming (software)
- Prelim. Est. Of geotechnical parameters
- Design: must calibrate with conventional borings (lab tests, local geology)
- Great for swamps, shallow foundations

# Add-on CPT



# Consultant Add-on CPT



# The New Addition





CPT #2

11.18.2003

# CPT #3

To Arrive Spring of 2006

# General Relationships

- Granular soils - high tip resistance, high sleeve friction, low friction ratio
- Cohesive soils - low tip resistance, high sleeve friction, high friction ratio
- Organics - very low tip, very low sleeve, very high friction ratio

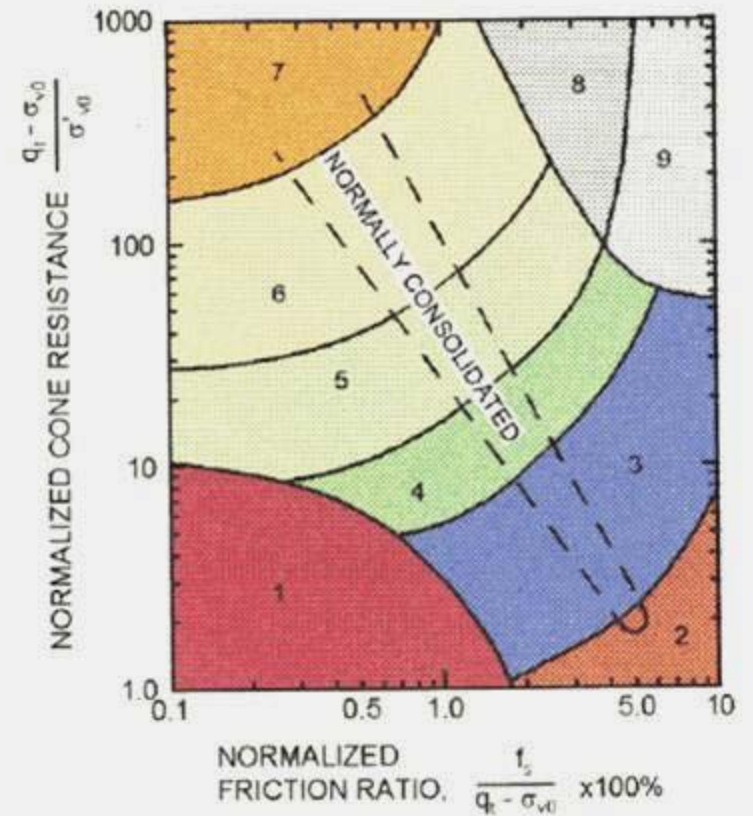
# Soil Behavior Type

Not a formal classification method

Zone	$Q_t/N$	Description
1	2	Sensitive, Fine Grained
2	1	Organic Soils-Peats
3	1.5	Clays-Clay to Silty Clay
4	2	Silt Mixtures-Clayey Silt to Silty Clay
5	3	Sand Mixtures-Silty Sand to Sandy Silt
6	4.5	Sands-Clean Sand to Silty Sand
7	6	Gravelly Sand to Sand
8	1	Very Stiff Sand to Clayey Sand *
9	2	Very Stiff, Fine Grained *
		Undefined Soil Layer

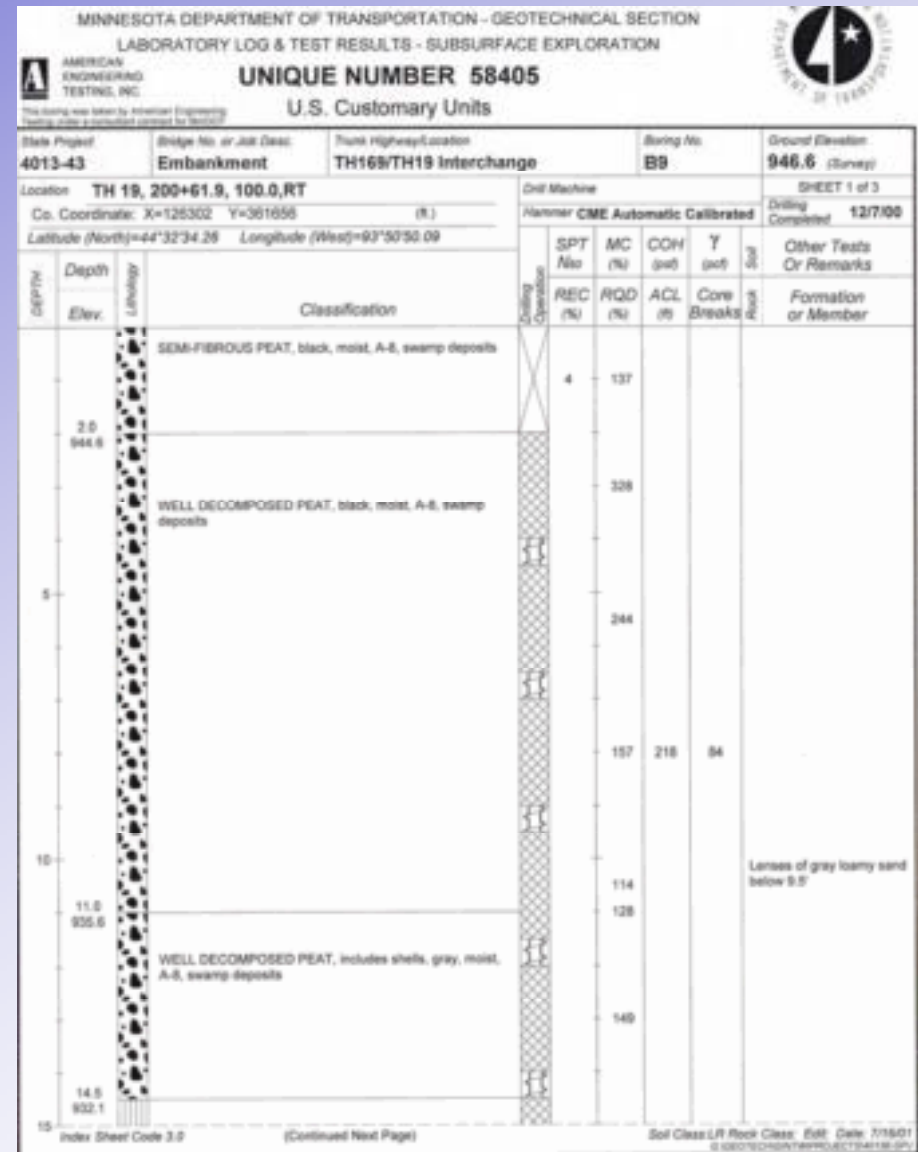
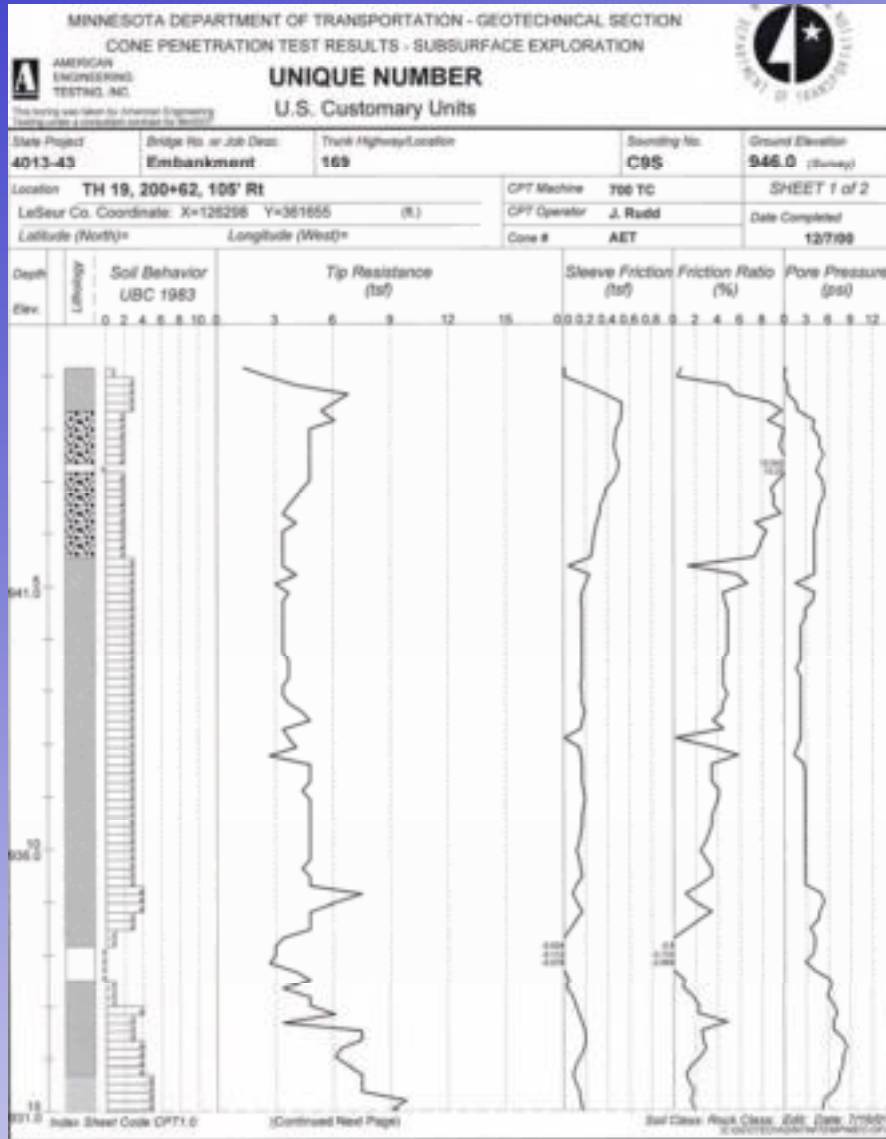
(\*) Heavily Overconsolidated or Cemented

Normalized Friction Ratio Classification Chart

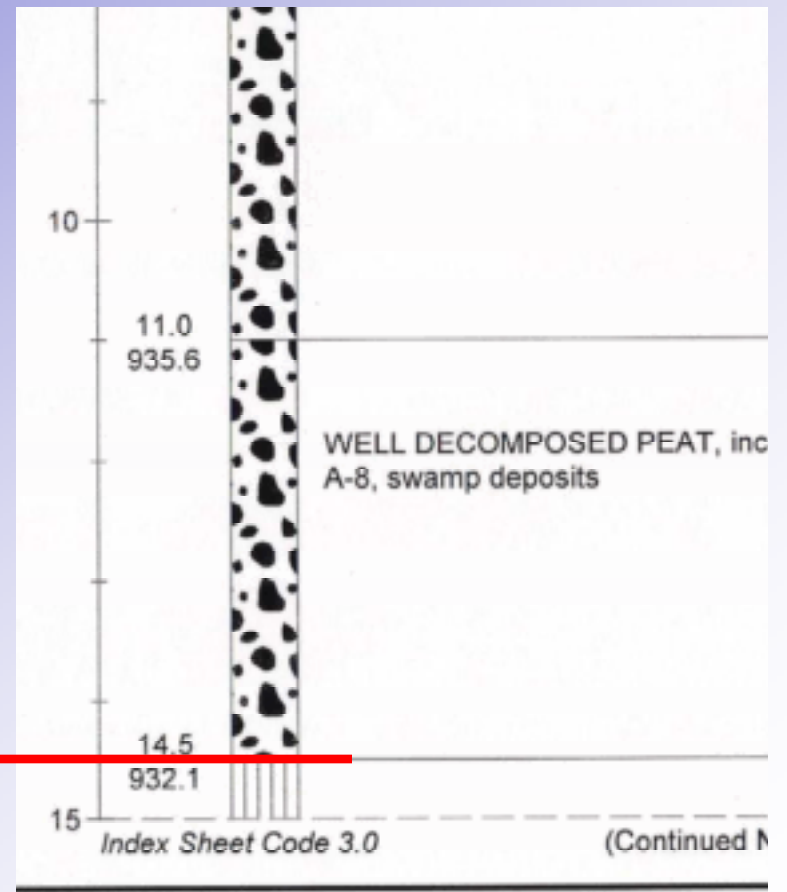
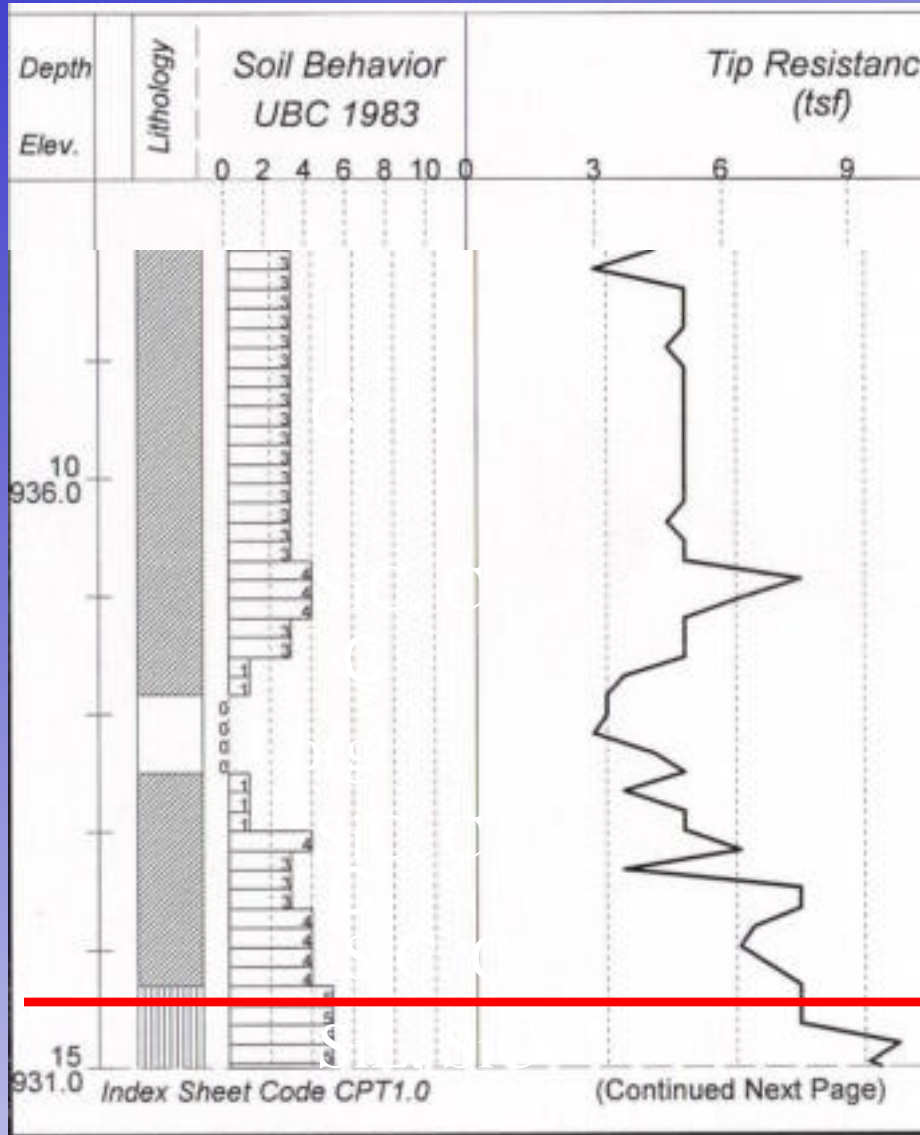


(Ref. Robertson, 1990)

# CPT Sounding / Boring Log



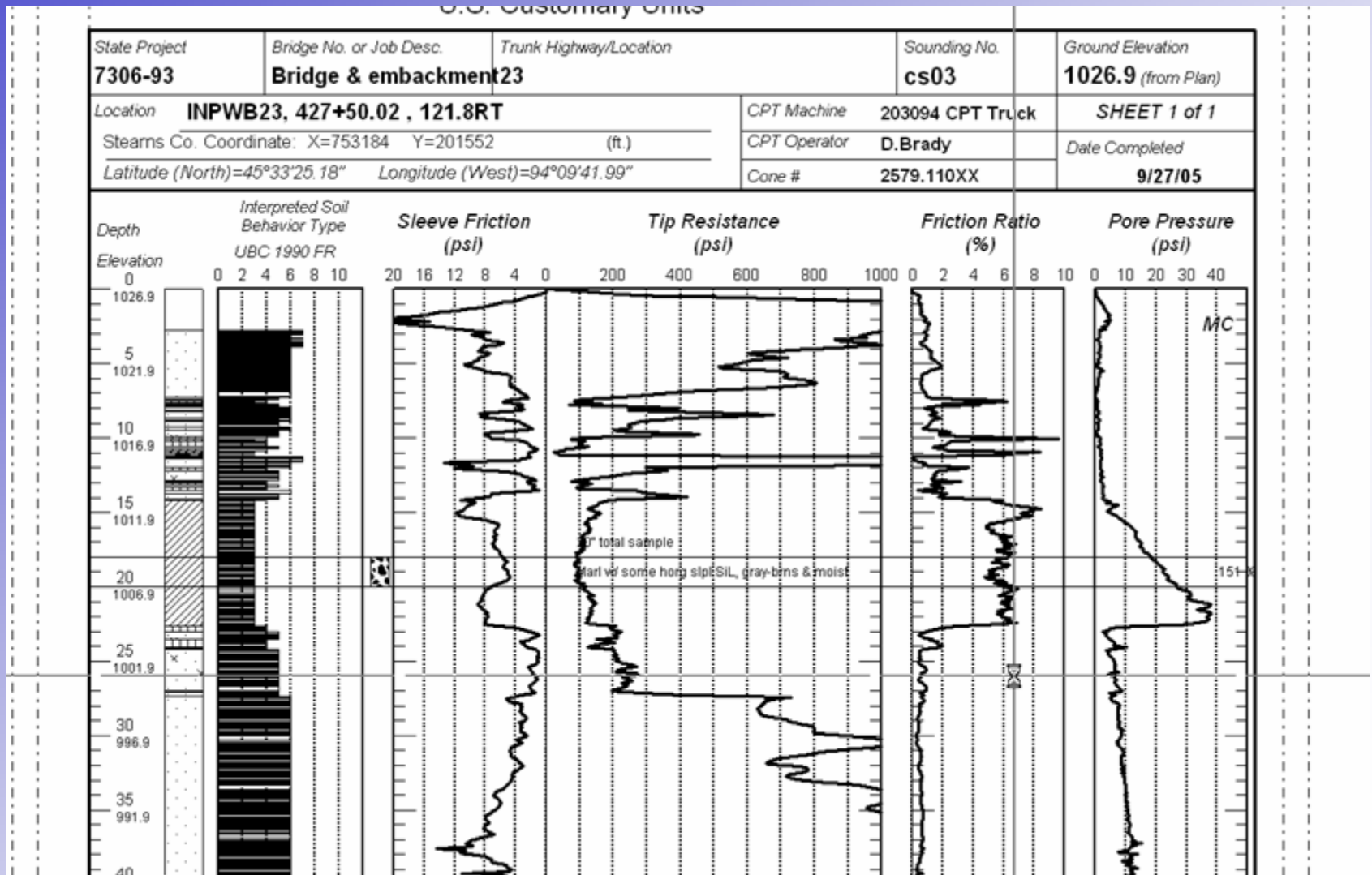
# CPT Vs. Boring



# Soil Sampler



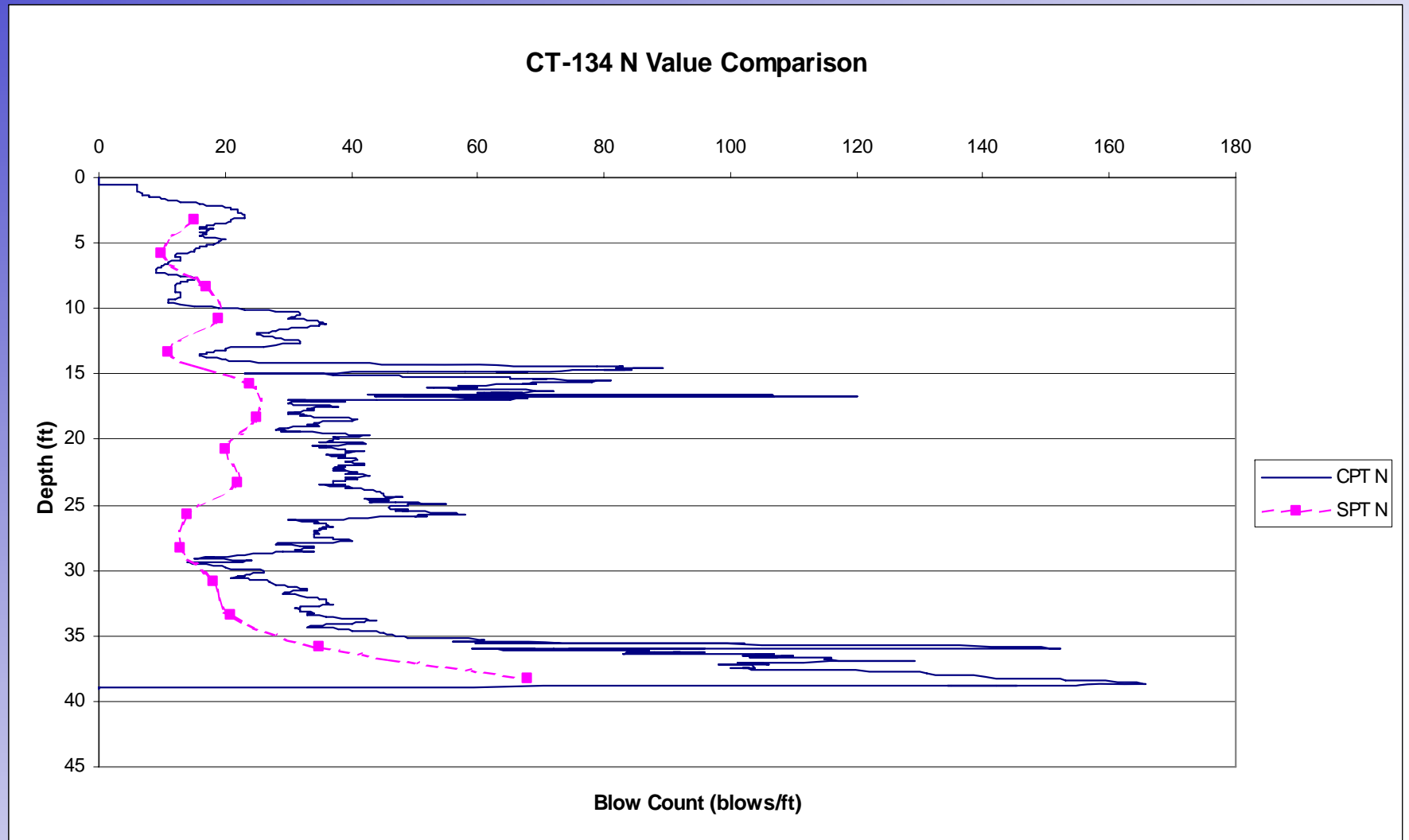
# Sampler





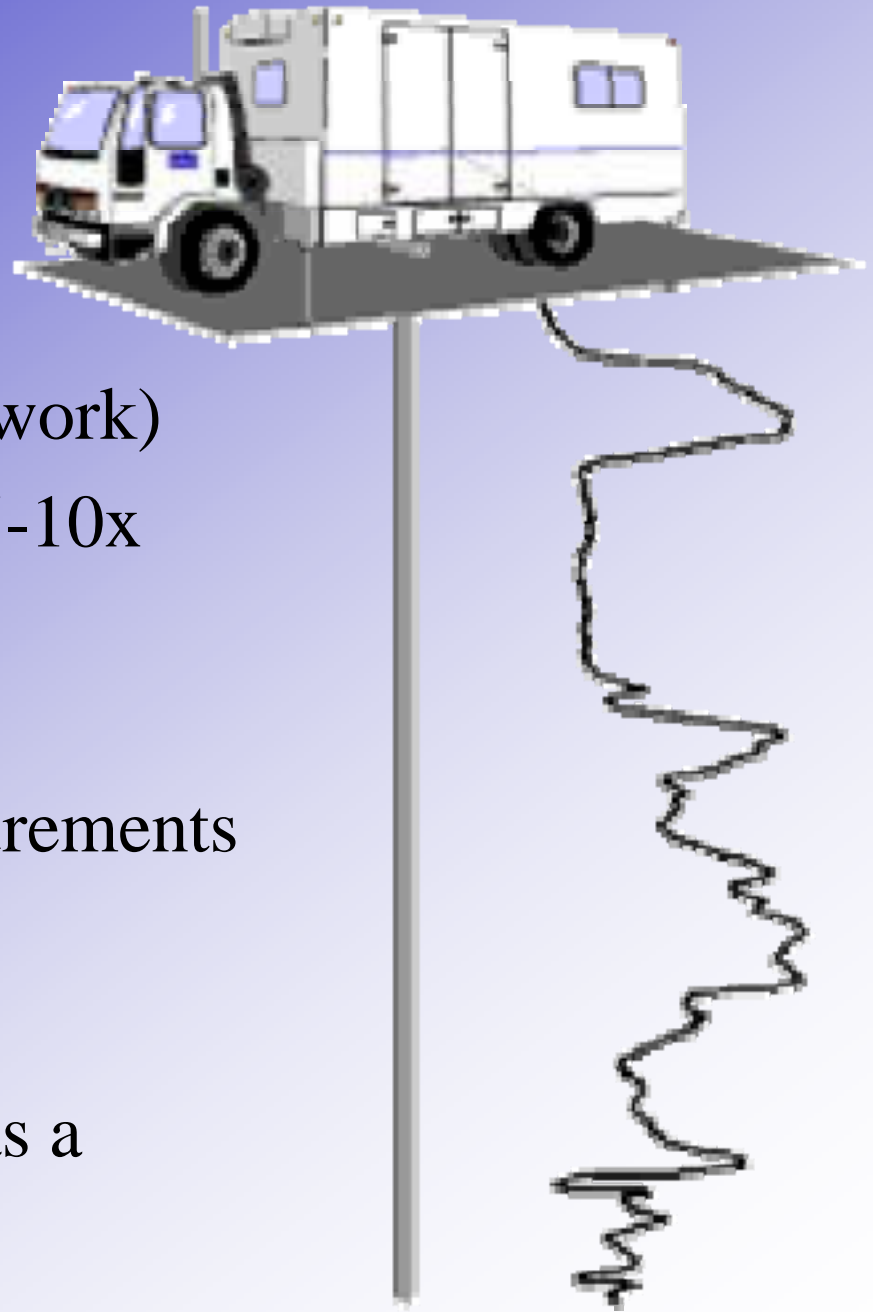
Where Is the  
Blow Count?

# N Value Comparison



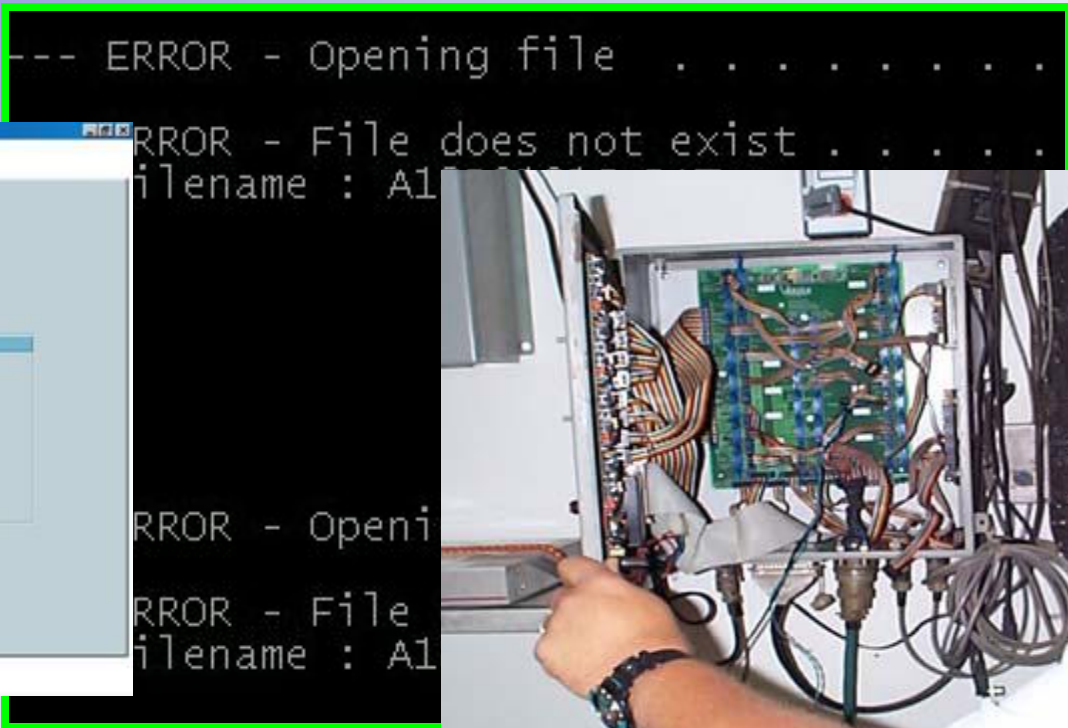
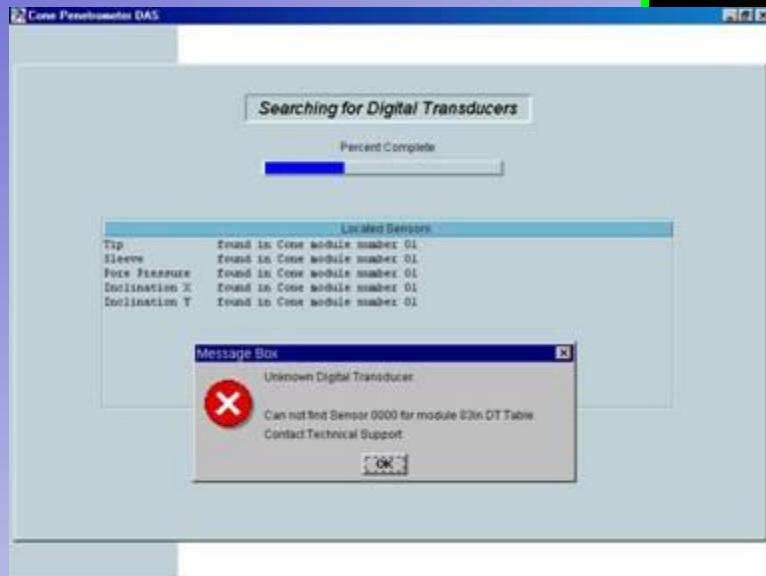
# Advantages

- Immediate results (no lab work)
- Footage (150-500 ft/day, 5-10x faster)
- Continuous soil profile
- Pore water pressure measurements
- Great tool for preliminary investigations
- Can define a 'hard layer' as a supplement to SPT



# Disadvantages

- No samples
- Rocks, concrete, rubble
- Depth limitations (friction, tip, buckling)
- Electronics!



# Roadway Investigation



# During Construction



# Solution



# Post Construction Investigation

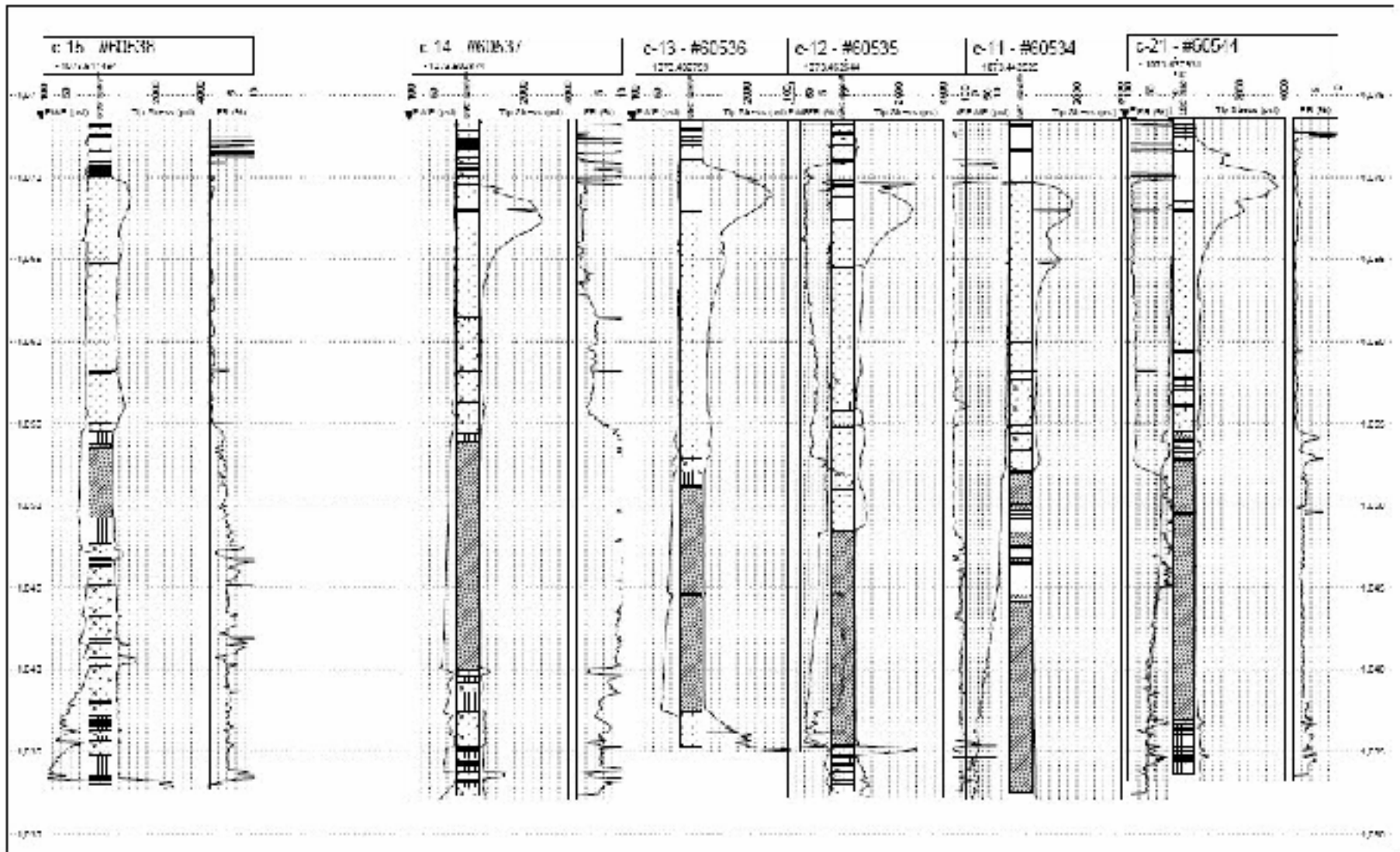




# Oops



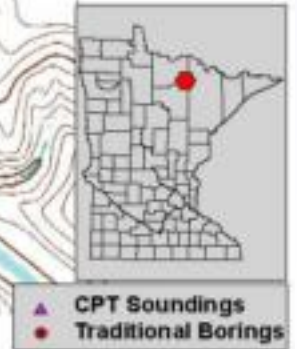
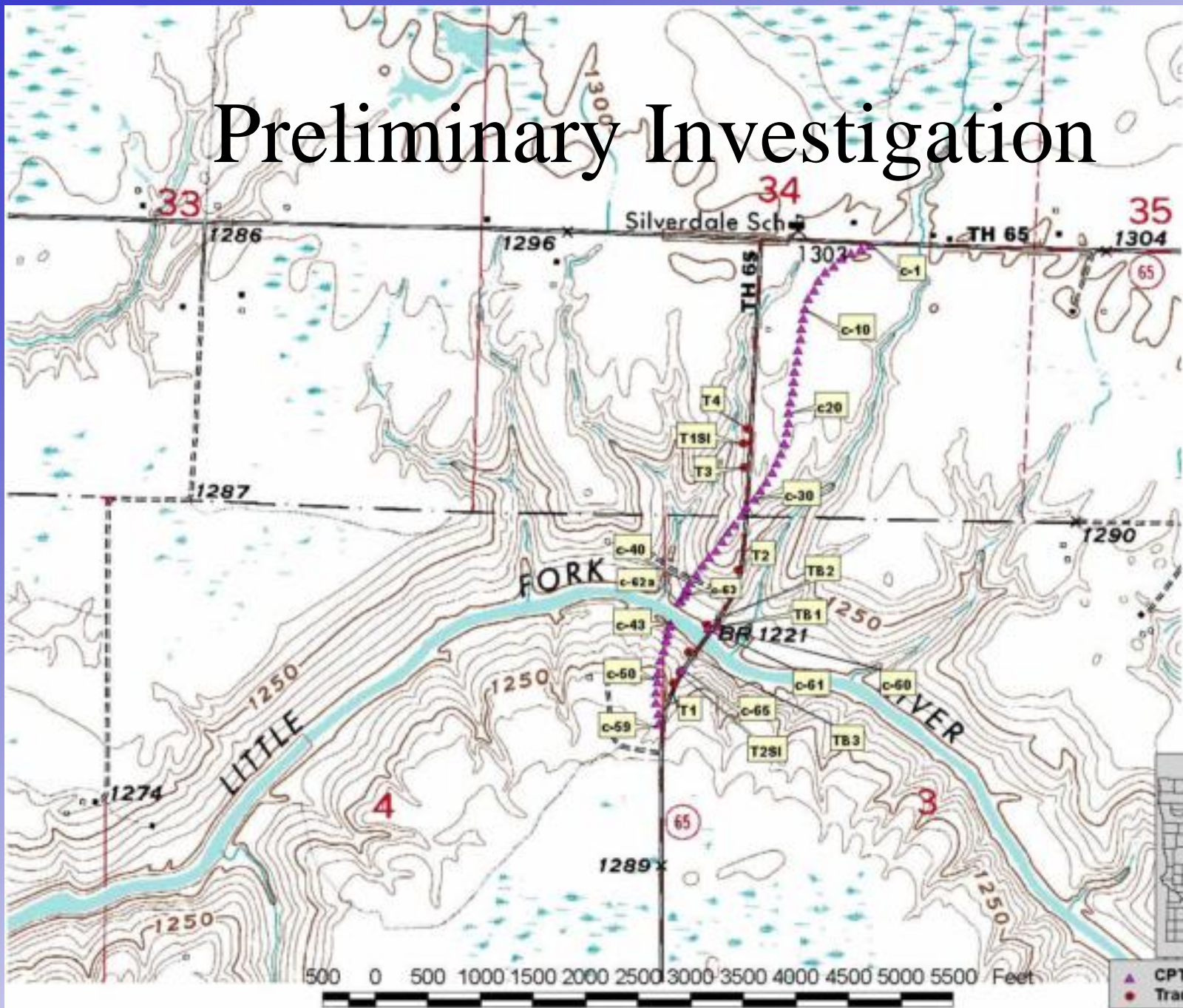
# CPT Profile



# Preliminary Investigation



SP 3609-25 Boring and Cone  
Sounding Locations



- ▲ CPT Soundings
- Traditional Borings

# Quantity Determination



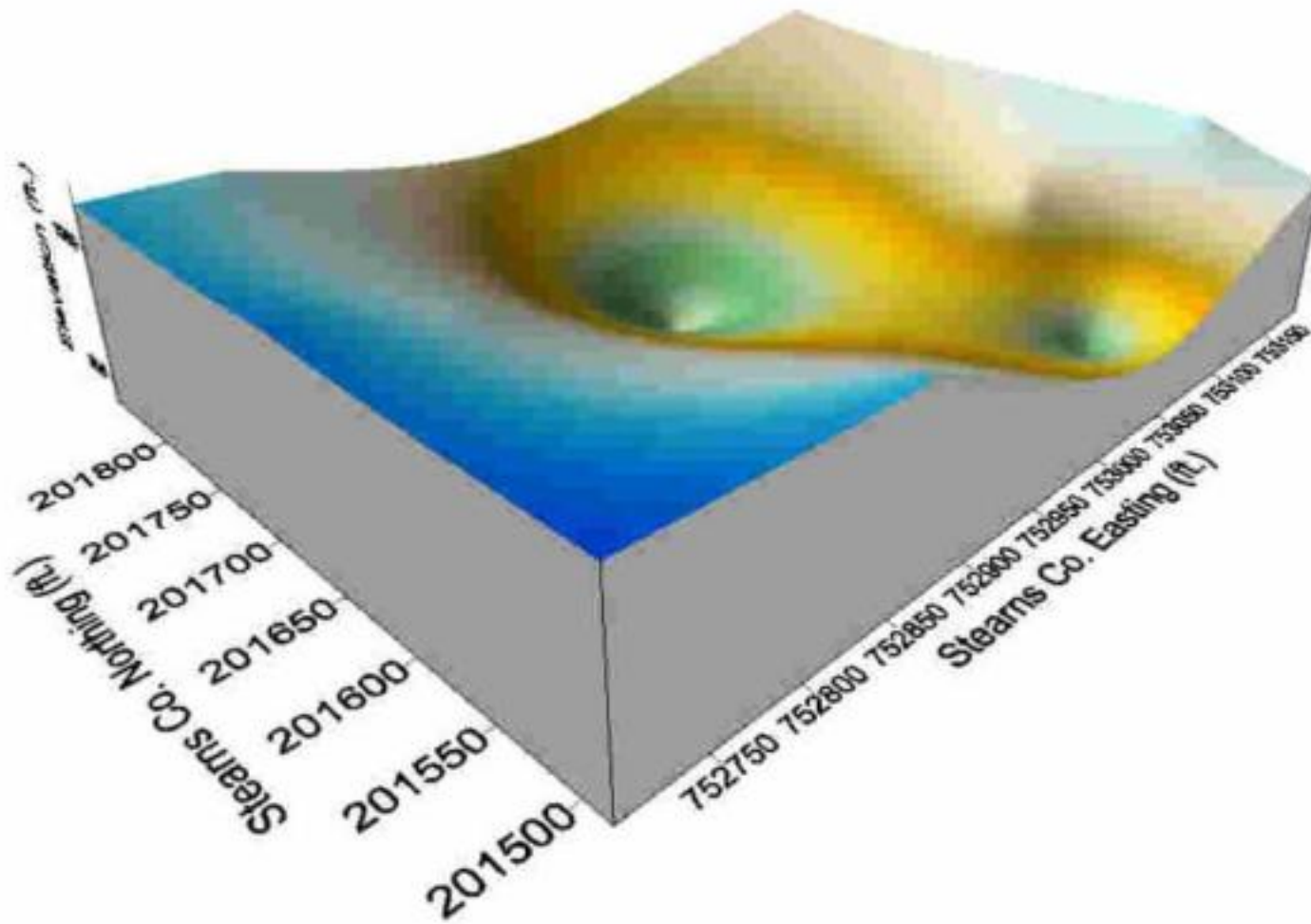
# Sinkhole Investigation



# Looking for Top of Rock



# 3D Plot Based on CPT Data

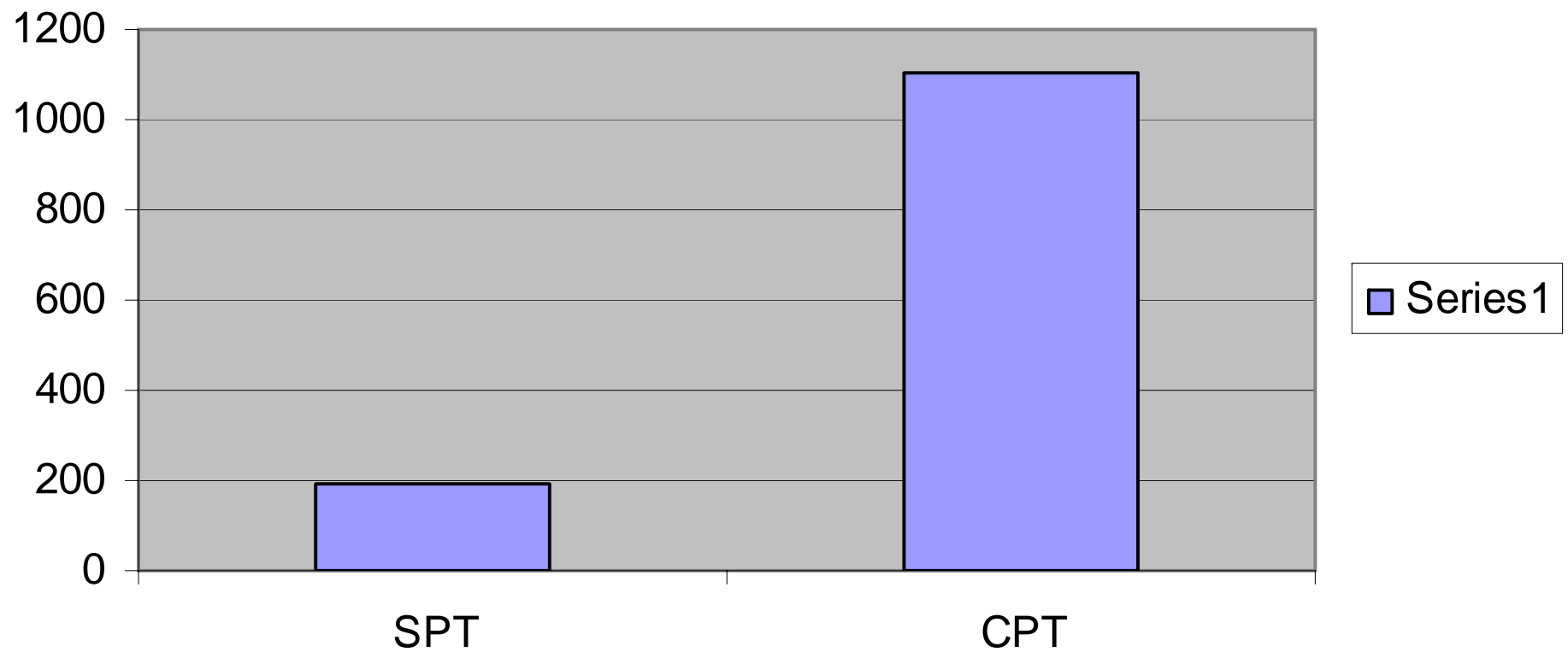


# The Downside



# More Information to Process

**2005 Borings**



# Sealing

# Early Grouting Attempt



7.16.2002

# Pan With Grout and Probe



# Grout Adapter



# Grout Adapter With Probe



# Insert for Grout System



# Rods in Rack With Grout System





# Where Next?

- CPT for preliminary
  - Targeted sampling
  - Targeted testing
- Dilatometer

# What Is Needed?

- Presenting data to various interests
  - Structural engineers
  - Contractors
  - Non-geotechnical interests
- Design methods using CPT data directly

# Minnesota?



# Any Questions?



**Got Soft Soils?**

Thanks for your attention, and participation in the seminar.

