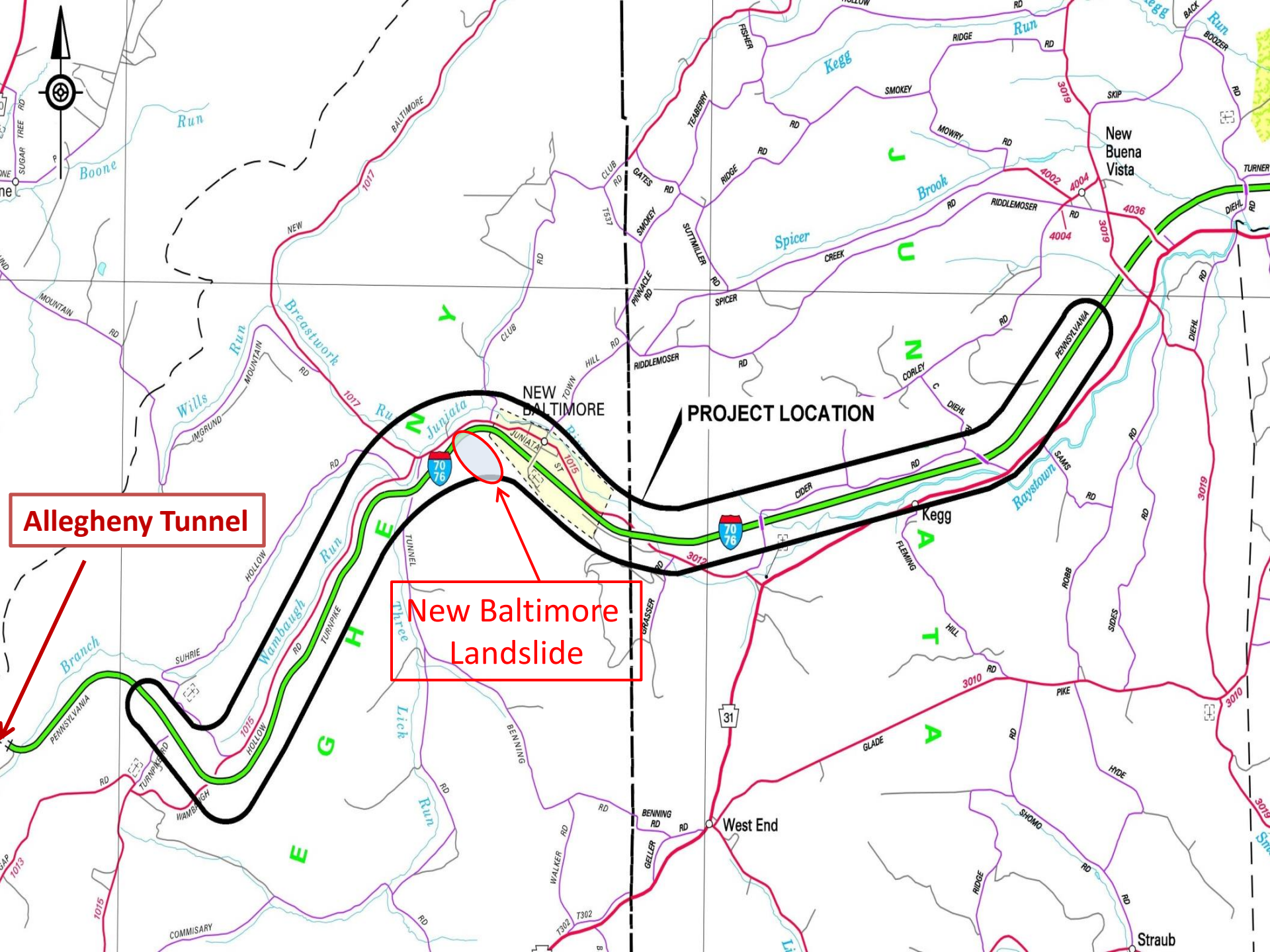


# New Baltimore Landslide – Evolution of Instrumentation

Suresh Gutta, Ph.D., P.E.

American Geotechnical & Environmental Services, Inc.





**Allegheny Tunnel**

**New Baltimore Landslide**

**PROJECT LOCATION**

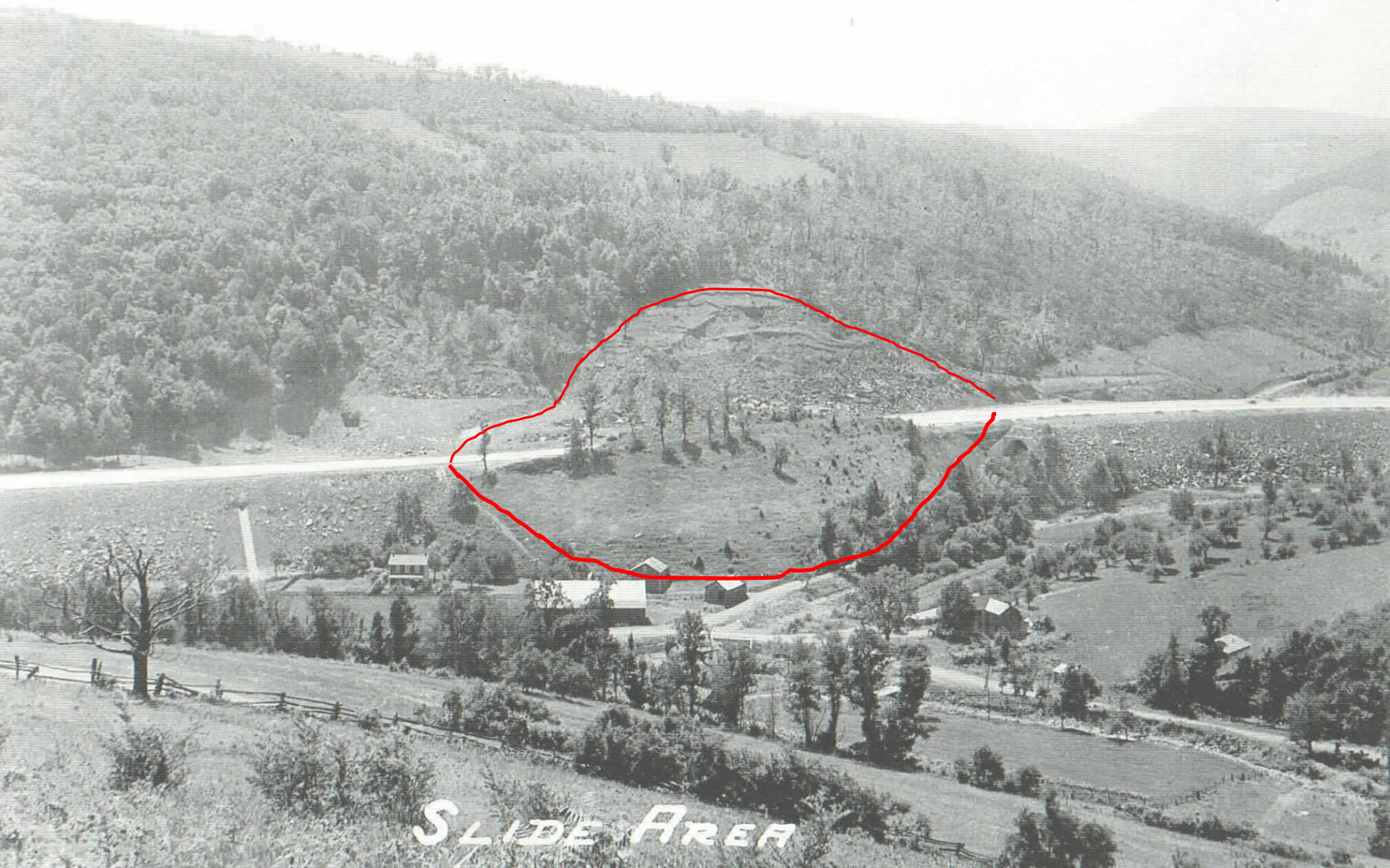
New Buena Vista

West End

Straub



# During the Turnpike Original Construction (~ 1940)

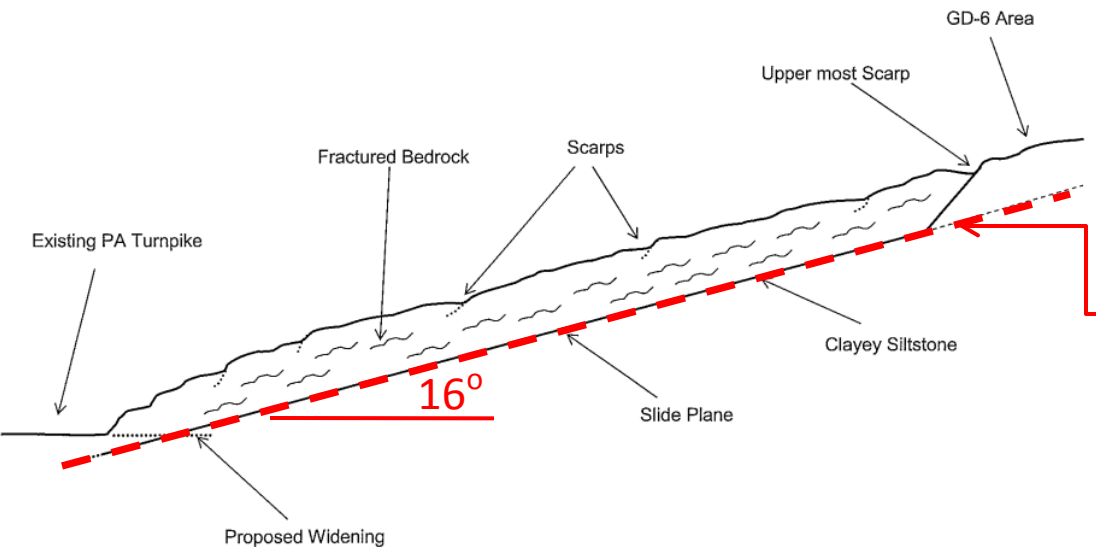


*SLIDE AREA*

# NBS – Prior to Remediation



01/27/2014



**Failure Plane**

Figure ES-1: Schematic view

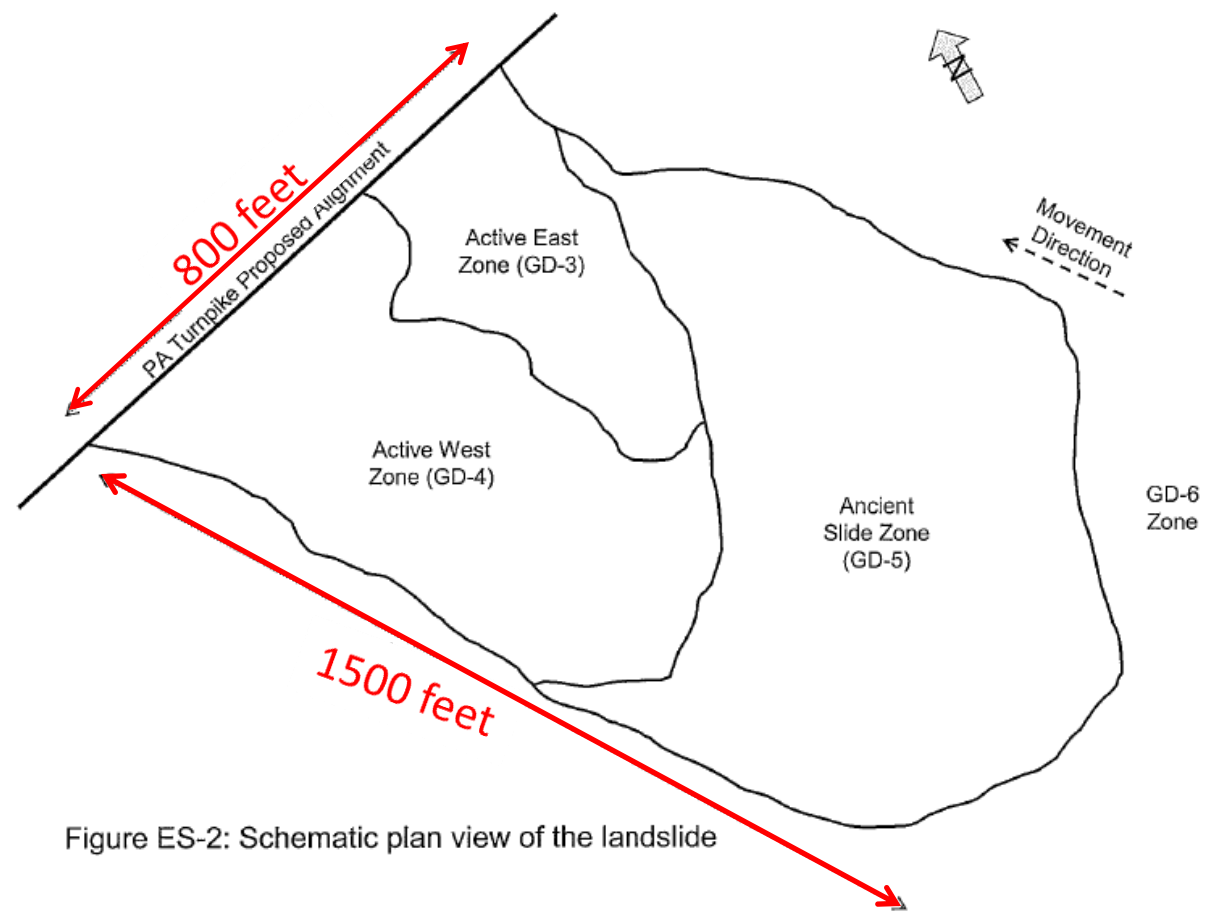
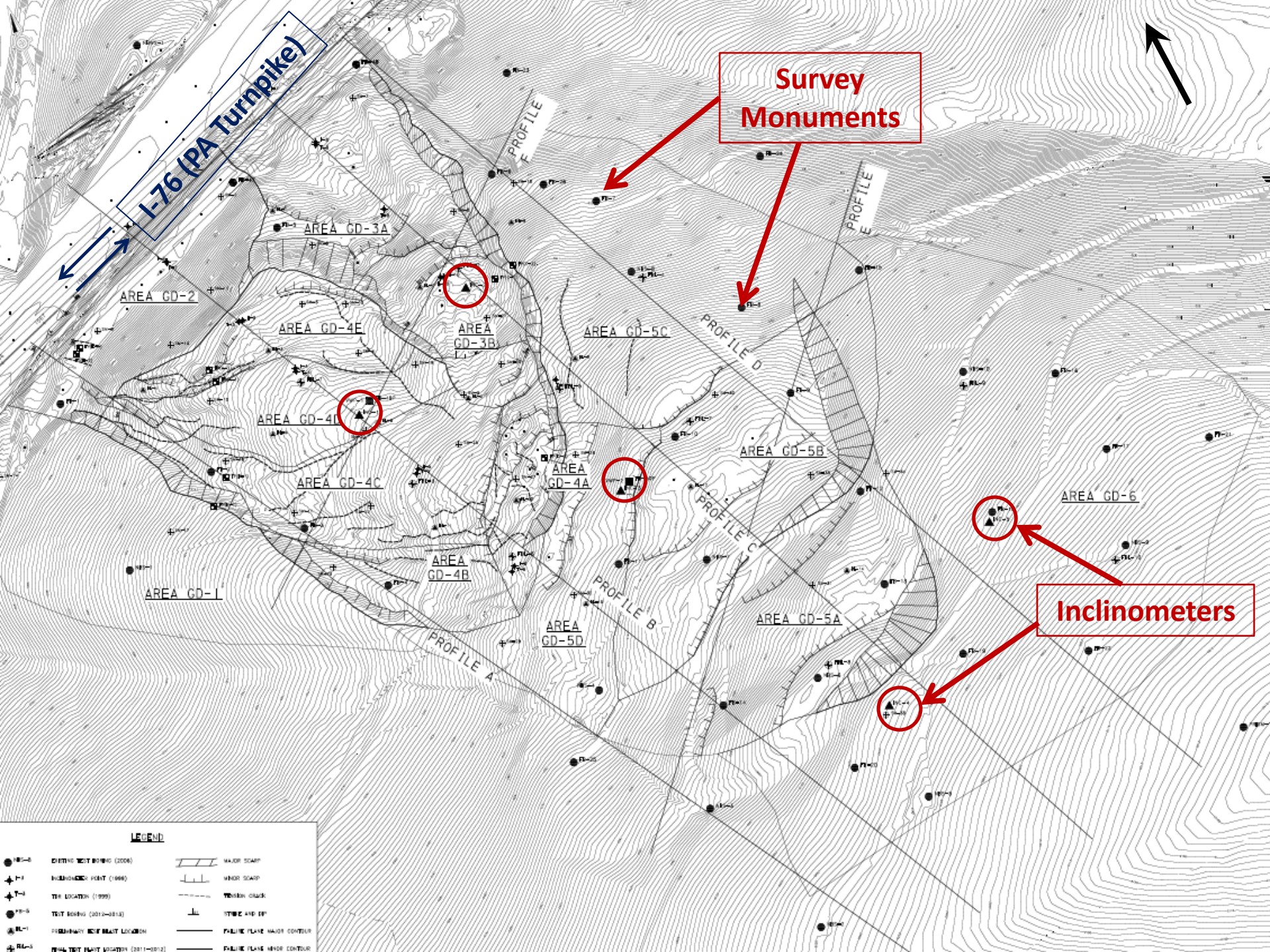


Figure ES-2: Schematic plan view of the landslide



# SLIDE MONITORING

- Survey Monitoring
- Instrumentation
  - TDRs
  - Inclinometers (manual)
  - In-Place Inclinometers
  - Vibrating Wire Piezometers
- Laser Total Station System



**I-76 (PA Turnpike)**

**Survey Monuments**

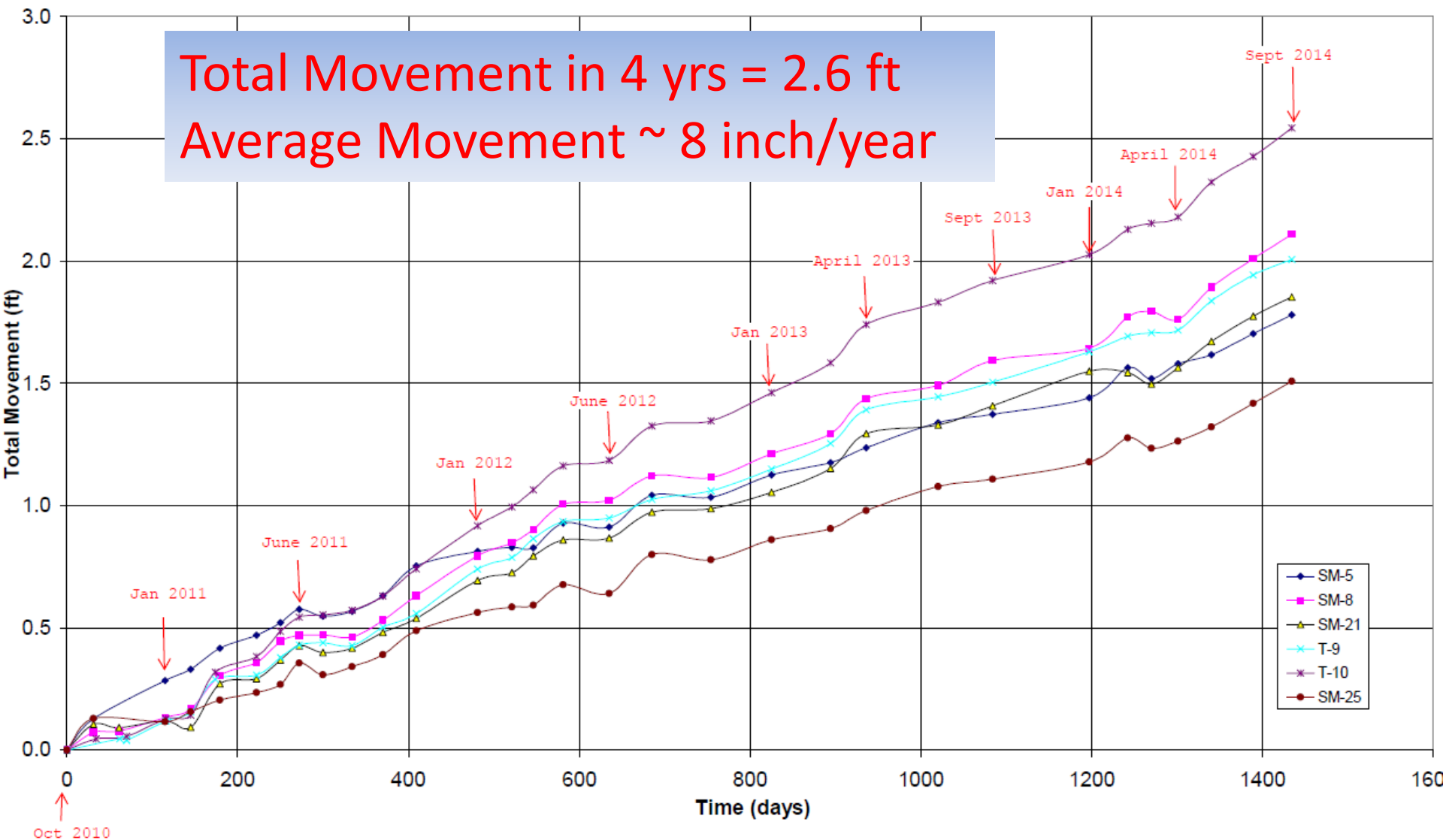
**Inclinometers**

**LEGEND**

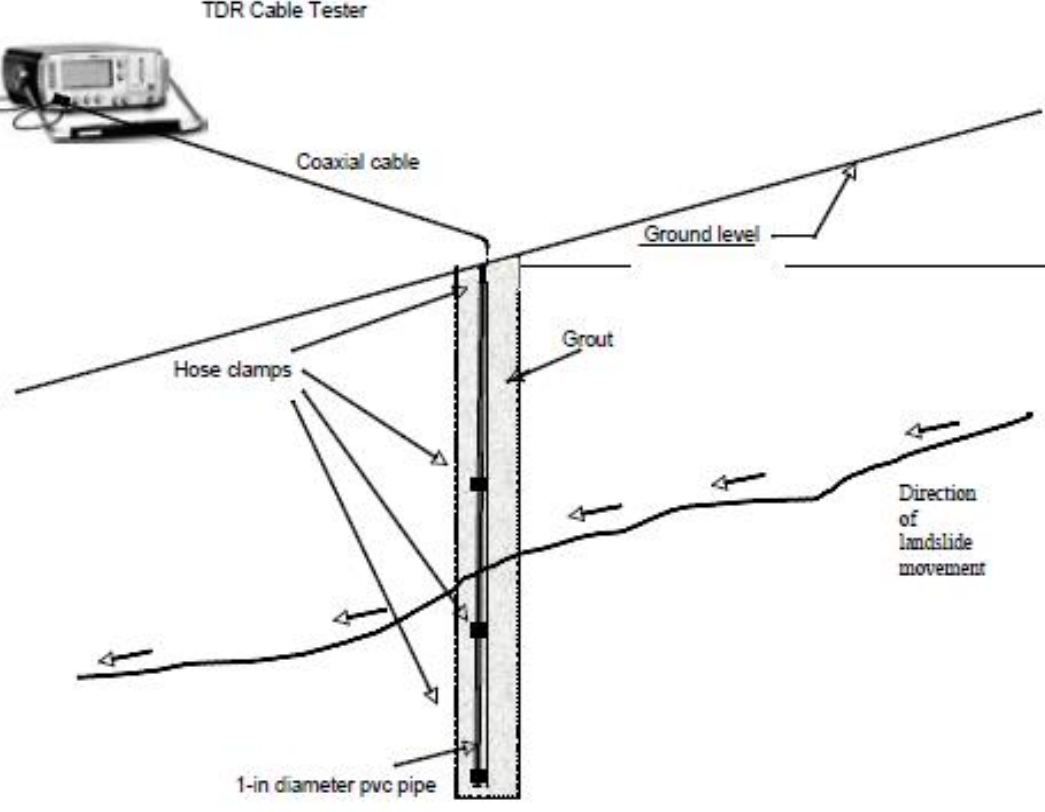
● PT-0	EXISTING TEST MONUMENT (2006)	▨	MAJOR SCARP
⊕ T-1	BOUNDARY POINT (1999)	▧	MINOR SCARP
⊕ T-2	TRIP LOCATION (1999)	▬	WEDGGE CRACK
● PT-3	TEST MONUMENT (2012-2013)	▬	STRIKE AND DIP
● RL-1	PERMANENT BENCH MARK LOCATION	—	PUBLIC PLANE MAJOR CONTOUR
● RL-2	TEMPORARY BENCH MARK LOCATION (2011-2012)	—	PUBLIC PLANE MINOR CONTOUR



# Survey of Surface Monuments



Survey performed by JMT



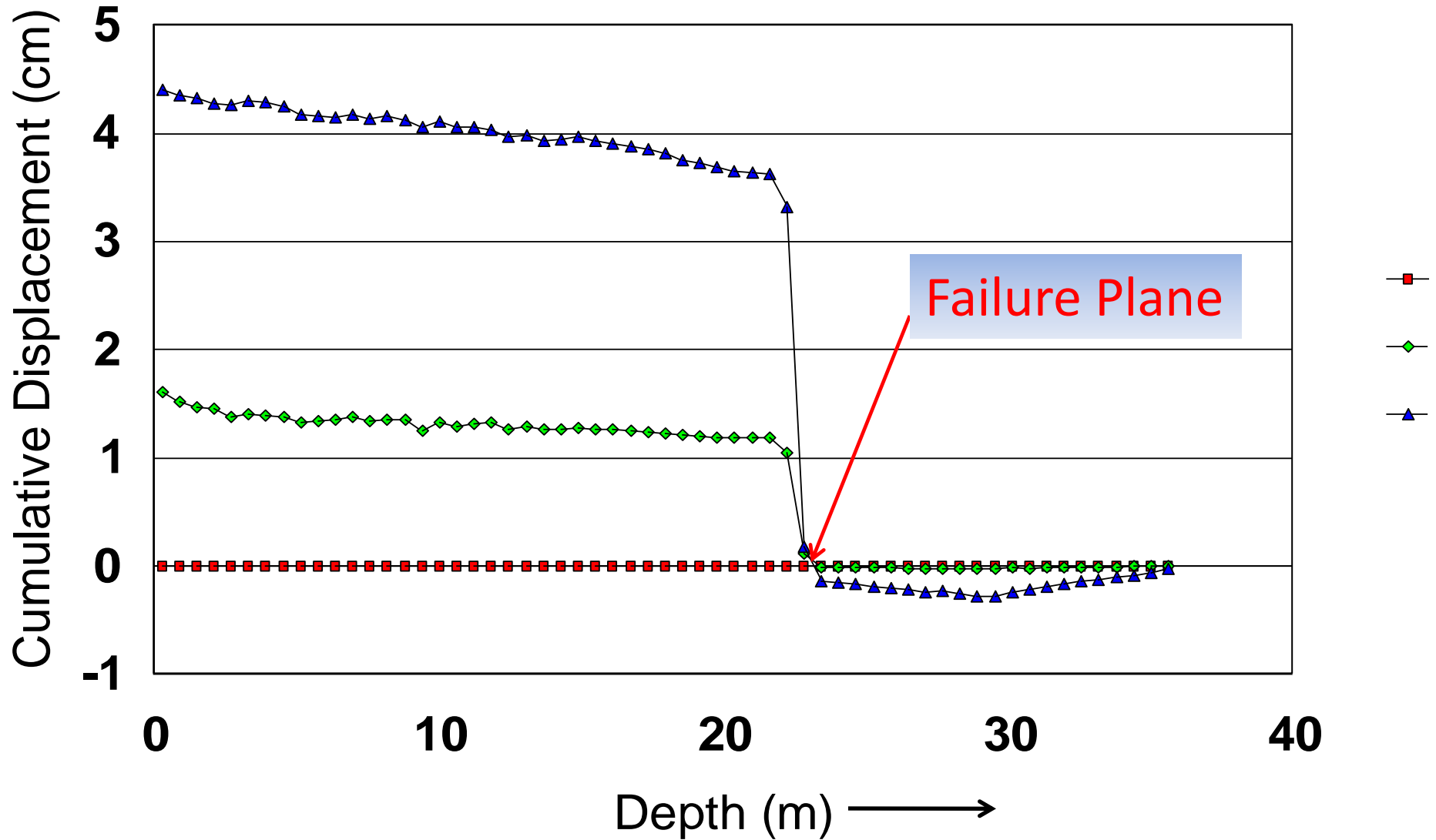
Basic components of TDRs

TDR data collection

## Time Domain Reflectometry (TDR) Monitoring 1999-2000

# Inclinometer T-4(TDR)

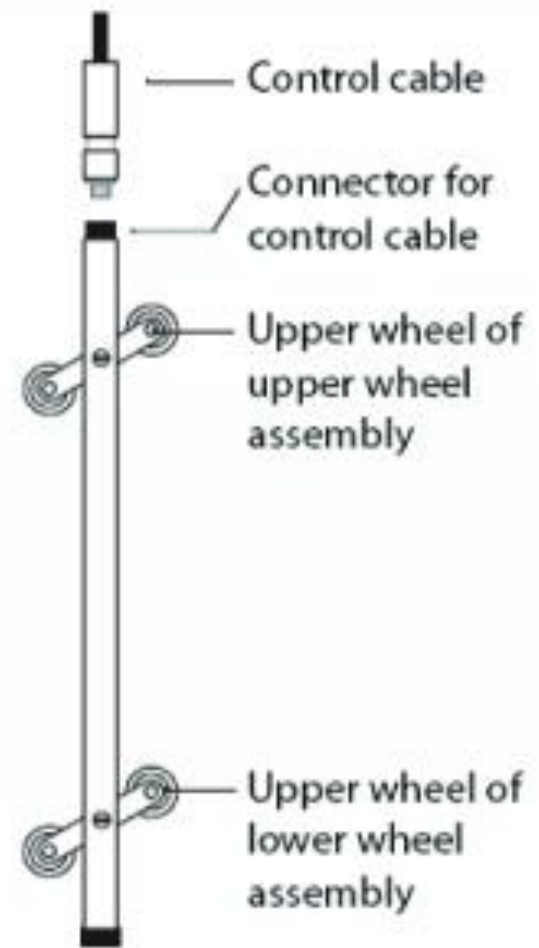
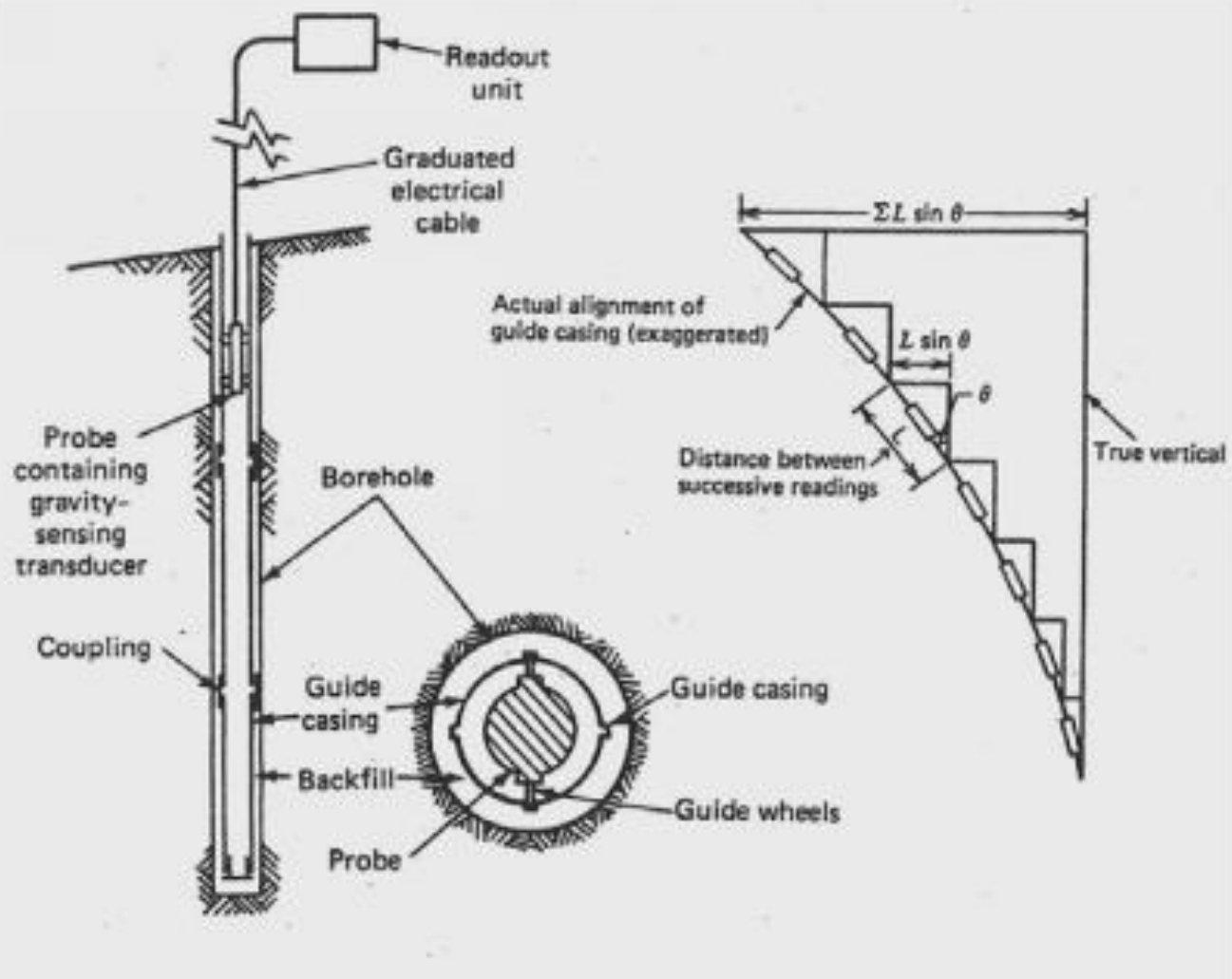
## Cumulative Displacement vs. Depth, A-Axis





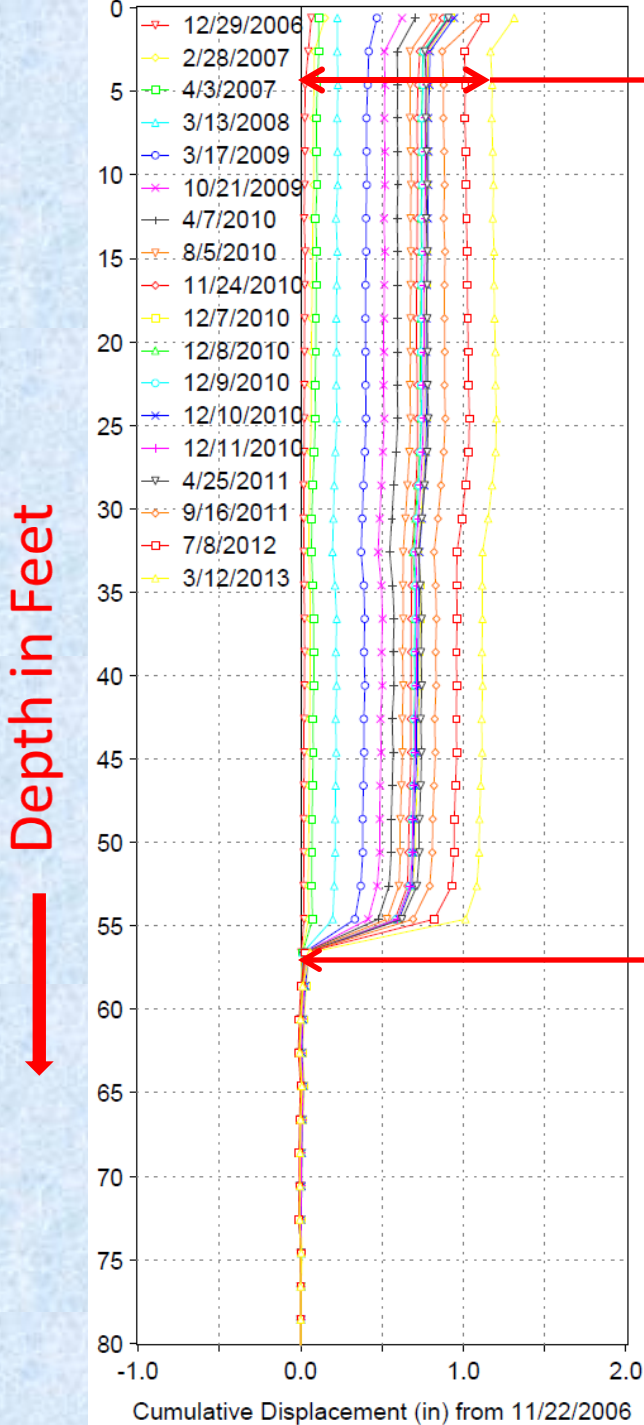
## Slope Inclinometers (Traditional)

2006 - 2012



**Schematic of Inclinometer Probe inserted in Inclinometer Casing  
(Ref: TRB Circular 129)**

# Inclinometer (Traditional) Data

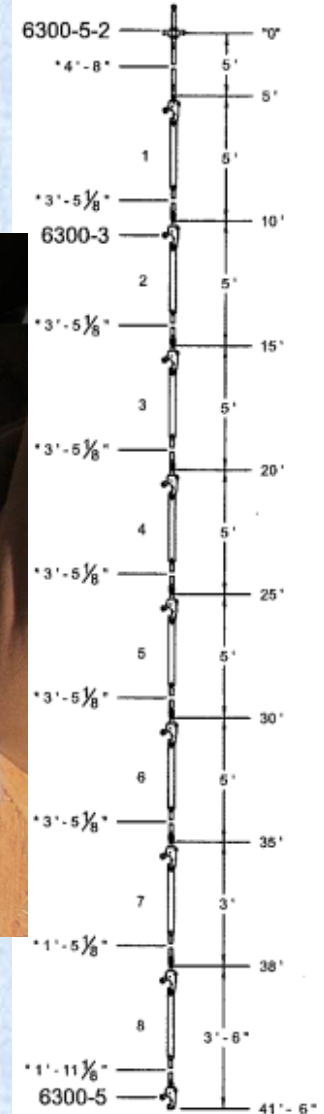
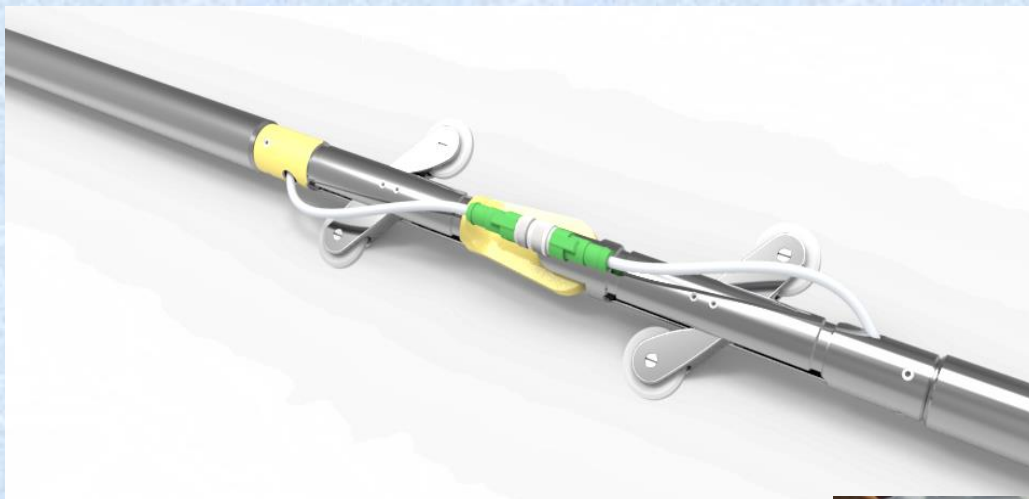


Cumulative  
Movement

Depth to Failure  
Surface

## Advantages

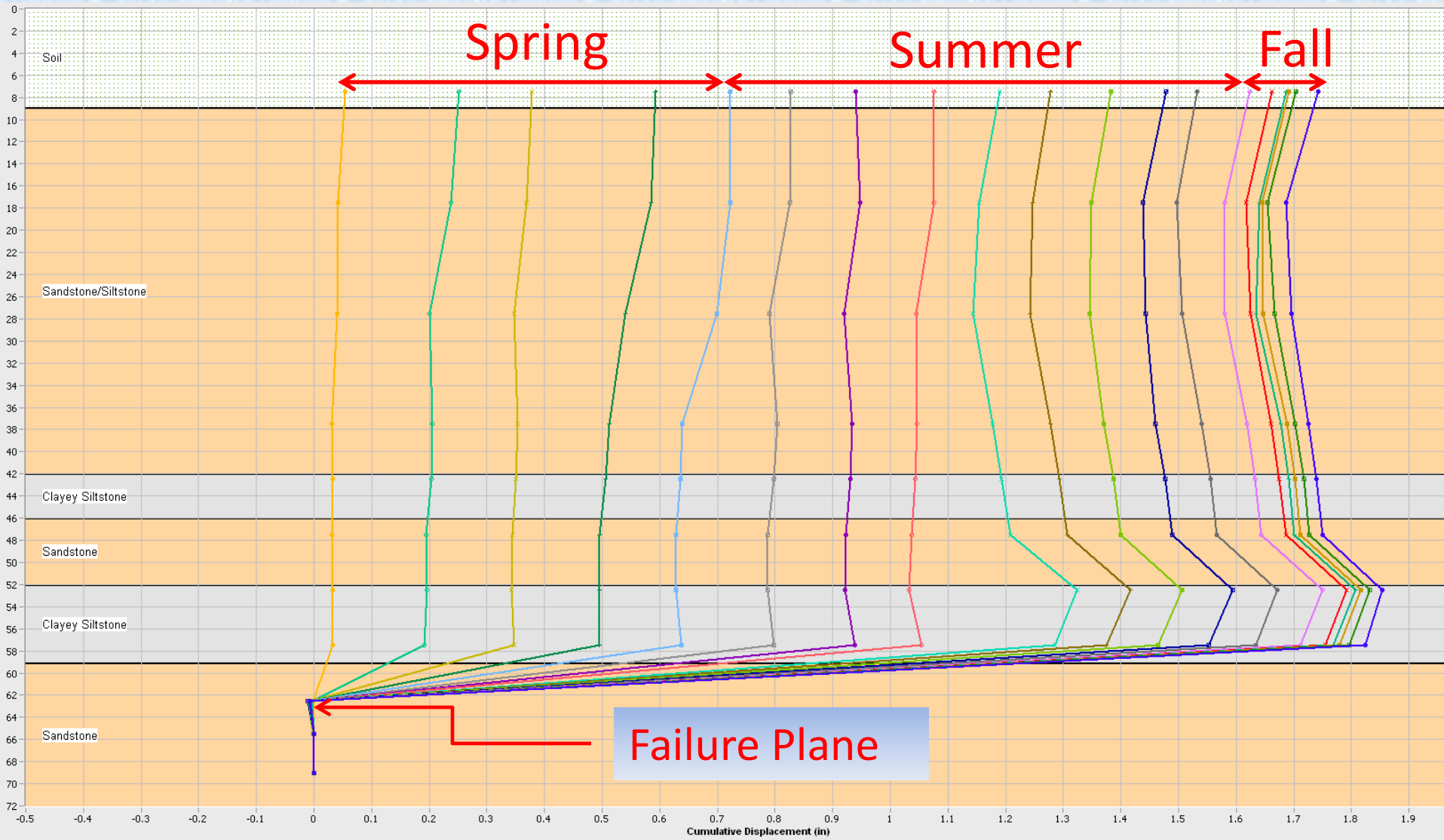
- Real-time monitoring
- Remote data collection
- Alarm/email



**In-Place Inclinometers**  
**2013-2016**

# In-Place Inclinometer Data

## INC-1: April, 13 – Sept, 13





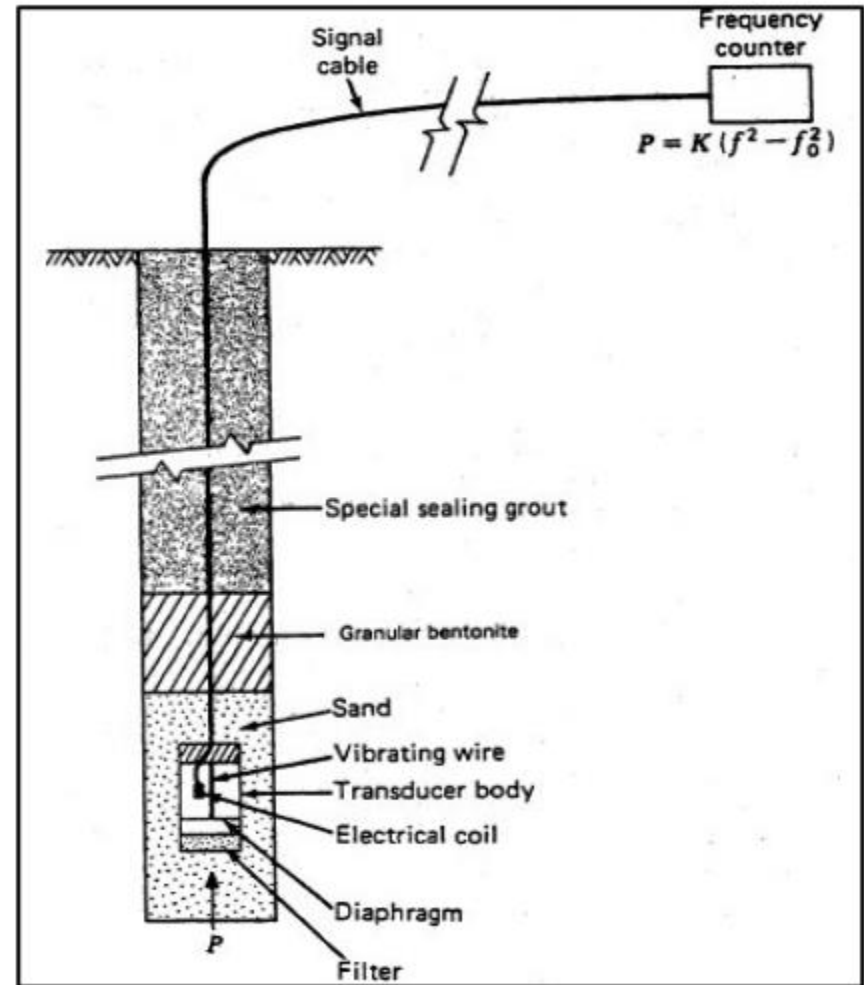
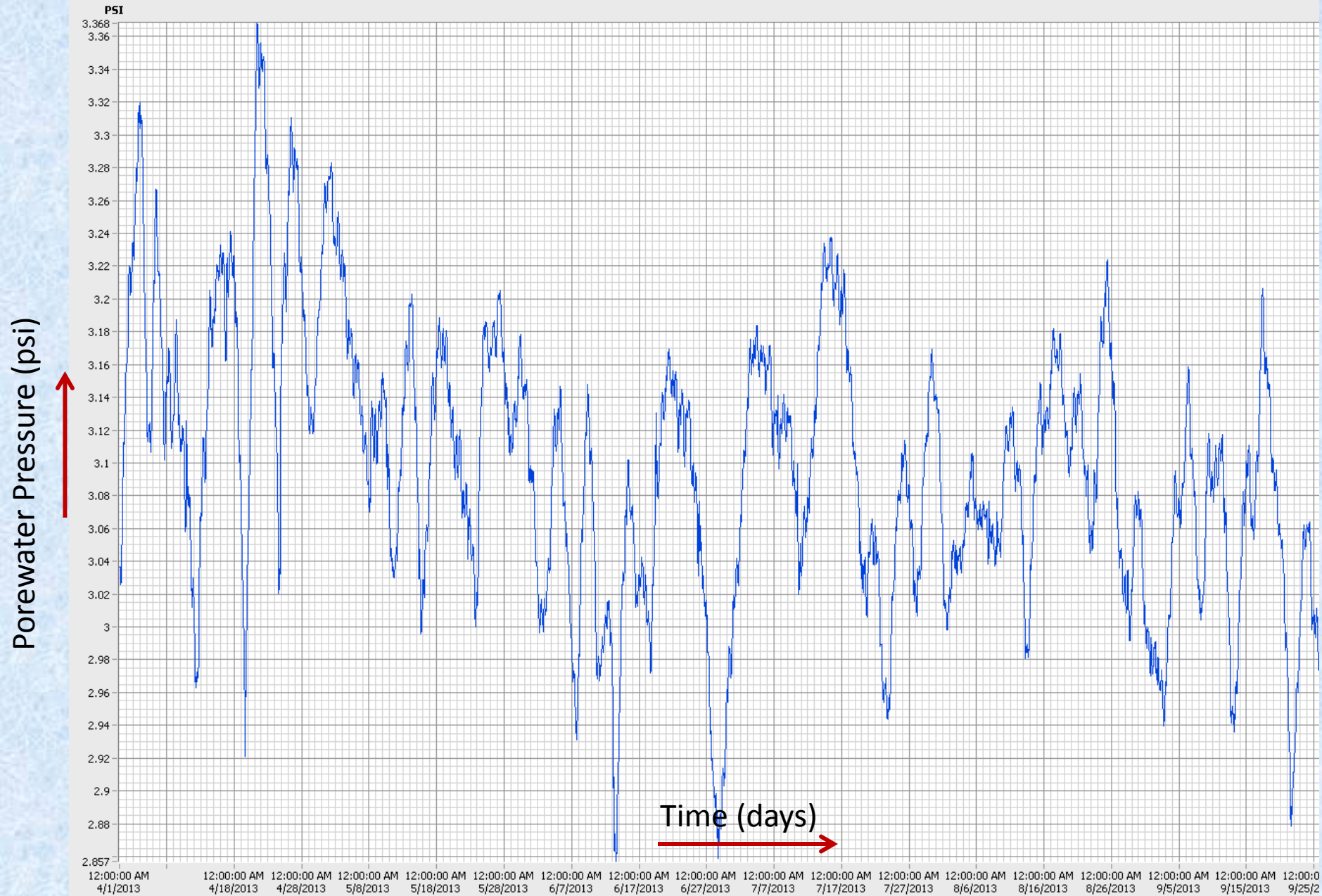


Figure 1 - Schematic of Vibrating Wire Piezometer Installed in a Borehole  
(Dunncliff, 1998 (After Dunncliff, 1988, 1993))

## Vibrating Wire Piezometer



# Vibrating Wire Piezometer - Data



Laser Total Station System

# Slope Monitoring During Construction



# GEOSTRATA

SEPTEMBER // OCTOBER 2018

## What to Do about an **Awakened** **Ancient Landslide**

Solving a 75-Year-Old Problem  
along America's First Super Highway



By Suresh Gutta, PhD, PE, M.ASCE,  
and Ala M. Hajdarwish, PhD, PG

In school, we all learned that several factors can contribute to cause a mass of earth to landslide. But with more experience, it becomes clear that these factors must work together to mobilize a landslide. Encompassing these factors is the key to success in finding the ultimate treatment or solution.



**Thank you!**

**Comments/Questions:**

**[Sgutta@agesinc.com](mailto:Sgutta@agesinc.com)**

**You can access the article at:**

**[https://www.readgeo.com/geostrata/sept\\_oct\\_2018/MobilePagedArticle.action?articleId=1424829#articleId1424829](https://www.readgeo.com/geostrata/sept_oct_2018/MobilePagedArticle.action?articleId=1424829#articleId1424829)**