Instrumentation for Transportation Applications

Geohazards in Transportation in the Appalachian Region

5 August, 2009

URS

Presentation Overview

- Case Histories of Instrumentation used for Transportation Related Projects
  - Landslide
  - Bridge Reconstruction
  - Movement in Rock Below a Roadway
  - Airport
- Automated Data Acquisition Systems (Brief Discussion)

URS

Bridge Abutment

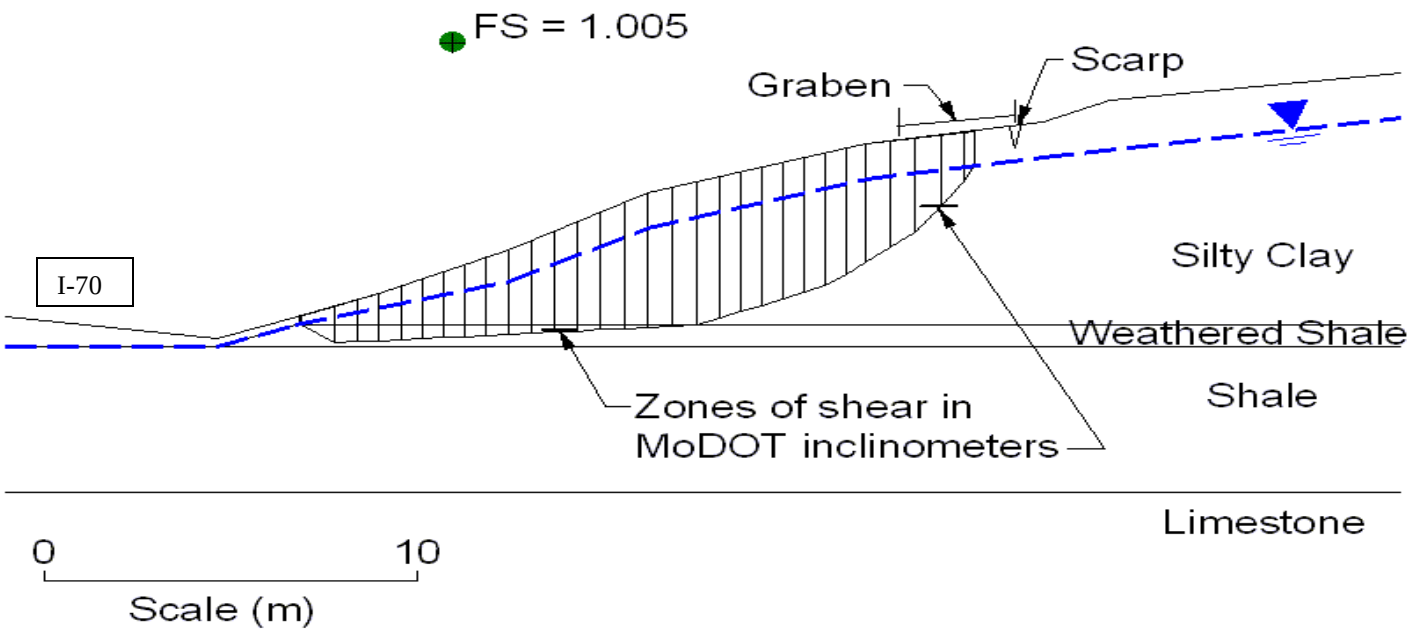
Toe of Slide

URS

Piezometers and Inclinometers

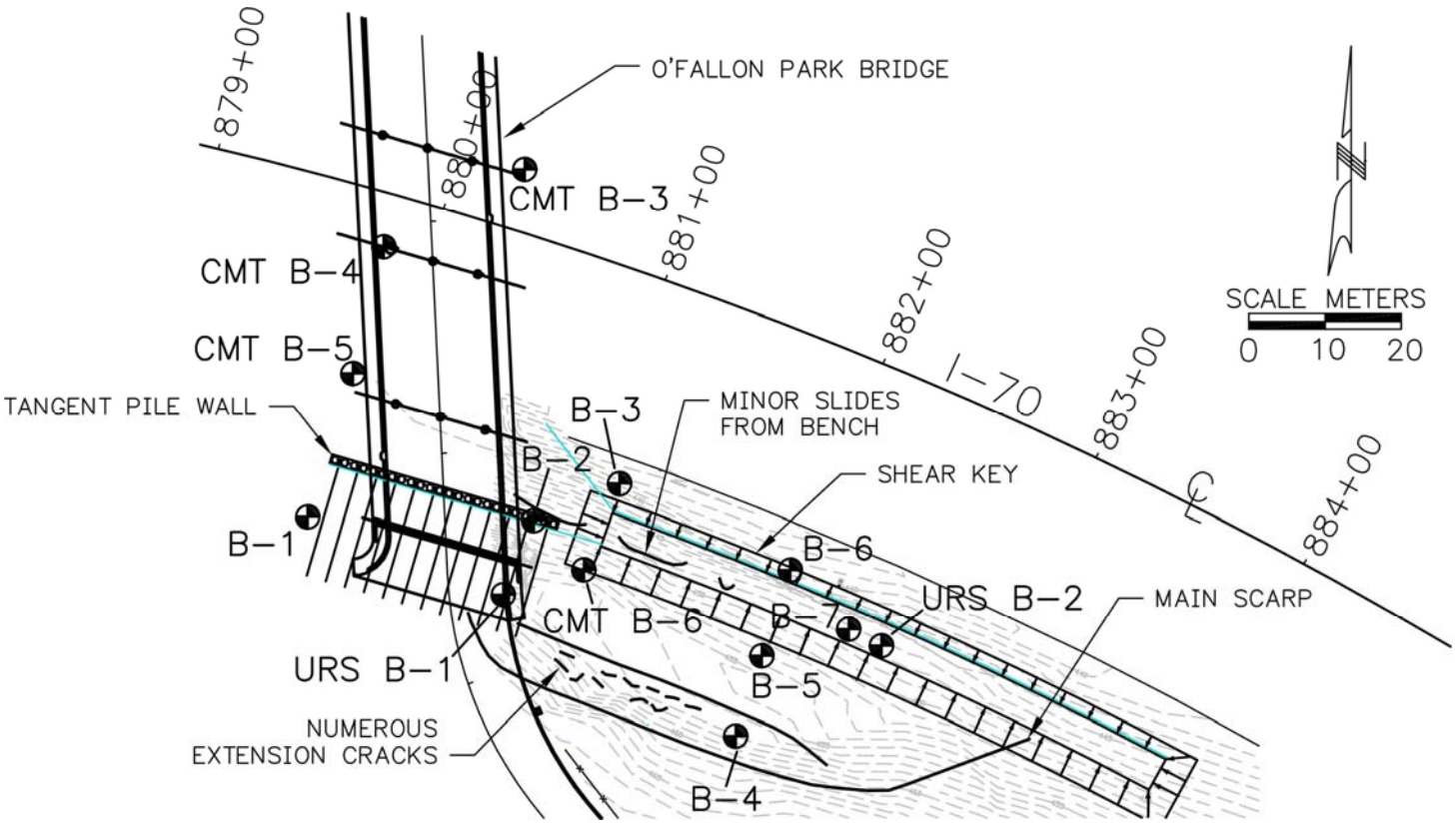
URS

Cross Section



URS

Site Plan


O'FALLON PARK BRIDGE
879+00
880+00
881+00
882+00
883+00
884+00
I-70
℄
CMT B-3
CMT B-4
CMT B-5
TANGENT PILE WALL
B-3
B-2
MINOR SLIDES
FROM BENCH
SHEAR KEY
B-1
B-6
CMT B-6
B-7
URS B-2
MAIN SCARP
URS B-1
B-5
NUMEROUS
EXTENSION CRACKS
B-4
SCALE METERS
0 10 20

Final Slope

I-55 Over Lake Springfield

URS

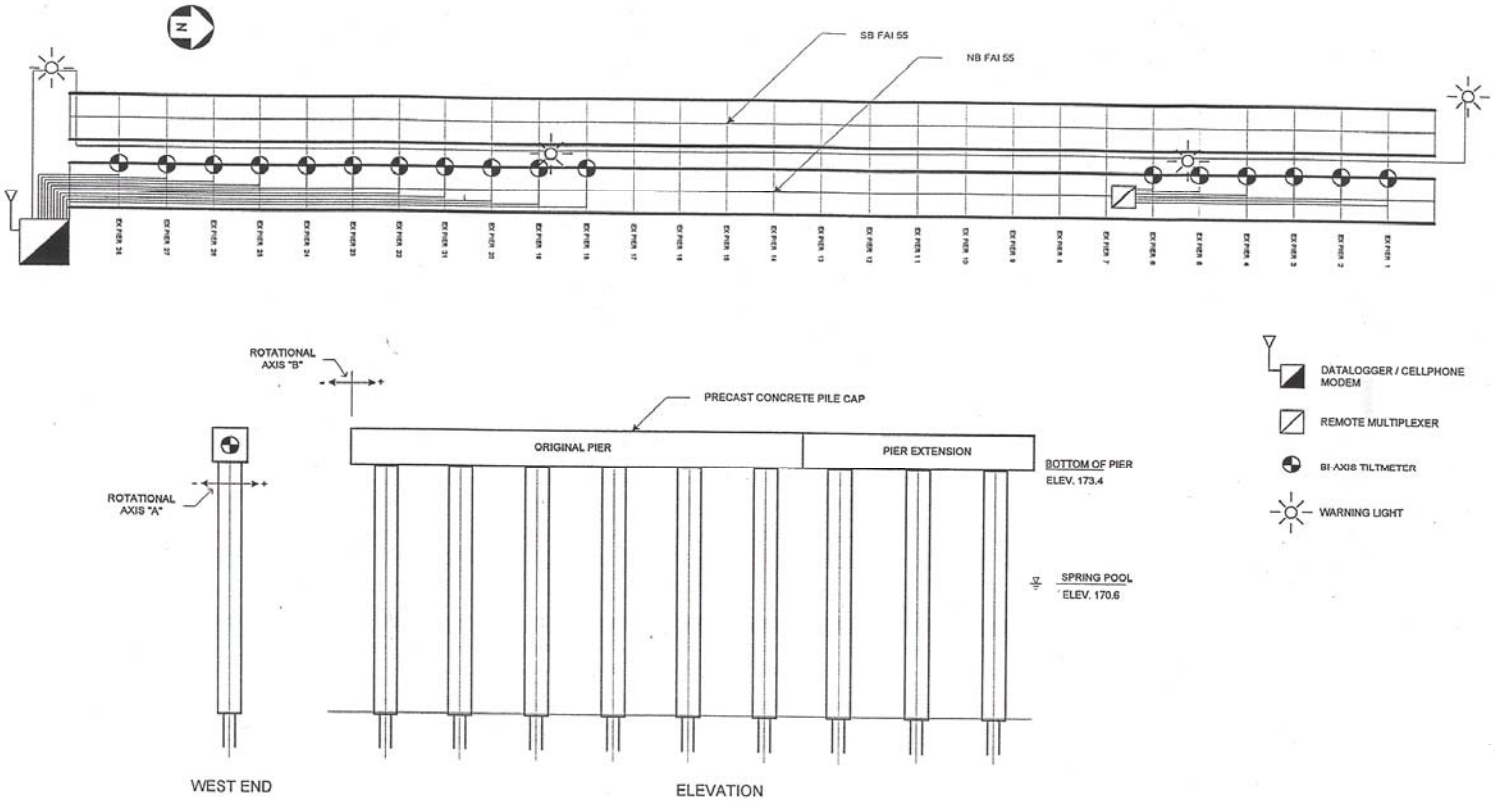
Temporary Steel Hangar

Reasons for Instrumentation

- Weak and Variable Soils
- Poor Condition of Existing Structures
- Traffic Volume (42,000 vpd)
- Lack of Suitable Detour Routes
- Possible Uneven Lateral Loads and "Dozer Hits"
- Pier Cap Rotation Would Reduce Contact Area (Beams on Cap)

URS

FIGURE 1 – Pier Instrumentation Schematic

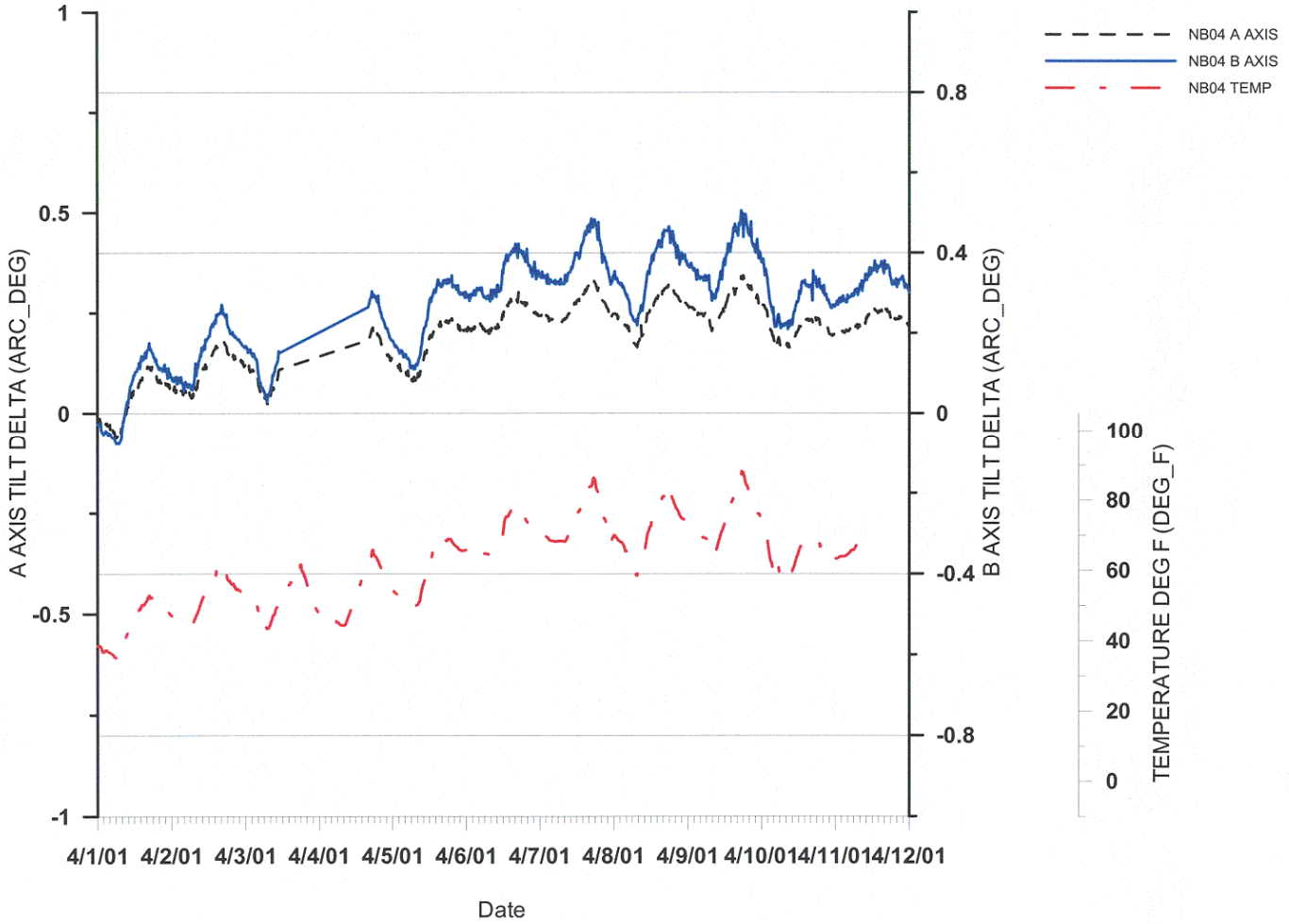


URS

Tiltmeter Installation

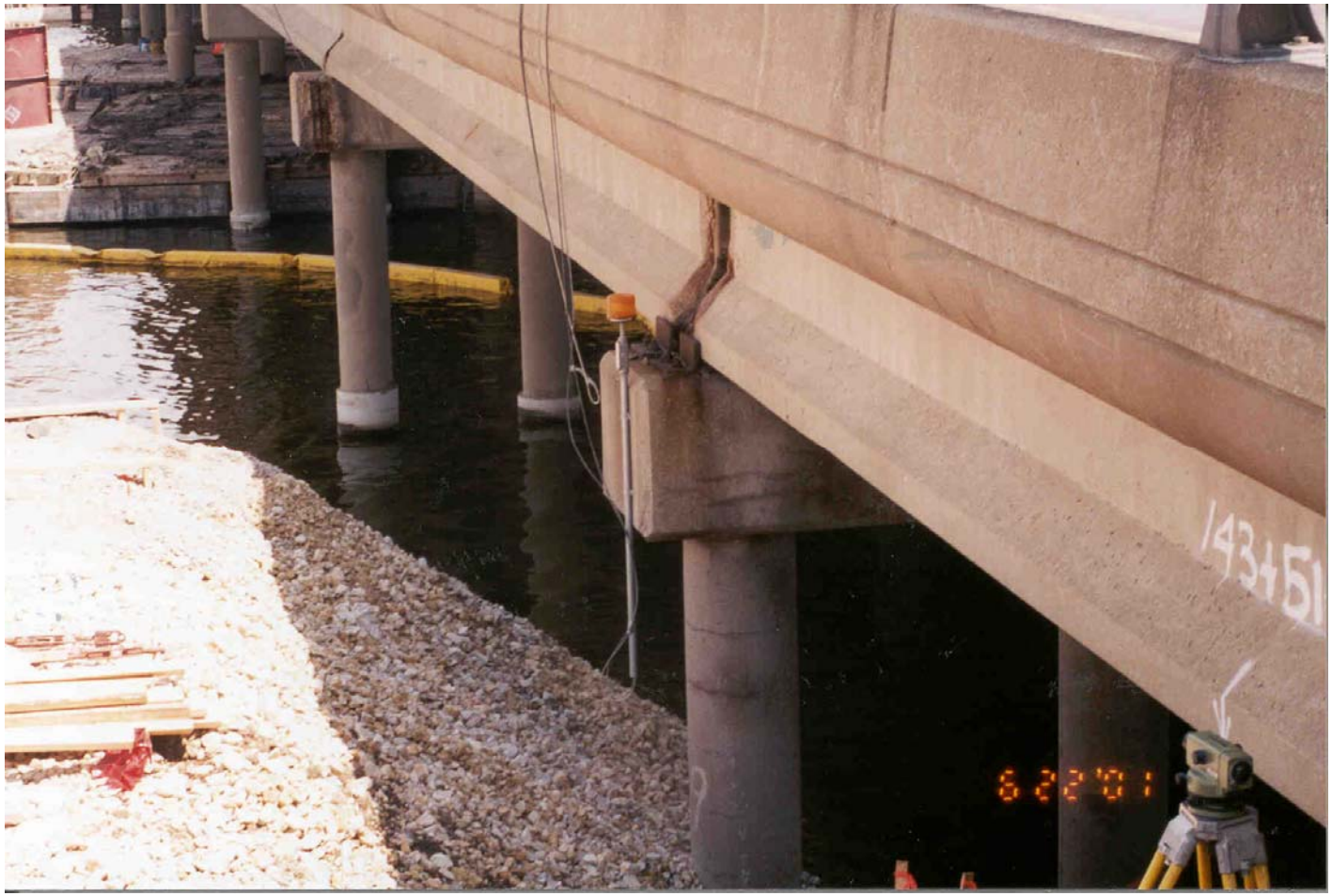
URS

FIGURE 2 - Sample Data (NB04 Delta Movement)



URS

Warning Light



URS

Typical RMU

Software

- Large Volume and Long-Term Data Management
- Automate Instrumentation Data Collection, Reduction, Reporting and Plotting
- Desktop PC at Field Trailer
- Output Includes Detailed Analytical Plots and Data Reports

URS

Distress in Rock Pillar

URS

Distress in Rock Pillar

URS

Distress in Rock Pillar

URS

View of Road Surface

Signs of Distress

Design Considerations

- Define Objectives/Purpose
- Early Warning System
- Instrumentation Selection (Types of Measurements and Accuracy)
- Installation Criteria
- Data Management System
- System Maintenance

URS

Instrumentation

- PK Nails to measure lateral and relative displacement
- Brittle “sulfaset” patches
- GPS checks on benchmarks
- VW Crack Gages/Avongard Manual Back-up
- Tape Extensometers measure breaks in Jersey barriers
- Inclinometers and sondex casings to 400 ft

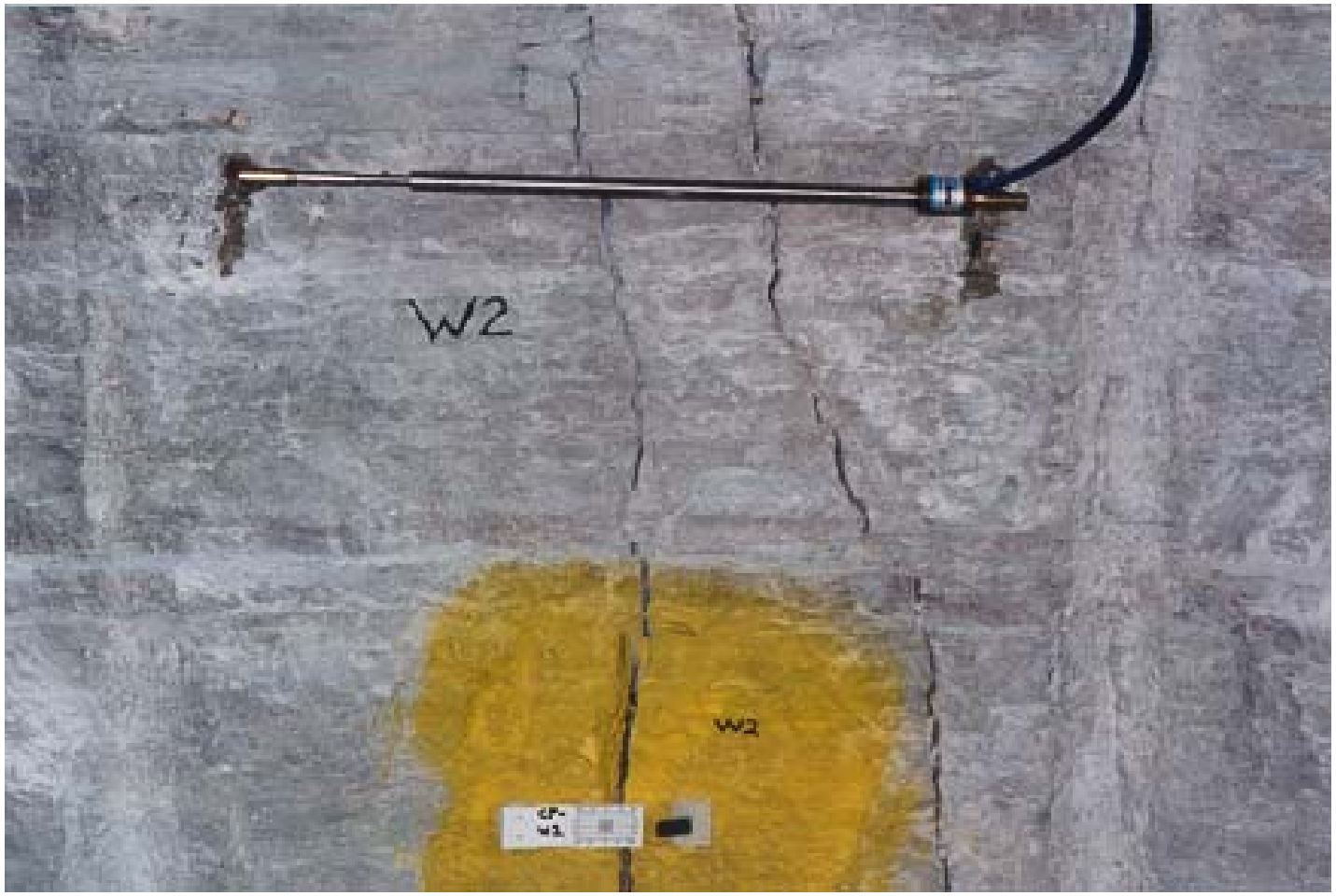
URS

Instrumentation (Cont.)

- Vertical TDR cables - 400 ft deep
- Survey Prisms on quarry highwalls to measure lateral movement via total station
- Seismometer
- Piezometers
- Borehole Videos
- USBR Rock Overcoring (To 300 ft depth)
- Rock Dilatometer Testing

URS

VW Crack Gage-Tunnel



URS

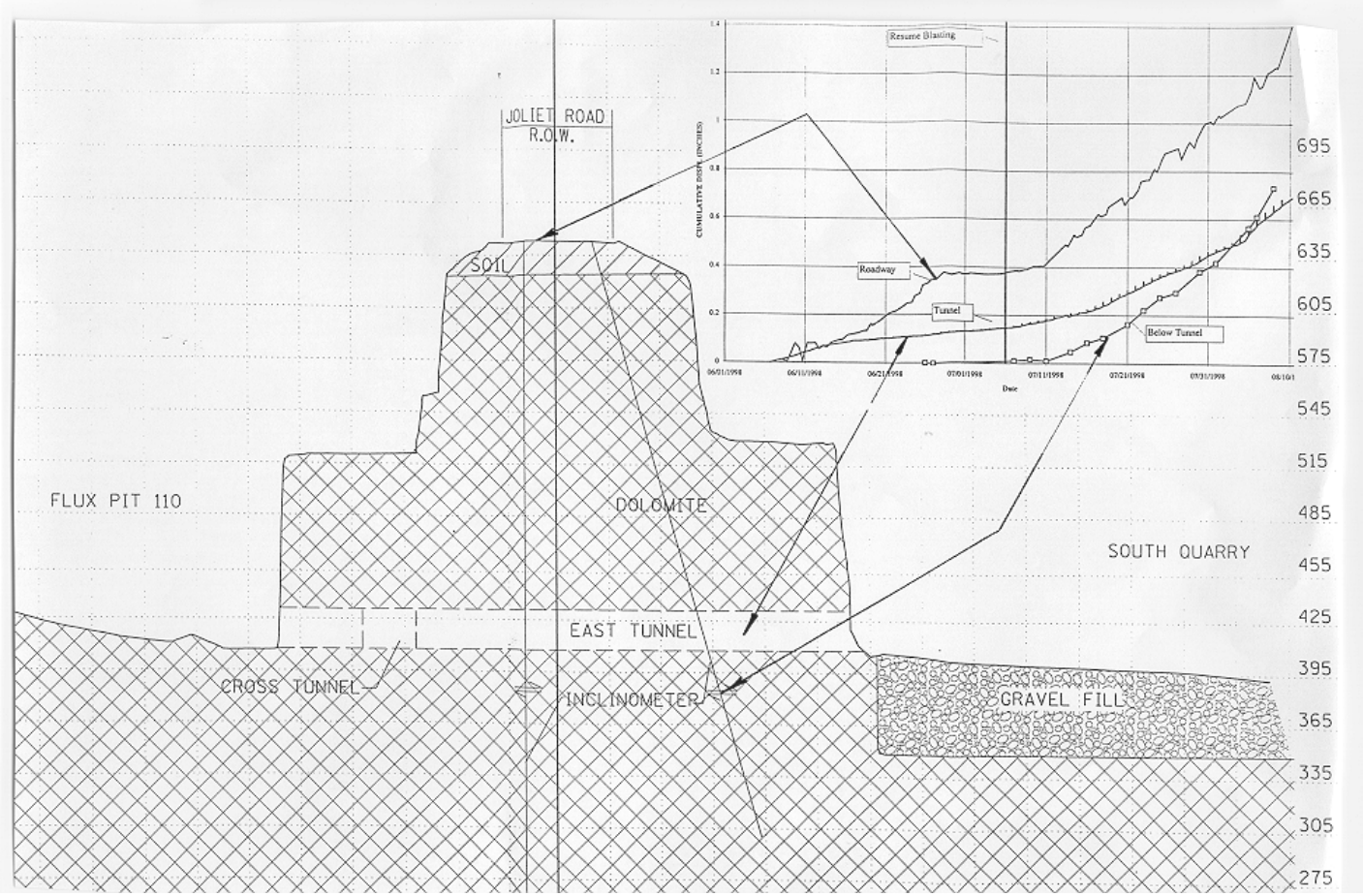
2D Crack Gage Rock Wall

URS

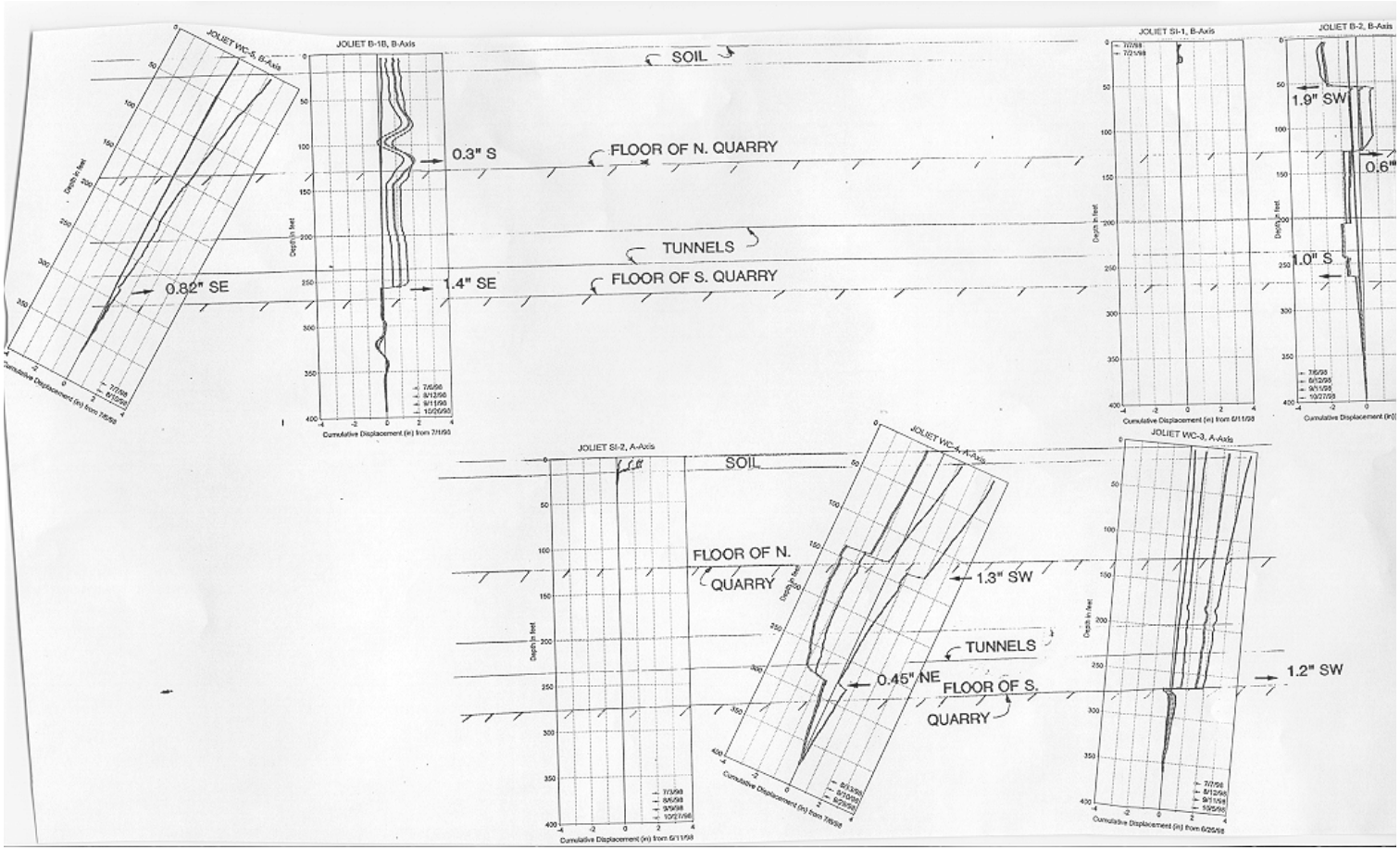
Dataloggers

URS

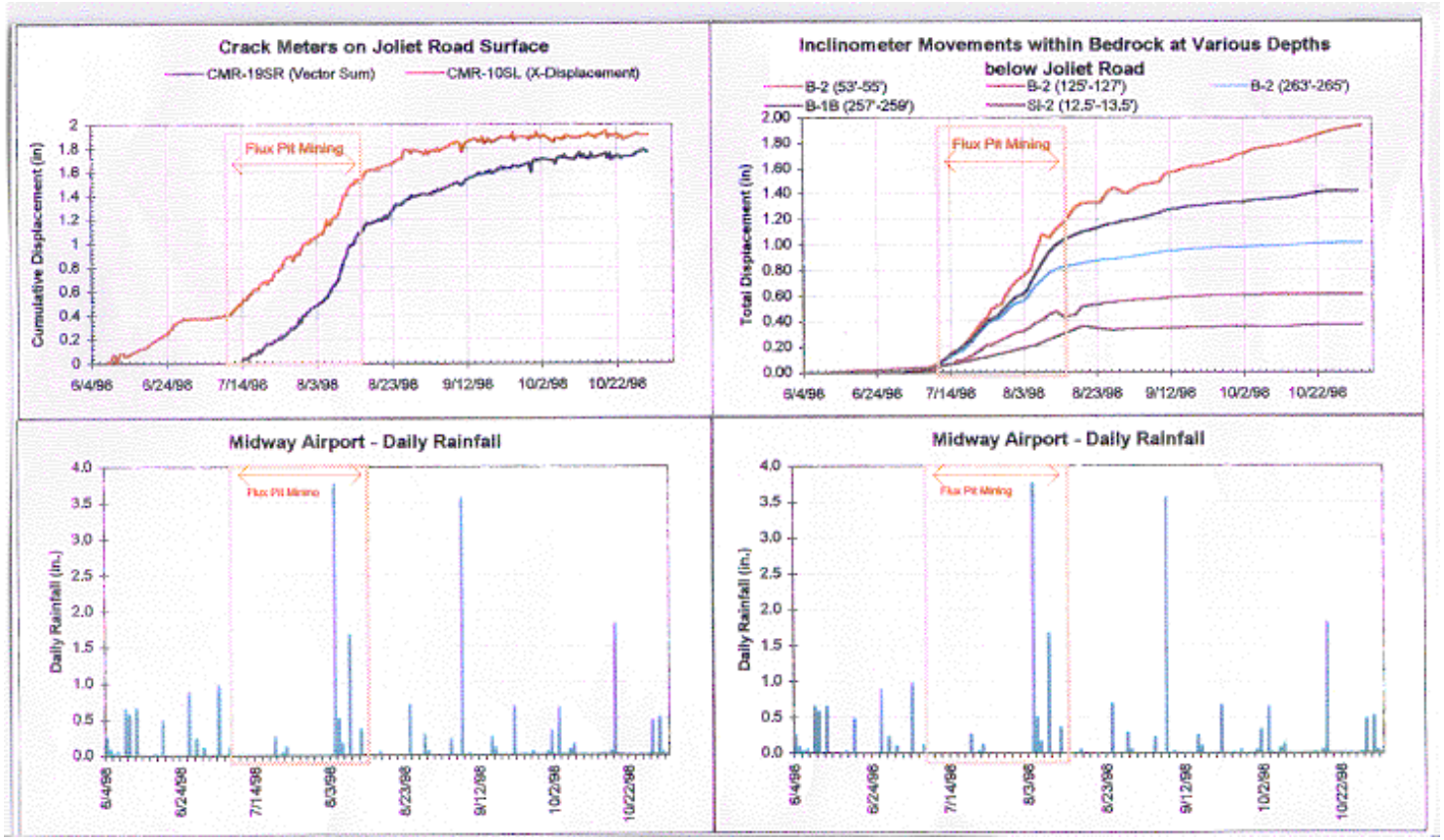
Movements at Various Depths



Inclinometers



Movement with Time



URS

DamSmart

- Large Volume and Long-Term Data Management
- Automate Instrumentation Data Collection, Reduction, Reporting and Plotting
- Desktop PC at Field Trailer
- Output Includes Detailed Analytical Plots and Data Reports

URS

Lambert-St Louis Airport Expansion

- Project Introduction
  - New 9,000 ft Runway
  - Road Relocations
  - “Cut and Cover” Tunnel for Lindbergh Boulevard (6 lanes)
  - Stormwater Retention Structures
  - Miscellaneous

URS

General Subsurface Conditions

- Upland Profile
  - Modified Loess
  - Residual Clay
  - Shale and Limestone Bedrock
  - Groundwater 15 to 30 ft deep
- Lacustrine (Lakebed) Profile
  - Lake deposited clays and silts, organics
  - Residual Clay
  - Shale Limestone Bedrock
  - Groundwater 2 to 5 feet deep

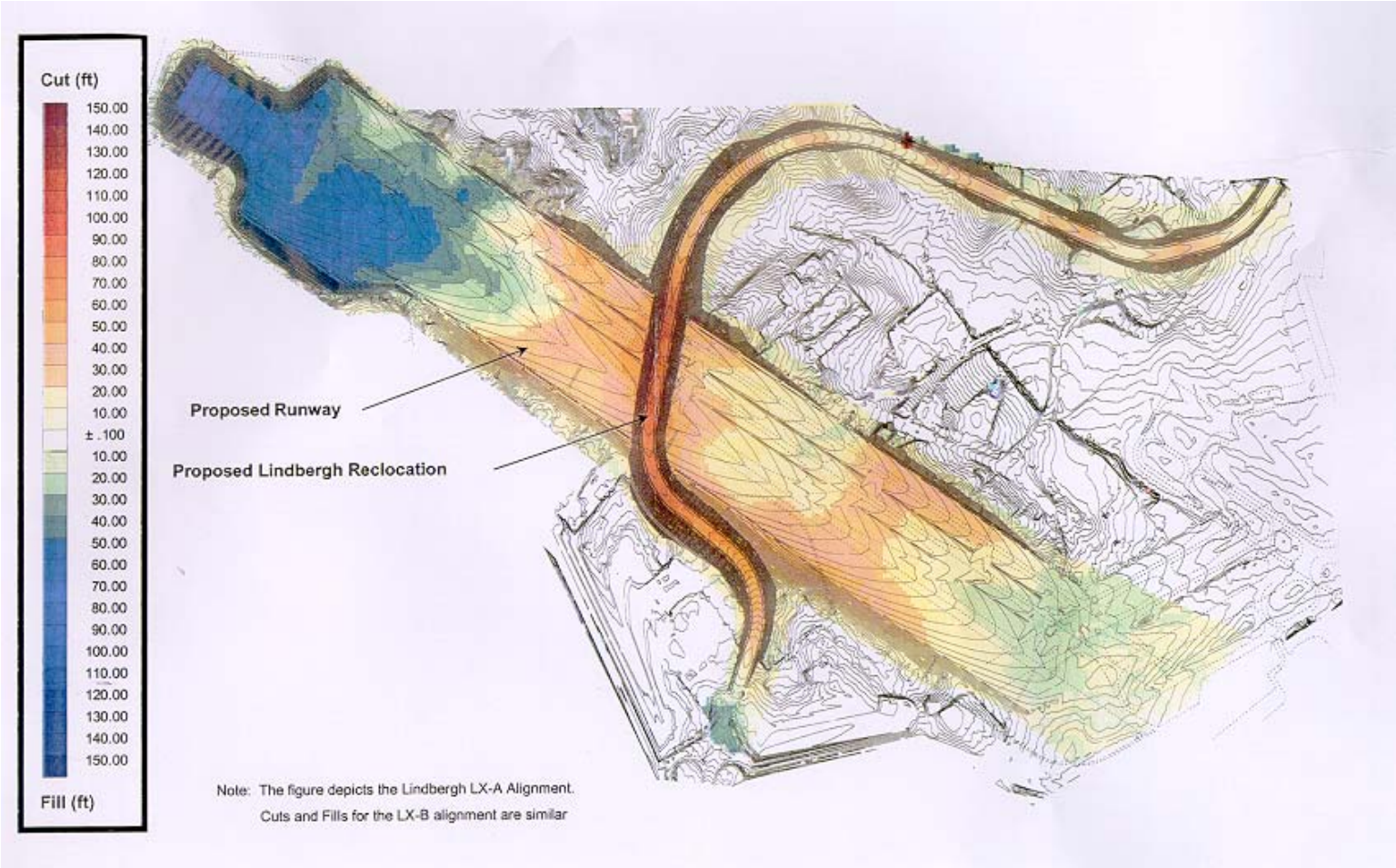
URS

Key Geotechnical Issues

- Stability of Cut Slopes in Shale
  - Tunnel Portal Cuts 80+ ft Deep
  - Possible Partial Height Retaining Walls
- Lakebed Soils
  - Stability of Cut Slopes, Subgrade

URS

Cuts and Fills



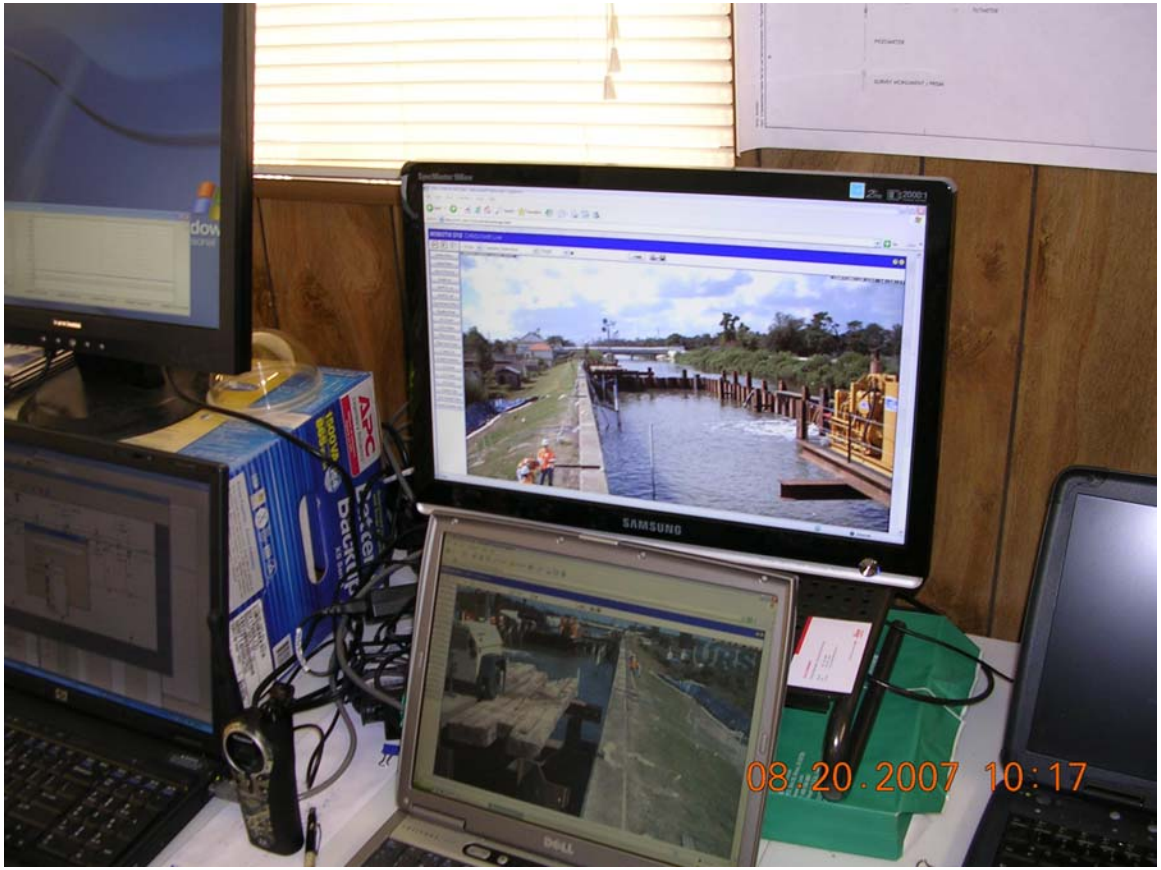
URS

Lessons Learned

- Keep It Simple
- Value of Obtaining Data From Various Sources
- Account for Future Expansions
- Multiple Alarm Thresholds

URS

Cameras



URS

Automated Data Acquisition System (ADAS) Design Considerations

- System Layout and Schematic
- Equipment and Software Selection
- Installation Criteria
- Data Management System

URS

Equipment Selection

- Sensors
- Remote Monitoring Unit
- Power – AC/Solar Panels
- Telemetry Components
- Computer
- Data Output Devices

URS

Installation Criteria

- Lightning Protection
- Physical Site Conditions
- Minimize Lateral Cable Runs
- Avoid Subsurface Construction
- Flexible Deployment Scheme
- Manual Readout Capability

URS

Benefits of ADAS

- Provides Timely Data Collection and Reduction
- Reduces Human Error
- Increased Reading Frequency Can Provide Additional Insights
- Provides More Time for Analysis and for Field Personnel
- Can be Extended into Early Warning System

URS

Thank You

URS