2005 Tri-Service Infrastructure Systems Conference & Exhibition

St. Louis, MO
"Re-Energizing Engineering Excellence"

2-4 August 2005

Agenda

Panel*:* The Future of Engineering and Construction

- LTG Carl A. Strock, Commander, USACE
- Dr. James Wright, Chief Engineer, NAVFAC

Panel*:* USACE Engineering and Construction

- Dr. Michael J. O'Connor, Director, R&D

Panel*:* Navy General Session

- Mr. Steve Geusic, Engineering Criteria & Programs NAVFAC Atlantic

Introduction to Multi-Disciplinary Tracks, by Mr. Gregory W. Hughes
Engineering Circular: Engineering Reliability Guidance for Existing USACE Civil Works Infrastructure, by Mr. David M. Schaaf, PE, LRD Regional Technical Specialist, Navigation Engineering Louisville District
MILCON S&A Account Study, by Mr. J. Joseph Tyler, PE, Chief, Programs Integration Division, Directorate of Military Programs HQUSACE
Financial Justification on Bentley Enterprise License Agreement (ELA)

Track 1

- The Chicago Shoreline Storm Damage Reduction Project, by Andrew Benziger
- Protecting the NJ Coast Using Large Stone Seawalls, by Cameron Chasten
- Cascade: An Integrated Coastal Regional Model for Decision Support and Engineering Design, by Nicholas C. Kraus and Kenneth J. Connell
- Modeling Sediment Transport Along the Upper Texas Coast, by David B. King Jr., Jeffery P. Waters and William R. Curtis
- Sediment Compatibility for Beach Nourishment in North Carolina, by Gregory L. Williams
- Evaluating Beachfill Project Performance in the USACE Philadelphia District, by Monica Chasten and Harry Friebel
- US Army Corps of Engineers' National Coastal Mapping Program, by Jennifer Wozencraft
- Flood Damage Reduction Project Using Structural and Non-Structural Measures, by Stacey Underwood
- Shore Protection Project Performance Improvement Initiative (S3P2I), by Susan Durden
- Hurricane Isabel Post-Storm Assessment, by Jane Jablonski
- US Army Corps of Engineers Response to the Hurricanes of 2004, by Rick McMillen and Daniel R. Haubner
- Increased Bed Erosion Due to Increased Bed Erosion Due to Ice, by Decker B. Hains, John I. Remus, and Leonard J. Zabilansky
- Mississippi Valley Division, by James D. Gutshall
- Impacts to Ice Regime Resulting from Removal of Milltown Dam, Clark Fork River, Montana, by Andrew M. Tuthill and Kathleen D. White, and Lynn A. Daniels
- Carroll Island Micromodel Study: River Miles 273.0-263.0, by Jasen Brown
- Monitoring the Effects of Sedimentation from Mount St. Helens, by Alan Donner, Patrick O'Brien and David Biedenharn
  Watershed Approach to Stream Stability and Benefits Related to the Reduction of Nutrients, by John B. Smith
- A Lake Tap for Water Temperature Control Tower Construction at Cougar Dam, Oregon, by Stephen Schlenker, Nathan Higa and Brad Bird
- San Francisco Bay Mercury TMDL – Implications for Constructed Wetlands, by Herbert Fredrickson, Elly Best and Dave Soballe
- Abandoned Mine Lands: Eastern and Western Perspectives, by Kate White and Kim Mulhern
  Translating the Hydrologic Tower of Babel, byDan Crawford
- Demonstrating Innovative River Restoration Technologies: Truckee River, Nevada, by Chris Dunn
- System-Wide Water Resource Management – Tools of the Trade

Track 2

- Ecological and Engineering Considerations for Dam Decommissioning, Retrofits, and Reoperations, by Jock Conyngham
- Hydraulic Design of tidegates and other Water Control structures for Ecosystem Restoration projects on the Columbia River estuary, by Patrick S. O'Brien
- Surface Bypass & Removable Spillway Weirs, by Lynn Reese
- Impacts of using a spillway for juvenile fish passage on typical design criteria, by Bob Buchholz
- Howard Hanson Dam: Hydraulic Design of Juvenile Fish Passage Facility in Reservoir with Wide Pool Fluctuation, by Dennis Mekkers and Daniel M. Katz
- Current Research in Fate Current Research in Fate & Transport of Chemical and Biological Contaminants in Water Distribution Systems, by Vincent F. Hock
- Regional Modeling Requirements, by Maged Hussein
- Tools for Wetlands Permit Evaluation: Modeling Groundwater and Surface Water Interaction, by Cary Talbot
- Ecosystem Restoration for Fish and Wildlife Habitat on the UMRS, by Jon Hendrickson
- Missouri River Shallow Water Habitat Creation, by Dan Pridal
- Aquatic Habitat Restoration in the Lower Missouri River, by Chance Bitner
- Transition to an Oracle Based Data System (Corps Water Management System, CWMS), by Joel Asunskis
- RiverGages.com: The Mississippi Valley Division Water Control Website, by Rich Engstrom
- HEC-ResSim 3.0: Enhancements and New Capabilities, by Fauwaz Hanbali
- Hurricane Season 2004 – Not to Be Forgotten, by Jacob Davis
- Re-Evaluation of a Flood Control Project, by Ferris W. Chamberlin
- Helmand Valley Water Management Plan, by Jason Needham
- A New Approach to Water Management Decision Making, by James D. Barton
- Developing Reservoir Operational Plans to Manage Erosion and Sedimentation during Construction – Willamette Temperature
- Control, Cougar Reservoir 2002-2005, by Patrick S. O'Brien
- Improved Water Supply Forecasts for the Kootenay Basin, by Randal T. Wortman
- ResSIM Model Development for Columbia River System, by Arun Mylvahanan
- Prescriptive Reservoir Modeling and the ROPE, by Jason Needham
- Missouri River Basin Water Management, by Larry Murphy

Track 3

- Corps Involvement in FEMA's Map Modernization Program, by Kate White, John Hunter and Mark Flick
- Innovative Approximate Study Method for FEMA Map Moderniation Program , by John Hunter
- Flood Fighting Structures Demonstration and Evaluation Program (FFSD), by Fred Pinkard
- Integrating Climate Dynamics Into Water Resources Planning and Management, by Kate White
- Hydrologic and Hydraulic Contributions to Risk and Uncertainty Propagation Studies, by Robert Moyer
- Uncertainty Analysis: Parameter Estimation, by Jackie P. Hallberg
- Geomorphology Study of the Middle Mississippi River, by Eddie Brauer
- Bank Erosion and Morphology of the Kaskaskia River, by Michael T. Rodgers
- Degradation of the Kansas City Reach of the Missouri River, by Alan Tool
- Sediment Impact Assessment Model (SIAM), by David S. Biedenharn and Meg Jonas
- Mississippi River Sedimentation Study, by Basil Arthur
- Sediment Model of Rivers, by Charlie Berger
- East Grand Forks, MN and Grand Forks, ND Local Flood Damage Reduction Project, by Michael Lesher
- Hydrologic and Hydraulic Analyses, by Thomas R. Brown
- Hydrologic and Hydraulic Modeling of the Mccook and Thornton Tunnel and Reservoir Plans, by David Kiel
- Ala Wai Canal Project, by Lynnette F. Schaper
- Missouri River Geospatial Decision Support Framework, by Bryan Baker and Martha Bullock
- Systemic Analysis of the Mississippi & Illinois Rivers Upper Mississippi River Comprehensive Plan, by Dennis L. Stephens

Section 227: National Shoreline Erosion Control Demonstration and Development Program Annual Workshop

- Workshop Objectives
- Section 227: Oil Piers, Ventura County, CA, by Heather Schlosser
- An Evaluation of Performance Measures for Prefabricated Submerged Concrete Breakwaters: Section 227 Cape May Point, New Jersey Demonstration Project, by Donald K Stauble, J.B. Smith and Randall A. Wise
- Bluff Stabilization along Lake Michigan, using Active and Passive Dewatering Techniques, by Rennie Kaunda, Eileen Glynn, Ron Chase, Alan Kehew, Amanda Brotz and Jim Selegean
- Storm Damage at Cape Lookout
- Branchbox Breakwater Design at Pickleweed Trail, Martinez, CA
- Section 227: Miami, FL
- Section 227: Sheldon Marsh Nature Preserve
- Section 227: Seabrook, New Hampshire
- Jefferson County, TX – Low Volume Beach Fill
- Sacred Falls, Oahsacred Falls, Oahu Section 227 Demonstration Project

Track 4

- Fern Ridge LakFern Ridge Lake Hydrologic Aspects of Operation during Failure, by Bruce J Duffe
- A Dam Safety Study Involving Cascading Dam Failures, by Gordon Lance
- Spillway Adequacy Analysis of Rough River Lake Louisville District, by Richard Pruitt
- Water Management in Iraq: Capability and Marsh Restoration, by Fauwaz Hanbali
- Iraq Ministry of Water Resources Capacity Building, by Michael J. Bishop, John W. Hunter, Jeffrey D. Jorgeson, Matthew M. McPherson, Edwin A. Theriot, Jerry W. Webb, Kathleen D. White, and Steven C. Wilhelms

- HEC Support of the CMEP Program, by Mark Jensen
- Geospatial Integration of Hydrology & Hydraulics Tools for Multi-Purpose, Multi-Agency Decision Support, by Timothy Pangburn, Joel Schlagel, Martha Bullock, Michael Smith, and Bryan Baker
- GIS & Surveying to Support FEMA Map Modernization and Example Bridge Report, by Mark Flick
- High Resolution Bathymetry and Fly-Through Visualization, by Paul Clouse
- Using GIS and HEC-RAS for Flood Emergency Plans, by Stephen Stello
- High Resolution Visualizations of Multibeam Data of the Lower Mississippi River, by Tom Tobin and Heath Jones
- System Wide Water Resources Program Unifying Technologies Geospatial Applications, by Andrew J. Bruzewicz
- Raystown Plate Locations
- Hydrologic Engineering Center: HEC–HMS Version 3.0 New Features, by Jeff Harris
- SEEP2D & GMS: Simple Tools for Solving a Variety of Seepage Problems, by Clarissa Hansen, Fred Tracy, Eileen Glynn, Cary Talbot and Earl Edris
- Sediment and Water Quality in HEC-RAS, by Mark Jensen
- Advances to the GSSHA Model, by Aaron Byrd and Cary Talbot
- Watershed Analysis Tool: HEC-WAT Program, by Chris Dunn
- Little Calumet River UnsteadLittle Calumet River Unsteady Flow Model Conversion UNET to HEC-RAS, by Rick D. Ackerson
  Kansas River Basin Model, by Edward Parker
- Design Guidance for Breakup Ice Control Structures, by Andrew M. Tuthill
- Computational Hydraulic Model of the Lower Monumental Dam Forebay, by Richard Stockstill, Charlie Berger, John Hite, Alex Carrillo, and Jane Vaughan
- Use of Regularization as a Method for Watershed Model Calibration, by Brian Skahill
- Demonstration Program Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions (UFDP), by Joan Pope, Jack Davis, Ed Sing, John Warwick, Meg Jonas

Track 5

- Walla Walla District Northwestern Division, by Robert Berger
- Best Practices for Conduits through Embankment Dams, by Chuck R. Cooper
- Design, Construction Design, Construction and Seepage at Prado Dam, by Douglas E. Chitwood
- 2-D Liquefaction Evaluation with Q4Mesh, by David C. Serafini
- Unlined Spillway Erosion Risk Assessment, by Johannes Wibowo, Don Yule, Evelyn Villanueva and Darrel Temple
- Seismic Remediation of the Clemson Upper and Lower Diversion Dams; Evaluation, Conceptual Design and Design, by Lee Wooten and Ben Foreman
- Seismic Remediation of the Clemson Upper and Lower Diversion Dams; Deep Soil Mix Construction, by Lee Wooten and Ben Foreman
- Historical Changes in the State of the Art of Seismic Engineering and Effects of those changes on the Seismic Response Studies of Large Embankment Dams, by Sam Stacy
- Iwakuni Runway Relocation Project, by Vincent R. Donnally
- Internal Erosion & Piping at Fern Ridge Dam, by Jeremy Britton
- Rough River Dam Safety Assurance Project, by Timothy M. O'Leary
- Seepage Collection & Control Systems: The Devil is in the Details , by John W. France
- Dewey Dam Seismic Assessment, by Greg Yankey
- Seismic Stability Evaluation for Ute Dam, New Mexico, by John W. France
- An Overview of Criteria Used by Various Organizations for Assessment and Seismic Remediation of Earth Dams, by Jeffrey S. Dingrando
- A Review of Corps of Engineers Levee Seepage Practices and Proposed Future Changes, by George Sills
- Ground-Penetrating Radar Applications for the Assessment of Pavements, by Lulu Edwards and Don R. Alexander
- Peru Road Upgrade Project, by Michael P. Wielputz
- Slope Stability Evaluation of the Baldhill Dam Right Abutment, by Neil T. Schwanz
- Design and Construction of Anchored Bulkheads with Synthetic Sheet Piles Seabrook, New Hampshire, by Siamac Vaghar and Francis Fung
- Characterization of Soft Claya Case Study at Craney Island, by Aaron L. Zdinak
- Dispersive ClayDispersive Clays – Experience andHistory of the NRCS (Formerly SCS), by Danny McCook
- Post-Tensioning Institute, by Michael McCray
- Demonstration Program Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions (UFDP), by Joan Pope, Jack Davis, Ed Sing, John Warwick, Meg Jonas

Track 6

- State of the Art in Grouting: Dams on Solution Susceptible or Fractured Rock Foundations, by Arthur H. Walz
- Specialty Drilling, Testing, and Grouting Techniques for Remediation of Embankment Dams, by Douglas M. Heenan
- Composite Cut-Offs for Dams, by Dr. Donald A. Bruce and Trent L. Dreese
- State of the Art in Grout Mixes, by James A. Davies
- State of the Art in Computer Monitoring and Analysis of Grouting, by Trent L. Dreese and David B. Wilson
- Quantitatively Engineered Grout Curtains, by David B. Wilson and Trent L. Dreese
- Grout Curtains at Arkabutla Dam: Outlet Monolith Joints and Cracks using Chemical Grout, Arkabutla Lake, MS, by Dale A. Goss
- Chicago Underflow Plan – CUP: McCook Reservoir Test Grout Program, by Joseph A. Kissane
- Clearwater Dam: Sinkhole Repair Foundation Investigation and Grouting Project, by Mark Harris
- Update on the Investigation of the Effects of Boring Sample Size (3" vs 5") on Measured Cohesion in Soft Clays, by Richard Pinner and Chad M. Rachel
- Soil-Bentonite Cutoff Wall Through Free-Product at Indiana Harbor CDF, by Joe Schulenberg and John Breslin
- Soil-Bentonite Cutoff Wall Through Dense Alluvium with Boulders into Bedrock, McCook Reservoir, by William A. Rochford
- Small Project, Big Stability Problem the Block Church Road Experience, by Jonathan E. Kolber
- Determination of Foundation Rock Properties Beneath Folsom Dam, by Michael K. Sharp, José L. Llopis and Enrique E. Matheu
  Waterbury Dam Mitigation, by Bethany Bearmore
- Armor Stone Durability in the Great Lakes Environment, by Joseph A. Kissane
- Mill Creek - An Urban Flood Control Challenge, by Monica B. Greenwell
- Next Stop, The Twilight Zone, by Troy S. O'Neal
- Limitations in the Back Analysis of Shear Strength from Failures, by Rick Deschamps and Greg Yankey
- Reconstruction of Deteriorated Concrete Lock Walls After Blasting and Other Demolition Removal Techniques, by Stephen G. O'Connor

- Flood Fighting Structures Demonstration and Evaluation Program (FFSD), by George Sills
- Innovative Design Concepts Incorporated into a Landfill Closure and Reuse Design Portsmouth Naval Shipyard, Kittery, Maine, by Dave Ray and Kevin Pavlik
- Laboratory Testing of Flood Fighting Structures, by Johannes L. Wibowo, Donald L. Ward and Perry A. Taylor
- Bluff Stabilization Along Lake Michigan, Using Active and Passive Dewatering Techniques, Allegan Co. Michigan, by Rennie Kaunda, Eileen Glynn, Ron Chase, Alan Kehew and Jim Selegean

Track 7

- Case History: Multiple Axial Statnamic Tests on a Drilled Shaft Embedded in Shale, by Paul J. Axtell, J. Erik Loehr, Daniel L. Jones
- The Sliding Failure of Austin Dam Pennsylvania - Revisited, by Brian H. Greene
- M3 –Modeling, Monitoring and Managing: A Comprehensive Approach to Controlling Ground Movements for Protection of Existing Structures and Facilities, by Francis D. Leathers and Michael P. Walker
- Time-Dependent Reliability Modeling for Use in Major Rehabilitation of Embankment Dams and Foundation, by Robert C. Patev
- Lateral Pile Load Test Results Within a Soft Cohesive Foundation, by Richard J. Varuso
- Engineering Geology Challenge Engineering Geology Challenges During Design and Construction of the Marmet Lock Project, by Ron Adams and Mike Nield
- Mill Creek Deep Tunnel Geologic Conditions and Potential Impacts on Design/Construction, by Kenneth E. Henn III
- McAlpine Lock Replacement Instrumentation: Design, Construction, Monitoring, and Interpretation, by Troy S. O'Neal
- Geosynthetics and Construction of the Second Powerhouse Corner Collector Surface Flow Bypass Project, Bonneville Lock and Dam Project, Oregon and Washington, by Art Fong
- McAlpine Lock Replacement Project Foundation Characteristics and Excavation, by Kenneth E. Henn III
- Structural and Geotechnical Issues Impacting The Dalles Spillwall Construction and Bay 1 Erosion Repair, by Jeffrey M. Ament
  Rock Anchor Design and Construction: The Dalles Dam Spillwalls, by Kristie M. Hartfeil
- The Future of the Discrete Element Method in Infrastructure Analysis, by Raju Kala, Johannes L. Wibowo and John F. Peters
- Sensitive Infrastructure Sites - Sonic Drilling Offers Quality Control and Non-Destructive Advantages to Geotechnical Construction Drilling, by John P. Davis

Track 8

- Evaluation of The Use of LithiuEvaluation of The Use of Lithium Compounds in Controlling ASR in Concrete Pavement, by Mike Kelly
- Roller Compacted Concrete for McAlpine Lock Replacement, by David E. Kiefer
- Soil-Cement for Stream Bank Stabilization, by Wayne Adaska
- Using Cement to Reclaim Asphalt Pavements, by David R. Luhr
- Valley Park 100-Yr Flood Protection Project: Use of 'Engineered Fill' in the Item IV-B Levee Core, by Patrick J. Conroy
- Bluestone Dam: AAR –A Case Study, by Greg Yankey
- USDA Forest Service: Unpaved Road Stabilization with Chlorides, by Michael R. Mitchell
- Use of Ultra-Fine Amorphous Colloidal Silica to Produce a High-Density, High-Strength Grout, by Brian H. Green
- Modular Gabion Systems, by George Ragazzo
- Addressing Cold Regions Issues in Pavement Engineering, by Edel R. Cortez and Lynette Barna
- Geology of New York Harbor: Geological and Geophysical Methods of Characterizing the Stratigraphy for Dredging Contracts, by Ben Baker, Kristen Van Horn and Marty Goff
- Rubblization of Airfield Concrete Pavements, by Eileen M. Vélez-Vega
- US Army Airfield Pavement Assessment Program, by Haley Parsons, Lulu Edwards, Eileen Velez-Vega and Chad Gartrell
- Critical State for Probabilistic Analysis of Levee Underseepage, by Douglas Crum,
- Curing Practices for Modern Concrete Production, by Toy Poole
- AAR at Carters Dam: Different Approaches, by James Sanders
- Concrete Damage at Carters Dam, by Toy Poole
  Damaging Interactions Among Concrete Materials, by Toy Poole
- Economic Effects on Construction of Uncertainty in Test Methods, by Toy Poole
- Trends in Concrete Materials Specifications, by Toy Poole
- Spall and Intermediate-Sized Repairs for PCC Pavements, by Reed Freeman and Travis Mann
- Acceptance Criteria Acceptance Criteria for Unbonded Aggregate Road Surfacing Materials, by Reed Freeman, Toy Poole, Joe Tom and Dale Goss
- Effective Partnering to Overcome an Interruption In the Supply of Portland Cement During Construction at Marmet Lock and Dam, by Billy D. Neeley, Toy S. Poole and Anthony A. Bombich

Track 10

- Marmet Lock &Dam: Automated Instrumentation Assessment, Summer/Fall 2004, by Jeff Rakes and Ron Adams
  Success Dam Seismic Remediation

Track 9

- Fern Ridge Dam, Oregon: Seepage and Piping Concerns (Internal Erosion)

Track 11

- Canton Dam Spillway Stability: Is a Test Anchor Program Necessary?, by Randy Mead
- Dynamic Testing and Numerical Correlation Studies for Folsom Dam, by Ziyad Duron, Enrique E. Matheu, Vincent P. Chiarito, Michael K. Sharp and Rick L. Poeppelman

Status of Portfolio Risk Assessment, by Eric Halpin
- Mississinewa Dam Foundation Rehabilitation, by Jeff Schaefer
- Wolf Creek Dam Seepage Major Rehabilitation Evaluation, by Michael F. Zoccola
- Bluestone Dam DSA Anchor Challenges, by Michael McCray
- Clearwater Dam Major Rehab Project, by Bobby Van Cleave
- Design, Construction and Seepage at Prado Dam, by Douglas E. Chitwood
- Seven Oaks Dam: Outlet Tunnel Invert Damage, by Robert Kwan
- An Overview of An Overview of the Dam Safety ProgramManagement Tools (DSPMT), by Tommy Schmidt

Track 12

- Greenup L&D Miter Gate Repair and Instrumentation, by Joseph Padula, Bruce Barker and Doug Kish
- Marmet Locks and Dam Lock Replacement Project, by Jeffrey S. Maynard,
- Status of HSS Inspections in The Portland District, by Travis Adams
- Kansas City District: Perry Lake Project Gate Repair, by Marvin Parks
- Mel Price – Auxiliary Lock Downstream Miter Gate Repair, by Thomas J. Quigley, Brian K. Kleber and Thomas R. Ruf
- J.T. Myers Lock Improvements Project Infrastructure Conference, by David Schaaf and Greg Werncke
- J.T. Myers Dam Major Rehab, by David Schaaf, Greg Werncke and Randy James
- Greenup L&D, by Rodney Cremeans
- McAlpine Lock Replacement Project, by Kathy Feger
- Roller Compacted Concrete Placement at McAlpine Lock, by Larry Dalton
- Kentucky Lock Addition Downstream Middle Wall Monolith Design, by Scott A. Wheeler
- London Locks and Dam Major Rehabilitation Project, by David P. Sullivan
- Replacing Existing Lock 4: Innovative Designs for Charleroi Lock, by Lisa R. Pierce, Dave A. Stensby and Steve R. Stoltz
- Olmsted L&D, Dam In-the-wet Construction, by Byron McClellan, Dale Berner and Kenneth Burg
- Olmsted Floating Approach Walls, by Terry Sullivan
- John Day Navigation Lock Monolith Repair, by Matthew D. Hanson
- Inner Harbor Navigation Canal (IHNC) Lock Replacement, by Mark Gonski
- Comite River Diversion Project, by Christopher Dunn
- Waterline Support Failure: A Case Study, by Angela DeSoto Duncan
- Public Appeal of Major Civil Projects: The Good, the Bad and the Ugly, by Kevin Holden and Kirk Sunderman
- Chickamauga Lock and Dam Lock Addition Cofferdam Height Optimization Study, by Leon A. Schieber
- Des Moines Riverwalk, by Thomas D. Heinold

Track 13

- Folsom Dam Evaluation of Stilling Basin Performance for Uplift Loading for Historic Flows and Modification of Folsom Dam
- Stilling Basin for Hydrodynamic Loading, by Rick L. Poeppelman, Yunjing (Vicky) Zhang, and Peter J. Hradilek
- Seismic Stress Analysis of Folsom Dam, by Enrique E. Matheu
- Barge Impact Analysis for Rigid Lock Walls ETL 1110-2-563, by John D. Clarkson and Robert C. Patev
- Belleville Locks & Dam Barge Accident on 6 Jan 05, by John Clarkson
- Portugues Dam Project Update, by Alberto Gonzalez, Jim Mangold and Dave Dollar
- Portugues Dam: RCC Materials Investigation, by Jim Hinds
- Nonlinear Incremental Thermal Stress Strain Analysis Portugues Dam, by David Dollar, Ahmed Nisar, Paul Jacob and Charles Logie
- Seismic Isolation of Mission-Critical Infrastructure to Resist Earthquake Ground Shaking or Explosion Effects, by Harold O. Sprague, Andrew Whitaker and Michael Constantino
- Obermeyer Gated Spillway S381, by Michael Rannie
- Design of High Pressure Vertical Steel Gates Chicago Land Underflow Plan McCook Reservoir, by Henry W. Stewart, Hassan Tondravi, Lue Tekola,
- Development of Design Criteria for the Rio Puerto Nuevo Contract 2D/2E Channel Walls, by Janna Tanner, David Shiver, and Daniel Russell
- Indianapolis NortIndianapolis North Phase 3A Warfleigh Section
- Design of Concrete Lined Tunnels in Rock CUP McCook Reservoir Distribution Tunnels Contract, by David Force

Track 14

- GSA Progressive Collapse Design Guidelines Applied to Concrete Moment-Resisting Frame Buildings, by David N. Bilow and Mahmoud E. Kamara,
- UFC 4-023-02 Retrofit of Existing Buildings to Resist Explosive Effects, by Jim Caulder
- Summit Bridge Fatigue Study, by Jim Chu
- Quality Assurance for Seismic Resisting Systems, by John Connor
- Seismic Requirements for Arch, Mech, and Elec. Components, by John Connor
- SBEDS - (Single degree of freedom Blast Effects Design Spreadsheets), by Dale Nebuda,
- Design of Buildings to Resist Progressive Collapse UFC 4-023-03, by Bernie Deneke,
- Fatigue and Fracture Assessment, by Jesse Stuart
- Unified Facilities Criteria: Seismic Design for Buildings, by Jack Hayes
- Evaluation and Repair Of Blast Damaged Reinforced Concrete Beams, by MAJ John L. Hudson
- Building an In-house Bridge Inspection Program
- United Facilities CriteriUnited Facilities Criteria Masonry Design for Buildings, by Tom Wright
- USACE Homeland Security Portal, by Michael Pace
- Databse Tools for Civil Works Projects

- Standard Procedure for Fatigue Evaluation of Bridges, by Phil Sauser
- Consolidation of Structural Criteria for Military Construction, by Steven Sweeney
- Cathodic Protectionfor the South Power Plant Reinforcing Steel, Diego Garcia, BIOT, by Thomas Tehada and Miki Funahashi

Track 15

- Engineering Analysis of Airfield Lighting System Lightning Protection, by Dr. Vladimir A. Rakov and Dr. Martin A. Uman
- Dr. Martin A. Uman
- Charleston AFB Airfield Lighting Vault
- UNIFIED FACILITIES CRITERIA (UFC) UFC 3-530-01 Design: Interior, Exterior Lighting and Controls, by Nancy Clanton and Richard Cofer
- Electronic Keycard Access Locks, by Fred A Crum
- Unified Facilities Criteria (UFC) 3-560-02, Electrical Safety, by John Peltz and Eddie Davis
- Electronic Security SystemElectronic Security Systems Process Overview
- Lightning Protection Standards
- Electrical Military Workshop
- Information Technology Systems Criteria, by Fred Skroban and John Peltz
- Electrical Military Workshop
- Electrical Infrastructure in Iraq- Restore Iraqi Electricity, by Joseph Swiniarski

Track 16

- BACnet® Technology Update, by Dave Schwenk
- The Infrastructur Conference 2005, by Steven M. Carter Sr. and Mitch Duke
- Design Consideration for the Prvention of Mold, by K. Quinn Hart
- COMMISSIONING, by Jim Snyder
- New Building Commissioning , by Gary Bauer
- Ventilation and IAQ TheNew ASHRAE Std 62.1, by Davor Novosel
- Basic Design Considerations for Geothermal Heat Pump Systems, by Gary Phetteplace
- Packaged Central Plants
- Effective Use Of Evaporative Cooling For Industrial And Institutional/Office Facilities, by Leon E. Shapiro
- Seismic Protection For Mechanical Equipment
- Non Hazardous Chemical Treatments for Heating and Cooling Systems, by Vincent F. Hock and Susan A. Drozdz
- Trane Government Systems & Services
- LONWORKS Technology Update, by Dave Schwenk
- Implementation of Lon-Based Specifications by Will White and Chris Newman

Track 17

- Utility System Security and Fort Future, by Vicki Van Blaricum, Tom Bozada, Tim Perkins, and Vince Hock
- Festus/Crystal City Levee and Pump Station
- Chicago Underflow Plan McCook Reservoir (CUP) Construction of Distribution Tunnel and Pumps Installation
- Technological Advances in Lock Control Systems, by Andy Schimpf and Mike Maher
- Corps of Engineers in Iraq Rebuilding Electrical Infrastructure, by Hugh Lowe
- Red River of the North at East Grand Forks, MN & Grand Forks, ND: Flood Control Project – Armada of Pump Stations Protect Both Cities, by Timothy Paulus
- Lessons Learned for Axial/Mixed Flow Propeller Pumps, by Mark A. Robertson
- Creek Automated Gate Considerations, by Mark A. Robertson
- HydroAMP: Hydropower Asset Management, by Lori Rux
- Acoustic Leak Detection for Water Distribution Systems, by Sean Morefield, Vincent F. Hock and John Carlyle
- Remote Operation System, Kaskaskia Dam Design, Certification, & Accreditation, by Shane M. Nieukirk
- Lock Gate Replacement System, by Shaun A. Sipe and Will Smith

Track 20

- “Re-Energizing Medical Facility Excellence”, by COL Rick Bond
- Rebuilding and Renovating The Pentagon , by Brian T. Dziekonski,
- Resident Management System
- Design-Build and Army Military Construction, by Mark Grammer
- Defense Acquisition Workforce Improvements Act - Update, by Mark Grammer
- Construction Management @ Risk: Incentive Price Revision – Successive Targets, by Christine Hendzlik
- Construction Reserve Matrix, by Christine Hendzlik
- Award contingent on several factors..., by Christine Hendzlik
- 52.216-17 Incentive Price Revision--Successive Targets (Oct 1997) - Alt I (Apr 1984), by Christine Hendzlik
- Preconstruction Services, by Christine Hendzlik
- Proposal Evaluation Factors, by Christine Hendzlik
- MILCON Transformation in Support of Army Transformation, by Claude Matsui
- Construction Practices in Russia, by Lance T. Lawton

- Partnering as a Best Practice, by Ray Dupont
- USACE Tsunami Reconstruction for USAID, by Andy Constantaras

Track 21

- Dredging Worldwide, by Don Carmen
- SpecsIntact Editor, by Steven Freitas
- SpecsIntact Explorer, by Steven Freitas
- American River Watershed Project, by Steven Freitas
- Unified Facilities Guide Specifications (UFGS) Conversion To MasterFormat 2004, by Carl Kersten
- Unified Facilities Guide Specifications (UFGS) Status and Direction , by Jim Quinn

Workshops

- Design of Buildings to Resist Progressive Collapse UFC 4-023-03, by Bernie Deneke
- Security Engineering and at Unified Facility Criteria (UFC), by Bernie Deneke, Richard Cofer, John Lynch and Rudy Perkey
- Packaged Central Plants, by Trey Austin

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

NDIA

STRENGTH THROUGH INDUSTRY & TECHNOLOGY

2005 Tri-Service Infrastructure Systems Conference & Exhibition

"Re-Energizing Engineering Excellence"

ON-SITE AGENDA

The America's Center
St. Louis Convention Center
St. Louis, MO
August 2-4, 2005
Event # 5150

ISC
Tri-Service Infrastructure Systems Conference & Exposition 2005

2005 Tri-Service Infrastructure Systems Conference & Exhibition

AGENDA

Monday, August 1, 2005

8:00 AM-9:00 PM	Exhibit Move-In
12 Noon-5:00 PM	Registration

Tuesday, August 2, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-8:15 AM Ferrara Theatre	Welcome and Introduction
8:15 AM-9:00 AM Ferrara Theatre	The Future of Engineering and Construction Panel Moderator: *Mr. Don Basham, Chief, Engineering & Construction, USACE* Panelists: *LTG Carl A. Strock, Commander, USACE* *Dr. James Wright, Chief Engineer NAVFAC*
9:00 AM-9:45 AM Ferrara Theater	Keynote Address The Lord of the Things: The Future of Infrastructure Technologies *Mr. Paul Doherty, AIA, Managing Director,* *General Land Corporation*
9:45 AM-10:15 AM	Break
10:15 AM-11:15 AM Ferrara Theatre	USACE Engineering and Construction Panel Moderator: *Mr. Don Basham, Chief, Engineering & Construction, USACE* Panelists: *MG Donald T. Riley, Director, Civil Works, USACE* *BG Bo M. Temple, Director, Military Programs, USACE* *Dr. Michael J. O'Connor, Director, R&D*
10:15 AM-11:15 AM Room 225	Navy General Session
11:00 AM - 7:00 PM	Exhibits Open
11:15 AM-1:00 PM	Lunch in Exhibit Hall (on your own)
11:15 AM-1:00 PM Washington G	Women's Career Lunch Session (Bring your lunch from Exhibit Hall) Moderator: *Ms. Demi Syriopoulou, HQ USACE* Opening Remarks: *LTG Carl A. Strock, Commander, USACE* Presentations & Discussion: *Dwight Beranek, Kristine Allaman, Donald Basham, HQ USACE*
1:00 PM-1:55 PM Ferrara Theatre	Introduction to Multi-Disciplinary Tracks

Tuesday, August 2, 2005

2:00 PM-2:50 PM — 1st Round of Multi-Disciplinary Concurrent Sessions (Continued)

Track 1: Acquisition Strategies for Civil Works
Room 230
Walt Norko

Track 2: Risk and Reliability Engineering
Room 231
Anjana Chudgar
David Schaaf

Track 3: Portfolio Risk Assessment
Room 232
Eric Halpin

Track 4: Hydrology, Hydraulics and Coastal Engineering
Room 240 Support for USACE
Jerry Webb
Darryl Davis

Track 5: Civil Works R&D Forum
Room 241
Joan Pope

Track 6: Civil Works Security Engineering
Room 242
Joe Hartman
Bryan Cisar

Track 7: Building Information Model Applications
Room 226
Brian Huston
Daniel Hawk

Track 8: Design Build for Military Projects
Room 220
Mark Grammer

Track 9: Army Transformation/Global Posture Initiative/
Room 221 Force Modernization
Al Young
Claude Matsui

Track 10: Force Protection - Army Access Control Points
Room 222
John Trout

Track 11: Cost Engineering Forum on Government Estimates
Room 227 vs. Actual Costs
Ray Lynn *Jack Shelton* *Kim Callan*
Miguel Jumilla *Ami Ghosh* *Joe Bonaparte*

Track 12: Engineering & Construction Information Technology
Room 228
MK Miles

Track 13: Sustainable Design
Room 223
Harry Goradia

Track 14: ACASS/CCASS/CPARS
Room 224
Ed Marceau
Marilyn Nedell

Track 15: Whole Building Design Guide
Room 229
Earle Kennett

Tuesday, August 2, 2005

2:50 PM-3:30 PM	Break in Exhibit Hall
3:30 PM-4:20 PM	2nd Round of Multi-Disciplinary Sessions
4:30 PM-5:20 PM	3rd Round of Multi-Disciplinary Sessions
5:30 PM-7:00 PM	Ice Breaker Reception in Exhibit Hall

Wednesday, August 3, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-9:30 AM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
9:00 AM	Exhibit Hall Opens
9:30 AM-10:30 AM	Break in Exhibit Hall
10:30 AM-12:00 Noon	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
12:00 Noon-1:30 PM	Lunch in Exhibit Hall
1:30 PM-3:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
3:00 PM-4:00 PM	Break in Exhibit Hall
4:00 PM-5:30 PM	Concurrent Sessions
5:00 PM	Exhibit Hall Closes

Thursday, August 4, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-9:30 AM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
9:30 AM-10:30 AM	Break in Exhibit Hall (Last Chance to view Exhibits)
10:30 AM-12:00 Noon	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
12:00 Noon-1:30 PM	Lunch (On your own)
12:00 Noon-6:00 PM	Exhibits Move-Out
1:30 PM-3:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
3:00 PM-3:30 PM	Break
3:30 PM-5:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on following pages)

Wednesday, August 3, 2005 Concurrent Sessions

HH&C Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 220	**TRACK 1 Coastal Structures** Session 1A	Protecting the NJ Coast using large stone seawalls — *Cameron Chasten*	Chicago shoreline storm damage reduction project — *Andrew Bezinger*	Risk and reliability in coastal structure design — *Jeffrey Melby*	**TRACK 1 Coastal Regional Manangement** Session 1B	Cascade: An integrated regional model for decision support — *Nicholas Kraus*	Upper Texas coast sediment transport modeling & sediment budgets — *David King*	Sediment compatibility for beach nourishment in North Carolina — *Gregory Williams*
Room 221	**TRACK 2 Ecological Engineering & Design** Session 2A	Ecological and engineering considerations for dam decommissioning, retrofits and operations — *Jock Conyngham*	Hydraulic design of tidegates and other water control structures for ecosystem restoration on the Columbia Estuary — *Patrick O'Brien*	Innovative Integration of engineering and biological tools aids hydraulic structure design for restoring T&E fish — *Andrew Goodwin*	**TRACK 2 Ecological Engineering & Design** Session 2B	Innovative hydraulic structure design at Lower Granite Dam: design that saves water and salmon — *Lynn Reese*	Impacts of using a spillway for juvenile fish passage on typical design criteria — *Robert Buchholz*	Hydraulic design of juvenile fish passage facility for reservoir with wide range of pool elevation - Hanson Dam — *Dennis Mekkers*
Room 222	**TRACK 3 Modeling** Session 3A	Corps involvement in the FEMA map modernization program — *Kete White*	Innovative approximate study method for FEMA map modernization program — *John Hunter*	Flood fight structures demonstration evaluation program — *Fred Pinkard*	**TRACK 3 Modeling** Session 3B	Integrating climate dynamics into water resources planning and management — *Kate White*	Risk and uncertainty in flood damage reduction studies — *Rob Moyer*	Uncertainty analysis and stochastic simulation — *Jacke Hallberg*
Room 223	**TRACK 4 H&H Aspects of Dam Safety** Session4A	Hydrologic aspects of operating in failure mode: Fern Lake — *Bruce Duffe*	Dam safety study with cascading failures — *Gordon Lance*	Rough river spillway capacity — *Richard Pruitt*	**TRACK 4 International/ Military H&H** Session 4B	Capability restoration and historic marsh restoration — *Fauwaz Hanbali*	USACE capacity building effort for Iraq MoWR — *Steven Wilhelms*	USACE support of CMEP in 2004 — *Mark Jensen*

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 220	**TRACK 1 Coastal Sediments** Session 1C	Evaluating beachfill project performance in the NAP — *Monica Chasten*	USACE's regional coastal mapping program — *Jennifer Wozencraft*	US Naval Academy flood damage reduction project using structural and non-structural measures — *Stacey Underwood*	**TRACK 1 Shore Protection Projects** Session 1D	Hurricane Isabel effects on communities — *Jane Jablonski*	Repair of the shore protection projects adversly affected by the hurricanes of 2004 — *Rick McMillen*	Shore protection project performance assessmet — *Sharon Haggett*
Room 221	**TRACK 2 Modeling Ecological Restoration/Systems Assessment** Session 2C	Regional modeling requirements for ecosystem restoration — *Maged Hussein*	Tools for wetlands permit evaluation: Modeling groundwater and surface water distribution systems — *Cary Talbot*	Current research in fate and transport of chemical and biological contaminants in water distribution systems — *Mark Ginsberg*	**TRACK 2 Ecosystem Habitat Restoration** Session 2D	Aquatic habitat restoration in the lower Missouri River — *Chance Bittner*	Missouri River restoration: shallow water habitat creation — *Daniel Pridal*	Ecosystem restoration for fish and wildlife habitat on the upper Mississippi River — *Jon Hendrickson*
Room 222	**TRACK 3 River Morphology** Session 3C	Geomorphology study of the Mississippi river — *Edward Braurer*	Bank erosion and morphology of the Kaskaskia river — *Michael Rodgers*	Sediment movement at Kansas City from water years 1920 to 2004 — *Alan Tool*	**TRACK 3 Modeling River Sedimentation** Session 3D	Sediment impact assessment model (SIAM) — *David Biedenharn*	Sediment modeling of MS River, Cairo to Gulf — *Basil Arthur*	Sediment modeling of rivers — *Charlie Berger*
Room 223	**TRACK 4 GIS and Surveying** Session 4C	GIS tools available now to support HHC — *Timothy Pangburn*	High resolution bathymetry and fly-through visualization — *Paul Clouse*	GIS & surverying to support national FEMA — *Mark Flick*	**TRACK 4 GIS and Surveying** Session 4D	Update flood emergency plans with GIS and HEC-RAS — *Stephen Stello*	High resolution visualizations of multibeam data: lower Mississippi River — *Thomas Tobin*	GIS in SWWRP — *Andrew Bruzewicz*

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Geotechnical Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 226	**TRACK 5**	Levee lowering for the Lewis & Clark bi-centennial celebration	Conduits through embankment dams - best practices for design, construction, problem id and evaluation, inspection, maintenance, renovation & repair		2-D liquefaction evaluation with q4MESH	Unlined spillway erosion risk assessment	Seismic remediation of the Clemson upper and lower diversion dams: evaluation, conceptal design and design (P1)
	Session 5A	***Robert Berger***	***Dave Pezza***	***Douglas Chitwood***	**Session 5B** ***David Serafini***	***Johannes Wibowo***	***Ben Foreman***
Room 227	**TRACK 6**	USACE dams on solution susceptible or highly fractured rock foundations	Special drilling and grouting techniques for remedial work in embankment dams	Composite grouting & cutoff wall solutions	State of the art in grout mixes	State of the art in computer monitoring, control, and analysis of grouting	Quantitatively engineered grout courtains
	Session 6A	***Art Walz***	***Doug Heenan***	***Donald Bruce***	**Session 6B** ***James Davies***	***Trent Dreese***	***David Wilson***
Room 228	**TRACK 7**	Case history: multiple axial statnamic test on a drilled shaft embedded in shale	Austin Dam, Pennsylvania: the sliding failure of a concrete gravity dam revisited	M^3 (Modeling, Monitoring and Manufacturing) - a comprehensive approach to controlling ground movements for protecting existing structures and facilities	Controlled modulus columns: A ground improvement technique	Time-dependent reliability models for use in major rehabilitation of embankment dams and foundations	Engineering geology design challenges at the Soo Lock replacement project
	Session 7A	***Paul Axtell***	***Brian Greene***	***Michael Walker***	**Session 7B** ***Martin Taube***	***Robert Patev***	***Mike Nield***
Room 229	**TRACK 8**	Evaluation of the use of lithium nitrate in controlling alkali-silica reactivity in an existing concrete pavement	Use of self-consolidating concrete in the installation of bulhead slots - Lessons learned in the use of this innovative concrete material	Roller compacted concrete for McAlpine lock walls	Soil-cement for stream bank stabilization	Using cement to reclaim asphalt pavements	Valley park 100-year flood protection project: use of "engineered fill" in item 4b levee core
	Session 8A	***Mike Kelly***	***Darrell Morey***	***David Kiefer***	**Session 8B** ***Wayne Adaska***	***David Luhr***	***Patrick Conroy***

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 226	**TRACK 5**	Seismic remediation of the Clemson upper and lower diversion dams: deep soil mix construction	Historical changes in the state-of-the-art of seismic engineering & effects of those changes on the seismic response studies of large embankement dams	New Iwakuni runway	Internal erosion and piping at Fern Ridge dam: Problems and solutions	Rough river dam safety assurance project	Seepage collection and control systems: The devil is in the details
	Session 5C	***Ben Foreman***	***Samuel Stacy***	***Vincent Donnally***	**Session 5D** ***Jeremy Britton, Ph.D.***	***Timothy O'Leary***	***John France***
Room 227	**TRACK 6**	Grout courtains at Arkabutla Dam outlet monolith joints using chemical grout to seal joints, Arkabutla, MS	Results from a large-scale grout test program, Chicago underflow plan (CUP) McCook Reservoir	Clearwater Dam - foundation drilling and grouting for repair of sinkholes	Update on the investigation of the effects of boring sample size (3' vs 5") on measured cohesion in soft clays	Soil-bentonite cutoff wall through free-product at Indiana Harbor CDF	Soil-bentonite cutoff wall through dense alluvium with boulders into bedrock, McCook Reservoir
	Session 6C	***Dale Goss***	***Joseph Kissane***	***Mark Harris***	**Session 6D** ***Richard Pinner***	***Joseph Schulenberg***	***William Rochford***
Room 228	**TRACK 7**	Engineering geology during design and construction of the Marmet lock project	Mill Creek deep tunnel - Geological affects on proposed structures and construction techniques	Earth pressure loads behind the new McAlpine Lock replacement project	Geosynthetics and construction of the Bonneville lock and dam second powerhouse corner collector surface flow bypass project	McAlpine lock replacement - foundation characteristics and excavation	
	Session 7C	***Michael Nield***	***Tres Henn***	***Troy O'Neal***	**Session 7D** ***Art Fong***	***Kenneth Henn***	
Room 229	**TRACK 8**	What to do if your dam is expanding: a case study	Unpaved road stabilization with chlorides	Use of ultra-fine amorphous colloidal silica to produce a high-density, high-strength rock-matching grout for instrumentation grouting	Innovative techniques in the Gabion system	Addressing cold regions issues in pavement engineering	Geology of New York Harbor - geological and geophysical methods of characterizing the stratigraphy for dredging contracts
	Session 8C	***Greg Yankey***	***Michael Mitchell***	***Brian Green***	**Session 8D** ***George Ragazzo***	***Lynette Barna***	***Ben Baker***

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Structural Engineering Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 240	**TRACK 12 Civil Works Structural**	Recent changes to Corps guidance on steel hydraulic structures	Crack repairs and instrumentation of Greenup L&D miter gate	Recent hydraulic steel structures findings in the Portland district	**TRACK 12 Civil Works Structural**	Perry Lake gate repair	Mel Price auxiliary lock gate repair	Mel Price auxiliary lock gate repair (Continued)
	Session 12A	*Joe Padula*	*Doug Kish*	*Travis Adams*	**Session 12B**	*Marvin Parks*	*Andrew Schimpf*	*Andrew Schimpf*
Room 241	**TRACK 13 Civil Works Structural**	Folsom Dam evaluation of stilling basin performance for uplift loading for historic flows	Rehabilitation of Folsom Dam stilling basin	Seismic stability evaluation of Folson Dam	**TRACK 13 Civil Works Structural**	Seismic stress analysis of Folsom Dam	Barge impact guidance for rigid lock walls, ETL 110-2-563 and probalistic barge impact analysis	Belleville barge accident
	Session 13A	*Rick Poeppelman*	*Rick Poeppelman*	*Enrique Matheu*	**Session 13B**	*Enrique Matheu*	*John Clarkson*	*John Clarkson*
Room 242	**TRACK 14 Bridges/ Buildings**	The USACE bridge management system	Standard procedures for fatigue evaluation of bridges	Fatigue and fracture assessment of Jesse Stuart Highway Bridge	**TRACK 14 Bridges/ Buildings**	Building an in-house bridge inspection program	Fatigue analysis of Summit bridge	Consolidation of Structural criteria for military construction
	Session 14A	*Phil Sauser*	*Phil Sauser*	*John Jaeger*	**Session 14B**	*Jennifer Laning*	*Jim Chu*	*Steve Sweeney*

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 240	**TRACK 12 Civil Works Structural**	Overview of John T. Myers locks improvements project	John T. Myers rehabilitation study	Ohio River Greenup Lock extension	**TRACK 12 Civil Works Structural**	McAlpine lock replacement project, project summary and status of construction	Results of Roller Compacted concrete placement at the McAlpine lock replacement project	Tennessee Valley authority Kentucky lock addition downstream middle wall monoliths
	Session 12C	*Greg Werncke*	*Greg Werncke*	*Rodney Cremeans*	**Session 12D**	*Kathleen Feger*	*Larry Dalton*	*Scott Wheeler*
Room 241	**TRACK 13 Civil Works Structural**	Portugues Dam, Ponce, Puerto Rico project update	Portugues Dam, Ponce, Puerto Rico, RCC design and testing program	Portugues Dam, Ponce, Puerto Rico, Thermal analysis of hydration and subsequent cooling of RCC	**TRACK 13 Civil Works Structural**	Miter gate anchorage design	Obermeyer gated spillway project - S381	McCook Reservoir design of high pressure steel gates
	Session 13C	*Jim Mangold*	*Jim Hinds*	*Ahmed Nisar*	**Session 13D**	*Andy Harkness*	*Michael Rannie*	*Luelseged Tekola*
Room 242	**TRACK 14 Brigdes/ Buildings**	Unified facilities criteria seismic design for buildings	Seismic requirements for architectural, mechanical and electrical components	Quality assurance for seismic resisting systems	**TRACK 14 Bridges/ Buildings**	Unified facilities criteria masonry structural design for buildings	Cathodic protection of building reinforcing steel (in Diego Garcia)	USACE Homeland security web portal
	Session 14C	*Jack Hayes*	*John Connor*	*John Connor*	**Session 14D**	*Tom Wright*	*Thomas Tehada*	*Mike Pace*

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Dam Safety Track & Construction Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 224	**TRACK 10 Dam Safety**	Tuttle Creek warning and alert systems	Lessons from the dam failure warning system exercise - Tuttle Creek	Tuttle Creek ground modification treatability program	**TRACK 10 Dam Safety**	Dam safety analysis of Cannelton Dam	John Martin Dam, CO - Dam safety structural upgrades	Vesuvius Lake Dam rehabilitation
	Session 10A	***Bill Empson***	***Bill Empson***	***Bill Empson***	**Session 10B**	***Terry Sullivan***	***George Diewald***	***Susan Peterson***
Room 225	**TRACK 11 Dam Safety**	Canton lake spillway stabilization project: IS a test anchor program NECESSARY?	Dynamic testing and numerical correlation studies for Folsom dam	Status of portfolio risk assessment	**TRACK 11 Dam Safety**	Mississinewa Dam remediation	Wolf creek seepage history	Blue dam major rehabilitation
	Session 11A	***Randy Mead***	***Ziyad Duron***	***Eric Halpin***	**Session 11B**	***Jeff Schaefer***	***Michael Zoccola***	***Michael McCray***
Room 230	**TRACK 19 Construction**	RMS Update	RMS Update (Continued)	Updated CQM for Contractors Course	**TRACK 19 Construction**	Lessons learned on major construction projects	Update on safety issues - Safety manual 385-1-1	Update on safety issues - safety manual 385-1-1 (continued)
	Session 19A	***Haskell Barker***	***Haskell Barker***	***Walt Norko***	**Session 19B**	***Jim Cox***	***Charles Ray Waits***	***Charles Ray Waits***
Room 231	**TRACK 20 Construction**	Construction methods in Russia	Construction methods in Russia (Continued)	Renovating the Pentagon using Design/Build delivery	**TRACK 20 Construction**	Completion of the Olmsted approach walls	Completion of the Olmsted approach walls (Continued)	Construction management at risk
	Session 20A	***Lance Lawton***	***Lance Lawton***	***Brian Dziekonski***	**Session 20B**	***Dale Miller***	***Dale Miller***	***Christopher Prinslow***

Break in Exhibit Hall

12 Noon **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 224	**TRACK 10 Dam Safety**	Project specific risk analysis - Success Dam	Dam safety lessons learned, Winter storm 2005, Muskingum & Scioto Basins	Dam security and Dams Government Coordinating Council	**TRACK 10 Dam Safety**	Prompton Dam hydrologic deficiency and spillway modification	"Well, that's water over the dam" - Rough River spillway adequacy design	Roller-compacted concrete for dam spillways and overtopping protection
	Session 10C	***Ronn Ross***	***Charles Barry***	***Roy Braden***	**Session 10D**	***Troy Cosgrove***	***Richard Pruitt***	***Fares Abdo***
Room 225	**TRACK 11 Dam Safety**	Clearwater Dam major rehabilitation	Success dam seismic dam safety modification	Problems on the Santa Ana River - Prado Dam	**TRACK 11 Dam Safety**	Problems on the Santa Ana River - Seven Oaks Dam	Dam safety program management tools	
	Session 11C	***Bobby Van Cleave***	***Norbert Suter***	***Douglas Chitwood***	**Session 11D**	***Robert Kwan***	***Tommy Schmidt***	
Room 230	**TRACK 19 Construction**	3D Modeling and impact on constructability	3D Modeling and impact on constructability (Continued)	Construction in Iraq & Afganistan	**TRACK 19 Construction**	Air Force streamlining Design/Build	Air Force streamlining Design/Build (Continued)	Sustainable design requirements & construction implementation
	Session 19C	***Gary Cough***	***Gary Cough***	***Walt Norko***	**Session 19D**	***Joel Hoffman***	***Joel Hoffman***	***Harry Goradia***
Room 231	**TRACK 20 Construction**	Tsunami reconstruction	Tsunami reconstruction (Continued)	Military construction transformation in support of Army transformation	**TRACK 20 Construction**	MEDCOM Construction Issues	MEDCOM Construction Issues (Continued)	*TBA*
	Session 20C	***Andy Constantaras***	***Andy Constantaras***	***Sally Parsons***	**Session 20D**	***Rick Bond***	***Rick Bond***	

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Electrical & Mechanical Engineering Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room A	**TRACK 15 Military Electrical**	Tri-Service Electrical Criteria Overview -	Tri-Service Electrical Criteria Overview - (Continued)	Tri-Service Electrical Criteria Overview -(Continued)	**TRACK 15 Military Electrical**	Interior/Exterior and security lighting criteria	Information technology systems criteria	Information technology systems criteria (Continued)
	Session 15A	***Tri-Service Panel***	***Tri-Service Panel***	***Tri-Service Panel***	**Session 15B**	***Tri-Service Panel***	***Tri-Service Panel***	***Tri-Service Panel***
Room B	**TRACK 16 Military Mechanical**	Building Commissioning	HVAC Commissioning	Ventilation and indoor air quality	**TRACK 16 Military Mechanical**	Ventilation and indoor air quality (Continued)	Refrigerant implications for HVAC specifications, selection, and o&m - now and future	Refrigerant implications for HVAC specifications, selection, and o&m - now and future (Continued)
	Session 16A	***Dale Herron***	***Dale Herron***	***Davor Novosel***	**Session 16B**	***Davor Novosel***	***Mike Thompson***	***Mike Thompson***
Room D	**TRACK 17 Military Mechanical / Electrical**	Sustainable design update			**TRACK 17 Military Mechanical / Electrical**	Utility systems security and fort future	Acoustic leak detection for utilities distribution systems	Acoustic leak detection for utilities distribution systems (Continued)
	Session 17A	***Harry Goradia***			**Session 17B**	***Vicki L. Van Blaricum***	***Sean Morefield***	***Sean Morefield***
Room E	**TRACK 18 Civil Mechanical**	Emsworth Dam vertical lift gate hoist replacement	Hydraulic drive for Braddock Dam	John Day navigation lock upstream lift gate wire rope failure	**TRACK 18 Civil Mechanical**	Overhead bulkhead at Olmstead Lock	Replacement of gate # 5 intermediate gear and pinion at RC Byrd Lock and Dam	Mechanical design issues during construction of McAlpine Lock
	Session 18A	***John Nites***	***Janine Krempa***	***Ronald Wridge***	**Session 18B**	***Rick Schultz***	***Brenden McKinley***	***Richard Nichols***

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM	5:00 PM
Room A	**TRACK 15 Military Electrical**	Mass notification system	Mass notification system (Continued)	Electronic card access locks	**TRACK 15 Military Electrical**	Lightning protection standards	Lightning and surge protection	Lightning and surge protection (Continued)
	Session 15C	***Tri-Service Panel***	***Tri-Service Panel***	***Fred Crum***	**Session 15D**	***Richard Bouchard***	***Tri-Service Panel***	***Tri-Service Panel***
Room B	**TRACK 16 Military Mechanical**	Basic design considerations for geothermal heat pump systems	Basic design considerations for geothermal heat pump systems (Continued)	Pentagon renovation	**TRACK 16 Military Electrical**	Effective use of evaporative cooling for industrial and institutional/office facilities	Efective use of evaporative cooling for industrial and institutional/office facilities (Continued)	Non-hazardous chemical treatments for heating and cooling systems
	Session 16C	***Gary Phetteplace***	***Gary Phetteplace***	***Mitch Duke***	**Session 16D**	***Leon Shapiro***	***Leon Shapiro***	***Vincent Hock***
Room D	**TRACK 17 Civil Mechanical / Electrical**	Hydropower asset management partnership (hydroAMP)	New gas fueled/diesel fueled turbine powered electrical generating station in Iraq	The construction of distribution tunnels and pump installation for the metropolitan Chicago sewer systems	**TRACK 17 Civil Mechanical / Electrical**	The Festus/Crystal City levee and pump station project	Remote operations for Kaskaskia Dam	Technological advances in lock control systems
	Session 17C	***Lori Rux***	***Lester Lowe***	***Ernesto Go***	**Session 17D**	***Stephen Farkas***	***Shane Nieukirk***	***Andy Schimpf***
Room E	**TRACK 18 Civil Mechanical**	New coating products for civil works structures	New guide specification for procurement of turbine oils	Synchronous condensing with large Kaplan turbine - A case study	**TRACK 18 Civil Mechanical**	Acquifer storage and recovery (ASR) system	Wastewater infrastructure improvements in Appalachia	Storm water pumps
	Session 18C	***Al Beitelman***	***John Micetic***	***Brian Moentenich***	**Session 18D**	***Gerald Deloach***	***James Sadler***	***Thomas Jamieson***

Break in Exhibit Hall

Thursday, August 4, 2005 Concurrent Sessions

HH&C Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 220	**TRACK 1 Sedimentation & New Concepts** Session 1E	Ice jams, contaminated sediment and structures Clark Fork River, MT — *Andrew Tuthill*	Increased bed erosion due to ice — *John Hains*	Monitoring the Mississippi River using GPS coordinated video — *James Gutshall*	**TRACK 1 Sedimentation, Case Examples** Session 1F	Watershed approach to stream stability the reduction of nutrients — *John B. Smith*	Monitoring the effects of sedimentation from Mount St. Helen — *Alan Donner*	Navigation and environmental interests in alleviating repetitive dredging — *Jason Brown*
Room 221	**TRACK 2 Water Management** Session 2E	Enhancements and new capabilities of HEC-ResSim 3.0 — *Fauwaz Hanbali*	Transition to Oracle based data system — *Joel Asunskis*	Accessing real time Mississippi Valley water level data — *Rich Engstrom*	**TRACK 2 Water Management** Session 2F	Hurricane Season 2004 — *Susan Sylvester*	Reevaluation of a project's flood control benefits — *Ferris Chamberlin*	Helmand Valley water management plan — *Jason Needham*
Room 222	**TRACK 3 Case Studies** Session 2E	Red River of the north flood protection project — *Michael Lesher*	Southeast Arkansas flood control & water supply feasibility study — *Thomas Brown*	McCook and Thorton tunnel and reservoir modeling — *David Kiel*	**TRACK 3 Case Studies** Session 3F	Ala Wai Canal Project, Honolulu, Oahu, Hawaii — *Lynnette Schapers*	Missouri River geospatial decision support framework — *Brian Baker*	Systemic analysis of the Mississippi & Illinois Rivers — *Dennis Stephens*
Room 223	**TRACK 4 Modeling** Session 4E	Hydrologic models supported by ERDC — *Robert Wallace*	HEC-HMS Version 3.0 new features — *Jeff Harris*	SEEP2D & GMS: Simple tools for solving a variety of seepage problems — *Clarissa Hansen*	**TRACK 4 Modeling** Session 4F	Water quality and sediment transport in HEC-RAS — *Mark Jensen*	Advances to the GSSHA program — *Aaron Byrd*	Software integration for watershed studies HEC-WAT — *Chris Dunn*

Break in Exhibit Hall

12 Noon — **Lunch**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 220	**TRACK 1 Water Quality Management** Session 1G	San Francisco Bay Mercury TMDL-Implications for constructed wetlands — *Herb Fredrickson*	Abandoned mine land: Eastern and Western perspectives — *Kate White*	A lake tap for temperature control tower construction at Cougar Dam — *Steve Schlenker*	**TRACK 1 Watershed Management** Session 1H	Demonstrating innovative river restoration technologies: Truckee River, NV — *Chris Dunn*	Comprehensive watershed restoration in the Buffalo district — *Anthony Friona*	Translating the hydrologic tower of Babel — *Dan Crawford*
Room 221	**TRACK 2 Water Management** Session 2G	Developing reservoir operation plans to manage erosion — *Patrick O'Brien*	New approaches to water management decision making — *James Barton*	Improved water supply forecasts for Kooteny basin using principal components regression — *Randal Wortman*	**TRACK 2 Water Management** Session 2H	Prescriptive reservoir modeling and ROPE study — *Jason Needham*	Missouri River mainstem operations — *Larry Murphy*	Res-Sim model for the Columbia River — *Arun Mylvahanan*
Room 222	**TRACK 3 Section 227** Session 3G	Section 227 Workshop/ Program Review — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*	**TRACK 3 Section 227** Session 3H	Section 227 Workshop/ Program Review — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*
Room 223	**TRACK 4 Modeling** Session 4G	Little Calumet River unsteady flow model conversion — *Rick Ackerson*	Kansas City River basin model — *Edward Parker*	Design guidance for breakup ice control — *Andrew Tuthill*	**TRACK 4 Modeling** Session 4H	Forebay flow simulations using Navier-Stokes code — *Charlie Berger*	Use of regularizatino as a method for watershed model calibration — *Brian Skahill*	Demonstration program in the arid southwest — *Margaret Jonas*

Break

Thursday, August 4, 2005 Concurrent Sessions

Geotechnical Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 226	**TRACK 5**	Dynamic deformation analyses Dewey Dam Huntintong District Corps of Engineers	Seismic stability evaluation for Ute Dam, NM	An overview of criteria used by various organizations for assessments and seismic remediation of earth dams	**TRACK 5**	USACE seepage berm design criteria and district practices	Ground penetrating radar applications for the assessment of airfield pavements	Challenges of the Fernando Belaunde Terry road upgrade Campanillia to Pizana - Peru road project
	Session 5E	***Greg Yankey***	***John France***	***Sean Carter***	**Session 5F**	***George Sills***	***Lulu Edwards***	***Michael Wielputz***
Room 227	**TRACK 6**	Small geotechnical project, big stability problem - The Block Church Road experience	Geophysical investigation of foundation conditions beneath Folsom Dam	Bioengineering slope stabilization techniques coupled with traditional engineering applications - The result a stable slope	**TRACK 6**	Shoreline armor stone quality issues	Mill Creek - An urban flood control challenge	Next stop, The Twilight Zone
	Session 6E	***Jonathan Kolber***	***Jose Llopis***	***Bethany Bearmore***	**Session 6F**	***Joseph Kissane***	***Monica Greenwell***	***Troy O'Neal***
Room 228	**TRACK 7**	The geotechnical and structural issues impacting the Dalles spillway construction	The Dalles spillway engineering and design	The future of the discrete element method in infrastructure analysis	**TRACK 7**	Evaluating the portable falling weight deflectometer as a low-cost technique for posting seasonal load restrictions on low volume payments	Soil structure interaction effects in the seismic evaluation of success dam control tower	Olmsted locks and Dam project geotechnical/construction issues
	Session 7E	***Kristie Hartfeil***	***Kristie Hartfeil***	***Raju Kala***	**Session 7F**	***Maureen Kestler***	***Michael Sharp***	***Jeff Schaefer***
Room 229	**TRACK 8**	Rubblization of airfield concrete pavement	US Army airfield pavement assessment program	Critical state for probabilistic analysis of levee underseepage	**TRACK 8**	Curing practices for modern concrete construction	AAR at Carters Dam, a different approach	Concrete damage at Carters Dam, GA
	Session 8E	***Eileen Velez-Vega***	***Haley Parsons***	***Douglas Crum***	**Session 8F**	***Toy Poole***	***James Sanders***	***Toy Poole***

Break in Exhibit Hall

12 Noon — **Lunch**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 226	**TRACK 5**	Slope stability evaluation of the Baldhill Dam right abutment	Lateral pile load test results within a soft cohesive foundation	Design and construction of anchored bulheads for river diversion, Seabrook, NH	**TRACK 5**	Characterization of soft marine clays - A case study at Craney Island	50 years of NRSC experience with engineering problems caused by dispersive clays	Changes in the post-tensioning institutes new (4th Ed. 2004) "Recommendations for prestressed rock and soil anchors"
	Session 5G	***Neil Schwanz***	***Richard Varuso***	***Siamac Vaghar***	**Session 5H**	***Aaron Zdinak***	***Danny McCook***	***Michael McCray***
Room 227	**TRACK 6**	Perils in back analysis failures	Reconstruction of deteriorated lock walls concrete after blasting and other demolition removal techniques	Flood fighting structures demonstrations and evaluation program	**TRACK 6**	Innovative design concepts incorporated into a landfill closure and reuse design	Laboratory testing of flood fighting structures	Bluff stabilization along Lake Michigan using active and passive dewatering techniques
	Session 6G	***Greg Yankey***	***Steve O'Connor***	***George Sills***	**Session 6H**	***Dave Ray***	***Johannes Wibowo***	***Eileen Glynn***
Room 228	**TRACK 7**	Geotechnical instrumentation and foundation re-evaluation of John Day lock and Dam, Columbia River, Oregon-Washington	A study of the long term performance of seepage cutoff barriers in dams	Design, construction, and performance of seepage barriers for Guanella Dam, near Empire, CO	**TRACK 7**	Sensitive infrastructure sites and structures - Sonic drilling offers quality control and non-destructive advantages to geotechnical construction drilling	Subgrade failure criteria according to soil type and moisture condition	The automated stability monitoring of the Mississippi River levees using the range scan system
	Session 7G	***David Scofield***	***John Rice***	***John France***	**Session 7H**	***John Davis***	***Edel Cortez***	***Robert Jolissian***
Room 229	**TRACK 8**	Damaging interactions among concrete materials	Economic effects on construction of uncertainty in test methods	Major issues in materials specifications	**TRACK 8**	Spall and intermediate-sized repairs for PCC pavements	Acceptance criteria for unbonded aggregate road surfacing materials	Effective partnering to overcome an interruption in the supply of Portland cement during construction of Marmet lock and Dam
	Session 8G	***Toy Poole***	***Toy Poole***	***Toy Poole***	**Session 8H**	***Reed Freeman***	***Reed Freeman***	***Billy Neeley***

Break

Thursday, August 4, 2005 Concurrent Sessions

Geotechnical, Specifications, Electrical & Mechanical Engineering & Construction Tracks

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 225	**TRACK 9 Geotechnical**	Seepage Committee Meeting	Seepage Committee Meeting (Continued)	Seepage Committee Meeting (Continued)			
	Session 9E	***GROUP DISCUSSION***	***GROUP DISCUSSION***	***GROUP DISCUSSION***			
Room 232	**TRACK 21 Specifications**	SpecsIntact-Demonstration of the SI explorer, publishing to PDF and Word	SpecsIntact - Demonstration of the SI editor, UMRL and reference wizard	UFGS status and direction			
	Session 21E	***Patricia Robinson***	***Patricia Robinson***	***Jim Quinn***			
Room A	**TRACK 15 Military Electrical**	Electronic Security	Electronic Security (Continued)	AIRFIELD lightning protection & grounding and lighting			
	Session 15E	***Tri-Service Panel***	***Tri-Service Panel***	***Tri-Service Panel***			
Room B	**TRACK 16 Military Mechanical**	Lon works technology update	BACnet Technology Update	Implementation of Lon-based specifications			
	Session 16E	***David Schwenk***	***David Schwenk***	***Will White***			
Room D	**TRACK 17 Civil Mechanical**	Lessons learned on flood water pump stations	Armada of pump stations, Grand Forks and East Grand Forks	Various screen equipment selection guide			
	Session 17E	***Mark Robertson***	***Timothy Paulus***	***Sara Benier***			
Room 230	**TRACK 19 Construction**	NAVFAC Construction scheduling	NAVFAC Construction scheduling (Continued)	ACASS/CASS - CPARS			
	Session 19E	***Glenn Saito***	***Glenn Saito***	***Ed Marceau***			
Room 231	**TRACK 20 Construction**	Update on DAWIA and Facilities Engineering	Update on DAWIA and Facilities Engineering (Continued)	Partnering as a best practice			
	Session 20E	***Mark Grammer***	***Mark Grammer***	***Ray DuPont***			
				Break in Exhibit Hall			
Room 225					**TRACK 9 Geotechnical**	GMCoP Forum	GMCoP Forum (Continued)	GMCoP Forum (Continued)
					Session 9F	***GROUP DISCUSSION***	***GROUP DISCUSSION***	***GROUP DISCUSSION***
Room 232					**TRACK 21 Specifications**	UFGS transitin to Master-Format 2004	Project specifications for the upper tier Folsom outlet works modifications	UFGS dredging
					Session 21F	***Carl Kersten***	***Steve Freitas***	***Don Carmen***
Room A					**TRACK 15 Military Electrical**	Electrical safety and arc flash UFC	Electrical safety and arc flash UFC (Continued)	Electrical infrastructure in Iraq - Restore Iraqi electricity
					Session 15F	***Tri-Service Panel***	***Tri-Service Panel***	***Joseph Swiniarski***
Room B					**TRACK 16 Military Mechanical**	Prefabricated Chiller Plants	Seismic for ME systems	Design considerations for the prevention of mold
					Session 16F	***Trey Austin***	***Greg Stutts***	***Quinn Hart***
Room D					**TRACK 17 Civil Mechanical**	Lock gate replacement system	Lock gate replacement system (Continued)	Automated closure gate design for Duck creek flood control
					Session 17F	***Will Smith***	***Will Smith***	***Mark Robertson***
Room 230					**TRACK 19 Construction**	Self-consolidating concrete	Self-consolidating concrete (Continued)	
					Session 19F	***Beatrix Kerhoff***	***Beatrix Kerhoff***	
Room 231					**TRACK 20 Construction**	S&A Update	Construction Issues Open Forum (Q&A)	Construction Issues Open Forum (Q&A) (Continued)
					Session 20F	***Harry Jones***	***Don Basham***	***Don Basham***

12 Noon — **Lunch**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 225	**TRACK 9 Geotechnical**	Seismic Manual	Seismic Manual (Continued)	Seismic Manual (Continued)			
	Session 9G	***GROUP DISCUSSION***	***GROUP DISCUSSION***	***GROUP DISCUSSION***			

Thursday, August 4, 2005 Concurrent Sessions

Dam Safety Track & Structural Engineering Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 224	**TRACK 10** Dam Safety	Seepage and stability, final evaluation for reservoir pool raising project, Terminus Dam, Kaweah River, CA	Initial filling plan, Terminus dam spillway enlargement, Terminus Dam, Kaweah River, CA	Hydrologic aspects of operating in a "failure mode" - Fern Ridge Lake, OR			
	Session 10E	*Michael Ramsbotham*	*Michael Ramsbotham*	*Bruce Duffe*			
Room 240	**TRACK 12** Civil Works Structural	London lock and dam, West Virginia major rehabilitation project	Replacing existing lock 4-Innovative designs for Charleroi lock	Use of non-linear incremental structural analysis in the design of the Charleroi lock			
	Session 12E	*David Sullivan*	*Steveb Stoltz*	*Randy James*			
Room 241	**TRACK 13** Civil Works Structural	Chicago shoreline project	Structural assessment of Bluestone Dam	Duck Creek, OH local flood protection projection phase III Culvert damage			
	Session 13E	*Jan Plachta*	*Robert Reed*	*Jeremy Nichols*			
Room 242	**TRACK 14** Bridges/ Buildings	Urban search & rescue program overview	Evaluation and repair of blast damaged reinforced concrete beams	Single degree of freedom blast effects spreadsheets			
	Session 14E	*Tom Niedernhofer*	*John Hudson*	*Dale Nebuda*			
				Break in Exhibit Hall			
Room 224	**TRACK 10** Dam Safety				A dam safety study involving cascading dam failures		The relationship of seismic velocity to the erodibility index
	Session 10F				*Gordon Lance*		*Joseph Topi*
Room 240	**TRACK 12** Civil Works Structural				Olmsted dam in-the-wet construction methods	Completion of the Olmstead approach walls	John Day lock monolith repair
	Session 12F				*Lynn Raque*	*Terry Sullivan*	*Mathew Hanson*
Room 241	**TRACK 13** Civil Works Structural				Development of design criteria for the Rio Puerto Nuevo contract 2D/2E channel wall	Design of concrete lined tunnels in rock	Indianapolis north phase IIIA project
	Session 13F				*Jana Tanner*	*David Force*	*Gene Hoard*
Room 242	**TRACK 14** Bridges/ Buildings				UFC 4-023-02 Structural design to resist explosive effects for existing buildings	Progressive collapse UFC requirements	U.S. general services admnistrative progressive collapse design guidelines applied to concrete moment-resisting frame buildings
	Session 14F				*Jim Caulder*	*Brian Crowder*	*David Billow*

12 Noon — **Lunch**

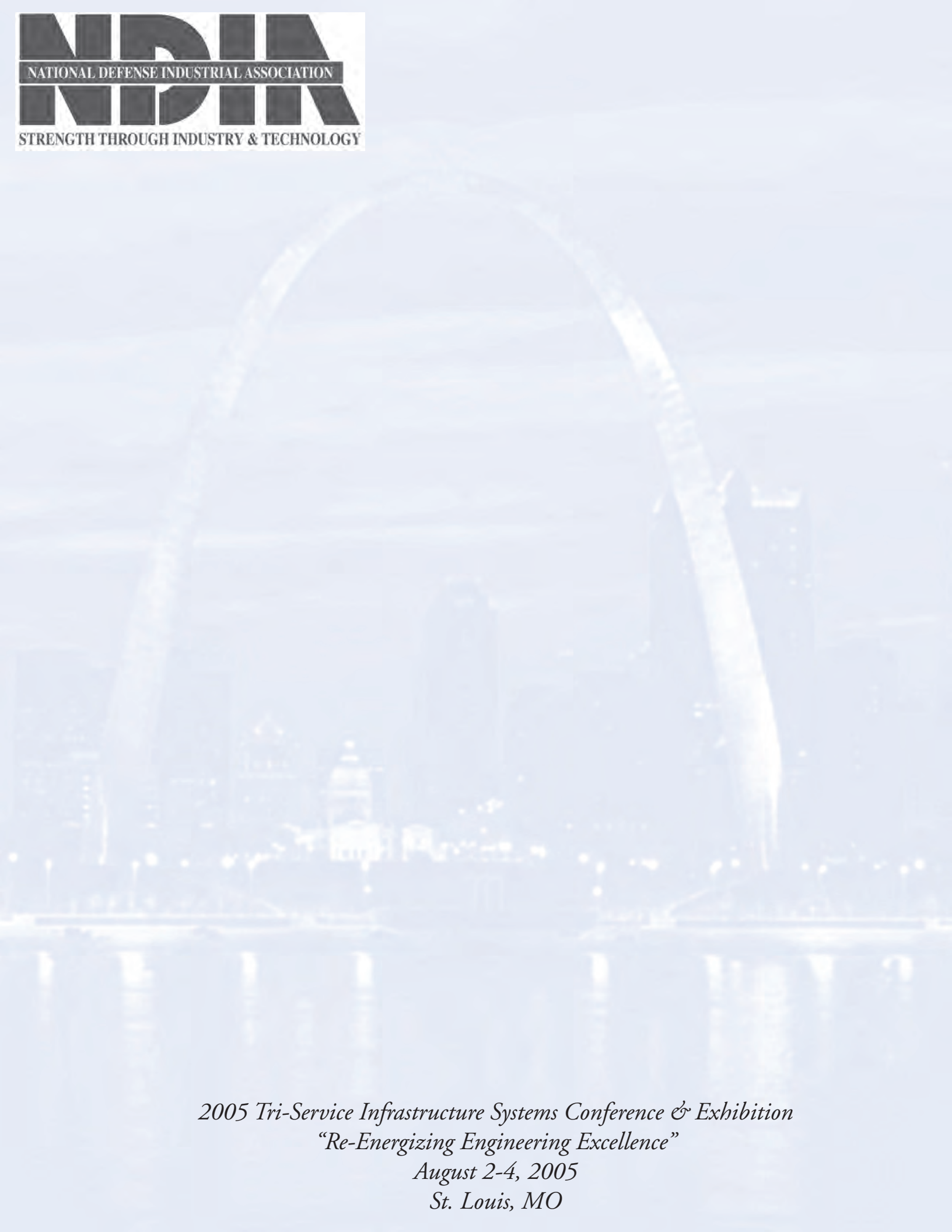
	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 224	**TRACK 10** Dam Safety	Dam safety instrumentation data management utilizing WinIDP to aid data collection and evaluation	Automated instrumentation assessments at Marmet lock & Dam	Potential failure mode analysis of Eau Galle Dam			
	Session 10G	*Travis Tutka*	*Ronald Rakes*	*David Rydeen*			
Room 240	**TRACK 12** Civil Works Structural	Inner Harbor navigation canal and lock structure	Design features and challenges of the Comite River diversion project	Waterline support failure on the Harvey canal: A case study			
	Session 12G	*Mark Gonski*	*Christopher Dunn*	*Angela DeSoto Duncan*			
				Break			
Room 224	**TRACK 10** Dam Safety				Dam safety officers panel - The Good	Dam safety officers panel - The Bad	Dam safety officers panel - The Ugly
	Session 10H				*Bruce Murray*	*Bruce Murray*	*Bruce Murray*
Room 240	**TRACK 12** Civil Works Structural				Public appeal of major civil projects- The good, the bad and the ugly	Des Moines Riverwalk	Chickamauga lock and Dam height optimization study using Monte Carlo simulation
	Session 12H				*Kevin Holden*	*Thomas Heinold*	*Leon Schieber*

Thursday, August 4, 2005 Concurrent Workshops

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 241	**Workshop 1** DoD Security Engineering	Security planning & minimum standards	Security planning & minimum standards (Continued)	Security planning & minimum standards (Continued)	Security design manuals	Security design manuals (Continued)	Security design manuals (Continued)
	Session 1A	*Curt Betts*	*Curt Betts*	*Curt Betts*	**Session 1B**	*Bernie Deneke*	*Bernie Deneke*	*Bernie Deneke*
Room 231	**Workshop 2** Electrical Workshop	National Electrical Code 2005 Changes	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)
	Session 2A	*Mark McNamara*	*Mark McNamara*	*Mark McNamara*	**Session 2B**	*Mark McNamara*	*Mark McNamara*	*Mark McNamara*
Room 242	**Workshop 3** Mechanical Engineering	Design and application of packaged central cooling plants	Design and application of packaged central cooling plants (Continued)	Design and application of packaged central cooling plants (Continued)	Improving dehumidification in HVAC systems	Improving dehumidification in HVAC systems (Continued)	Improving dehumidification in HVAC systems (Continued)
	Session 3A	*The Trane Company*	*The Trane Company*	*The Trane Company*	**Session 3B**	*The Trane Company*	*The Trane Company*	*The Trane Company*
Room 230	**Workshop 4** Construction	Construction Community of Practice Forum	Construction Community of Practice Forum (Continued)	Construction Community of Practice Forum (Continued)			
	Session 4A	*Walt Norko*	*Walt Norko*	*Walt Norko*			
Room 232	**Workshop 5** Specifications	Open Meeting of Corps Specifications Steering Committee	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)
	Session 5A	*Robert Iseli, et al.*	*Robert Iseli, et al.*	*Robert Iseli, et al.*	**Session 5B**	*Robert Iseli, et al.*	*Robert Iseli, et al.*	*Robert Iseli, et al.*

Break

NOTES



2005 Tri-Service Infrastructure Systems Conference & Exhibition
"Re-Energizing Engineering Excellence"
August 2-4, 2005
St. Louis, MO

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2005 Tri-Service Infrastructure Systems Conference
"Re-energizing Engineering Excellence"

BIOENGINEERING SLOPE STABILIZATION TECHNIQUES COUPLED WITH TRADITIONAL ENGINEERING APPLICATIONS –

THE RESULT IS A STABLE SLOPE

Waterbury Dam Mitigation

Thursday August 4th, 2005

St. Louis, Missouri

Presented By: Ms. Bethany Bearmore

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Waterbury Dam Mitigation

The objective of the project is to improve the water quality in the Waterbury Reservoir and Little River by implementing shoreline stabilization measures that reduce the sediment yield.





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Waterbury Dam Mitigation
Vicinity Map

Background Information:

1. Winooski River Basin ~ 1,200.0 mi^2
2. Little River above Dam = 109.0 mi^2.
3. Built by Civilian Construction Corps
4. Operational in 1938
4. State of Vermont Owns & Operates

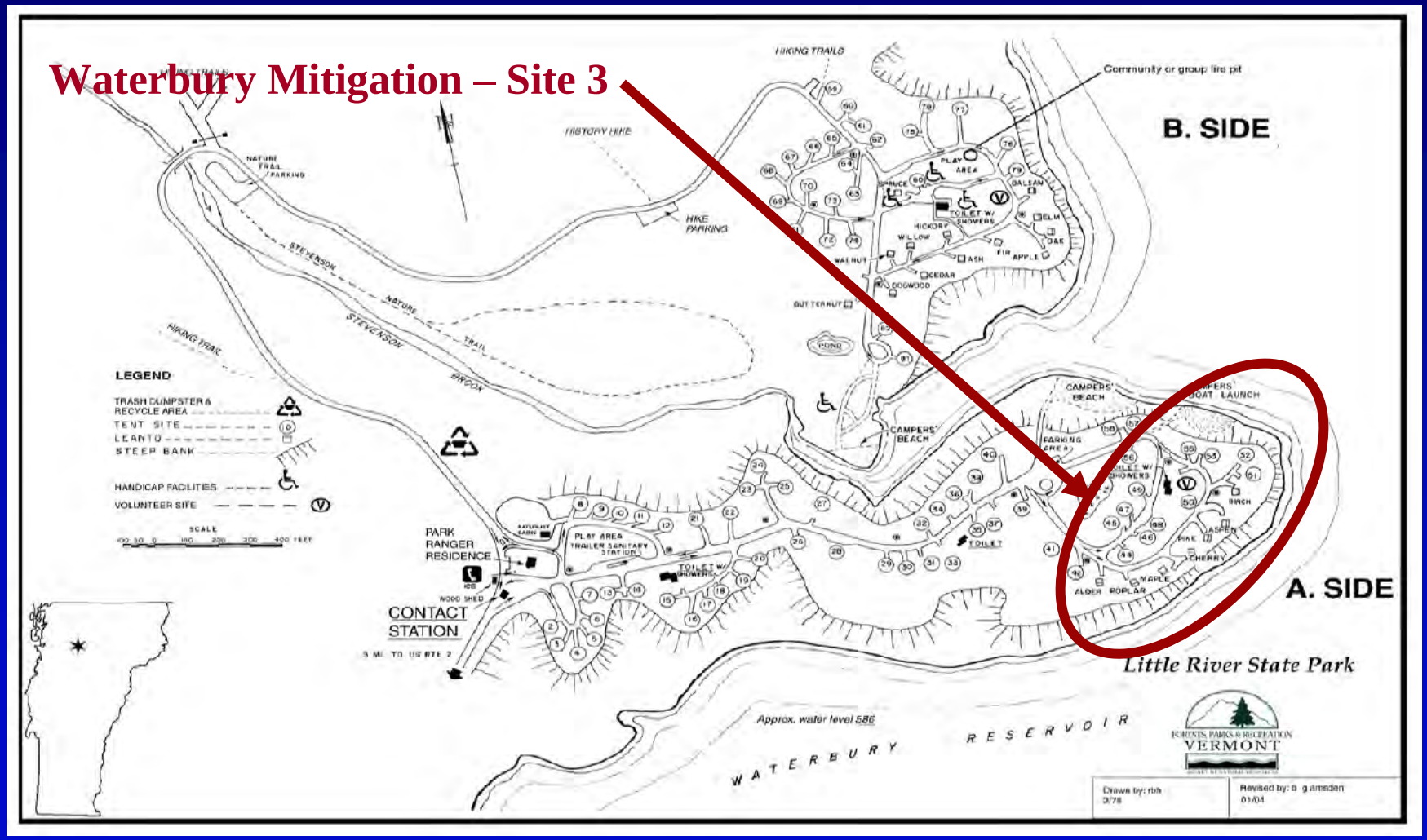
General Location





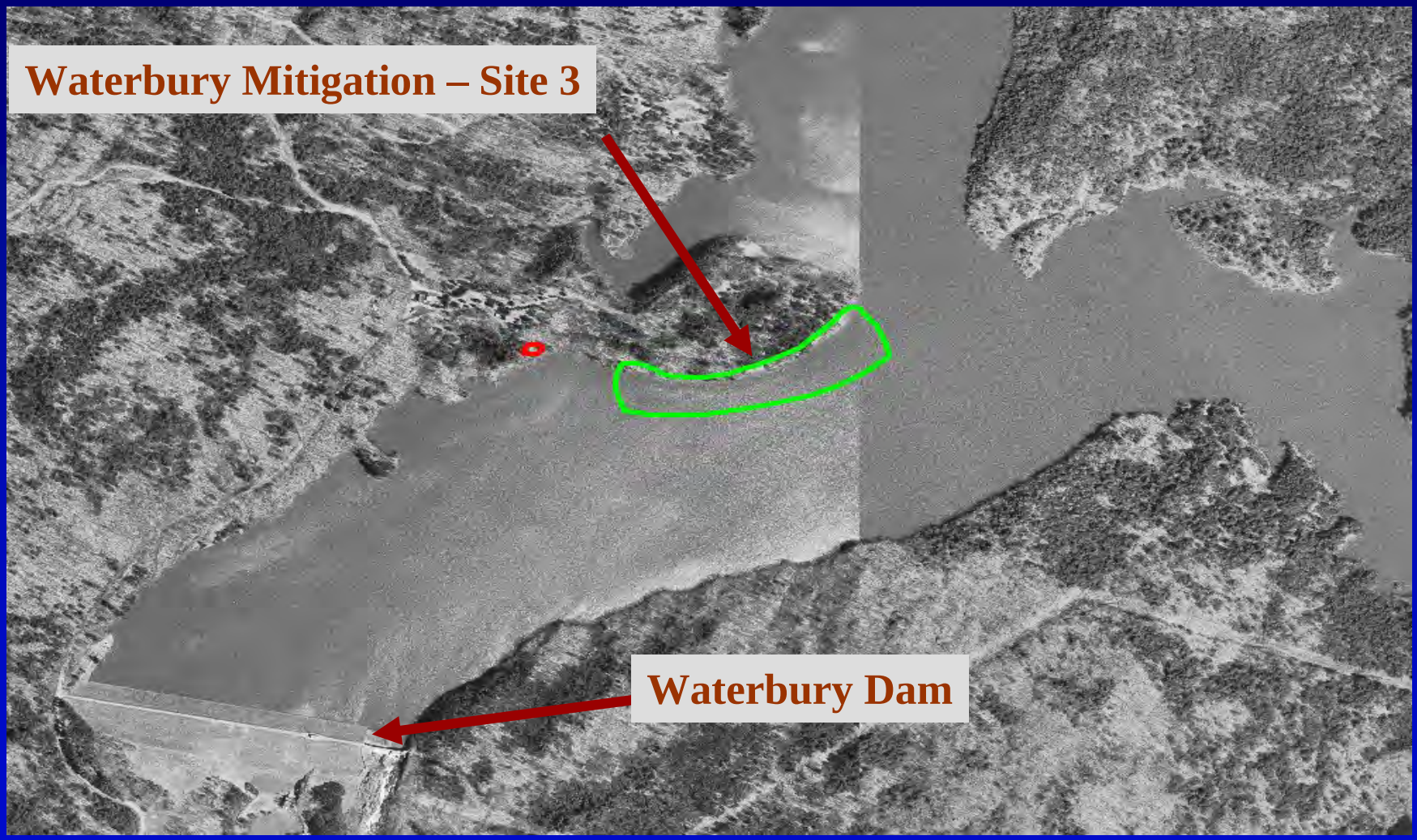
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Waterbury Dam Mitigation Location Map



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Waterbury Dam Mitigation Location Map



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Waterbury Dam Mitigation Construction History

- Original Construction (April 1935 - October 1938)
  - Built in response to 1927 Flood event
  - Project constructed by Civilian Conservation Corps; designed by Corps of Engineers
- Later Modifications to Dam with COE Involvement
  - 1957 Modification.
    - Embankment was raised 3 feet.
    - Added Third Tainter Gate.
  - 1985 Seepage Remediation.
    - Corrected terrace seepage.
    - Discovered and remediated gorge seepage.
  - 2002 Seepage Remediation.
    - Repair of conduit through dam
    - Lowering of Pool to Elevation 520, which resulted in slope instability along reservoir
    - Placement of Secant Piles

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Waterbury Dam Mitigation
Why Stabilization is Needed

- Slope erosion
  - Seepage forces generated from water level drawdown
  - Wind and wave energy from reservoir
  - Overland flow
  - Loss of soil tensile strength
    - Water quality
      - Increased turbidity down stream of the dam
    - Loss of habitat
      - Loss of vegetation due to bank failure
    - Potential loss of state park area

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Waterbury Dam Mitigation
What is Bioengineering?

Bioengineering is a technical term used to describe a variety of techniques that use dormant cuttings from woody plants to alleviate erosion. Cuttings are taken from species that root easily, such as willow and dogwood, then planted in a specific arrangement depending upon the technique. The beauty of these techniques is that they alleviate erosion, improve water quality, enhance wildlife habitat and look more natural than a pile of rock filled wire baskets or other such structures.*

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Waterbury Dam Mitigation
Why Use Bioengineering?

- Provides a more aesthetically pleasing site
- Allows the reintroduction of native plants species
- Encourages a more responsive approach to adaptive management
- Allows for a more rapid return to a “natural” setting
- Fosters the interaction of the biologist and engineer to produce a better project
- Reduce seepage forces and surface erosion
- Increase soil tensile strength
- Water quality improvement

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Waterbury Dam Mitigation
Existing Site



Location of campsite



Location of fire pit

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Waterbury Dam Mitigation
Existing Site



Summer water level of
reservoir 589.5’

Current water level of
reservoir 550’



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Waterbury Dam Mitigation
Existing Site



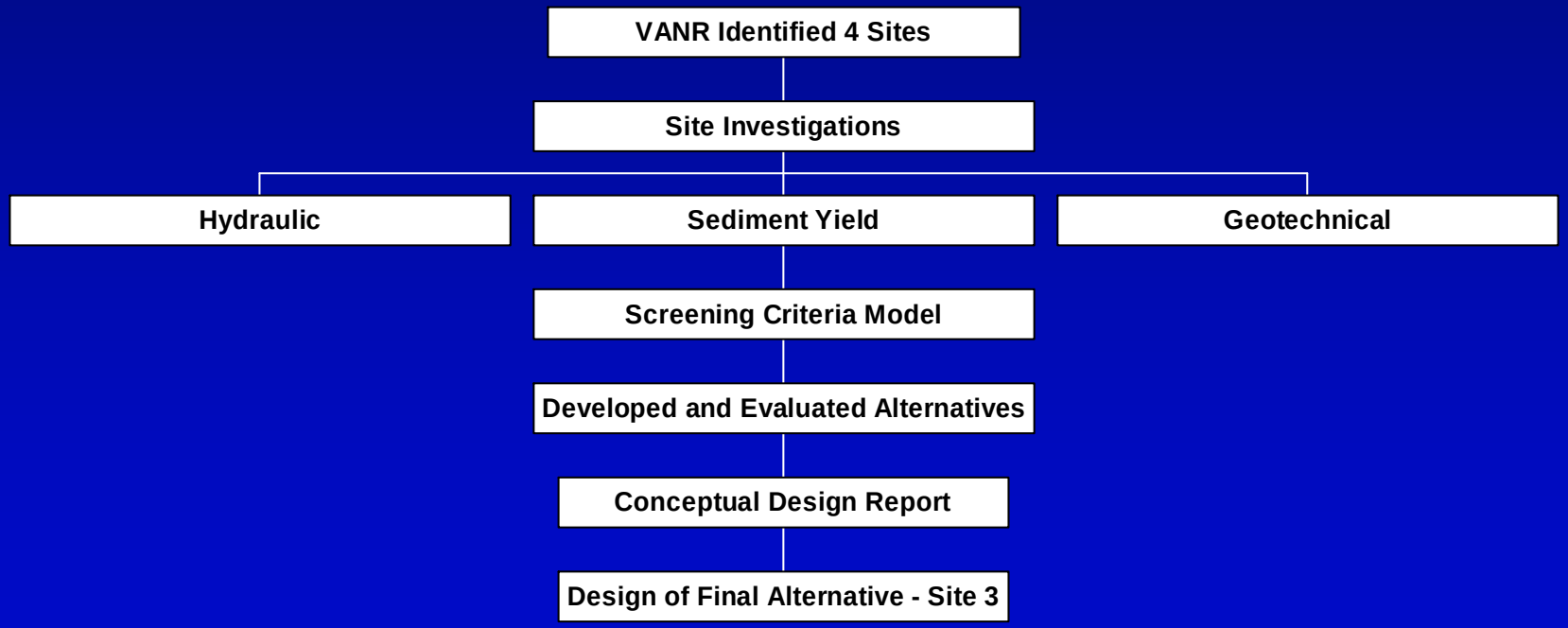
Current Angle of Slope – 23° to 47°
Max stable slope - 41°
Colton gravelly, loamy sand



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Waterbury Dam Mitigation
Conceptual process

Conceptual Process



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Waterbury Dam Mitigation
Design of Final Alternative

- Three Components to the final design
  - Toe Protection
  - Transition Zone
  - Upland Slope

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Waterbury Dam Mitigation
Toe Protection

- Traditional Engineering Application
  - Wind Waves
    - USACE EM 1110-2-1414, Water Levels and Wave Heights for Coastal Engineering Design
    - Assumed waves would not be greater than 5 ft
    - Largest fetch at site is 3,360 ft

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Waterbury Dam Mitigation
Toe Protection

- Traditional Engineering Application
  - Vessel Waves
    - 3 recommended equations from the Interim Report for the Upper Mississippi River – Illinois Waterway System Navigation Study, ENV Report 4, December 1997
      - Used to determine vessel generated waves in deeper water
      - Sorrenson and Weggel 1984, Sorrenson and Weggel 1986 and PIANC 1987
    - PIANC was used to calculate vessel wave heights
    - The dispersion equation was used to determine the shallow water wave height

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Waterbury Dam Mitigation
Toe Protection

- Traditional Engineering Application
  - Quarry Stone
    - Stone from surrounding area
    - EM 1110-2-1614 – Revetment Design and the CEDAS version 2.01G Software (USACE WES, 2003)
    - Stone matches the natural rock outcrops that currently exist around the reservoir
    - Armor layer will extend 4 ft above maintained water surface to account for run-up
    - Armor layer will extend 5 ft below water surface to account for scour
  - Large woody debris from site will be used

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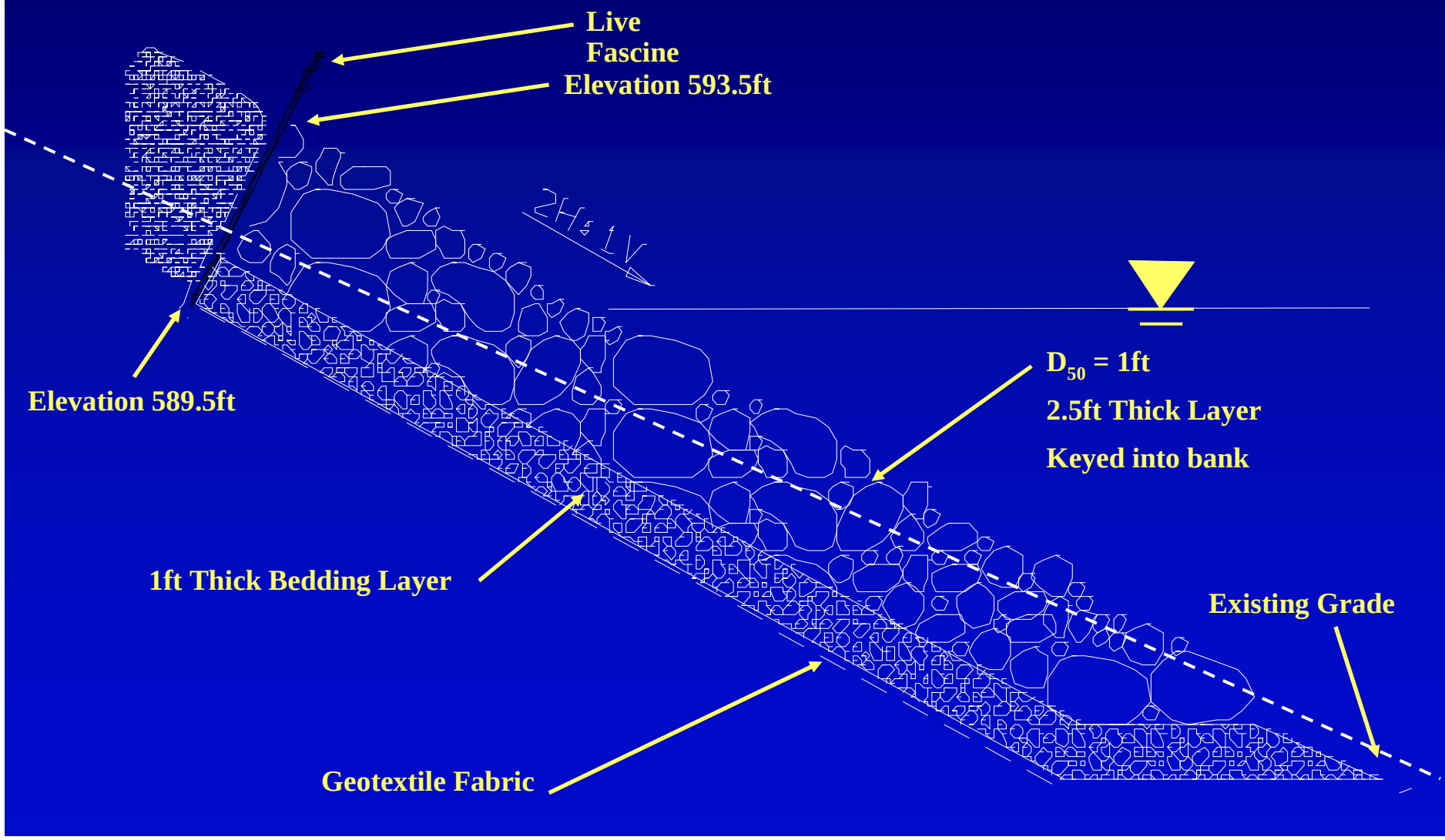
Waterbury Dam Mitigation
Toe Protection

- Revetment Design Input Parameters

Design Vessel Dimensions	8 ft wide, 20 ft long, 2 ft draft
Vessel Speed, Depth, Distance to Shore	10 knots, 30 ft depth, 50 ft from shore
Wave Height – Deep Water	3.0 ft
Wave Height at Toe of Revetment	3.72 ft
Wave Period	2.7 SECONDS
Unit Weight of Rock	170 lb/ft^3
Revetment Slope	1Vertical: 2Horizontal
Permeability Coefficient	0.1
Damage Level	2 (minimum)
Armor Layer Median Stone Size	206 lbs (1.07 ft)
Armor Layer Thickness	2.5 ft
Filter Layer Median Stone Size	0.38 lbs (0.13 ft)
Filter Layer Thickness	1 ft
Armor Layer Location	593.5 to 584.5 ft at 2.5 ft thickness
Bedding Layer Location	589.5 to 583.5 at 1.0 ft thickness
Linear Ft of Shoreline to be Armored	723 ft

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Waterbury Dam Mitigation
Toe Protection



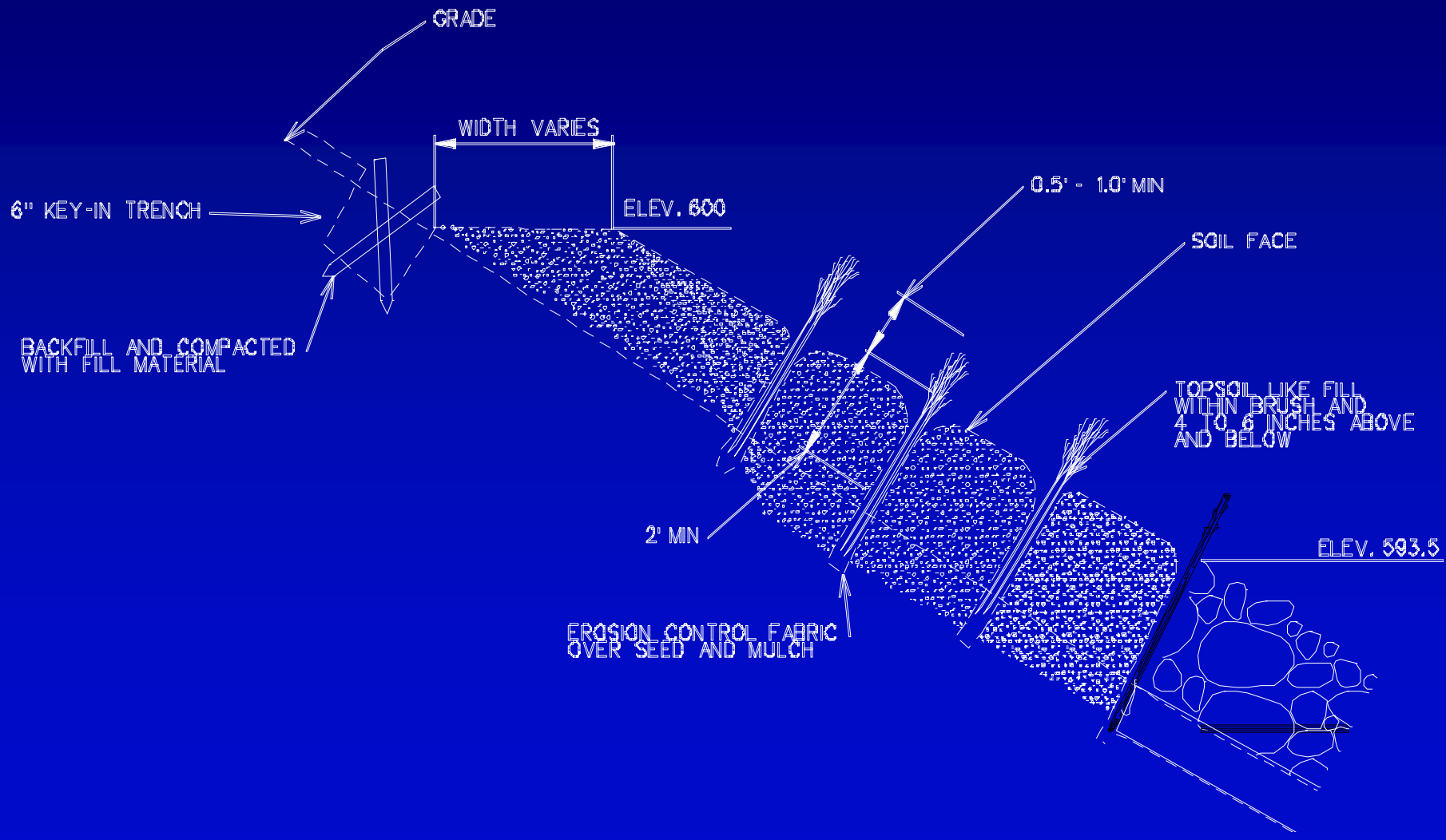
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Waterbury Dam Mitigation Transition Zone

- Bioengineering Application
  - Vegetated Geo-grid
    - Live cut branches interspaced between layers of soil
    - Stabilize slope and provide surface erosion protection
    - Retards runoff velocity and filters sediment out of the slope runoff
    - Brush layering – Red-osier Dogwood, Silky Dogwood, Pussy Willow and Purple Osier Willow
    - Vegetated soil lifts, after established should be able to withstand run-up form vessel waves
    - Material generally ranges ½” – 2” in diameter and 3 – 7 ft in length

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Waterbury Dam Mitigation
Transition Zone



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Waterbury Dam Mitigation
Upland Slope Stabilization

- Bioengineering Application
  - Cutting back the slope
    - Maximum slope angle of 41 degrees
  - Branches
    - Woody, root able plant cutting inserted into ground
    - Alternate leaved Dogwood and Purple Osier Willow
    - Branches are usually ½ to 2 inches in diameter and 2 to 3 feet in length
    - Extract excess soil moisture which reduces the soil pore water pressure

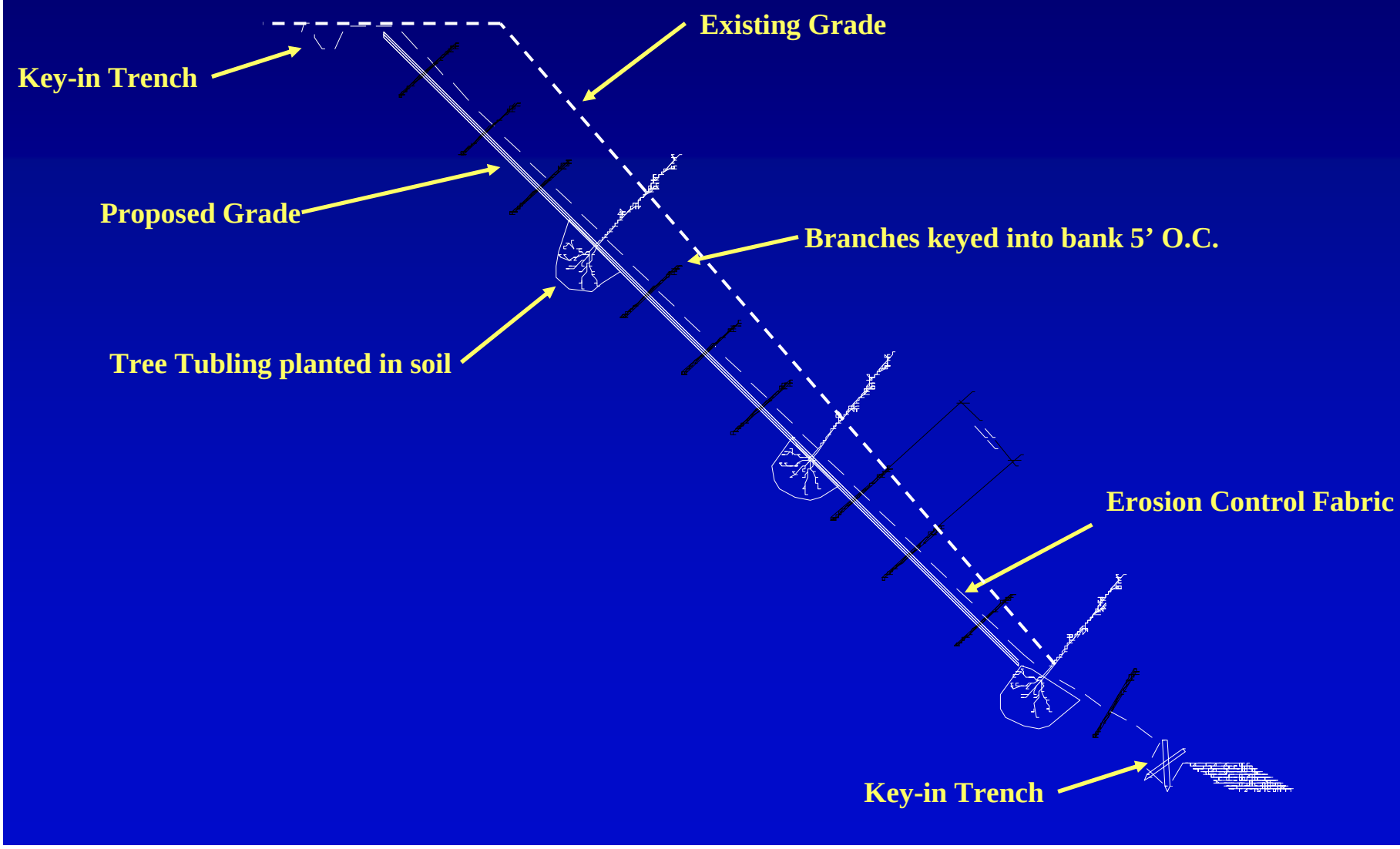
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Waterbury Dam Mitigation
Upland Slope Stabilization

- Bioengineering Application
  - Tublings
    - Tree and shrub seedlings
    - White Pine, Eastern Hemlock, Bearberry and Buttonbush
    - Typically 2” in diameter and 6 ft in length
    - Increase the cohesion and integrity of the soil
  - Erosion Control fabric
    - Temporary degradable blankets used to enhance the establishment of vegetation
    - Provide tractive resistance and resist water velocity on slopes

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Waterbury Dam Mitigation
Upland Slope Stabilization



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Waterbury Dam Mitigation Monitoring

- VANR will monitor the site weekly from April to October.
- Monitoring period will be up to five years.
- The New York District will receive regular updates from VANR.
- The New York District will conduct site visits periodically through the monitoring period.

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Waterbury Dam Mitigation Conclusion

The USACE - New York District was able to work effectively with the Vermont Agency of Natural Resources (VANR) to promote bioengineering as a significant part of the mitigation. This “marriage” of bioengineering and traditional slope stabilization techniques had not been utilized by the New York District before this project and this project provided an opportunity to incorporate the Environmental Operating Principles into the project. The final mitigation design is a combination of bioengineering techniques for the slope stabilization and the placement of riprap for toe protection against wind and vessel waves.

- Costs for the project
  - Total Project Cost = $572,000
    - Toe Protection = $201,000
    - Transition Zone = $74,000
    - Upland Planting = $245,000
    - Other = $52,000

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Waterbury Dam Mitigation
Lessons Learned

- **Partnerships**
  - Involving the Local Sponsor, VANR early in the conceptual process
  - Corps understanding and incorporating the requests of VANR
  - Combining the the design goals of the biologist and engineers
- **More research needs to be conducted on recreational vessel wave heights in reservoirs**
- **Think out of the box**

US Army Corps
of Engineers
New York District

Waterbury Dam Mitigation Team Members

- Army Corps of Engineers – New York District
  - Paul Tumminello – Project Manager
  - Marty Goff – Project Engineer
  - Kerry Anne Donohue – Design Engineer
  - Bethany Bearmore – Design Engineer
  - Kimberly Rightler – Biologist
  - Emily Eng – Cost Engineer
  - Kevin Meranda - Constructability
- Vermont Agency of Natural Resources
  - Brian Fitzgerald – Hydrologist
  - Susan Warren – Biologist
  - Susan Baulmer – Parks
- Army Corps of Engineers – New England District
  - Kate Atwood – Cultural Resources
- A/E
  - Northern Ecological Associates

US Army Corps
of Engineers
New York District

Waterbury Dam Mitigation
Future Site and Questions



COMPOSITE CUT-OFFS FOR DAMS

Dr. Donald A. Bruce, C.Eng.
and
Trent L. Dreese, P.E.

Gannett Fleming

GEOSYSTEMS, L.P.

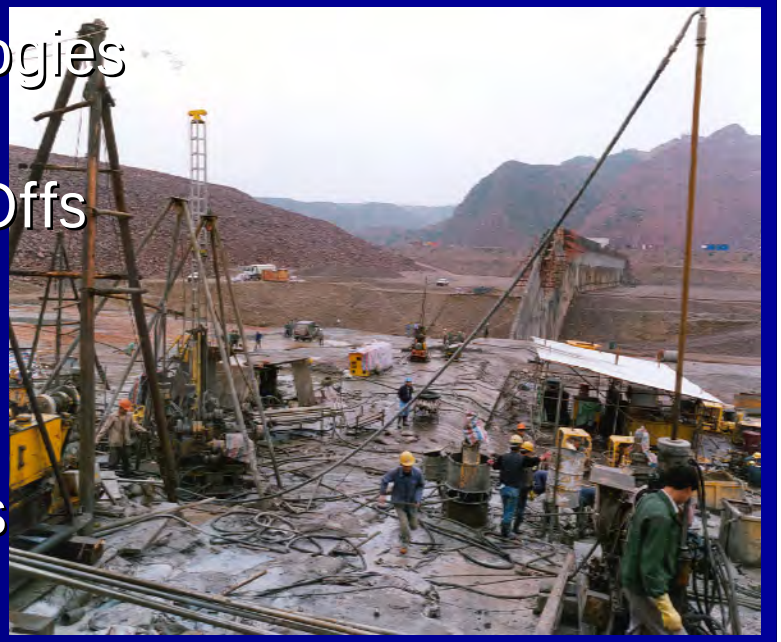
Contents

1. Alternative Definitions of “Composite” Cut-Offs

2. Review of Individual Technologies
   2.1 Concrete Cut-Offs
   2.2 Drilled and Grouted Cut-Offs

3. Illustrative Case Histories

4. Observations and Conclusions



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1. Alternative Definitions of "Composite" Cut-Offs

A. By Technology

Using two or more technologies to:

A. Create the cut-off (e.g., concrete cut-off through alluvium with grout curtain in rock below).

B. Permit the construction of a concrete cut-off by pretreating the rock mass.

B. By Material

Using two or more distinct families of grouts to form a multicomponent curtain (e.g., LMG, HMG, polyurethanes and hot bitumen to stop large fast flows).

Note: Cut-offs may be conceived and designed as composite prior to construction, or can become composite, out of necessity, after construction begins.

2. Review of Individual Cut-Off Technologies



Basically there are two groups of Cut-off technologies:

1. Cut-offs comprising some type of concrete wall. Such walls can:
   - be constructed by different methods
     - Diaphragm wall (grab or cutter/mill)
     - Secant pile wall
     - DMM
     - TRD
   - comprise a variety of materials from high strength concrete, to plastic concrete
2. Cut-offs formed by drilling and grouting techniques. Such cut-offs can:
   - be created in rock (fissure or void grouting) or in soil (jet grouting, permeation grouting, hydrofracture grouting)
   - can deploy a wide variety of materials depending on the project goals and conditions

Each family of cut-offs has advantages and disadvantages (both real and perceived). We have traditionally elected to "live with" the consequences of one technology.

Advantages

Concrete Cut-Offs

- "Positive" long-term solution (if constructed properly).
- Low uniform permeability assured through all ground penetrated.
- Simple concept but sophisticated equipment.



Drilled and Grouted

- Excellent recent record in hard fractured rock masses.
- Can focus on targeted zones.
- Smaller equipment, sophisticated methods and materials (responsive).

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Disadvantages

Concrete Cut-Offs



- Cost.
- Not “flexible” in response to variable in-ground conditions, i.e., much of wall may be wasted.
- Rock properties (hardness, rippability) pose major controls over feasibility and productivity.
- Can be high risk to dam slurry loss.
- Site logistics and space.
- Alignment.
- Depth limitations.

Drilled and Grouted

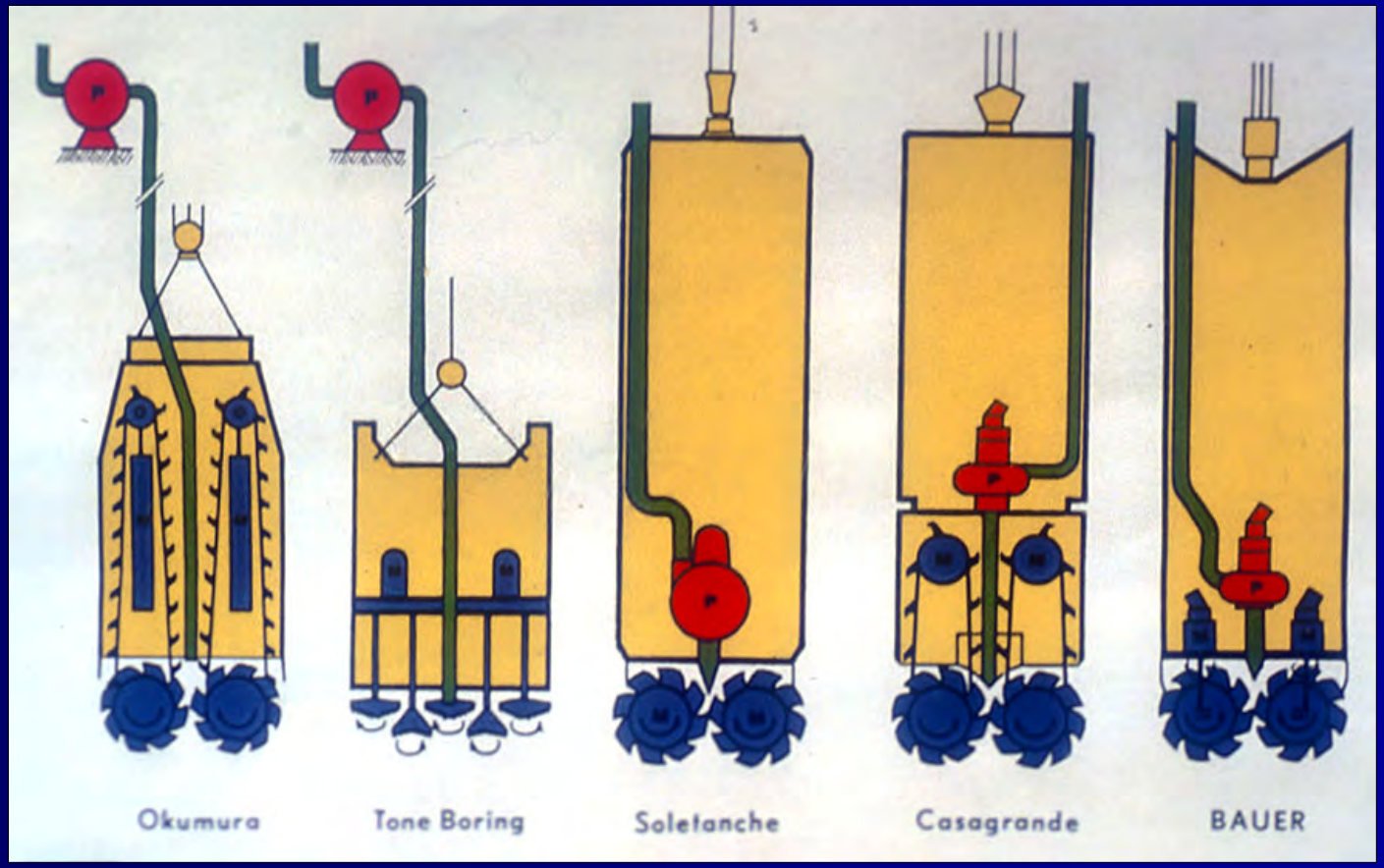
- Efficiency will decline in soluble/ erodible conditions.
- Therefore, not perceived as “positive.”
- Historical bias.

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2. Review of Individual Cut-Off Technologies

1. Diaphragm Wall Techniques

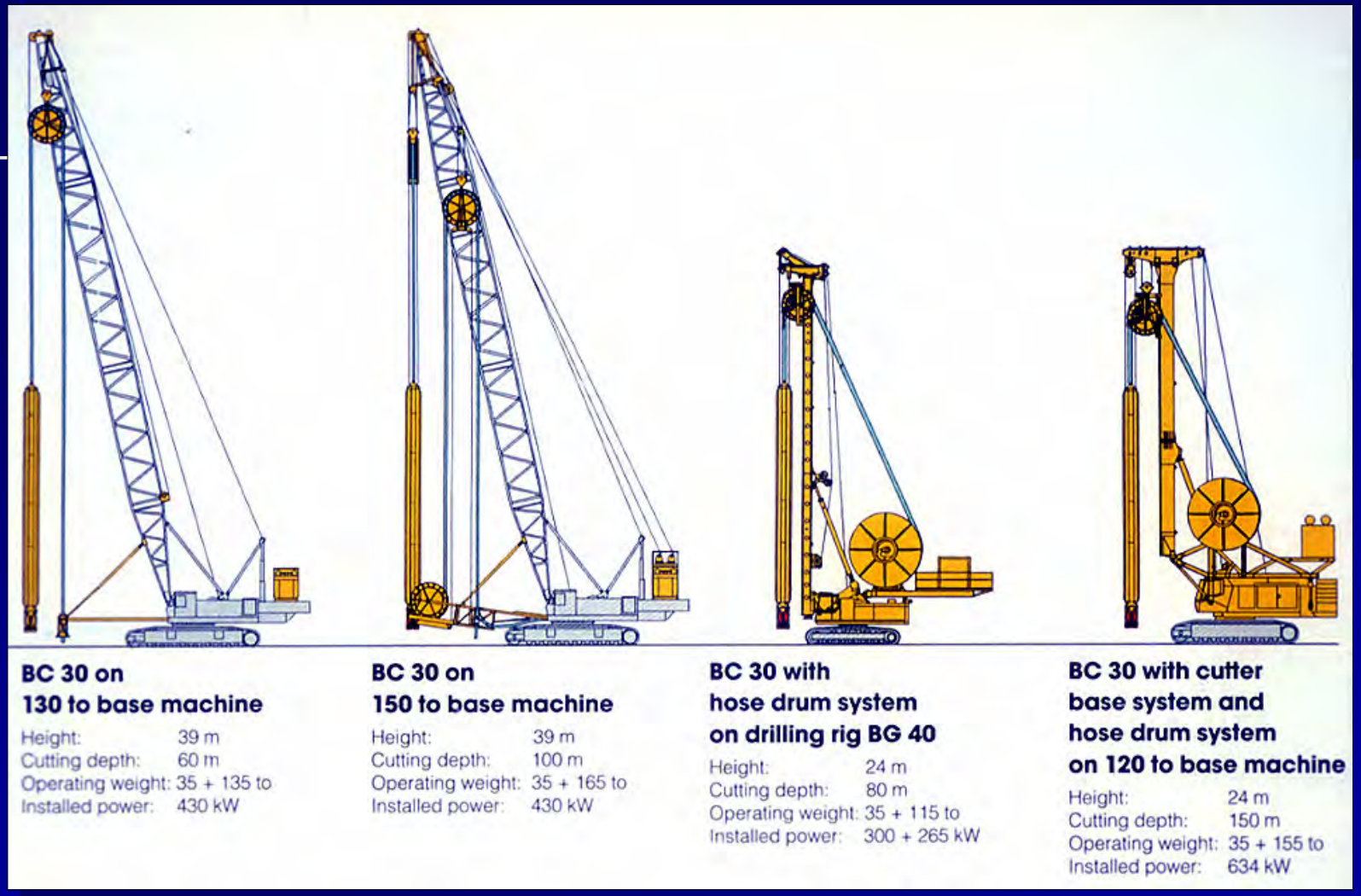
- Cutters/Mills



Development of Trench Cutters

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BC 30 on 130 to base machine

Height: 39 m
Cutting depth: 60 m
Operating weight: 35 + 135 to
Installed power: 430 kW

BC 30 on 150 to base machine

Height: 39 m
Cutting depth: 100 m
Operating weight: 35 + 165 to
Installed power: 430 kW

BC 30 with hose drum system on drilling rig BG 40

Height: 24 m
Cutting depth: 80 m
Operating weight: 35 + 115 to
Installed power: 300 + 265 kW

BC 30 with cutter base system and hose drum system on 120 to base machine

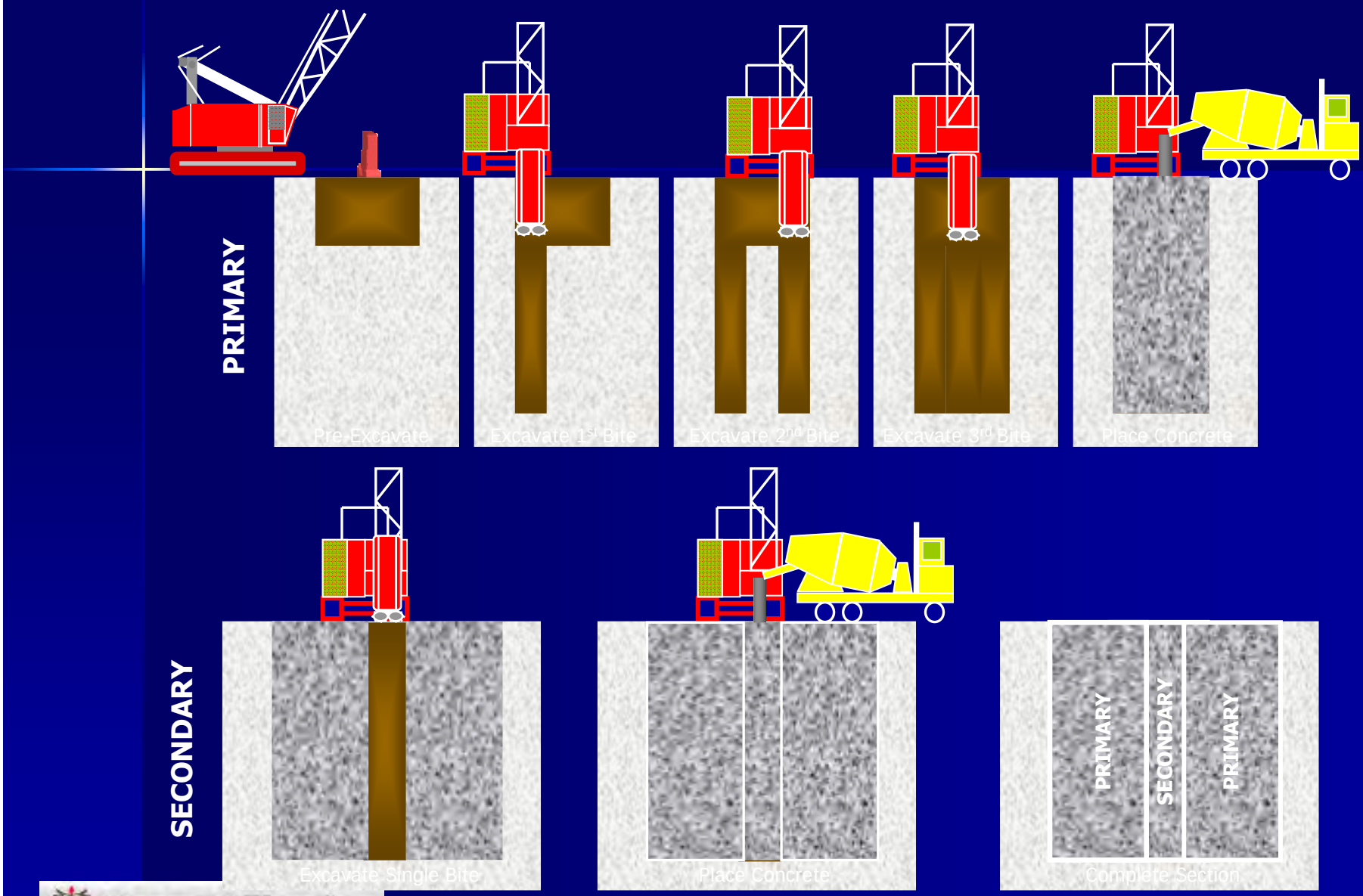
Height: 24 m
Cutting depth: 150 m
Operating weight: 35 + 155 to
Installed power: 634 kW

Development of Bauer Trench Cutters

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Diaphragm Wall Panel Construction Sequence



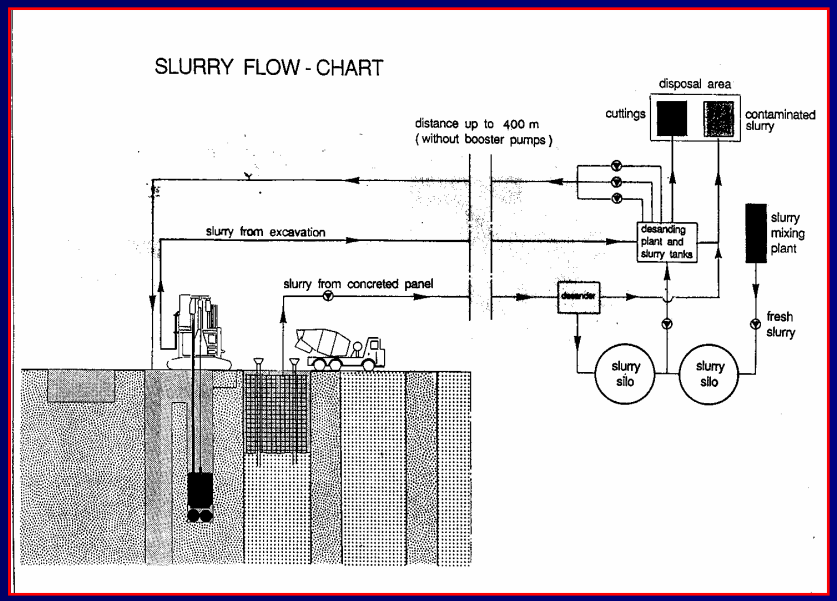
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Panel Excavation

The cutters continuously remove the soil from the bottom of the trench, breaks it up and mixes it with a bentonite slurry in the trench.





The slurry charged with soil particles is pumped through a pipe to the de-sanding plant where it is cleaned and returned into the trench.

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Navajo



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2. Review of Individual Cut-Off Technologies

- Conventional grabs (cable or hydraulic)



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2. Review of Individual Cut-Off Technologies

– Secant Pile Wall Technique



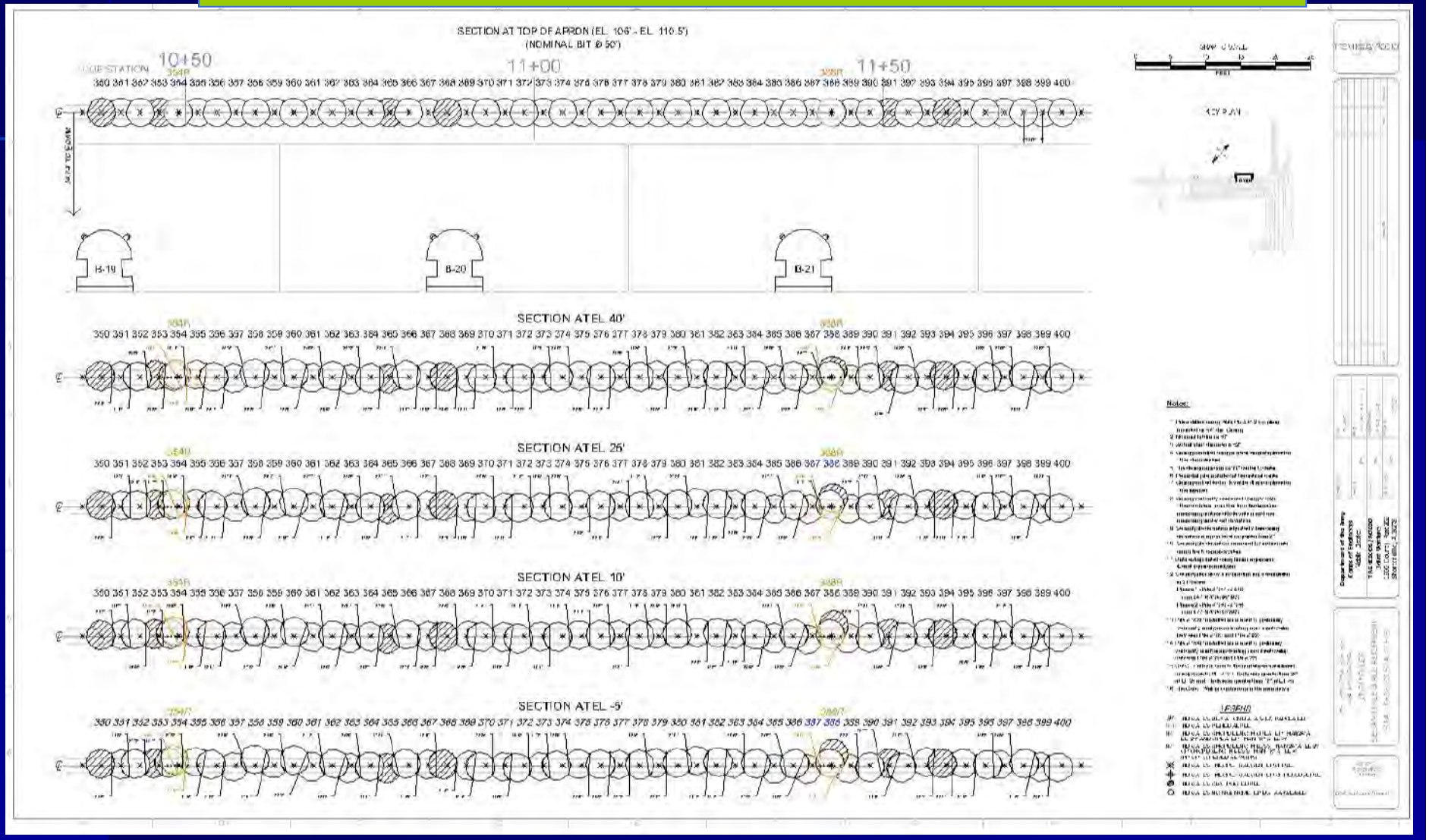


Drilling Around the Clock

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Verification of Cut-Off Wall Design Criteria At Various Elevations



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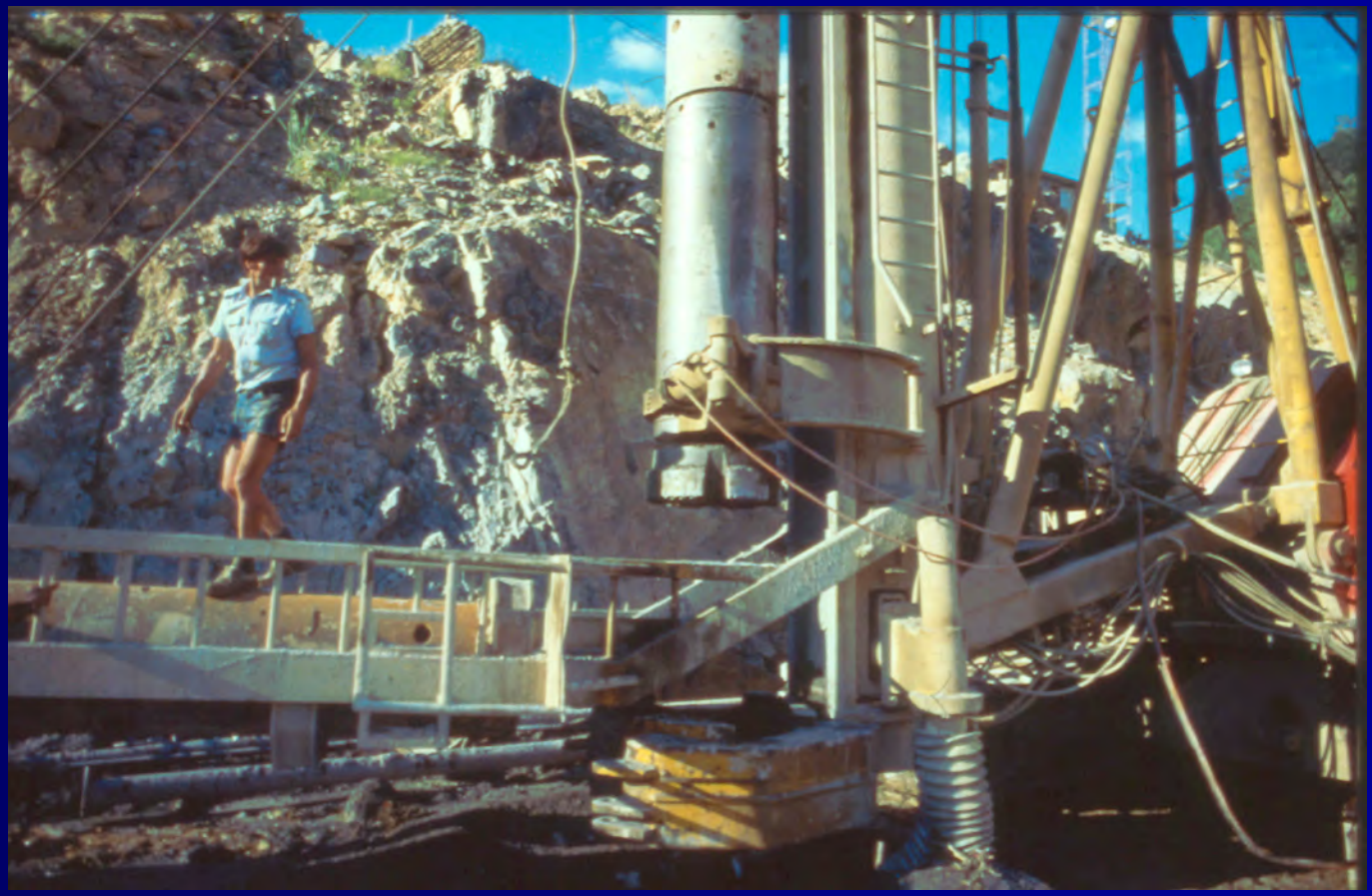
Beaver Dam, AR



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Khao Laem Dam, Thailand



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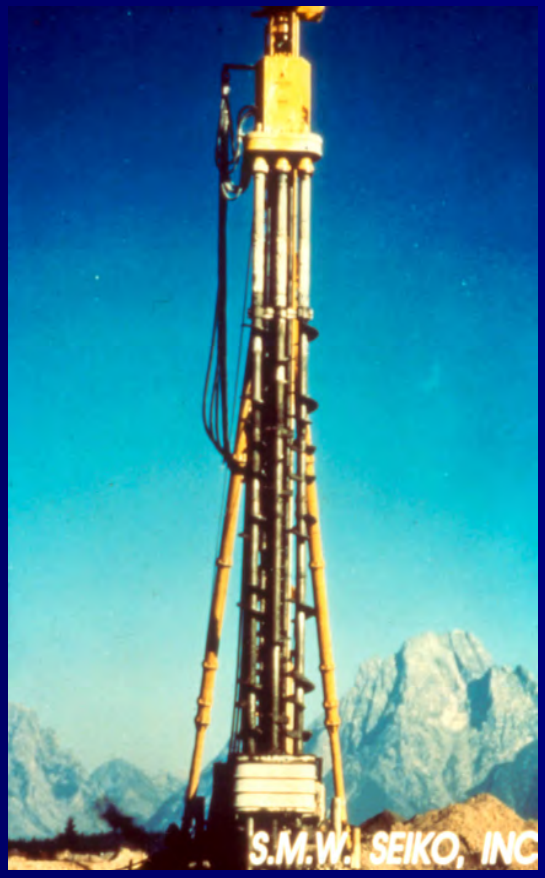
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DMM Method at Jackson Lake Dam, WY



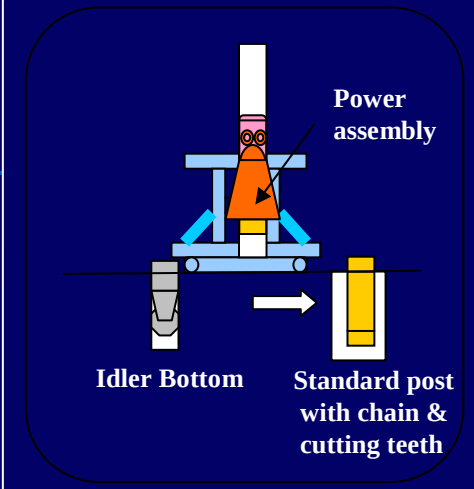


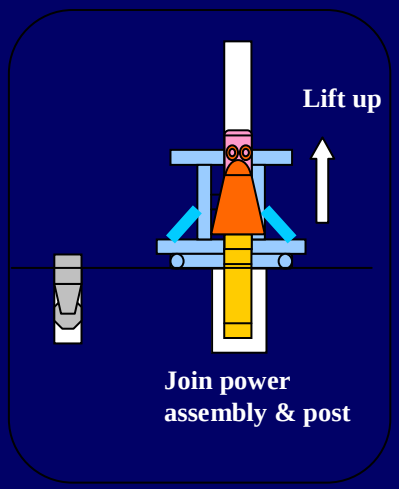
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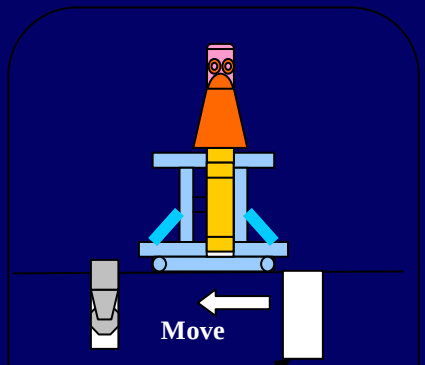
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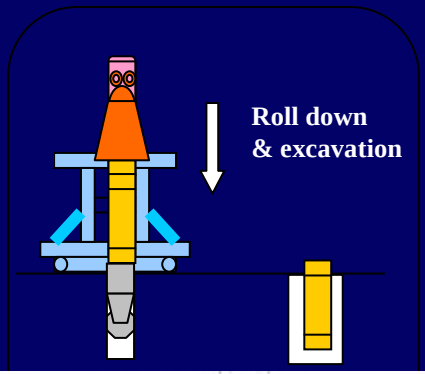

TRD Method
Trench cutting & Re-mixing
Deep wall method since 1993
Up to July 2003,
Number of job sites : over than 220,
Max. depth : about 53m(170 ft.)
September, 2003
M.Aoi &
K.Tsujimoto
Blue print

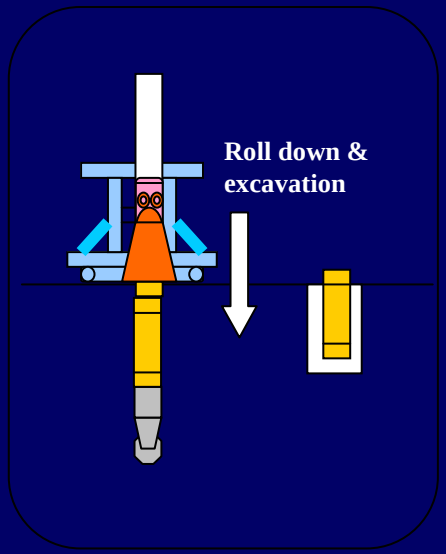
Process of insertion

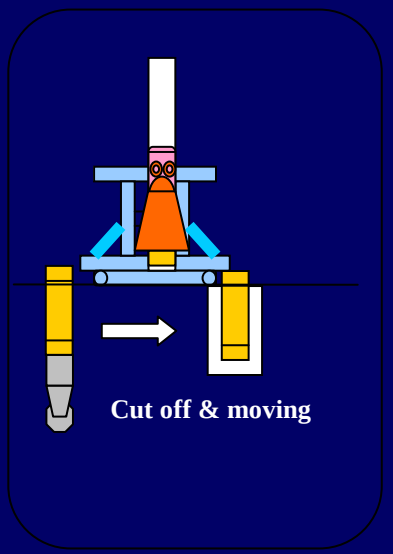














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40m(131 ft) depth takes normally about 16-20 hours.

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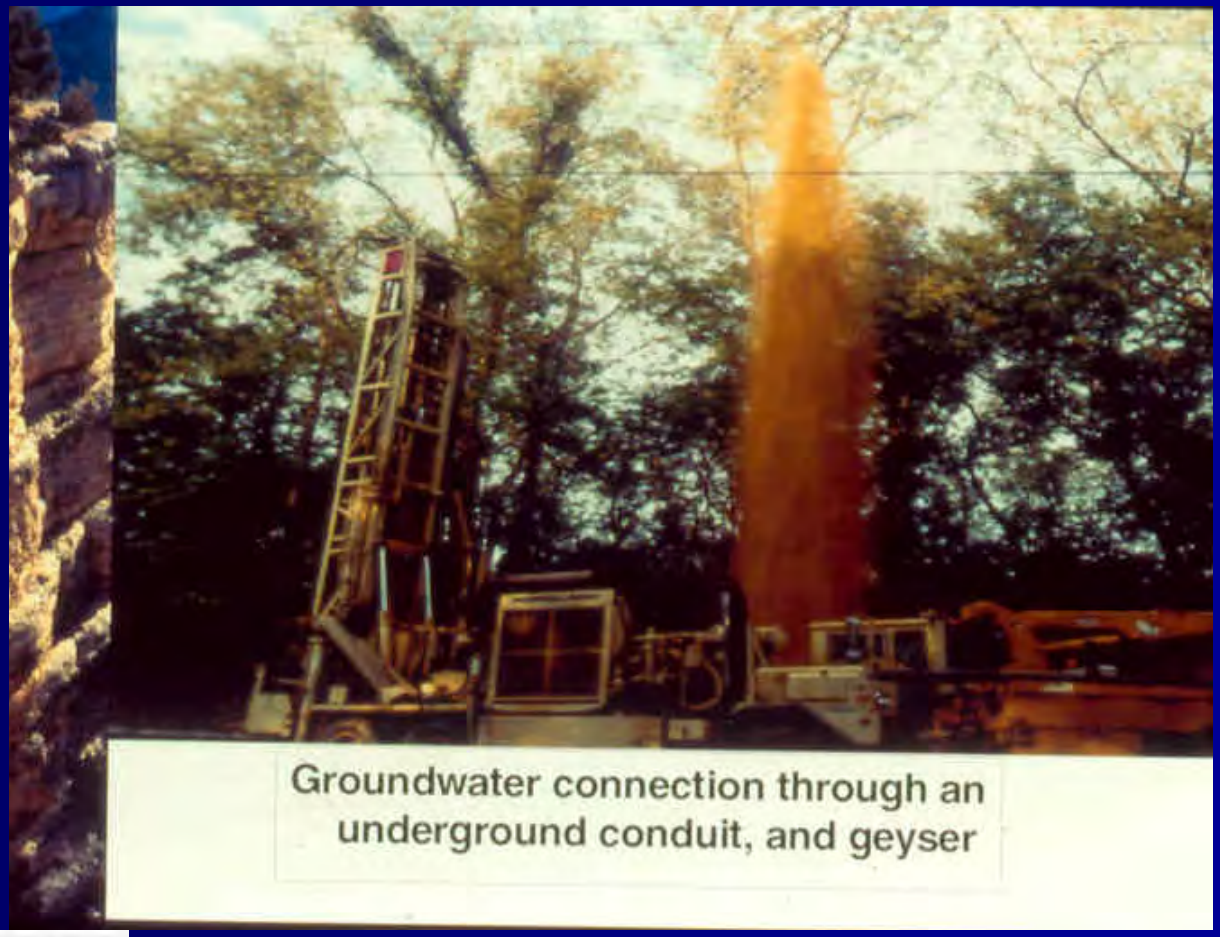
2. Drilling and Grouting Techniques
2.1 Rock Fissure Drilling and Grouting



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2. Drilling and Grouting Techniques
2.2 Rock Void Drilling for Grout Holes



Groundwater connection through an underground conduit, and geyser

2. Drilling and Grouting Techniques
2.3 Treatment of Soil by Permeation



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2. Drilling and Grouting Techniques
2.3 Treatment of Soil by Hydrofracture



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2. Drilling and Grouting Techniques
2.3 Treatment of Soil by Jet Grouting



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3. Illustrative Case Histories



	Designed as Composites (Two Components: as Facilitation: Materials)					
	Wall Type		Grouting Type			
	Diaphragm (Mill/Cutter)	Secant	Rock Fissure	Rock Void	Permeation/ Hydrofracture	Jet
1. Papadia, Greece		✓	✓			
2. Diavik, NWT	✓					✓
3. W.F. George, AL	✓	✓	✓			
4. Clearwater, MO	✓		✓	✓		
5. Tims Ford, TN			✓	✓		
6. Cape Girardeau, MO			✓	✓		
	Modified during construction to become composites.					
7. Mud Mountain, WA	✓				✓	
8. Mississenewa Dam, IN	✓		✓	✓		
9. Peixe Dam, Brazil			✓			✓

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1. Papadia Dam, Greece

Plastic concrete cut-off in alluvium, grouting in underlying rock.



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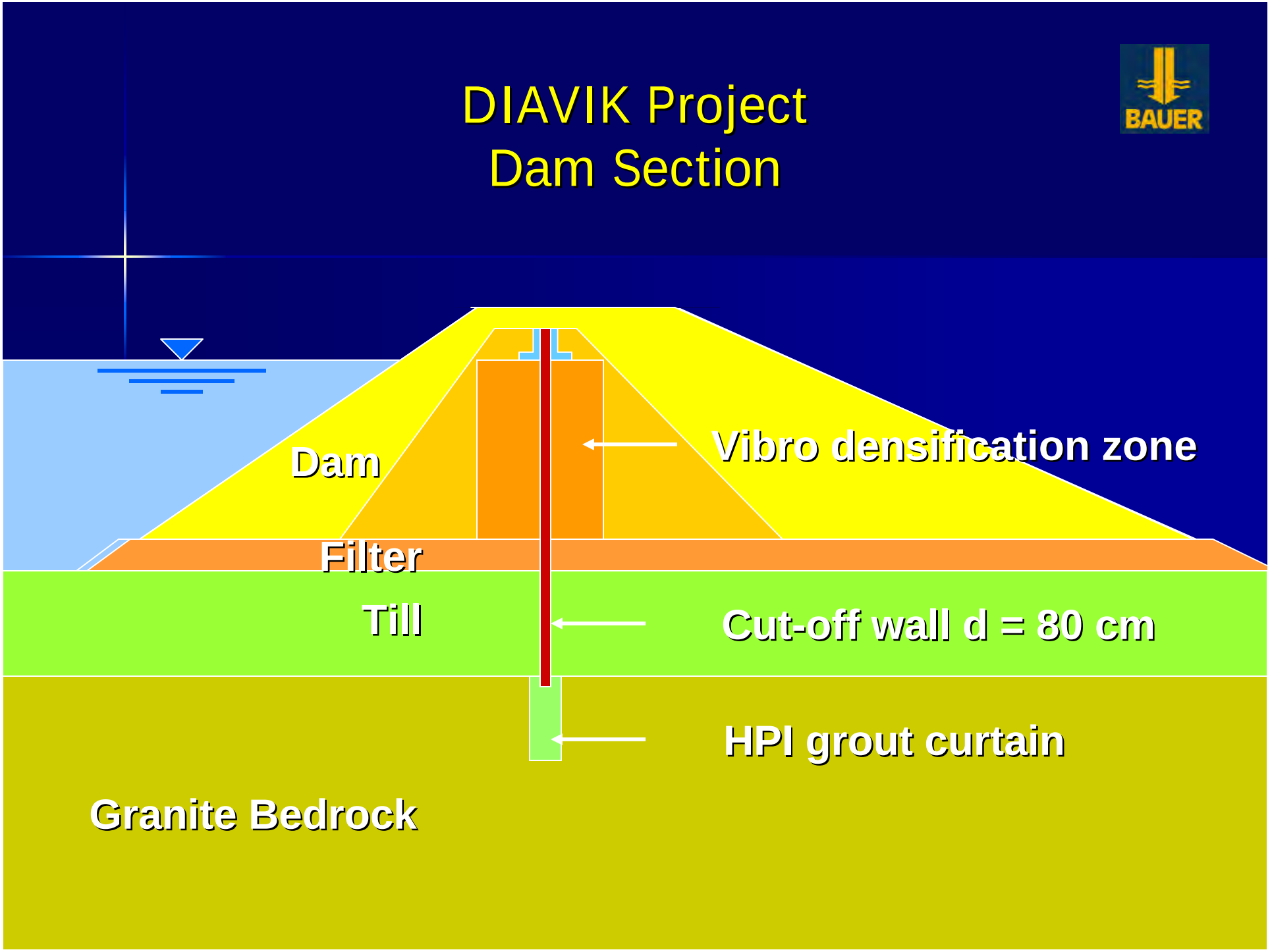
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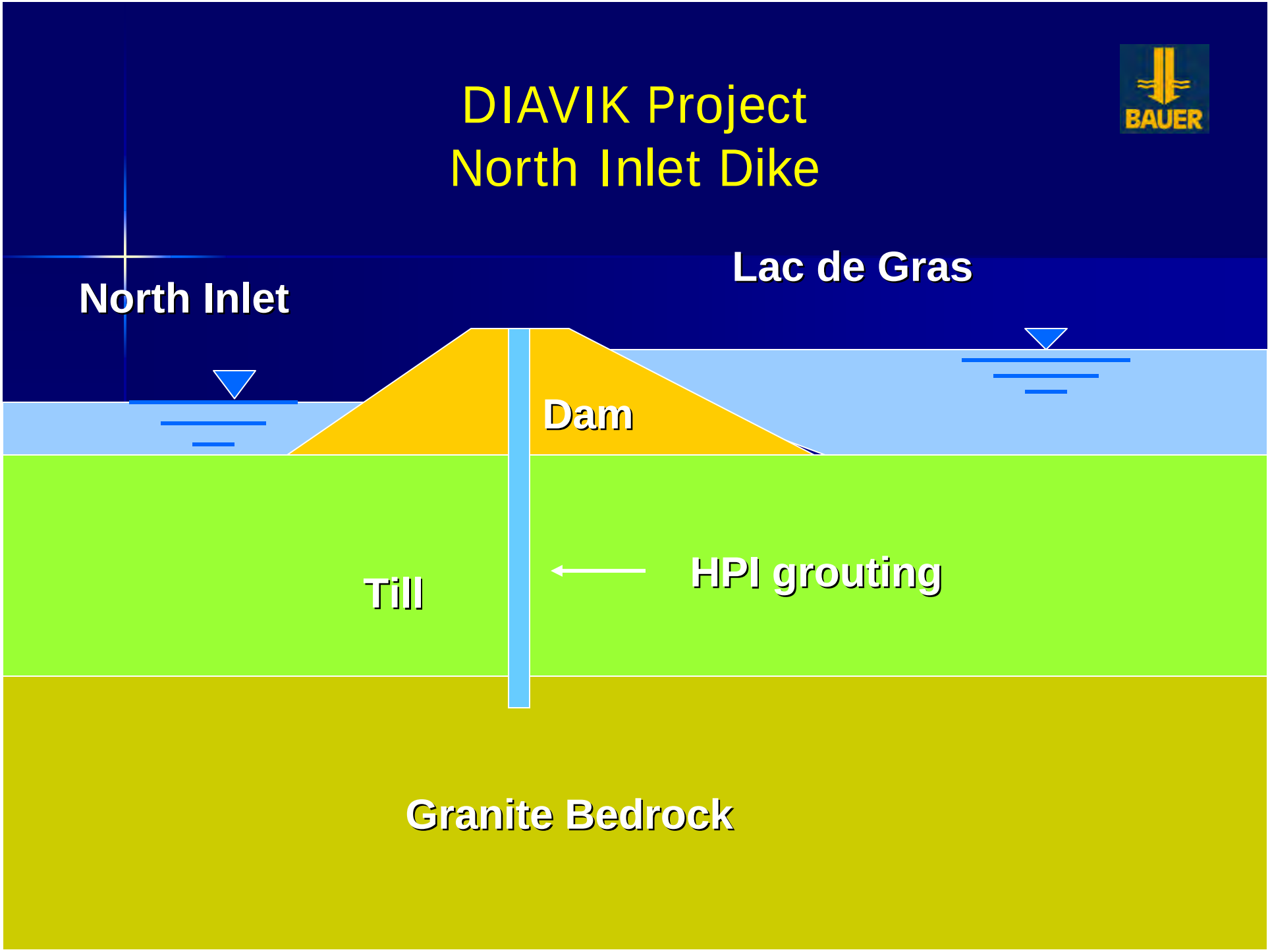
2. DIAVIK Diamond Mines, Project in year 2018



DIAVIK Project
Dam Section



DIAVIK Project
North Inlet Dike



Cut-off wall data:

- *max depth* — *35 m*
  thickness — *800 mm*
- ***artificial fill dam :*** — *22.000 m²*
  main equipment — *grab*
  av. performance — *15 m²/h*
- ***till and frozen till:*** — *11.000 m²*
  (cohesive with stones and boulders)
  main equipment — *1 cutter*
  2 grabs
  chisel
  av. performance — *2,5 m²/h*
  big boulders — *1 m²/h*



DIAVIK Project

High Pressure Grout



US Army Corps of Engineers ®
Mobile District

TREVIICOS / RODIO
JOINT VENTURE

3. W.F. George Dam, AL



Program of investigatory drilling and grouting prior to construction of concrete cut-off wall.

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Mobile District

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JOINT VENTURE

Exploratory Holes and Grouting



Drilling
– 11,800 lft
– 102 Holes

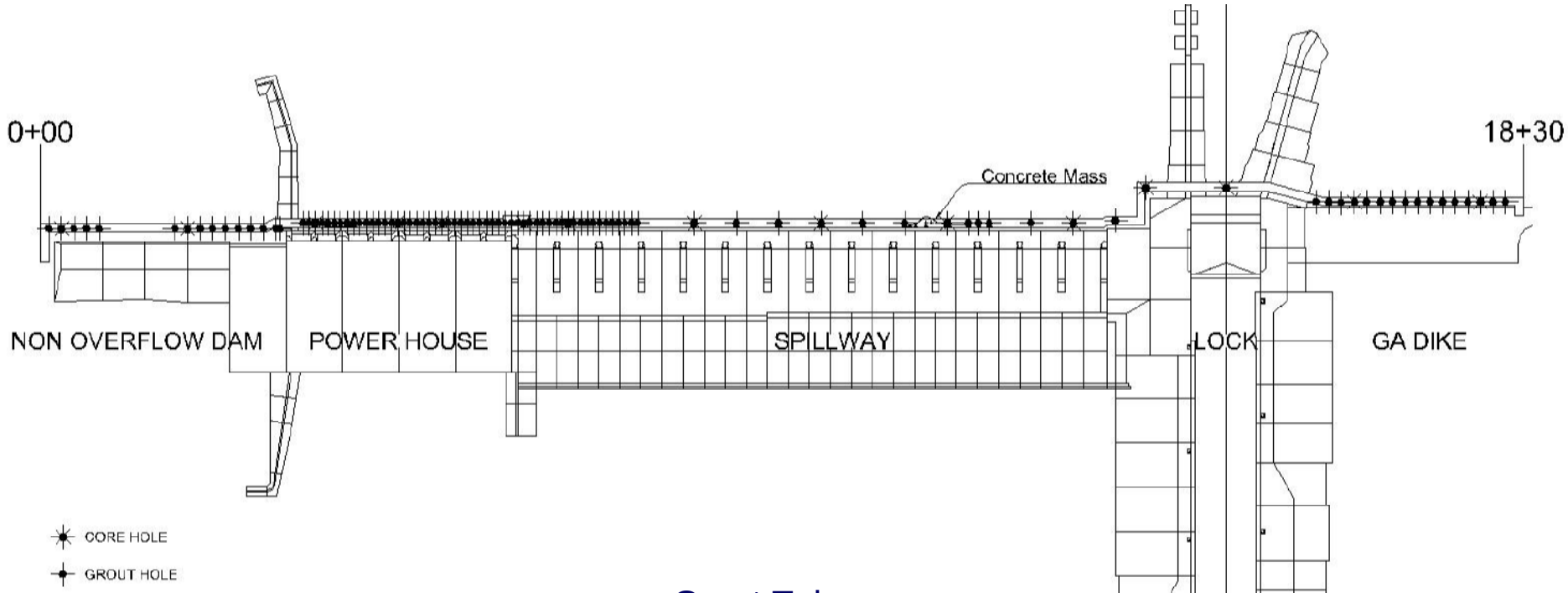
Coring
– 1,900 lft
– 13 Holes

Grouting
– 450 cy

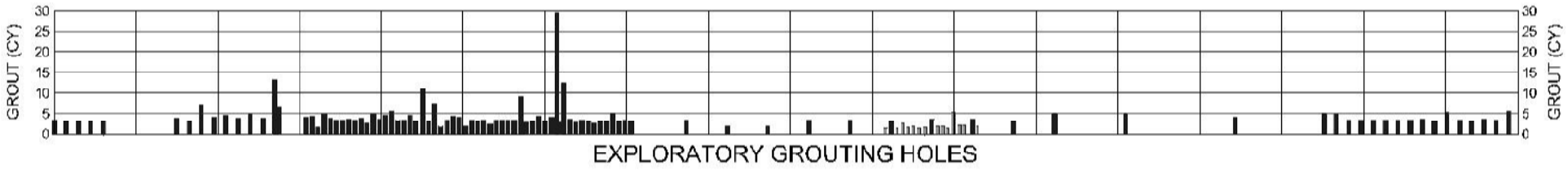
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Exploratory Grouting Layout



Grout Takes



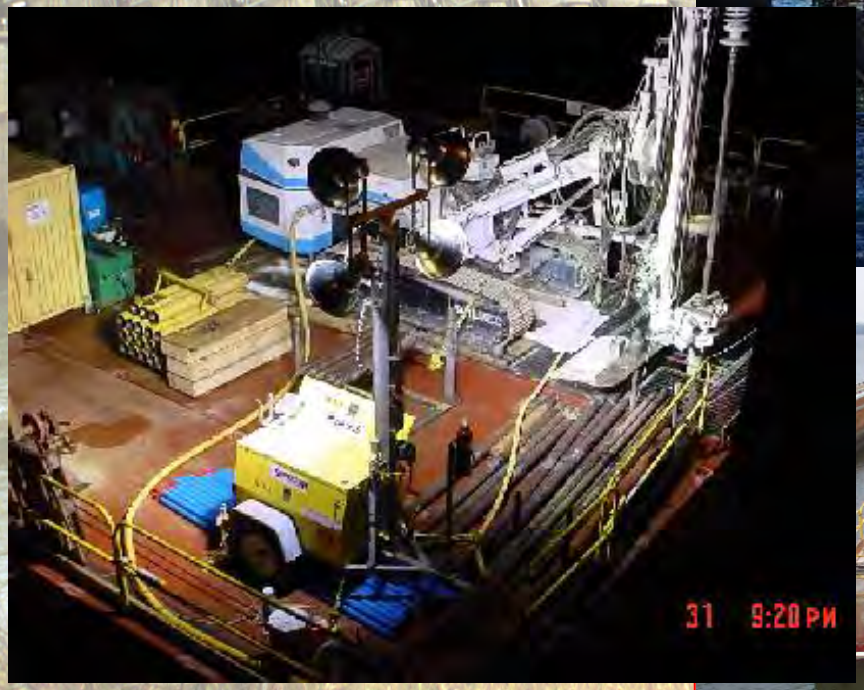


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Drilling and Coring Using an SM-405 Rig on Flexi-Floats







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PRELIMINARY INVESTIGATION

By conducting an extensive exploratory campaign the JV gained vital information which allowed it to plan the work ahead even when confronted with situations at variance from what the contract documents showed.

Advance information is relatively cheap to acquire and it pays for itself many times over in avoiding or mitigating delays and extra costs during the performance of the work.

THERE IS NO SUCH THING AS TOO MUCH INFORMATION, ESPECIALLY OF UNDERGROUND CONDITIONS!

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TREVIICOS / RODIO
JOINT VENTURE

Happy Lake Dwellers



4. Clearwater Dam, Missouri



Localized drilling and grouting program for suspected major sinkhole locations, followed by more intensive program of drilling and grouting to optimize design (depth and length) of foreseen concrete cut-off.



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5. Tims Ford Dam, TN



Remedial grout curtain in karst employing three families of grout materials – HMG, Polyurethane, LMG.

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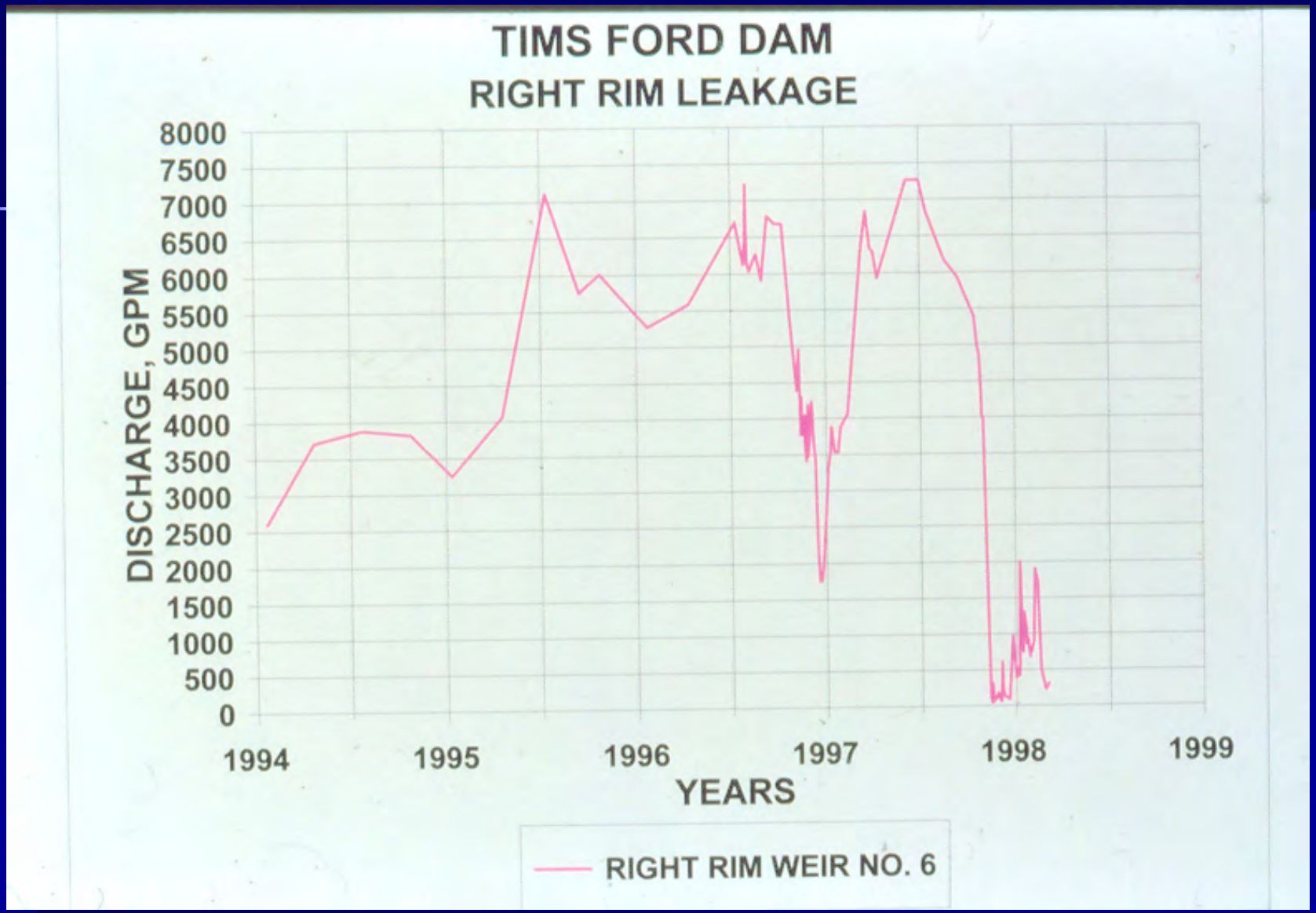
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GEOSYSTEMS, L.P.



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GEOSYSTEMS, L.P.



6. Limestone Quarry, Cape Girardeau, MO

Grout curtain created to stop 30,000 gpm flow through karst into quarry using three families of grout – HMG, LMG and Hot Bitumen.



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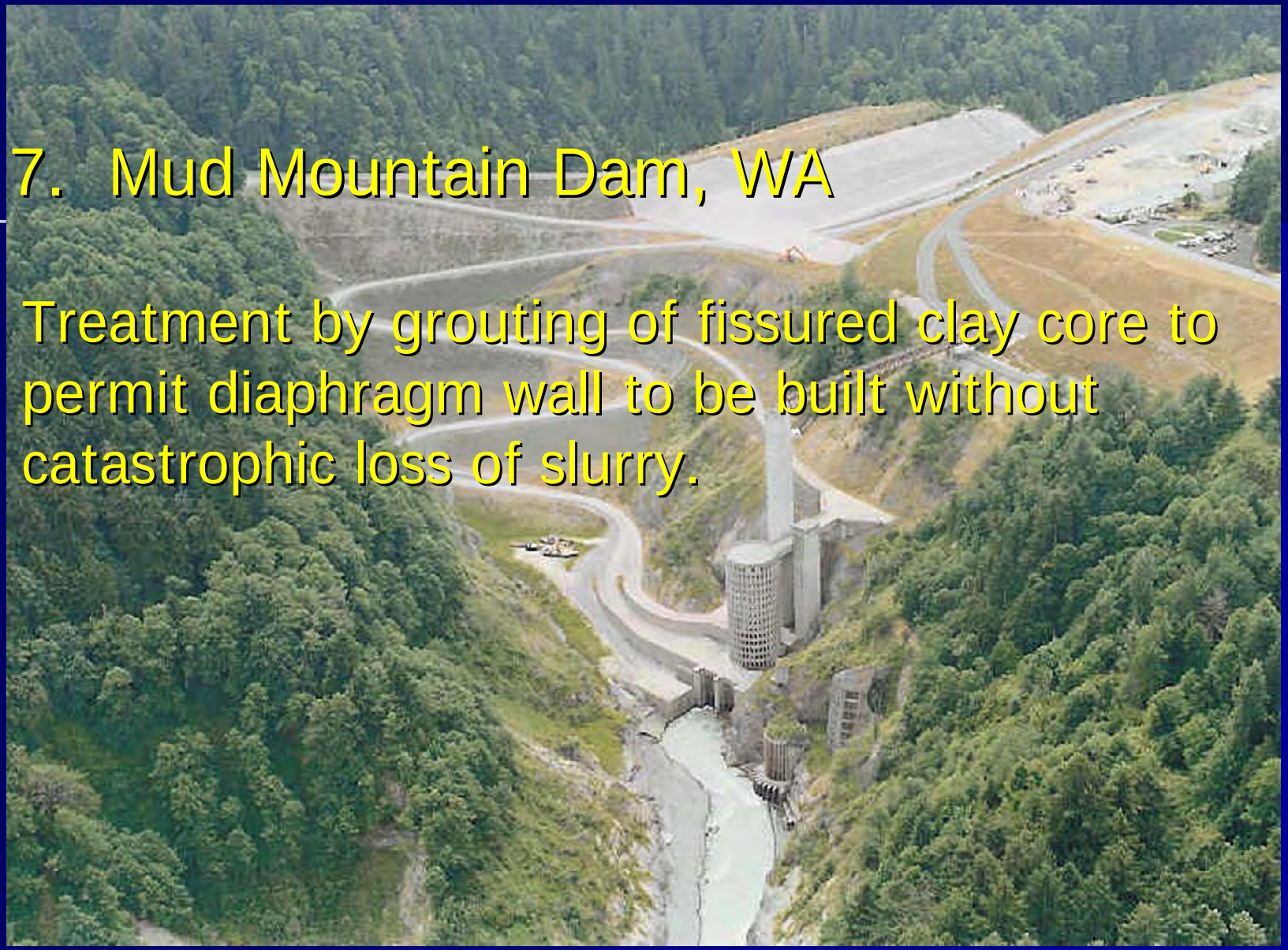
GEOSYSTEMS, L.P.



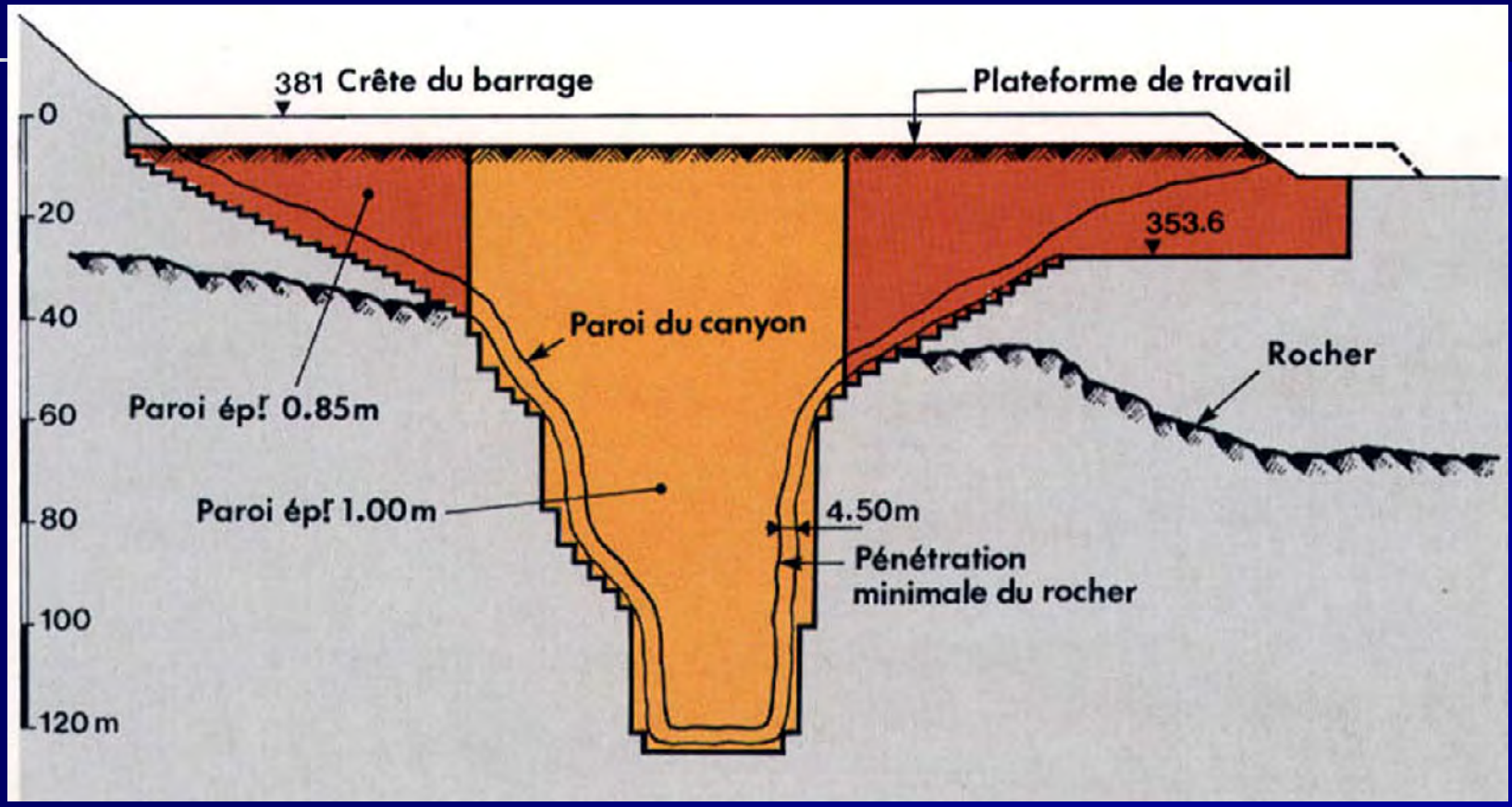
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7. Mud Mountain Dam, WA



Treatment by grouting of fissured clay core to permit diaphragm wall to be built without catastrophic loss of slurry.



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MUD MOUNTAIN

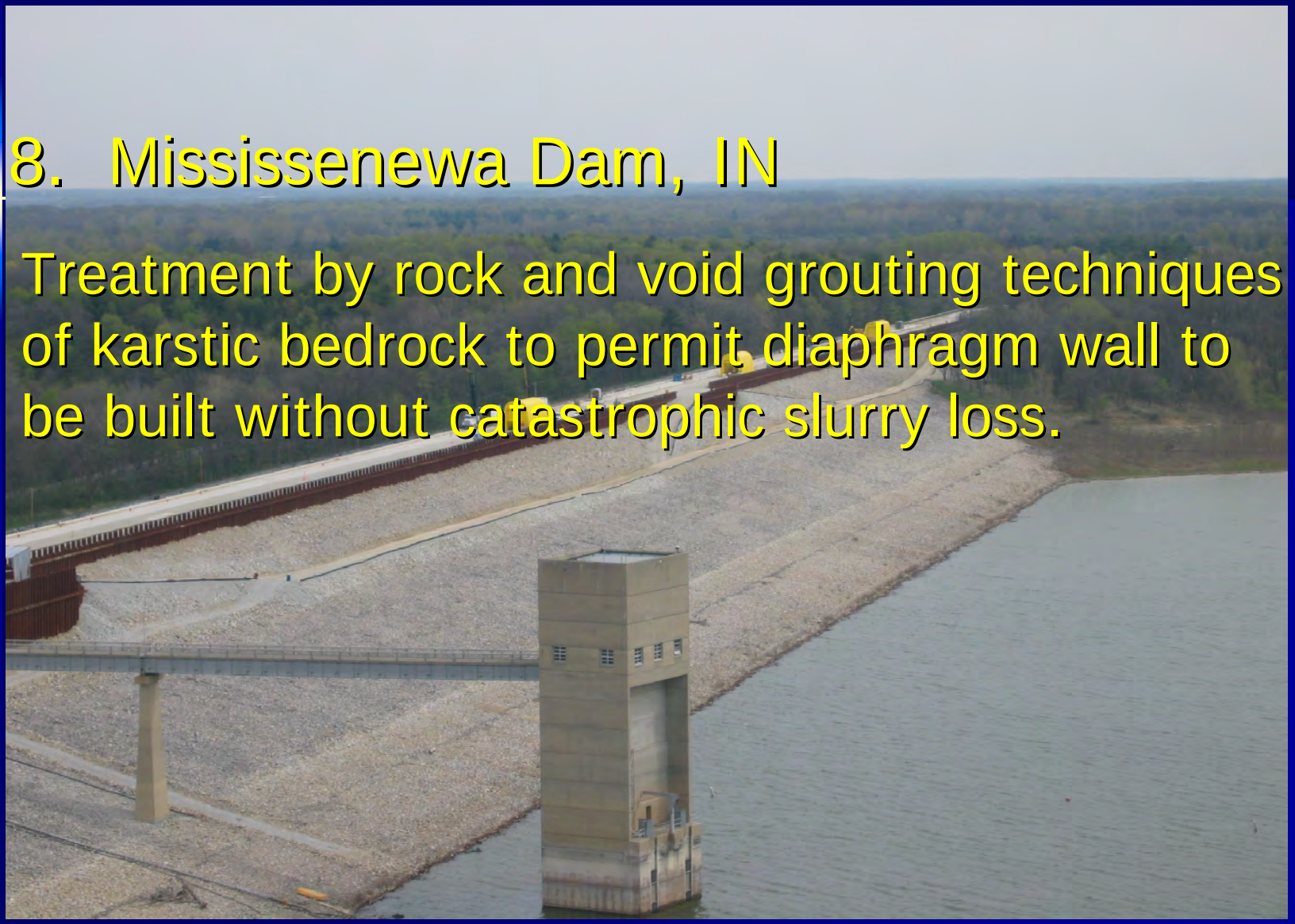


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8. Mississenewa Dam, IN

Treatment by rock and void grouting techniques of karstic bedrock to permit diaphragm wall to be built without catastrophic slurry loss.



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Clear example of equivalent performance of grouting to concrete cut-off wall construction.

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9. Peixe Dam, Brazil

Rock grouting used in voided/fissured karstic limestone inlier. Jet grouting required to treat weathered, soil-like materials lying above fresher rock.



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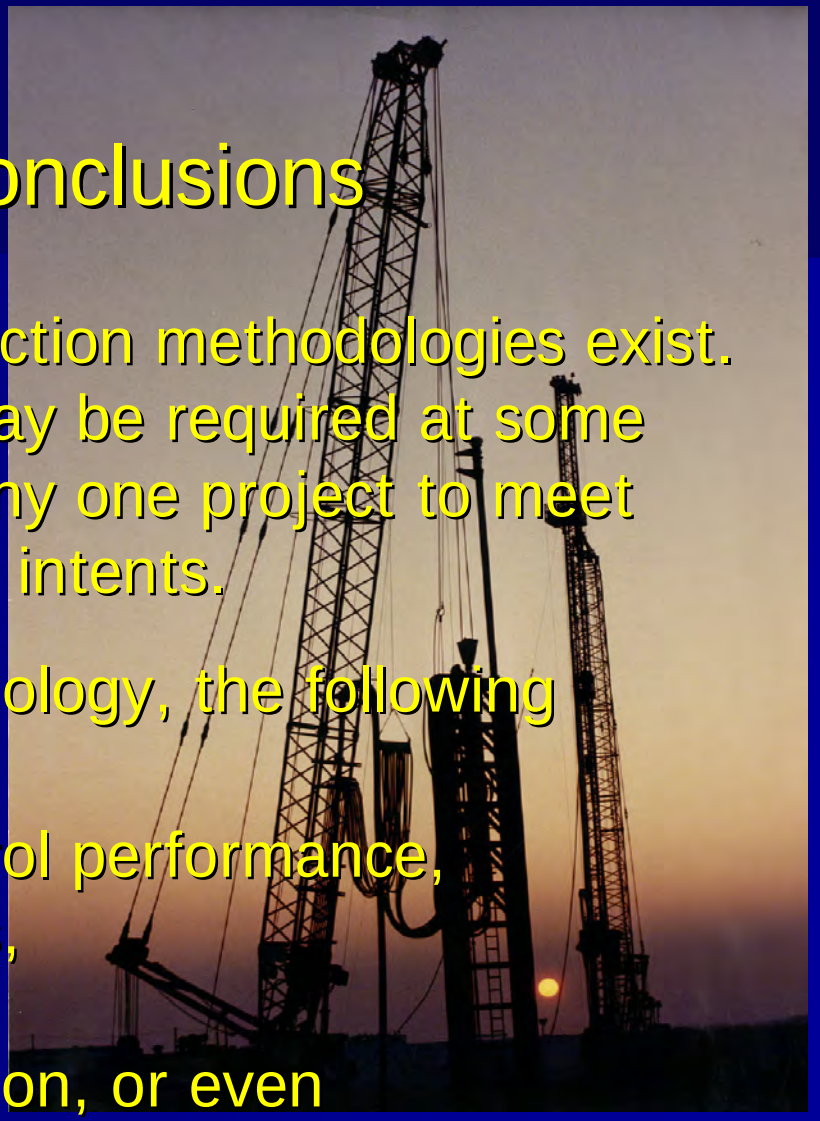
GEOSYSTEMS, L.P.



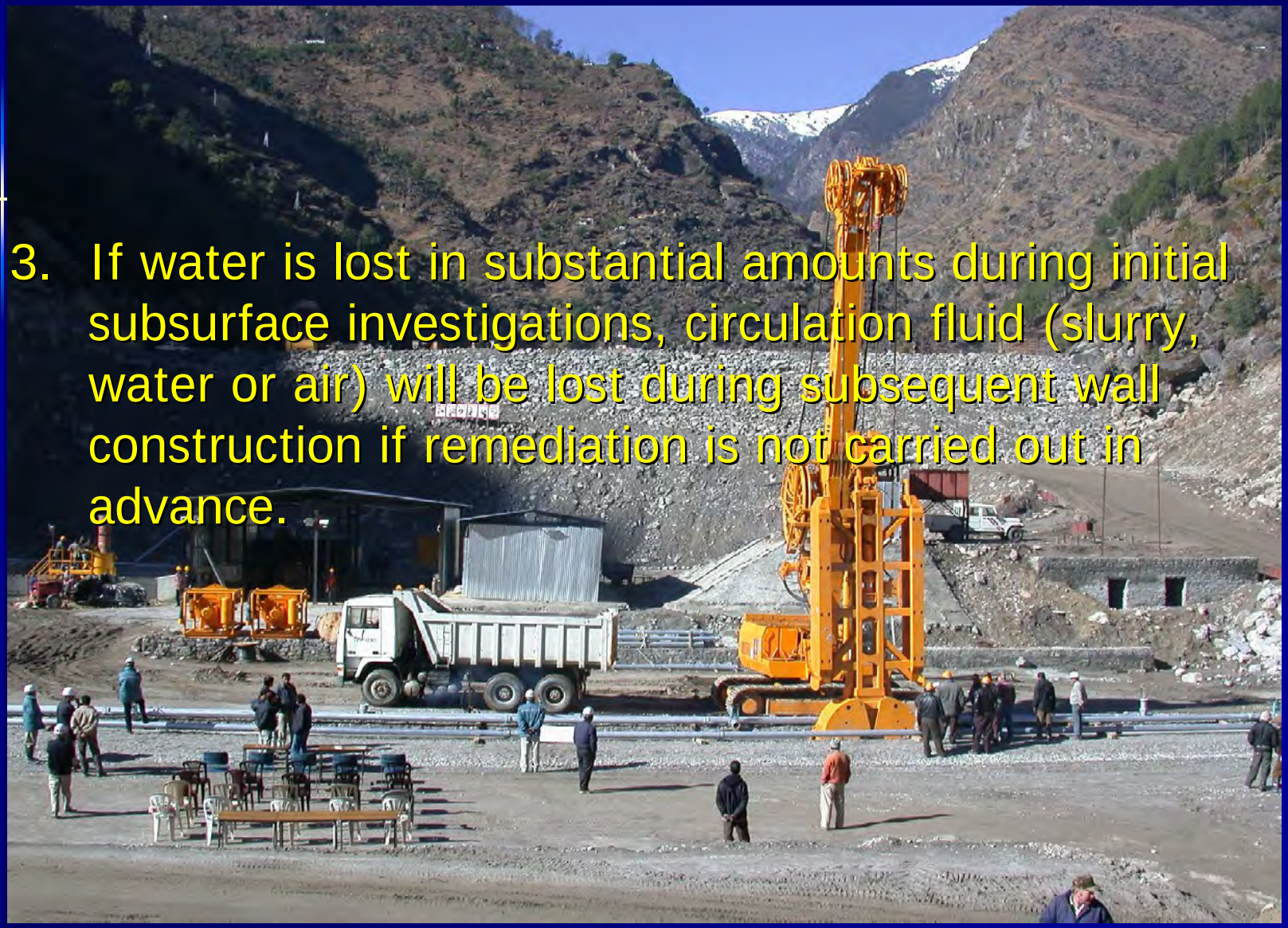
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GEOSYSTEMS, L.P.

4. Observations and Conclusions



1. Numerous excellent construction methodologies exist. However, more than one may be required at some time, or some location on any one project to meet the design and construction intents.
2. By “shoehorning” one technology, the following outcomes often occur:
   - Ineffective seepage control performance,
   - Large construction claims,
   - Damage to structure,
   - Need for future remediation, or even
   - Abandonment of remediation efforts.



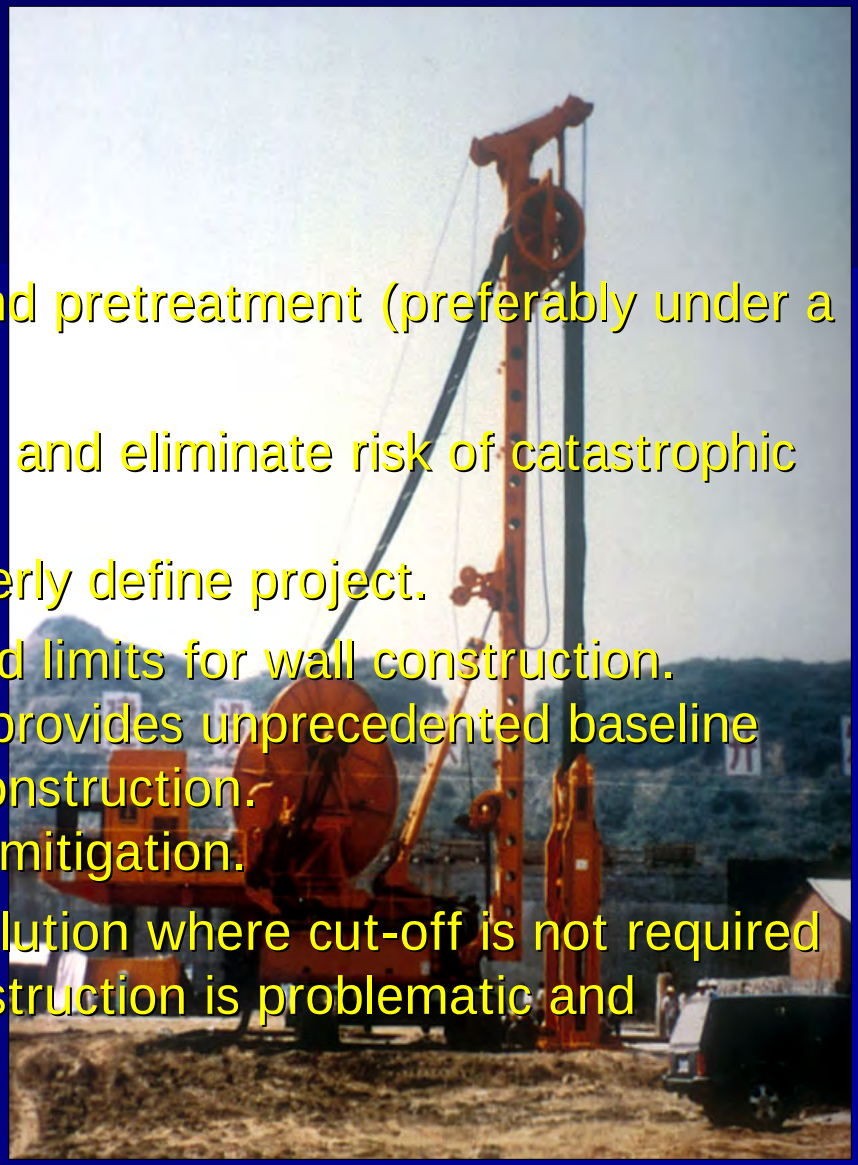
3. If water is lost in substantial amounts during initial subsurface investigations, circulation fluid (slurry, water or air) will be lost during subsequent wall construction if remediation is not carried out in advance.

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GEOSYSTEMS, L.P.

4. Intensive site investigation and pretreatment (preferably under a separate contract) will:

- Prepare the site of cut-off and eliminate risk of catastrophic slurry loss.
- Explore the site and properly define project.
  - Used to define required limits for wall construction.
  - Information obtained provides unprecedented baseline data for cut-off wall construction.
  - Claims avoidance and mitigation.
- Can provide lower cost solution where cut-off is not required at depths where wall construction is problematic and increasingly expensive.





5. Configurations for Compatible Performance of Cut-Off Wall and Permanent Grouting
   - Two fully grouted lines at 5 to 10 feet spacing.
   - Grouting in stages to absolute refusal with balanced stable grouts.
   - Verification holes along centerline (core and water pressure test).



6. Rock Conditions Suitable for Terminating a Cut-Off Wall

- RQD greater than 40%.
- Clean rock fractures.
- Some well-defined “acceptable” residual permeability.

Note: Wall depth can be varied to match encountered site conditions (i.e., can be deepened to cut-off unique features).

Acknowledgements

- Bauer Maschinen
- Enerpeixe, Brazil
- Soletanche Bachy
- Trevi S.p.A.
- Trevi Rodio, JV
- Others TNTM



Gannett Fleming

GEOSYSTEMS, L.P.

State of the Art in Grout Mixes

Presented By:

James A. Davies, P.Eng.

Advanced Construction Techniques Ltd.

3935 Lloydtown Aurora Road

Kettleby, Ontario

L0G 1J0

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Email: jdavies@agtgroup.com



ISC Tri-Service Infrastructure Systems Conference & Exposition 2005

BALANCED STABLE GROUTS

- Definitions
- Theory
- Materials
- Testing





Definition

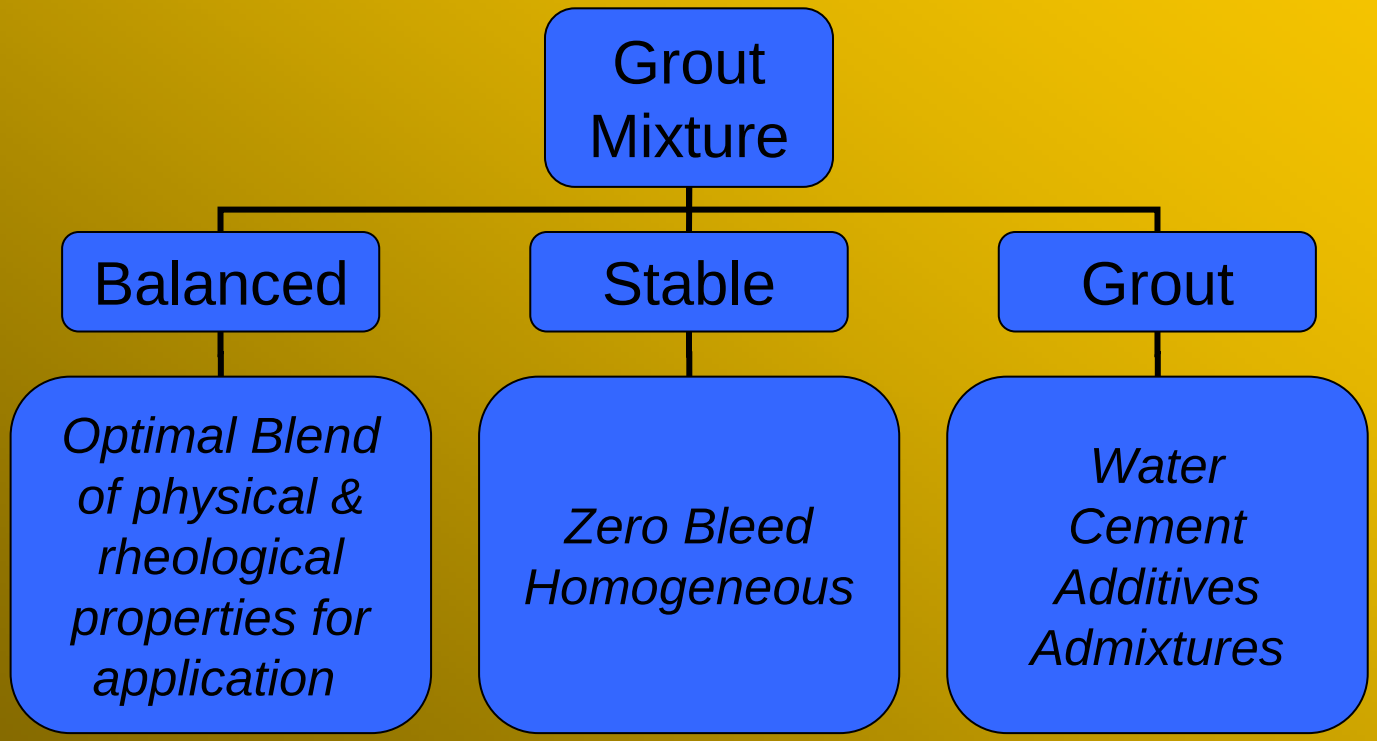
Balanced Stable Cement Grout

A homogenous balanced blend of water and cement combined with selected additives and admixtures producing a product with zero bleed, low cohesion and good resistance to pressure filtration.





Balanced Stable Grout







Unstable Grout Mixtures

- Variable Rheology
- Poor Particle Orientation
- High Segregation & Sedimentation
- High Pressure Filtration Coefficient
- Unpredictable Behavior
- Unstable During Injection
- Marginal Durability
- High Bleed Potential





Theory

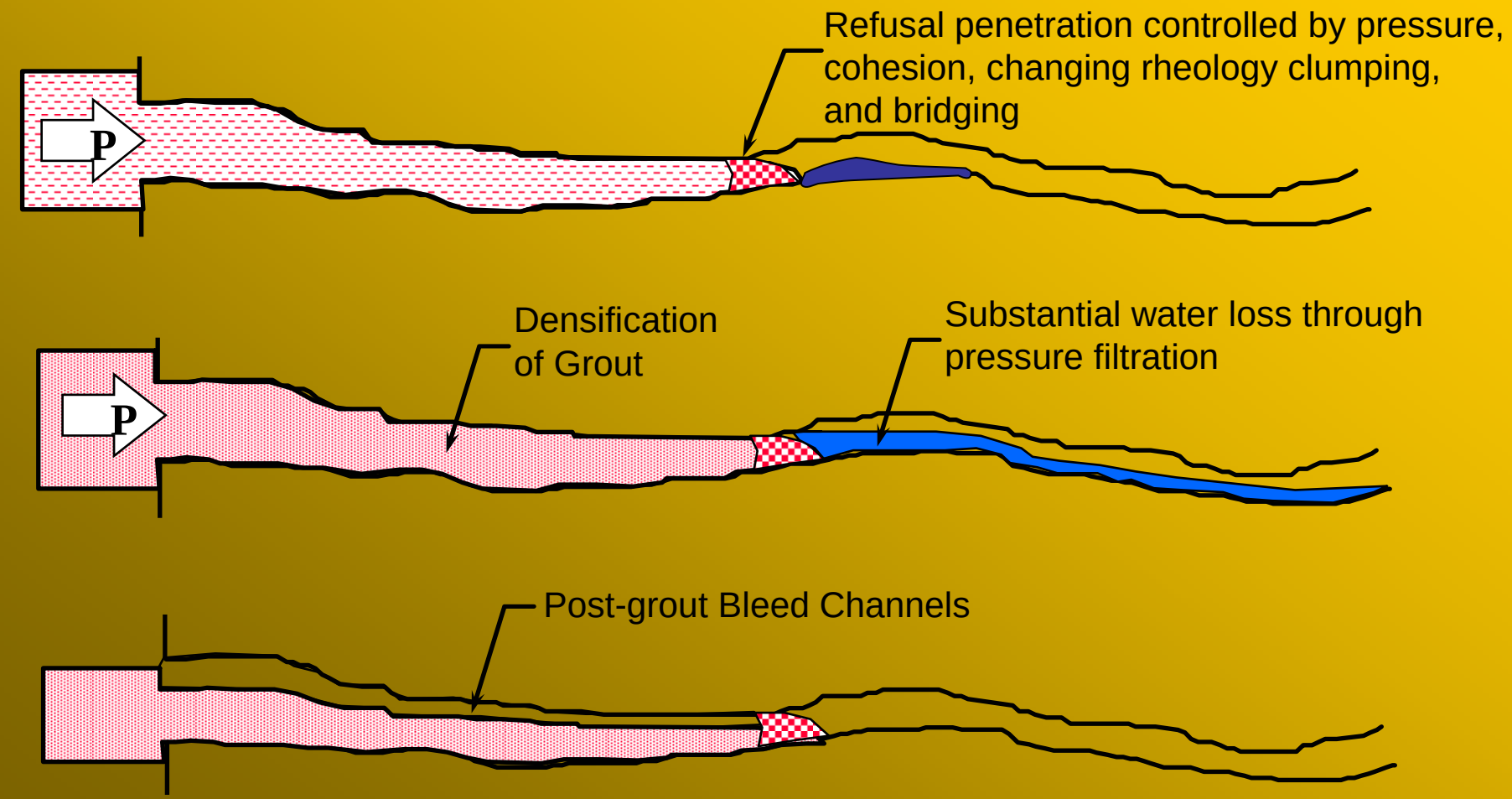
What are the desired properties of a cement based suspension grout?

- Low cohesion
- Viscosity consistent with acceptable penetration rate
- Minimal to zero bleed
- Constant rheology during application
- Dispersed particles
- High durability



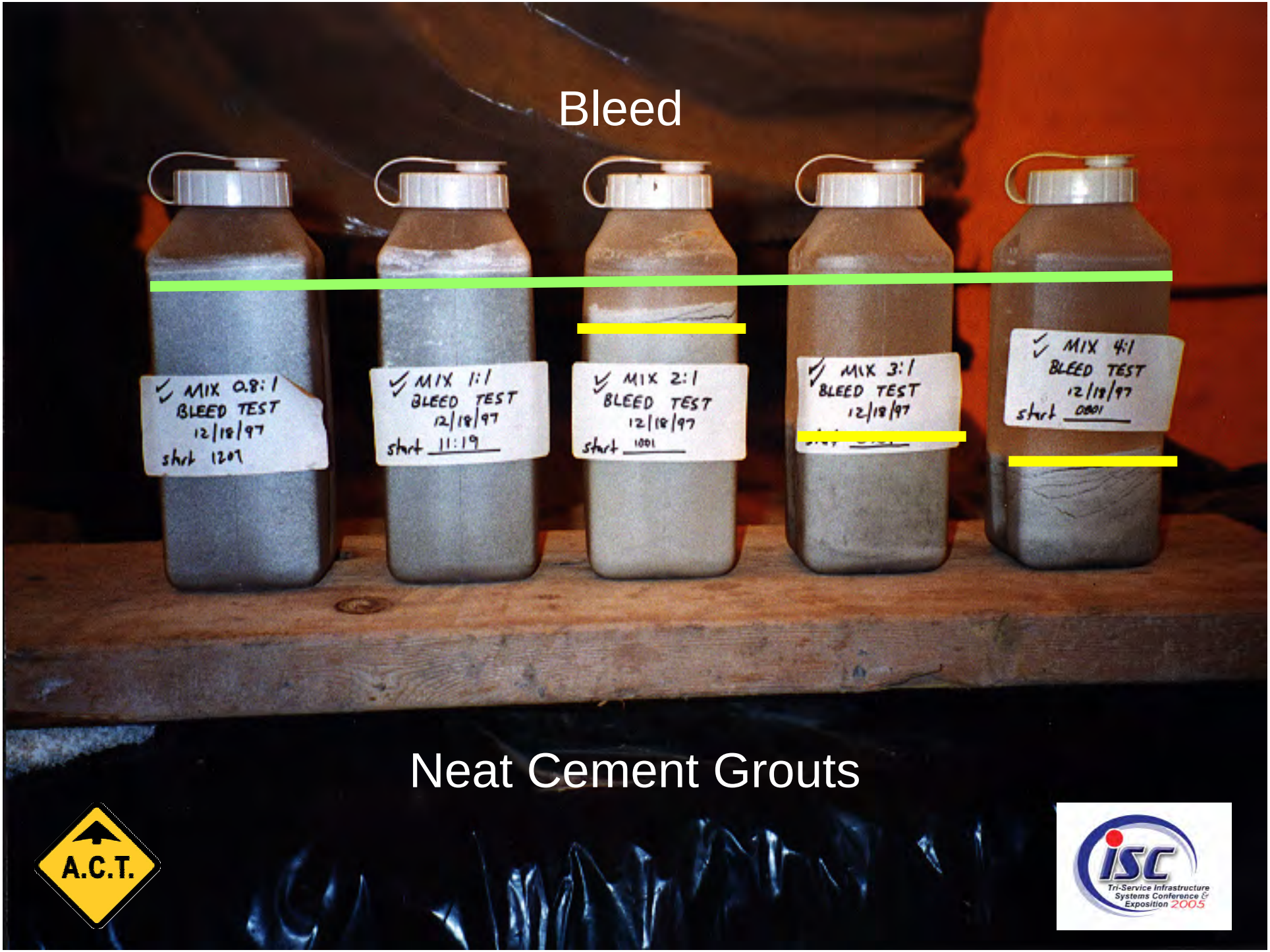


Grouting Theory - Neat Cement Grouts

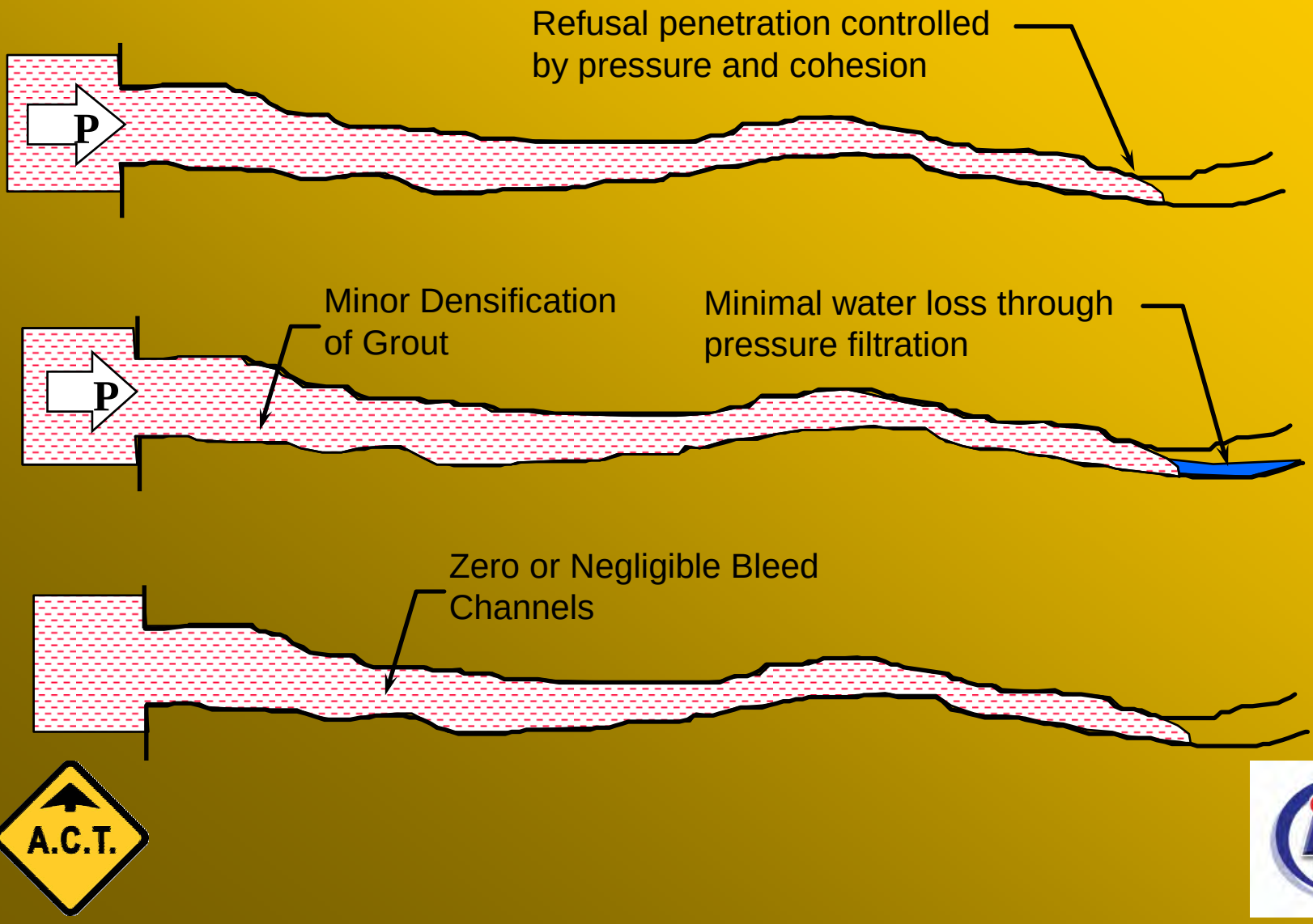


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Bleed
MIX 0.8:1
BLEED TEST
12/18/97
start 1207
MIX 1:1
BLEED TEST
12/18/97
start 11:19
MIX 2:1
BLEED TEST
12/18/97
start 1001
MIX 3:1
BLEED TEST
12/18/97
MIX 4:1
BLEED TEST
12/18/97
start 0801
Neat Cement Grouts
A.C.T.
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Grouting Theory - Balanced, Stable Grouts

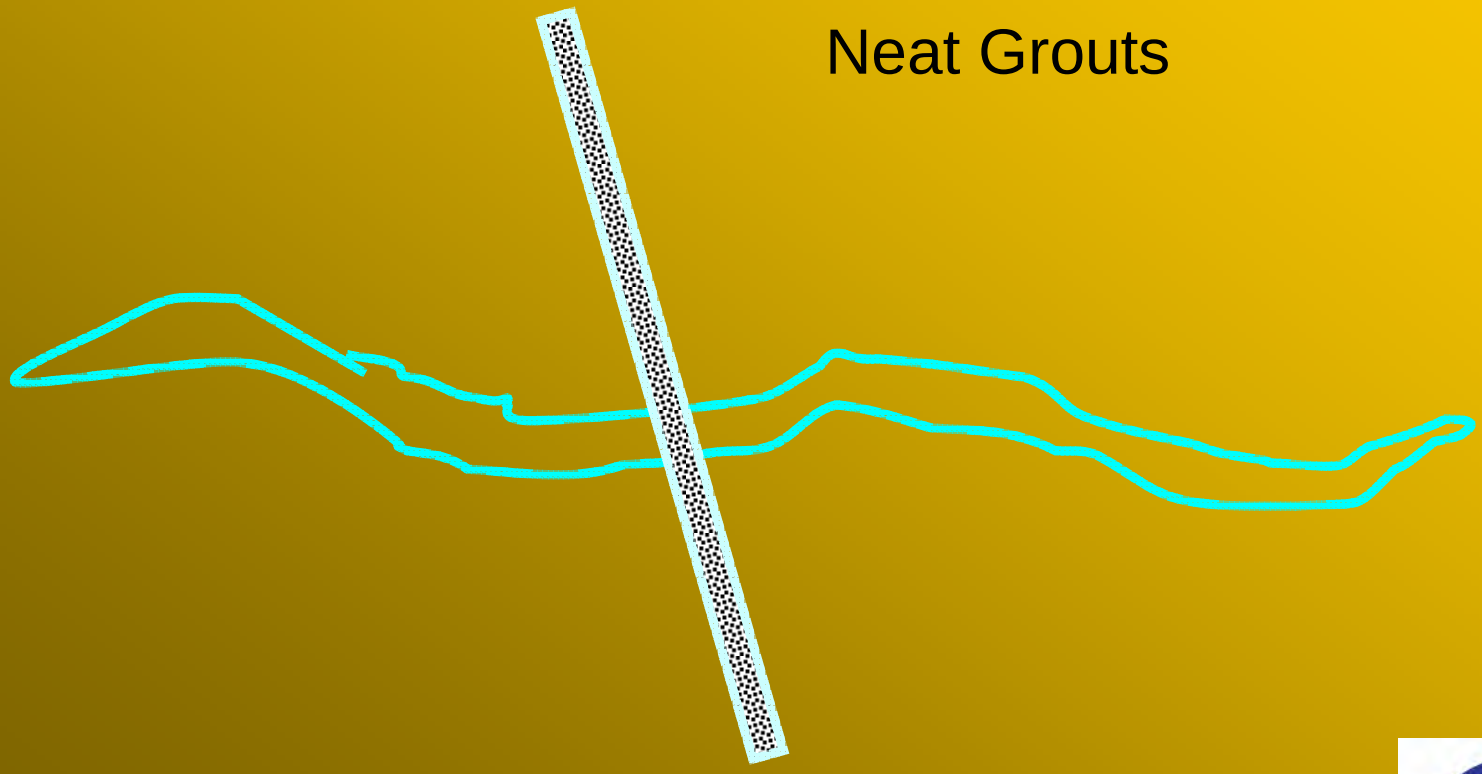



Bleed
MIX A
BLEED TEST
12/18/97
start 0891
MIX D
BLEED TEST
12/18/97
start 1032
MIX F
BLEED TEST
12/18/97
start 1147
MIX G
BLEED TEST
12/18/97
start 1239
Balanced Stable Grouts
A.C.T.
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Stabilized vs. Neat Grouts

Grout Injection Theory

Neat Grouts



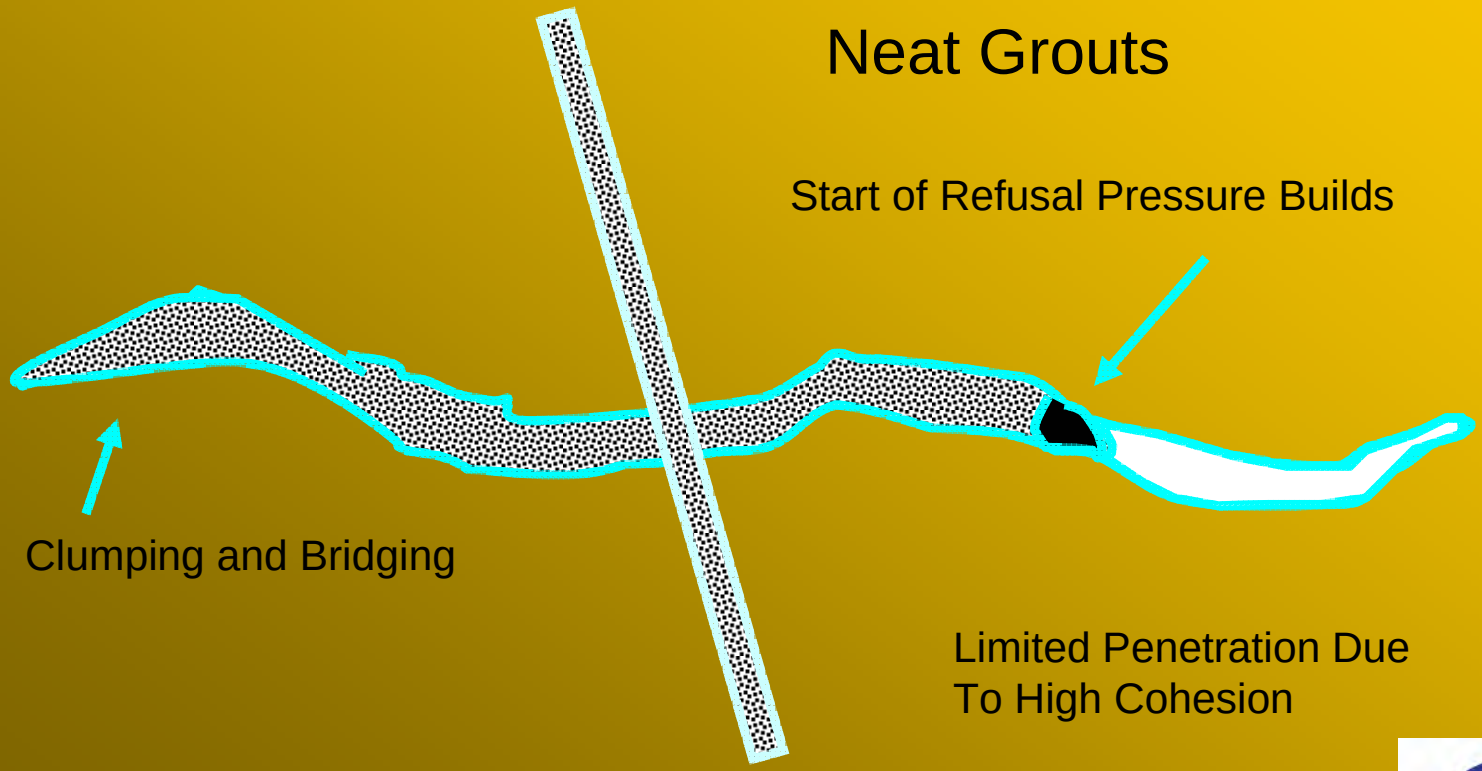
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Stabilized vs. Neat Grouts

Grout Injection Theory

Neat Grouts



A.C.T.

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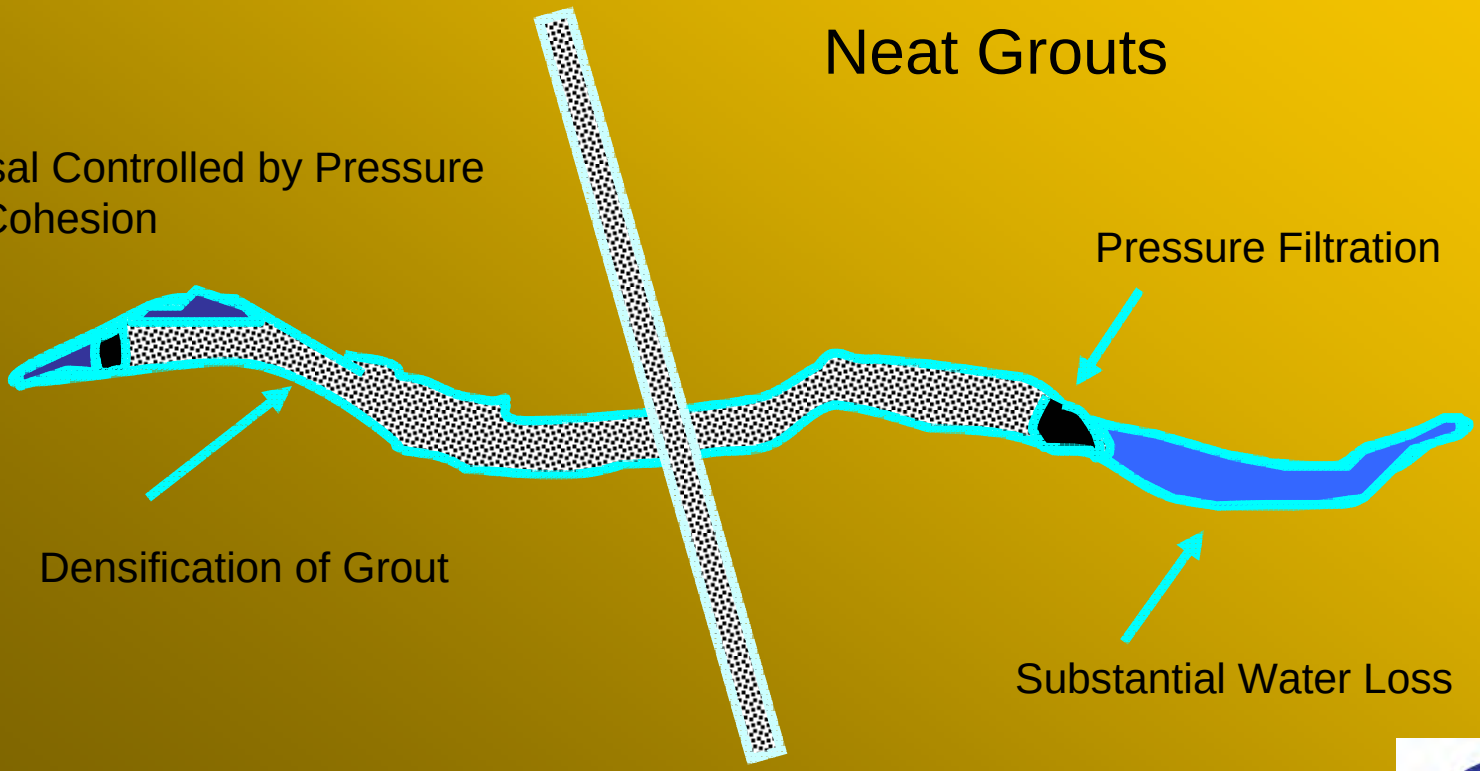
Stabilized vs. Neat Grouts

Grout Injection Theory

Neat Grouts

Refusal Controlled by Pressure and Cohesion

Pressure Filtration



Densification of Grout

Substantial Water Loss

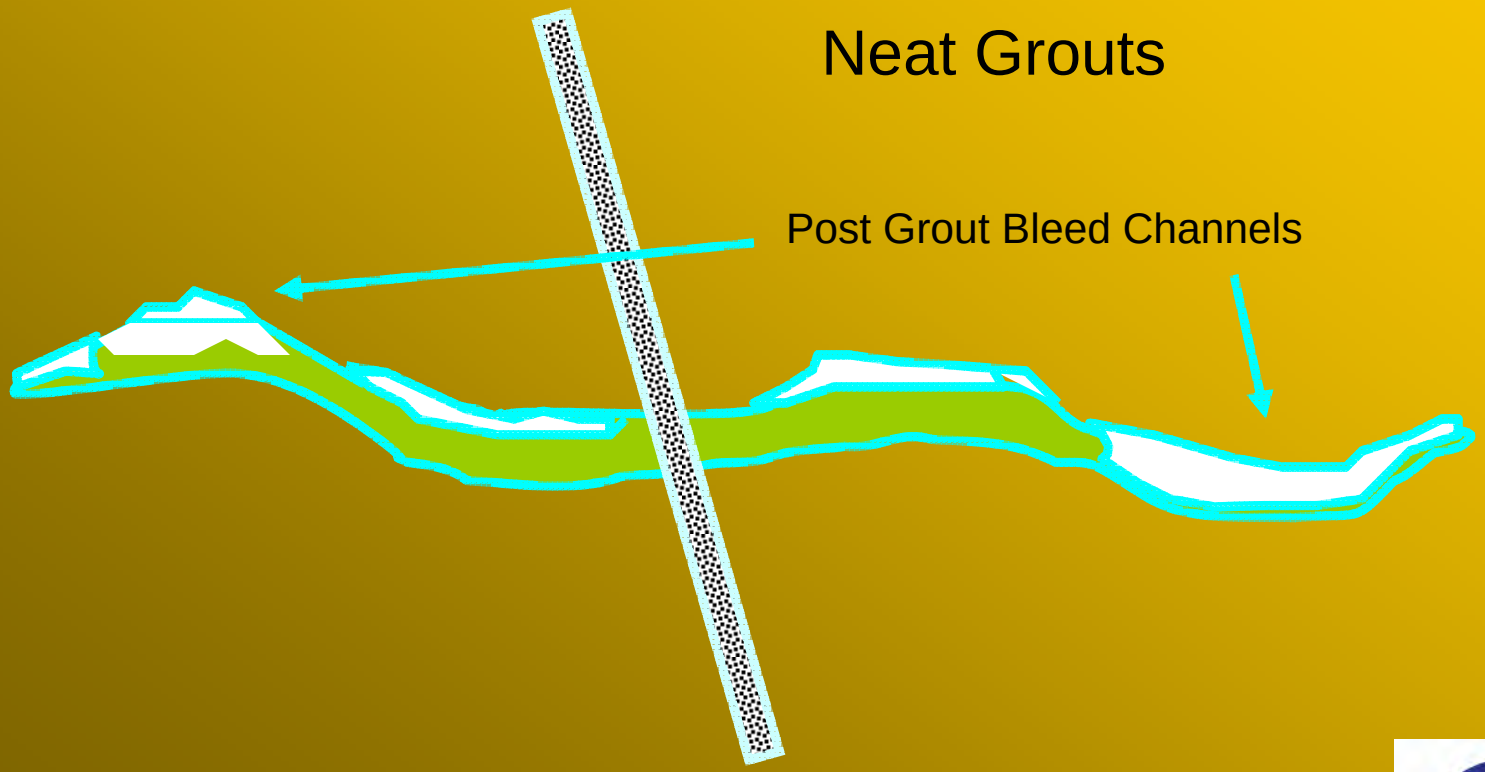
A.C.T.

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Stabilized vs. Neat Grouts

Grout Injection Theory

Neat Grouts

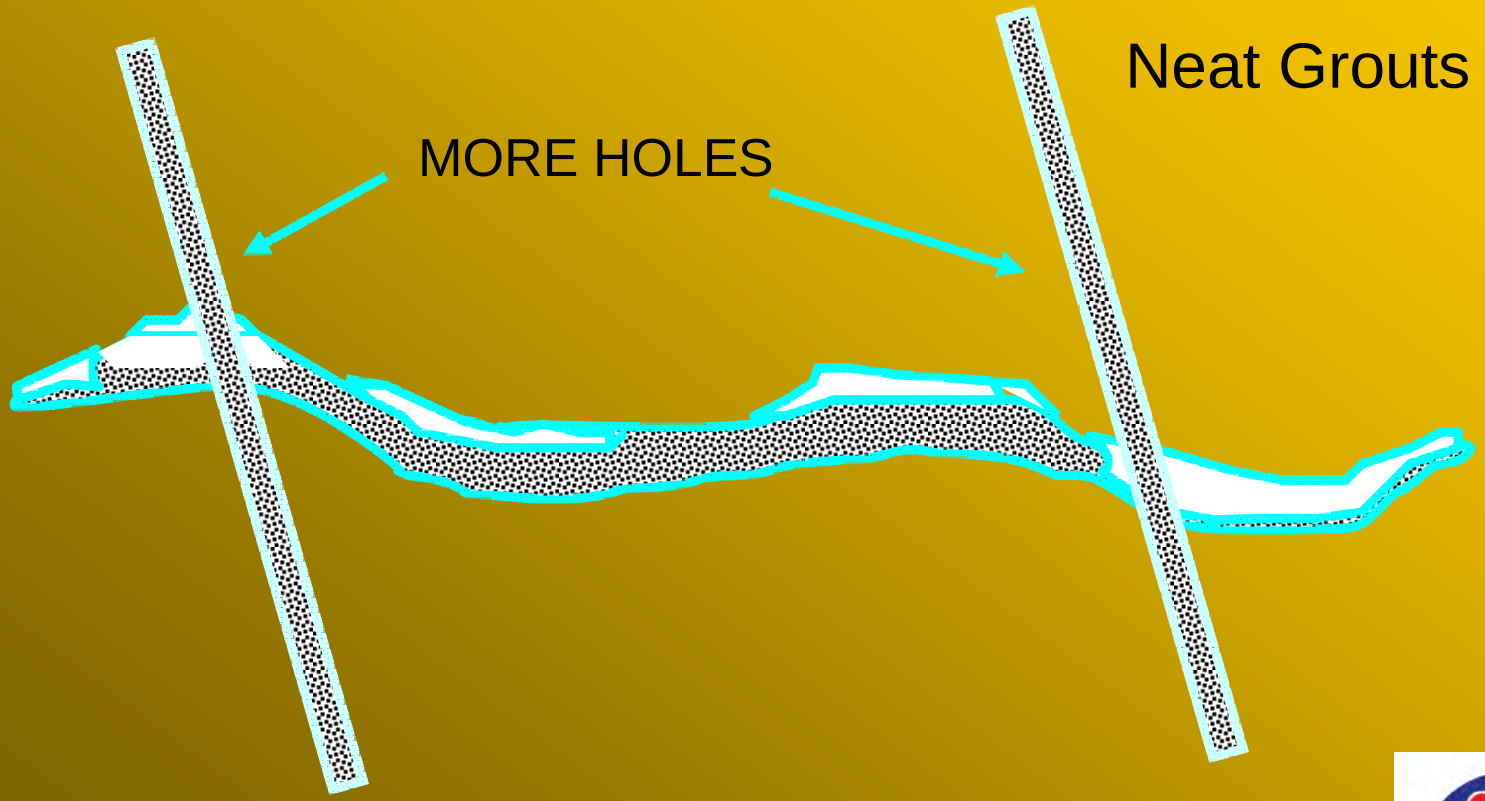


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Stabilized vs. Neat Grouts

Grout Injection Theory



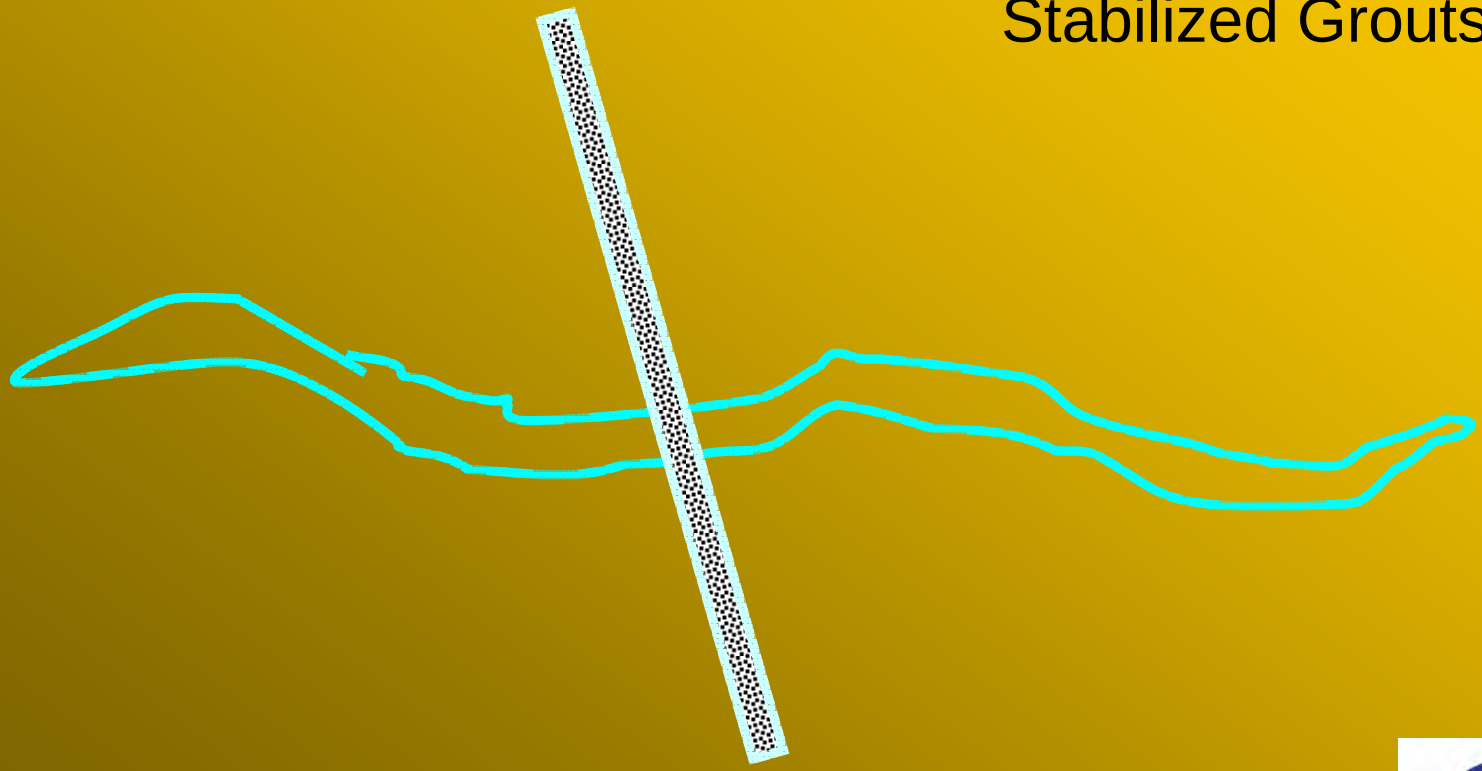
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Stabilized vs. Neat Grouts

Grout Injection Theory

Stabilized Grouts



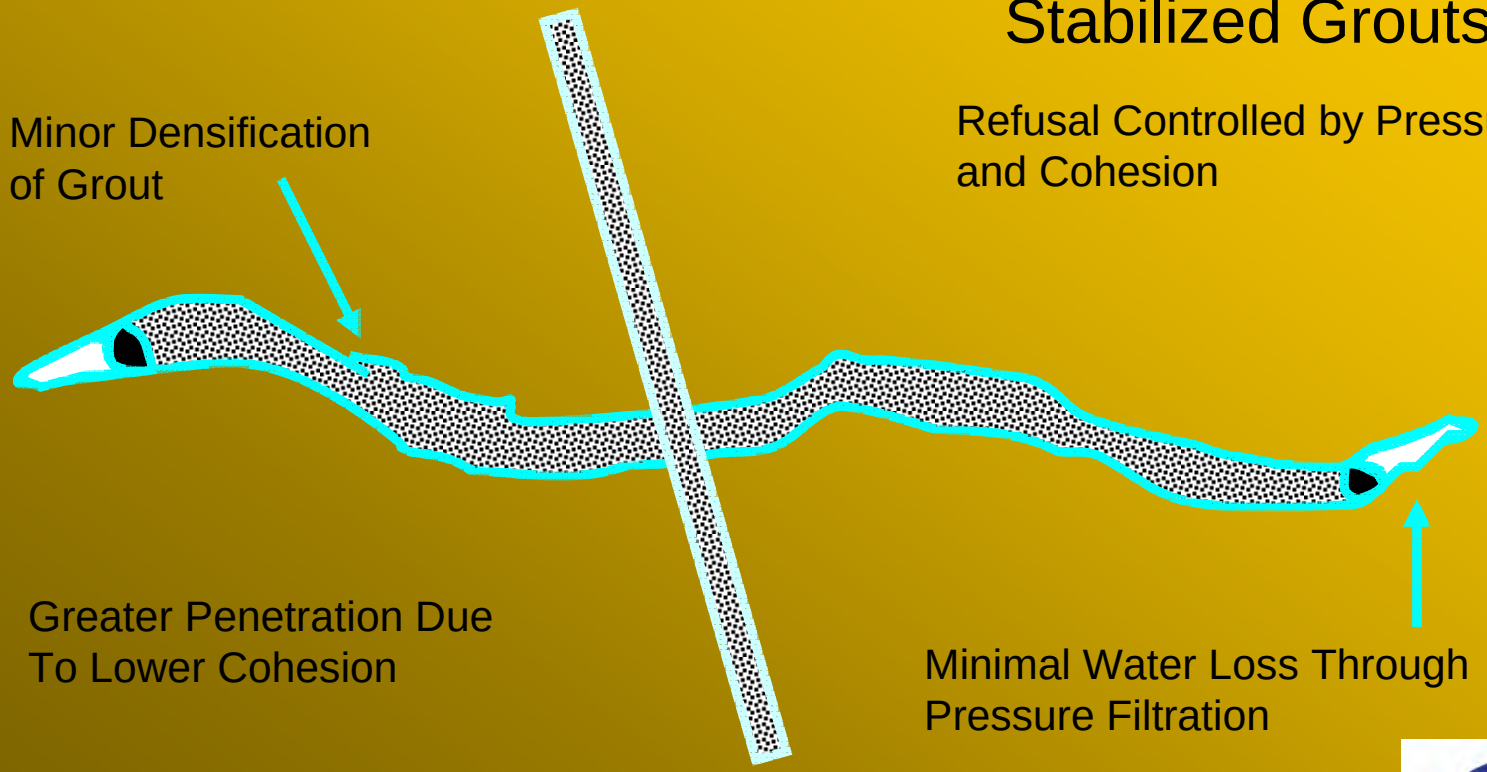
Stabilized vs. Neat Grouts

Grout Injection Theory

Stabilized Grouts

Minor Densification of Grout

Refusal Controlled by Pressure and Cohesion



Greater Penetration Due To Lower Cohesion

Minimal Water Loss Through Pressure Filtration

A.C.T.

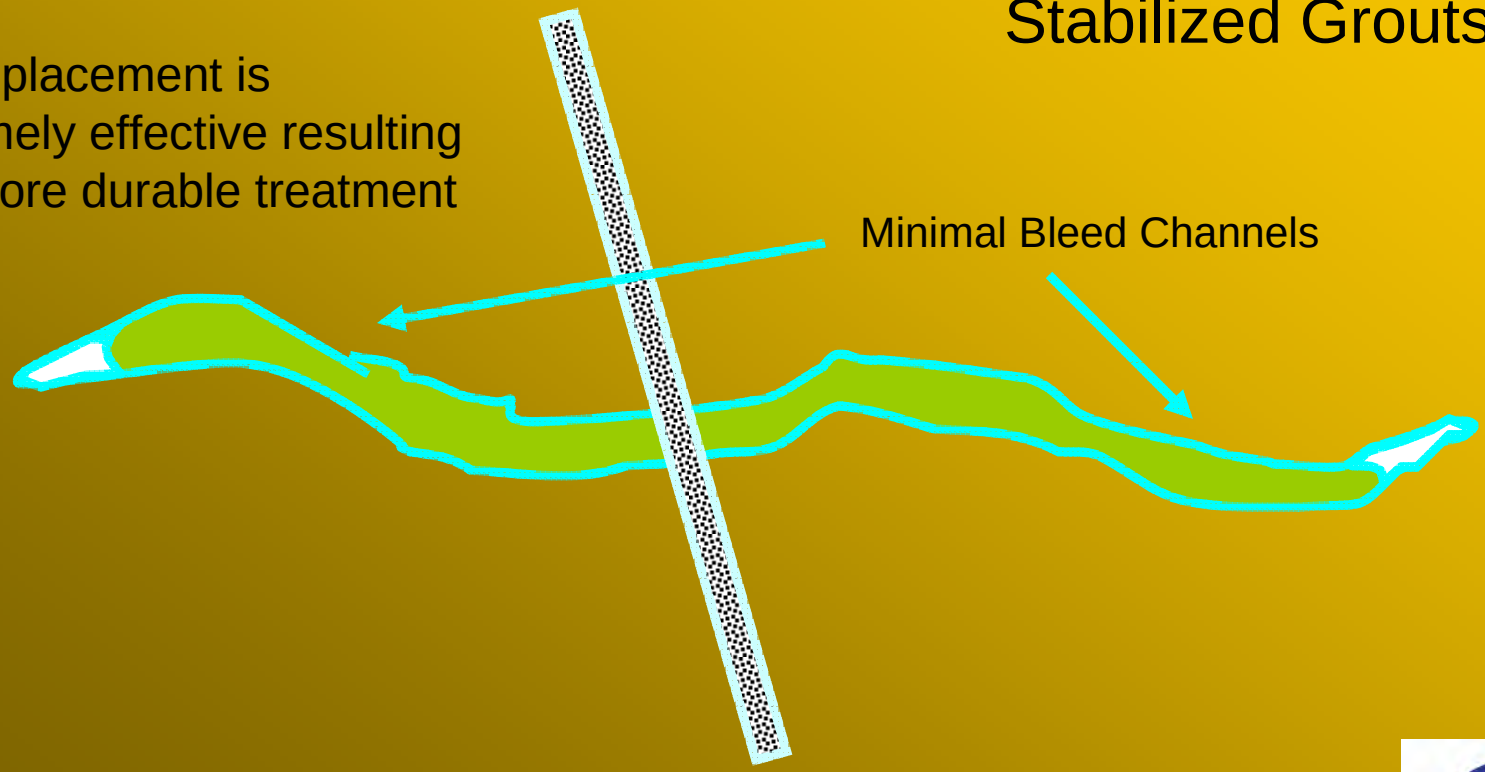
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Stabilized vs. Neat Grouts

Grout Injection Theory

Stabilized Grouts

Grout placement is extremely effective resulting in a more durable treatment



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Characteristics of Balanced Stable Cement-Based Suspension Grouts

- Cement + water + additives + admixtures
- Minimal to zero bleed
- High resistance to pressure filtration
- Organized particles due to electrostatic and chemical interaction
- High durability





Characteristics of Unstable Water Cement Grouts

- Cement + water
- Considerable bleed potential
- Low resistance to pressure filtration
- Unorganized particles
- Lower durability





Advantages of Balanced Stable Grouts

- Dispersed structure, stable rheology and lower cohesion result in increased penetrability and greater radius of grout spread
- Minimal to zero bleed – The fractures that are filled remain 100% filled
- Increased penetration and minimal to zero bleed result in lower residual permeability
- Lower residual curtain and grout matrix permeability result in increased durability





Materials

Common Additives to Balanced Stable Grout

- Bentonite
- Silica Fume
- Flyash (Type C or F)
- Welan Gum
- Dispersant (Super Plasticizer)





Bentonite

- Product

  Natural sodium montmorillonite clay product.

  Typical dosage is 2-8 % by weight of cement.

  Should be pre-hydrated and added as a slurry.

- Characteristics

  Advantages
  Reduced pressure filtration
  Reduced final bleed
  Enhanced stability

  Disadvantages
  Increased cohesion
  Increased viscosity





Silica Fume

- Product

  By-product of the production silicon.

  Very fine spherical particulate.

  Typical dosage between 4-8 % by weight of cement.

- Characteristics

  Advantages

  Increased penetrability
  Reduced final permeability
  Enhanced durability
  Water repellant
  Reduces pressure filtration

  Disadvantages

  Increased Strength





Welan Gum

- Product

  High molecular weight bipolymer.

  Used to increase resistance to pressure filtration and for artesian conditions.

  Typical dosage is 0.1 % by weight of cement.

- Characteristics

  Advantages
  Reduces pressure filtration
  Reduced segregation
  Enhanced water repellant

  Disadvantages
  Increases cohesion

Dispersant

- Product

  Naphthalene sulfonate based.

  Enrobes cement particles with a negative charge so particles repell.

  Typical dosage is 1- 2% by weight of cement.

- Characteristics

  Advantages
  Increased penetrability
  Increased pumping time

  Disadvantages
  Increases set time





Testing

Properties	Test	Units
Cohesion	Viscometer	Pa
Viscosity	Marsh Funnel	Sec
Pressure Filtration	Filter Press	Kpf
Bleed	Cylinders	%
Density	Mud Balance	#/ft3
Set Time	Vicat Needle	Hrs
Compressive Strength	Cubes	psi





Cohesion Testing

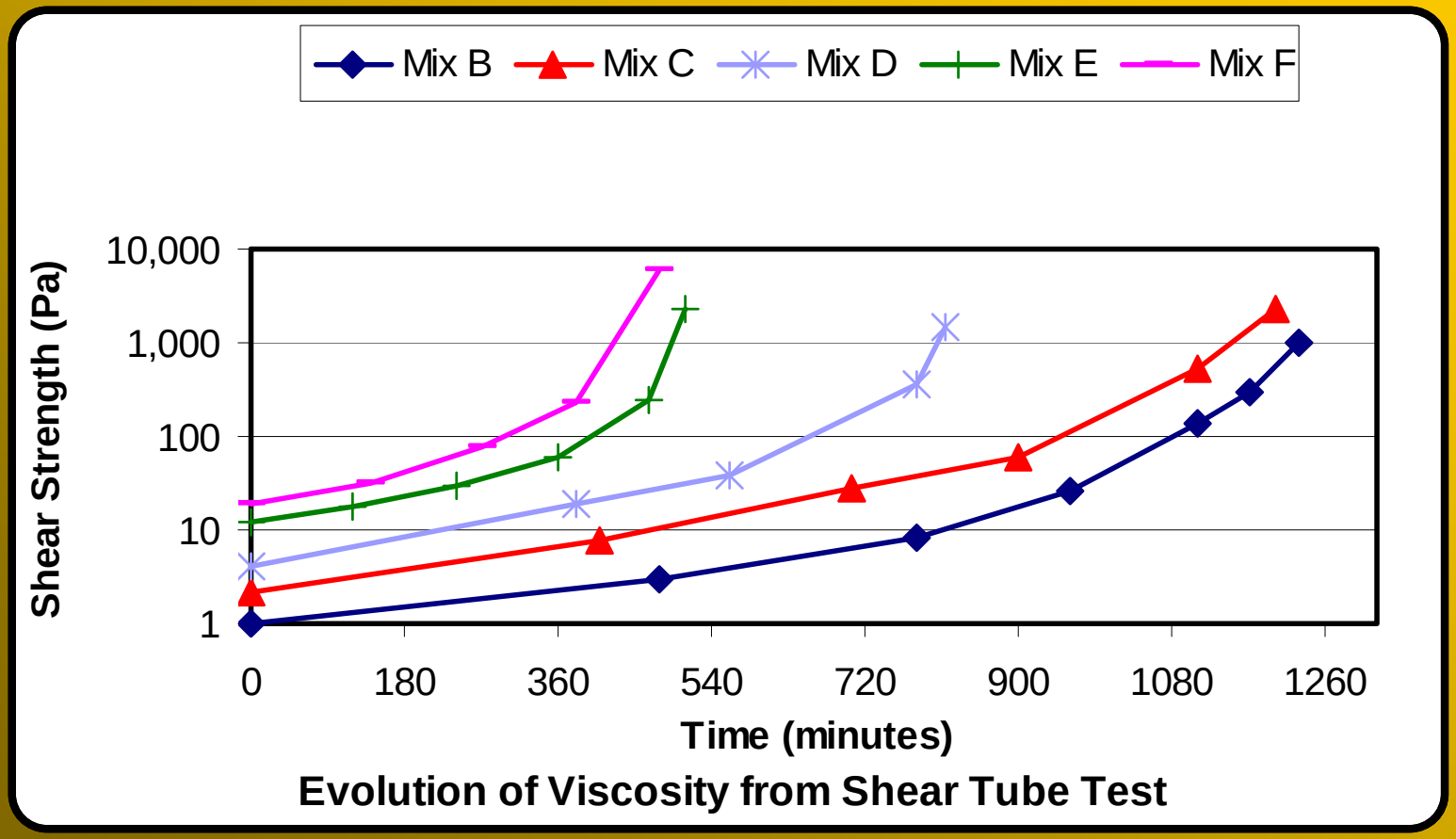
- Viscometer Test
  - Cohesion

    pascals (Pa)





Evolution of Cohesion



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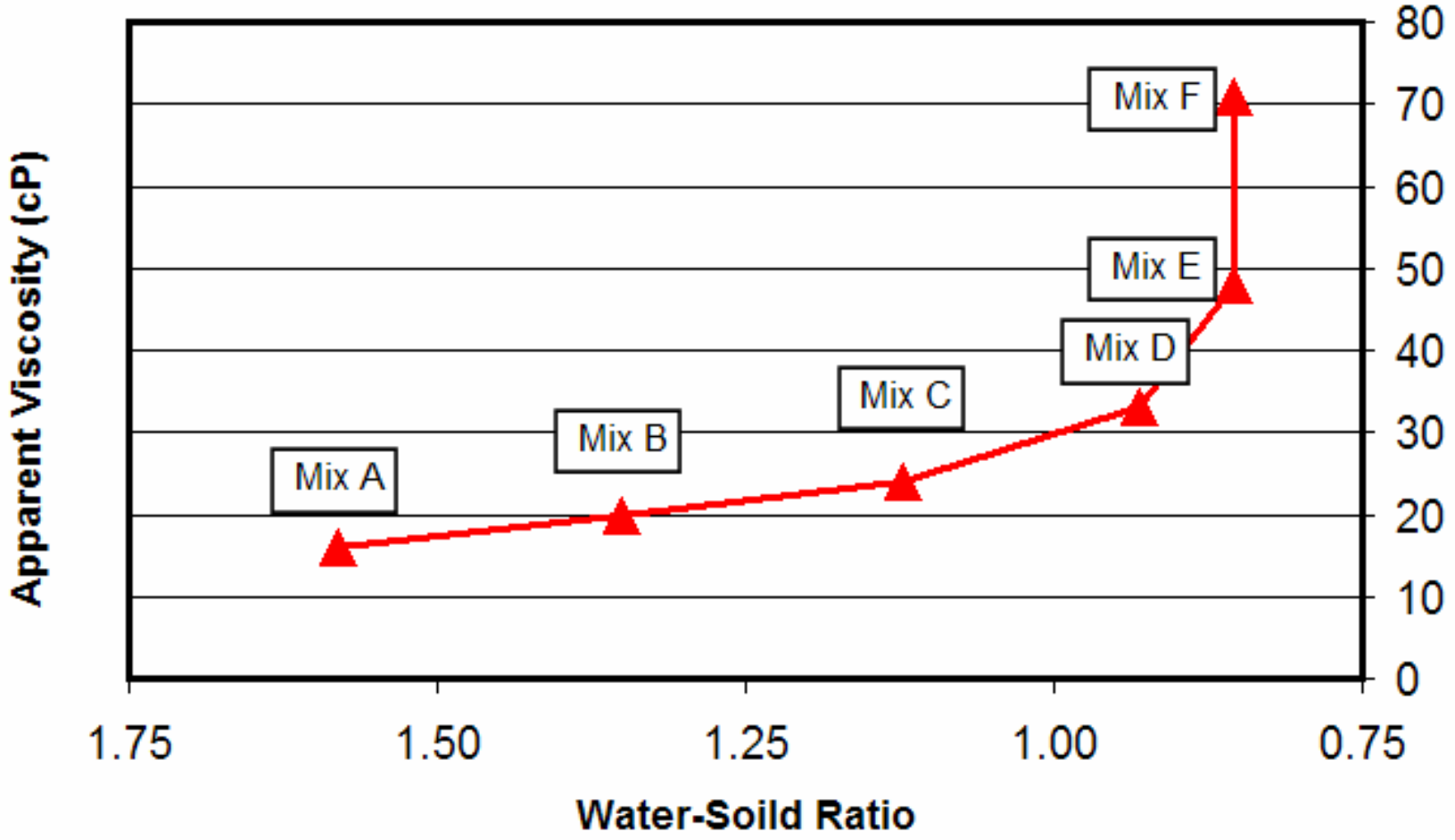
Viscosity (Marsh Funnel)

- Viscosity Reading seconds
- Measure of flowability of fluid grout
- Water = 28 sec
- Grout = 32 – 70 sec



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Relationship of Apparent Viscosity and Water-Soild Ratio

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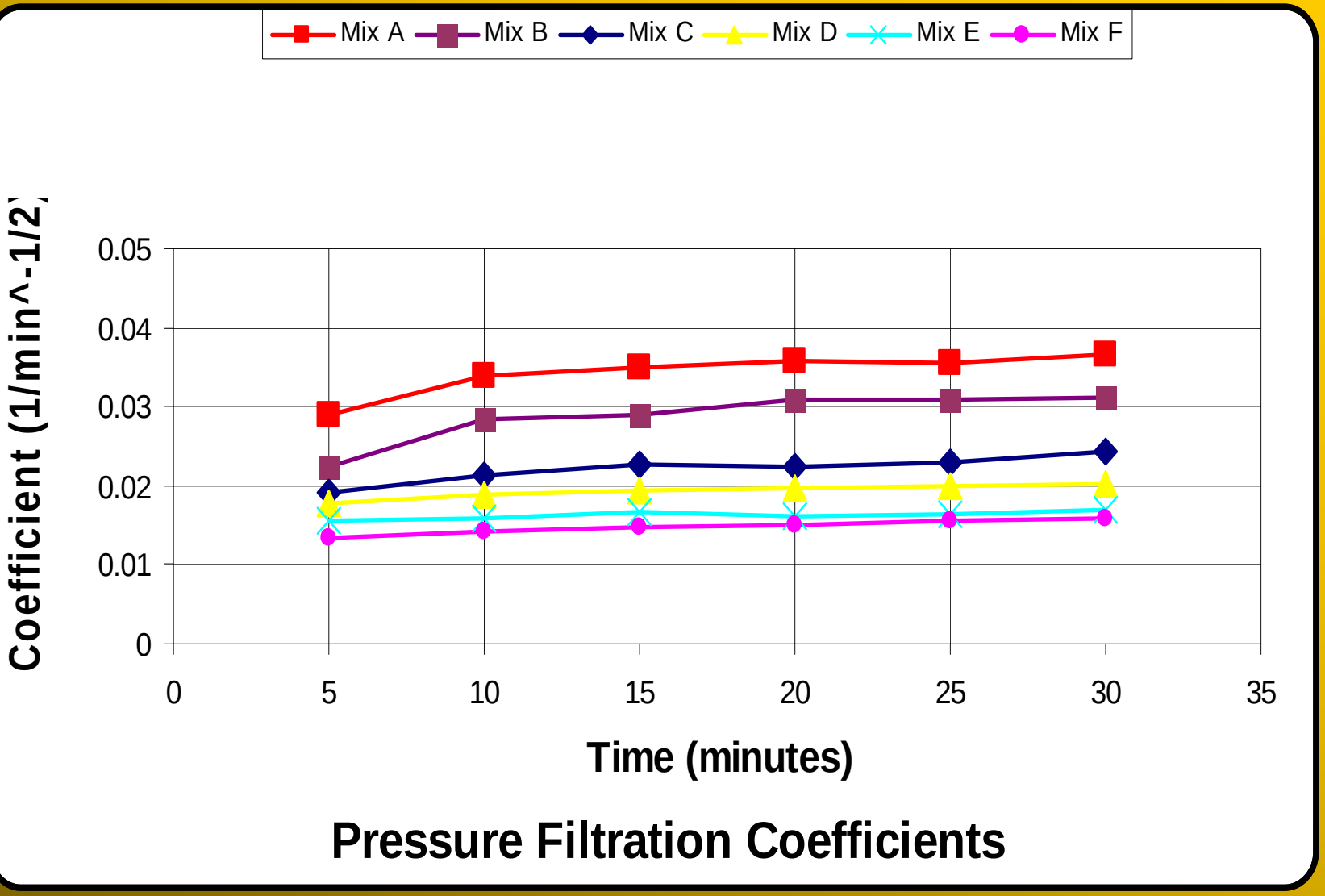
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Pressure Filtration Testing





$$Kpf = \frac{\textit{volume of water ejected}}{\text{initial volume of grout x (filtration time (min))}1/2}$$



Pressure Filtration Coefficients

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Mud Balance

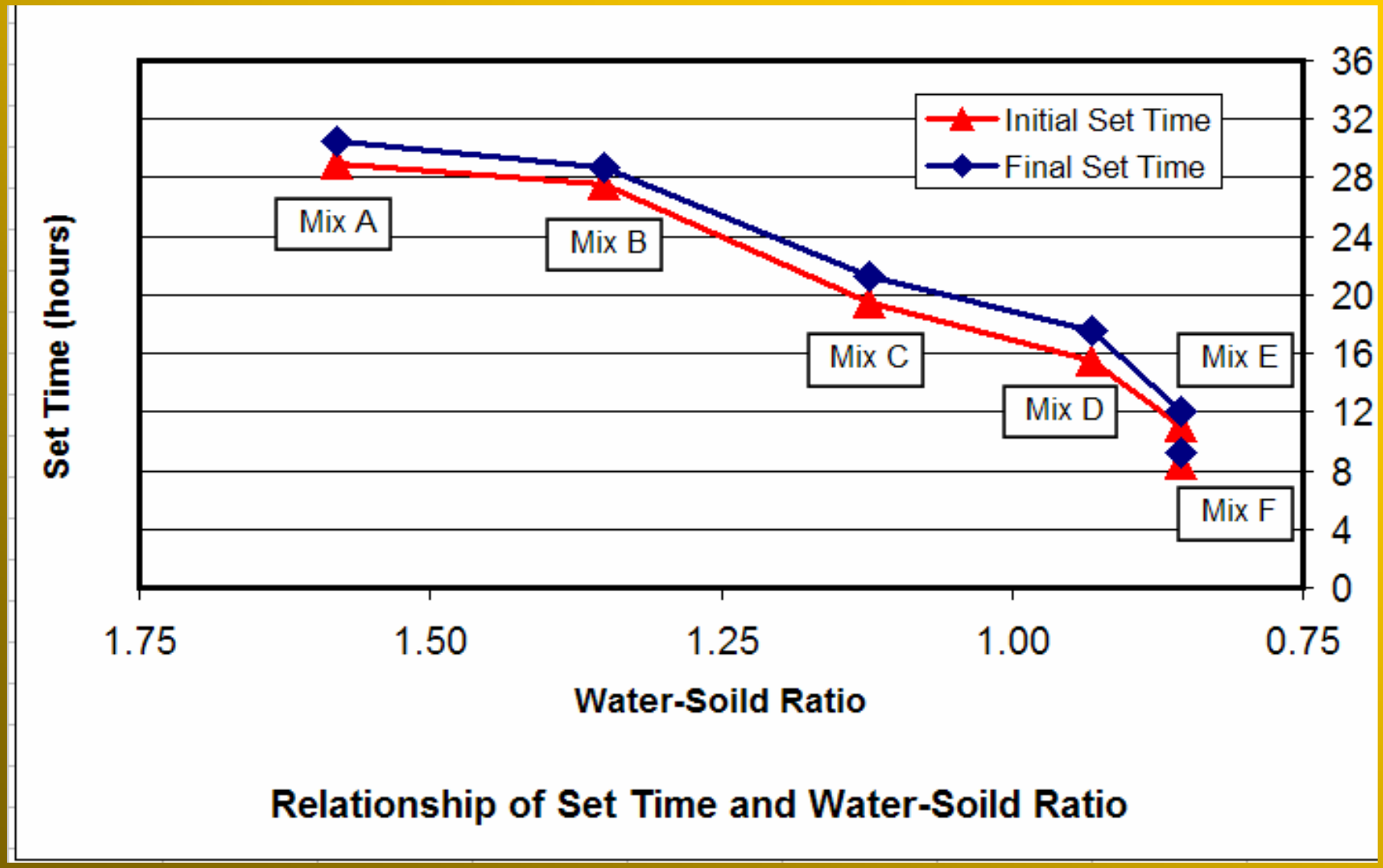
- Measures Density
- Useful test for quality control on mix consistency



Set Time

- Vicat Needle
  Initial set 25 mm
  Final set 0 mm

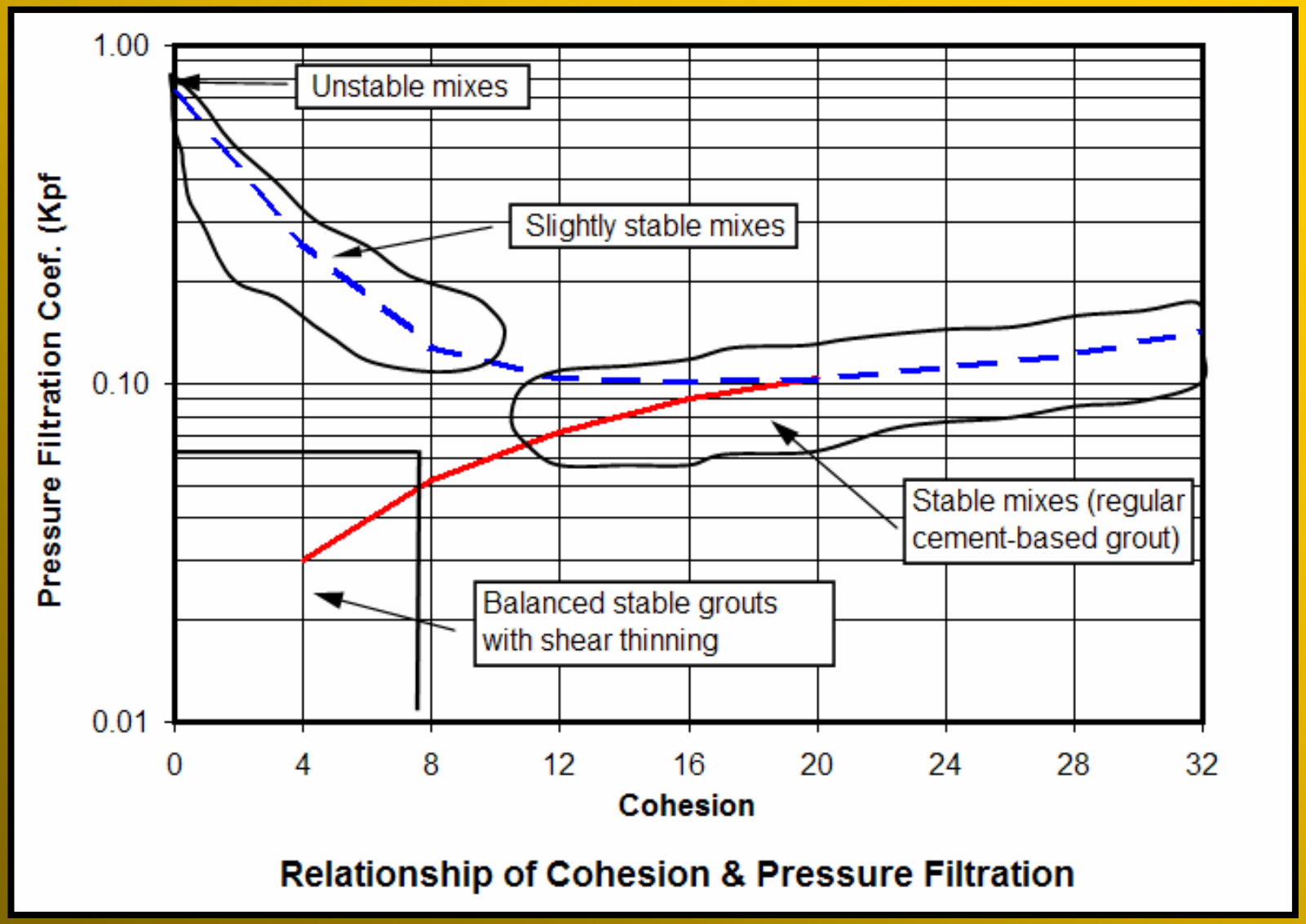




Relationship of Set Time and Water-Soild Ratio

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Relationship of Cohesion & Pressure Filtration

A.C.T.

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THANK YOU

Presented By:

James A. Davies, P.Eng.

Advanced Construction Techniques Ltd.

3935 Lloydtown Aurora Road

Kettleby, Ontario

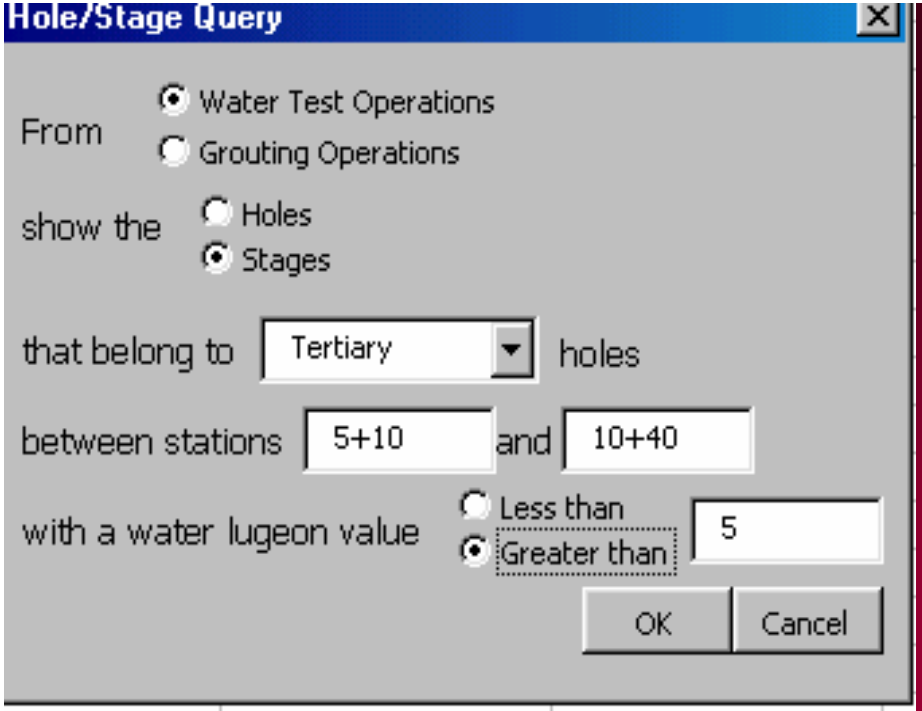
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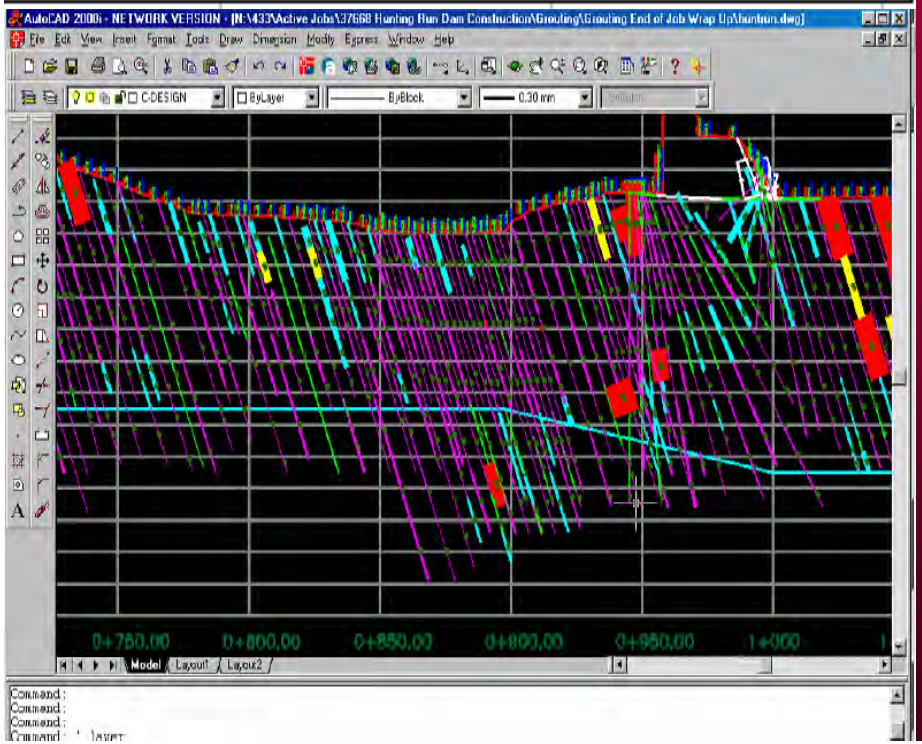
Toll Free Telephone: 877-373-7248

Email: jdavies@agtgroup.com









2005 Tri-Service Infrastructure Systems Conference

Re-Energizing Engineering Excellence

State of the Art in Computer Monitoring and Analysis of Grouting

Trent L. Dreese, P.E.
David B. Wilson, P.E.

Gannett Fleming
ENGINEERS AND PLANNERS

The Old Way of Grouting

- Qualitative Design
  - Example: Depth of holes equal to height of dam
- Vertical Holes –
  - might or might not be appropriate depending on geology
- Unstable Grouts –
  - Typically neat cement grouts
- Pressures – Based on usually conservative rules of thumb
- Data Acquisition – Dipstick and Gauge Technology
- Data Recording - Inspector at each header manually recording and plotting grout take versus time with average pressure recorded.

Data Collection & Monitoring (2000)





Analysis (2000)



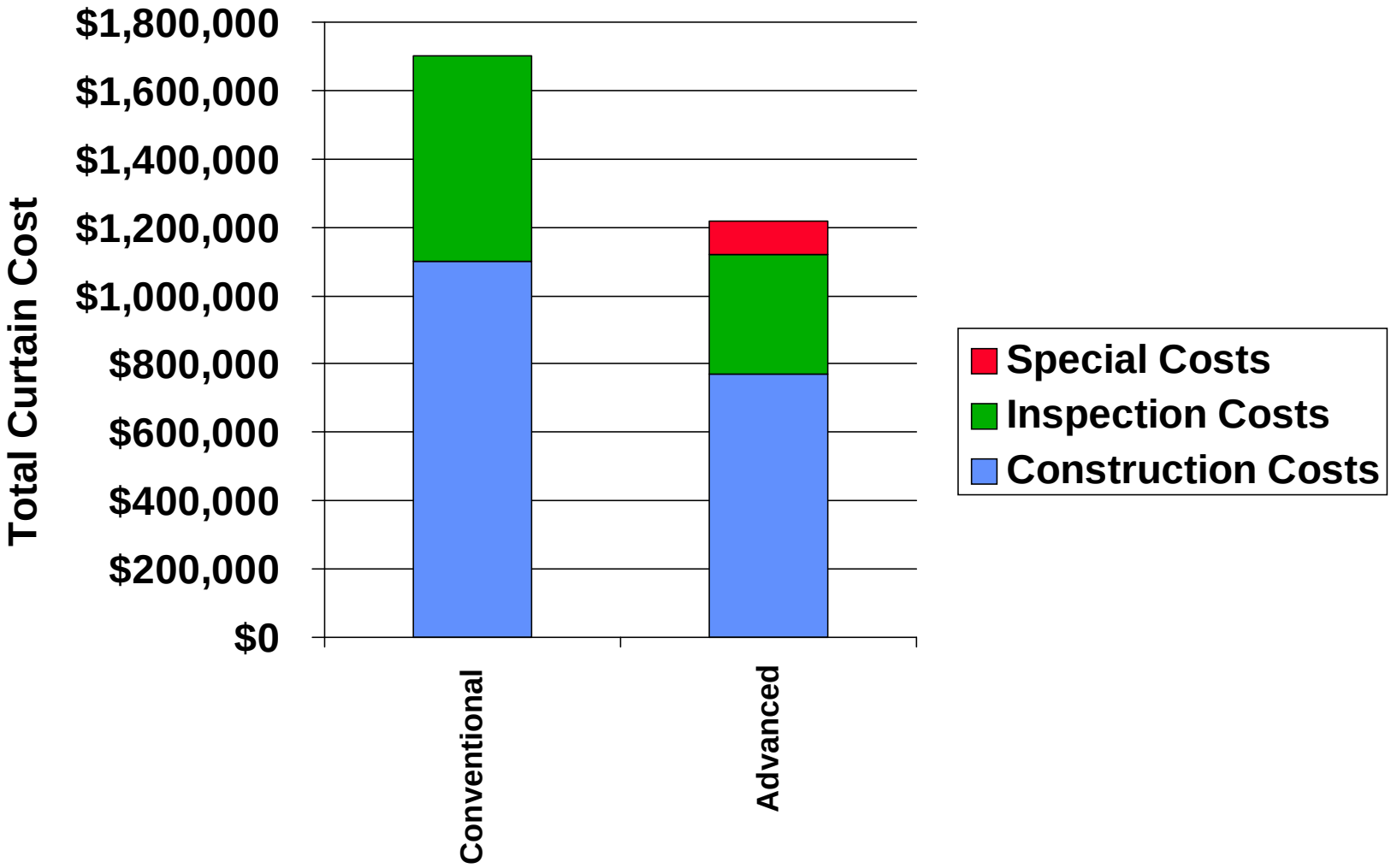
The New Way of Grouting

- Quantitative Design
  - Intensity of Grouting consistent with design assumptions and requirements
- Hole Orientation and Depth selected consistent with site geology
- Stable Grouts with multiple admixtures
- Pressures – Maximum safe pressure utilized
- Data Acquisition – Flowmeters and Pressure Transducers
- Data Recording – Computer Monitoring by experienced Engineer of Geologist

Advantages

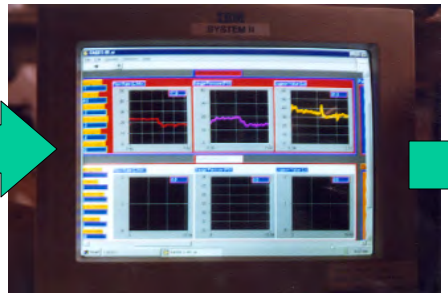
- Measurement Accuracy Significantly Improved
- Real Time Data is obtained (2-10 seconds vs. 5-15 min.)
- Allows one to use higher pressures with confidence; Dilation and Lifting easily picked up on screen
- Formation Response to procedure changes (mix or pressure) are known immediately
- Accelerates the Work
- Reduces Inspection Manpower Requirements
- Permits reallocation of resources to analyze program results and recommend cost effective program modifications.

Curtain Total Costs



Level 2 Technology



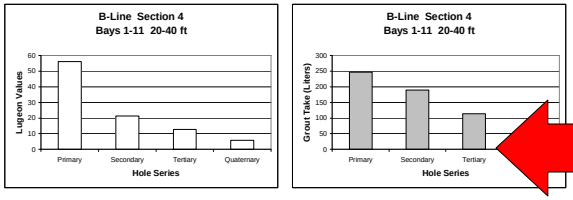


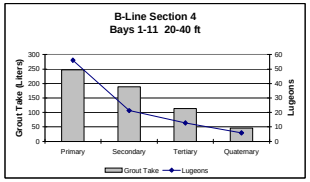
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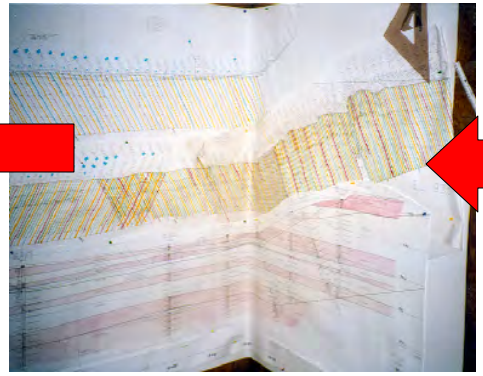
Time (sec.)	Flow (L/min.)	Gauge P. (psi)	Eff. P. (psi)	Apparent Lu Value	Gr. Radius (ft)	Gr. Take (L)	Marsh Time (sec.)	Specific Gravity
0.0647	22.973633	0	-10.20876	731.433834	0.106854	0.743197	38	1.32
0.15975	24.5	0	-11.521	780.015	0.208	2.999	38	1.32
0.25359333	23.828	0	-10.944	758.639	0.279	5.267	38	1.32
0.34745	20.654	0	-8.214	657.591	0.355	7.354	38	1.32
0.4414	18.03	0.146	-5.811	574.032	0.424	9.172	38	1.32
0.53531667	17.603	0	-5.59	560.429	0.468	10.845	38	1.32
0.62925	18.152	0.879	-5.183	577.918	0.494	12.524	38	1.32
0.72323333	17.053	0	-5.117	542.94	0.542	14.178	38	1.32
0.81725	16.992	1.245	-3.82	540.997	0.573	15.779	38	1.32
0.91123333	16.26	0	-4.435	517.678	0.614	17.341	38	1.32
1.0053	16.138	2.71	-1.62	513.791	0.643	18.865	38	1.32
1.09928333	15.71	1.245	-2.717	500.189	0.677	20.362	38	1.32
1.19335	20.654	12.231	4.017	163.689	1.231	22.072	38	1.32
1.28736667	23.035	16.626	6.365	115.225	1.534	24.128	38	1.32
1.38141667	22.461	16.626	6.209	114.973	1.58	25.961	38	1.32
1.47551667	22.461	16.626	6.209	114.973	1.58	25.961	38	1.32
1.56958333	22.461	16.626	6.209	114.973	1.627	27.795	38	1.32
1.6636667	22.363	18.823	9.139	77.905	2.172	32.682	38	1.32
1.7576667	22.058	18.457	9.036	77.724	2.243	34.772	38	1.32
1.8517	22.485	19.189	9.401	76.153	2.333	36.868	38	1.32
1.9461667	22.546	19.922	10.081	71.21	2.48	38.328	38	1.32
2.0403333	22.18	19.556	10.029	70.411	2.541	40.433	38	1.32
2.10495	22.302	20.288	10.657	66.63	2.679	42.526	38	1.32
2.16981667	21.631	19.922	10.868	63.368	2.793	43.951	38	1.32
2.26398333	21.936	21.021	11.704	59.671	2.944	46.002	38	1.32
2.35805	21.936	21.753	12.437	56.157	3.102	48.065	38	1.32
2.45221667	21.814	22.852	13.64	50.917	3.327	50.125	38	1.32
2.54628333	21.387	20.654	11.81	57.654	3.19	52.157	38	1.32
2.64036667	21.753	21.387	12.228	56.639	3.28	54.187	38	1.32
2.735	21.082	20.654	12.073	55.596	3.372	56.213	38	1.32
2.8292167	21.509	22.119	13.17	51.996	3.548	58.22	38	1.32
2.92351667	21.692	23.218	14.111	48.941	3.721	60.257	38	1.32
3.01835	21.936	24.683	15.366	45.45	3.927	62.325	38	1.32
3.11298333	21.082	21.753	13.171	50.959	3.769	64.361	38	1.32

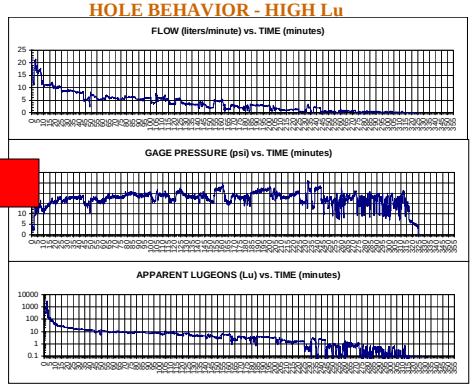
SAMPLE TEXT FILE (CAGES OUTPUT)

HOLE BEHAVIOR - HIGH Lu









Water Lugeon Value = 100

S3B16S\grt0_20

Key:

- Automatically obtained by system
- Obtained with moderate additional effort
- Obtained with significant additional effort



Original CAGES File 2.txt - Notepad

File Edit Format View Help

CAGES Output

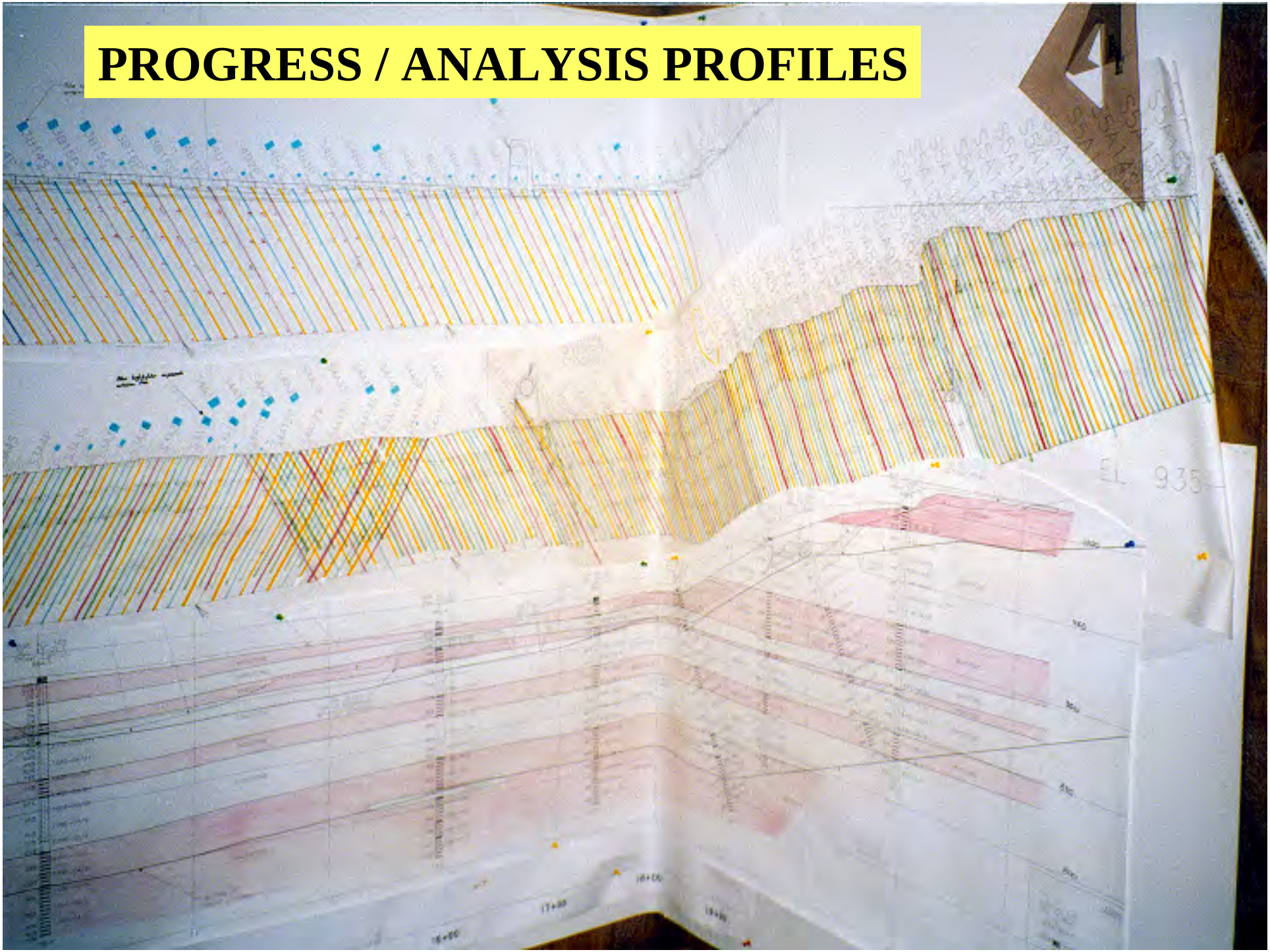
Project:	Lyman Run Dam
C:\Lyman Run Dam\CS24_100-107_0_USFT.xls	
Grouting Date	08\29\2006
Starting Time	12:54 AM
Unit Type:	US Standard
Grouting Type:	Rock Grouting

Comments:

Accessible Porosity	Lugeon Start	Lugeon End	Stage Length (ft)	Packer Depth (ft)	Water Lv.	Gauge Rt. (ft)	Hole Rt. (ft)	H. Plunge (deg)	G.W.Table (ft)	Hole Dia. (in)
0.75 180 350	7.6 100	10	4.5 0	60 -9.7	3					

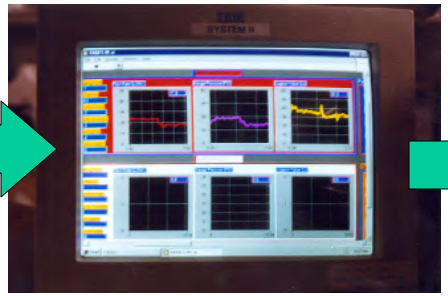
Elapsed Time (secs)	Time	Flow (gpm)	Gauge P. (psi)	Off P. (psi)	Acc. Lugeon	Gr Radius (ft)	Gr Take (ft³)	Marsh Time	Mix S.G.	Mix	Init. Lugeon	Init Amenability
4.984 10:54:51 AM	0	1.239716	13.607785	0	0	0	38	1.4	Mix A	0	0	
9.835 10:55:00 AM	0	1.250011	16.648452	0	0	0	38	1.4	Mix A	0	0	
14.898 10:55:05 AM	0	1.178473	16.54651	0	0	0	38	1.4	Mix A	0	0	
20.002 10:55:10 AM	0	1.226538	16.593575	0	0	0	38	1.4	Mix A	0	0	
24.984 10:55:15 AM	0	1.244559	16.652596	0	0	0	38	1.4	Mix A	0	0	
29.936 10:55:20 AM	0	1.226538	16.594575	0	0	0	38	1.4	Mix A	0	0	
34.887 10:55:25 AM	0	4.286663	19.606699	0	0	0	38	1.4	Mix A	0	0	
40.005 10:55:30 AM	0.4683 4.200621		13.282994	7.664519	0.528367	0.005335	38	1.4	Mix A	0		
44.964 10:55:35 AM	1.237083	4.212633	18.826031	20.73936	0.99743	0.059015	38	1.4	Mix A	0		
49.928 10:55:40 AM	1.23802 5.378234		13.691079	18.745702	1.308147	0.052702	38	1.4	Mix A	0		
54.889 10:55:45 AM	1.237812	5.474364	22.687338	19.448774	1.557909	0.048388	38	1.4	Mix A	0		
60.023 10:55:50 AM	1.284798	5.468199	18.810909	23.469212	1.549196	0.061336	38	1.4	Mix A	0		
64.984 10:55:55 AM	1.237714	5.462113	18.812719	23.480881	1.290149	0.065739	38	1.4	Mix A	0		
69.93 10:56:00 AM	1.186651	4.779543	15.684396	17.463431	1.111362	0.102108	38	1.4	Mix A	0		
74.892 10:56:05 AM	1.650111	4.782948	19.088517	27.449179	2.510504	0.120462	38	1.4	Mix A	0		
80.005 10:56:10 AM	10.10297	4.719726	13.624933	228.989346	5.510586	0.295553	38	1.4	Mix A	0		
84.967 10:56:15 AM	10.10349	4.747367	13.652276	229.152705	5.262424	0.347253	38	1.4	Mix A	0		
89.93 10:56:20 AM	10.103052	4.81346	14.017415	227.523768	5.900448	0.418988	38	1.4	Mix A	0	0	
94.894 10:56:25 AM	10.107637	4.929078	14.031444	227.336859	5.464723	0.370776	38	1.4	Mix A	0	0	
100.005 10:56:30 AM	10.56213	4.81346	13.516207	253.886624	6.02757	0.594807	38	1.4	Mix A	0		
104.969 10:56:35 AM	10.561108	0	8.742141	392.216885	6.528406	0.814399	38	1.4	Mix A	0	0	
109.93 10:56:40 AM	10.561964	0	8.748218	391.309887	6.992734	0.934595	38	1.4	Mix A	0	0	
114.894 10:56:45 AM	0 0	15.368037	0	8.992734	0.934595	38	1.4	Mix A	0	0		
120.007 10:56:50 AM	0 0	15.368037	0	8.992734	0.934595	38	1.4	Mix A	0	0		
124.969 10:56:55 AM	0 0	15.368037	0	8.992734	0.934595	38	1.4	Mix A	0	0		
129.933 10:57:00 AM	0 0	15.368037	0	8.992734	0.934595	38	1.4	Mix A	0	0		
134.996 10:57:05 AM	2.81922 0	13.648312	35.194361	7.1084	1.265768	38	1.4	Mix A	0	0		
140.01 10:57:10 AM	2.820762	0	13.647677	65.221486	7.223691	0.697908	38	1.4	Mix A	0	0	
144.969 10:57:15 AM	2.817658	16.084168	27.738433	32.065989	7.337534	1.029035	38	1.4	Mix A	0	0	
149.933 10:57:20 AM	0 14.069751	29.437788	0	7.337534	1.029035	38	1.4	Mix A	0	0		
154.995 10:57:25 AM	0 14.082668	29.451005	0	7.337534	1.029035	38	1.4	Mix A	0	0		
160.05 10:57:30 AM	0 16.581196	31.949233	0	7.337534	1.029035	38	1.4	Mix A	0	0		
164.973 10:57:35 AM	0 16.582388	31.950434	0	7.337534	1.029035	38	1.4	Mix A	0	0		
169.933 10:57:40 AM	0 16.583599	31.951636	0	7.337534	1.029035	38	1.4	Mix A	0	0		
174.899 10:57:45 AM	0 16.584696	31.952743	0	7.337534	1.029035	38	1.4	Mix A	0	0		
180.212 10:57:50 AM	0 15.306361	40.674308	0	7.337534	1.029035	38	1.4	Mix A	0	0		
184.972 10:57:55 AM	0 15.323569	40.691606	0	7.337534	1.029035	38	1.4	Mix A	0	0		
189.937 10:58:00 AM	0 15.3895<1	40.657778	0	7.337534	1.029035	38	1.4	Mix A	0	0		
194.947 10:58:05 AM	0 35.44132	50.709257	0	7.337534	1.029035	38	1.4	Mix A	0	0		
200.01 10:58:10 AM	0 34.926757	50.294793	0	7.337534	1.029035	38	1.4	Mix A	0	0		
204.976 10:58:15 AM	0.013992	34.92073	50.2808	0.082179	7.338051	1.029179	38	1.4	Mix A	0.017653	0.001104	
209.937 10:58:20 AM	0.012368	34.926737	50.287242	0.077346	7.338338	1.029316	38	1.4	Mix A	0.028252	0.028252	0.001768
214.9 10:58:25 AM	0.01453 42.363229	57.92239	0.079283	7.339133	1.029477	38	1.4	Mix A	0.026882	0.002303		
220.014 10:58:30 AM	0.012467	42.595273	57.955705	0.067898	7.339618	1.029618	38	1.4	Mix A	0.041493	0.002593	
224.976 10:58:35 AM	2.530745	42.528121	56.452403	14.149005	7.438671	1.057397	38	1.4	Mix A	1.778182	0.111136	
229.94 10:58:40 AM	2.532827	44.531615	59.138669	13.745200	7.539541	1.08761 38	1.4	Mix A	3.225457	0.107347		
234.9 10:58:45 AM	2.531266	48.826215	82.61018	12.731918	7.633029	1.113582	38	1.4	Mix A	4.166082	0.260379	
240.018 10:58:50 AM	3.278313	48.82742	82.216564	18.213822	7.716129	1.149791	38	1.4	Mix A	5.337085	0.334818	
244.98 10:58:55 AM	3.247771	43.314007	76.207209	15.971716	7.8272 1.184021	38	1.4	Mix A	0.29272	0.293284		
249.943 10:59:00 AM	3.241587	32.901069	65.814543	15.082856	7.88745	1.218369	38	1.4	Mix A	7.041345	0.440159	
254.903 10:59:05 AM	3.144667	34.739527	68.189317	16.555202	8.100464	1.25415 38	1.4	Mix A	7.652263	0.478288		
260.059 10:59:10 AM	2.224257	34.741942	68.763272	10.117015	8.181293	1.276275	38	1.4	Mix A	7.884137	0.490255	
264.981 10:59:15 AM	2.223727	34.729911	68.753868	10.115348	8.238728	1.305639	38	1.4	Mix A	9.009629	0.560227	
269.945 10:59:20 AM	2.225403	22.555792	56.578538	10.029245	8.337611	1.32802 38	1.4	Mix A	8.400565	0.525054		

PROGRESS / ANALYSIS PROFILES



Level 3 Technology



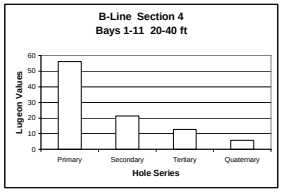


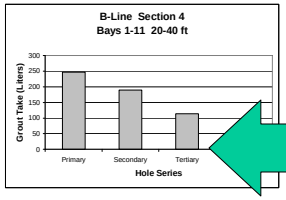
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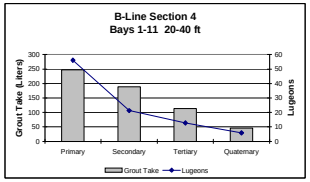
Time (sec.)	Flow (L/min.)	Gauge. P. (psi)	Eff. P. (psi)	Apparent Lu Value	Gr. Radius (ft)	Gr. Take (L)	Marsh Time (sec.)	Specific Gravity
0.0647	22.973633	0	-10.20876	731.433834	0.106854	0.743197	38	1.32
0.15975	24.5	0	-11.521	780.015	0.208	2.999	38	1.32
0.25359333	23.828	0	-10.944	758.639	0.279	5.267	38	1.32
0.34745	20.654	0	-8.214	657.591	0.355	7.354	38	1.32
0.4414	18.03	0.146	-5.811	574.032	0.424	9.172	38	1.32
0.53531667	17.603	0	-5.59	560.429	0.468	10.845	38	1.32
0.62925	18.152	0.879	-5.183	577.918	0.494	12.524	38	1.32
0.72323333	17.053	0	-5.117	542.94	0.542	14.178	38	1.32
0.81725	16.992	1.245	-3.82	540.997	0.573	15.779	38	1.32
0.91123333	16.26	0	-4.435	517.678	0.614	17.341	38	1.32
1.0053	16.138	2.71	-1.62	513.791	0.643	18.865	38	1.32
1.09928333	15.71	1.245	-2.717	500.189	0.677	20.362	38	1.32
1.19335	20.654	12.231	4.017	163.689	1.231	22.072	38	1.32
1.28736667	23.035	16.626	6.365	115.225	1.534	24.128	38	1.32
1.38141667	22.211	16.626	5.709	14.973	1.58	25.981	38	1.32
1.47551667	22.211	16.626	5.709	14.973	1.58	25.981	38	1.32
1.56958333	22.58	18.579	7.597	77.664	2.122	30.05	38	1.32
1.6636667	22.363	18.823	9.139	77.905	2.172	32.682	38	1.32
1.7576667	22.058	18.457	9.036	77.724	2.243	34.772	38	1.32
1.8517	22.485	19.189	9.401	76.153	2.333	36.868	38	1.32
1.9461667	22.546	19.922	10.081	71.21	2.48	38.328	38	1.32
2.0403333	22.18	19.556	10.029	70.411	2.541	40.433	38	1.32
2.10495	22.302	20.288	10.657	66.63	2.679	42.526	38	1.32
2.16981667	21.631	19.922	10.868	63.368	2.793	43.951	38	1.32
2.26398333	21.936	21.021	11.704	59.671	2.944	46.002	38	1.32
2.35805	21.936	21.753	12.437	56.157	3.102	48.065	38	1.32
2.45221667	21.814	22.852	13.64	50.917	3.327	50.125	38	1.32
2.54628333	21.387	20.654	11.81	57.654	3.19	52.157	38	1.32
2.64036667	21.753	21.387	12.228	56.639	3.28	54.187	38	1.32
2.735	21.082	20.654	12.073	55.596	3.372	56.213	38	1.32
2.8292167	21.509	22.119	13.17	51.996	3.548	58.22	38	1.32
2.92351667	21.692	23.218	14.111	48.941	3.721	60.257	38	1.32
3.01835	21.936	24.683	15.366	45.45	3.927	62.325	38	1.32
3.11298333	21.082	21.753	13.171	50.959	3.769	64.361	38	1.32

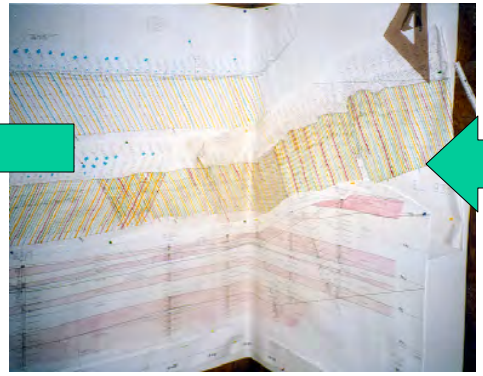
SAMPLE TEXT FILE (CAGES OUTPUT)

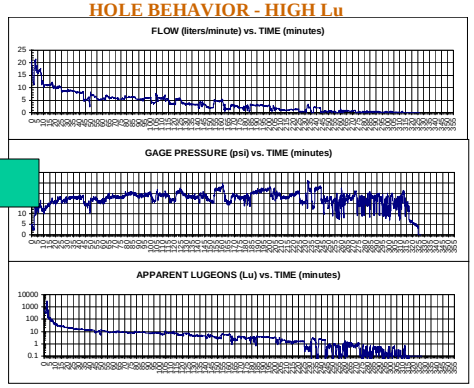
HOLE BEHAVIOR - HIGH Lu











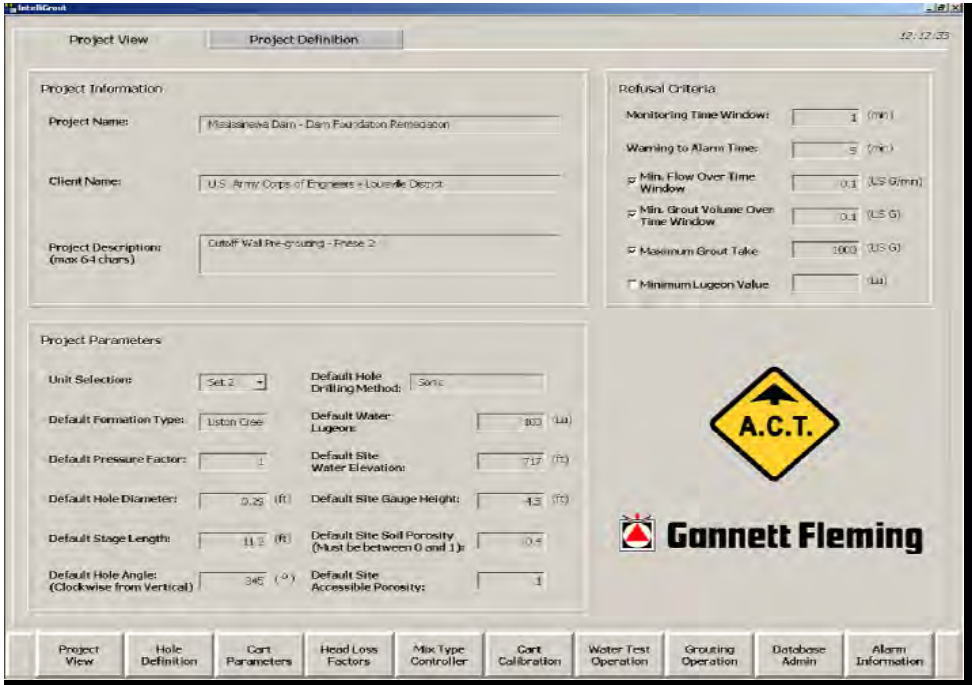
Water Lugeon Value = 100

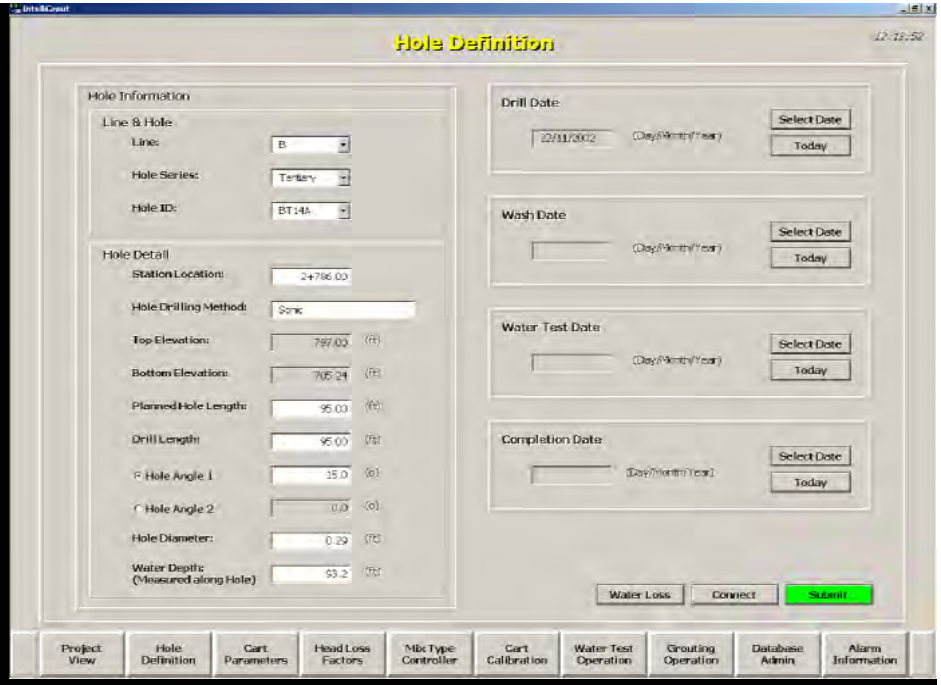
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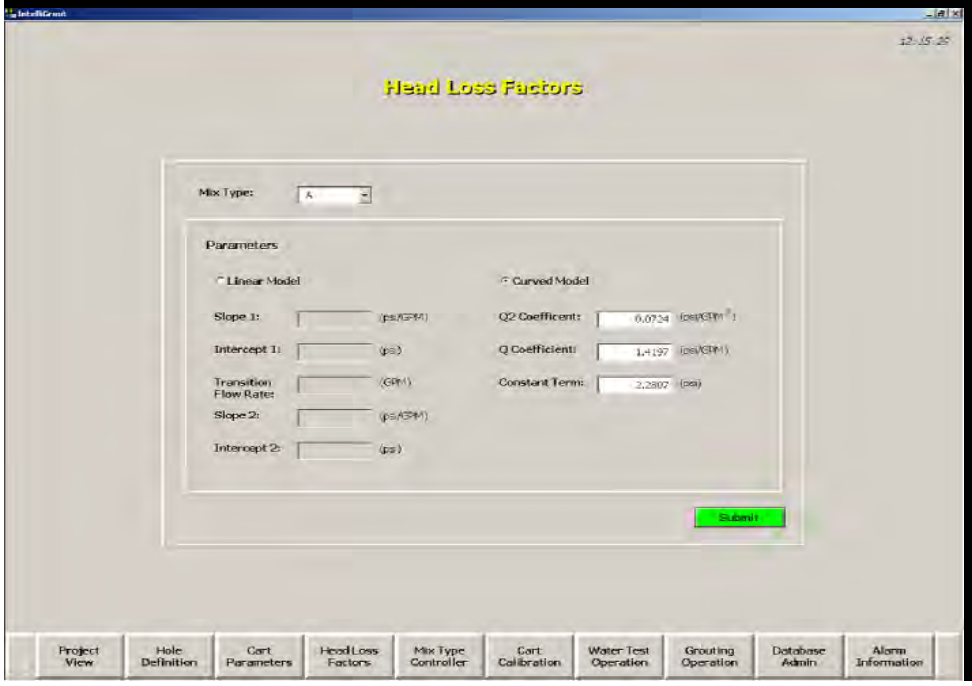
Key:

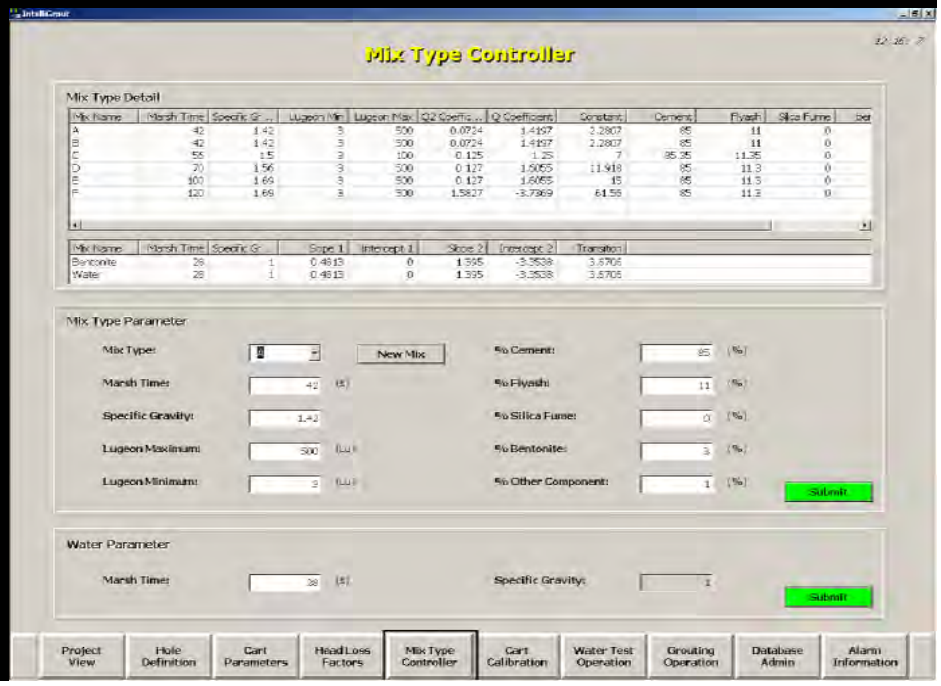
- Automatically obtained by system
- Obtained with moderate additional effort
- Obtained with significant additional effort

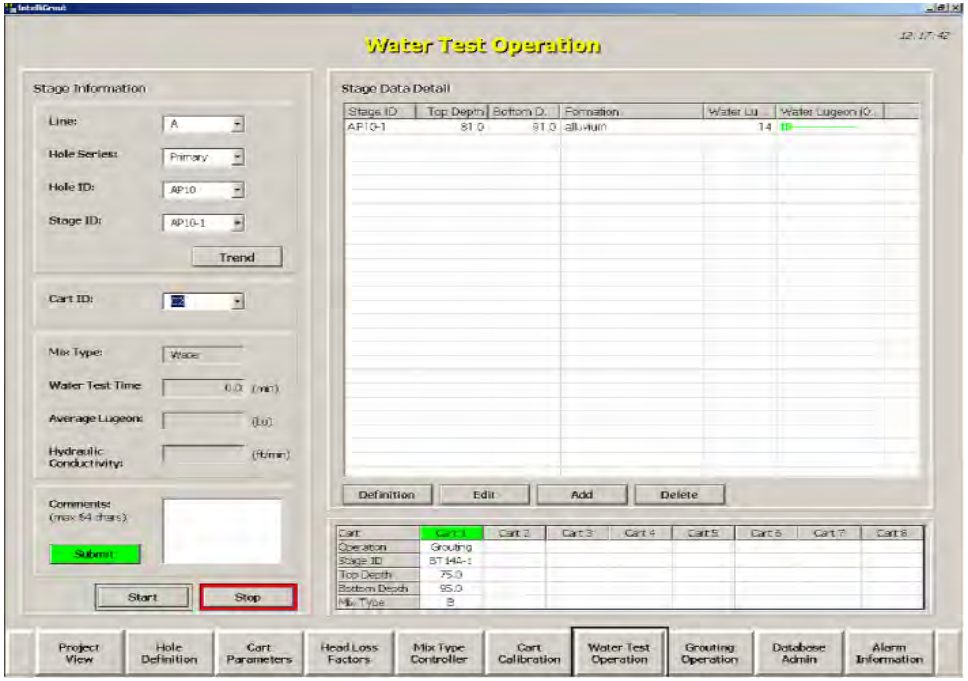

01/06/2003

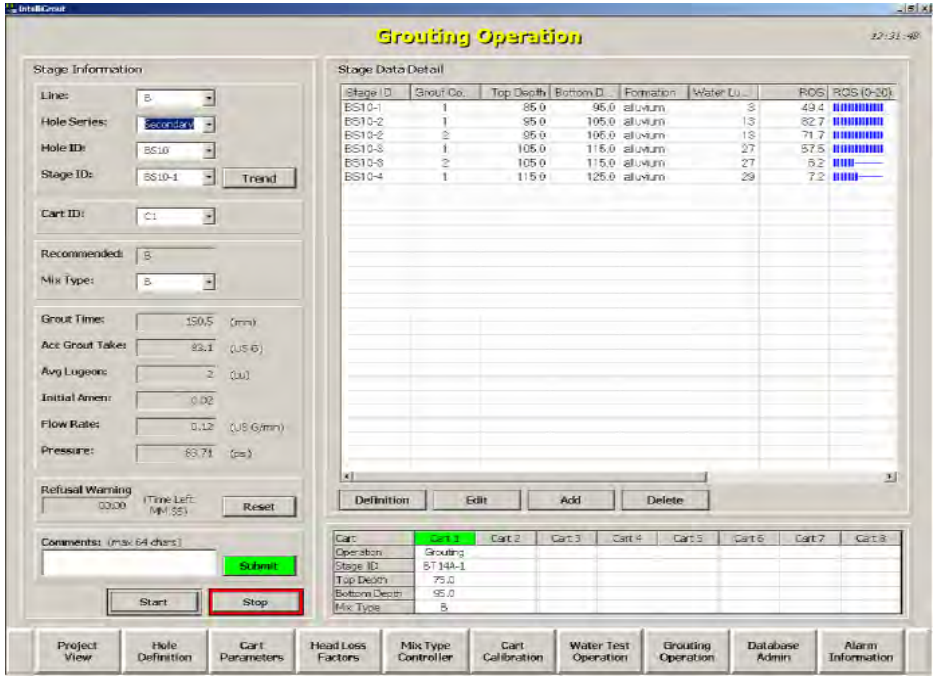

Project View
Project Definition
Project Information
Project Name:
Mississinewa Dam - Dam Foundation Remediation
Client Name:
U.S. Army Corps of Engineers - Louisville District
Project Description: (max 64 chars)
Cutoff Wall Pre-grouting - Freese 2
Refusal Criteria
Monitoring Time Window:
Warning to Alarm Time:
Min. Flow Over Time Window
Min. Grout Volume Over Time Window
Maximum Grout Take
Minimum Lugeon Value
Project Parameters
Unit Selection:
Default Hole Drilling Method:
Default Formation Type:
Default Water Lugeon:
Default Pressure Factor:
Default Site Water Elevation:
Default Hole Diameter:
Default Site Gauge Height:
Default Stage Length:
Default Site Soil Porosity (Must be between 0 and 1):
Default Hole Angle: (Clockwise from Vertical)
Default Site Accessible Porosity:
A.C.T.
Gannett Fleming
Project View
Hole Definition
Cart Parameters
Head Loss Factors
Mix Type Controller
Cart Calibration
Water Test Operation
Grouting Operation
Database Admin
Alarm Information

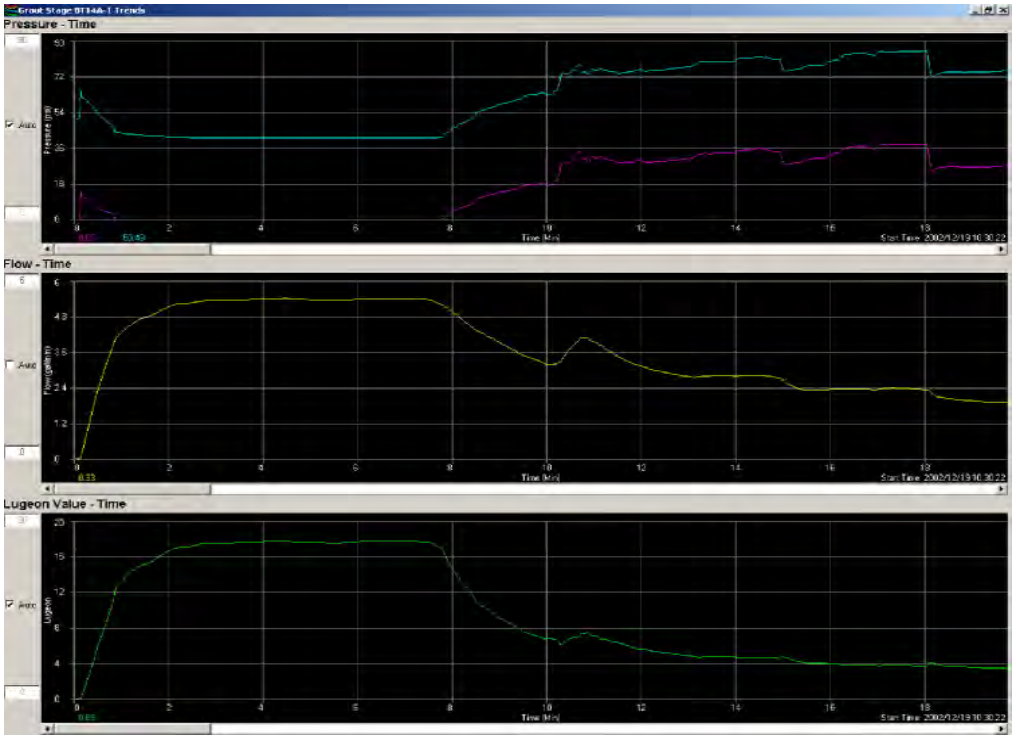

Hole Definition
Hole Information
Line & Hole
Line:
Hole Series:
Hole ID:
Hole Detail
Station Location:
Hole Drilling Method:
Top Elevation:
Bottom Elevation:
Planned Hole Length:
Drill Length:
Hole Angle 1
Hole Angle 2
Hole Diameter:
Water Depth: (Measured along Hole)
Drill Date
Wash Date
Water Test Date
Completion Date
Select Date
Today
Water Loss
Connect
Submit
Project View
Hole Definition
Cart Parameters
Head Loss Factors
Mix Type Controller
Cart Calibration
Water Test Operation
Grouting Operation
Database Admin
Alarm Information

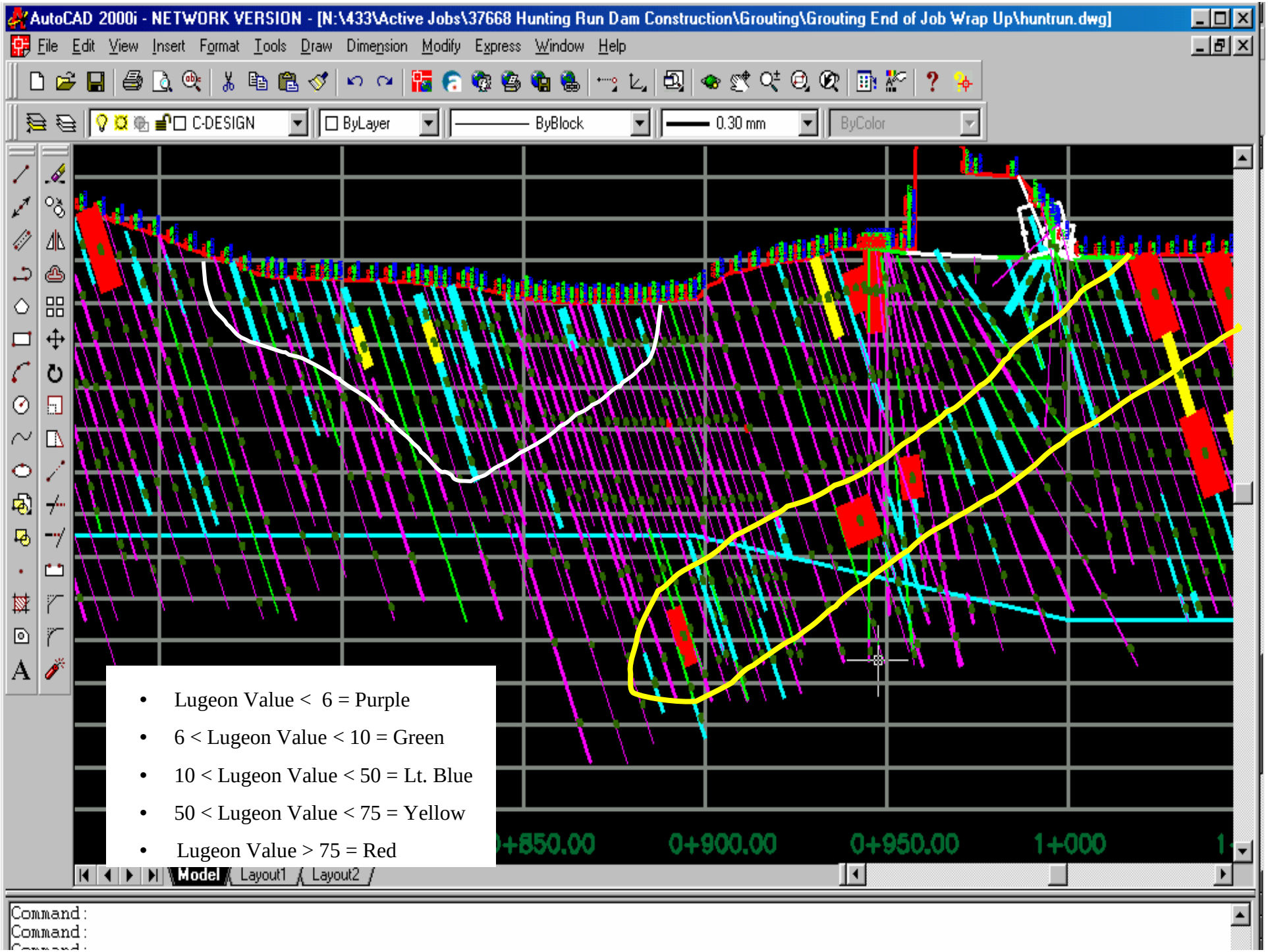

Head Loss Factors
Mix Type:
Parameters
Linear Model
Curved Model
Slope 1:
Intercept 1:
Transition Flow Rate:
Slope 2:
Intercept 2:
Q2 Coefficient:
Q Coefficient:
Constant Term:
Submit
Project View
Hole Definition
Cart Parameters
Head Loss Factors
Mix Type Controller
Cart Calibration
Water Test Operation
Grouting Operation
Database Admin
Alarm Information

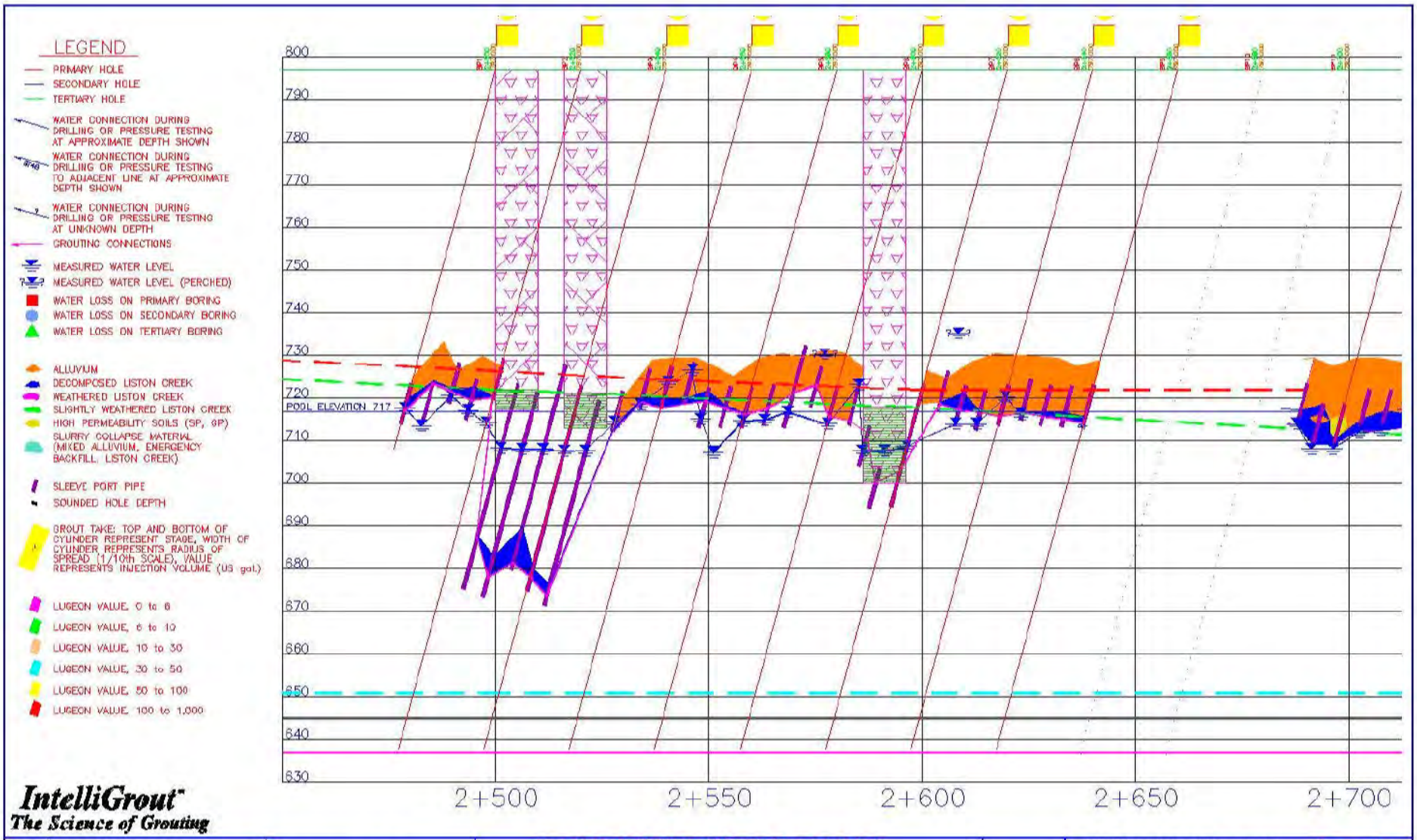

Mix Type Controller
Mix Type Detail
Mix Name
Marsh Time
Specific Gr...
Lugeon Min
Lugeon Max
Q2 Coefficient
Q Coefficient
Constant
Cement
Flyash
Silica Fume
Slope 1
Intercept 1
Slope 2
Intercept 2
Transition
Bentonite
Water
Mix Type Parameter
Mix Type:
New Mix
Marsh Time:
Specific Gravity:
Lugeon Maximum:
Lugeon Minimum:
% Cement:
% Flyash:
% Silica Fume:
% Bentonite:
% Other Component:
Submit
Water Parameter
Marsh Time:
Specific Gravity:
Submit
Project View
Hole Definition
Cart Parameters
Head Loss Factors
Mix Type Controller
Cart Calibration
Water Test Operation
Grouting Operation
Database Admin
Alarm Information


Water Test Operation
Stage Information
Line:
Hole Series:
Hole ID:
Stage ID:
Trend
Cart ID:
Mix Type:
Water Test Time:
Average Lugeon:
Hydraulic Conductivity:
Comments:
Submit
Start
Stop
Stage Data Detail
Stage ID
Top Depth
Bottom D.
Formation
Water Lu
Water Lugeon (Q
Definition
Edit
Add
Delete
Cart
Operation
Stage ID
Top Depth
Bottom Depth
Mix Type
Project View
Hole Definition
Cart Parameters
Head Loss Factors
Mix Type Controller
Cart Calibration
Water Test Operation
Grouting Operation
Database Admin
Alarm Information


Grouting Operation
Stage Information
Line:
Hole Series:
Hole ID:
Stage ID:
Trend
Cart ID:
Recommended:
Mix Type:
Grout Time:
Acc Grout Take:
Avg Lugeon:
Initial Amen:
Flow Rate:
Pressure:
Refusal Warning
Reset
Comments:
Submit
Start
Stop
Stage Data Detail
Stage ID
Grout Co.
Top Depth
Bottom D.
Formation
Water Lu
RQS
RQS (0-20)
Definition
Edit
Add
Delete
Cart
Operation
Stage ID
Top Depth
Bottom Depth
Mix Type
Project View
Hole Definition
Cart Parameters
Head Loss Factors
Mix Type Controller
Cart Calibration
Water Test Operation
Grouting Operation
Database Admin
Alarm Information


Pressure - Time
Flow - Time
Lugeon Value - Time
Time (Min)


AutoCAD 2000i - NETWORK VERSION - [N:\433\Active Jobs\37668 Hunting Run Dam Construction\Grouting\Grouting End of Job Wrap Up\huntrun.dwg]
File Edit View Insert Format Tools Draw Dimension Modify Express Window Help
C-DESIGN
ByLayer
ByBlock
0.30 mm
ByColor
0+850.00
0+900.00
0+950.00
1+000
Model
Layout1
Layout2
Command:
Command:
• Lugeon Value < 6 = Purple
• 6 < Lugeon Value < 10 = Green
• 10 < Lugeon Value < 50 = Lt. Blue
• 50 < Lugeon Value < 75 = Yellow
• Lugeon Value > 75 = Red



IntelliGrout™
The Science of Grouting

ADVANCED CONSTRUCTION TECHNIQUES, LTD. WAPLE, ONTARIO

CANNETT FLEMING, INC. HARRISBURG, PENNSYLVANIA

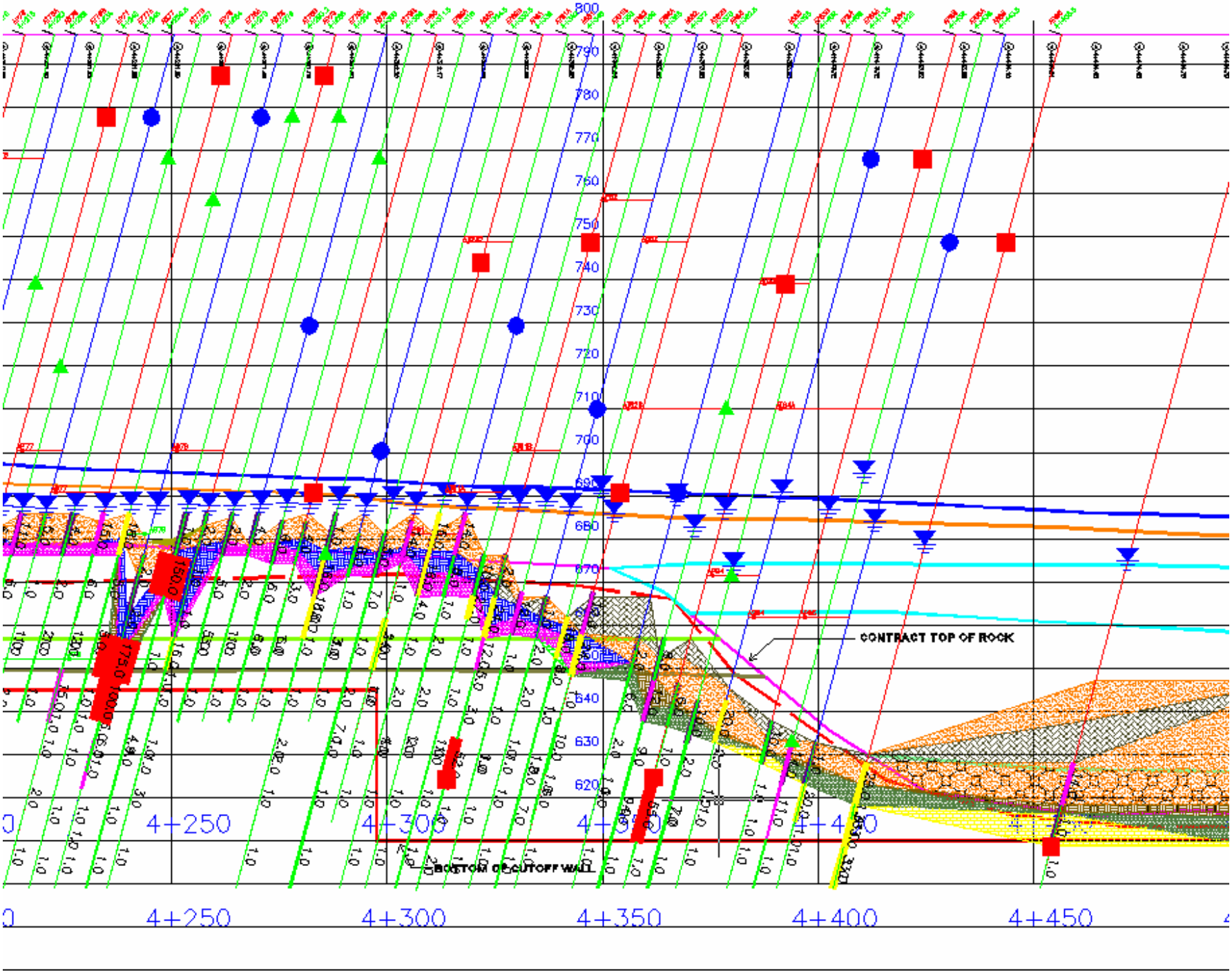
B-LINE INITIAL WATER LEVELS

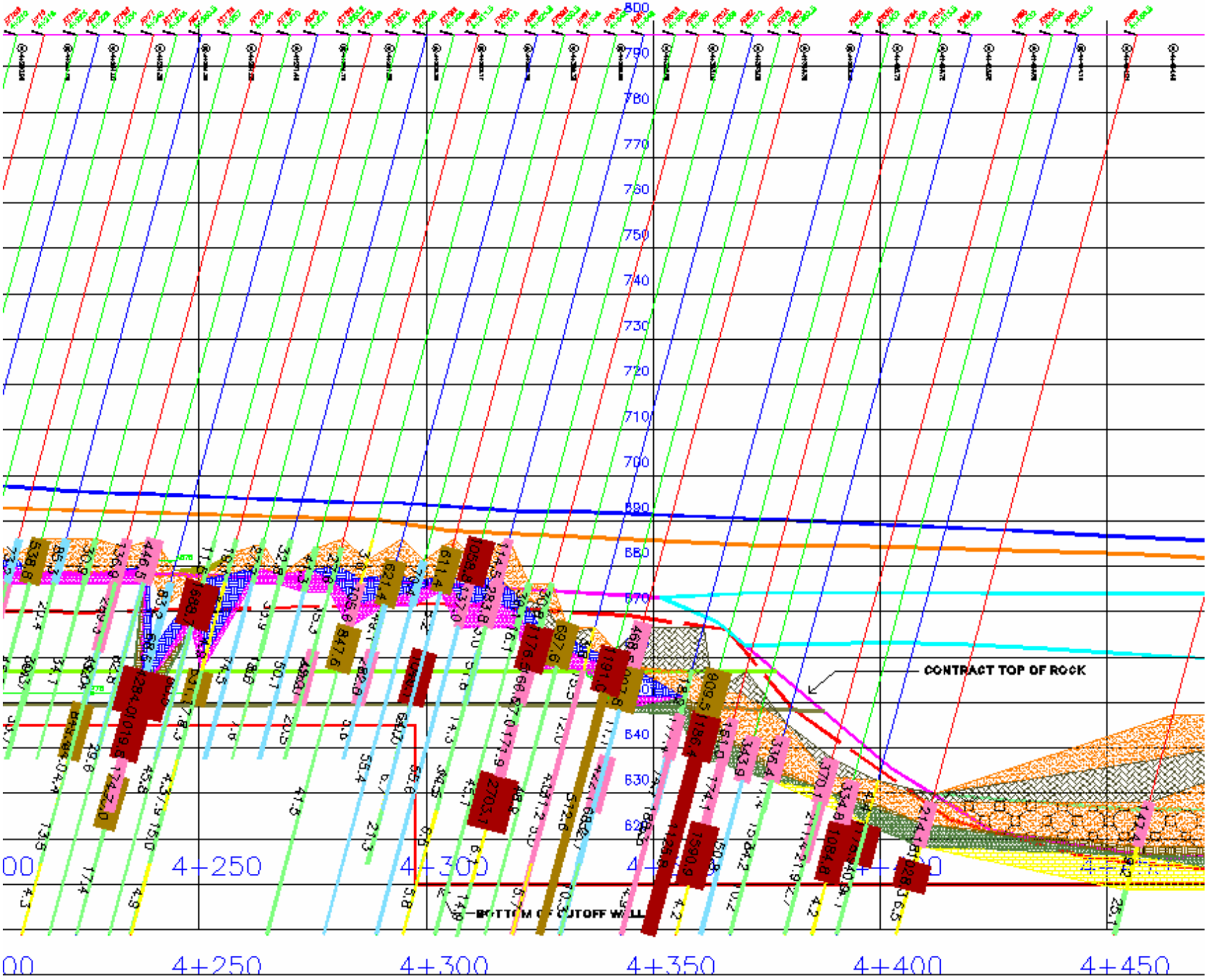
GROUTING TEST SECTION

B-LINE BAYS 1 THROUGH 10

MISSISSINEWA LAKE, INDIANA
CUT-OFF WALL PRE-GROUTING
DAM FOUNDATION REMEDIATION
CONTRACT NO.: DACA27-01-C-0016

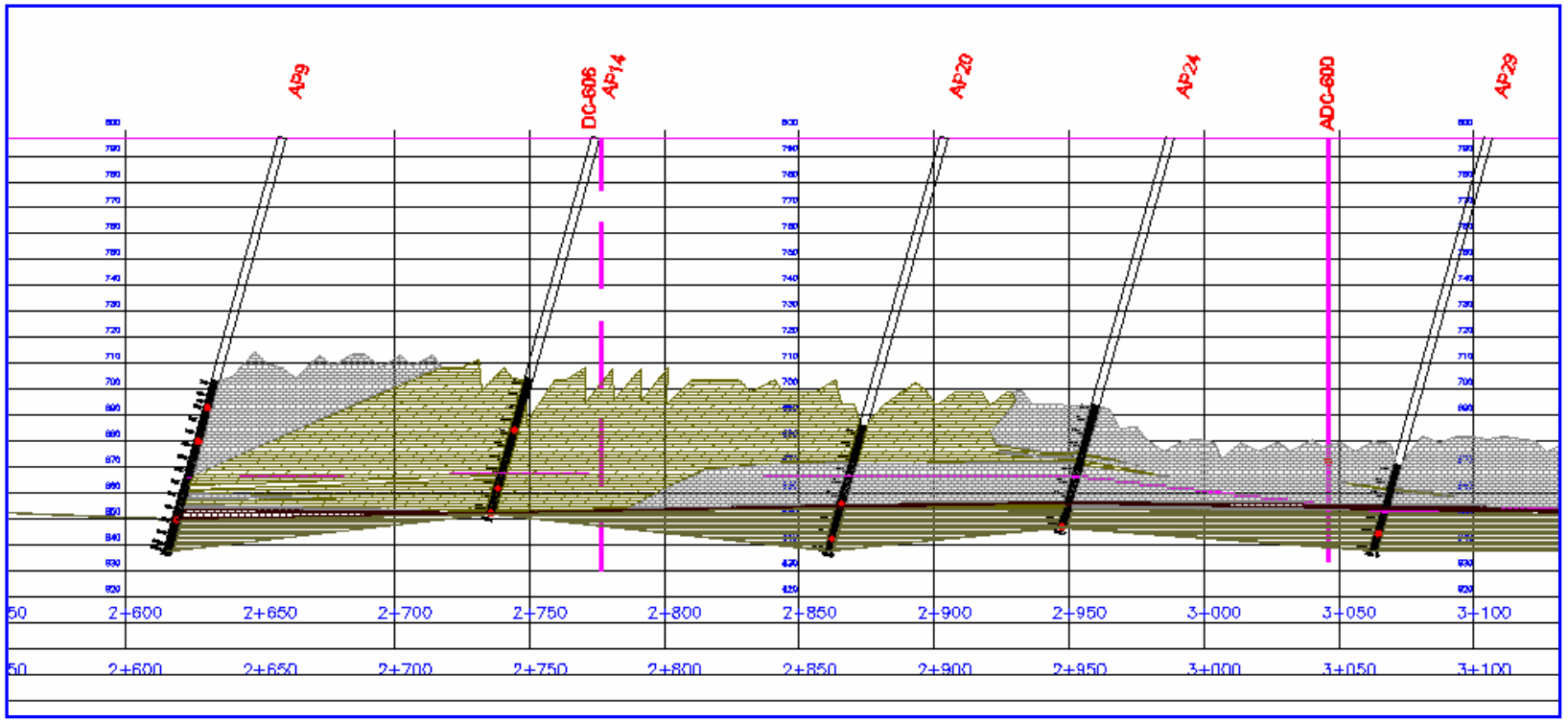
U.S. Army Corps of Engineers
Louisville District


800
790
780
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CONTRACT TOP OF ROCK
BOTTOM OF CUTOFF WALL
4+250
4+300
4+350
4+400
4+450

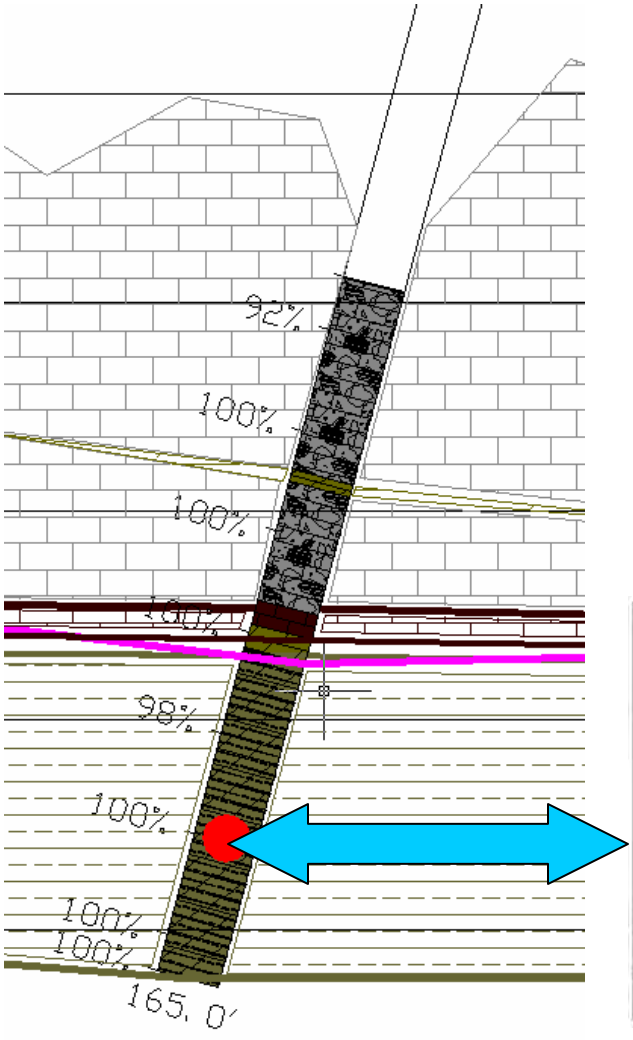

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CONTRACT TOP OF ROCK
4+250
4+300
4+350
4+400
4+450

Interactive Geology

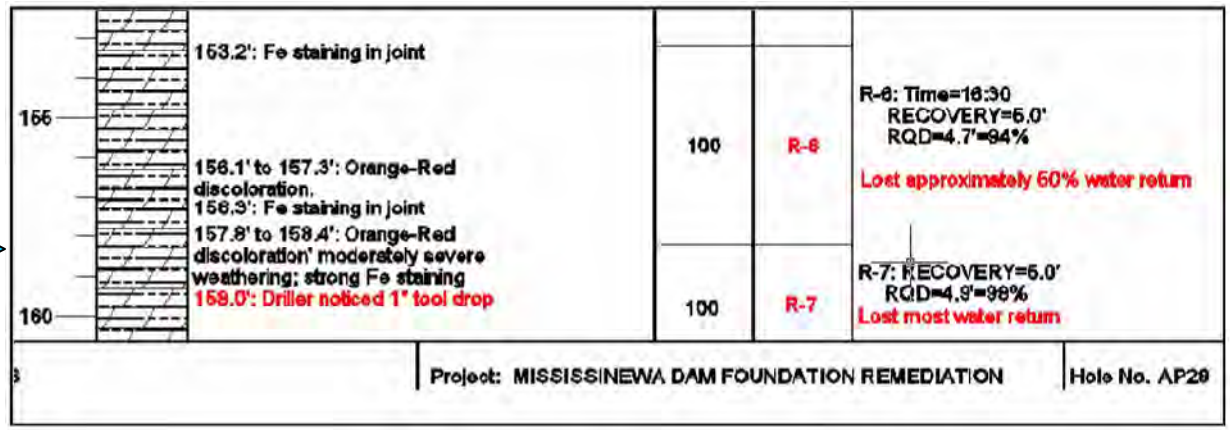
- Logical organization of Geotechnical and Geological Data
- Electronic link between data
- Eliminates sorting through paper logs, photographs, lab test results, etc. to interpret conditions



- Typed boring logs and stick logs are inserted into AutoCAD file
- Detailed geologic profile generated
- Data is linked using Hyperlinks



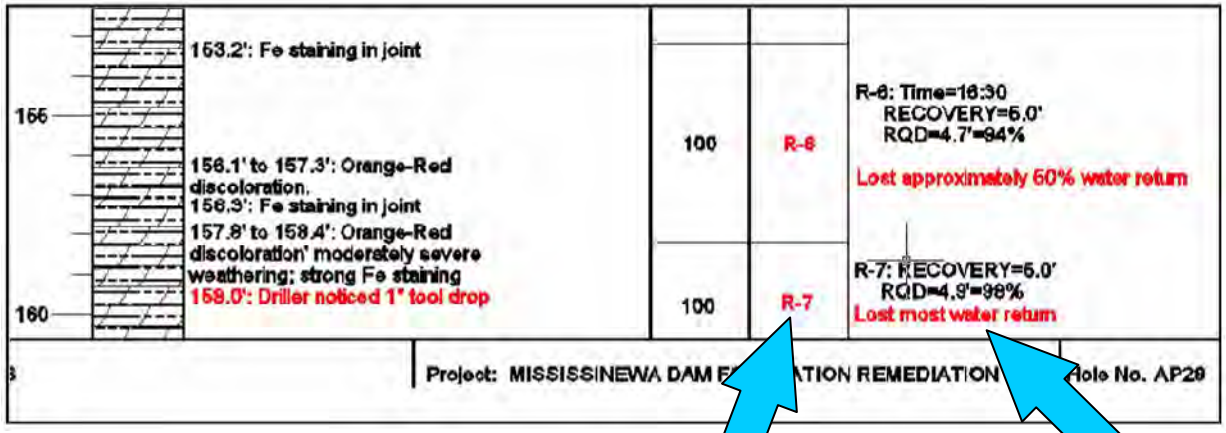
Hot spot on Stick boring log links to view of drilling log



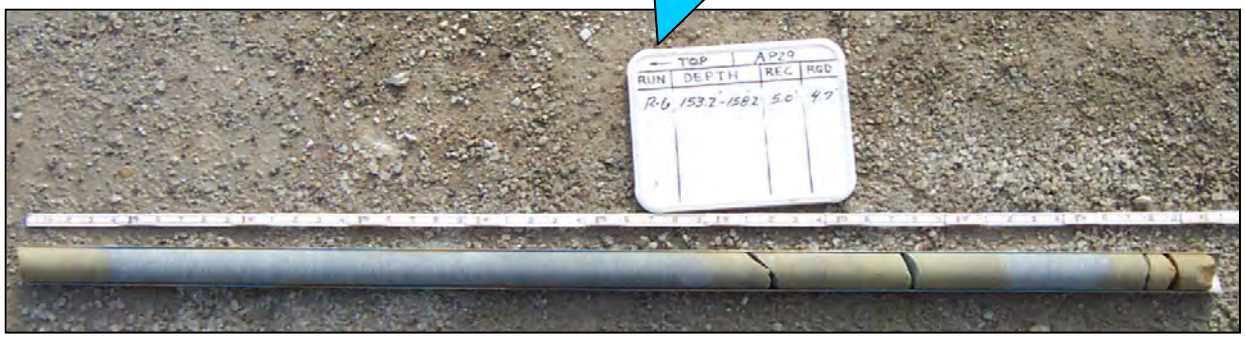
Red text on drilling logs indicates additional linked information.

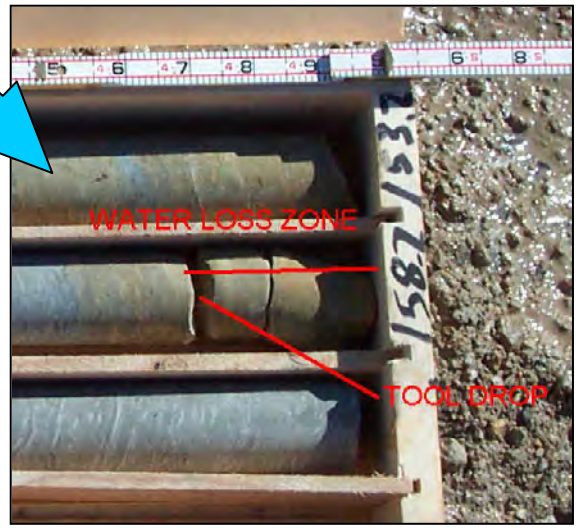
Core Run ID links to photo of recovered sample

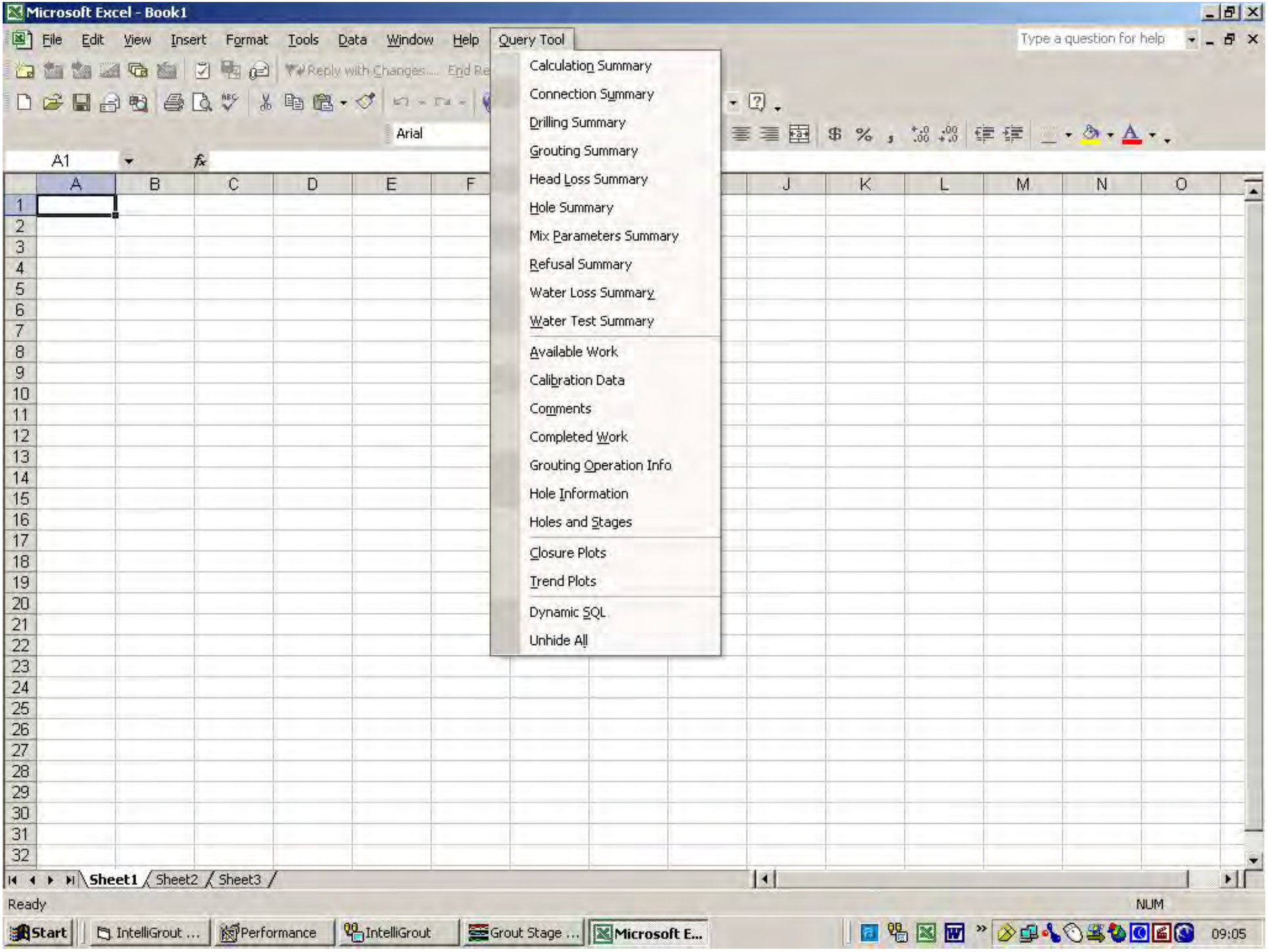
Comments links to photo of core box

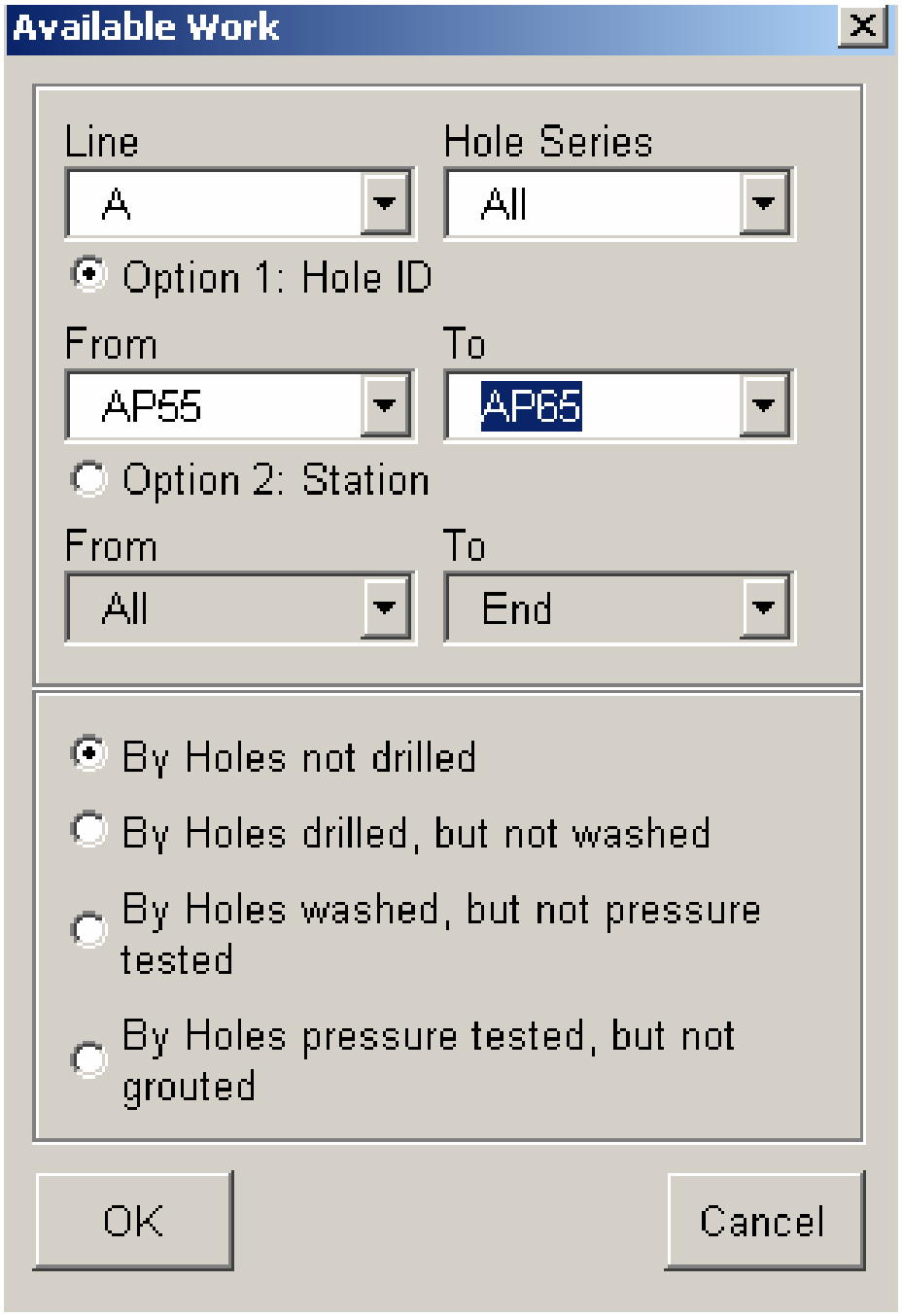


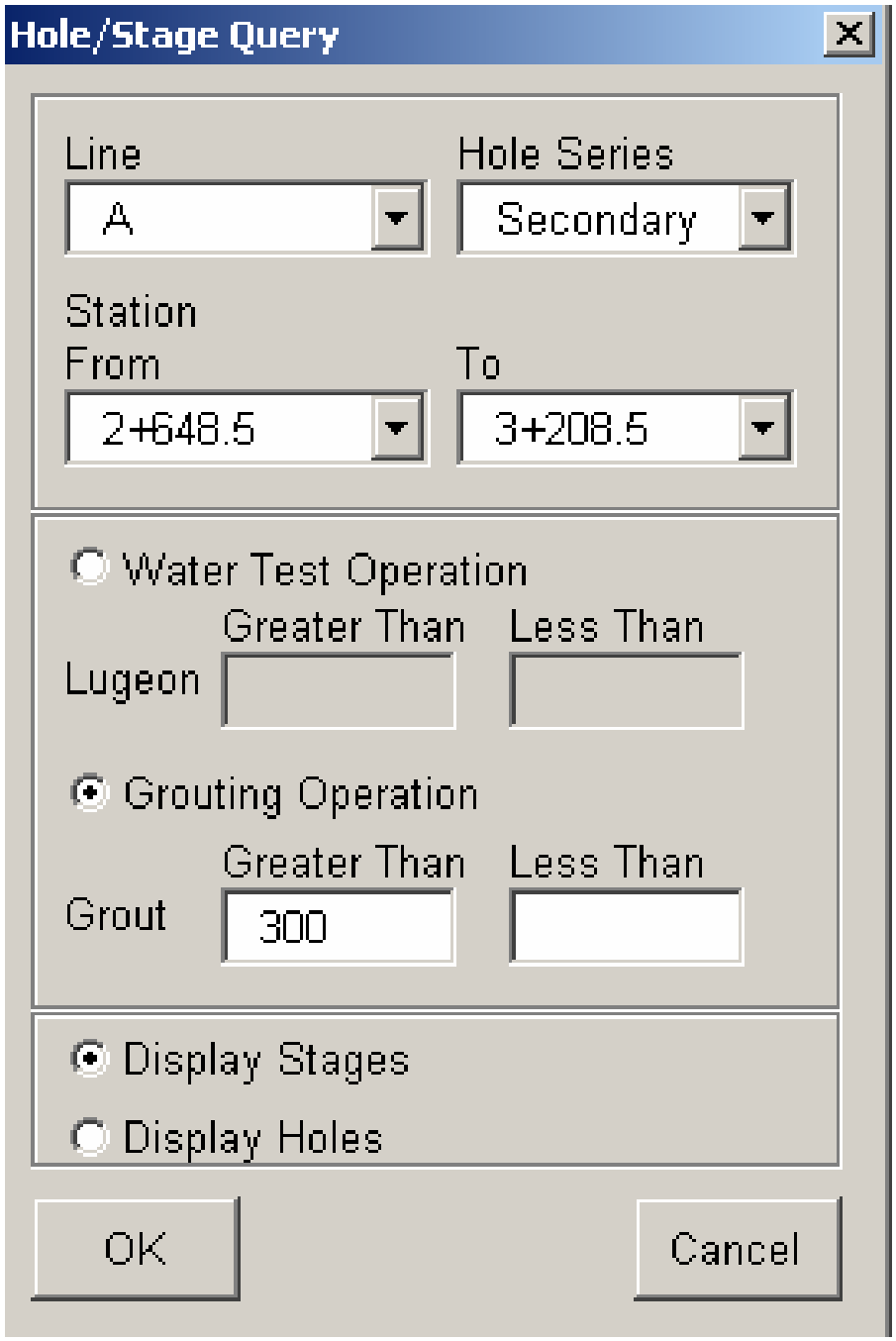
In this case a tool drop and loss of water return was noted.

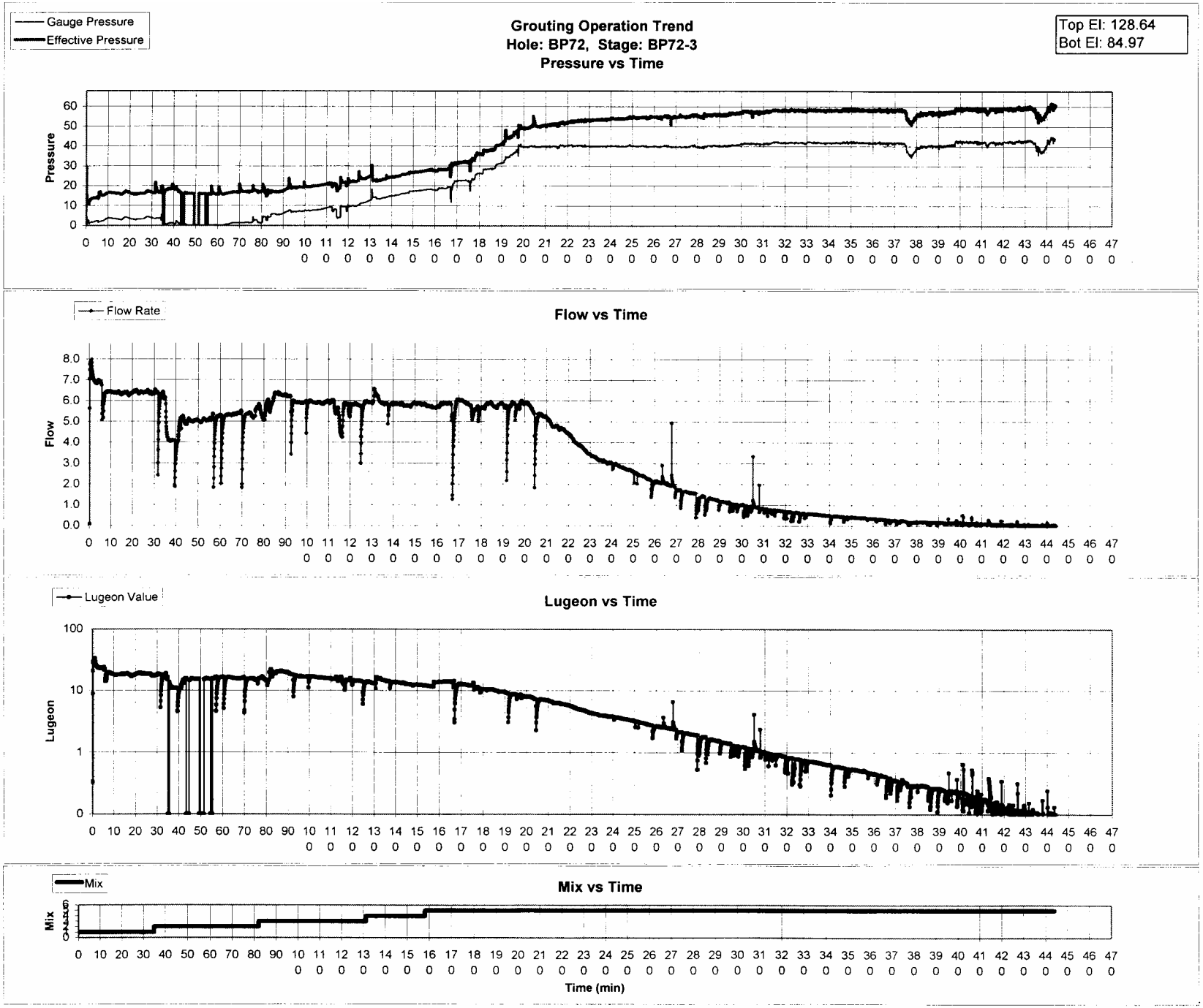




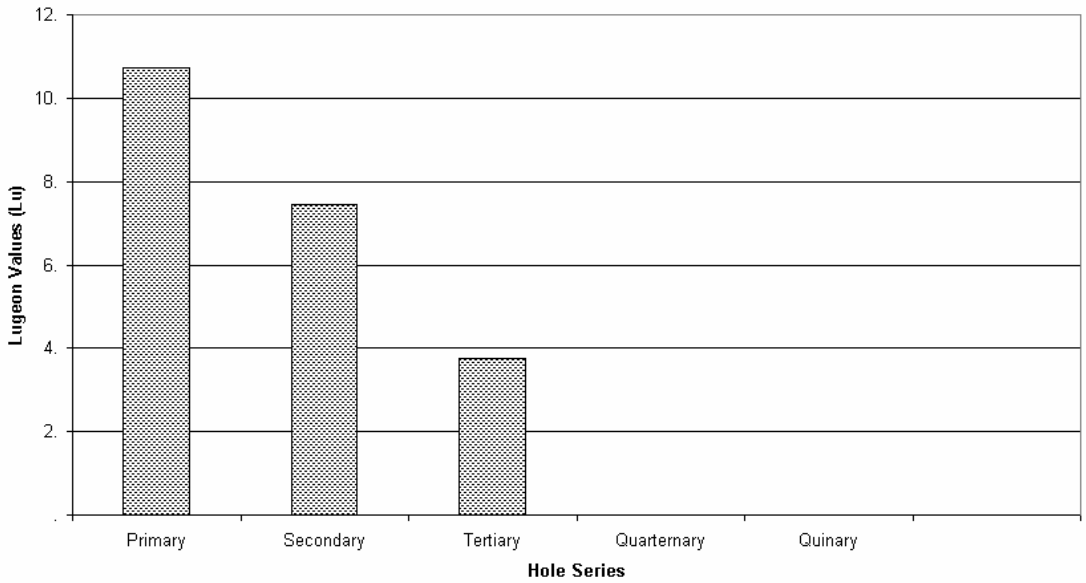

Microsoft Excel - Book1
File Edit View Insert Format Tools Data Window Help Query Tool
Type a question for help
Calculation Summary
Connection Summary
Drilling Summary
Grouting Summary
Head Loss Summary
Hole Summary
Mix Parameters Summary
Refusal Summary
Water Loss Summary
Water Test Summary
Available Work
Calibration Data
Comments
Completed Work
Grouting Operation Info
Hole Information
Holes and Stages
Closure Plots
Trend Plots
Dynamic SQL
Unhide All
Arial
A1
Sheet1 Sheet2 Sheet3
Ready
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Start
IntelliGrout ...
Performance
IntelliGrout
Grout Stage ...
Microsoft E...
09:05


Available Work
Line
A
Hole Series
All
Option 1: Hole ID
From
AP55
To
AP65
Option 2: Station
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All
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By Holes drilled, but not washed
By Holes washed, but not pressure tested
By Holes pressure tested, but not grouted
OK
Cancel

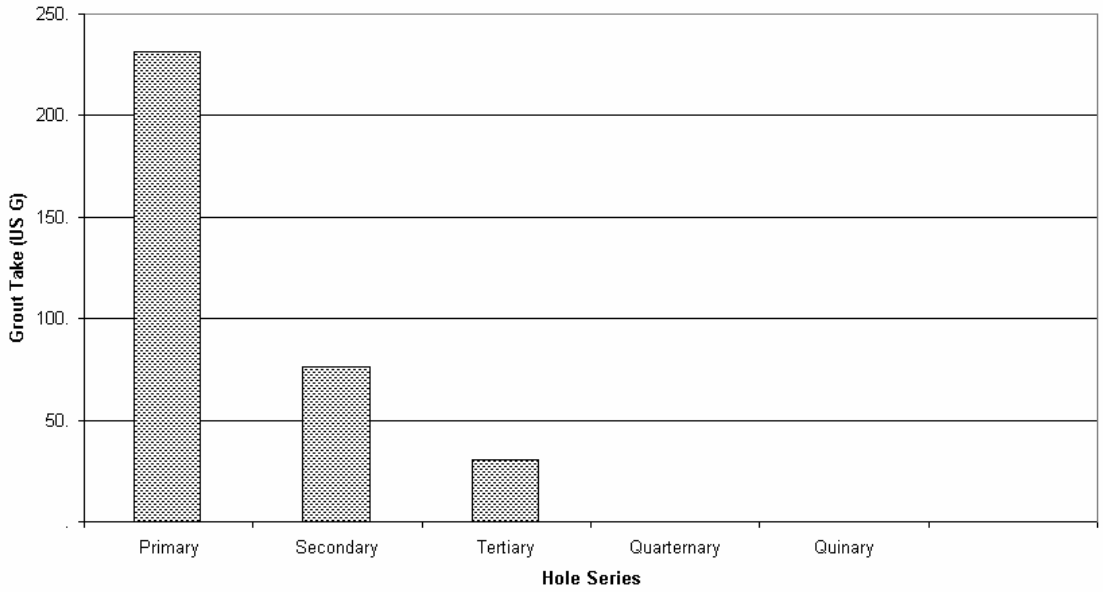

Hole/Stage Query
Line
A
Hole Series
Secondary
Station
From
2+648.5
To
3+208.5
Water Test Operation
Greater Than
Less Than
Lugeon
Grouting Operation
Greater Than
Less Than
Grout
300
Display Stages
Display Holes
OK
Cancel


Gauge Pressure
Effective Pressure
Grouting Operation Trend
Hole: BP72, Stage: BP72-3
Pressure vs Time
Top El: 128.64
Bot El: 84.97
Pressure
Flow Rate
Flow vs Time
Flow
Lugeon Value
Lugeon vs Time
Lugeon
Mix
Mix vs Time
Time (min)

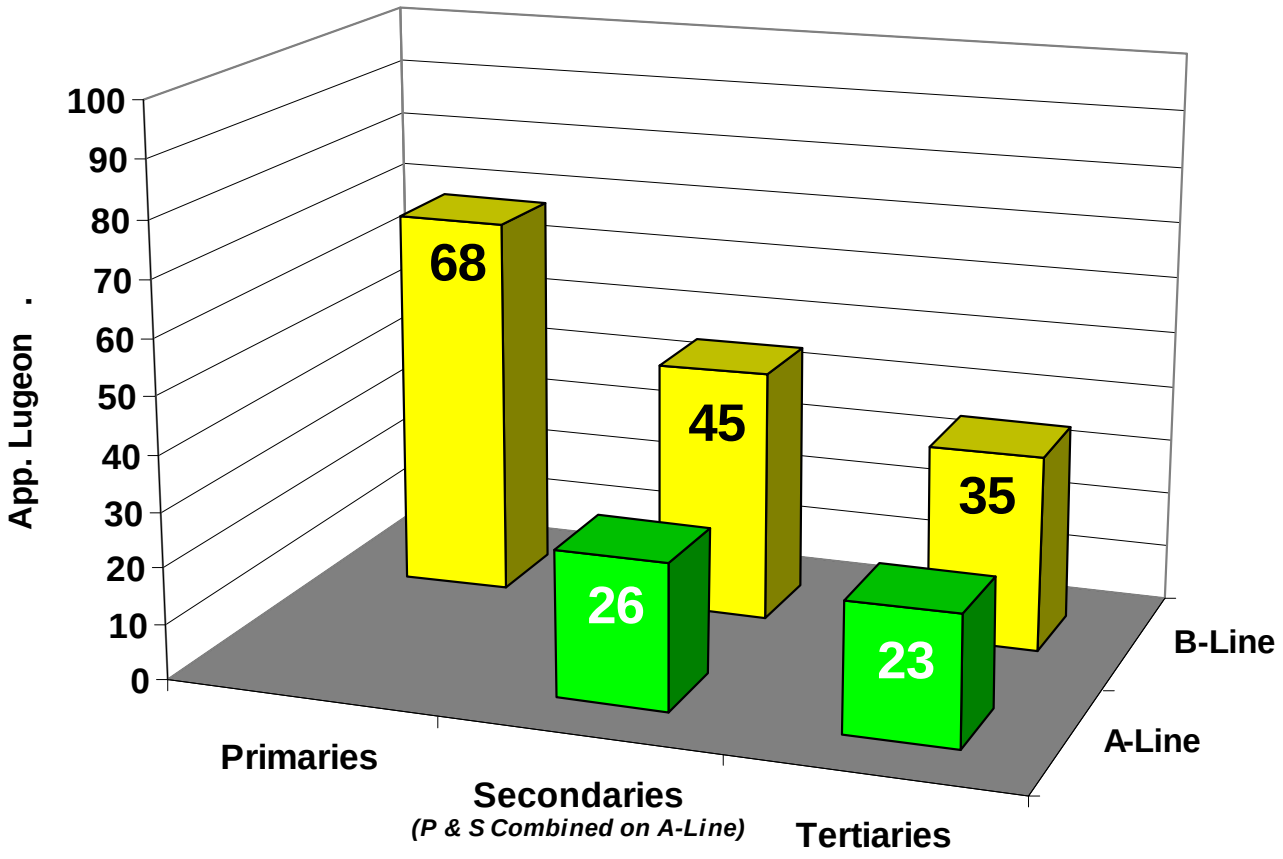
Mean Water Lugeon Values Plot
Line: A , Hole Series: All , Hole ID: AP15 To AP17 , Stage : All

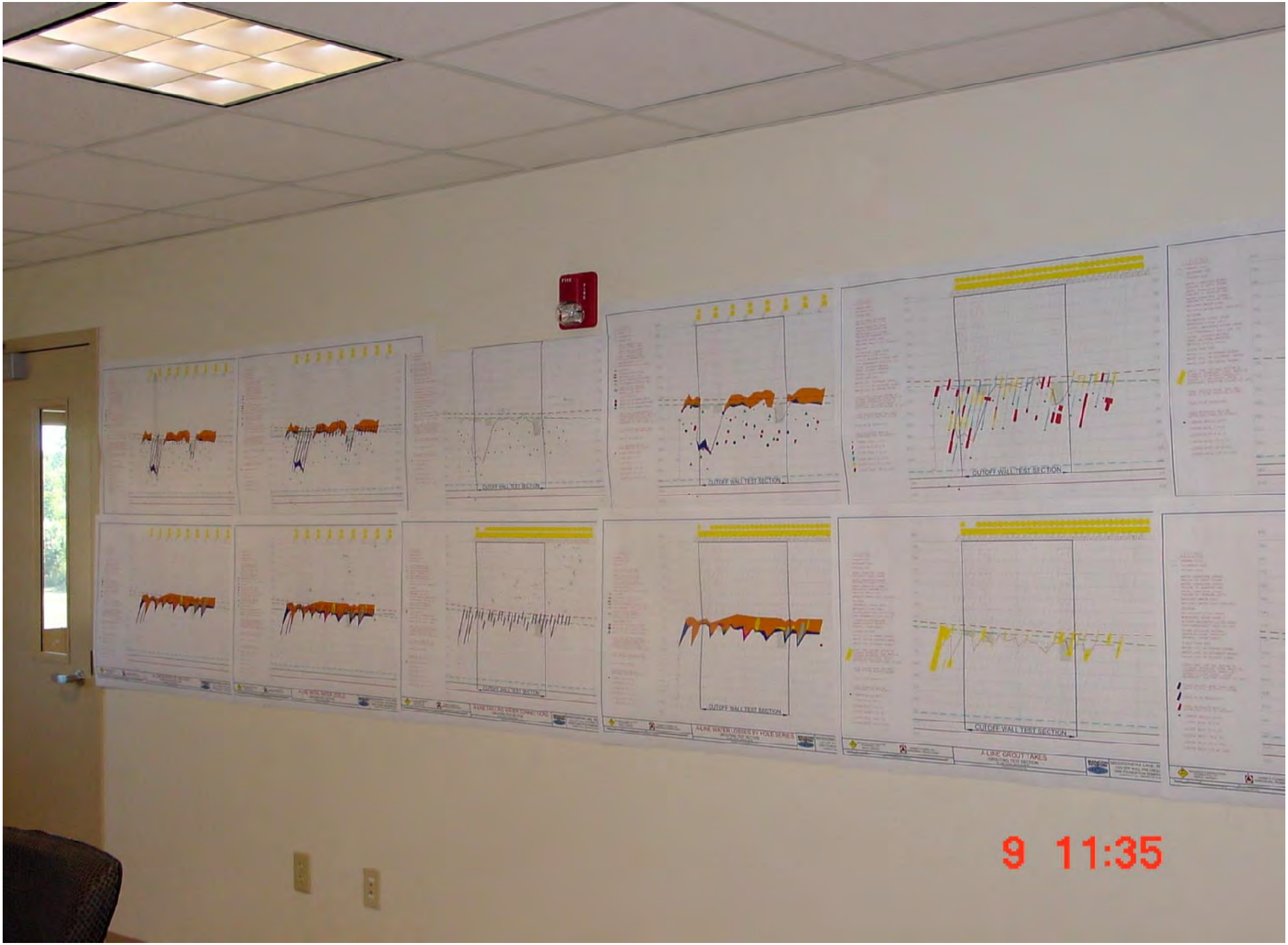


Mean Grout Take Values Plot
Line: A , Hole Series: All , Hole ID: AP15 To AP17 , Stage : All



Test Section - Lugeon Values in Liston Creek




CUTOFF WALL TEST SECTION
A-LINE GROUT TAKES
9 11:35

Intelligrout, The Science of Grouting - Microsoft Internet Explorer

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Address http://www.intelligrout.com Go Links

IntelliGrout™

The Science of Grouting



Contents

Project Drawing Updates

- Mississinewa Dam
- McCook Reservoir

Administration

- Download .DWF Viewing Software

Contacts

- Drawing Issues
- Web Page Issues







For information on the *IntelliGrout*™ system, please contact:

David B. Wilson,
Gannett Fleming, Inc.
or
James C. Cockburn,
Advanced Construction Techniques



Gannett Fleming

A.C.T. ADVANCED CONSTRUCTION TECHNIQUES

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Done Internet

Start Intelligrout, The Scie... C:\Documents and Settin... Microsoft PowerPoint - [... 3:03 PM

Gannett Fleming, Inc. - 2003 - Microsoft Internet Explorer

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Address http://www.intelligrout.com/McCook/acwebpublish.htm Go Links

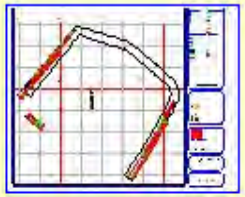
McCook Reservoir - Grout Test

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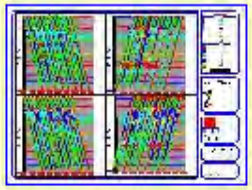
Gannett Fleming

ADVANCED CONSTRUCTION TECHNIQUES

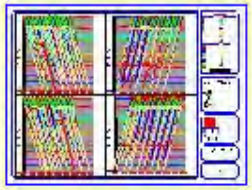
Preliminary Intelligrout Drawing Update (updated 11/01/03)



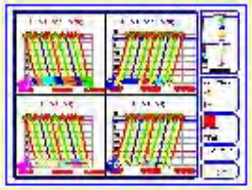
Plan View



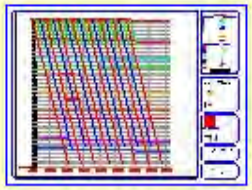
Comp Pres Test



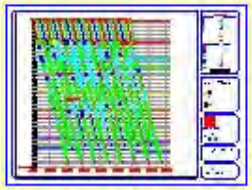
Comp Grouting



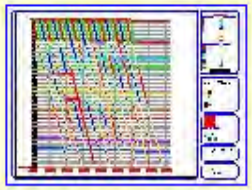
Demo Section



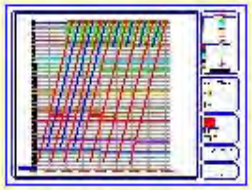
A-Drilling



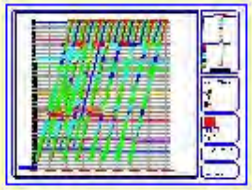
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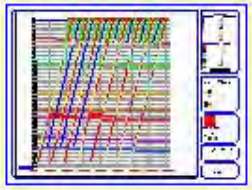


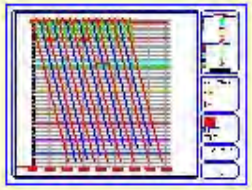
A-Grouting

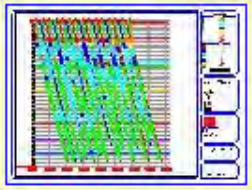


B-Drilling







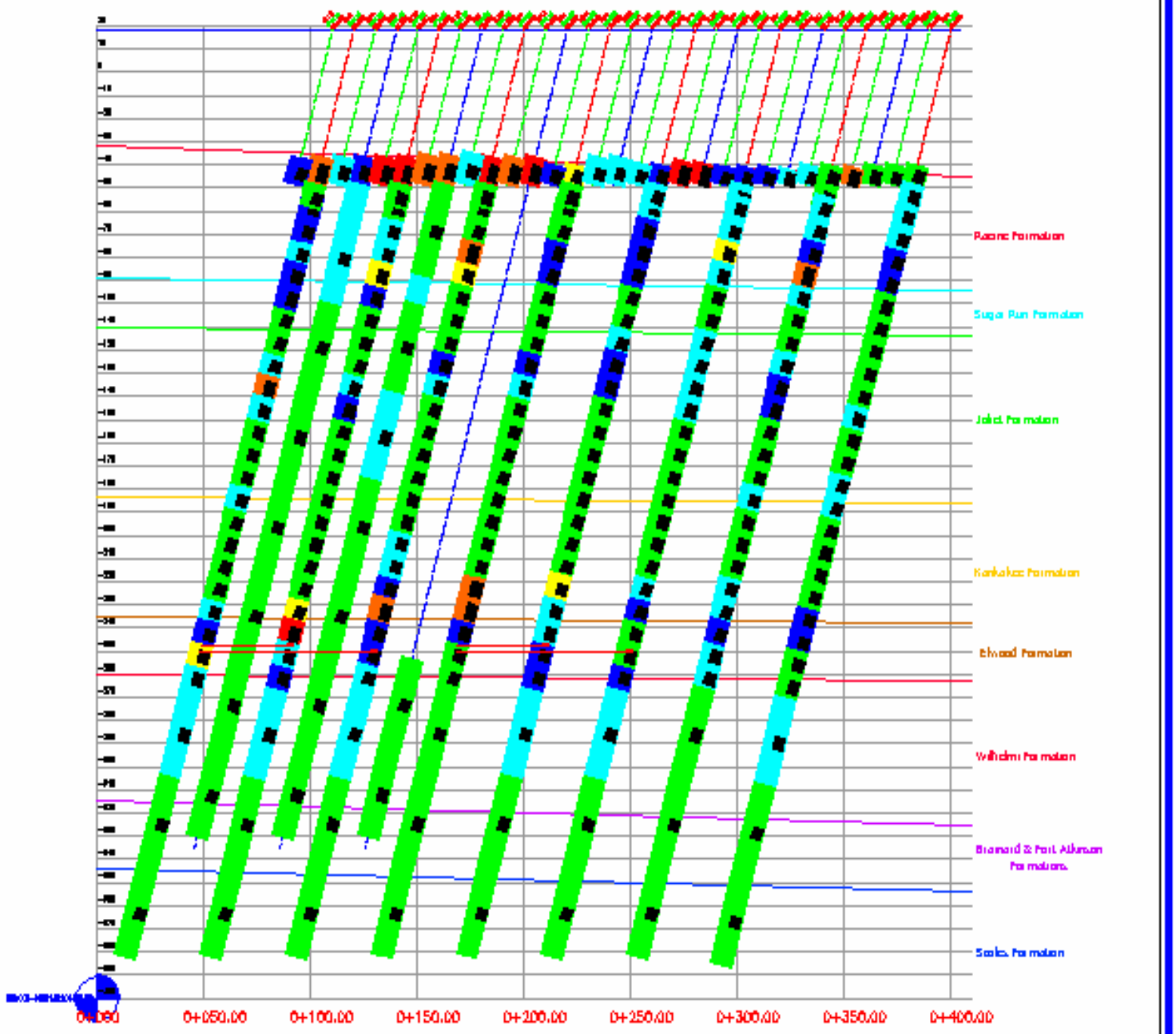


Notes:

1. Update drawings are not record drawings. Information shown is preliminary based on work in progress and is subject to revision.

2. Efforts will be made to provide update drawings on approximately a weekly basis.

Done Internet



Legend

Grout Hole

Pressure Testing

Hole Characteristics

Grouting

IntelliGrout™

The Science of Grouting

Advanced Construction Techniques

Cornell Dubilier

US Army Corps of Engineers
Chicago District

Black & Veatch Corporation

Chicagoland Underflow Plan (CUP)
McCook Reservoir Grout Test
Contract No.: DACW25-02-C0006

Grout Test Section

B-LINE

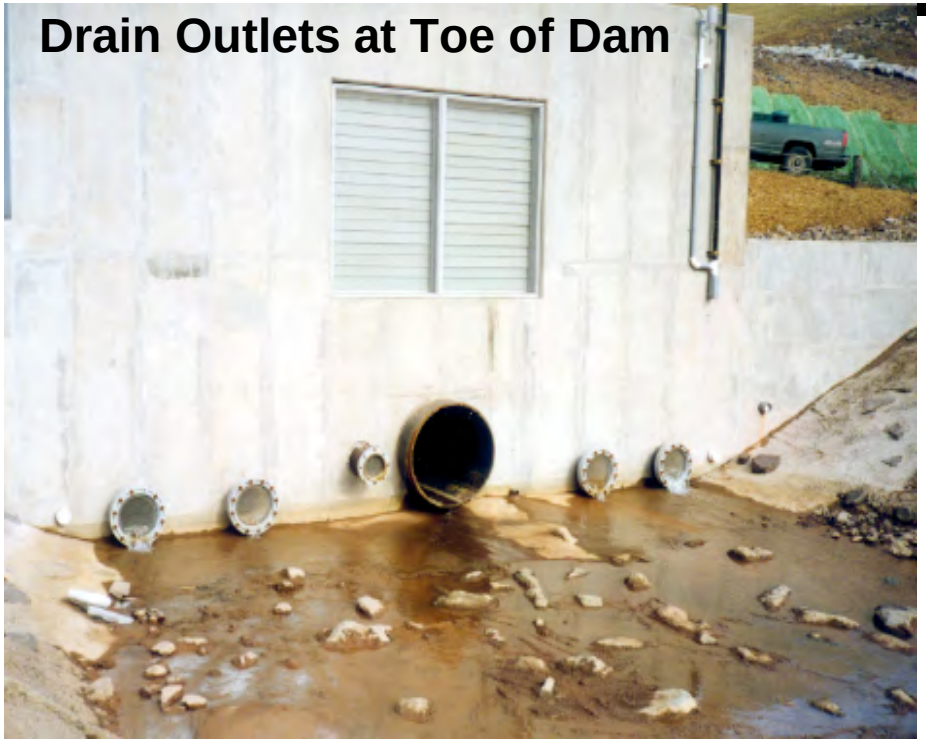
PRESSURE TESTING

Summary

- **Computer monitoring and and analysis of grouting has come of age as a reliable and effective tool for better faster and less expensive grouting.**

- **When combined with proper investigation, design, and contract mechanisms, real time data collection and analysis by a competent grouting engineer or geologist results in engineered grout curtains constructed with dependable predictable performance with virtually the same degree of confidence in quality as visible above ground construction.**

Project Success



Drain Outlets at Toe of Dam

QUESTIONS



Trent L. Dreese, P.E.

Gannett Fleming Inc.

tdreese@gfnet.com

717-763-7211, ext. 2686

SECTION 227

Bluff Stabilization along Lake Michigan, using Active and Passive Dewatering Techniques Allegan Co. Michigan

Rennie Kaunda, Western Michigan University, Geosciences
Eileen Glynn, ERDC, Geotechnical and Structures Laboratory
Ron Chase, WMU Geosciences
Alan Kehew, WMU Geosciences
Jim Selegean, USACE Detroit District

SECTION 227

Presentation Outline

Problem
Previous Studies
Planned solution to problem
Current work & technology
Conclusions
Future Work

Problem:

Bluff recession along Lake Michigan's Coast causes substantial property loss annually.

Recession rates:- 1 to 2 ft/yr at study site over the past 135 years.

Engineered structures consistently fail to deter erosion:

- Typically designed to prevent toe erosion, while precipitation and groundwater discharge from the bluff face may be the governing factor in bluff failure.

Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227

Problem



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227



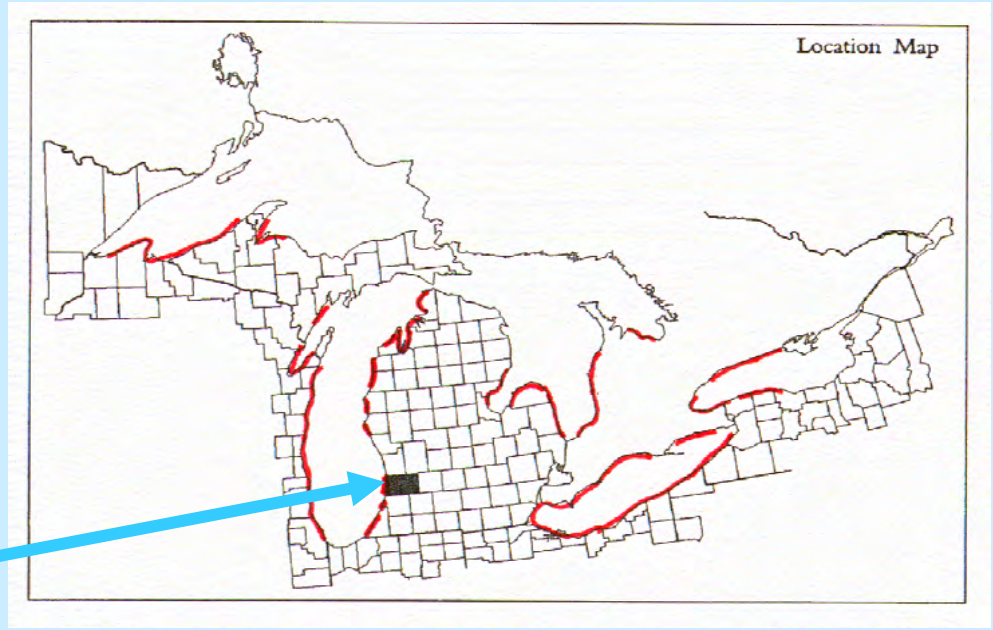




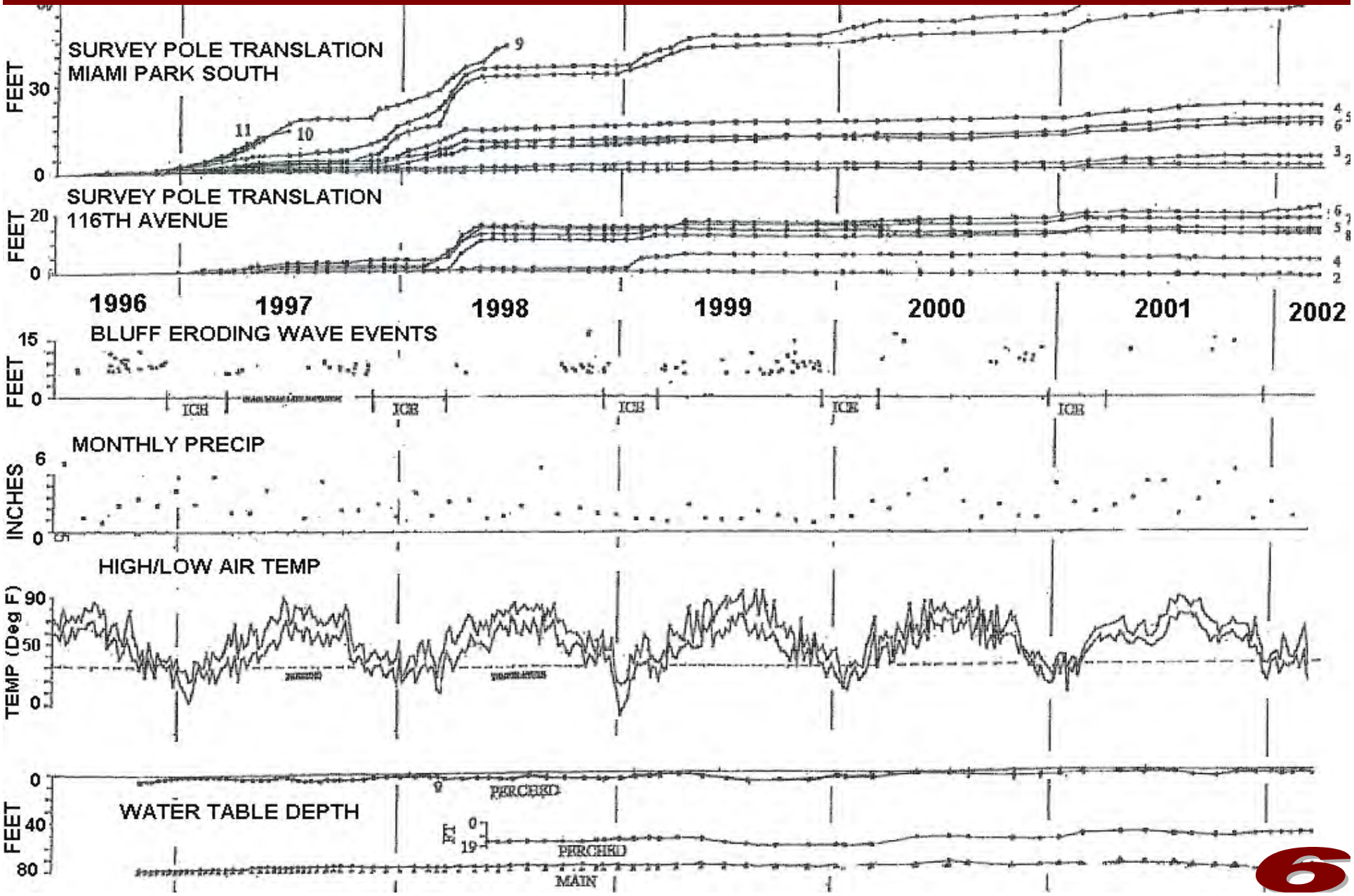
Phase I - Monitoring

Study at Allegan County, Miami Park South

- Through long term **(8 years)** monitoring correlations were made between bluff displacement and climate.



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan



Conclusions of monitoring
1996 to 2002

- **High lake levels** contributed to magnitude of earlier displacements (pre 1999).

- **Bluff movements** ⇔ rises in perched water levels

- Rises in perched water tables & pore pressures ⇔ **bluff face freezing**.

- **Wave erosion**: removal of displaced materials => more slumping.

- Continued slumping despite **little toe erosion**

Phase II - Dewatering the site

- Developed plan to dewater with pumps in vertical wells & passive horizontal wells drilled into bluff face
- Plan included instrumentation of slope for remote monitoring of:-
  - displacement
  - groundwater levels
  - ground temperatures
  - atmospheric conditions
  - bluff face freezing

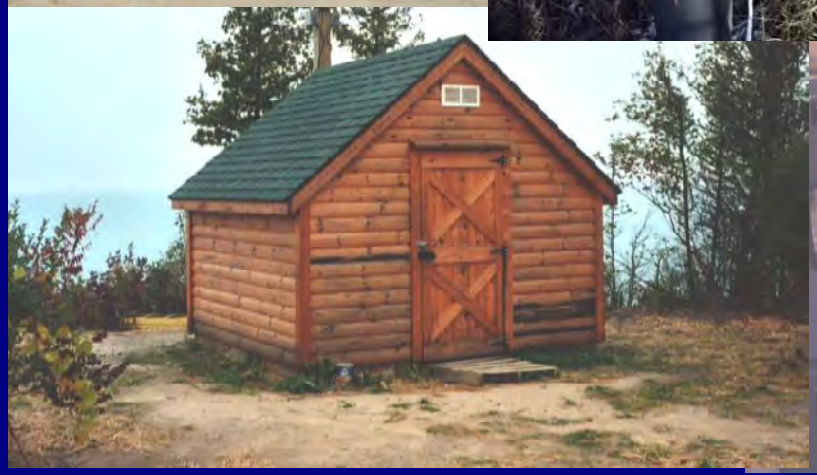
Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227









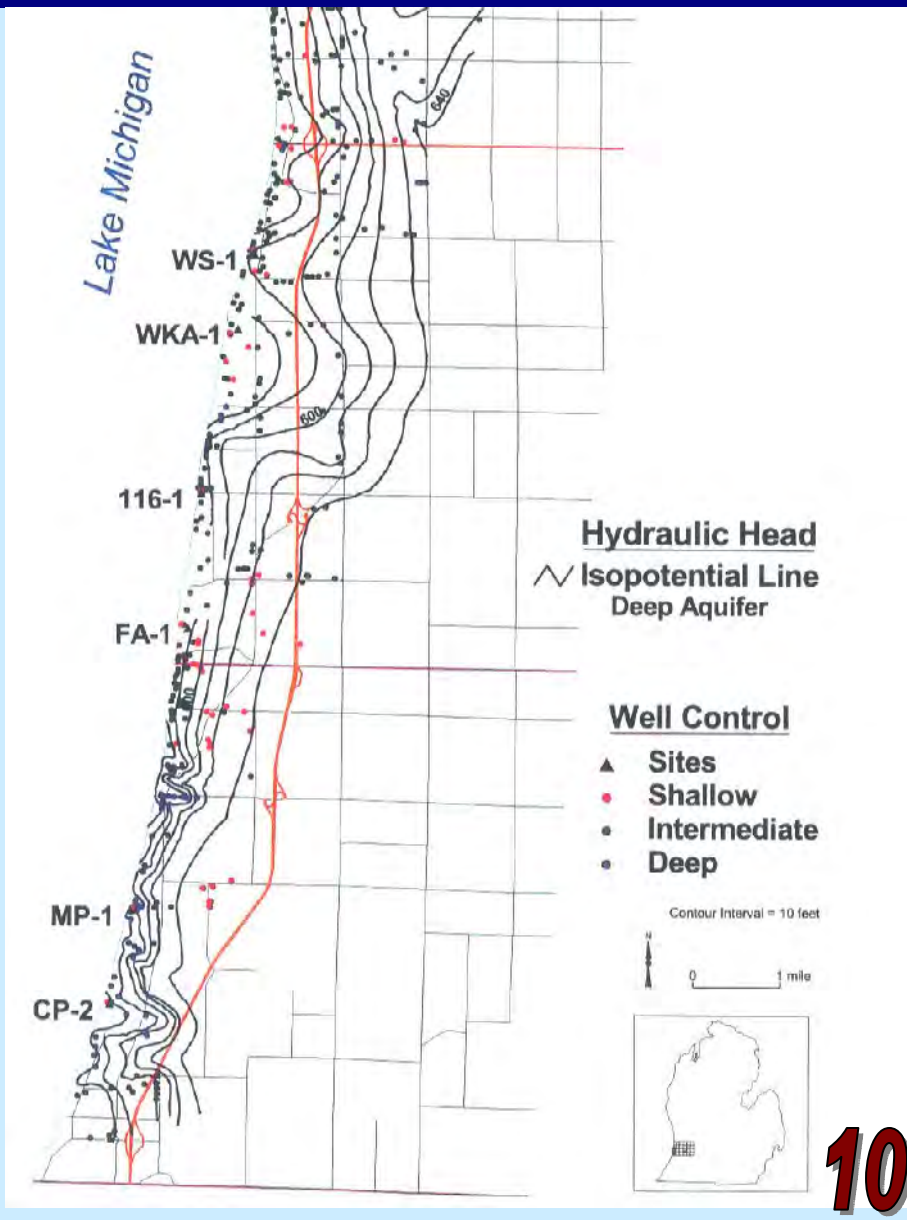


Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227

- Three recognized potentiometric surfaces
  - Deep (extension of lake level
  - Intermediate (perched)
  - Shallow (perched)

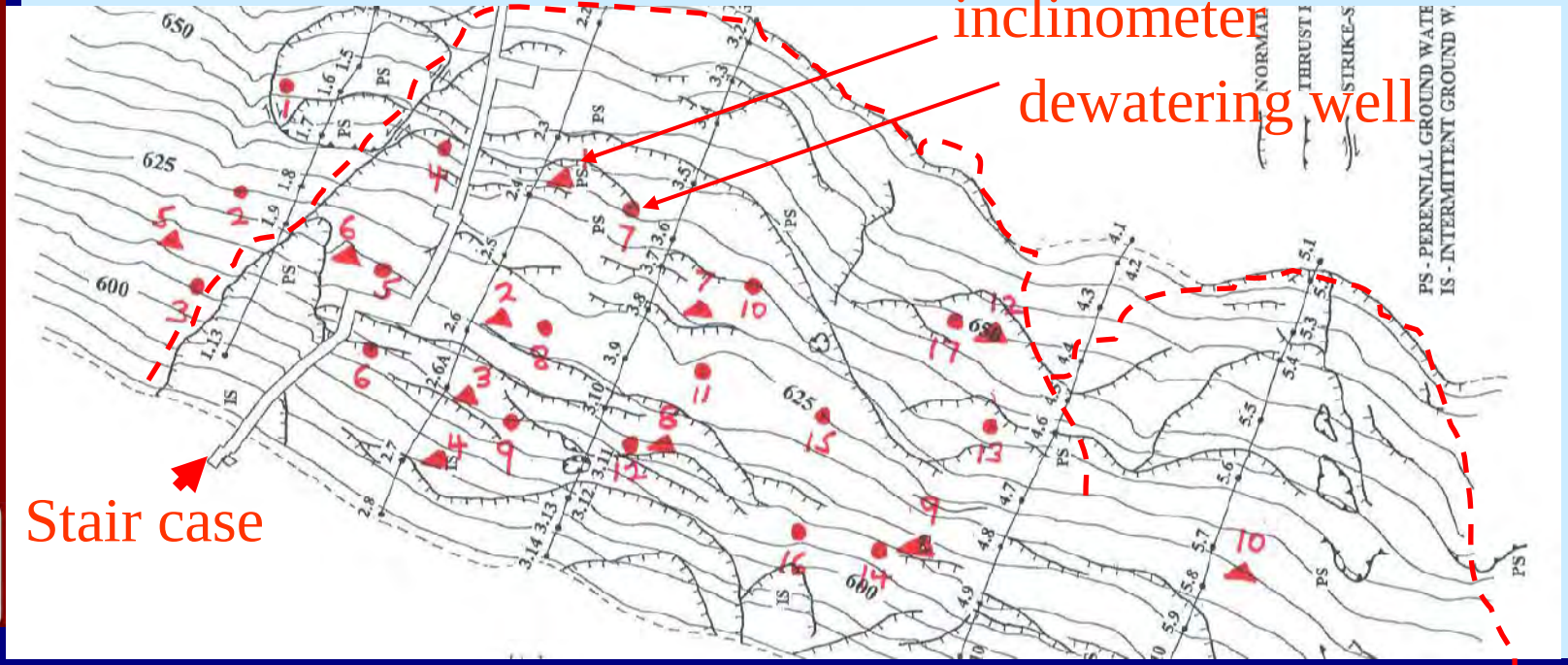
(after Montgomery, 1998)



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

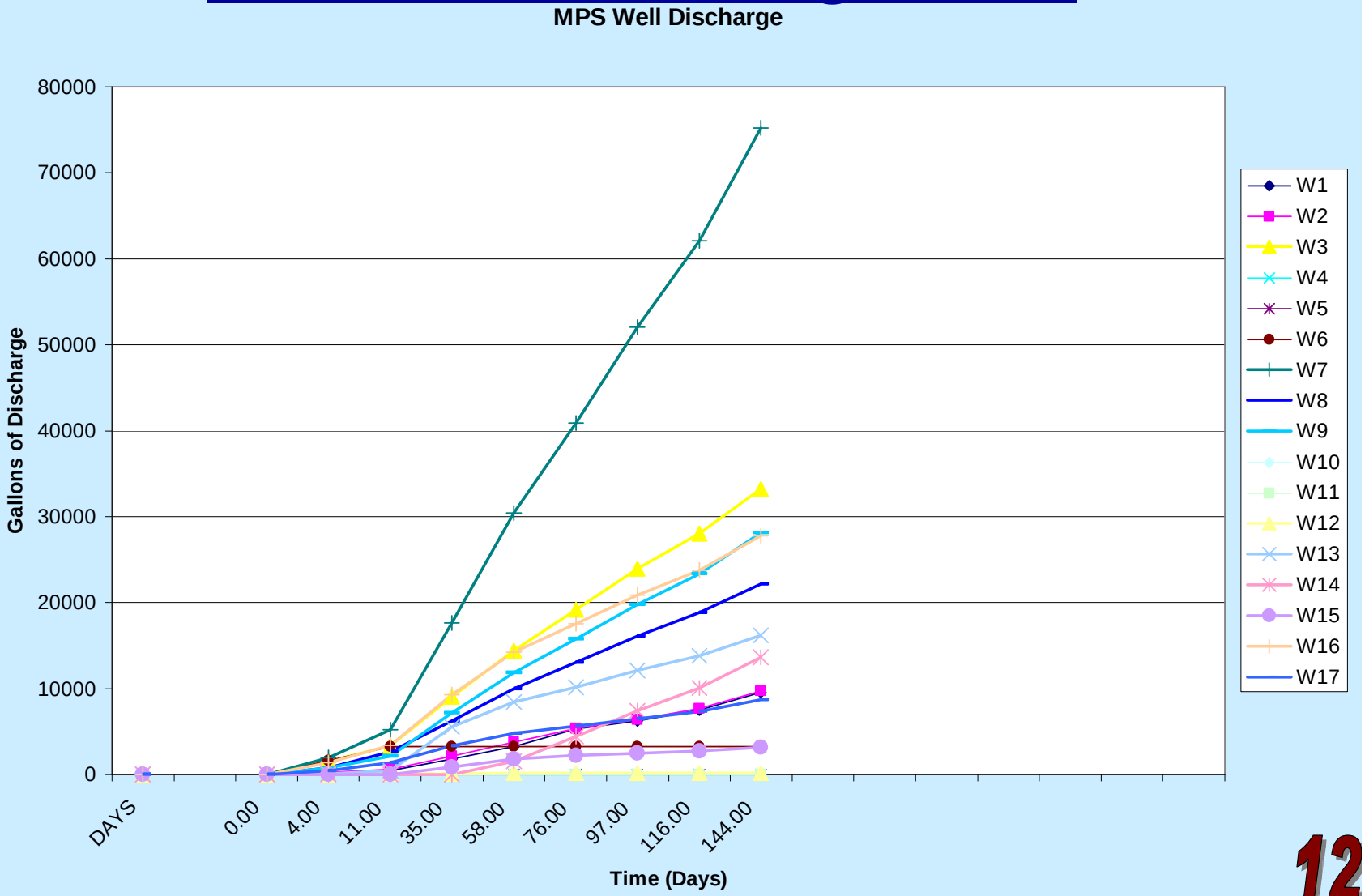
SECTION 227





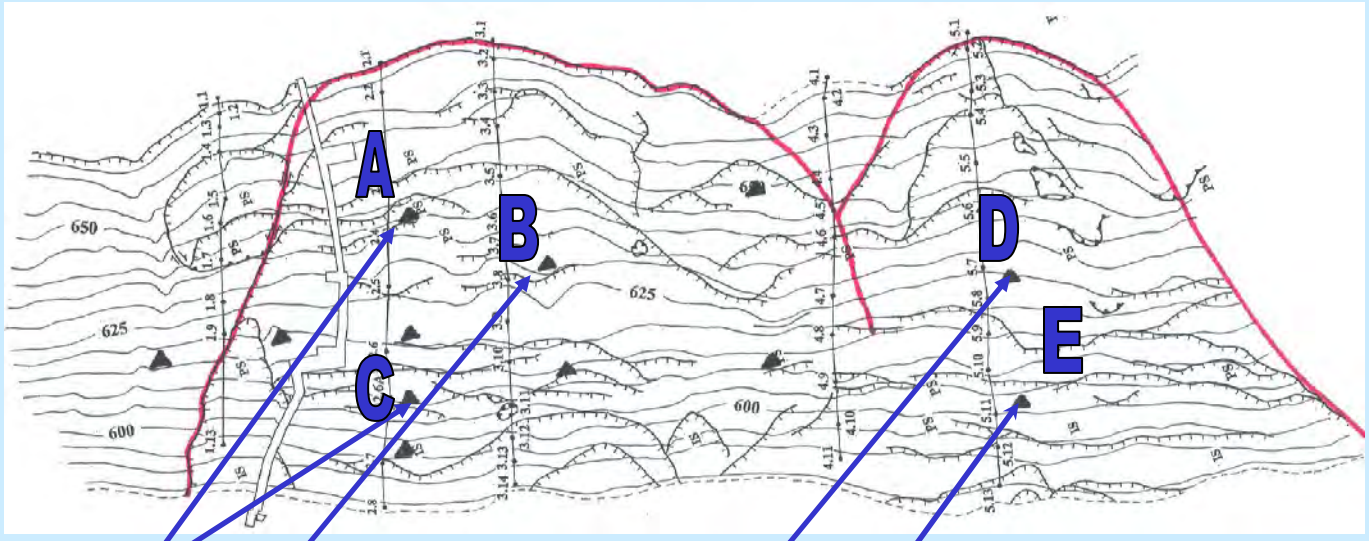
SECTION 227

Phase II - Dewatering the site



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227

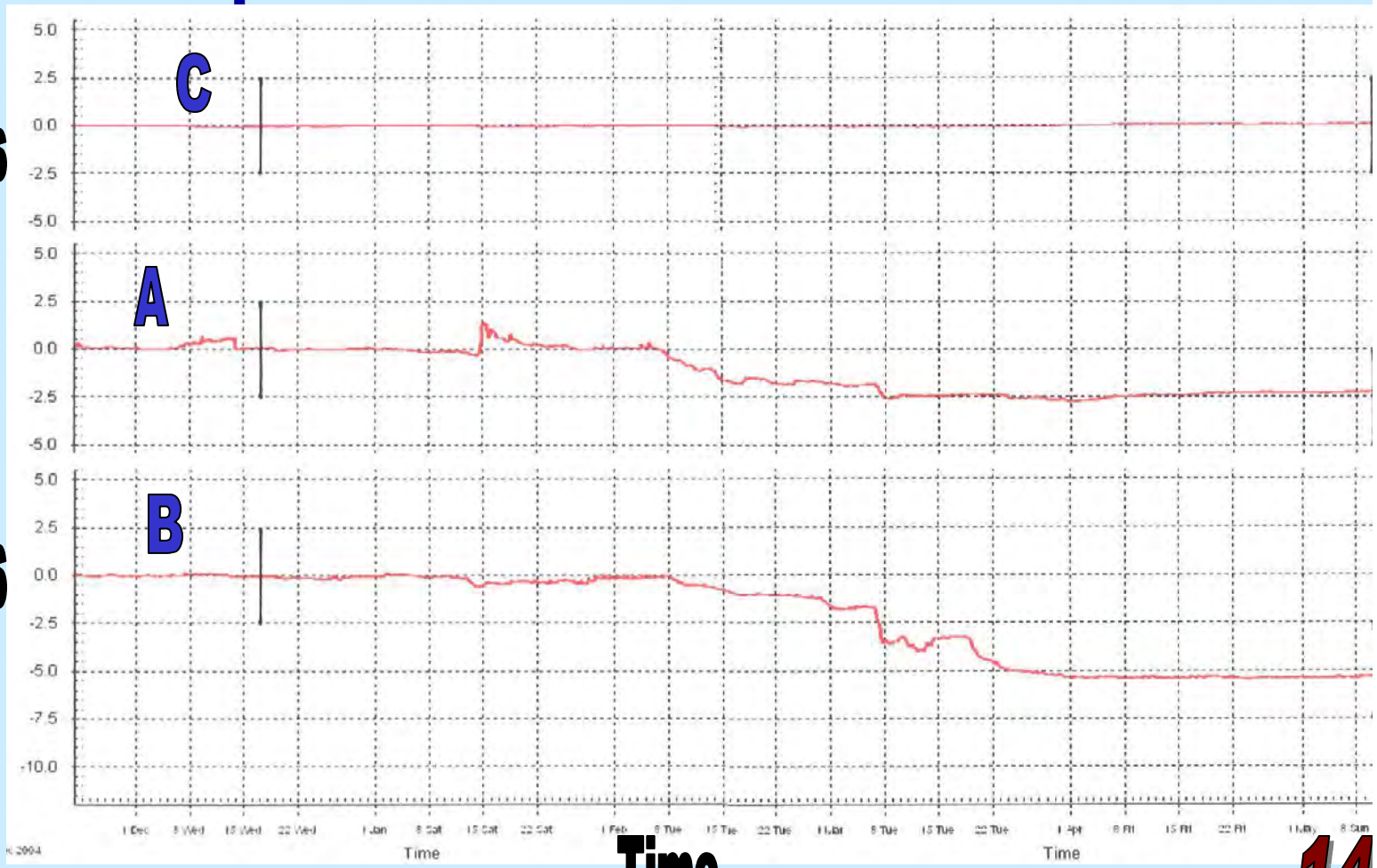


DEWATER

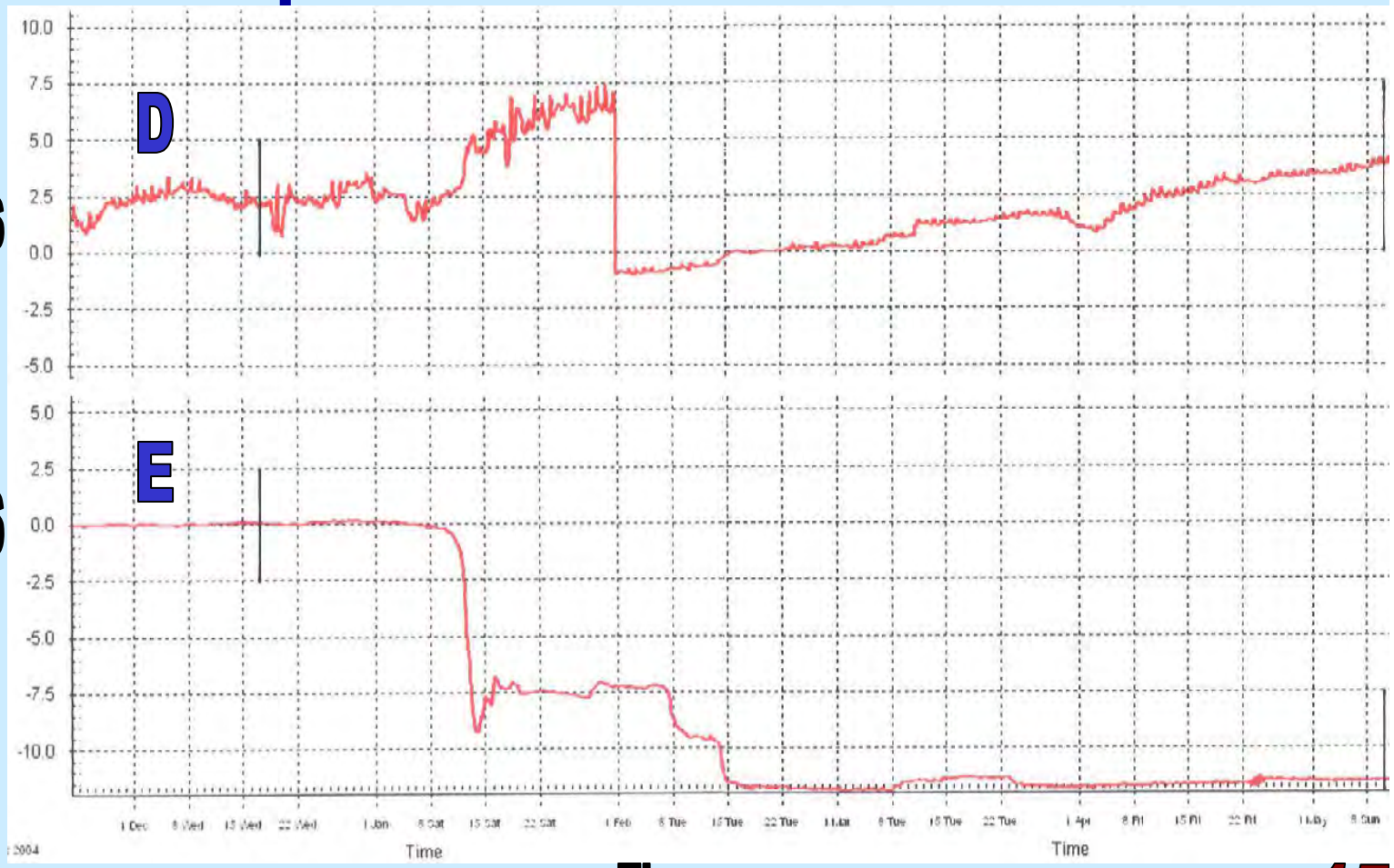
▲ inclinometer

No Water Removal

Effect of Water Removal on local Displacements-dewatered site



Effect of Water Removal on local Displacements-control site

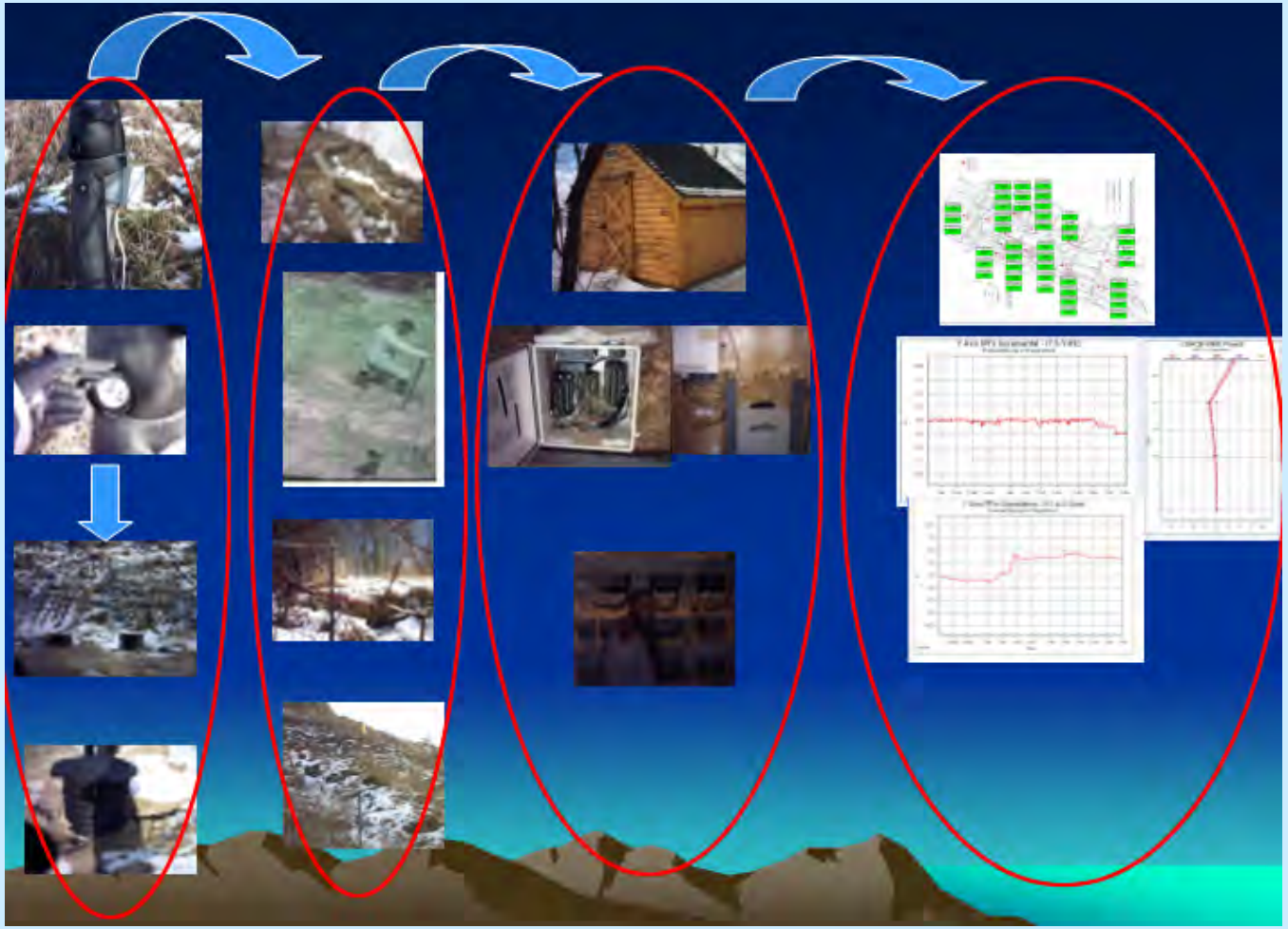


Time

Conclusions of first year's dewatering efforts

- After bluff face froze, groundwater flow direction changed periodically
- Horizontal passive wells not as effective as vertical active wells.
- Mean shear displacement in wells on dewatered site was about 2.83 in. per well
- Mean shear displacement in wells on control site was about 11.50 in. per well
- Removal of perched groundwater during the 2004-05 winter spring cycle created a three times more stable bluff than at control site
- Repeated experiments between now and 2009 will test repeatability of 2004-05 results

Future Work-development of knowledge-based data base system



Acknowledgements

Western Michigan University – for study facilities & personnel support.

U.S. Army Research Office – for supplying funding for investigations into the causes of bluff failure (Phase 1 of this project, 1996 - 1999).

U.S. Army Corps of Engineers – for supplying the funding and geotechnical field support to test the removal of ground water as a failure mitigation strategy (Phase 2 of this project, 2000 – 2009?).

Property owners – (private and government) for allowing unlimited access to the bluff.

SECTION 227

Contact Information

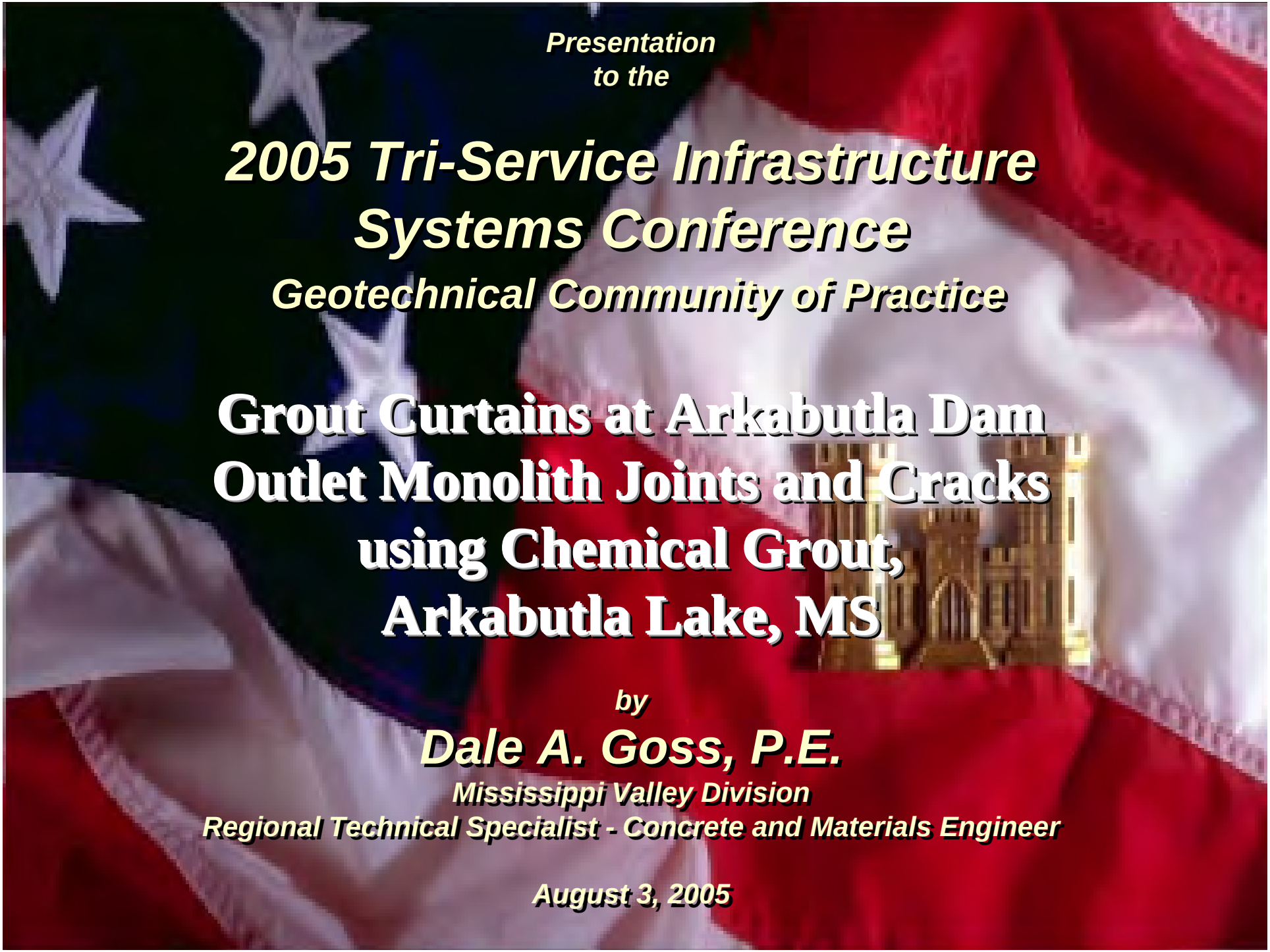
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Presentation to the

2005 Tri-Service Infrastructure Systems Conference

Geotechnical Community of Practice

Grout Curtains at Arkabutla Dam Outlet Monolith Joints and Cracks using Chemical Grout, Arkabutla Lake, MS

by

Dale A. Goss, P.E.

Mississippi Valley Division

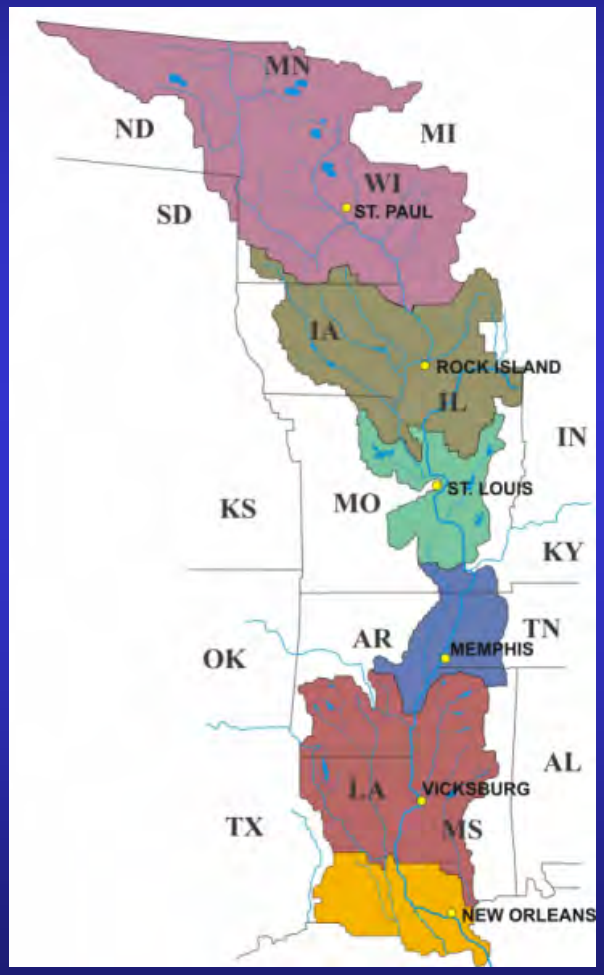
Regional Technical Specialist - Concrete and Materials Engineer

August 3, 2005

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Mississippi Valley Division





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Arkabutla Lake

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ARKABUTLA LAKE OUTLET WORKS



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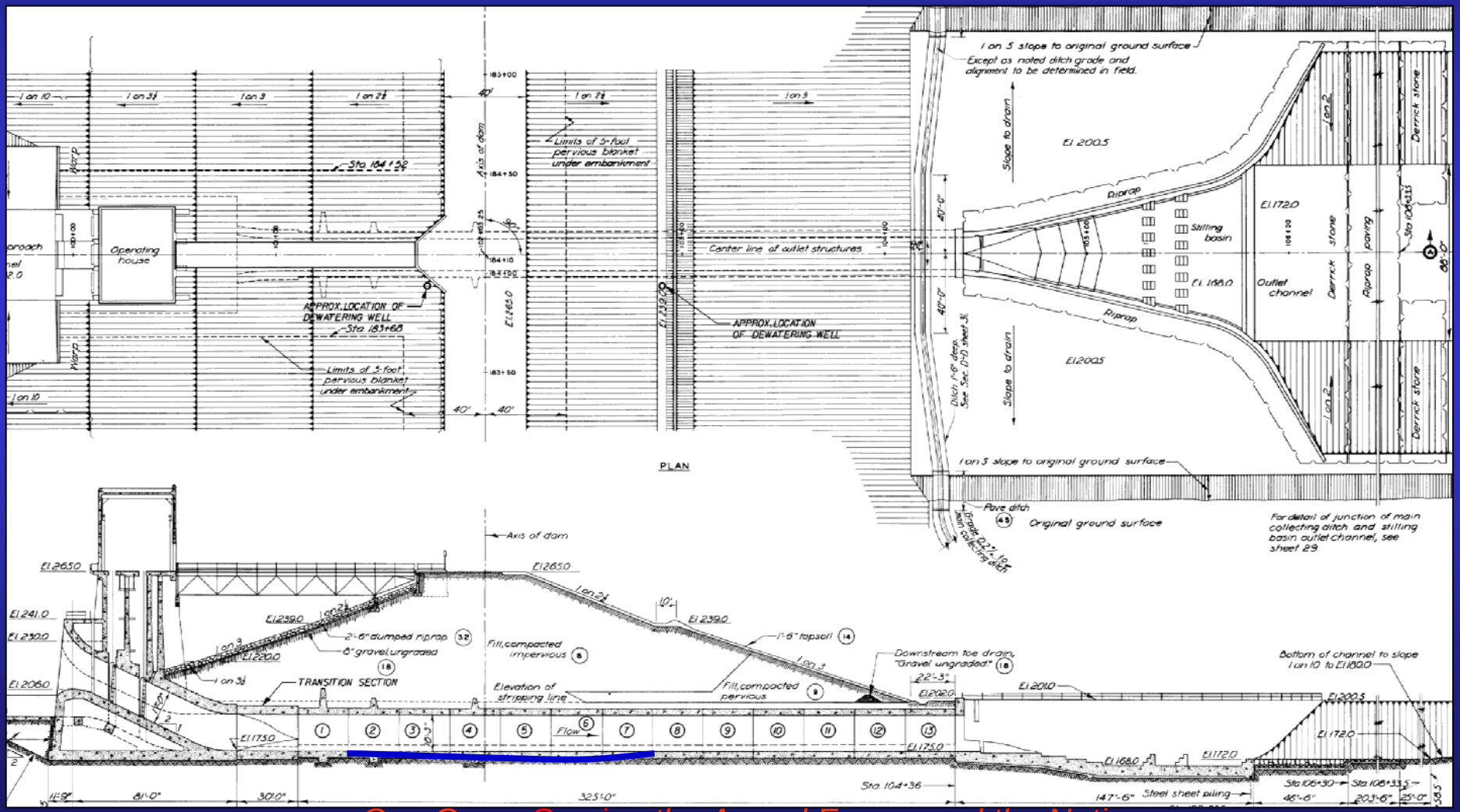
BACKGROUND

- Condition of Conduit
- Previous Grouting
- Previous Joint Repair

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OUTLET WORKS

(Constructed in 1941)

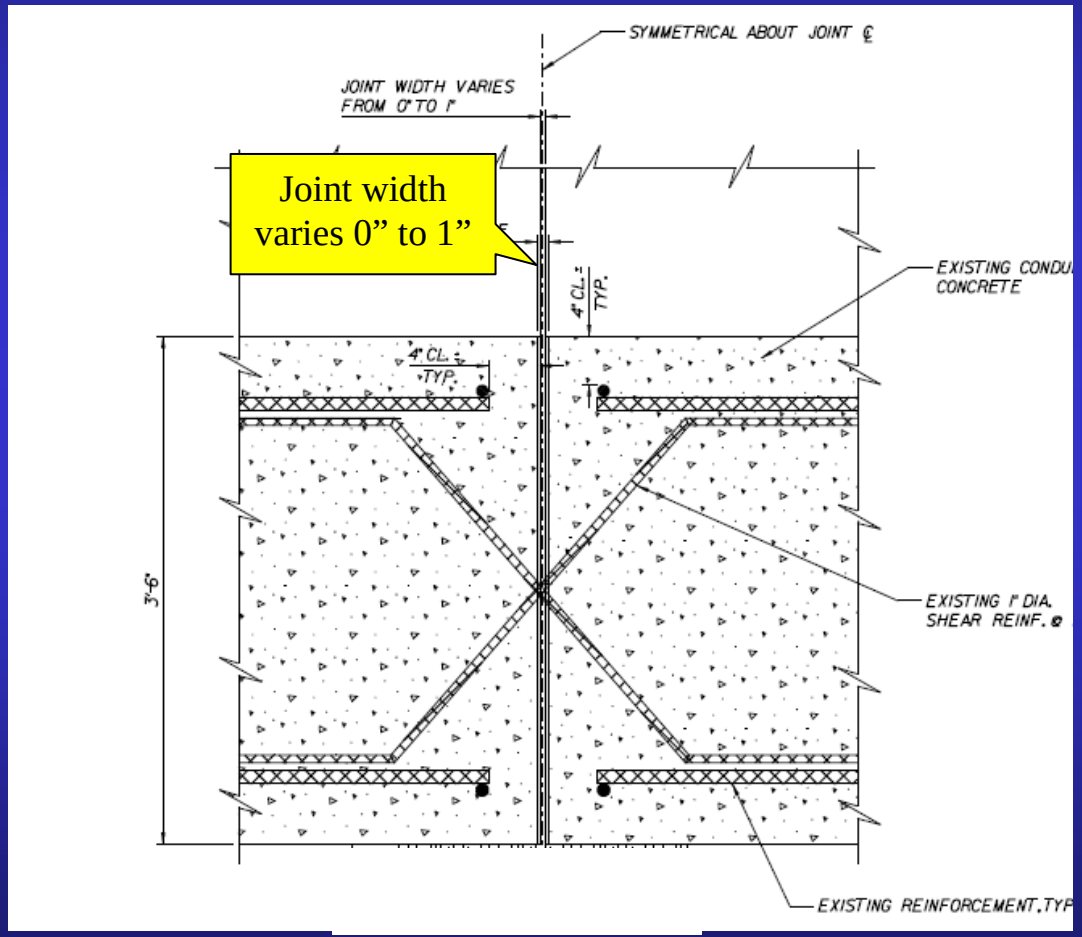


Typical Monolith Joint with no waterstop in base of conduit

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Factors affecting monolith joints.

- Structure constructed in old stream channel (sands) to minimize differential settlement.
- Missing Waterstops
- Misplaced Reinforcement



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Table 1

Previous Grouting at Outlet Works Performed during 1950 and 2003								
Joint No.	Cement Grout, Cu. Ft.			Chemical Grout, gal.				Cement Grout, Cu. Ft.
	1950	1971	1977	1988	1998	2000	2003	2003
Transiiton/1								
1/2		0.5	0.4	3.5	2.5		15	11.4
2/3	1.0	0.6		15.0		5.0		10.0
3/4	9.5	410	0.5	2.0				
4/5	12.5	4.6						
5/6	47	33.1	6.9	9.0				
6/7	98	67.6	7.6	10.0				13.4
7/8	7	0.8						
8/9		0.6	1.0					
9/10		1.0						
10/11		0.6						
11/12		0.4						
12/13								
Subtotal	175	519.8	16.4	39.5[1]	2.5[2]	5.0[2]	15[2]	34.8
	711.2			62 gal. ≈ 285.8cu. ft				
Total	1031.8 cu. ft. (38.2 cu. yd.)							

Note: 1. The chemical grouting was performed using Hydro Active Cut (1 gal ≈ 6.67 cu. ft. of stabilized soil)
2. The chemical grouting was performed using Hydro Active Flex LV (1 gal ≈ 1 cu. ft. of grout)
3. Settlement of monoliths 1 through 8 of approximately 11 inches account for the loss of 78 cu. yd. of material.

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Sand Bags, Three foot high, to Control Sand Boil at Monolith Joint 5/6, Aug. 2003



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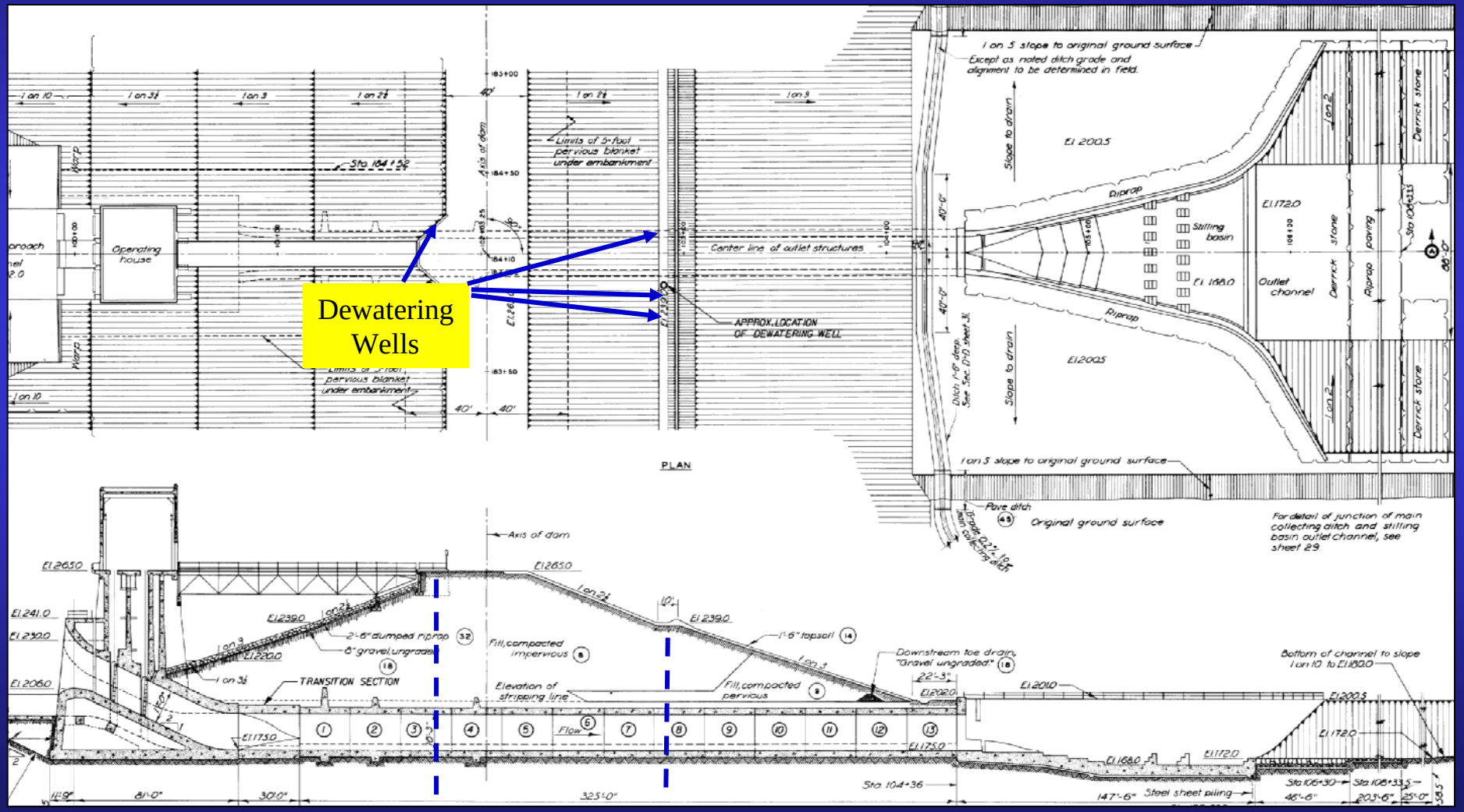
3/4 Cubic Yards of Foundation Sand piped through Monolith Joint 5/6, Aug. 2003



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OUTLET WORKS

Constructed in 1941

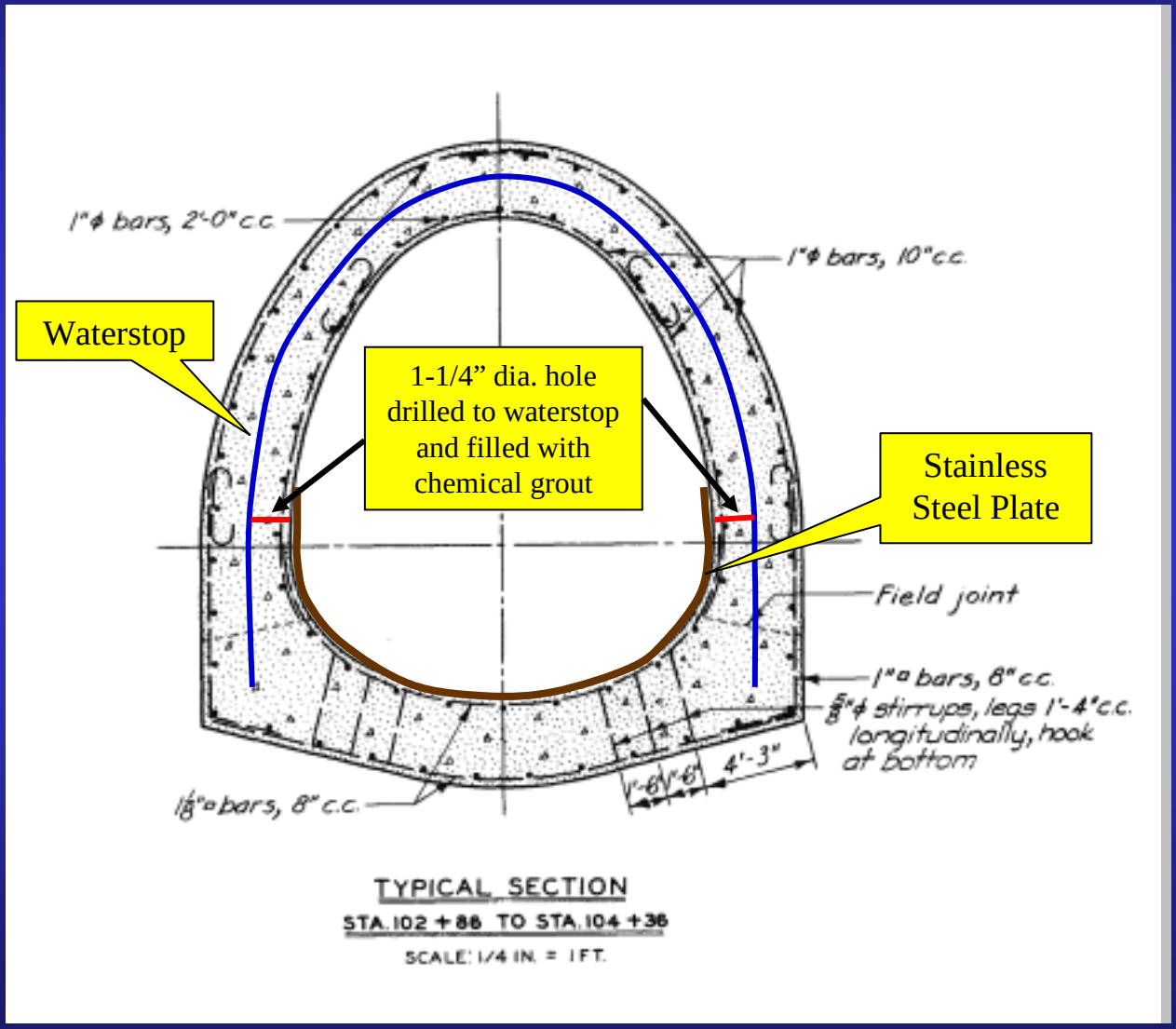


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Installation of Stainless Steel Plates at Two Monolith Joints as Test Section

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Detail for Installation of Stainless Steel Plates at Monolith Joints 5/6 and 6/7, Aug 2004



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Forming Plug at Concrete Surface of Conduit for Injection of Chemical Grout between Waterstop and Plate.



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Geotextile and Rubber Strips placed between Concrete Surface and Plate to trap any Material that could pipe through joint.



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Completed Plate Installation at one of the Monolith Joints, 17 Aug. 2004



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Failure of Plate at Monolith Joint 5/6 a Few Weeks after Installation, 2 Sep. 2004



US Army Corps of Engineers®

Close up View of Stainless Steel Plate Showing Tearing and Bending of Plate, 2 Sep 2004



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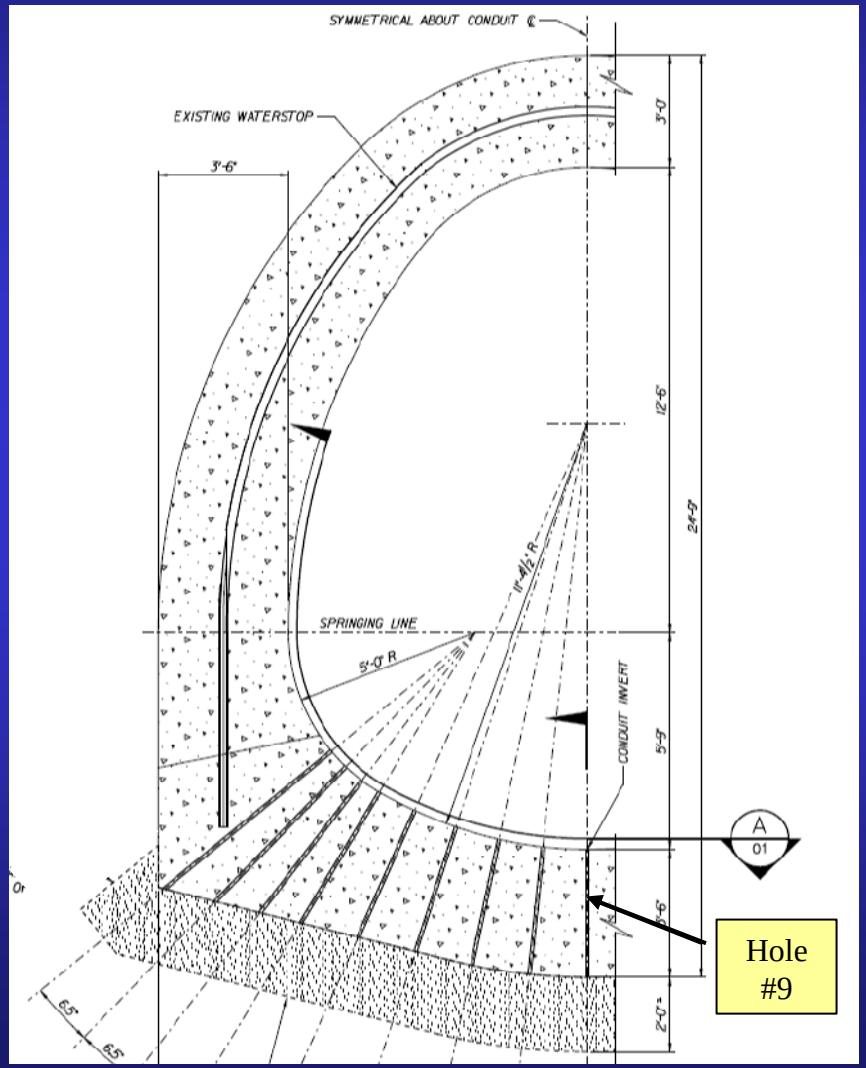
Example of 1/4-inch diameter jets of water observed on 26 Jan 05 from one location Joint 2/3 and from 3 locations Joint 3/4



Location of grout holes

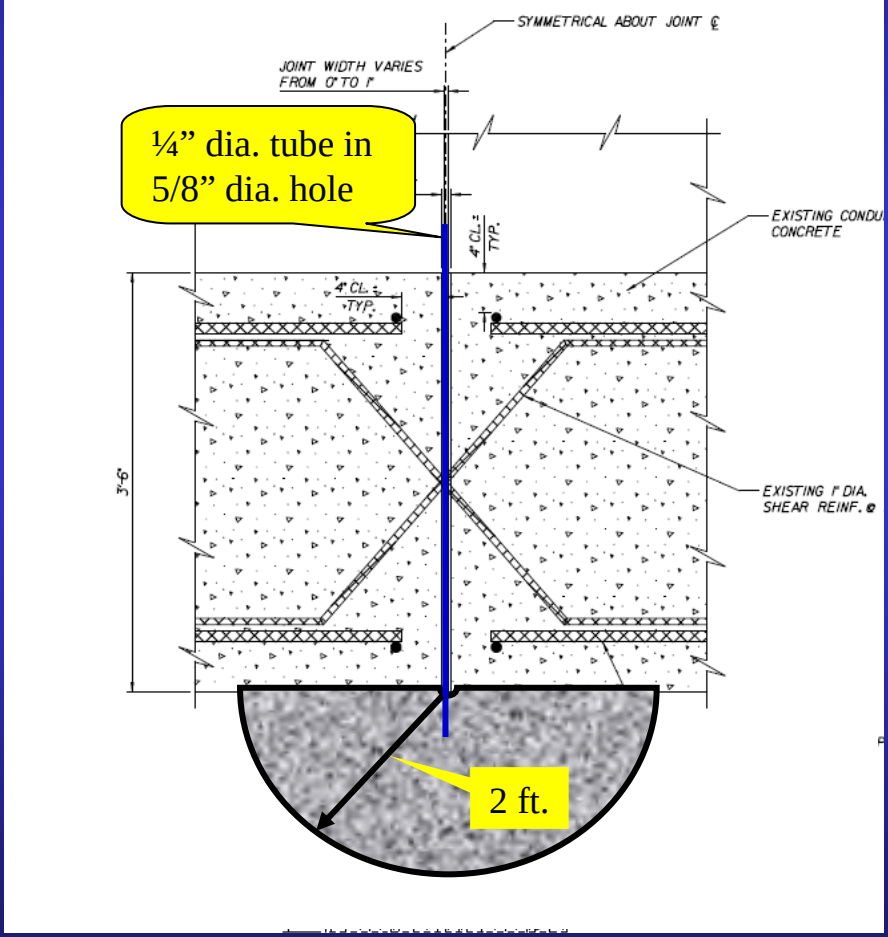
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Approximate location of the 9 holes using odd numbers, 9 through 17 or 1 through 9 depending on either looking upstream or downstream, respectively. Even number holes were used to verify soil stabilization between primary injection holes.



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Theoretical Cross Section of Stabilized Soil (Grout Curtain)



Assuming that grout is injected at the bottom of the conduit and expands radially from the injection point. For example if 2.7 gallons were injected at a hole, the radius of the hemisphere created would be 24.5inches.

Assuming 0.15 cu. ft. voids/ cu. ft. of soil, and 1gal of liquid chemical grout ≈ 1 cu. ft. of urethane foam. Therefore, volume of sand stabilized = 1/0.15 = 6.67 cu. ft

Chemical grout being injected as a hemisphere, radius = $\sqrt[3]{(3V/2\pi)}$;
V= 2.7 gal (6.67 cu. ft./ gal)

$\sqrt[3]{[(3)(18.0)/2\pi]}$= 2.05 ft = **24.5 inches**

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Table 2

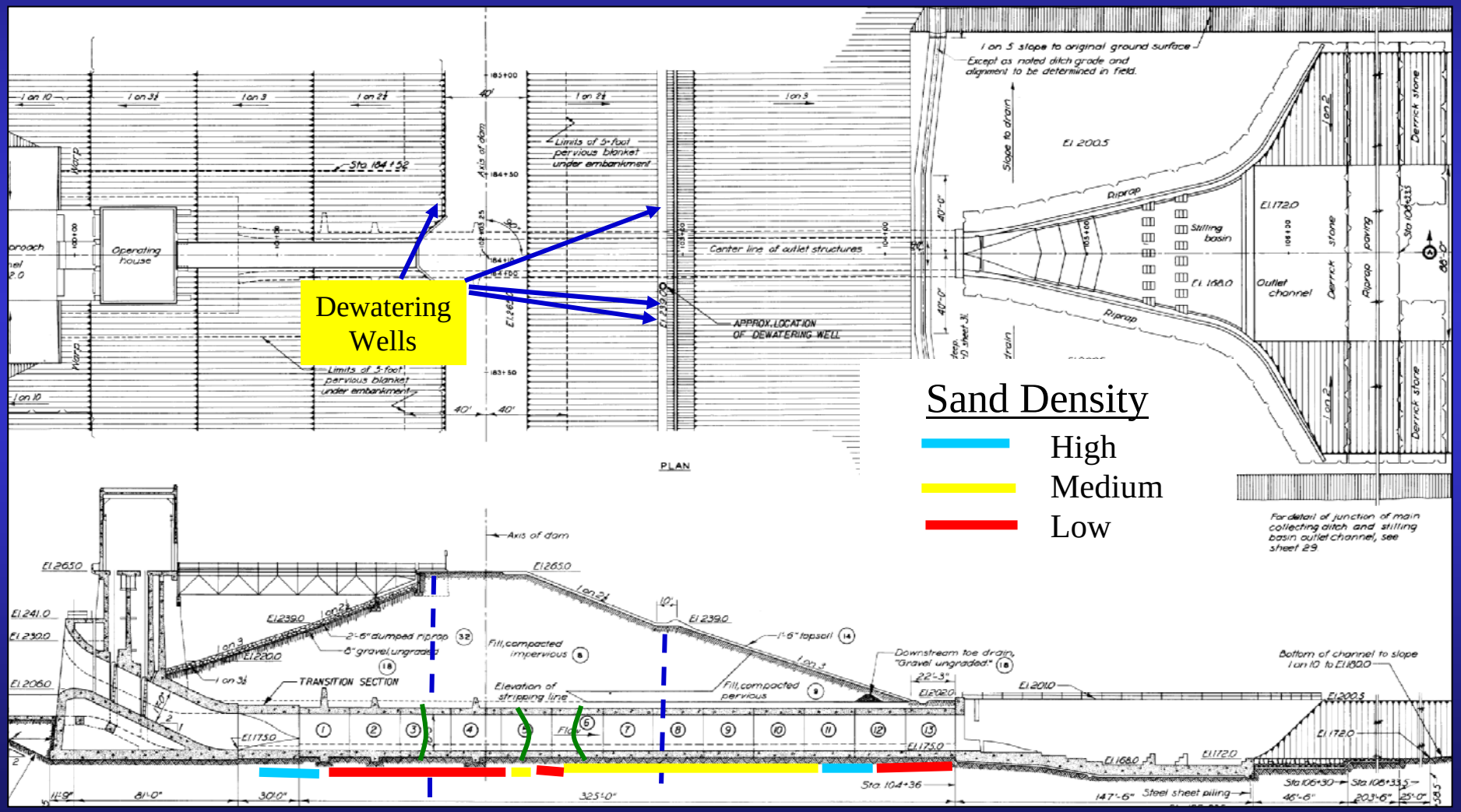
Hole No.	Monolith Joints or Cracks, 14-23 February 2005																Remedial Effort	
	T/1	1/2	2/3	A(3)	3/4	4/5	5/6	B(6)	6/7	7/8	8/9	9/10	10/11	11/12	12/13	13/C	A(3)	C(5)
	Chemical Grout Take per hole (gallons)																	
1	0.7	6.5	8.0	4.0	2.7	0.5	1.8	1.5	0.9	3.5	3.5	0.7	0.5	0.5	0.7	18”		3
2		0.5				G	G		G			0.5		G	G			
3	0.5	G	8.5	4.0	9.0	1.5	3.6	4.5	0.5	0.5	3.5	3.6	2.5	1.5	0.5	18”		0.5
4	G	6.3				6.7	0.9		3.5									
5	0.5	2.7	5.5	4.0	3.6	0.9	8.5	4.5	1.5	3.5	3.0	3.0	3.5	5.4	4.5	steel		5
6		4.5				8.5											5.0	
7	5.8	0.5	4.5	4.0	1.5	0.9	0.5	3.5	8.5	4.5	3.5	2.6	4.5	1.5	4.5	steel		1.5
8			1.0			G	9.0										5.0	
9	8.0	8.0	2.5	4.0	4.5	4.0	1.9	3.0	0.5	3.0	3.5	3.0	0.5	4.5	5.4	13.5		3.0
10					G								2.5				5.0	
11	1.0	4.5	9.0	4.0	4.0	6.7	0.5	0.9	6.0	4.5	3.5	2.6	0.5	2.5	4.5	steel		5.0
12	0.5						7.0						2.5					
13	0.5	4.3	2.5	4.0	0.5	9.0	2.5	3.5	2.5	3.0	3.5	2.6	4.0	0.5	4.9	steel		3.0
14	G				9.0						0.5		0.5					
15	0.5	4.5	13.0	4.0	1.5	0.5	1.9	0.5	2.5	3.5	0.5	0.5	0.5	0.5	4.5	18”		5.0
16	G	2.5			G	0.2		G	G		G	0.5	0.5	G	G			0.00
17	0.5	1.4	1.0	4.0	0.5	1.5	4.0	0.5	0.9	3.5	0.9	1.4	0.9	0.5	0.5	18”		0..25
18						3.6												
Total	18.5	46.2	55.5	36.0	36.8	44.5	42.1	22.4	27.3	29.5	25.9	21.0	23.4	17.4	30.0	13.5	15.0	26.25
	490.0 gallons ≈ 3267 cu. ft of stabilized sands																41.25 ≈ 275	

Notes: T – Transition Monolith; C- Chute Monolith; A(3) is crack in monolith 3; B(6) is crack in monolith 6; C(5) is crack in monolith 5;
G – drilled hole at this location and chemical grout was found and no additional chemical grout could be injected.

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OUTLET WORKS

Constructed in 1941



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Drilling of Holes during Feb 2005. Water used to remove cuttings from holes otherwise bit would become locked in hole.



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Washing injection tubing into drilled hole. TopCor Services, Baton Rouge, LA, personnel performed the chemical grouting.



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Placing oakum saturated with chemical grouting in annular space around tubing using a screw driver to pack the oakum



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Line for injection of chemical grout beneath conduit is attached and grout is being injected. Notice light brown color of material above tubing is water and unset liquid grout.



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Chemical grouting has setup after sealing off any voids in a joint or crack large enough to allow water seepage (0.02 in width).



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Foundation sand being pumped at monolith joint T/1 by gases being released from chemical grout injected at monolith joint 2/3, 50 feet away, prior to grouting joint T/1.



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Chemical grout has been measured in gallon bucket and catalyst was added and mixed by hand. Pouring grout into bucket so that it can be injected.



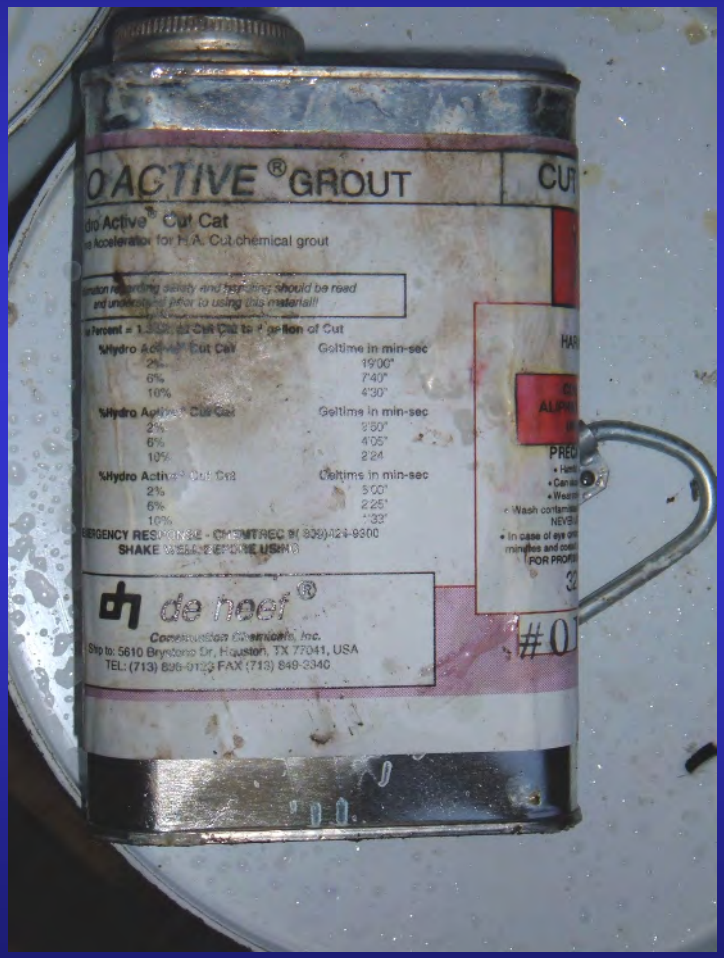
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Pails of Hydro Active Grout used for sealing joints and cracks and to bind foundation sands together beneath the conduit



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Can of Hydro Active Cut Catalyst used to vary setting time of chemical grout.



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Drilling holes at cracks in monoliths 3 & 5 during June 2005. Holes drilled at an angle of 45 to 60 degrees to surface to intercept cracks.



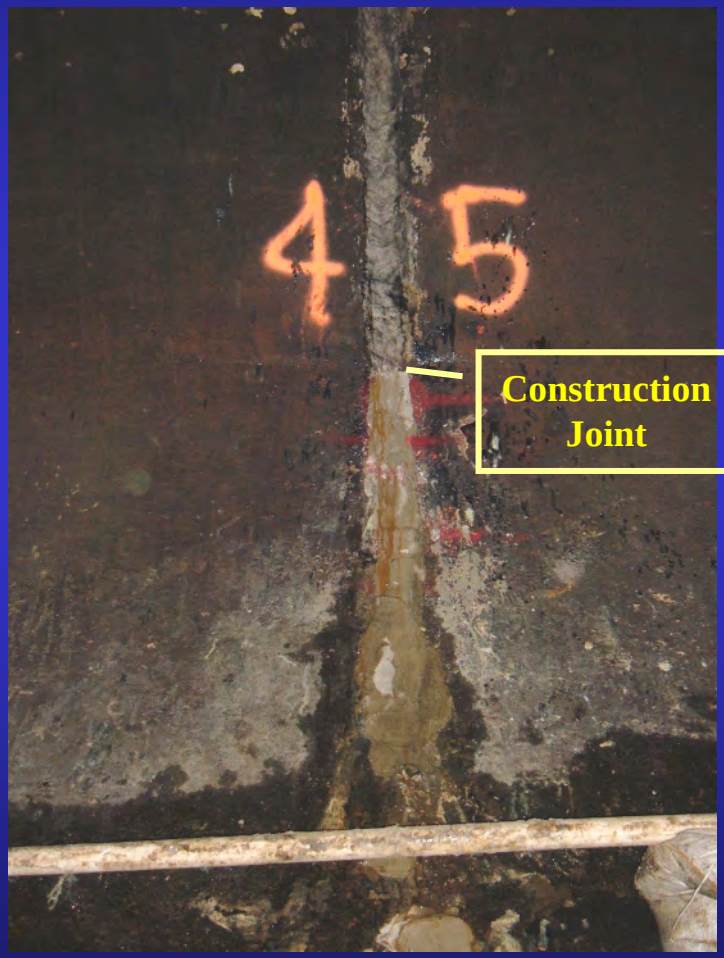
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Crack in monolith 5, the grout migrated up the crack to approx. 9 o'clock and then traveled through a zone of honeycombed concrete. Exited 7 feet downstream of crack



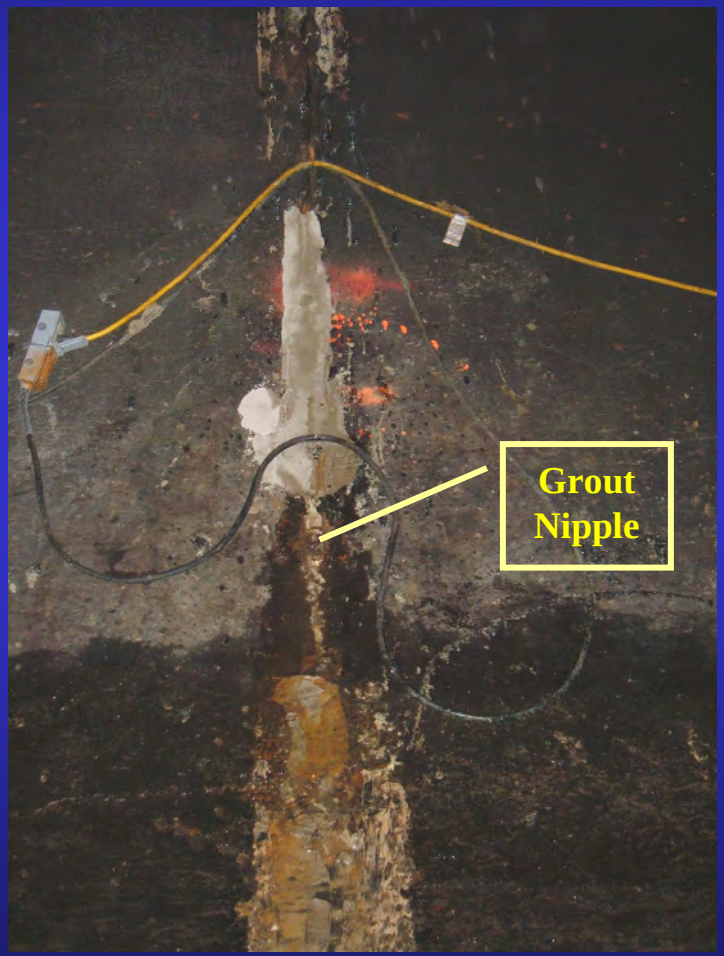
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Monolith joint 4/5 showing weeping from construction joint on left side of conduit when looking downstream, 24 Feb 05



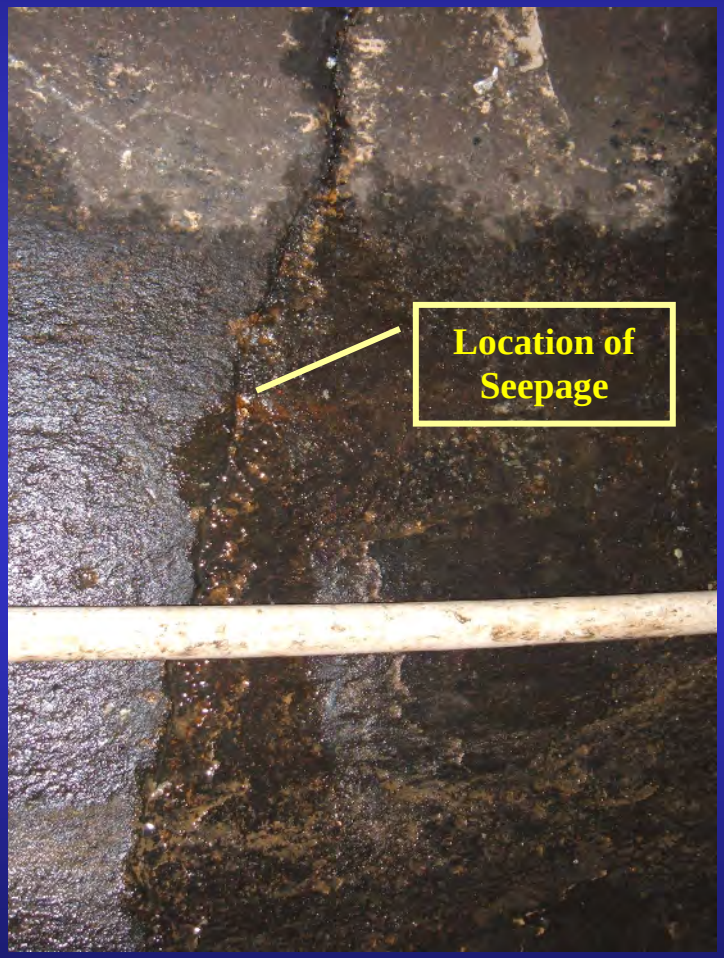
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Monolith joint 4/5 showing weeping from around grout nipple on right side of conduit when looking downstream, 24 Feb 05



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Crack in monolith 5 which was not grouted. Seepage at 2 feet left of centerline when looking downstream, 24 Feb 05



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Monolith joint 13/C showing a good seal due to the chemical grouting



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Table 3

Monolith Joints or Cracks	Remarks
Visual Evaluation of Chemical Grouting on 24 February 2005, Day after Completing the Initial Grouting	
T-1	Minor weeping at construction joint, right side
1/2	Minor weeping at construction joint and at grout nipple right side
2/3	Minor weeping at grout nipple, left side and construction joint right side
A(3)	Seepage 1 foot left and 2 foot right of center. Also, bubbles escaping indicting chemical grout still active.
3/4	Minor weeping at grout nipple right side
4/5	Minor weeping at grout nipple, right side, and at construction joint, left side
Crack Monolith 5	Not grouted, Seepage 2 feet left of centerline and 2 feet right of centerline. Flow increased to 1 gallon per minute from the invert on 21 Mar 05.
5/6	Seepage 3 feet left of centerline
B(6)	Seepage 2 feet left of centerline
6/7	Minor weeping at construction joint right side
7/8	Good
8/9	Minor weeping 4 feet right of centerline
9/10	Minor weeping 2 feet left of centerline
10/11	Minor weeping 2 feet above grout nipple on right side
11/12	Good, damp but not weeping
12/13	Good, damp but not weeping
13/C	Good

NOTES:
Damp – Concrete surface is darker than surrounding area but when area is touched, fingers remain dry.
Weeping – Concrete Surface is dark and reflective and when touched, fingers will be damp.
Seepage – Visually can see water movement on concrete surface.

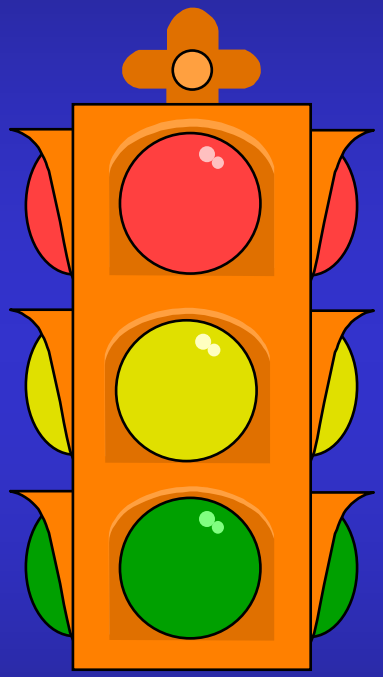
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Table 4

Monolith Joints or Cracks	Remarks
Visual Evaluation of Chemical Grouting on 9 June 05, Day after Completing Remedial Grouting.	
T-1	Damp at construction joint, right side
1/2	Damp at construction joint and at grout nipple right side
2/3	Damp at grout nipple, left side and construction joint right side
A(3)	Good, bubbles escaping indicting chemical grout still active.
3/4	Damp at grout nipple right side
4/5	Damp at grout nipple, right side, and at construction joint, left side
C(5)	Good, bubbles escaping indicting chemical grout still active.
5/6	Damp 3 feet left of centerline
B(6)	Minor weeping form crack at 2 o'clock and 10 o'clock
6/7	Damp at construction joint right side
7/8	Good
8/9	Good
9/10	Good
10/11	Good
11/12	Good
12/13	Good
13/C	Good
NOTES: Damp – Concrete surface is darker than surrounding area but when area is touched, fingers remain dry. Weeping – Concrete Surface is dark and reflective and when touched, fingers will be damp. Seepage – Visually can see water movement on concrete surface.	

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QUESTIONS?



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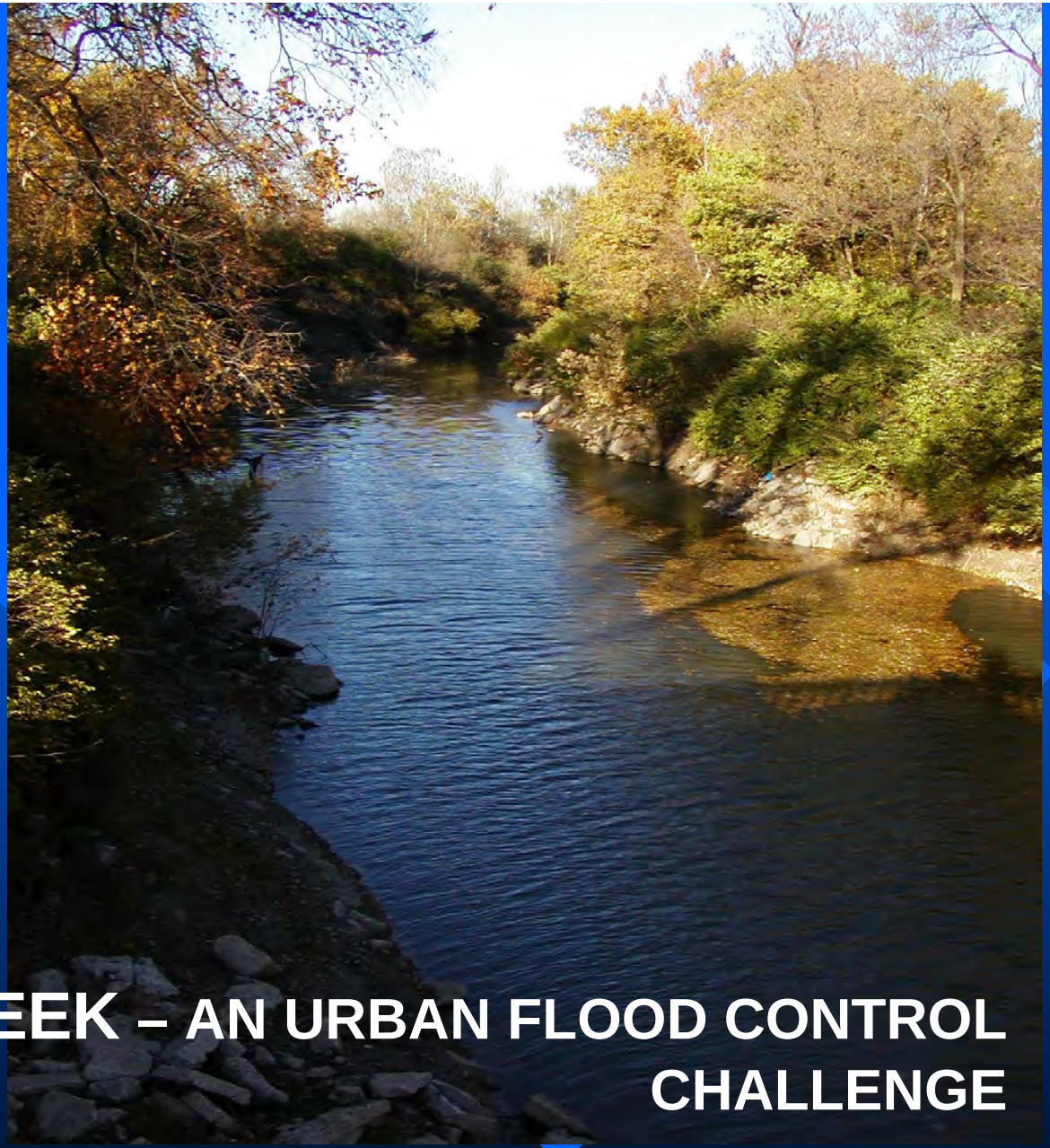
E-mail: Dale.A.Goss@us.army.mil

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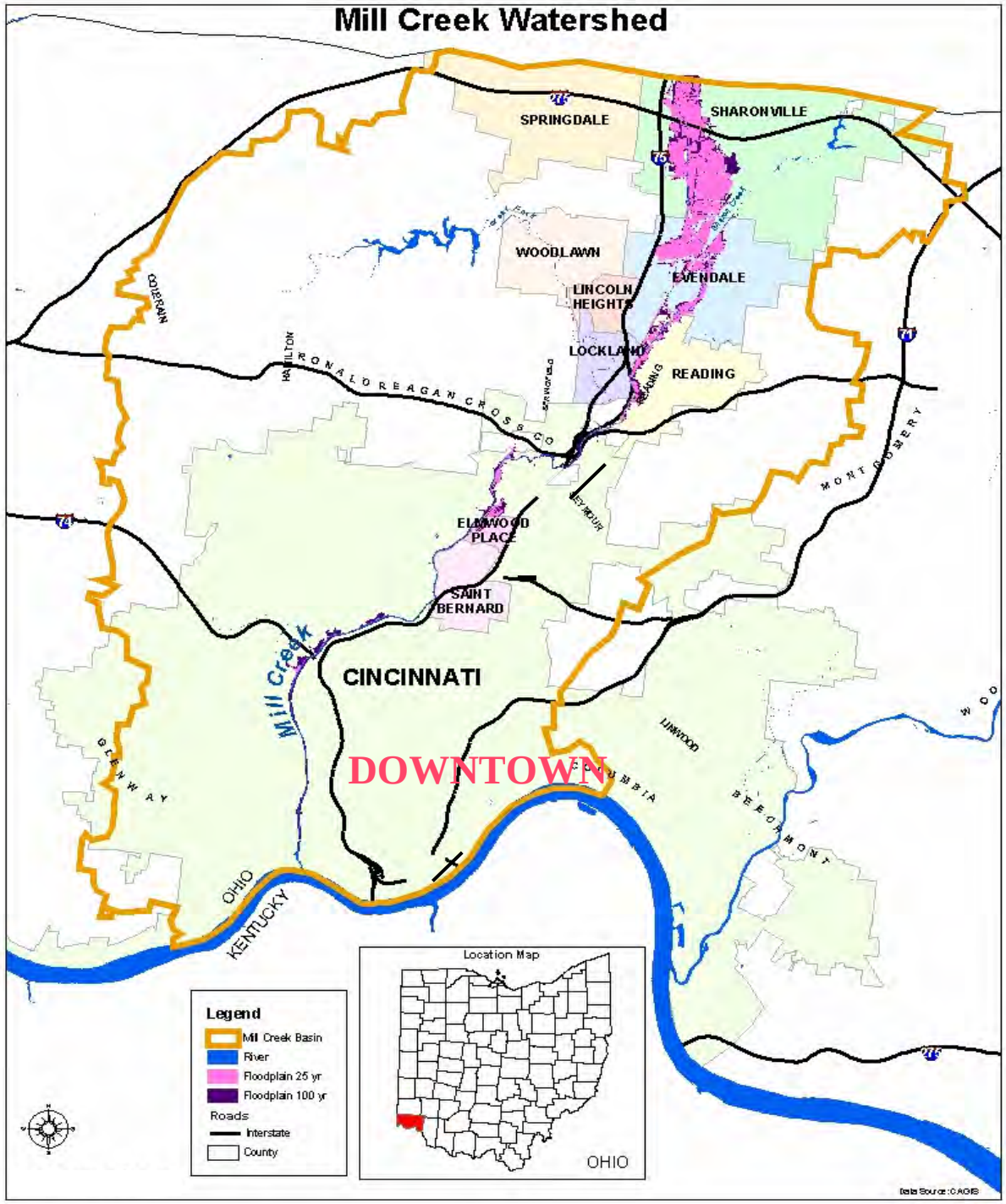
- TopCor Services, Baton Rouge, LA
  - Jon Gary – Project Manager
  - Stephanie Duplanits “Zena” – Crew Chief
  - Van Taylor – Crew Chief
- Arkabutla Lake Project Personnel
- MVK HQ – ED-D, ED-G, ED-O, ED-P, ED, C & Project Delivery Team
- Greenwood Area Office
- Inspectors – Noah Vroman, Jay Sims, & Al Hitchcock

US Army Corps
of Engineers

Louisville District



MILL CREEK – AN URBAN FLOOD CONTROL CHALLENGE


Mill Creek Watershed
SPRINGDALE
SHARONVILLE
WOODLAWN
EVENDALE
LINCOLN HEIGHTS
LOCKLAND
READING
RONALD REAGAN CROSSCO
ELMWOOD PLACE
SAINT BERNARD
CINCINNATI
Mill Creek
DOWNTOWN
GLENWAY
LINWOOD
COLUMBIA
BEECHMONT
OHIO
KENTUCKY
Legend
Mil Creek Basin
River
Floodplain 25 yr
Floodplain 100 yr
Roads
Interstate
County
Location Map
OHIO

History of Flooding





- Flooding from Ohio River backwater :
  1913, 1937, 1945
- Flooding from storms and flash floods
  1958, 1959, 1964, 1971, 1996, 1998, and 2001





HISTORY before GRR

1970 – Project was authorized.

1975 – A LCA was executed with the Millcreek Valley Conservancy District (MVCD) to construct the authorized project.

1975 – The GDM was completed.

1981 – Construction began.

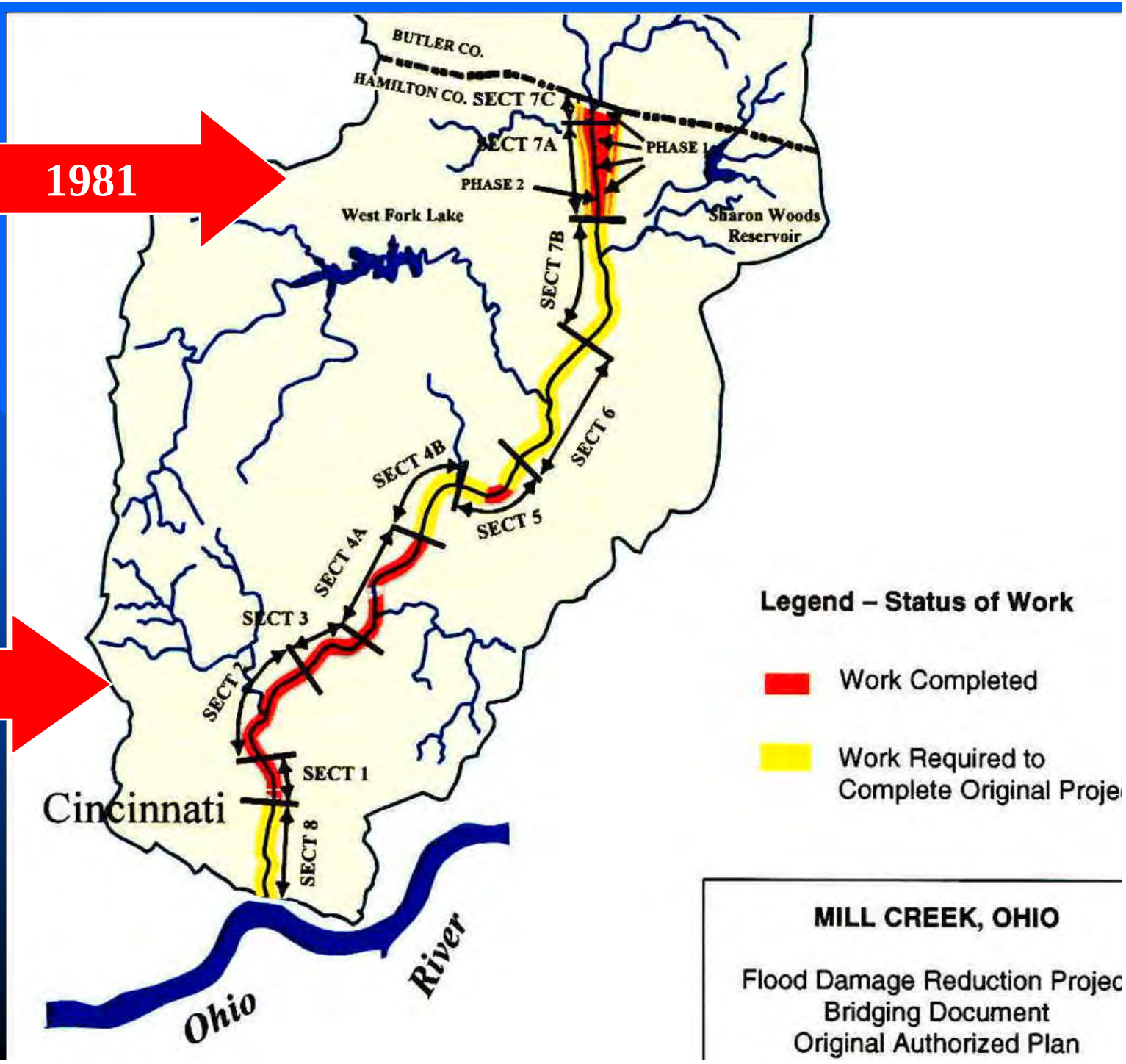
1991 – All design efforts and future construction were suspended at the direction of the Assistant Secretary of the Army (Civil Works).

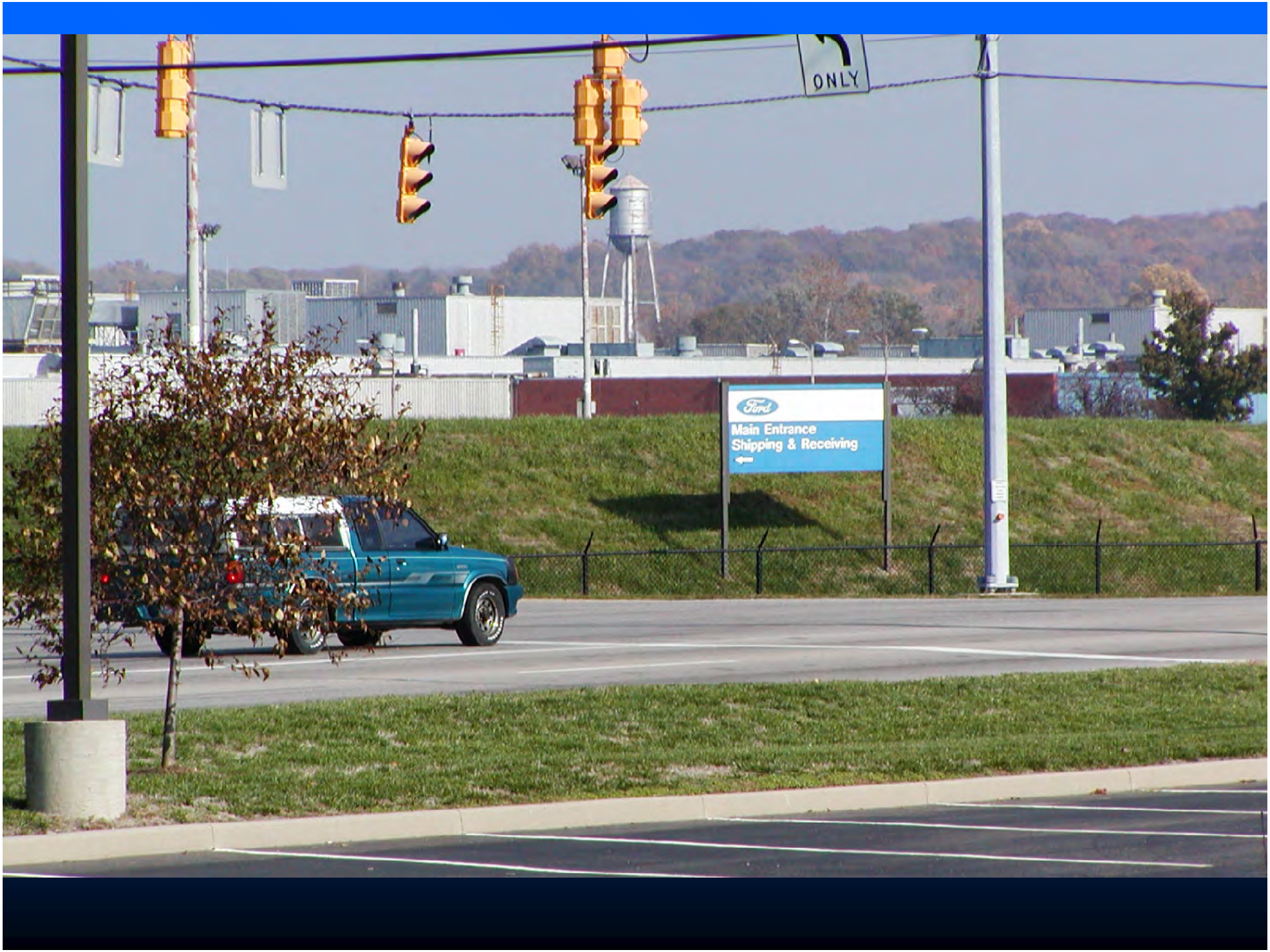
1998 – Contributed Funds agreement on GRR and Cooperative agreement with MVCD re O&M of completed sections.

Construction Started

1981

1983 - 91




ONLY
Ford
Main Entrance
Shipping & Receiving






FORD


AUG 26 2004



Constraints

- Hazardous Waste
- Railroads
- Industry adjacent to creek
- Combined Sewer Overflows (CSOs)
- Utilities






WARNING
COMBINED SEWER OVERFLOW
(CSO)
The water flowing from this pipe may be polluted during or after rainstorms. For more information about this CSO and effects on the water quality of our streams and rivers, call
Metropolitan
Sewer District (MSD)
(513) 352-4900
CSO No. 019
Please call MSD and report if water is flowing in dry weather.

Local Stakeholders

- Millcreek Valley Conservancy District (MVCD) – Local Sponsor
- Metropolitan Sewer District of Greater Cincinnati (MSD)
- Mill Creek Watershed Council (MCWC)
- Mill Creek Restoration Project (MCRP)
- Ohio, Kentucky, Indiana Regional Council of Governments (OKI)
- City of Cincinnati
- Cities of Sharonville, Evendale, and Reading
- Ohio EPA

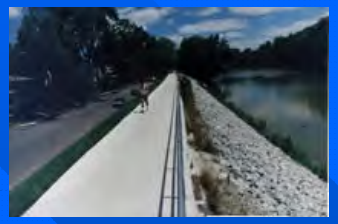
Goals of Various Stakeholders

- Flood Control
- Water quality – reduction of CSO's
- Economic viability of industrialized area – no loss of tax base
- Environmental restoration
- Greenway along creek with hike/bike paths

ALTERNATIVES

With-Project Alternatives

- Total Relocation
- Non-Structural
- Non-Structural 2A
- Non-Structural 3
- Channel Modification
- Channel Modification 2
- Floodwall & Levee
- Deep Tunnel
- Deep Tunnel 2

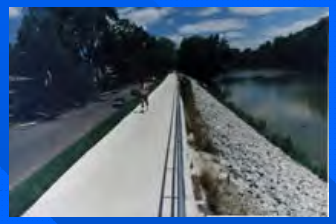






With-Project Alternatives

- Total Relocation
- Non-Structural
- Non-Structural 2A
- Non-Structural 3
- Channel Modification
- Channel Modification 2
- Floodwall & Levee
- Deep Tunnel
- Deep Tunnel 2







Channel Modification 2 (CM-2)

- Completes the 1970 Authorized Project
- Provides protection to most structures within the 1% chance (100-yr) flood plain
- Utilizes environmentally sustainable design features
- Major Features
  - 52 residential structures demolished
  - 69 commercial structures demolished
  - Extensive channel modifications in Sections 6 and 7
  - Floodwalls and levees constructed in Sections 4B and 5
  - 19 road and railroad bridge replacements

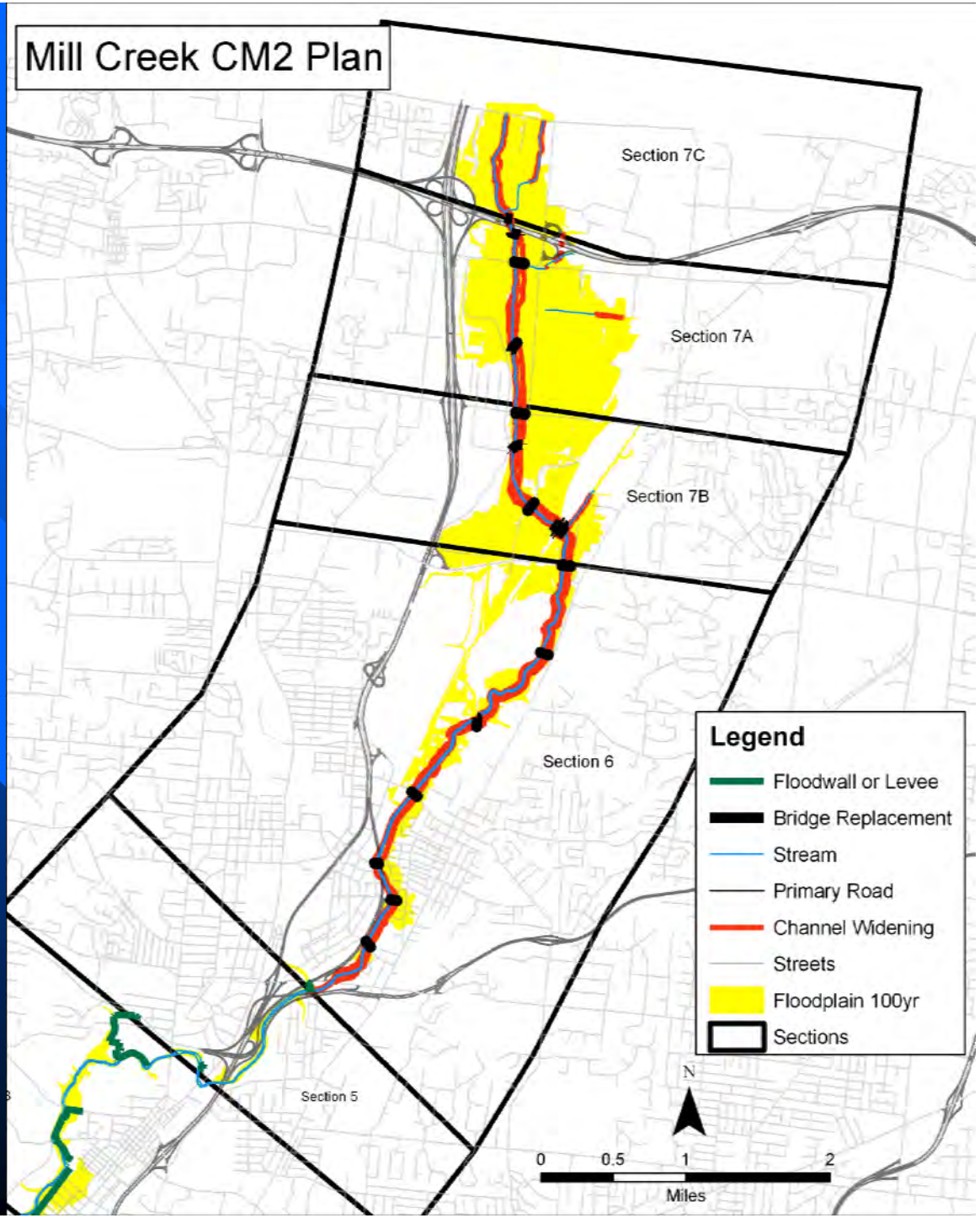
Major Features

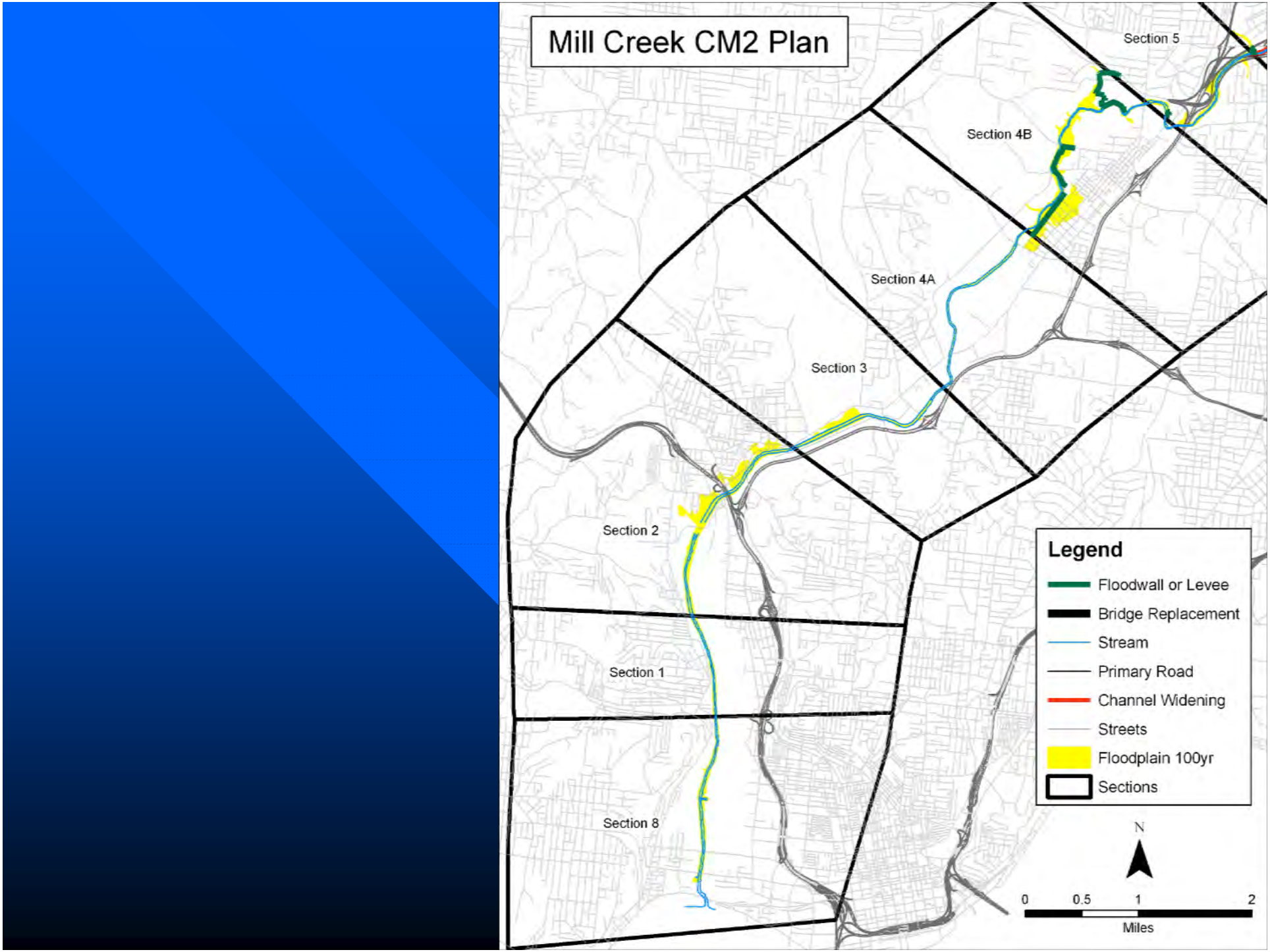
52 residential structures demolished

69 commercial structures demolished

37,250 lf of channel modification

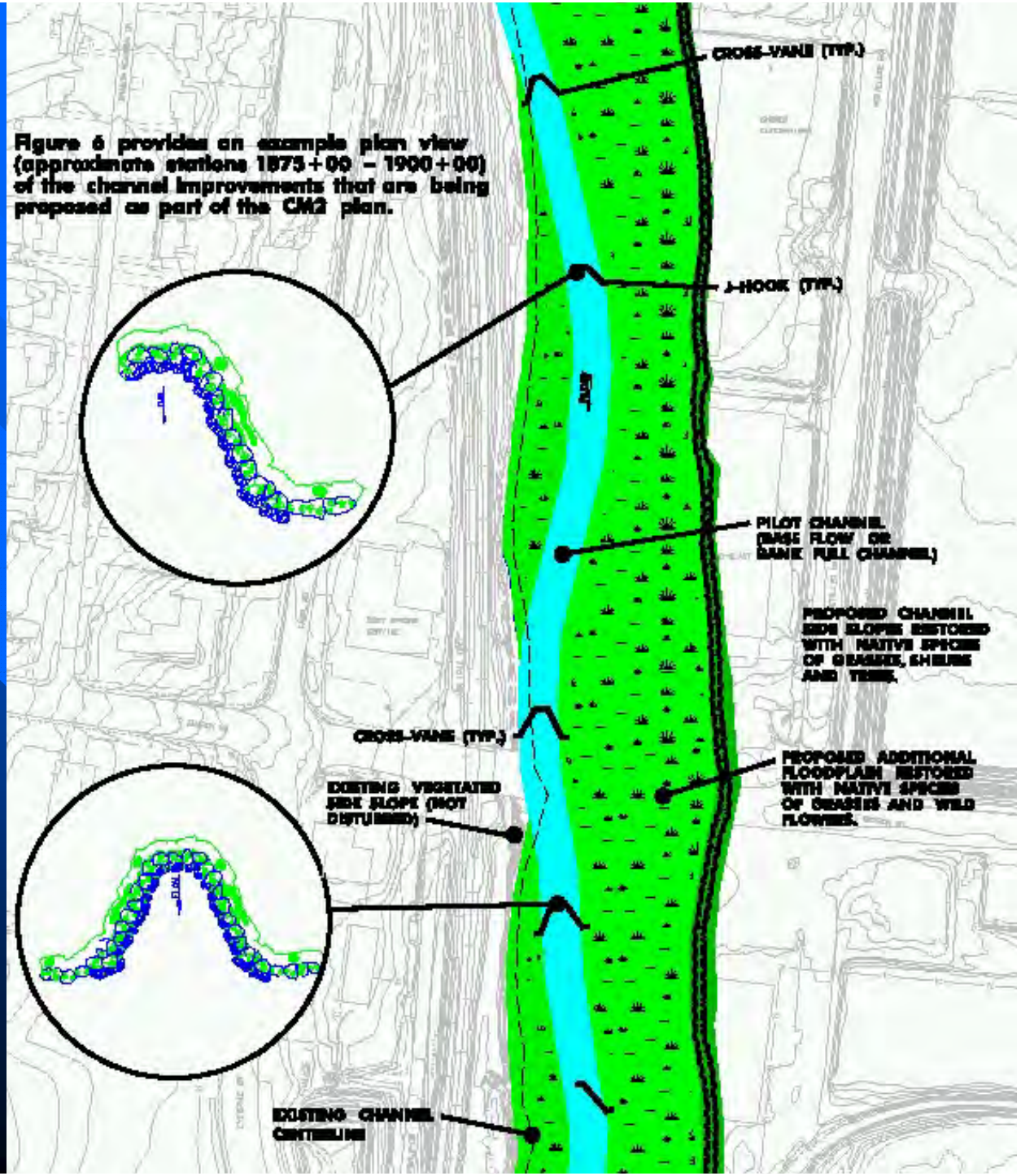
10,150 lf of floodwall



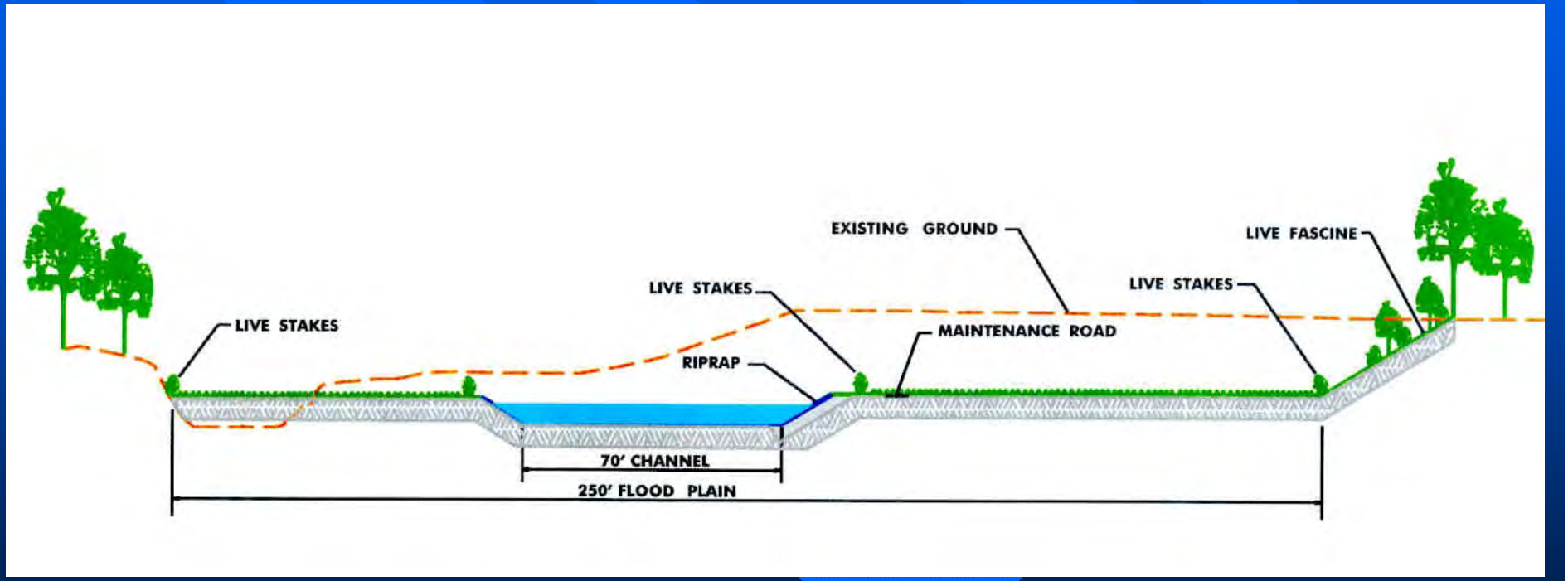

Mill Creek CM2 Plan
Section 5
Section 4B
Section 4A
Section 3
Section 2
Section 1
Section 8
Legend
Floodwall or Levee
Bridge Replacement
Stream
Primary Road
Channel Widening
Streets
Floodplain 100yr
Sections
N
0
0.5
1
2
Miles

CM-2 PLAN

(typical layout)



Plan CM-2 SAMPLE CROSS-SECTION





Deep Tunnel (TU)

- Consists of constructing a deep tunnel along the length of Mill Creek
- Provides flood protection from the 1% chance (100 -year) flood event
- Provides capacity to store CSOs for up to a 50% chance (2-year) storm event
- Locally preferred plan
- Major Features:
  - 300+ feet below ground
  - 31 foot diameter
  - 15.8 miles long
  - 7 flood water drop shafts / 16 CSO drop shafts

Major Features

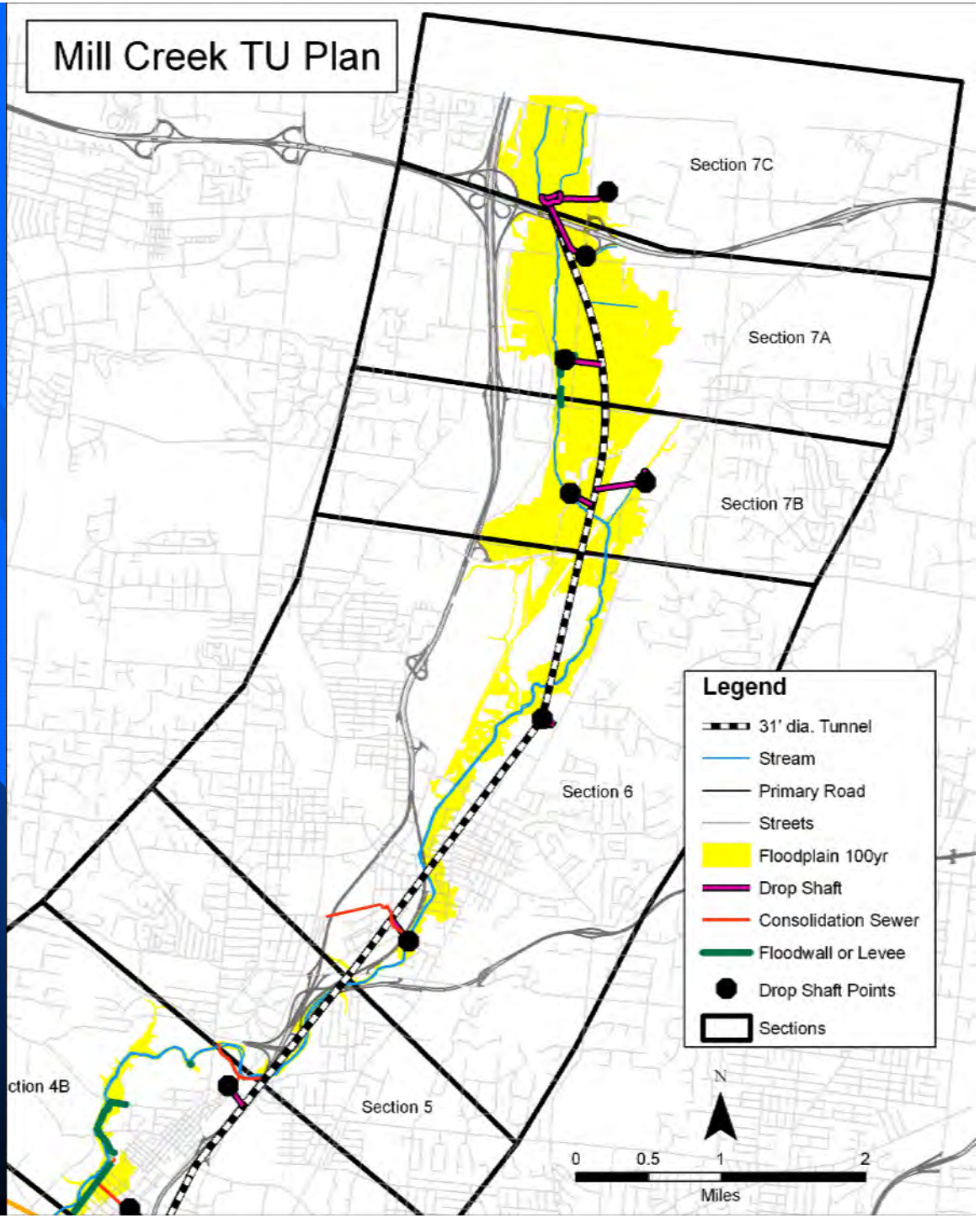
200-300 feet below ground

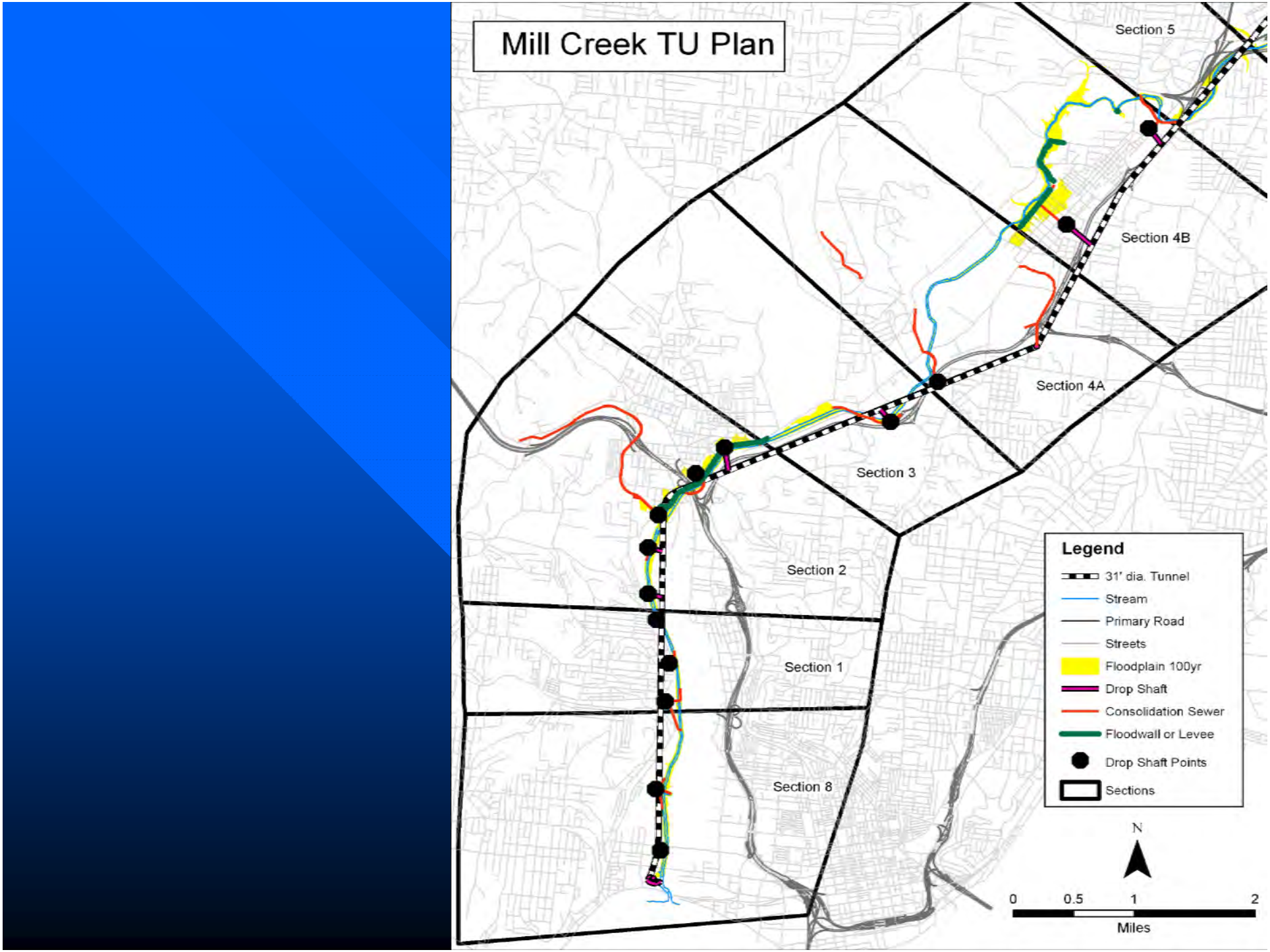
31 foot diameter

15.8 miles long

7 floodwater drop shafts

16 CSO drop shafts




Mill Creek TU Plan
Section 5
Section 4B
Section 4A
Section 3
Section 2
Section 1
Section 8
Legend
31' dia. Tunnel
Stream
Primary Road
Streets
Floodplain 100yr
Drop Shaft
Consolidation Sewer
Floodwall or Levee
Drop Shaft Points
Sections
N
0
0.5
1
2
Miles

Plan NS-2a

- Construct 3 sections of floodwalls and levees to protect 28 high value / high damage facilities against the 1% chance (100-yr) flood
- No relocations of non-protected structures
- Major Features:
  - 30,700 LF of floodwalls or levee constructed
  - 10 automated gate closure structures (road and railroad)
  - 6 pump stations
  - 7,580 LF of channel modifications (Section 7 only)


ONLY
Ford
Main Entrance
Shipping & Receiving

Major Features

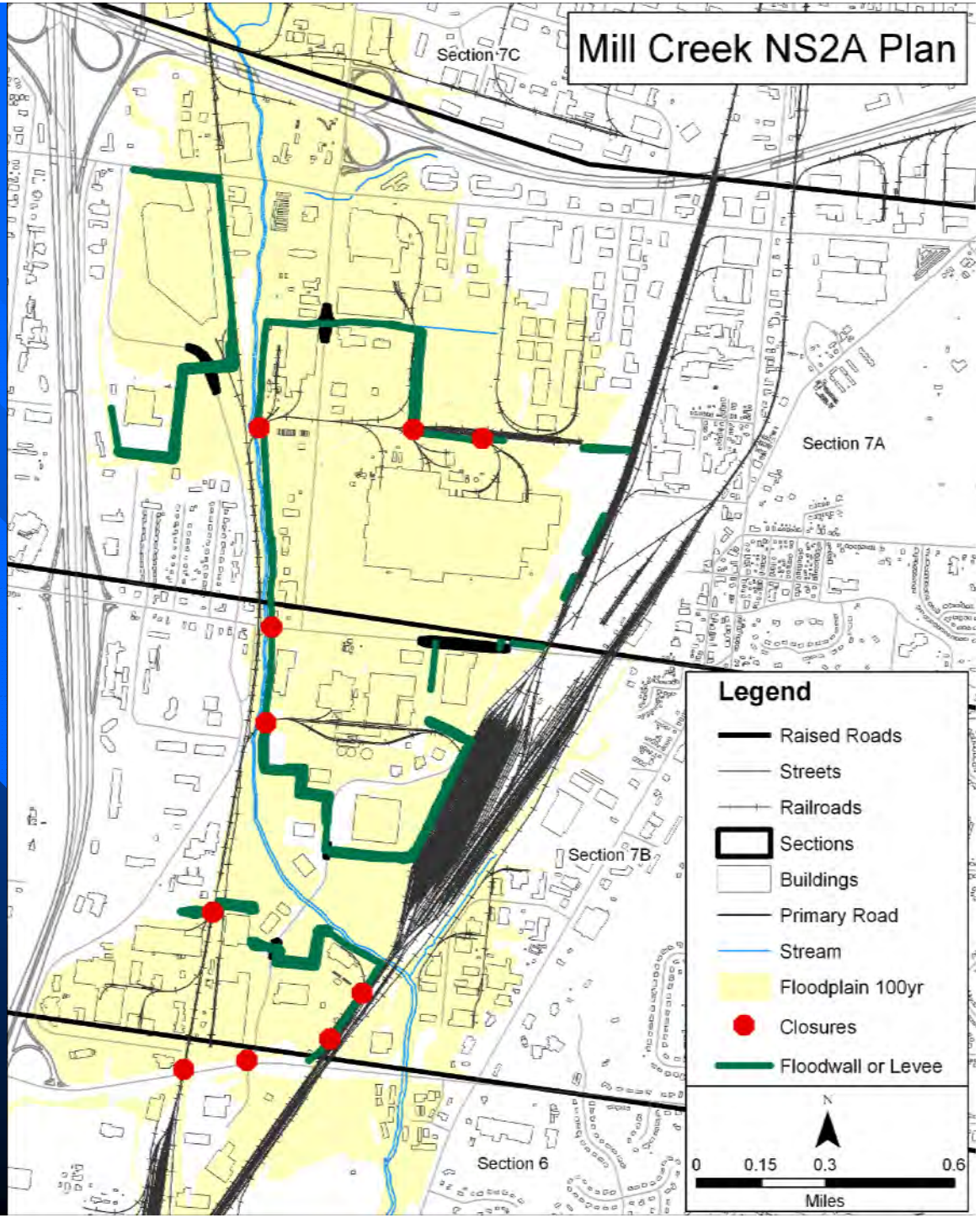
30,700 lf of floodwalls and levees

2 road closures

8 railroad closures

6 pump stations

7,580 lf of channel widening



PLAN COMPARISON

Plan	**Initial Cost (2004 price-levels)**	**% of Flood Damages Reduced**	**Net Annual Benefits** (2004 price levels)	**Benefit-Cost Ratio**
NS-2a	$99,235,000	31%	$10,358,000	2.5
CM-2	$562,896,000	98%	$14,207,000	1.4
TU	$1,563,505,000	98%	($26,379,000)	0.7

CONCLUSION

Plan CM-2 is the Federally Supportable Plan especially since it is the National Economic Development (NED) plan. Plan CM-2 reduces approximately 98% of flood damages along Mill Creek, at an initial cost of $562,896,000.

RECOMMENDATION

- Recommend that further Federal efforts on this project be DEFERRED until such time as the local sponsor (MVCD) or another local non-Federal interest, can provide the necessary assurances of local financial capability and willingness to support project implementation.

- If assurances of financial capability are provided, recommend that plan CM-2 be carried on to final design with the ultimate goal of project construction.

THE END

Monica B. Greenwell, P.E.

U.S. Army Corps of Engineers, Louisville District
(502) 315-6286
monica.b.greenwell@lrl02.usace.army.mil

US Army Corps
of Engineers ®

CLEARWATER DAM

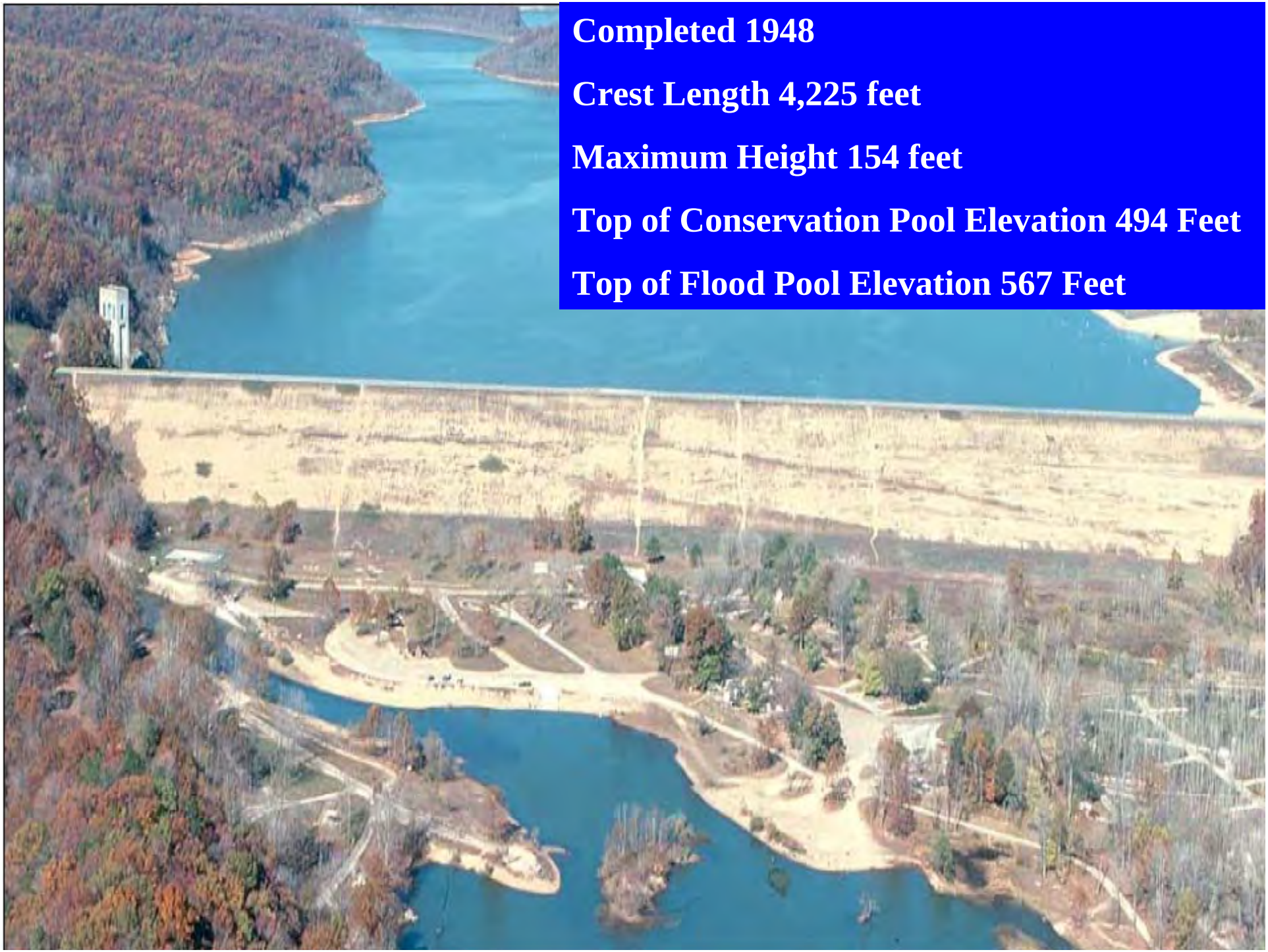
Sinkhole Repair

Foundation Investigation and Grouting Project

Mark Harris, P.G. – USACE-SWL

One Corps Serving The Army and the Nation


Clearwater Lake
Vicinity Map
1 inch equals 40 miles
Columbia
Saint Charles
Alton
Saint Louis Metro Area
Belleville
Illinois
Indiana
Evansville
Owensboro
Missouri
Springfield
Clearwater Lake Project
Poplar Bluff, MO.
Kentucky
Clarksville
Nashville
Tennessee
Arkansas
Memphis
Little Rock
Mississippi
Legend
state boundary
county boundary
project boundary



Completed 1948

Crest Length 4,225 feet

Maximum Height 154 feet

Top of Conservation Pool Elevation 494 Feet

Top of Flood Pool Elevation 567 Feet

Clearwater Dam
Pool of Record – May 2002
Elevation 566.7



Clearwater Emergency Spillway
Pool of Record – May 2002
Elevation 566.7

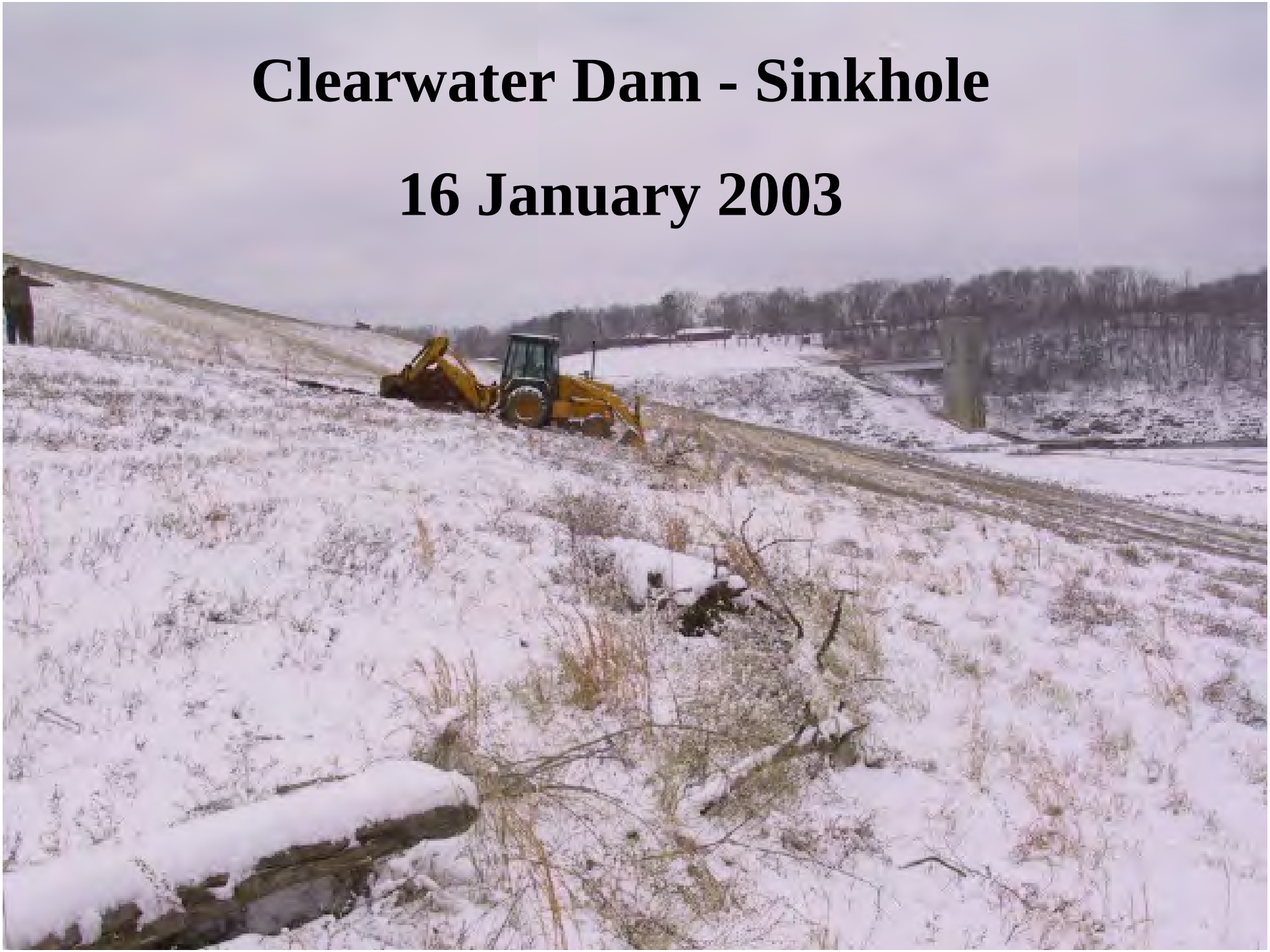


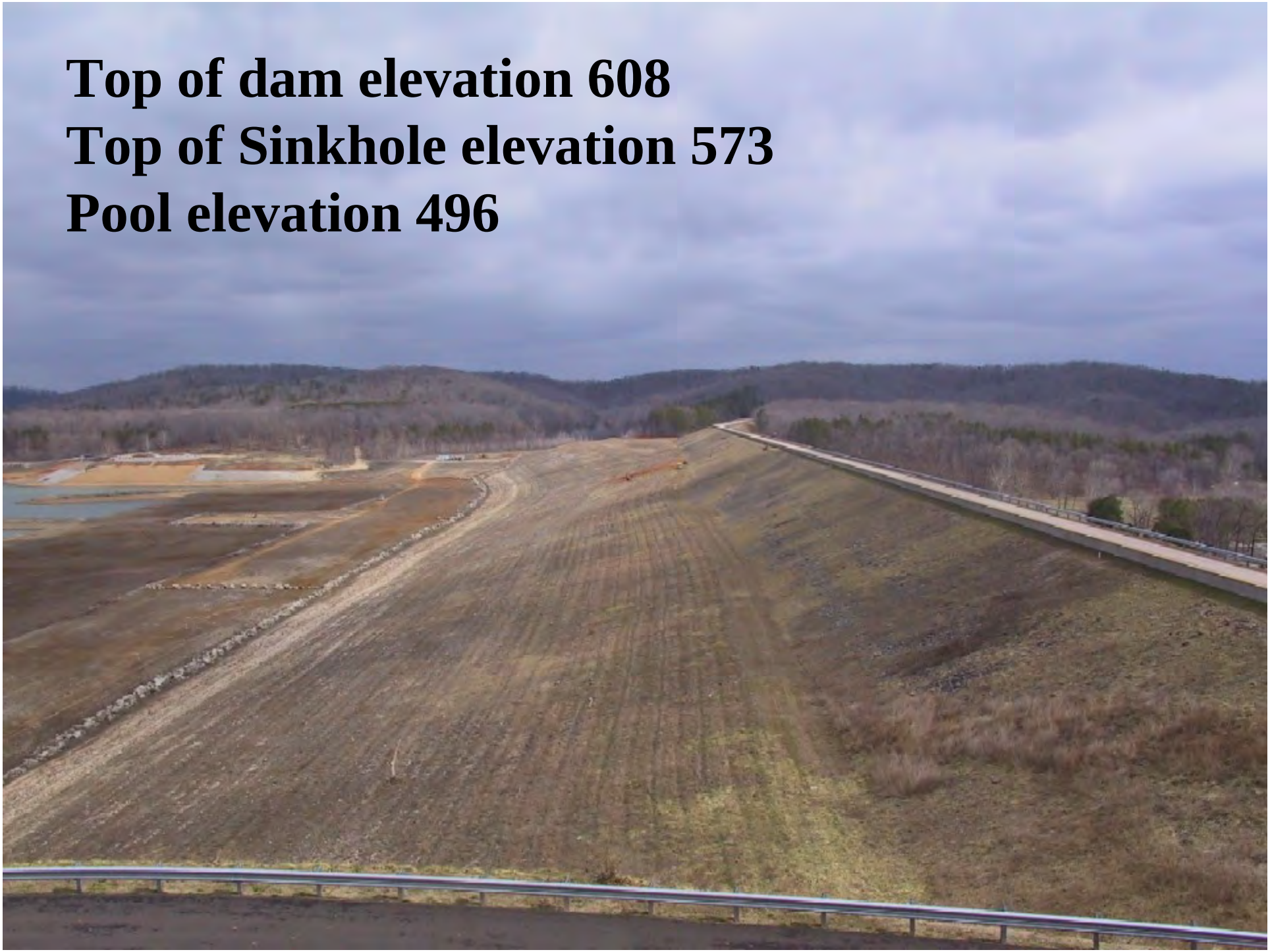
Sinkhole - 15 January 2003



Clearwater Dam - Sinkhole

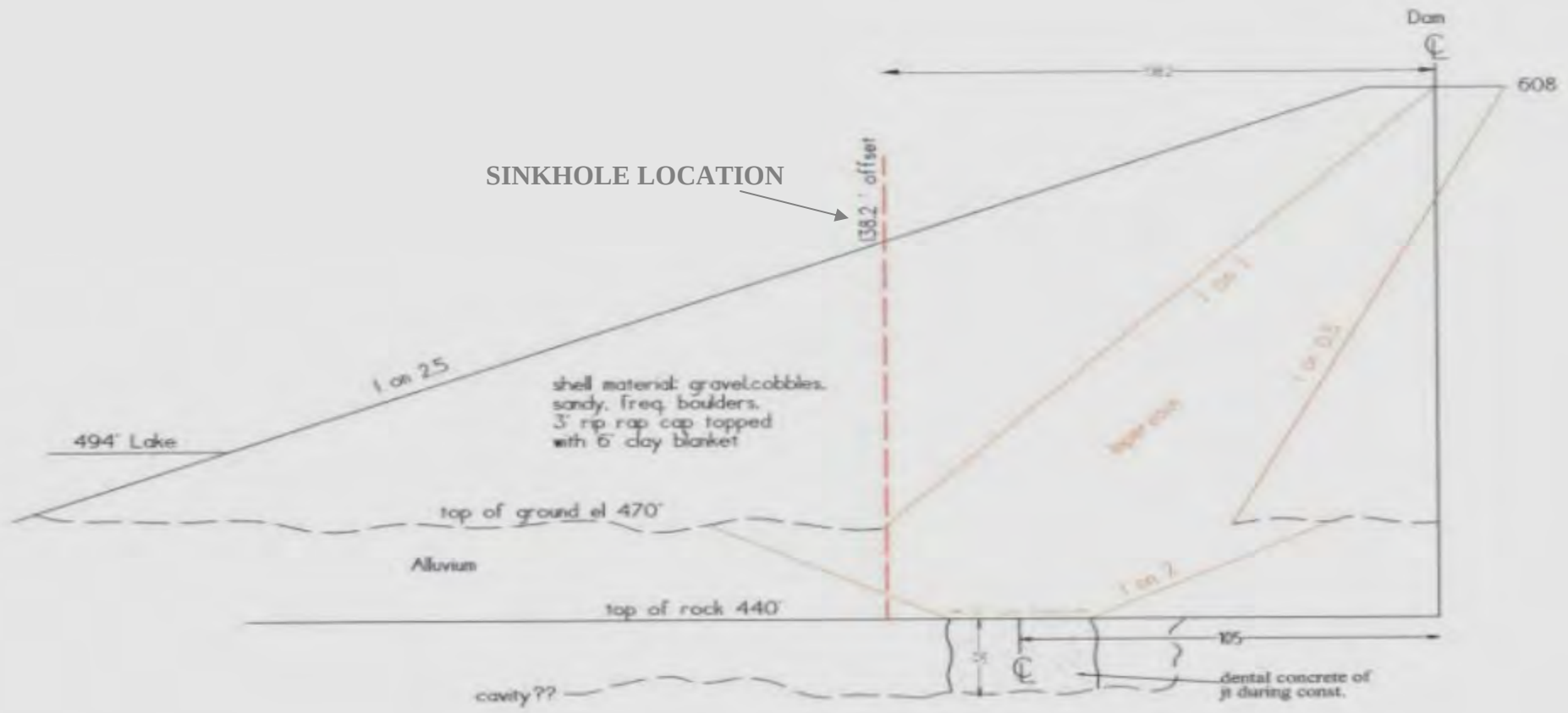
16 January 2003




Top of dam elevation 608
Top of Sinkhole elevation 573
Pool elevation 496

Clearwater Dam

Embankment Cross Section





Looking E from 150± U.S. of station 41 + 68.± General view of cut-off trench operations.

Original Construction – STA 39+20

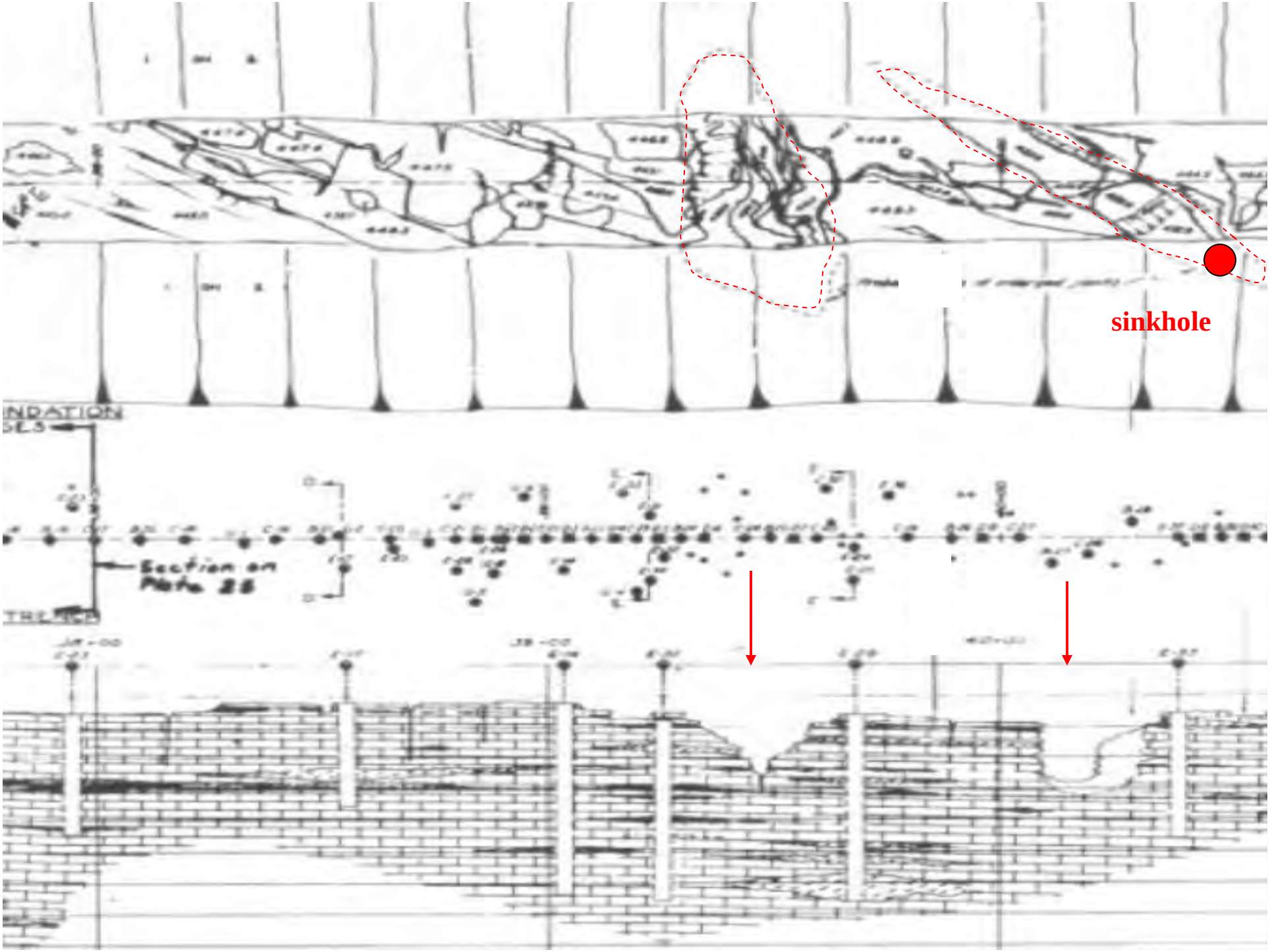


Looking S from 175' US of station 39 + 20: Open joint in cut-off trench foundation.

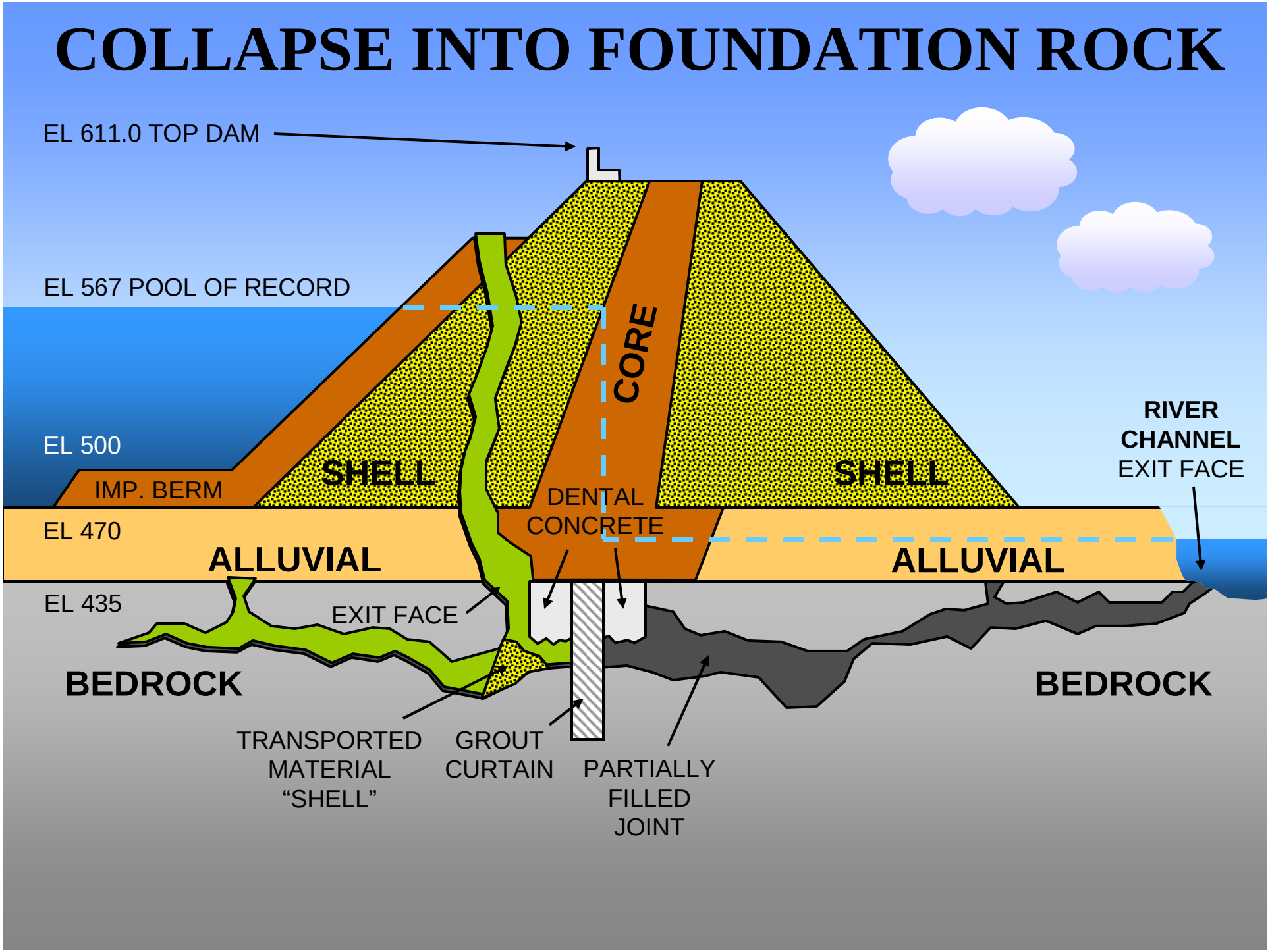
Original Construction – STA 40+15



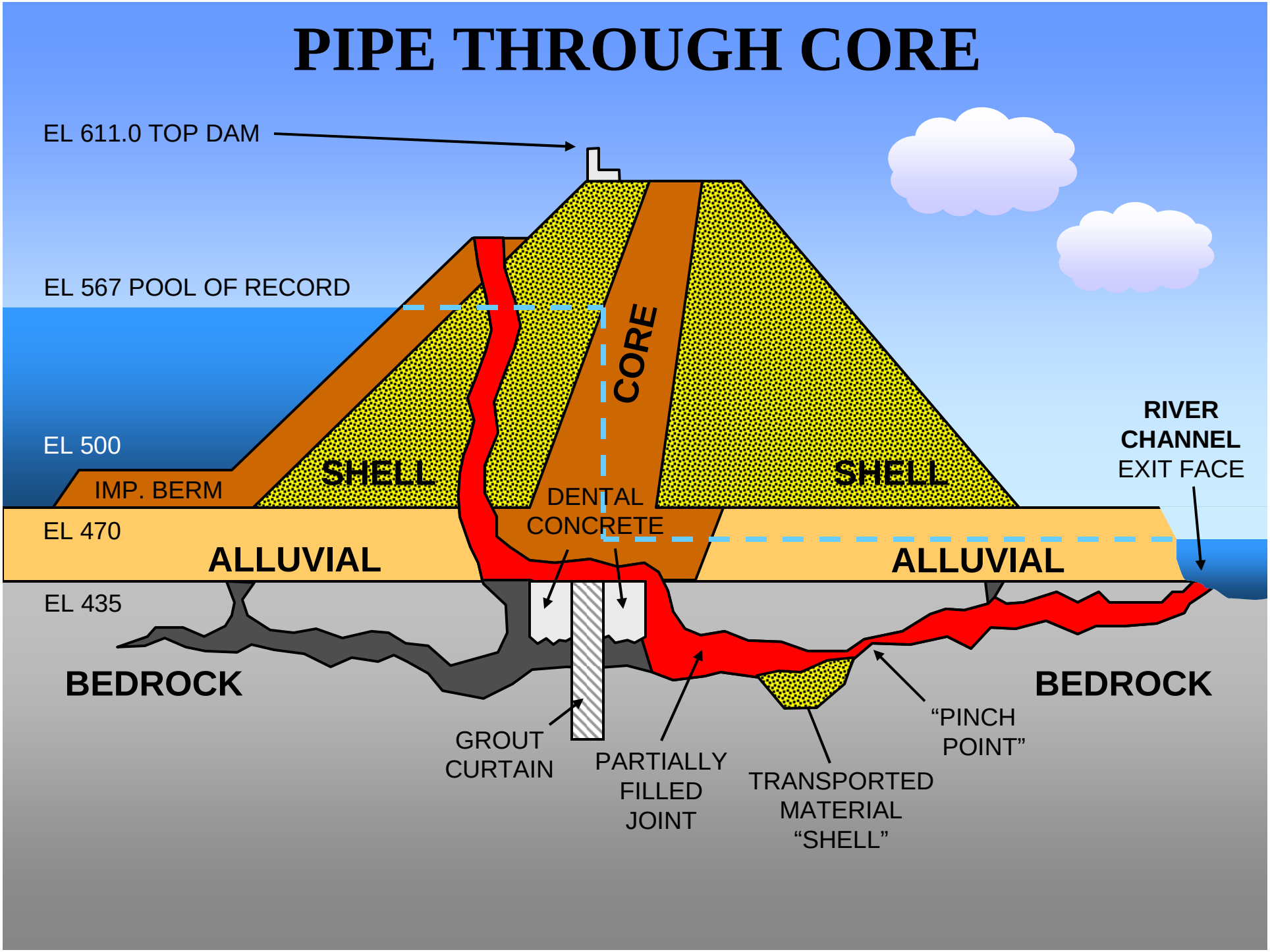
Looking NW from 35' U.S. of station 40 + 15: Open joint in cut-off trench foundation.


sinkhole

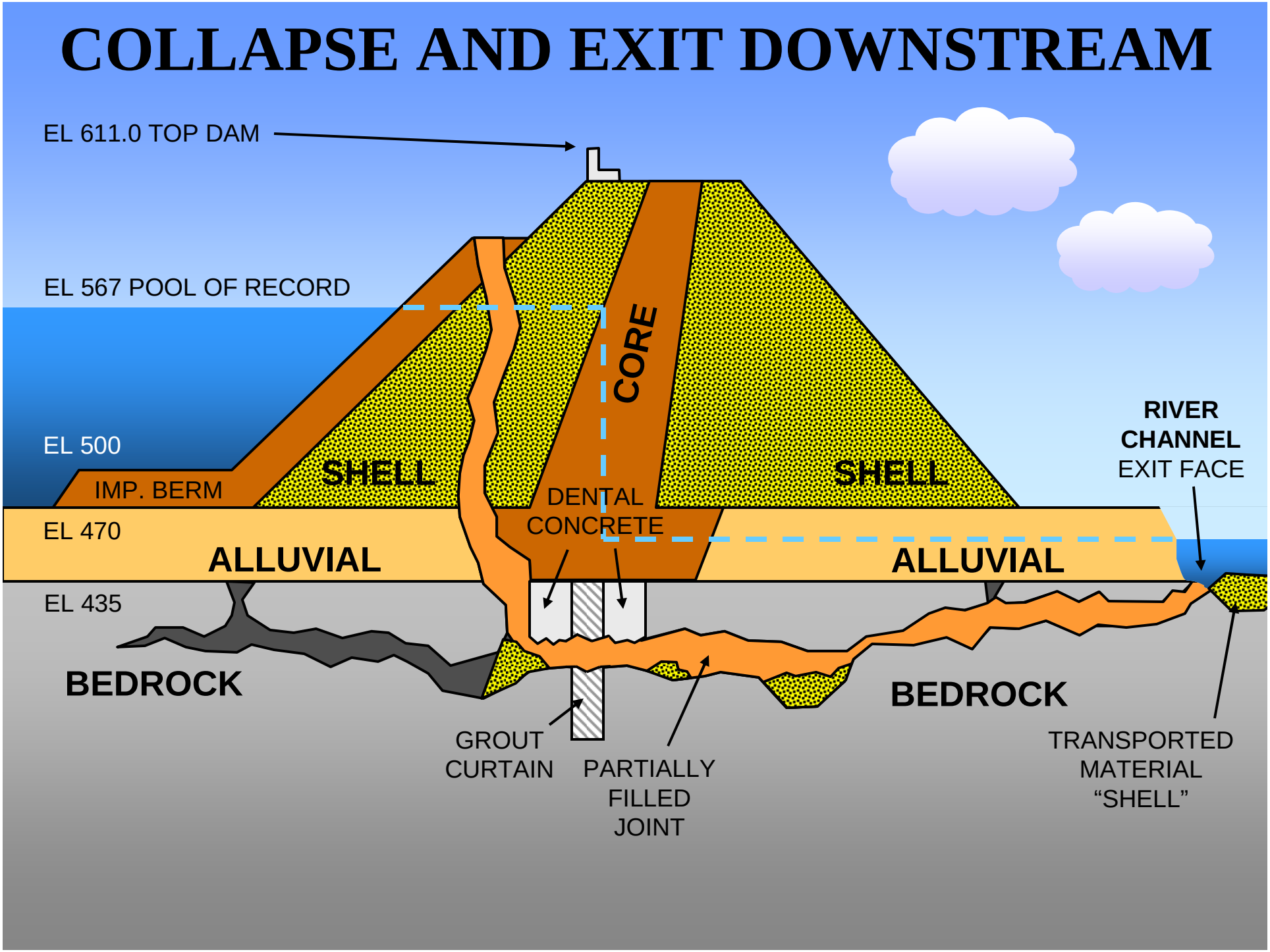
COLLAPSE INTO FOUNDATION ROCK



PIPE THROUGH CORE



COLLAPSE AND EXIT DOWNSTREAM



Investigations Prior to Grouting

- Performed Geophysical Surveys
  - Kansas Geological Survey – surface wave, reflection
  - Sonic Drilling – 6 borings, 50’ into rock
  - Bureau of Reclamation – crosshole tomography
  - ERDC – SP, EM conductivity, ER
- Geotechnical Consultation
  - Dr. Steve J. Poulos - GEI
  - Analysis Assistance - ERDC
- Prepared Investigation/Grouting Contract P&S
  - computer monitored, balanced/stabilized grout
  - awarded to Advanced Construction Techniques, LTD. (ACT)

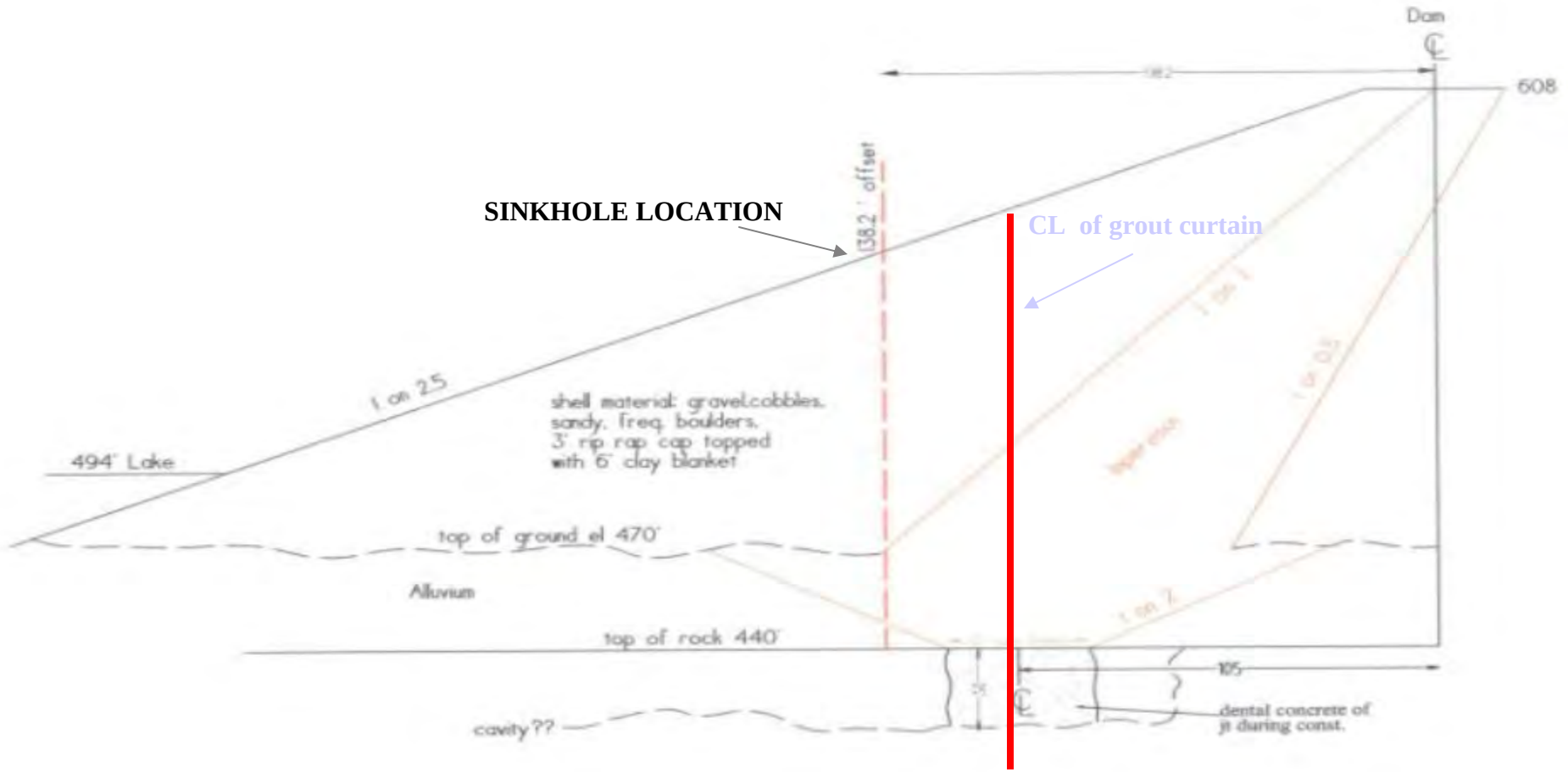
FY 04-05 Grouting Contract

- Nov 2003 - ACT/Gannett-Fleming/Boart-Longyear selected as contractor.
- Jan 2004 – begin Sonic drilling - clay core/foundation rock/dental concrete good.
- April 2004 – begin grouting.
- May 2005 – completed grouting w/ modification


Legend
sinkhole
Sinkhole
Grouting project

Clearwater Dam

Embankment Cross Section



Clearwater Dam – Sonic Drilling



Clearwater Dam – Grout Line



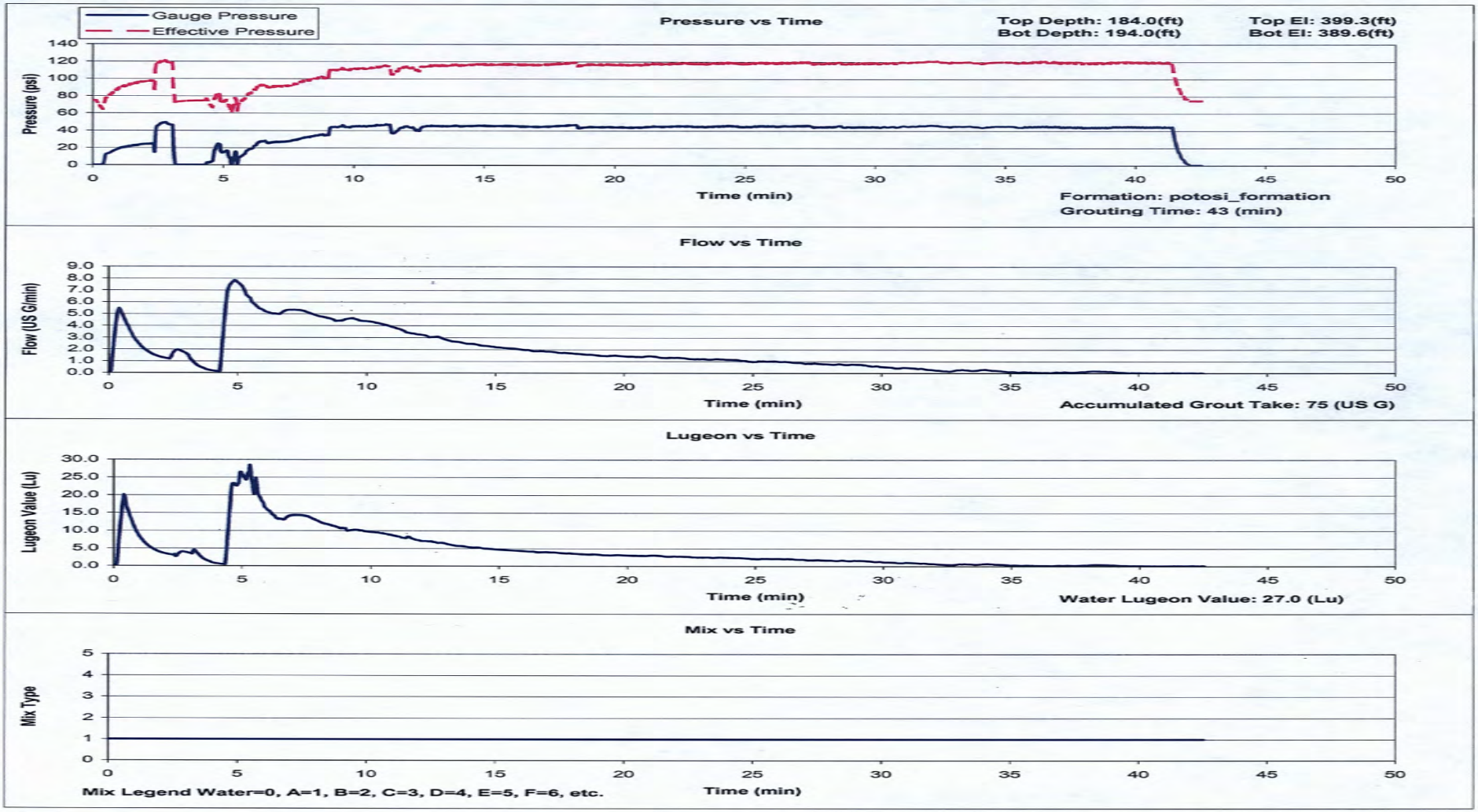

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The Science of Grouting


01/06/2003


Grouting Operation
Pressure - Time
Flow - Time
Start
Stop
NEC

Moderately High Lugeon

Trend Plots: Grouting Operation, Stage: AP10-7
Project Name: Clearwater Dam Sinkhole Repair
Start Time: 2004/09/13 07:36:42

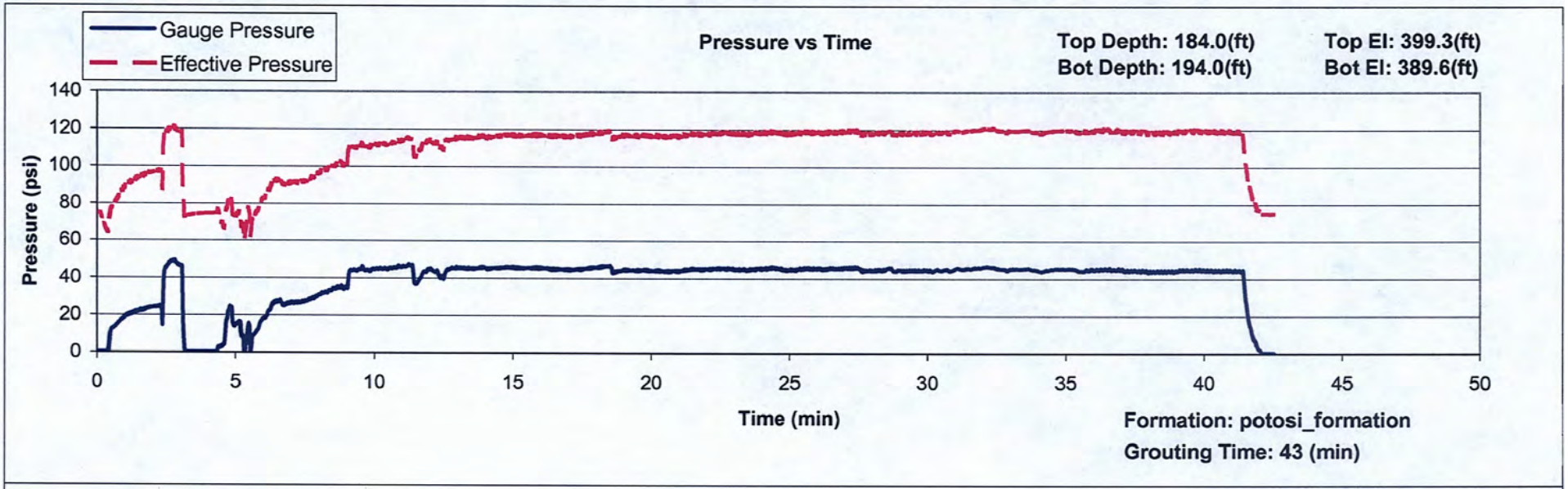


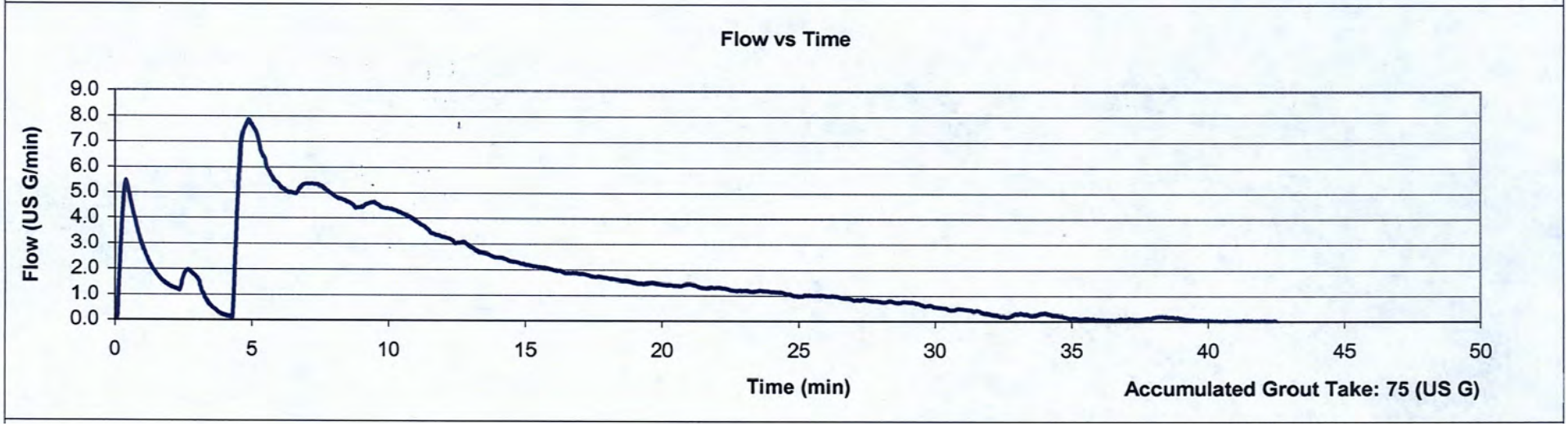
AP10-7	9/13/2004 07:41	Gator header station - Cart 1. Tremied 10 gallons. Packer set at 175'.
AP10-7	9/13/2004 07:41	Began pressure grouting at 4 minutes.
AP10-7	9/13/2004 08:18	Stage complete.

A.C.T.
Gannett Fleming

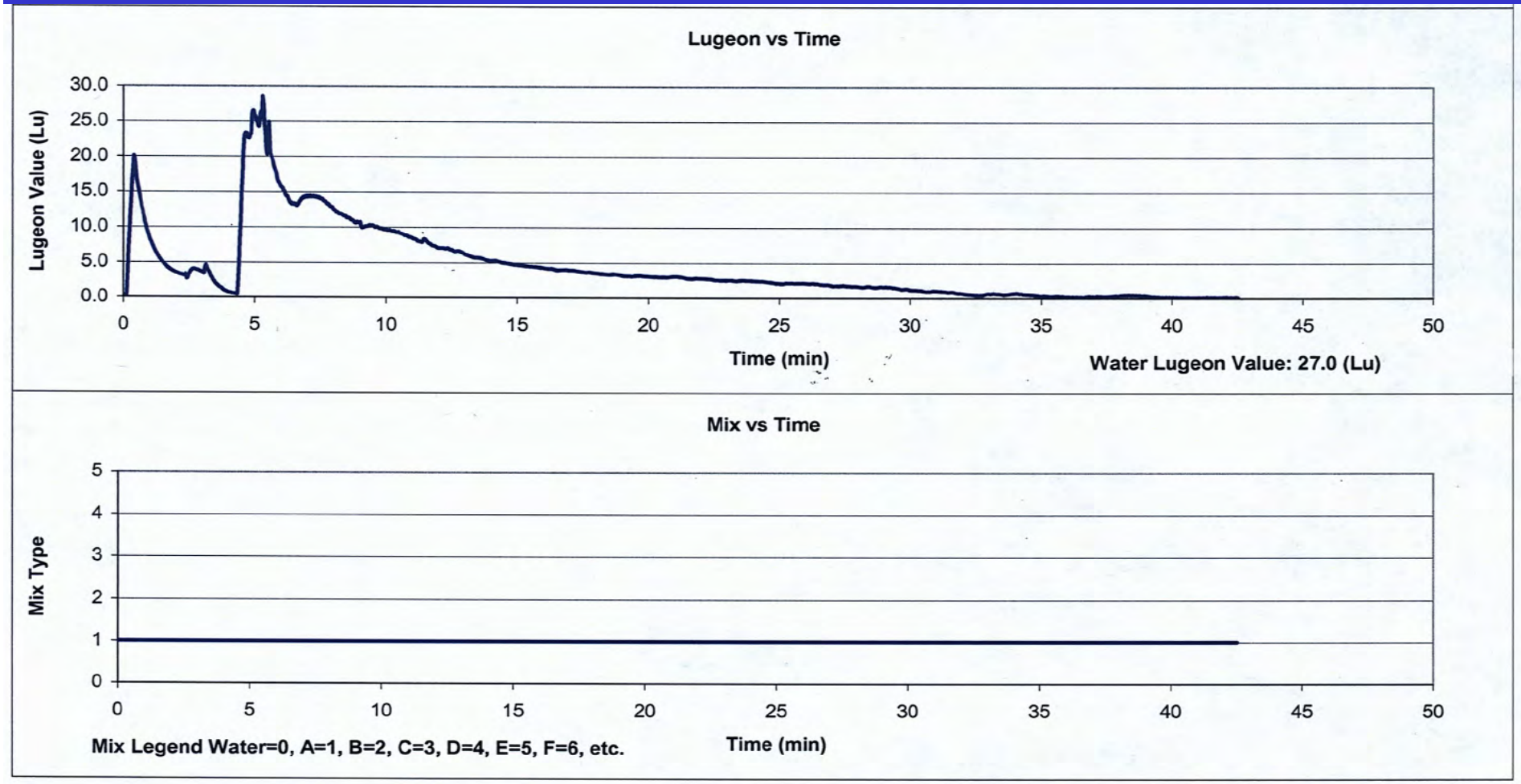
Moderately High Lugeon

Trend Plots: Grouting Operation, Stage: AP10-7
Project Name: Clearwater Dam Sinkhole Repair
Start Time: 2004/09/13 07:36:42





Moderately High Lugeon



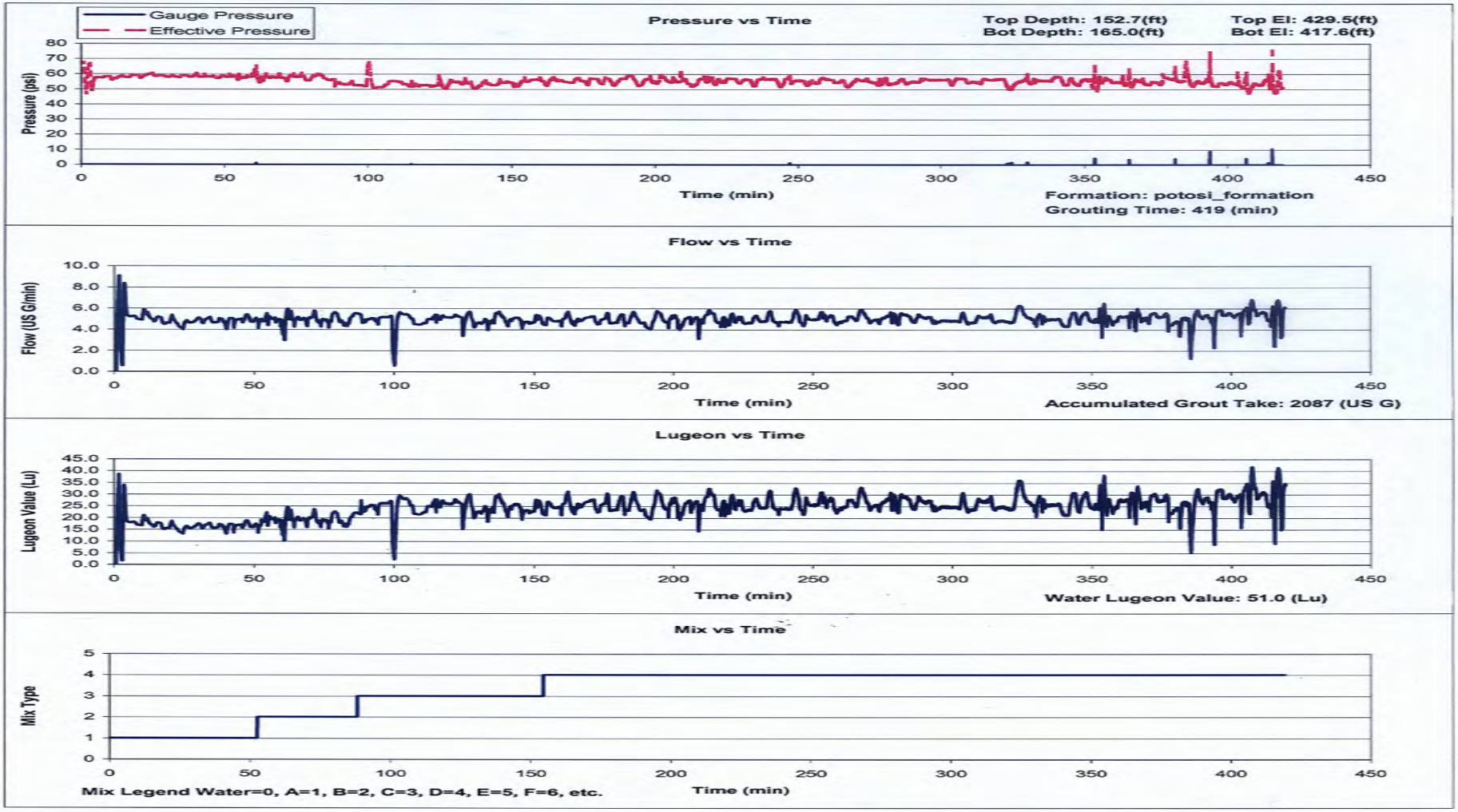
AP10-7	9/13/2004 07:41	Gator header station - Cart 1. Tremied 10 gallons. Packer set at 175'.
AP10-7	9/13/2004 07:41	Began pressure grouting at 4 minutes.
AP10-7	9/13/2004 08:18	Stage complete.

A.C.T.

Gannett Fleming

High Take – No Pressure

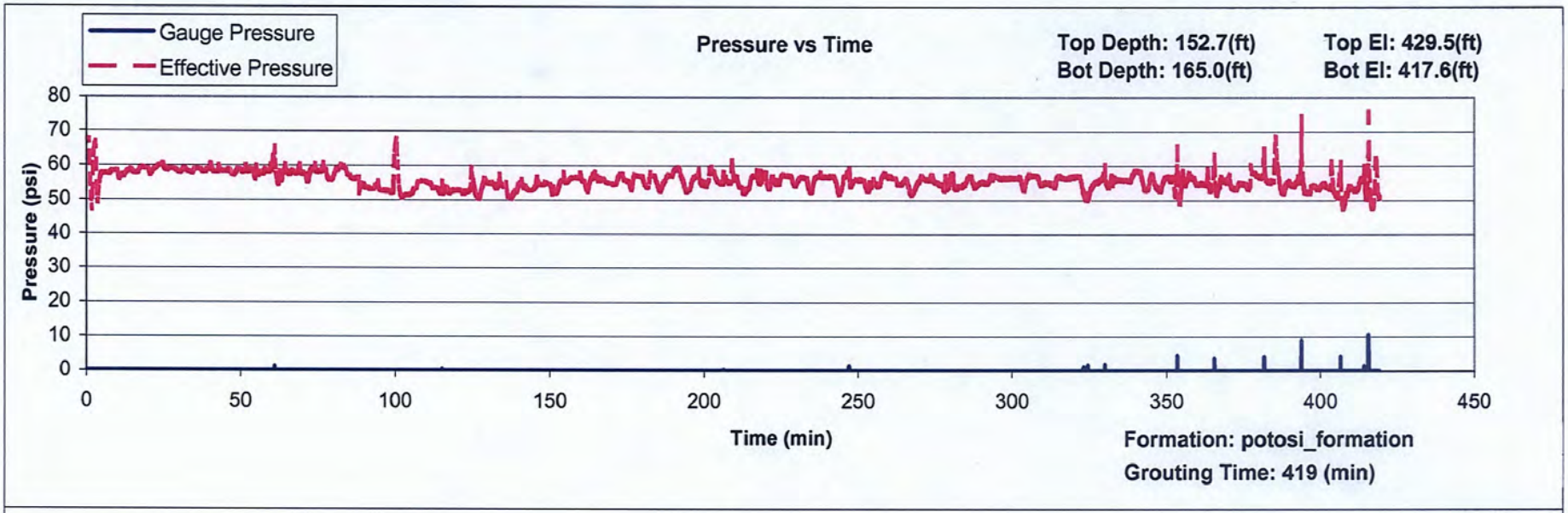
Trend Plots: Grouting Operation, Stage: AP12-4
Project Name: Clearwater Dam Sinkhole Repair
Start Time: 2004/07/06 07:18:44

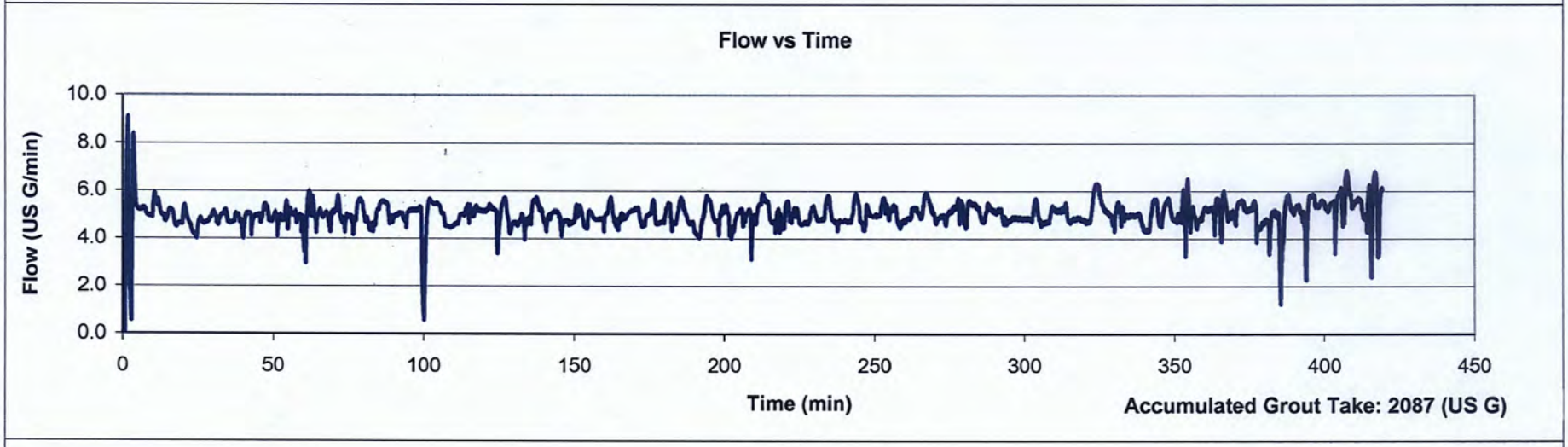


AP12-4	7/7/2004	Mobile-Blue Header Station - Cart 2.
AP12-4	7/7/2004	Packer set at 145'.
AP12-4	7/7/2004	Stopped at approximately 2000 gallons for the day as agreed upon by ACT and COE.
AP12-4	7/7/2004	Stage NOT Complete.
AP12-4	7/7/2004	Tremied 10 gallons from time 0 to 1 minute. Inflated packer and started to Re-Grout at 2.5 minutes.

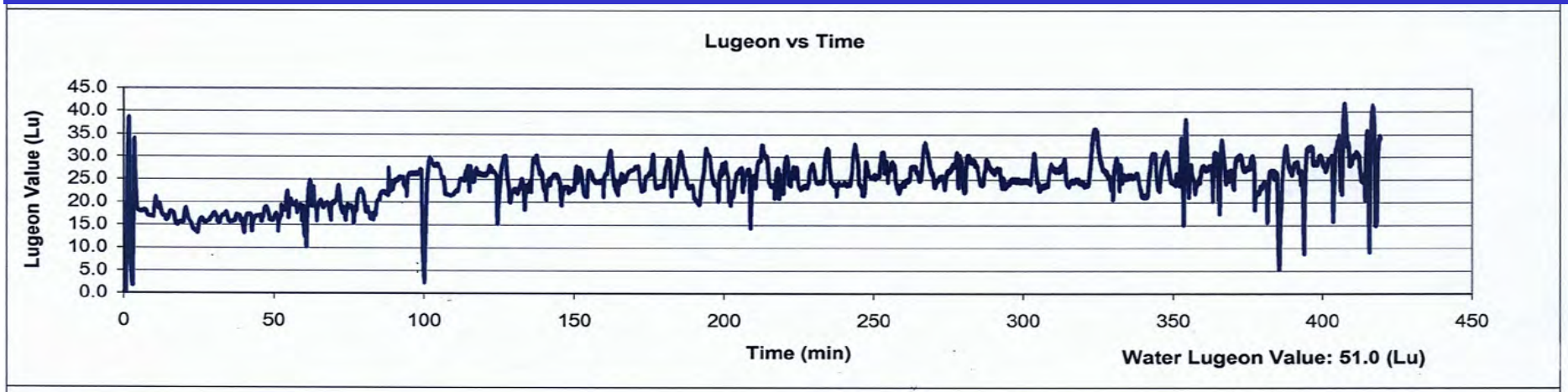
High Take – No Pressure

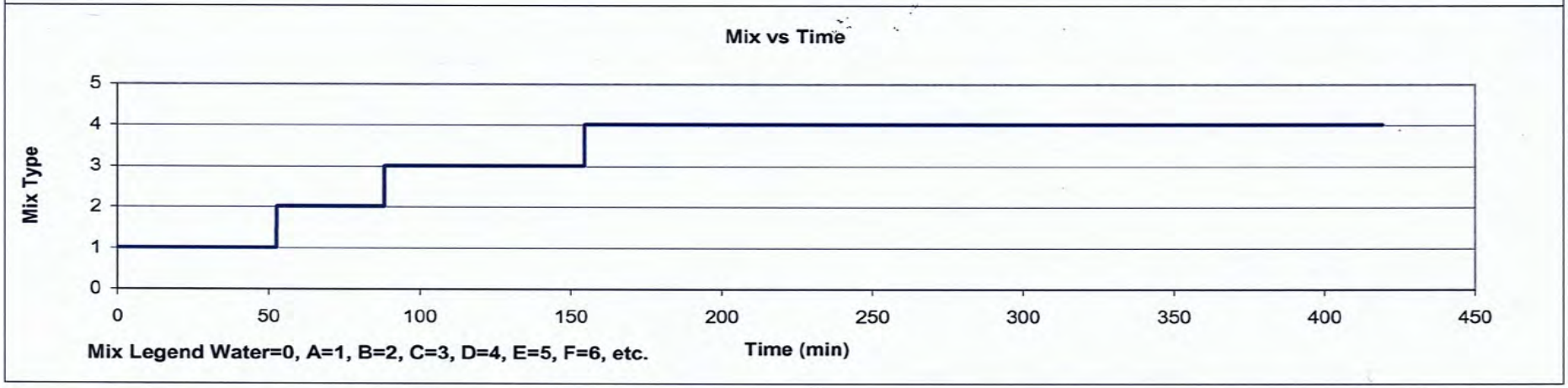
Trend Plots: Grouting Operation, Stage: AP12-4
Project Name: Clearwater Dam Sinkhole Repair
Start Time: 2004/07/06 07:18:44





High Take – No Pressure



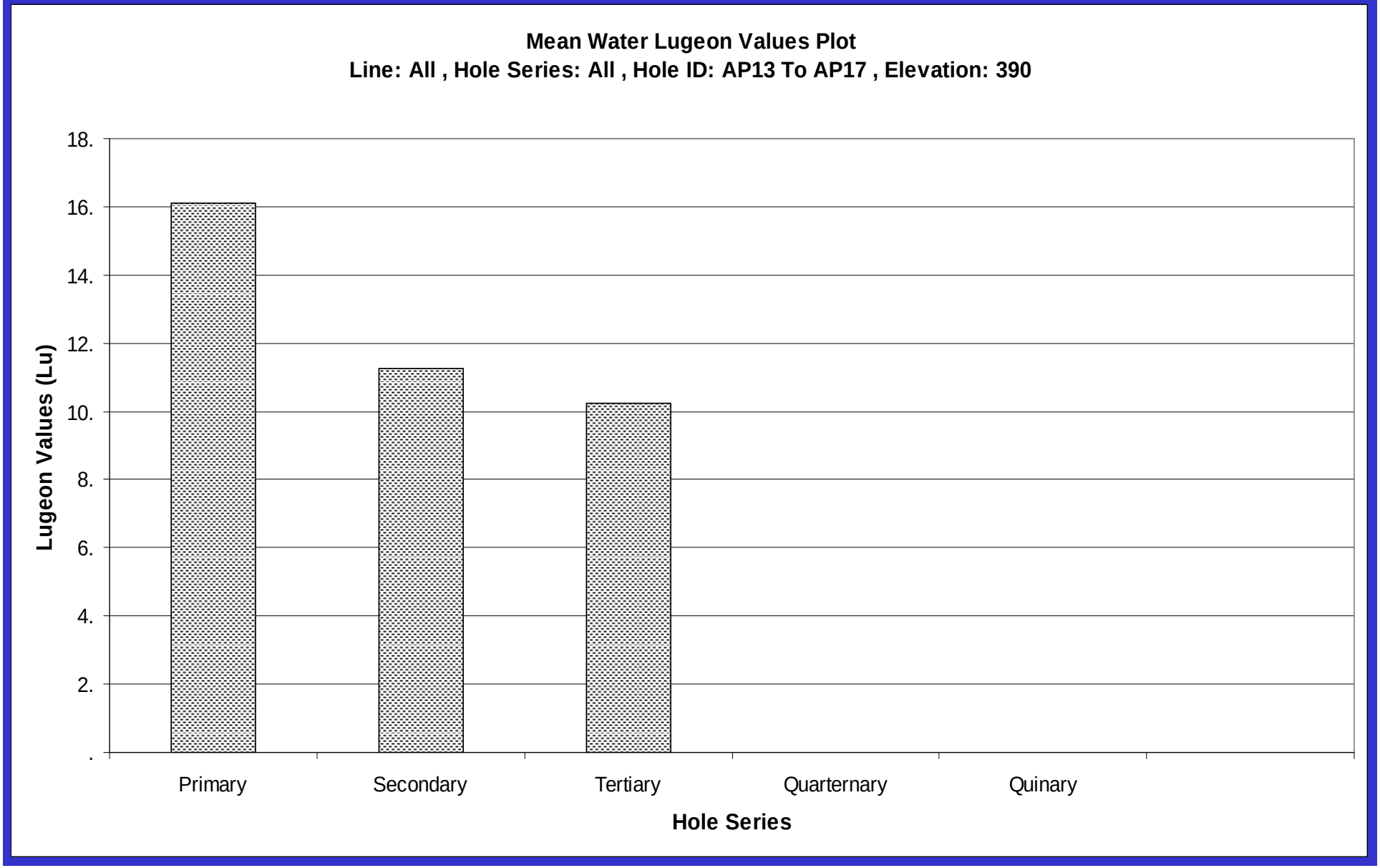


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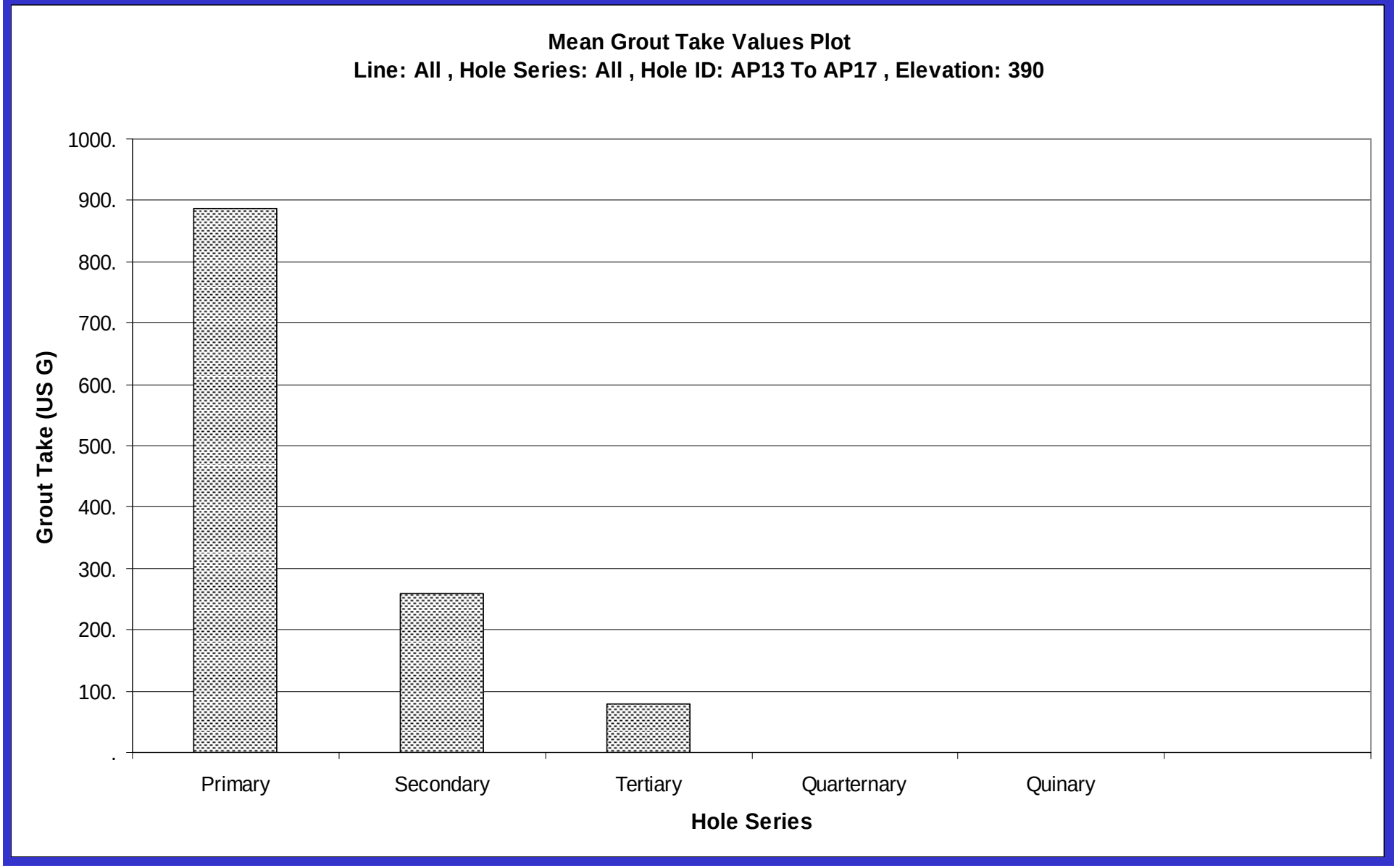
A.C.T.

Gannett Fleming

A - Line Closure Analysis
AP13 to AP17 - Elevation 390



A – Line Closure Analysis
AP13 to AP17 - Elevation 390



Gannett Fleming, Inc. - 2003 - Microsoft Internet Explorer

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Address http://www.intelligrout.com/ClearwaterDam/acwebpublish.htm Go Links

Clearwater Dam Sinkhole Repair

Copyright 2003

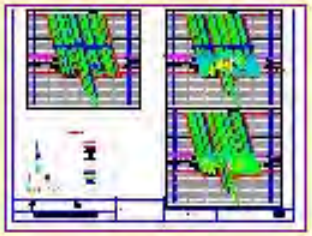
Gannett Fleming

A.C.T. ADVANCED CONSTRUCTION TECHNIQUES

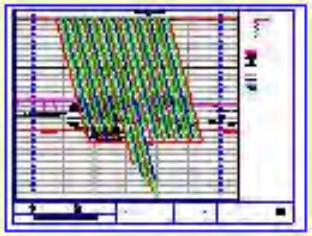
Preliminary IntelliGrout Drawings (Updated as of 09-21-04)



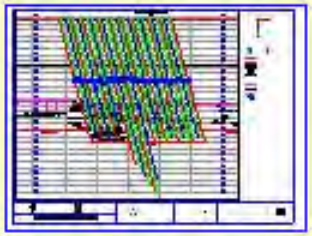
A-Line Plan View



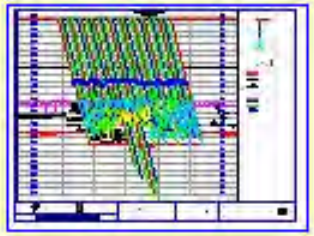
A-Update



A-Geology



A-Characteristics



A-Pres Test



A-Grout

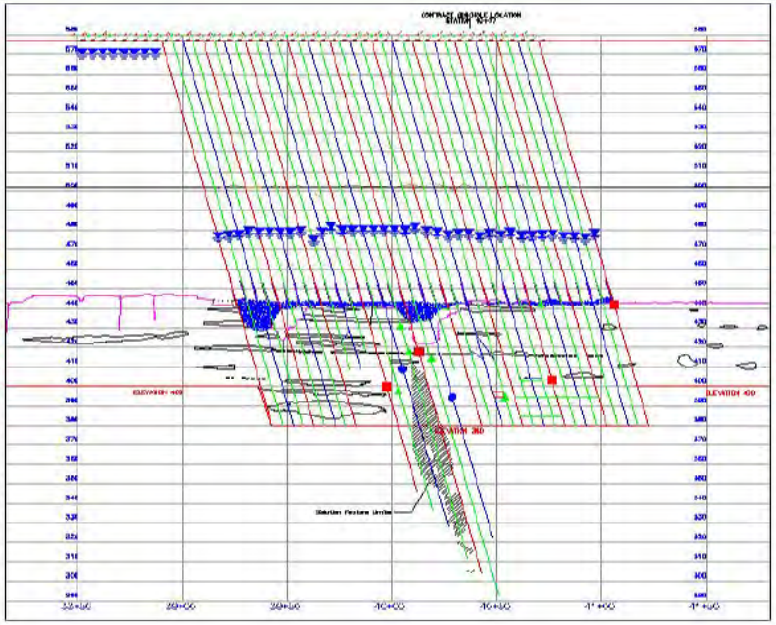
Notes:

1. Update drawings are not record drawings. Information shown is preliminary based on work in progress and is subject to revision.

2. Efforts will be made to provide update drawings on approximately a weekly basis.

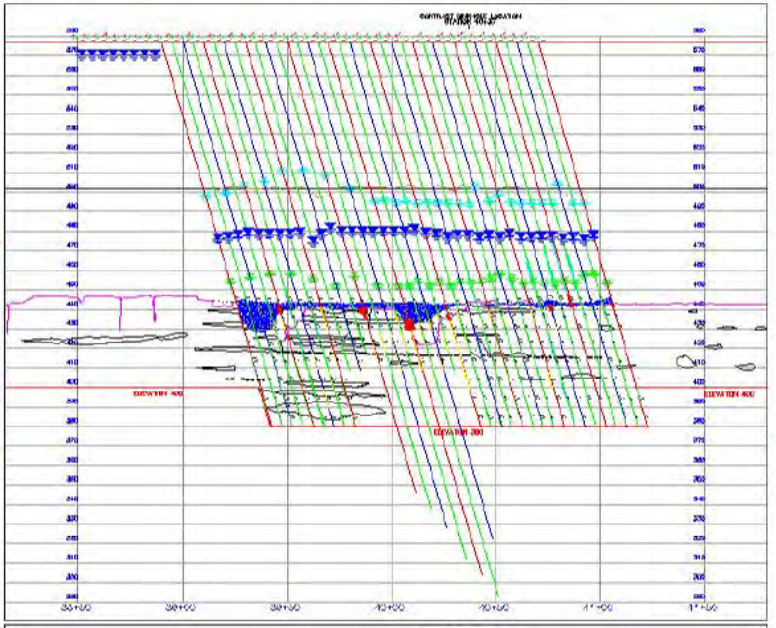
Internet

DRILLING



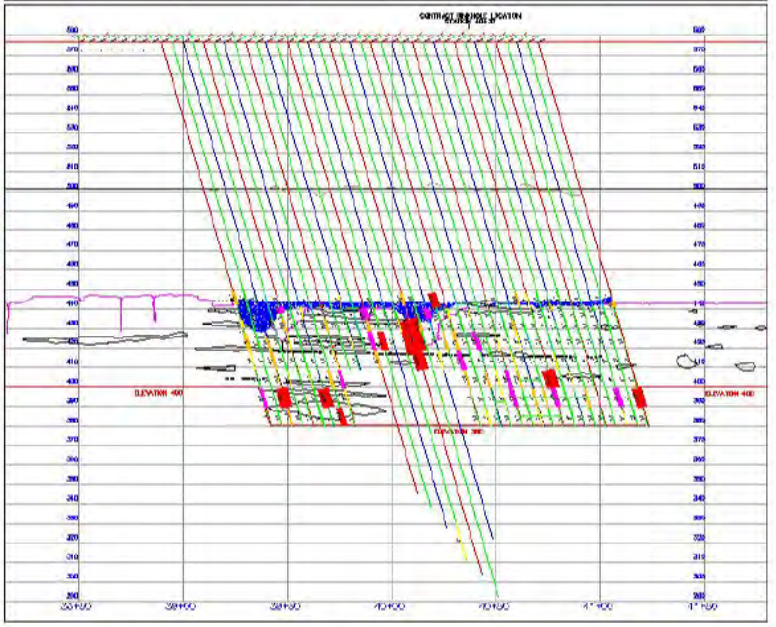
DRILLING

LUGEON VALUE



LUGEON VALUE

GROUTING



GROUTING

LEGEND



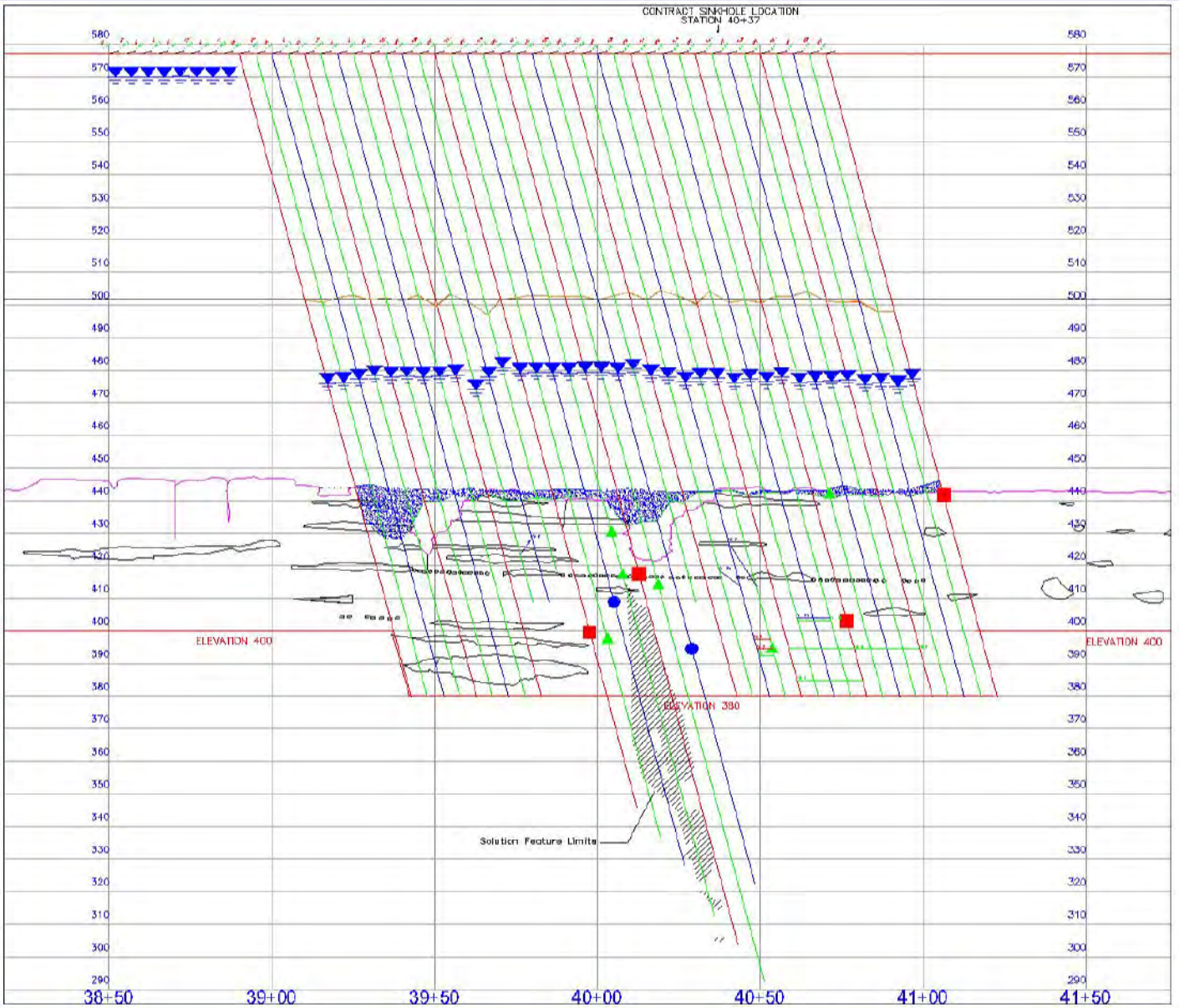
A - LINE PROFILE

October 5, 2004

IntelliGrout™
The Science of Grouting

CLEARWATER DAM SINKHOLE REPAIR

FOUNDATION DRILLING AND GROUTING



ADVANCED GROUTING TECHNOLOGY, LTD.
MAPLE, ONTARIO

GANNETT FLEMING, INC.
HARRISBURG, PENNSYLVANIA

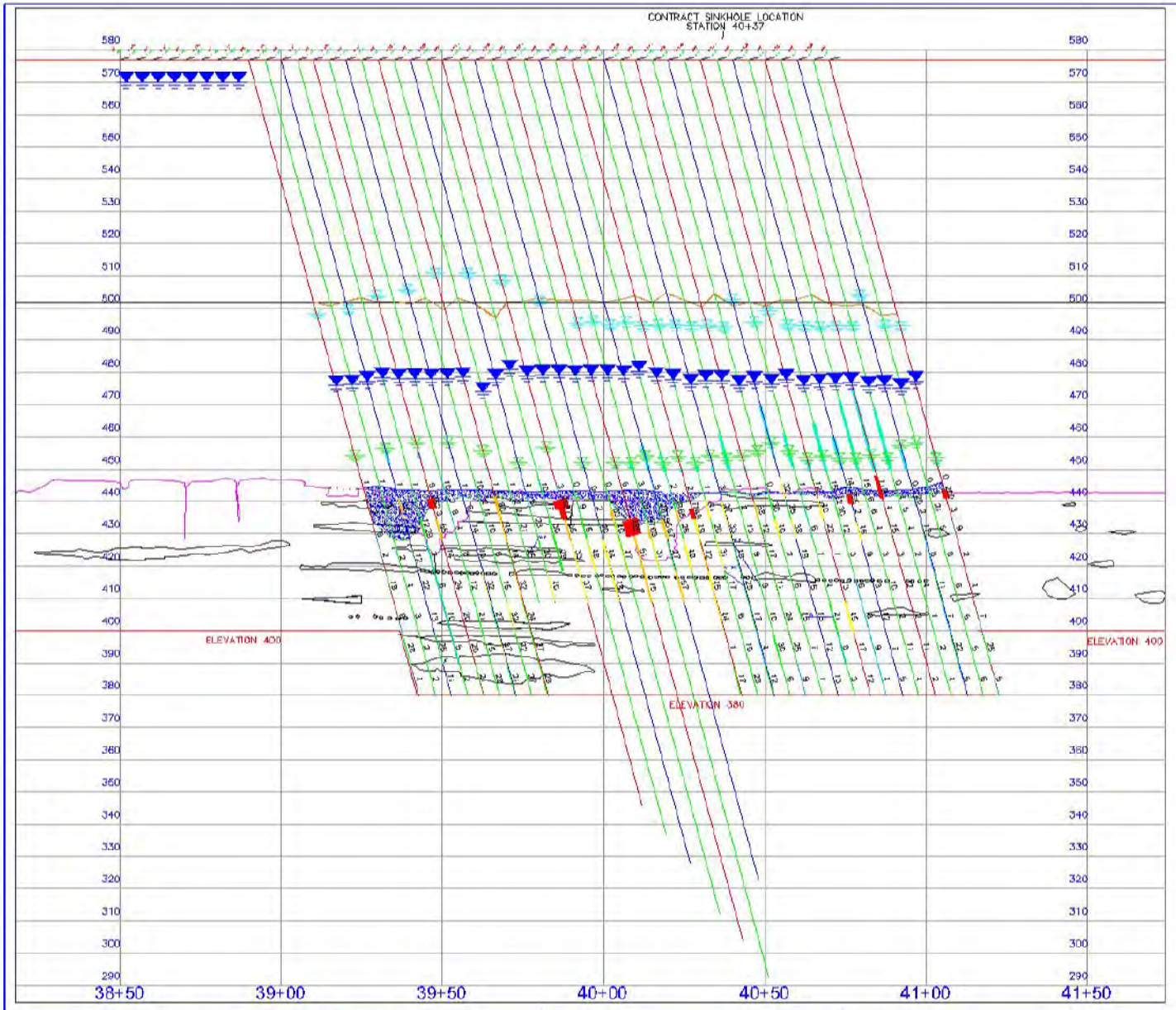
A - LINE HOLE CHARACTERISTICS

October 5, 2004

IntelliGrout™
The Science of Grouting

CLEARWATER DAM SINKHOLE REPAIR
FOUNDATION DRILLING AND GROUTING
CONTRACT NO. W912PS04C0005

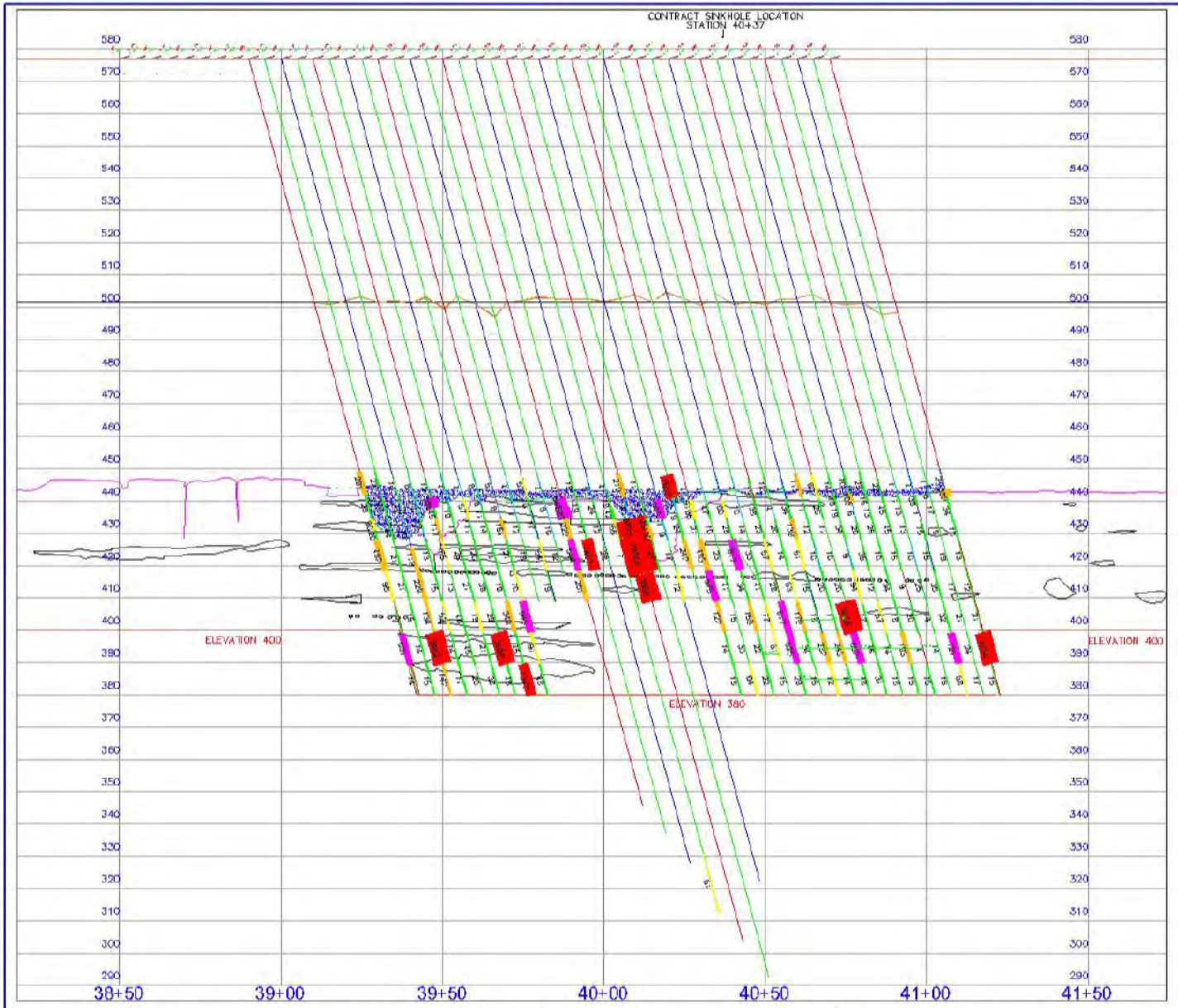
U.S. Army Corps of Engineers



A - LINE
PRESSURE TESTING
October 5, 2004

IntelliGrout™
The Science of Grouting

CLEARWATER DAM SINKHOLE REPAIR
FOUNDATION GROUTING AND GROUTING
CONTRACT NO. W912PS-04-C-0005



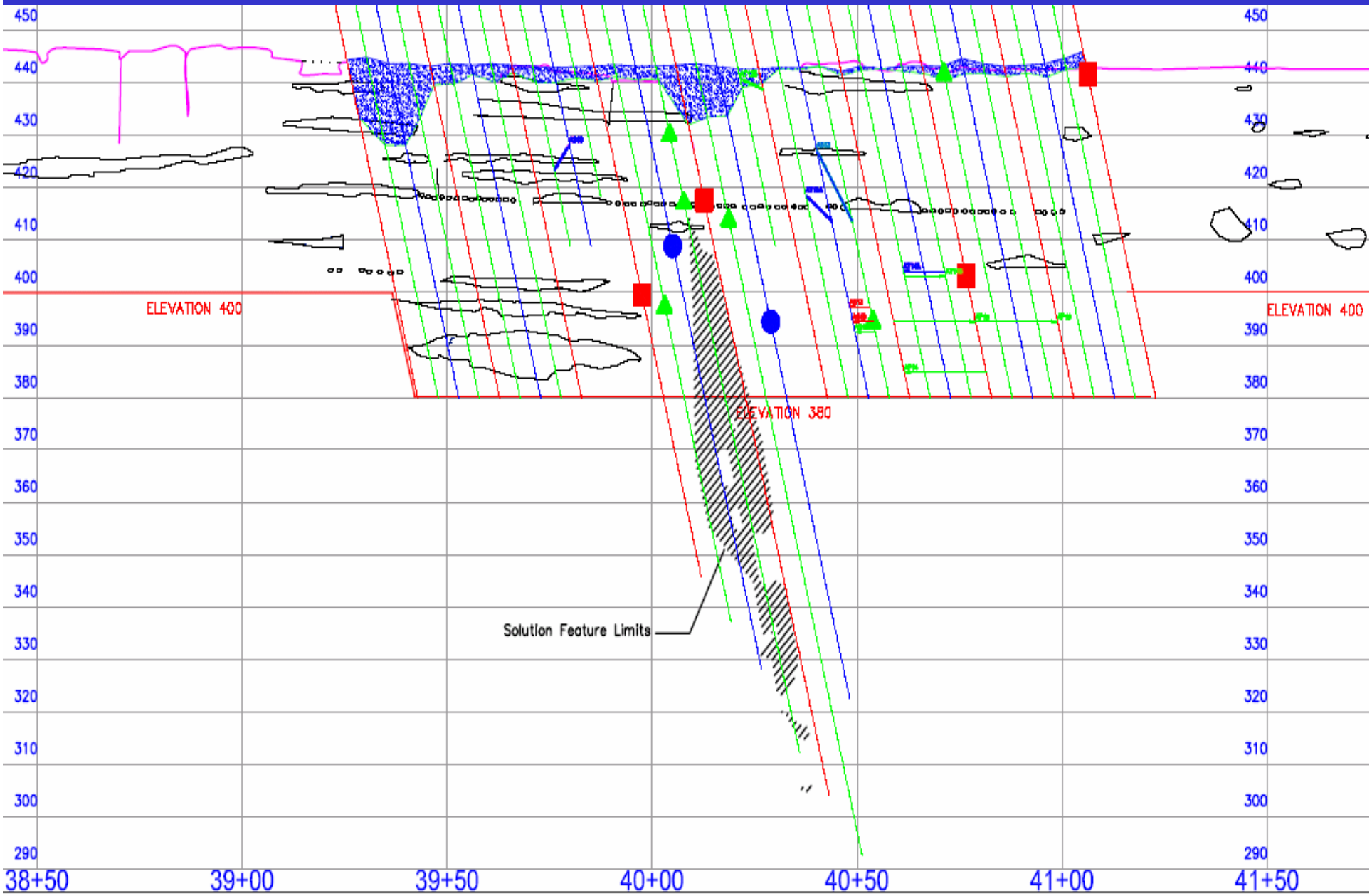
A - LINE GROUT

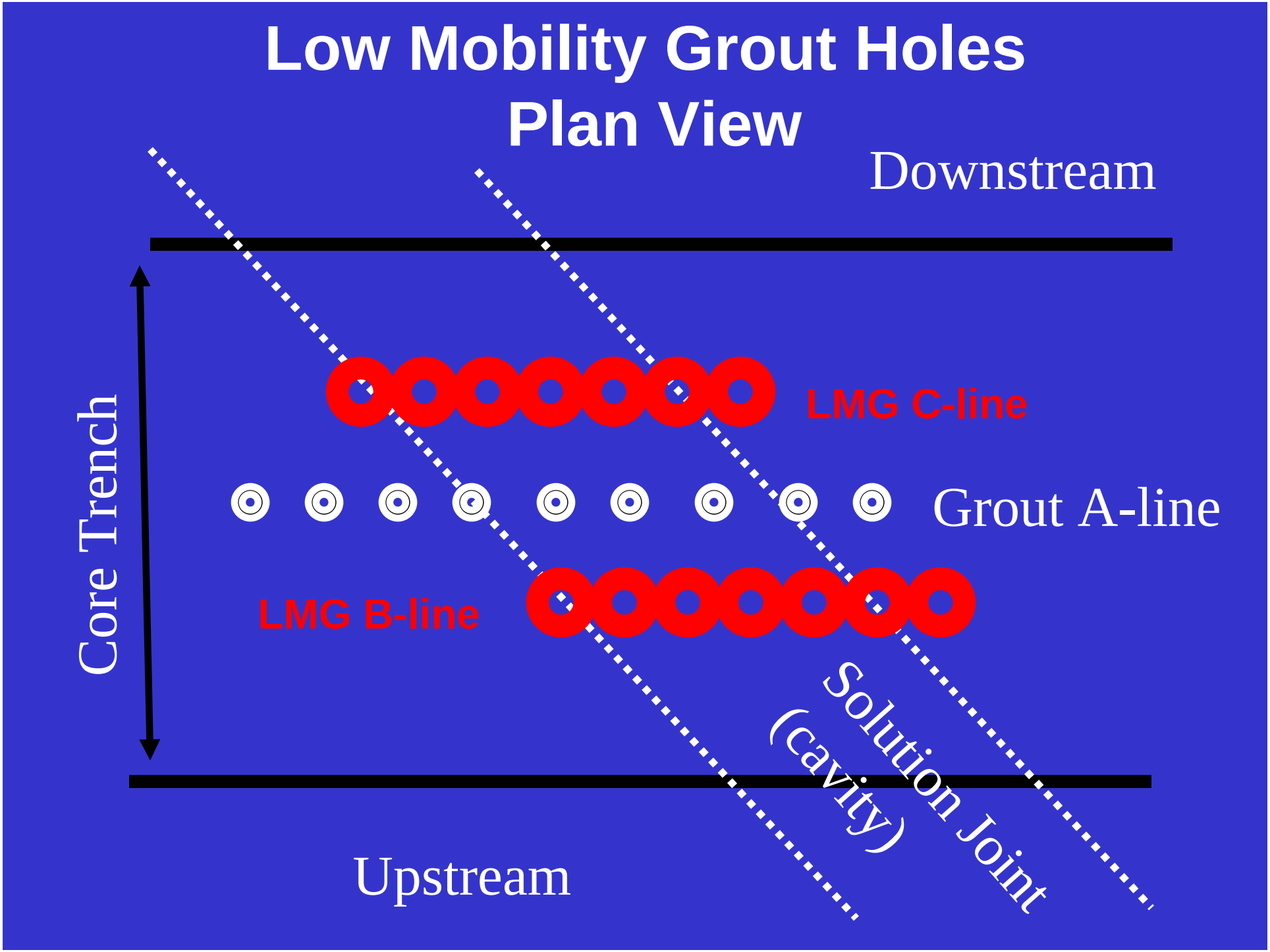
October 5, 2004

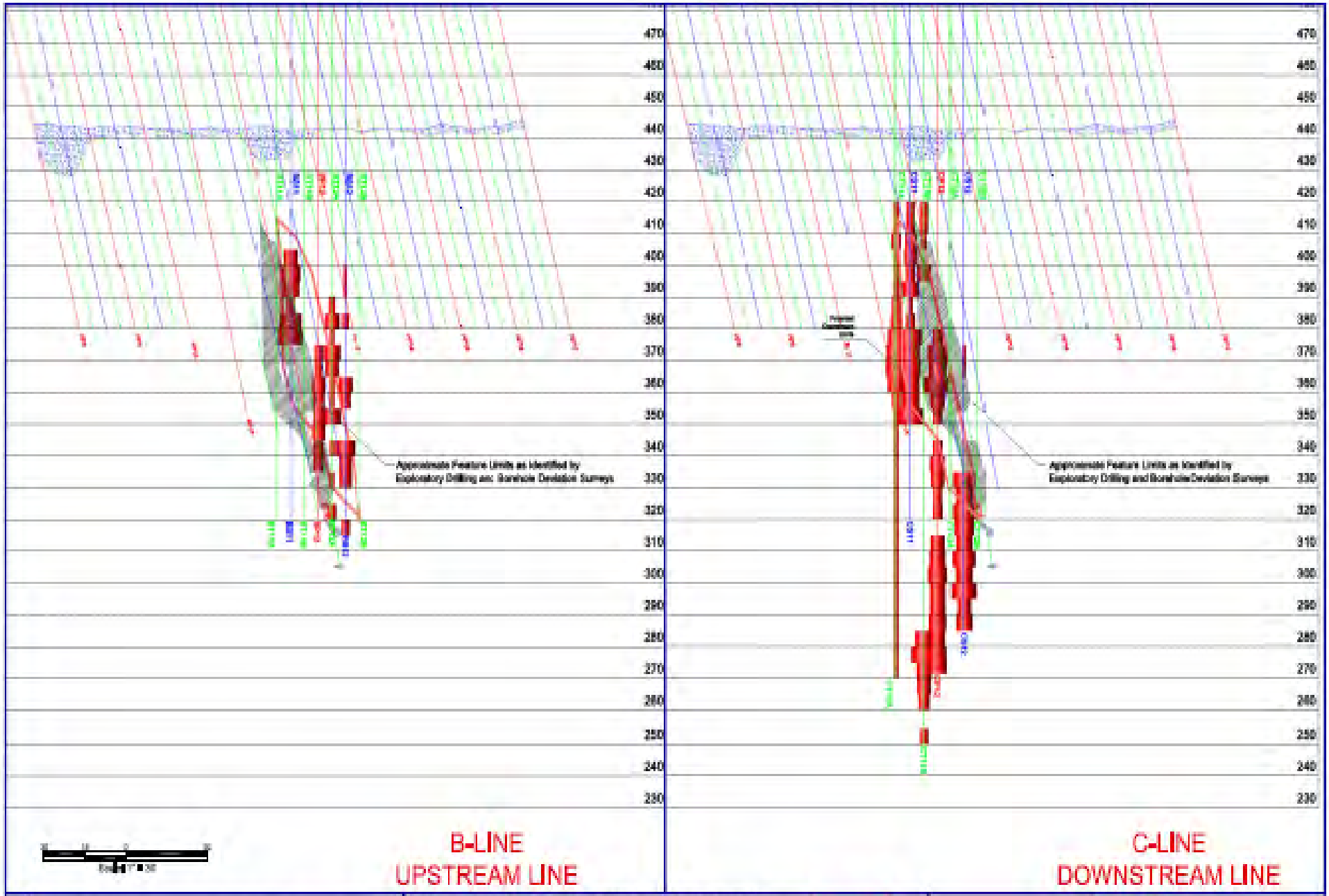
IntelliGrout™
The Science of Grouting

CLEARWATER DAM SINKHOLE REPAIR

Location of Cavity under Core Trench




Low Mobility Grout Holes
Plan View
Downstream
LMG C-line
Grout A-line
LMG B-line
Core Trench
Solution Joint
(cavity)
Upstream



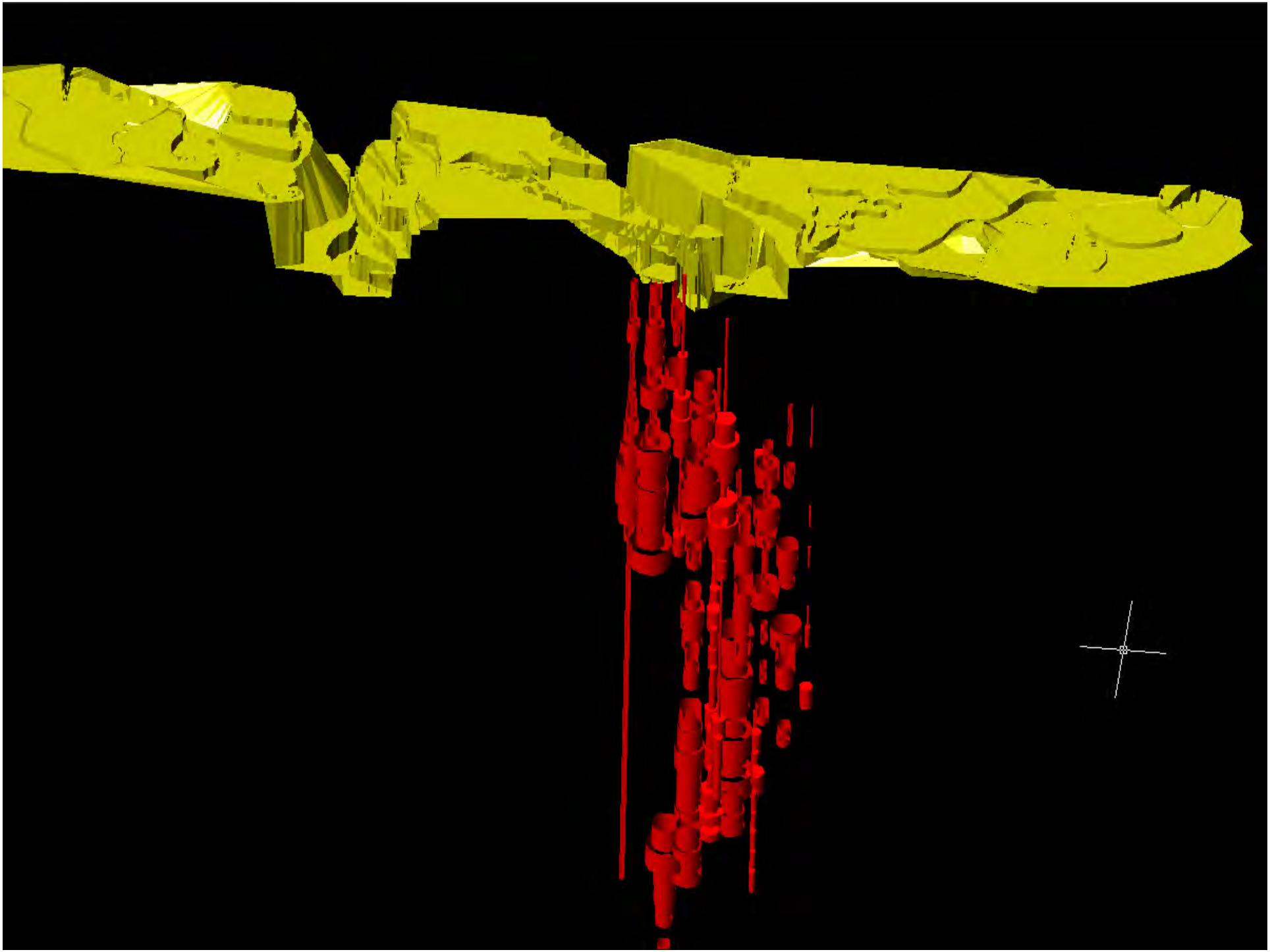
IntelliGrout™
The Science of Grouting

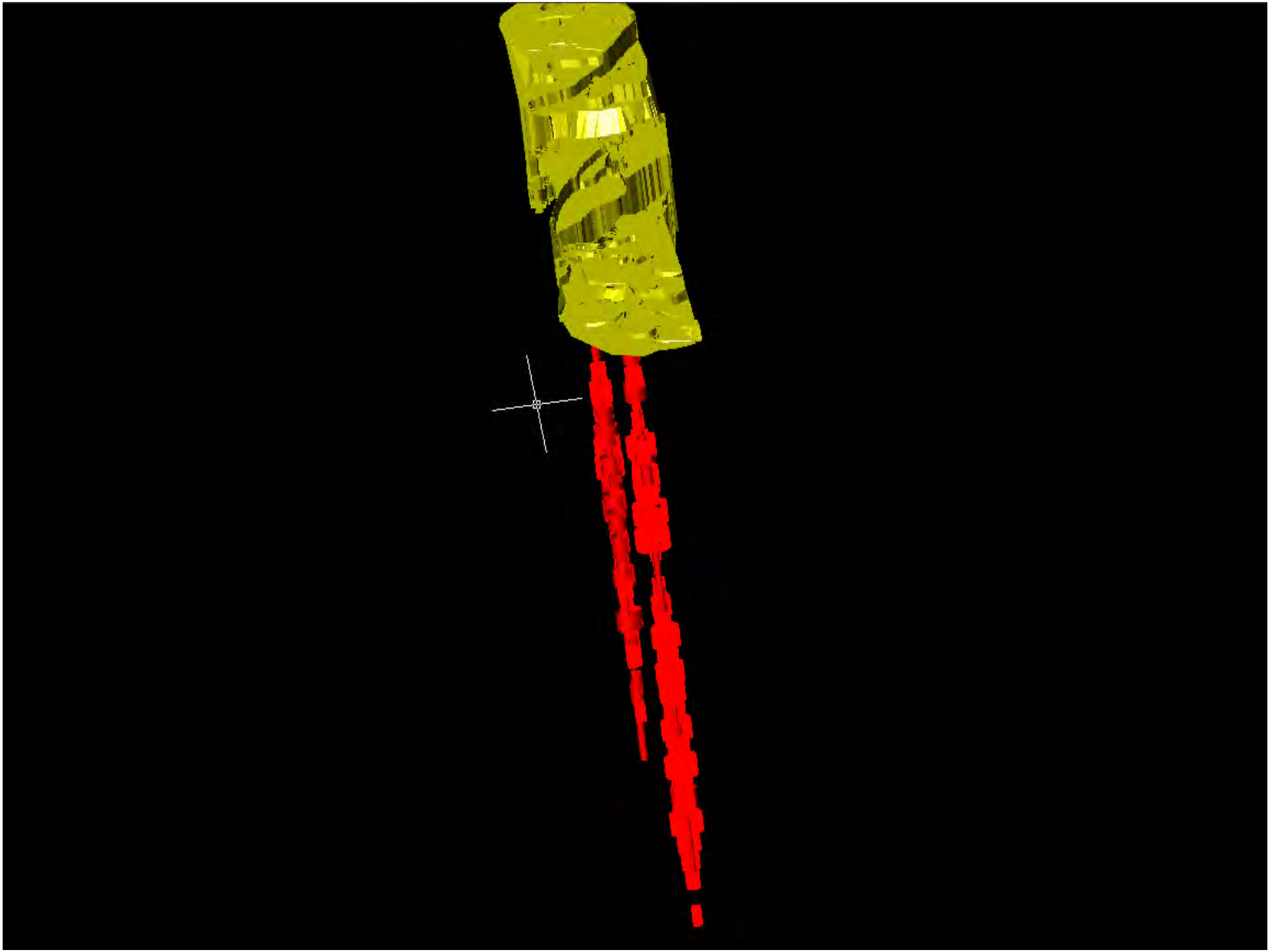
CLEARWATER DAM SINKHOLE REPAIR
PIEDMONT, MISSOURI
FOUNDATION DRILLING AND GROUTING
CONTRACT NO.: W9127S-04-C-0003

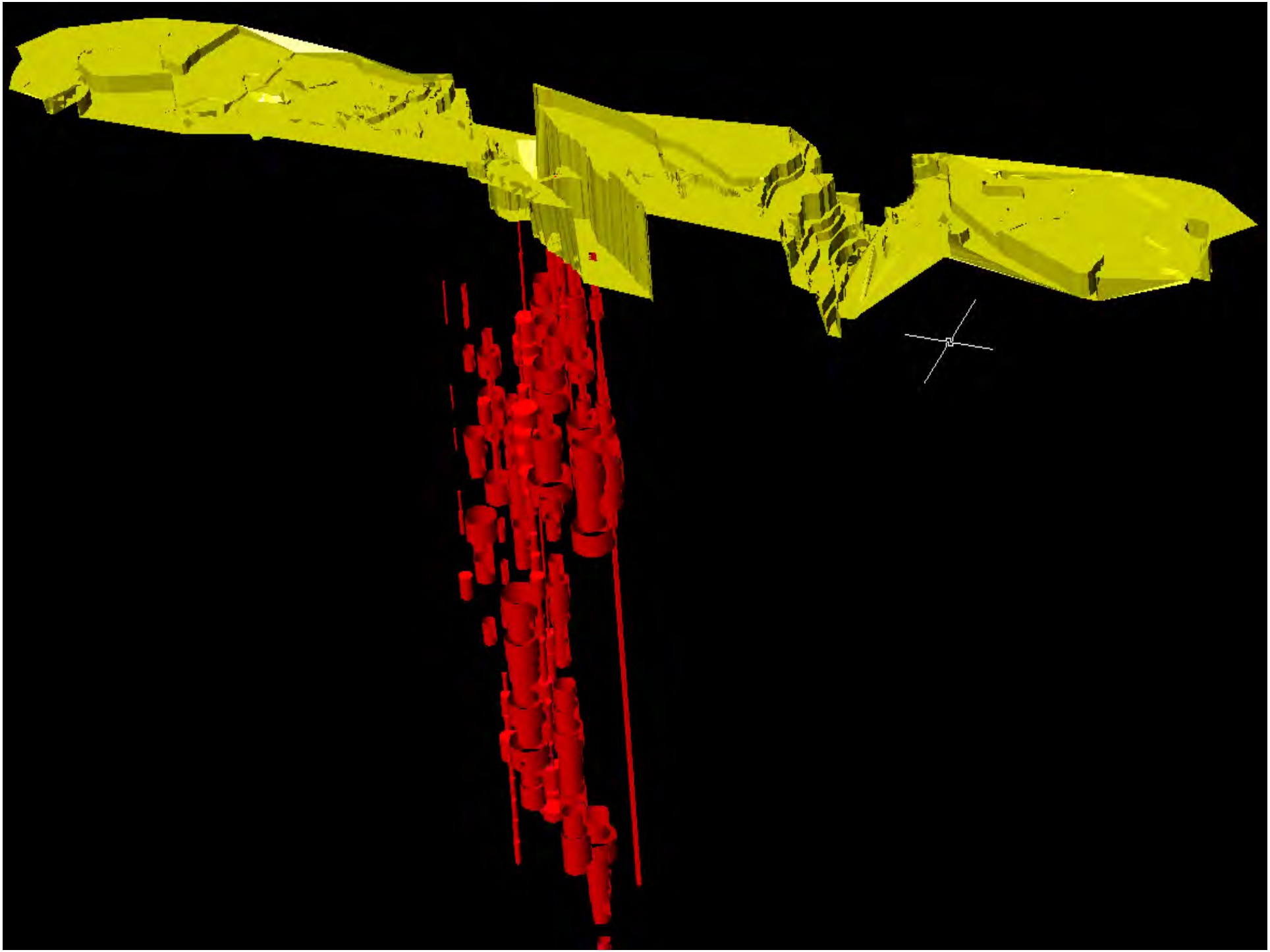
US Army Corps of Engineers

FIGURE 3
PROFILE VIEW OF LMG HOLES

Updated as of 3-15-05





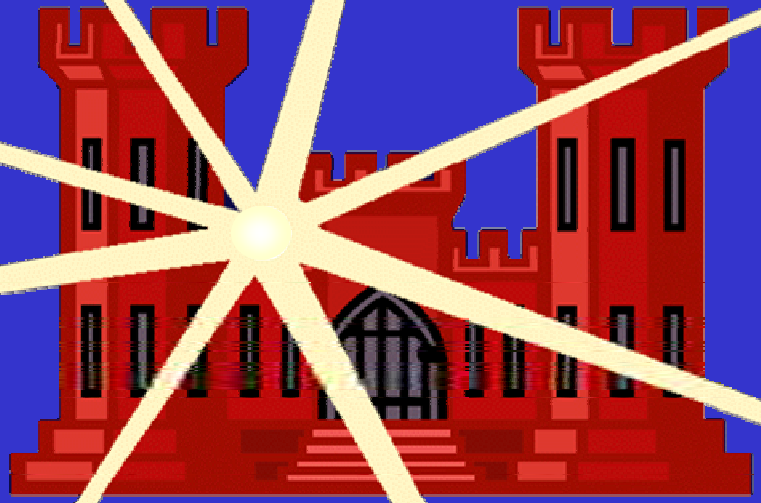


Clearwater Dam
Major Rehabilitation Project

- **PHASE I – Full length of dam, close spaced exploratory drilling and grouting.**

- **PHASE II – seepage cutoff wall through embankment and into rock (design dependent upon Phase I).**

Little Rock



District

SPECIALTY DRILLING, TESTING, AND GROUTING TECHNIQUES FOR REMEDIATION OF EMBANKMENT DAMS



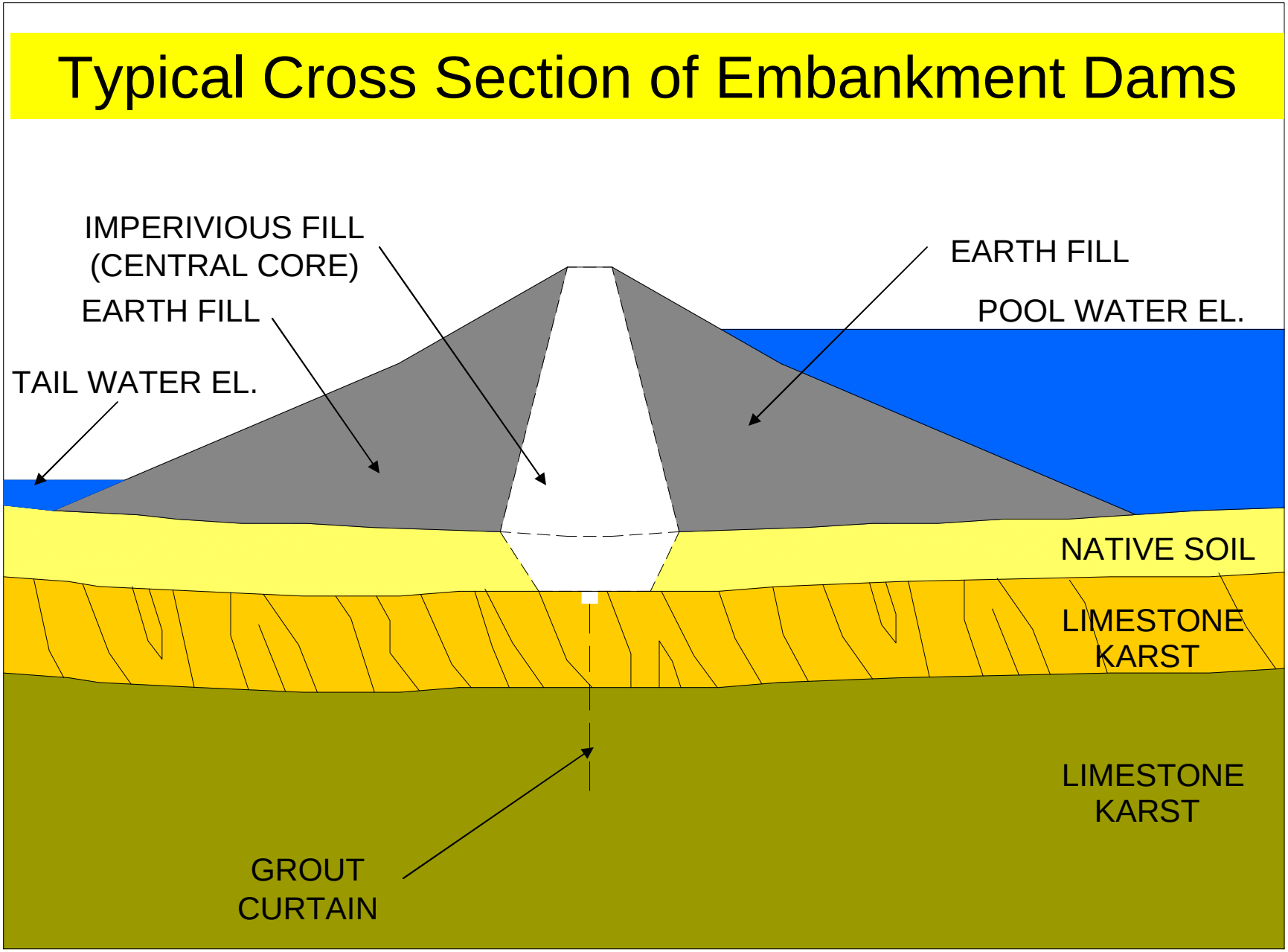
Presented By: Douglas M. Heenan, P.Eng

Advanced Construction Techniques, Ltd.

A.C.T.

ISC Tri-Service Infrastructure Systems Conference & Exposition 2005

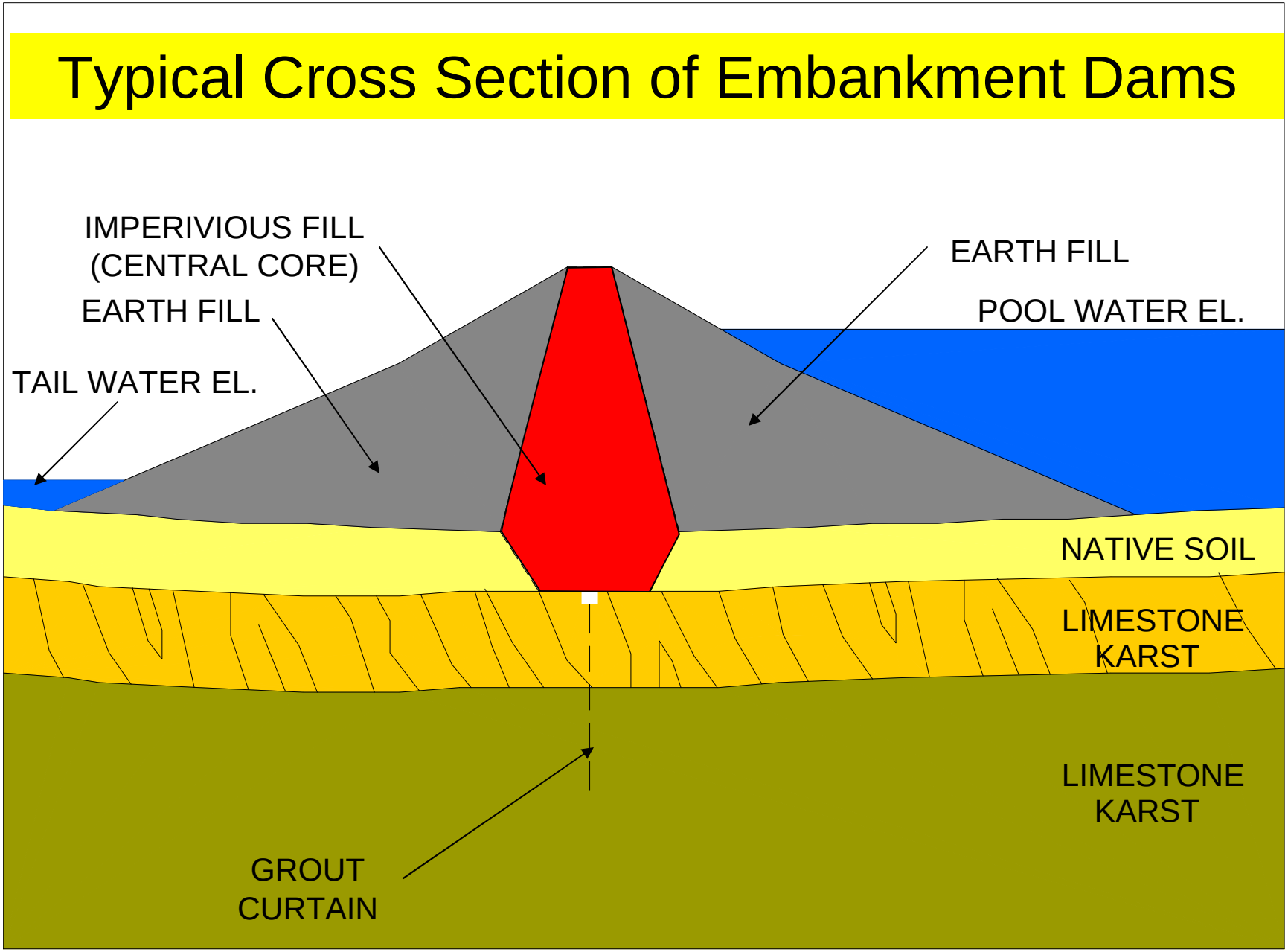
Typical Cross Section of Embankment Dams



Key Elements of Dam Remediation

- Central Core

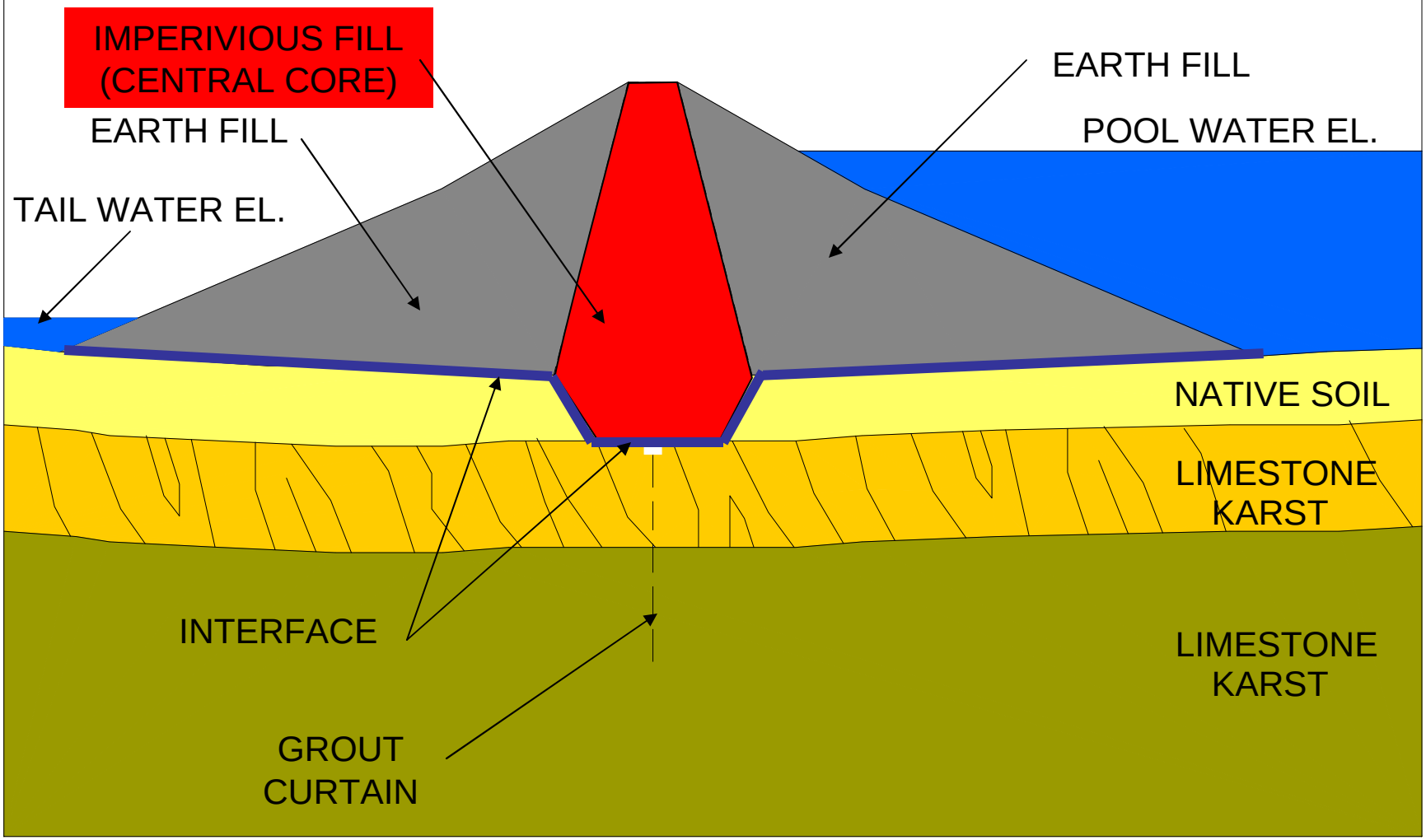
Typical Cross Section of Embankment Dams



Key Elements of Dam Remediation

- Central Core
- Interface

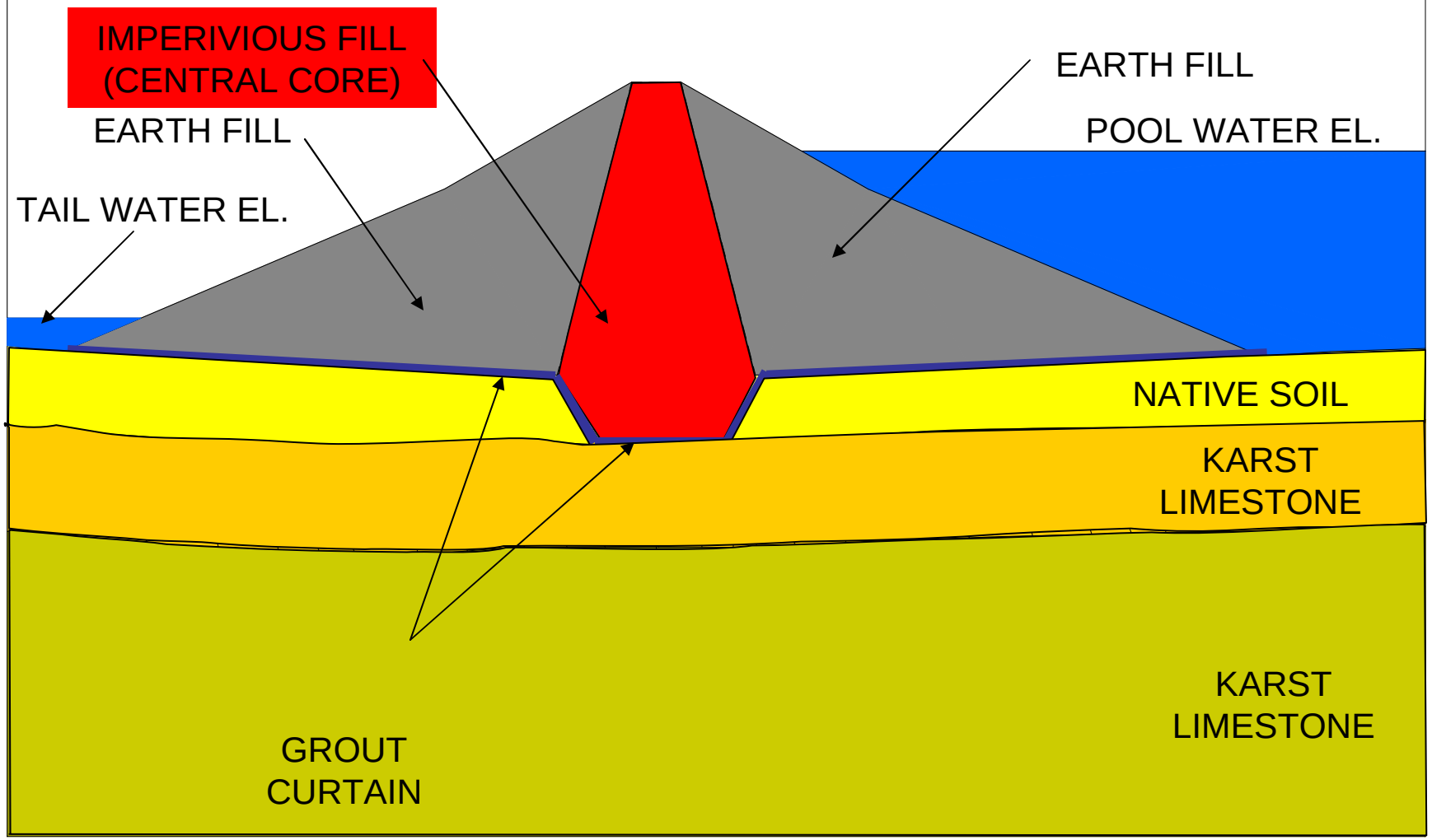
Typical Cross Section of Embankment Dams



Key Elements of Dam Remediation

- Central Core
- Interface
- Foundation

Typical Cross Section of Embankment Dams



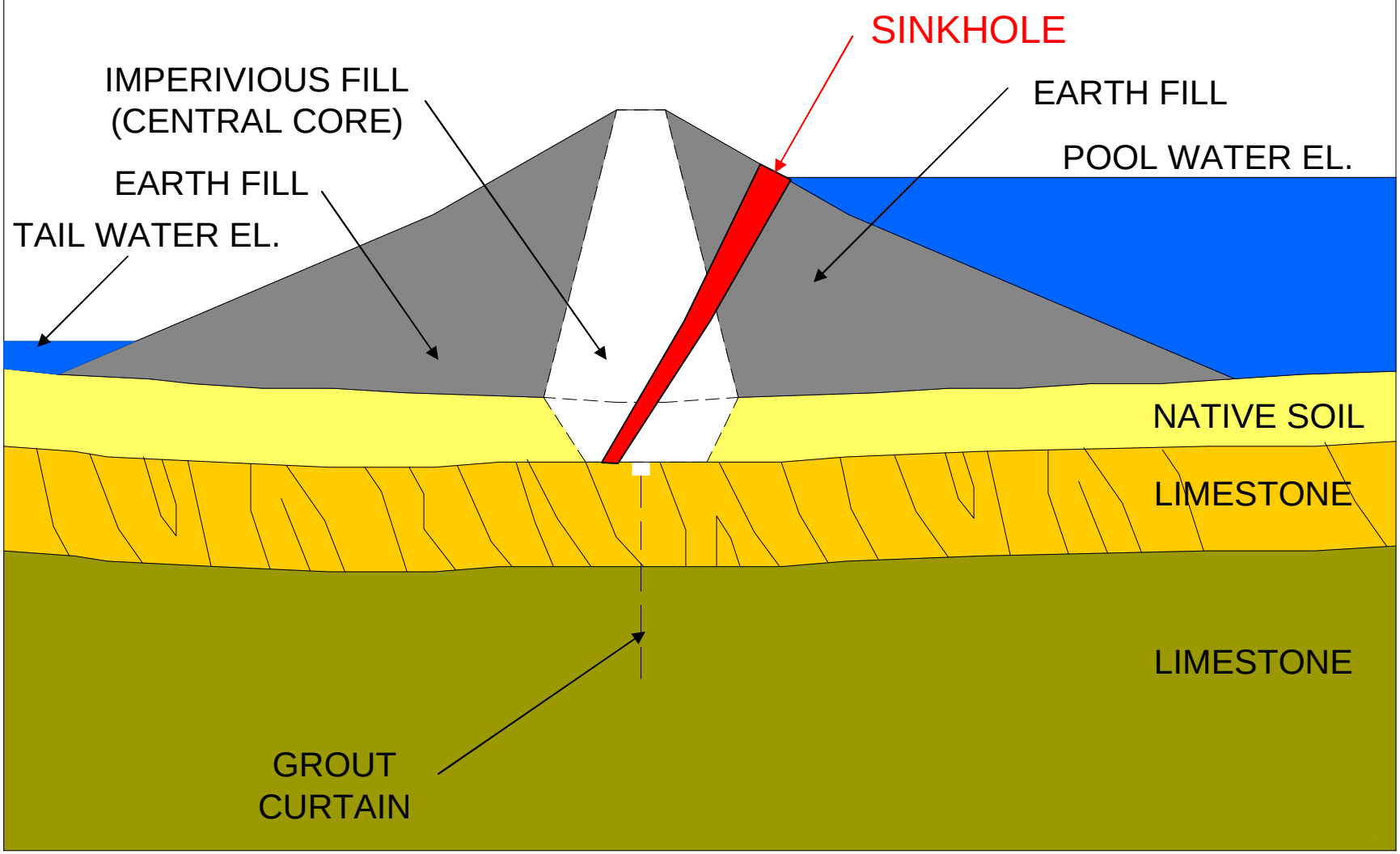
Reason
Why Drilling & Grouting Is Used For Remediation of Embankment Dams

- Repair Defects

Typical Defects of Embankment Dams

- Sinkholes

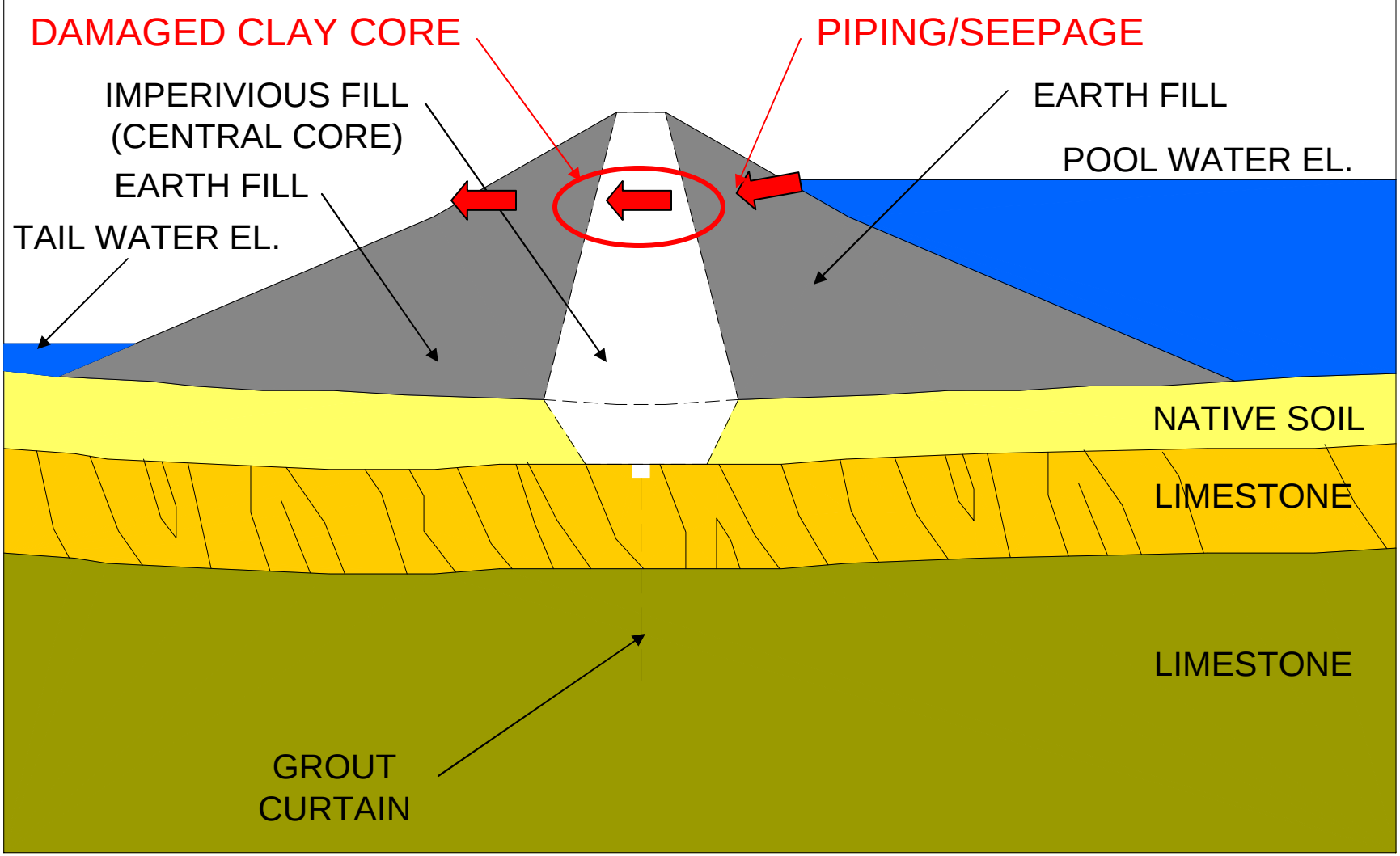
Typical Defects of Embankment Dams



Typical Defects of Embankment Dams

- SINKHOLES
- PIPING / SEEPAGE
- DAMAGED CLAY CORE

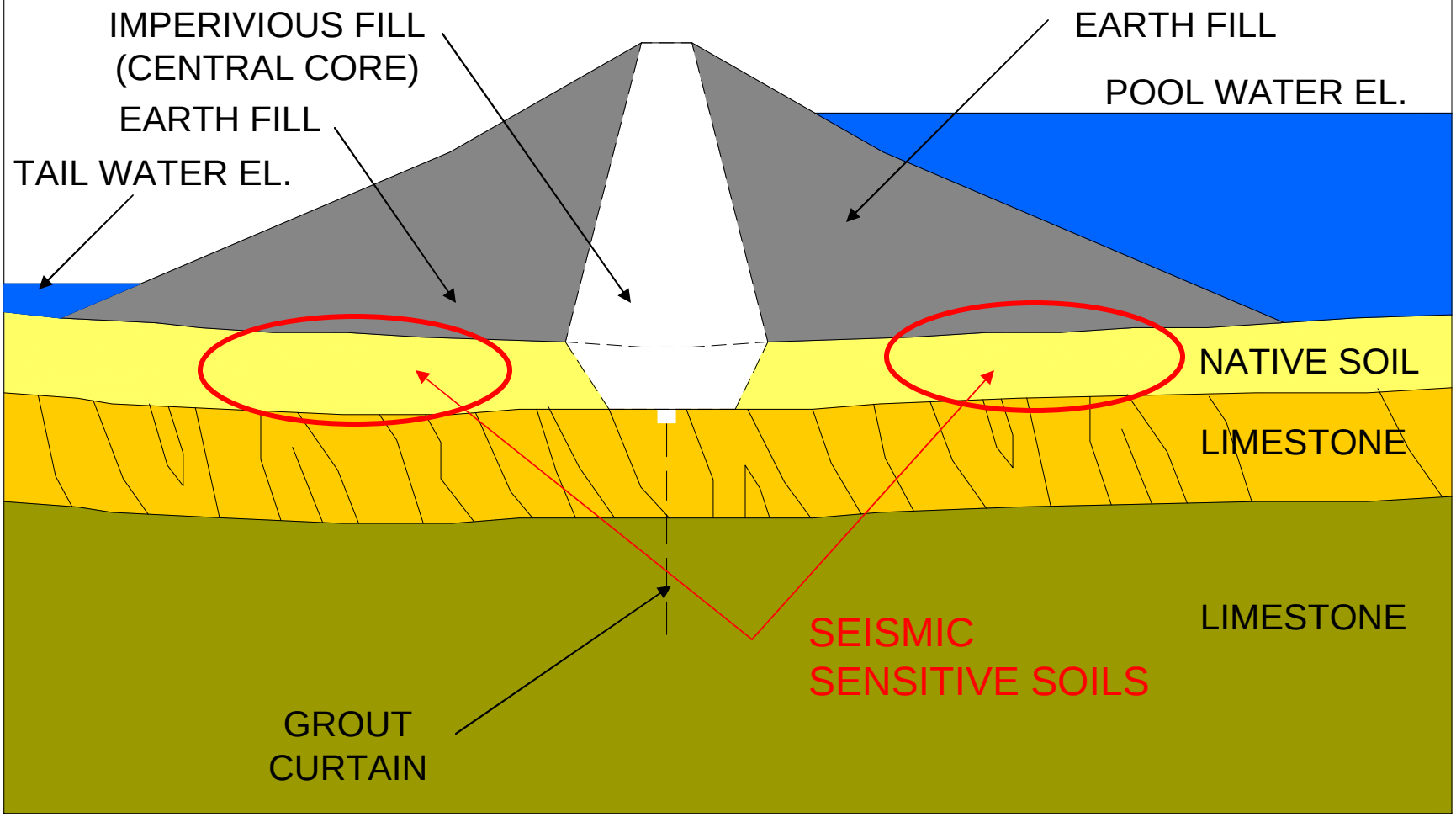
Typical Defects of Embankment Dams



Typical Defects of Embankment Dams

- SINKHOLES
- PIPING / SEEPAGE
- DAMAGED CLAY CORE
- SEISMIC SENSIVE SOILS

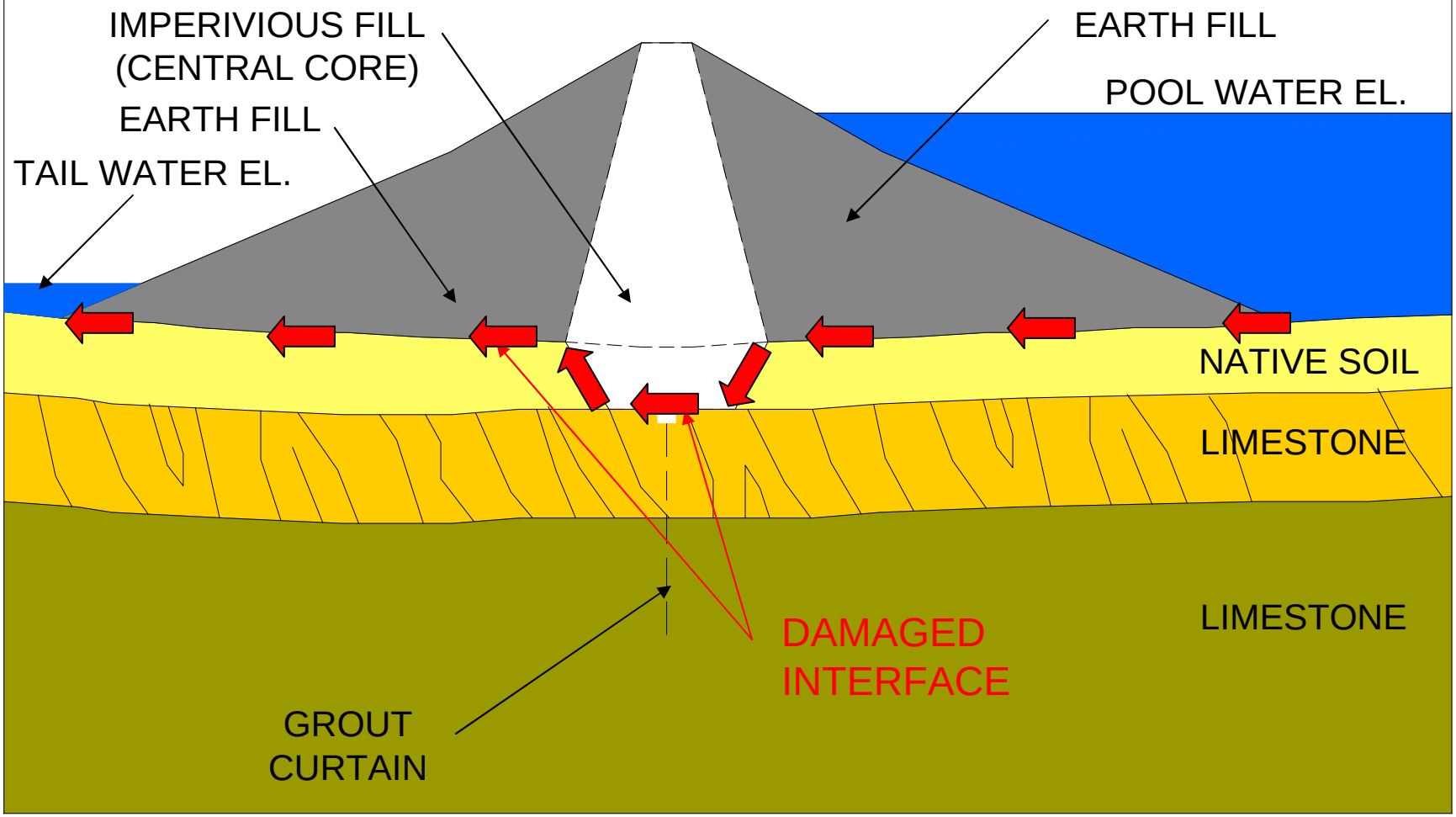
Typical Defects of Embankment Dams



Typical Defects of Embankment Dams

- SINKHOLES
- PIPING / SEEPAGE
- DAMAGED CLAY CORE
- SEISMIC SENSIVE SOILS
- DAMAGED INTERFACE

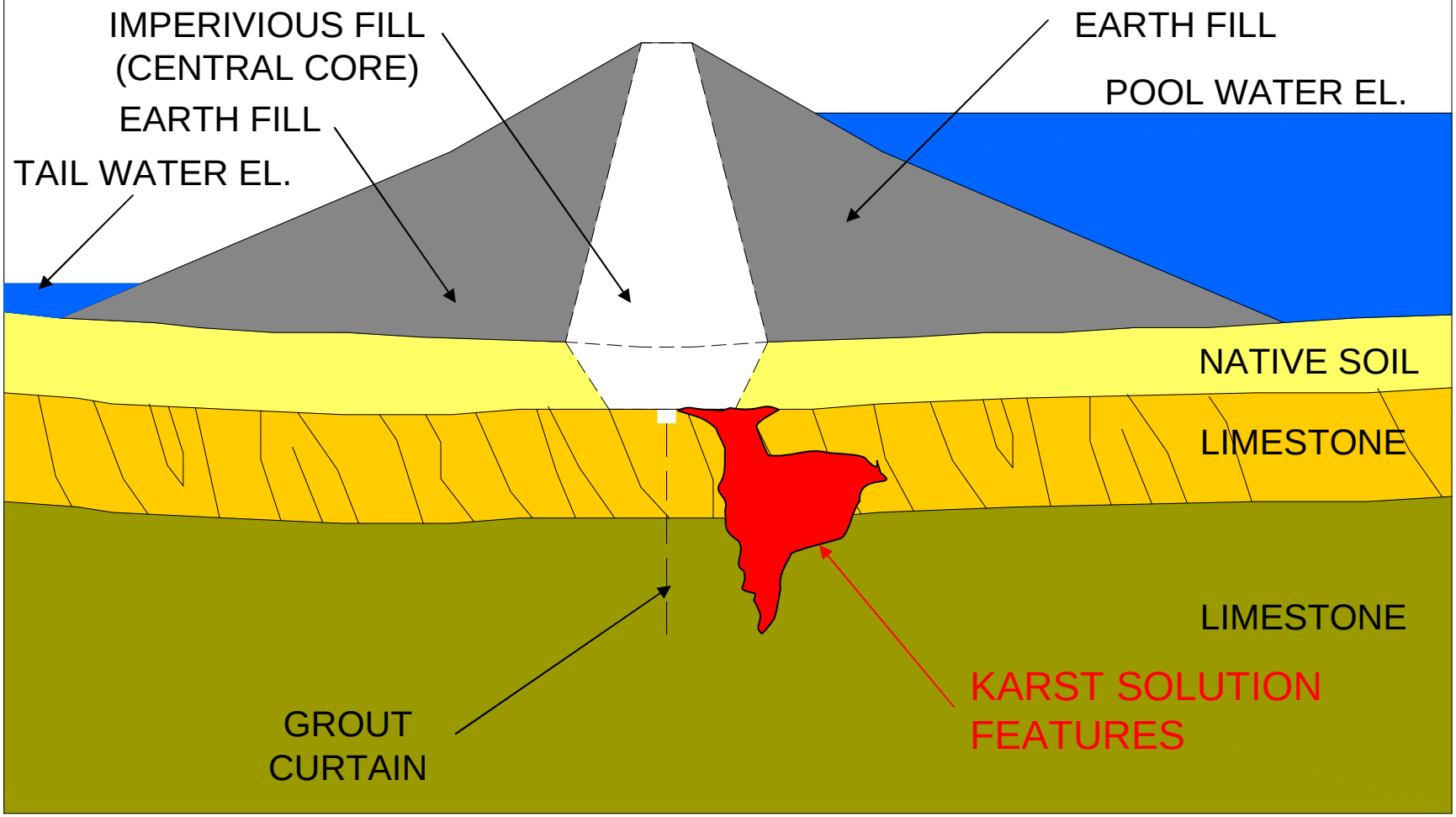
Typical Defects of Embankment Dams



Typical Defects of Embankment Dams

- SINKHOLES
- PIPING / SEEPAGE
- DAMAGED CLAY CORE
- SEISMIC SENSIVE SOILS
- DAMAGED INTERFACE
- KARST SOLUTION FEATURES

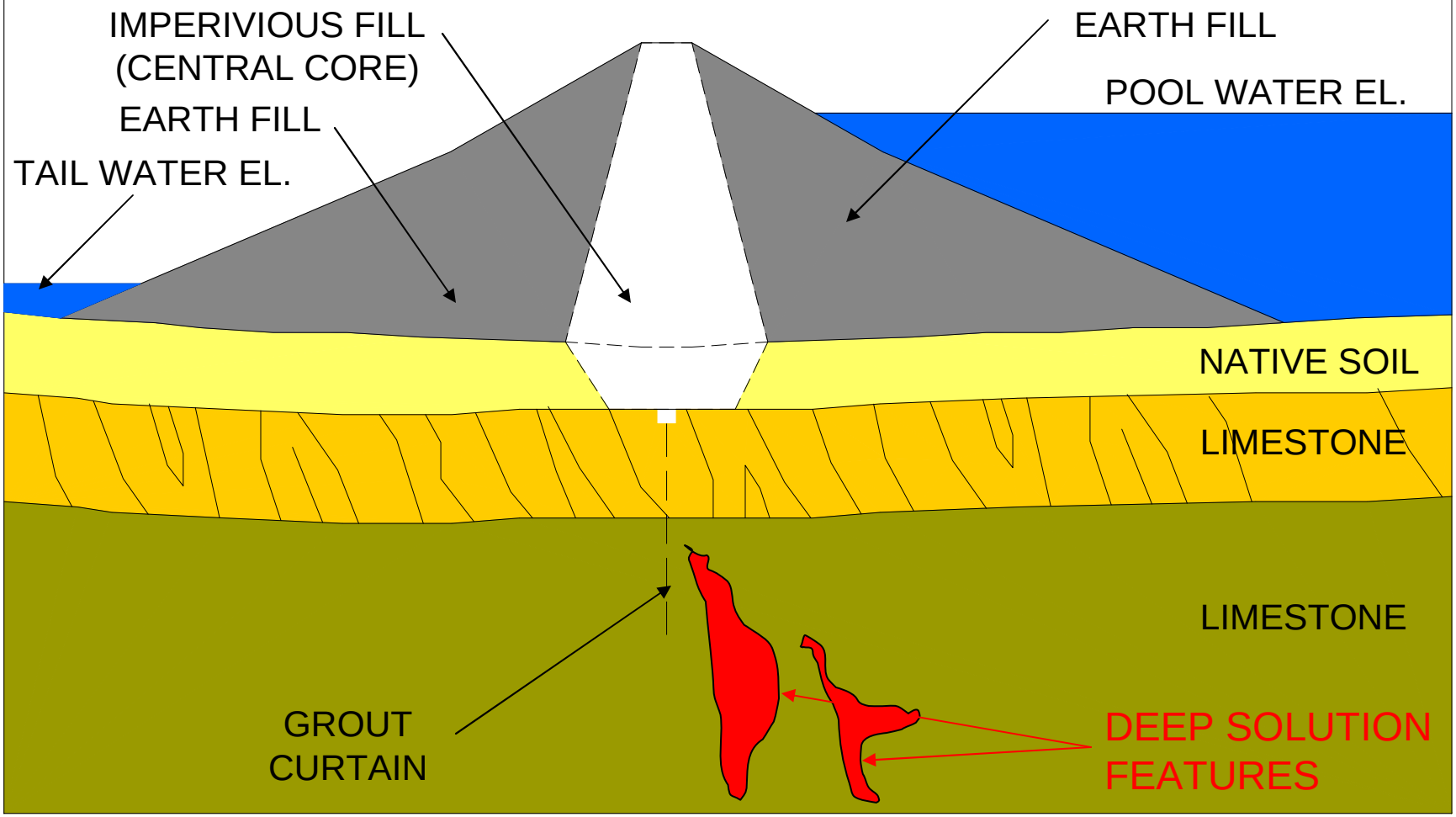
Typical Defects of Embankment Dams



Typical Defects of Embankment Dams

- SINKHOLES
- PIPING / SEEPAGE
- DAMAGED CLAY CORE
- SEISMIC SENSIVE SOILS
- DAMAGED INTERFACE
- KARST SOLUTION FEATURES
- DEEP SOLUTION FEATURES

Typical Defects of Embankment Dams



USACE Operational Manuals That Govern Drilling and Grouting Operation

- Procedures for Drilling in Earth Embankments

  ER 110-1-1807
- Grouting Technology

  EM 1110-2-3506
- Geotechnical Investigation

  EM 1110-1-1804
- Soil Sampling

  EM 1110-1-1906

Types of Embankment Drilling

- Sonic Drilling
- Rotary Drilling with Drilling Fluid
- Cased Auger

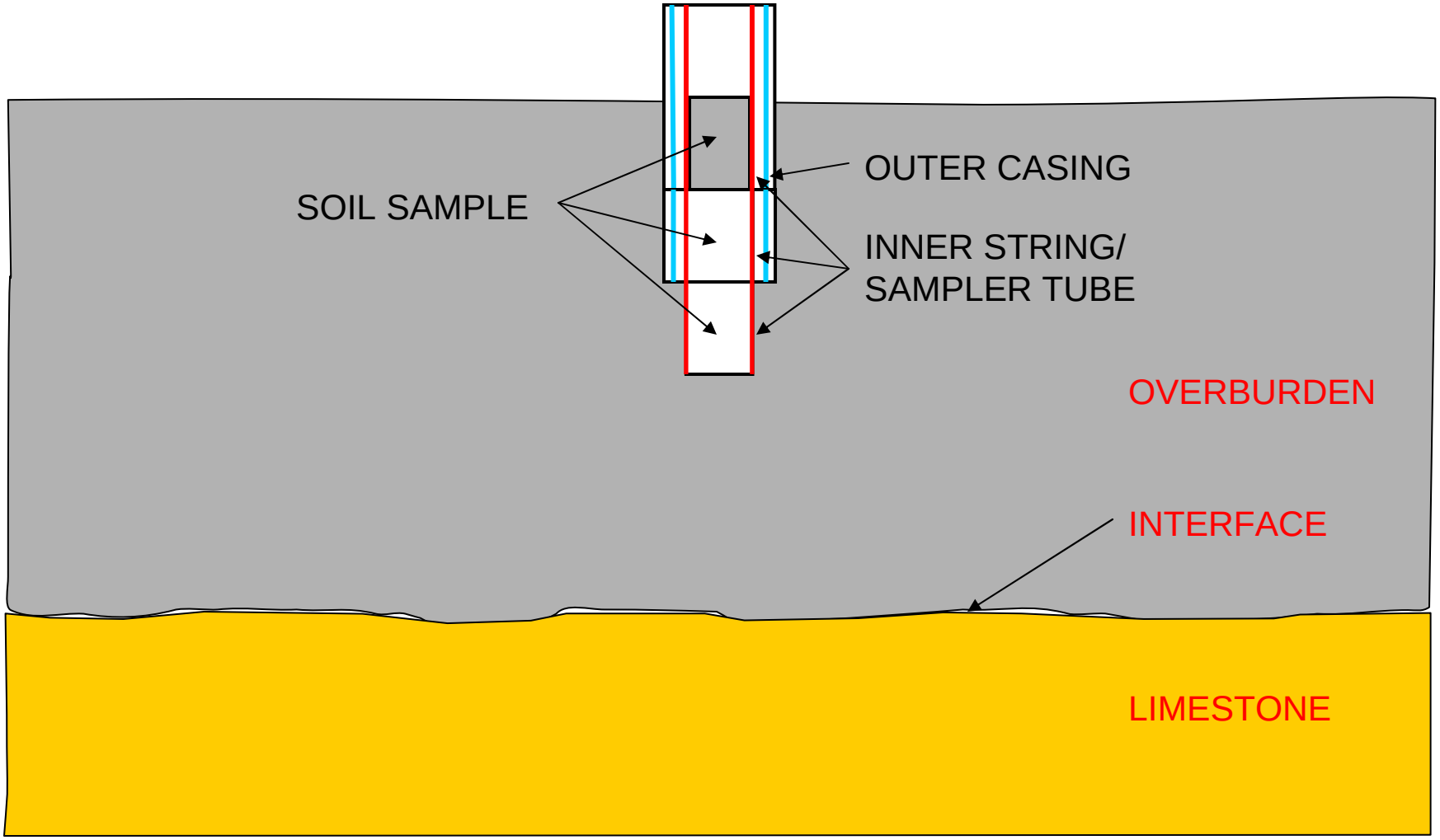


INTEROCK AN160

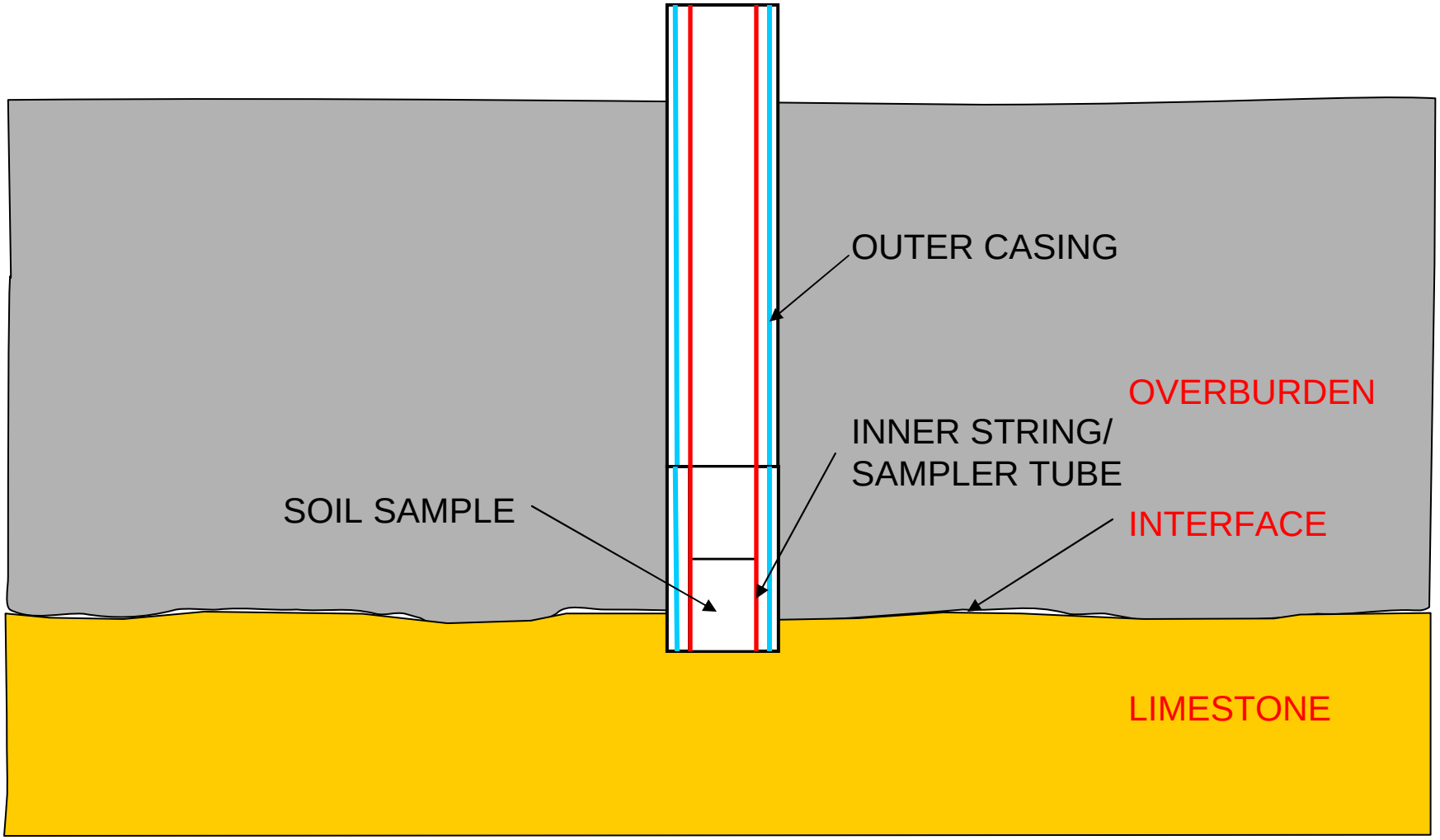
SONIC DRILL



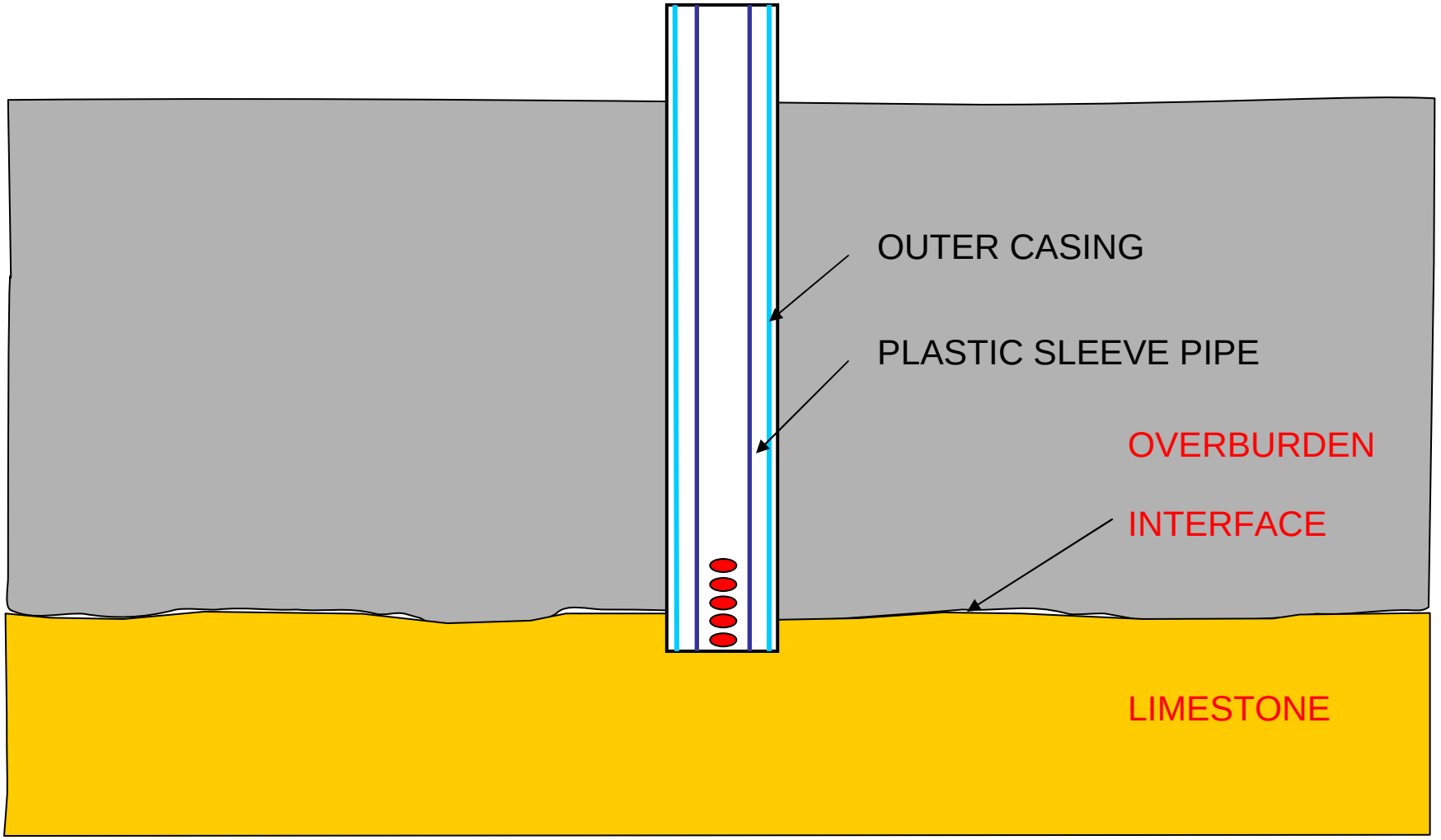
Sonic Drilling



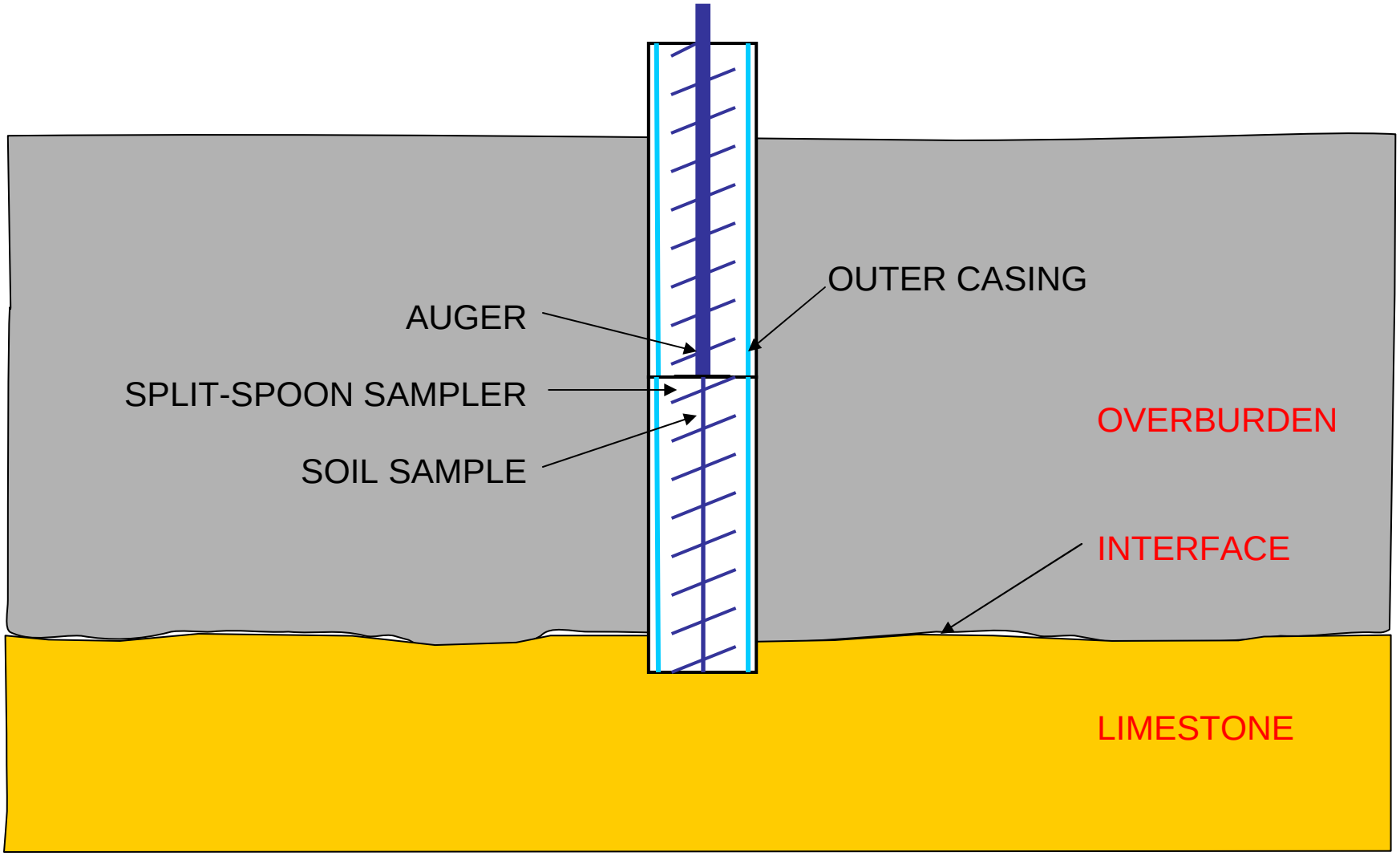
Sonic Drilling



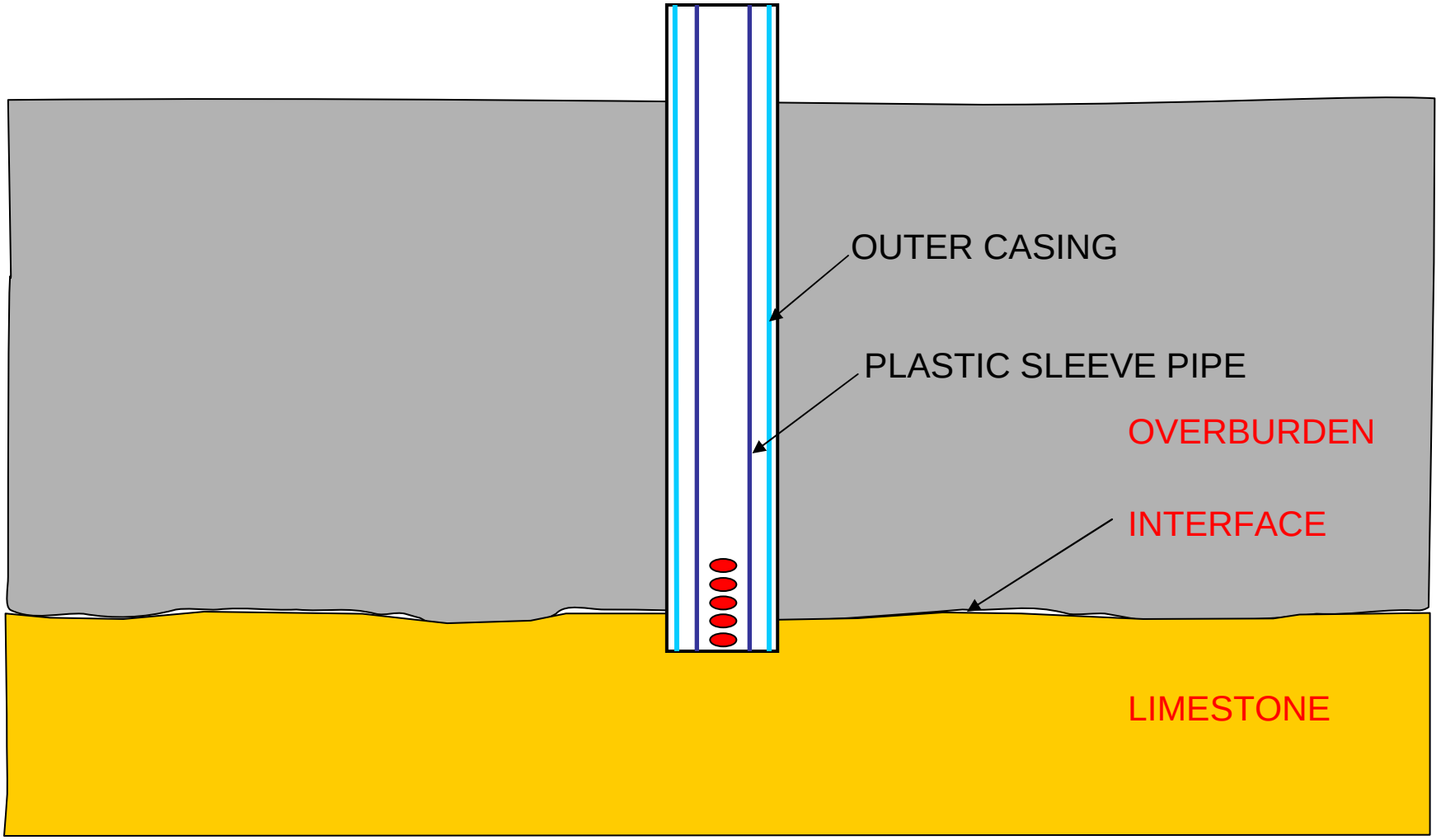
Sonic Drilling



Cased Auger Drilling



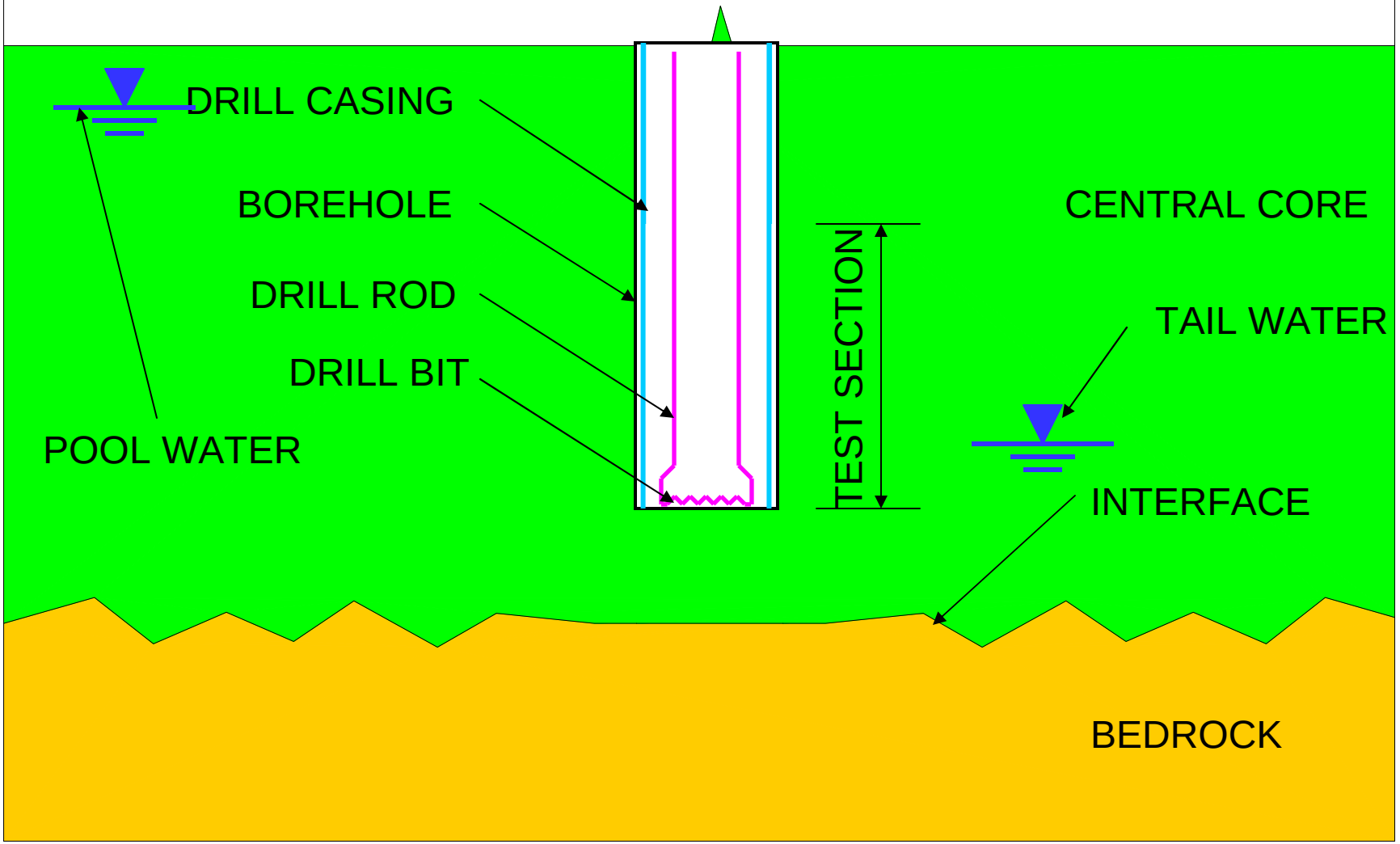
Cased Auger Drilling



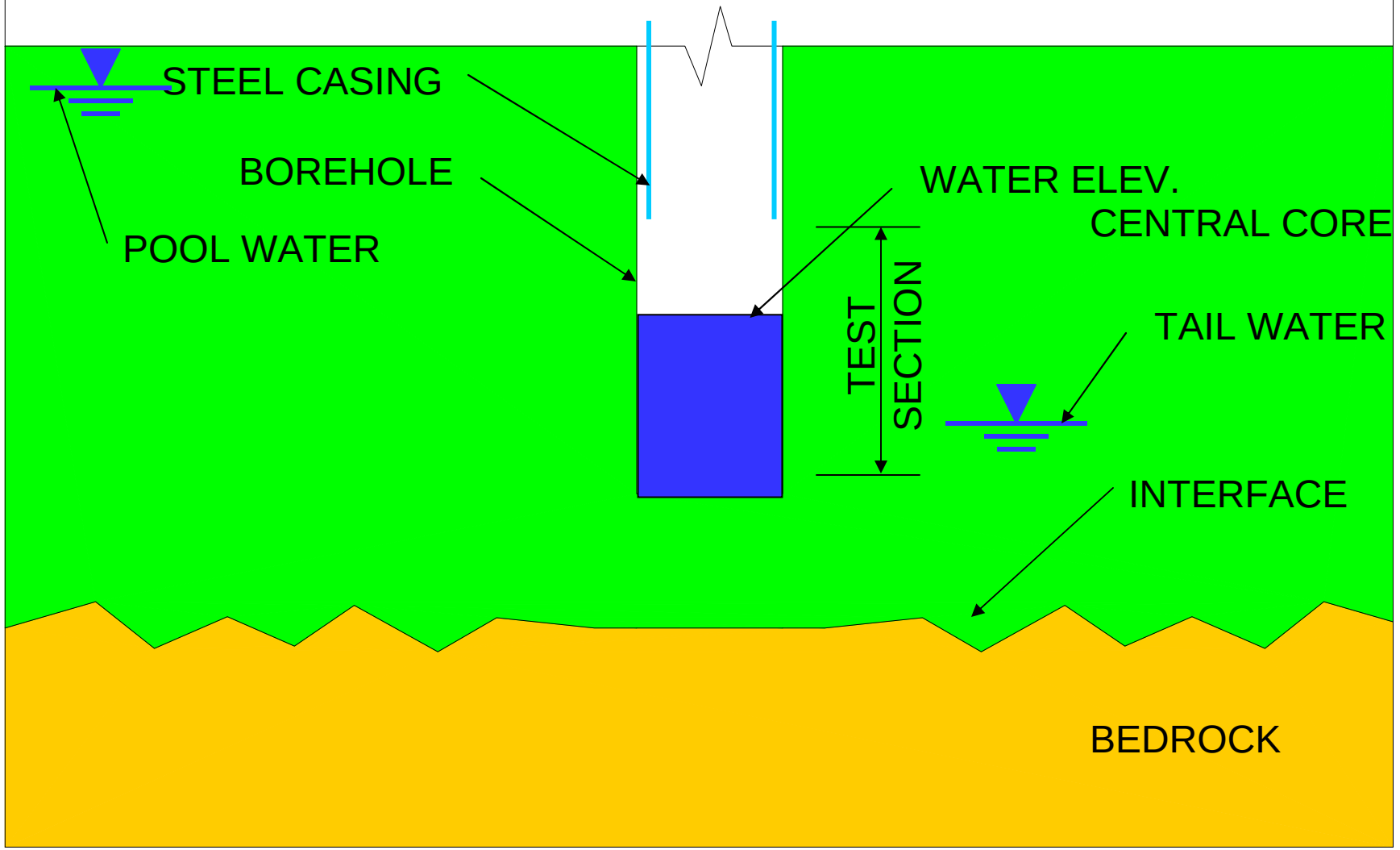
Specific Tests of Embankment Dams

- Core Integrity Test (C.I.T.)
- Interface Integrity Test (I.I.T.)
- Foundation Integrity Test (F.I.T.)

Core Integrity Test (C.I.T.)



Core Integrity Test (C.I.T.)

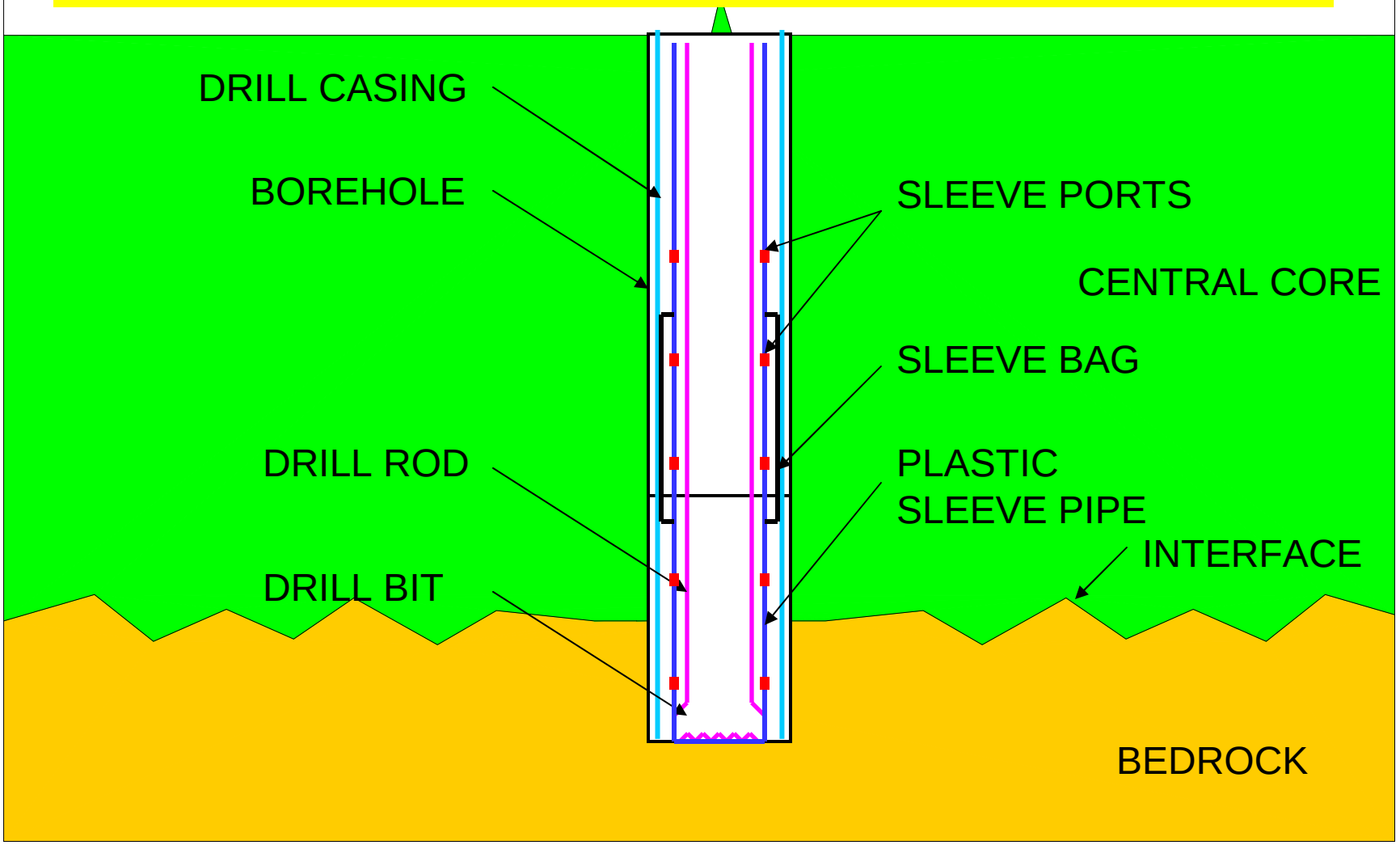


Core Condition Chart

WATER ELEVATION	CORE CONDITION	COMMENTS
NO WATER RISE	EXCELLENT	GOOD LONG TREM PERFORMANCE
RISE TO TAIL WATER ELEV.	POOR	CONNECTED TO DOWNSTREAM
RISE TO POOL WATER ELEV.	POOR	CONNECTED TO UPSTREAM
RISE BETWEEN HW & TW	POOR	GENERAL CONNECTION

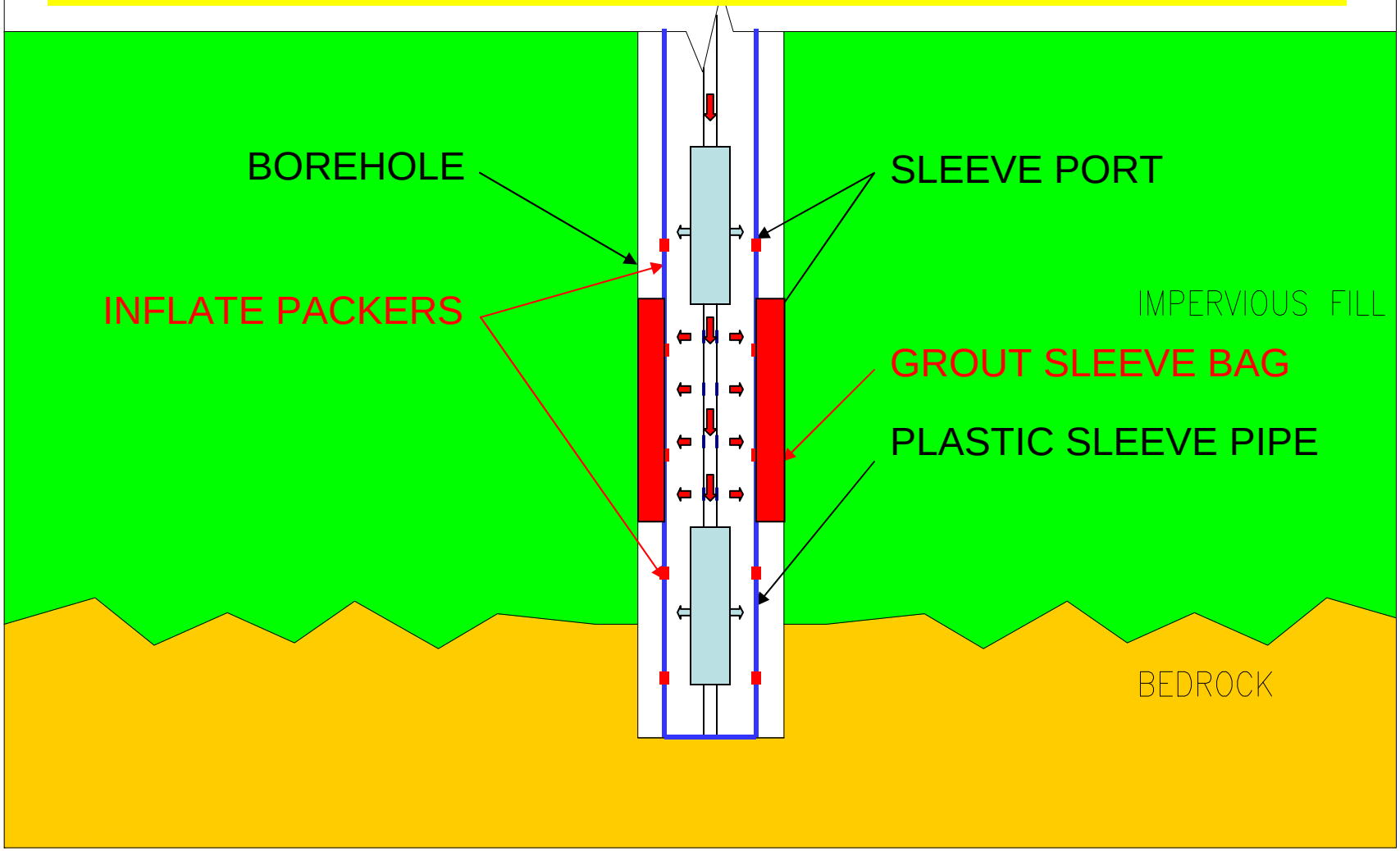
Interface Integrity Test (I.I.T.)

Casing Installation



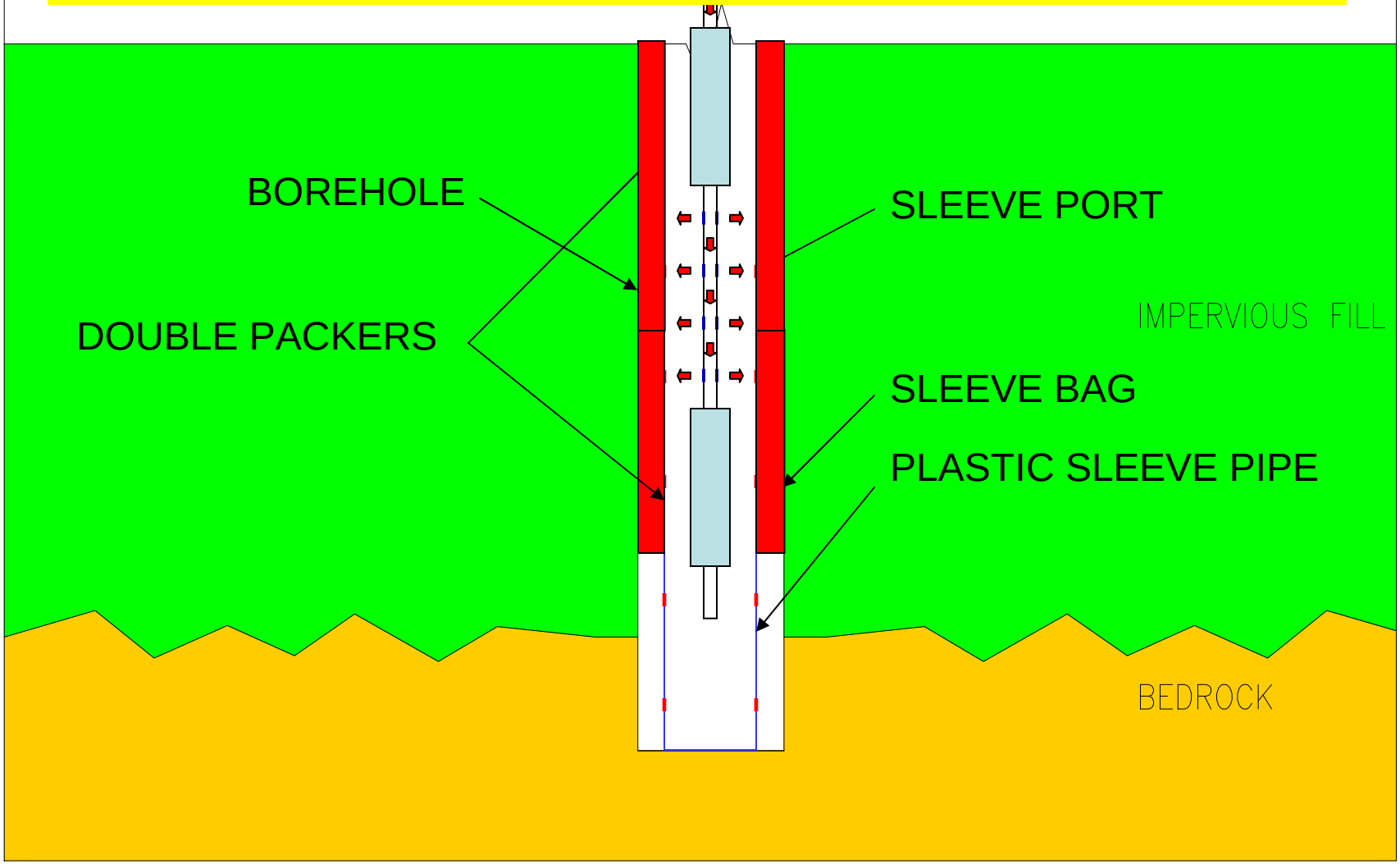
Interface Integrity Test (I.I.T.)

Interface Insulation



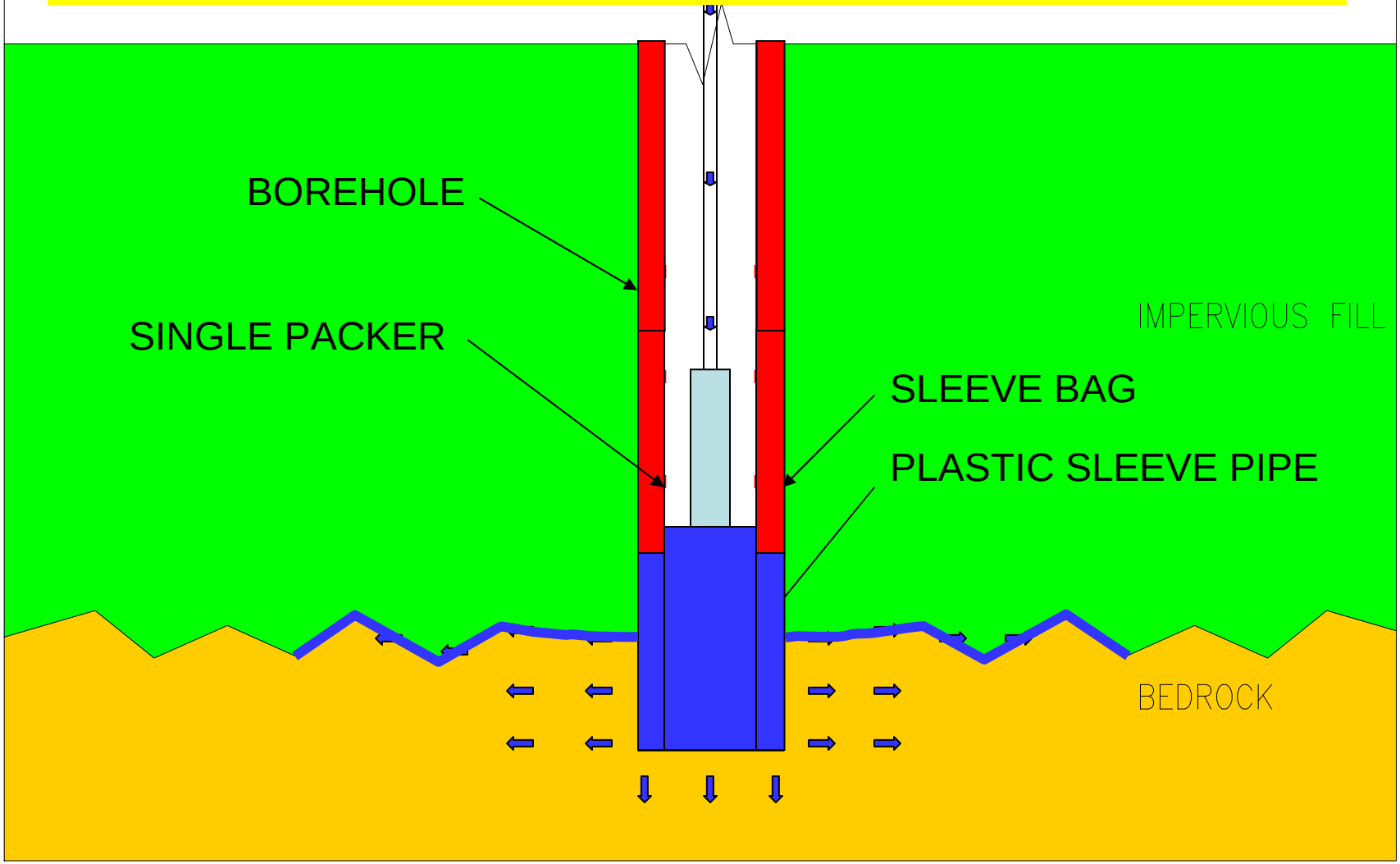
Interface Integrity Test (I.I.T.)

Overburden Casing Grouting



Interface Integrity Test (I.I.T.)

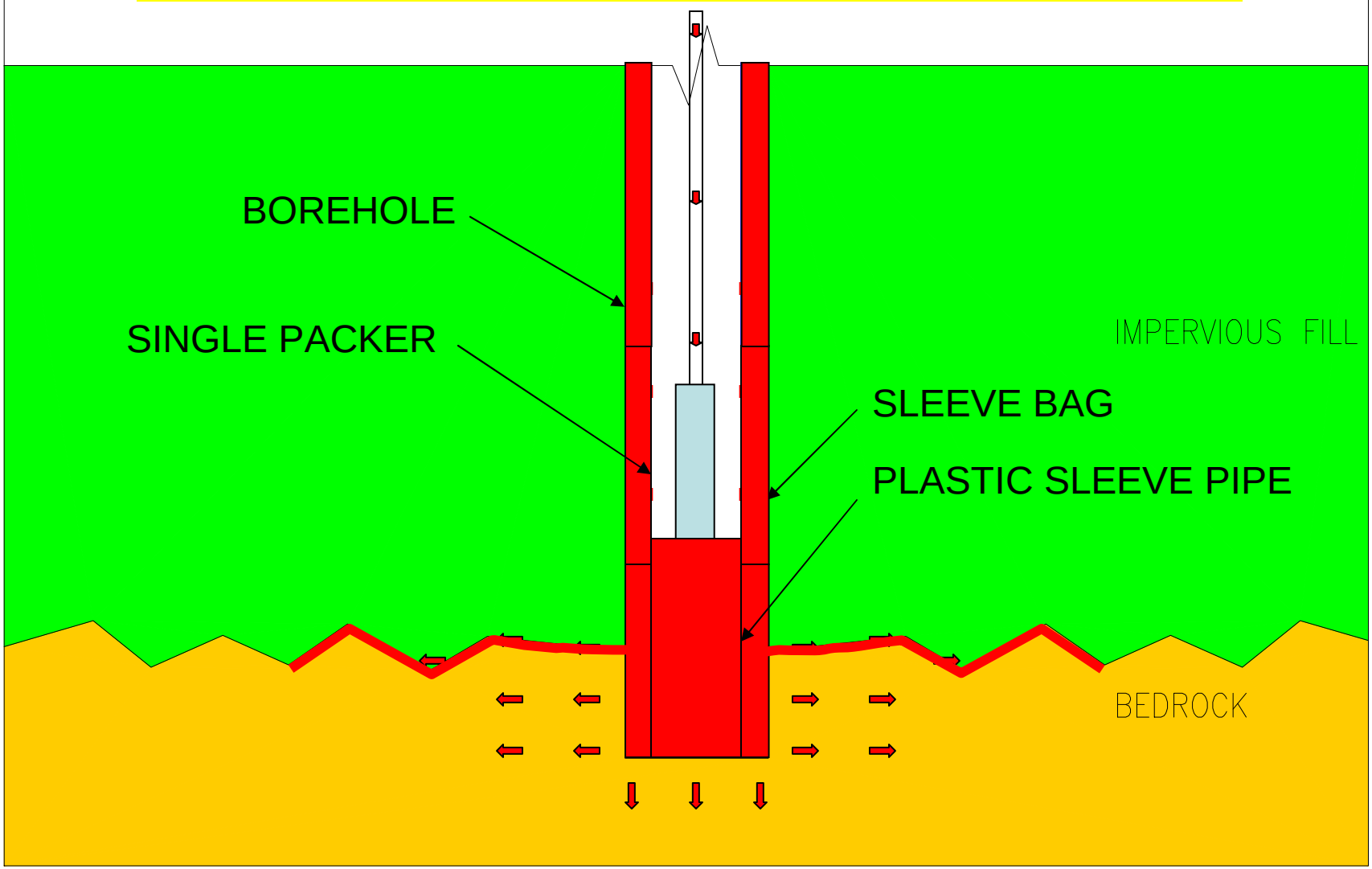
Interface Integrity Test



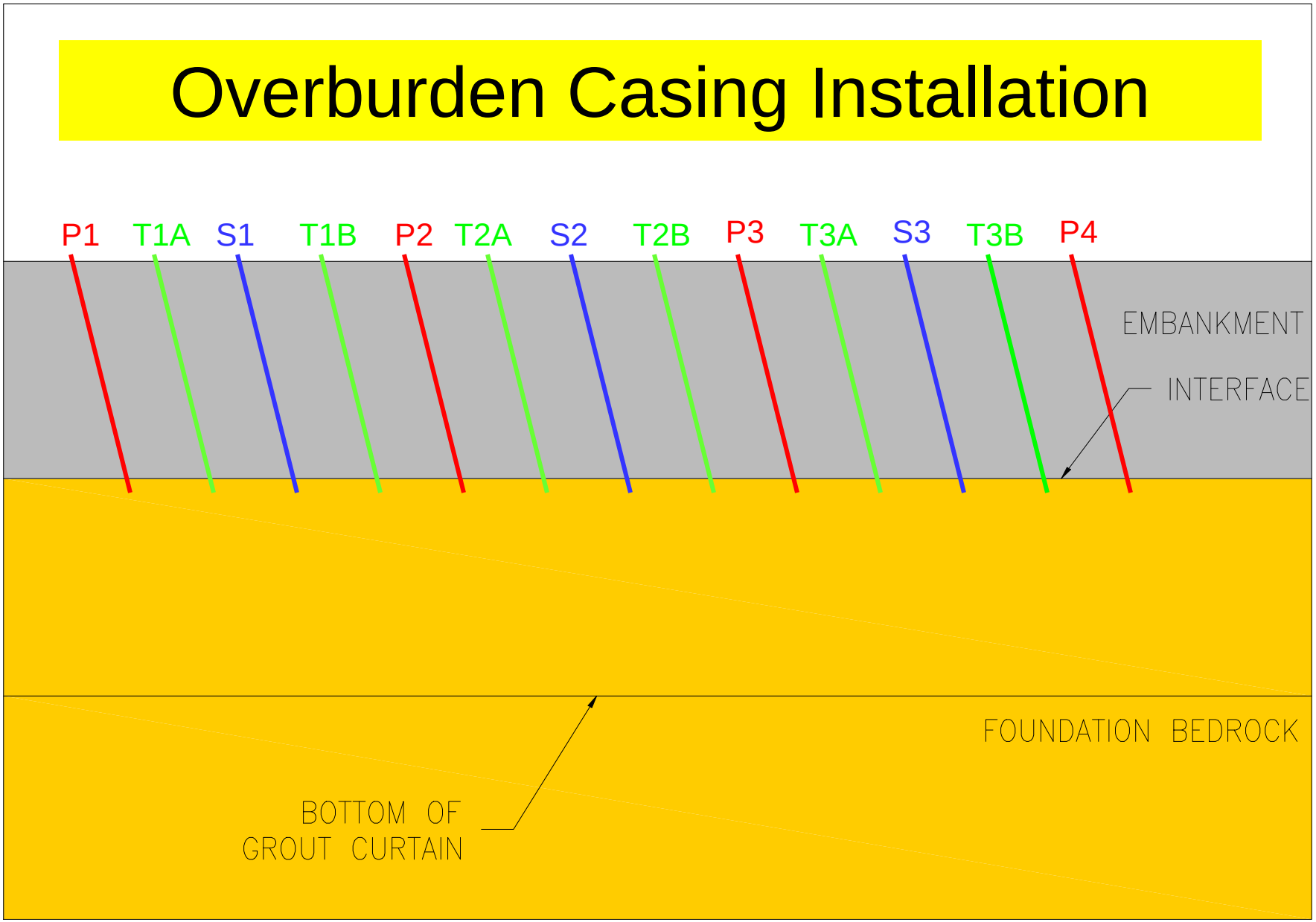
Interface Condition Chart

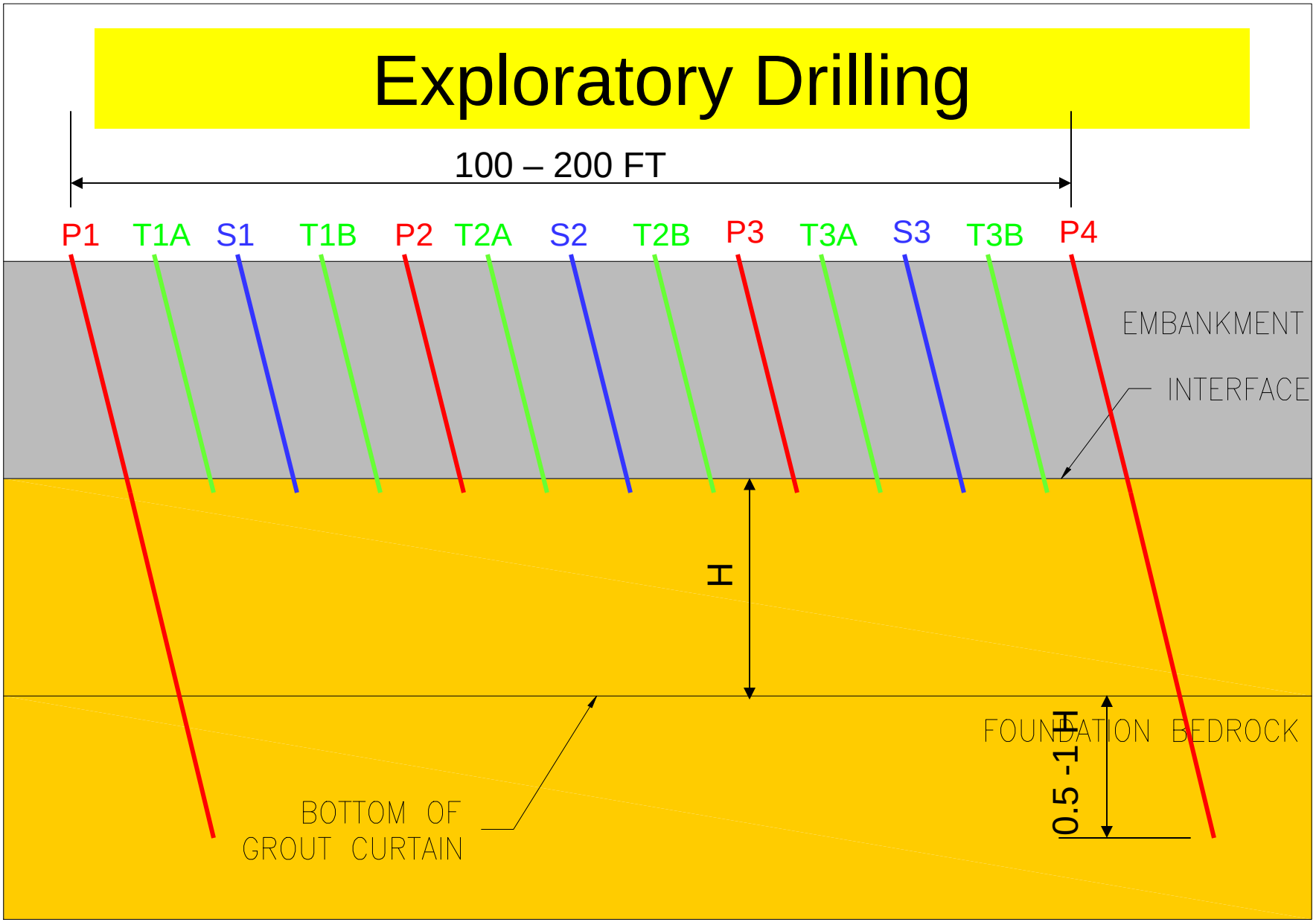
LUGEON VALUE	CONDITION OF INTERFACE	COMMENT
0 - 1	EXCELLENT	INTACT / NO ACTION REQUIRED
1 - 5	GOOD	INTACT / LONG TERM MONITORING REQUIRED
5 - 10	POOR	SUSPECTION CONDITION / MONITORING REQUIRED
> 10	UNSATISFACTORY	POSSIBLE PIPING / REMEDIATION REQUIRED

Interface Grouting

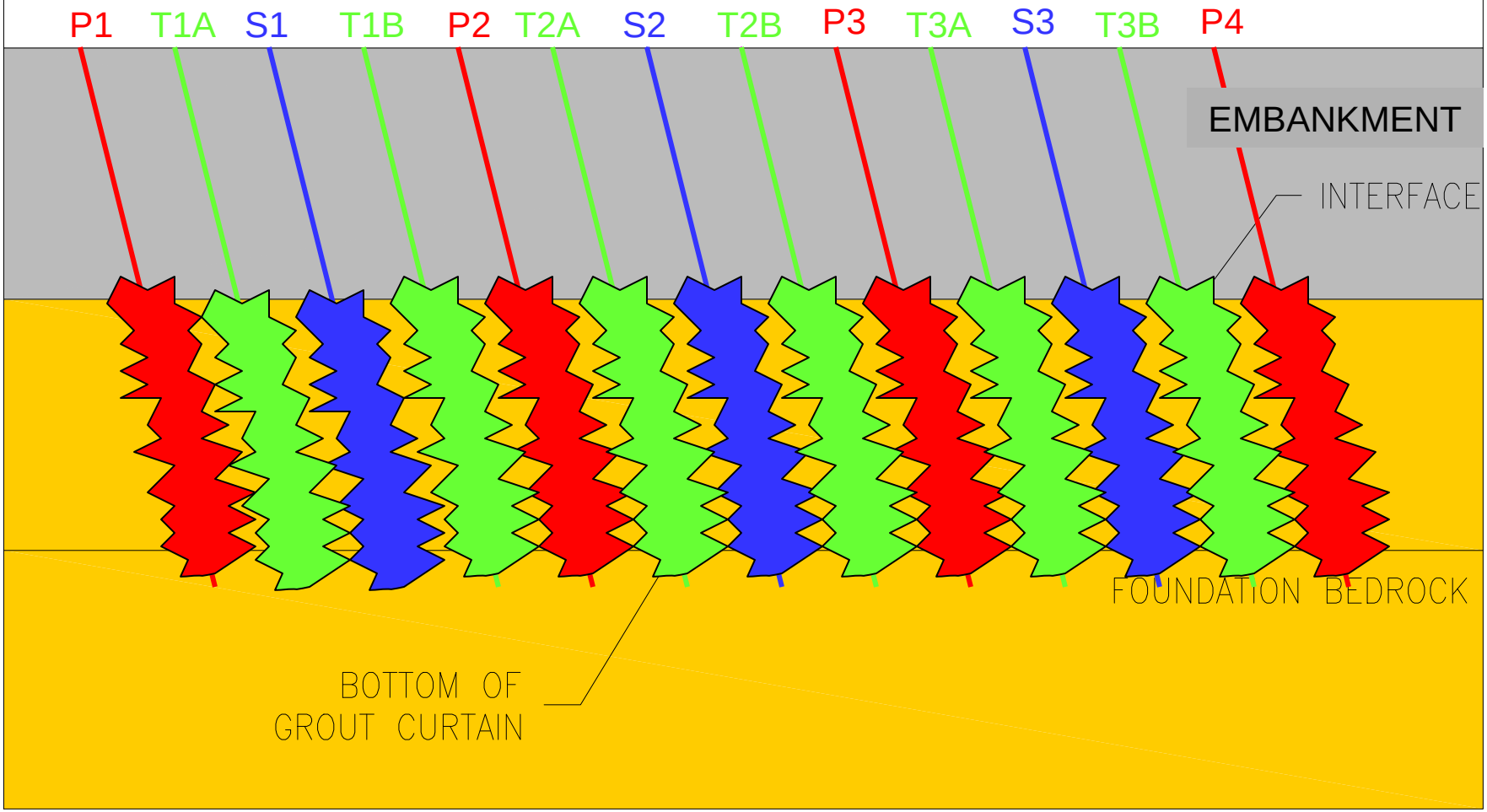


Overburden Casing Installation

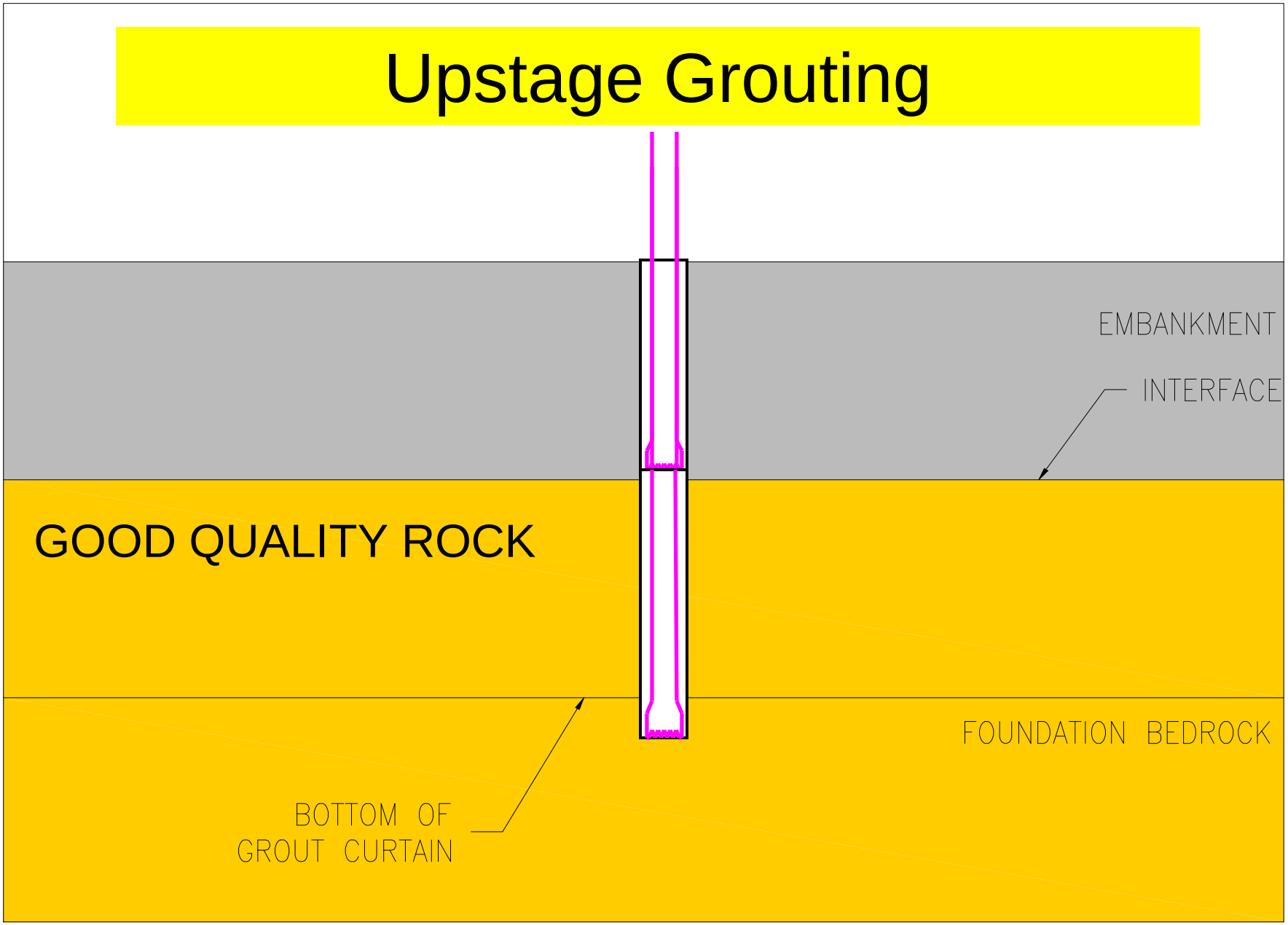



Exploratory Drilling
100 – 200 FT
P1
T1A
S1
T1B
P2
T2A
S2
T2B
P3
T3A
S3
T3B
P4
EMBANKMENT
INTERFACE
H
FOUNDATION BEDROCK
0.5 -1H
BOTTOM OF
GROUT CURTAIN

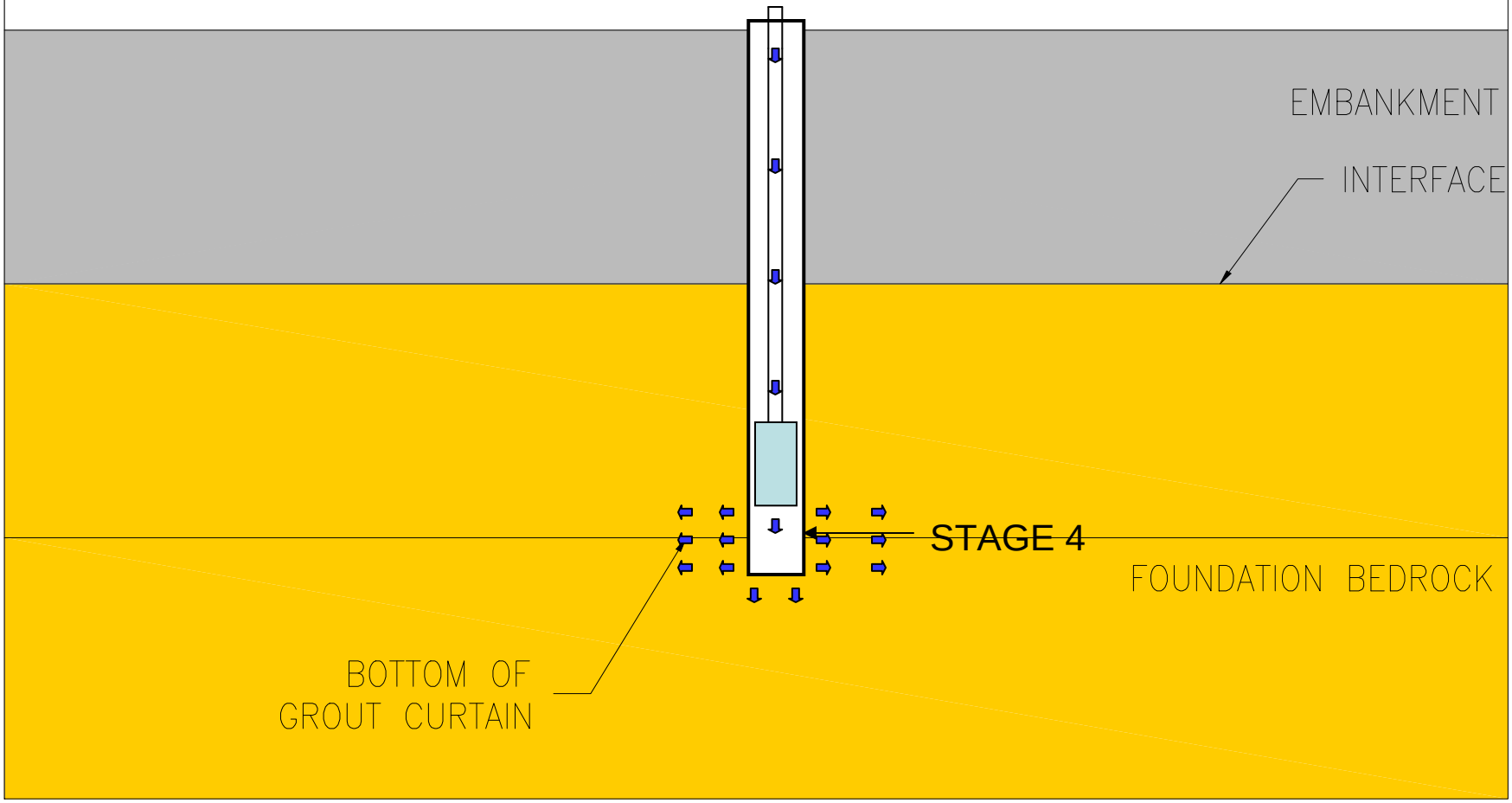
Sequences of Drilling, Water Testing & Grouting



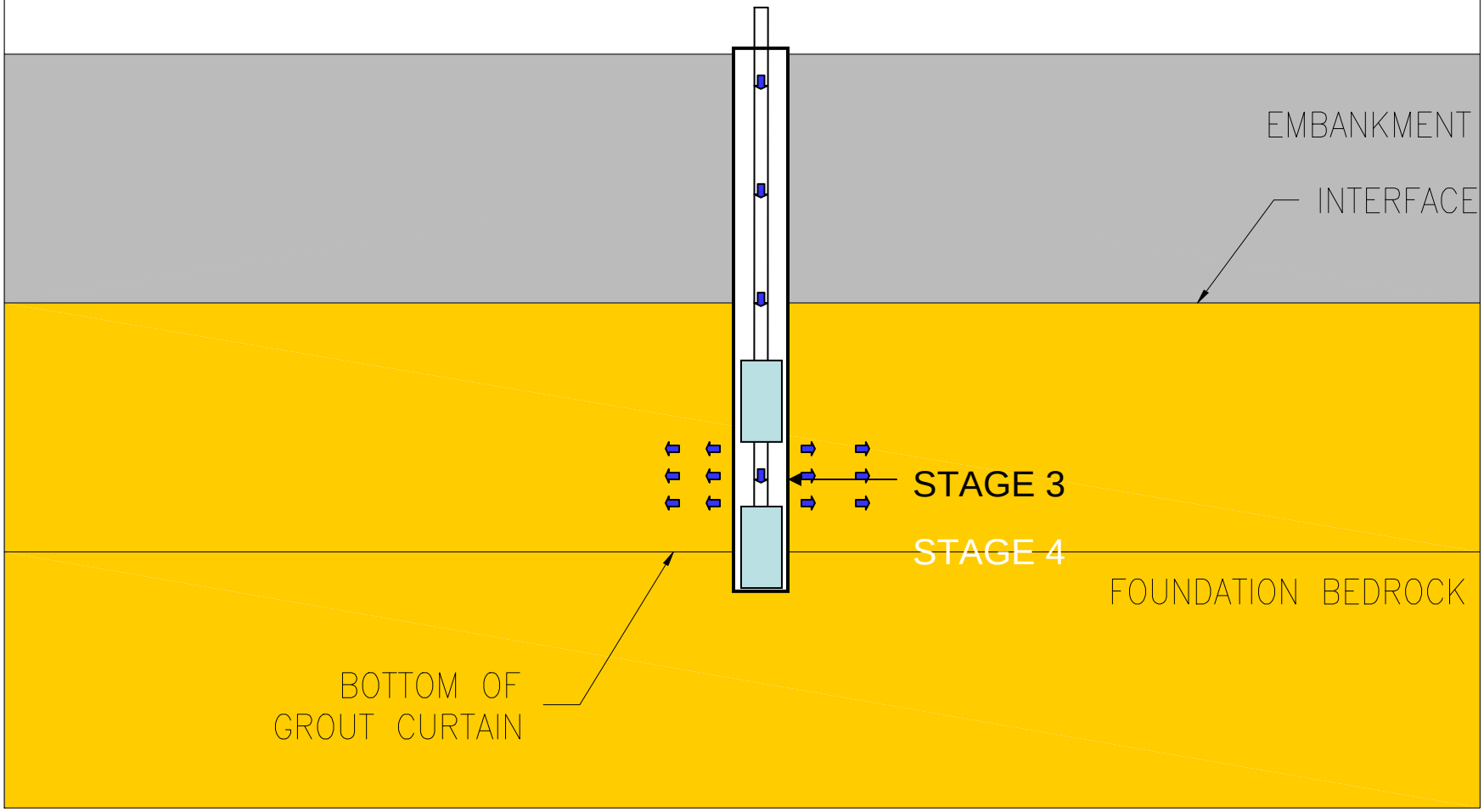
Upstage Grouting



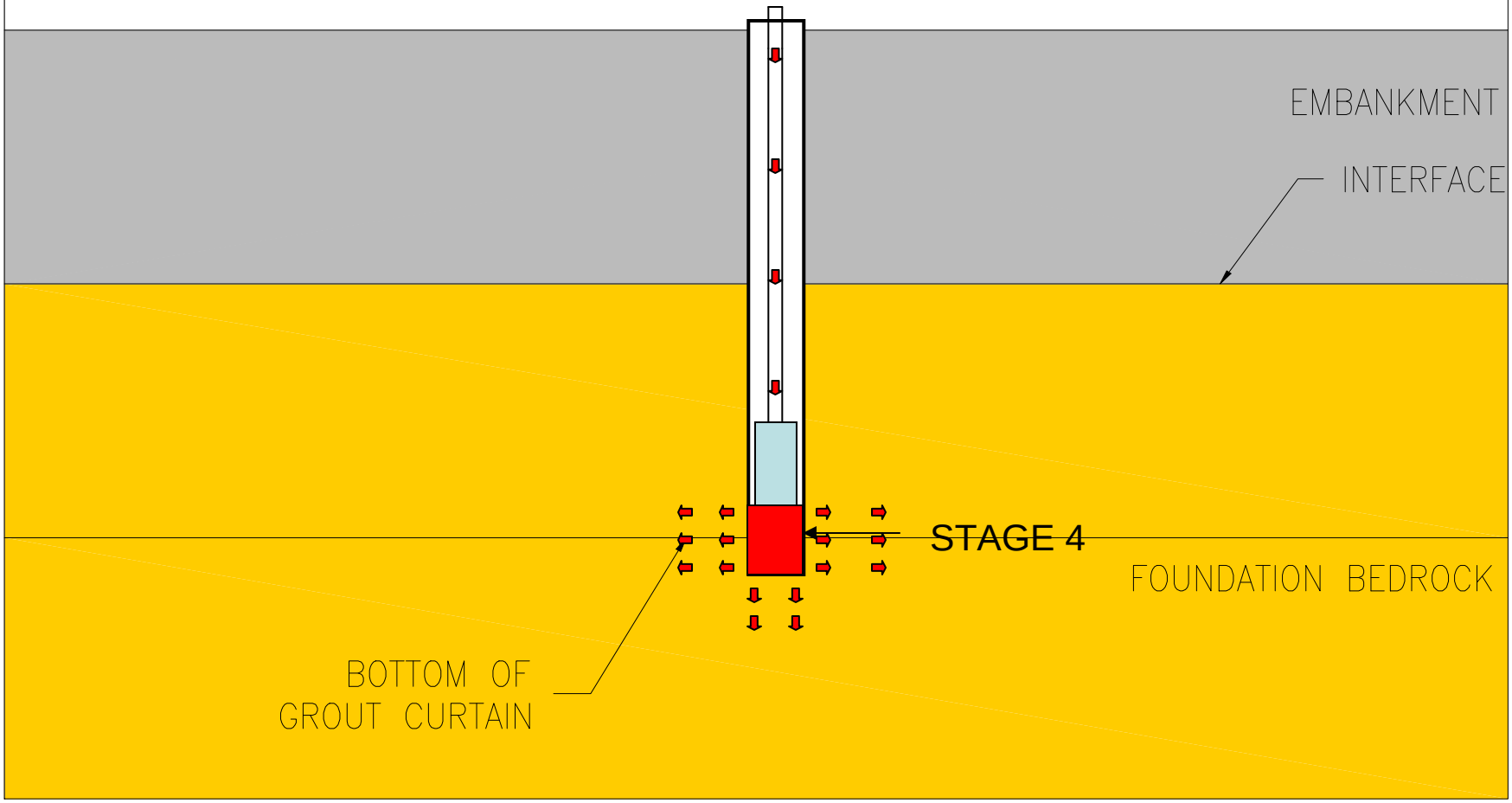
Single Packer Water Testing



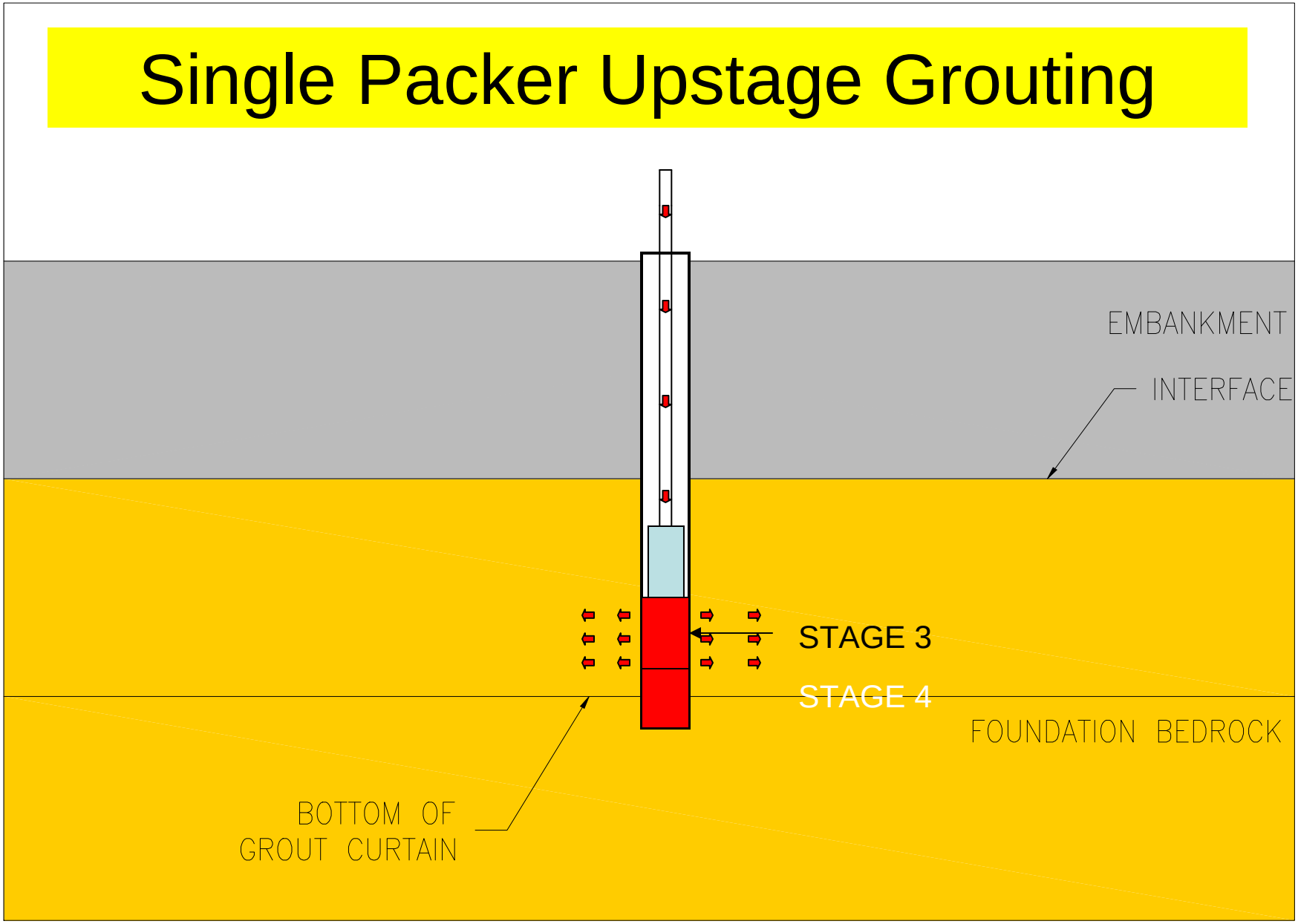
Double Packer Upstage Water Testing



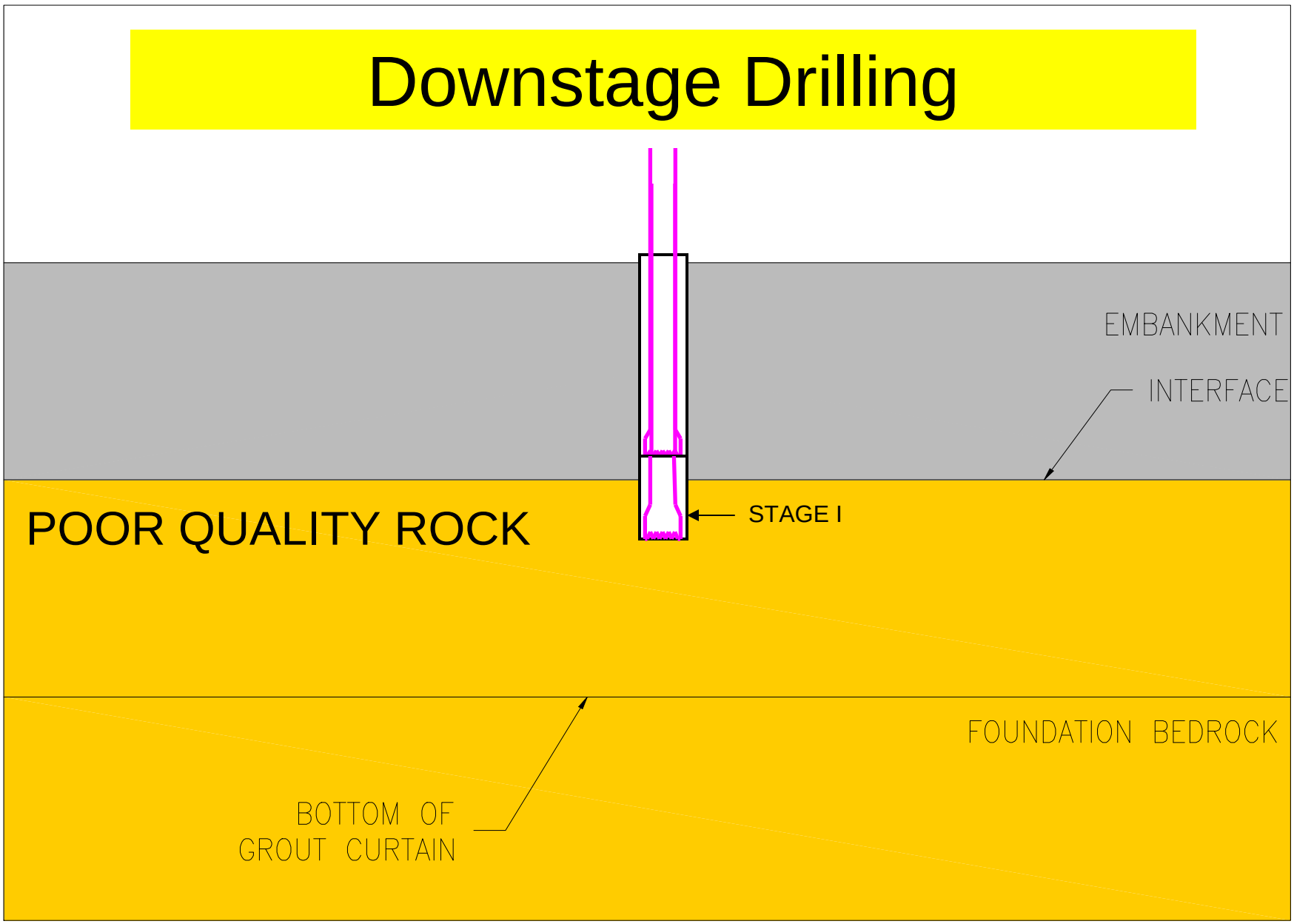
Single Packer Upstage Grouting



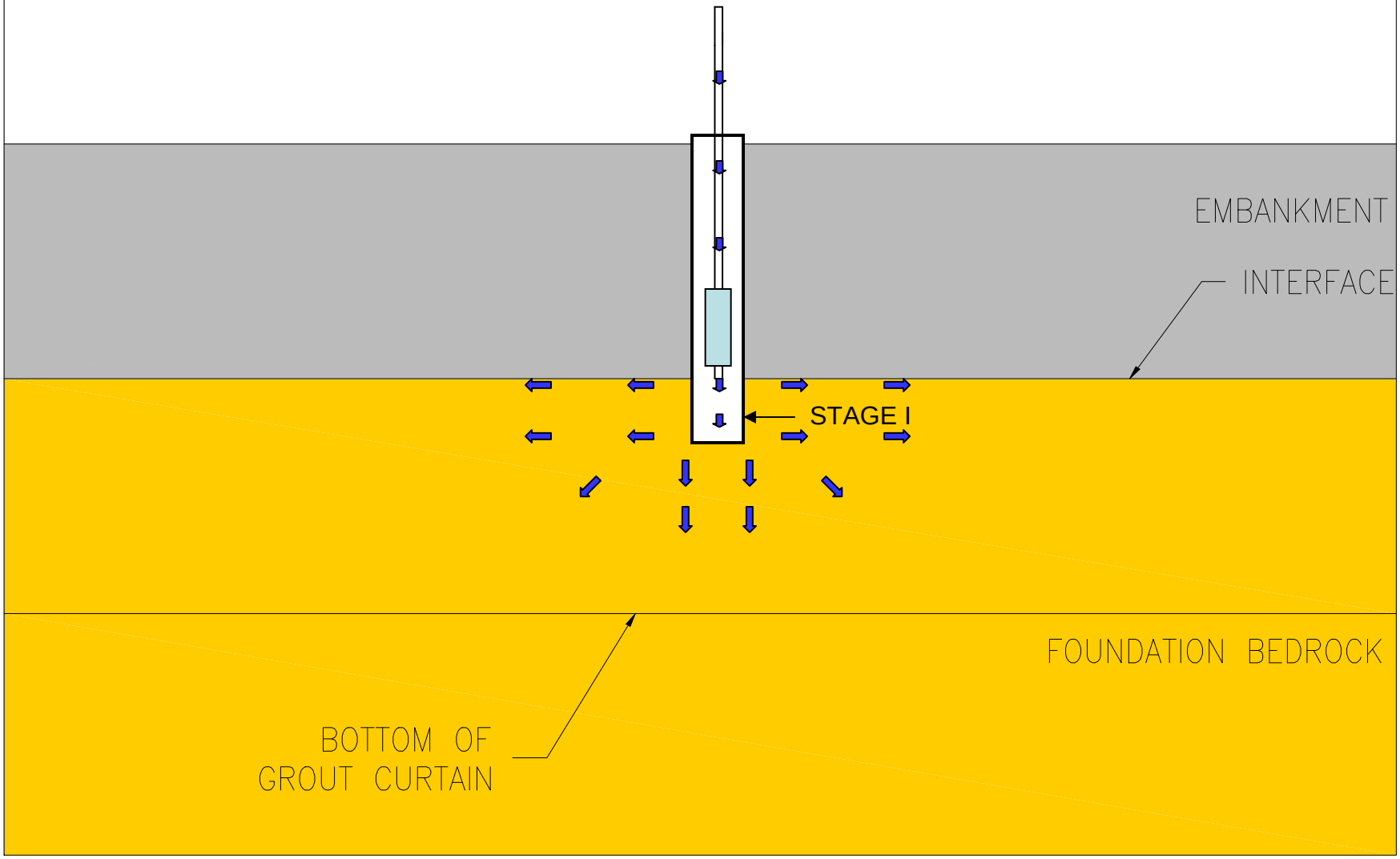
Single Packer Upstage Grouting



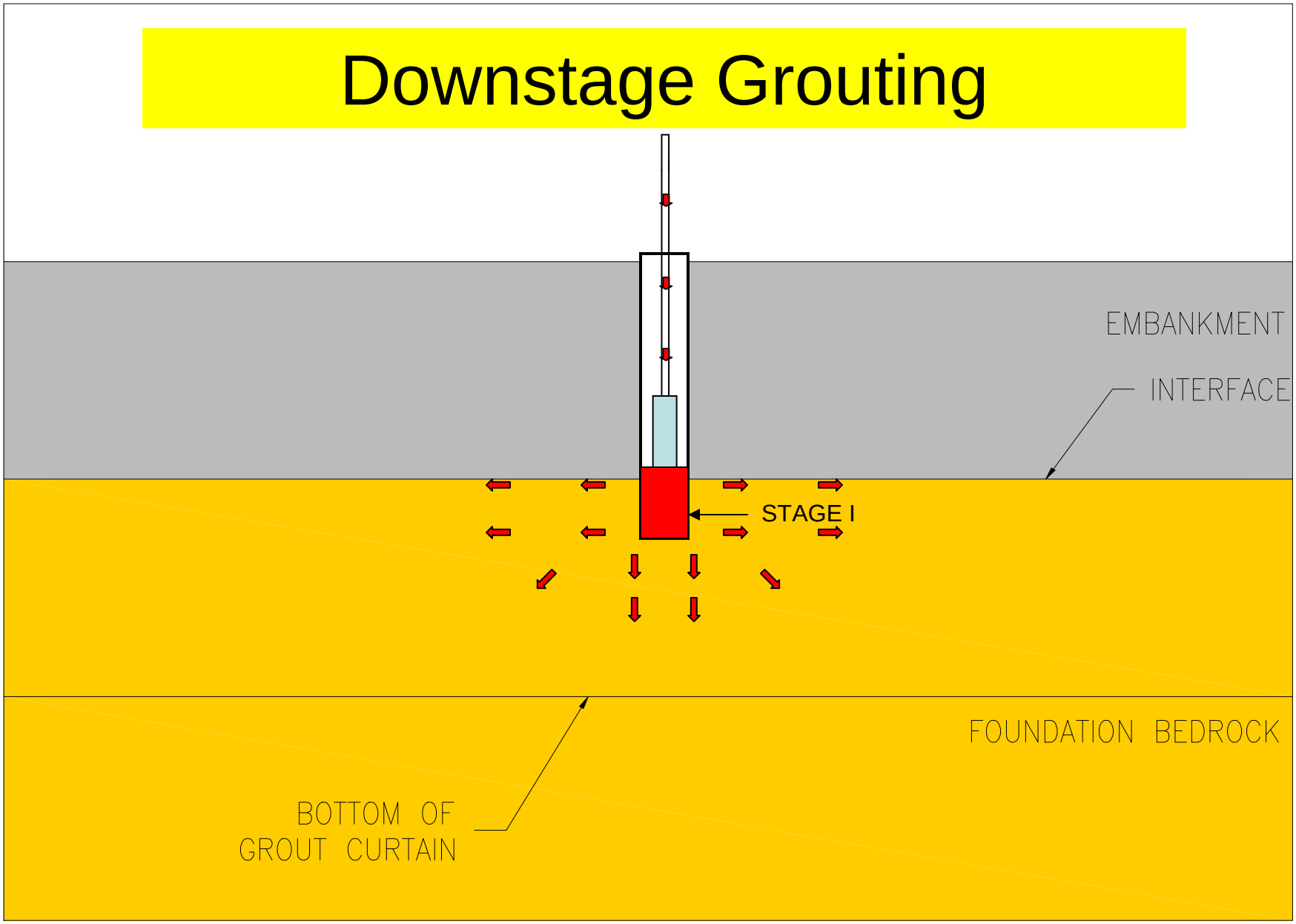
Downstage Drilling



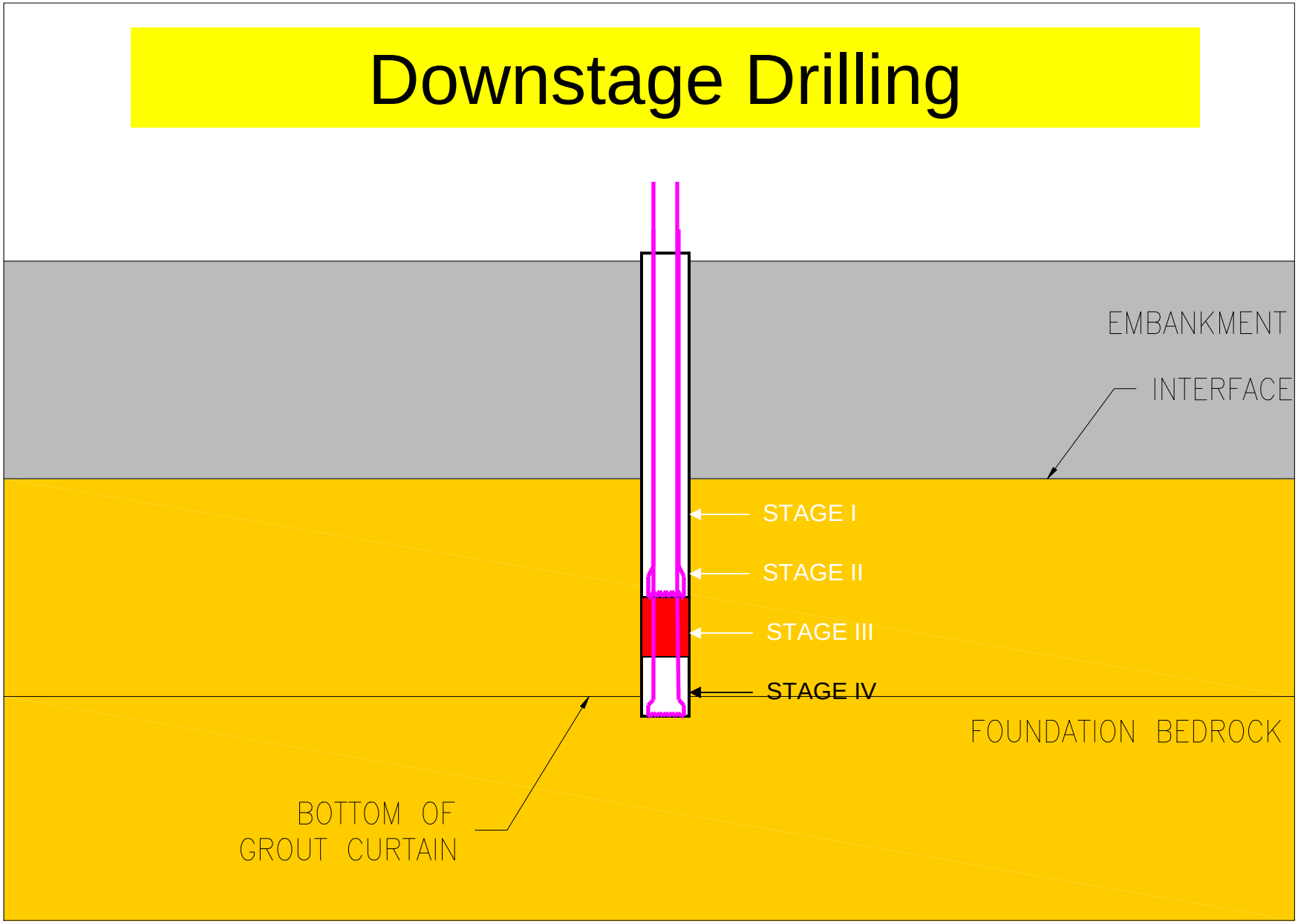
Downstage Water Testing



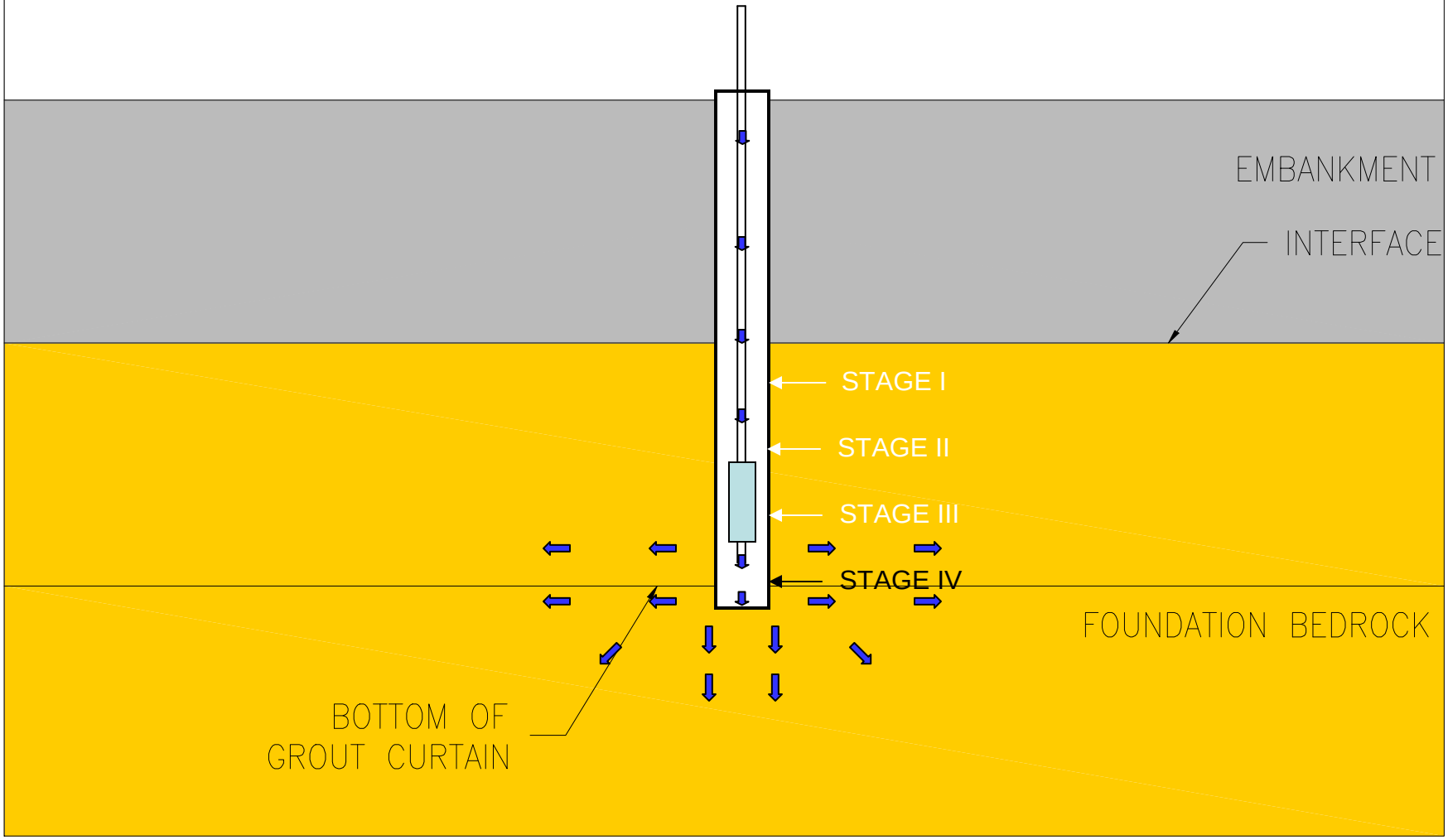
Downstage Grouting



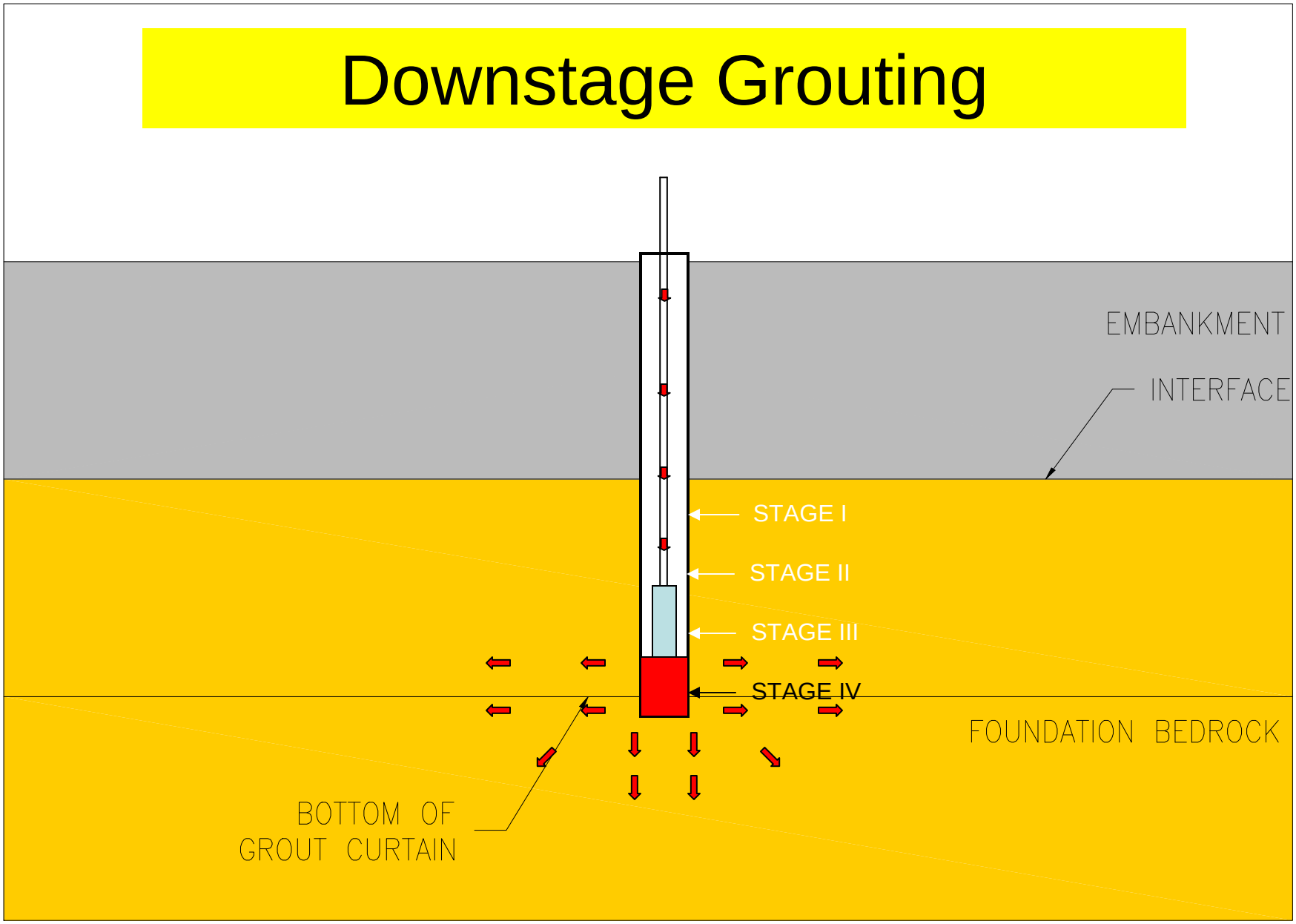
Downstage Drilling



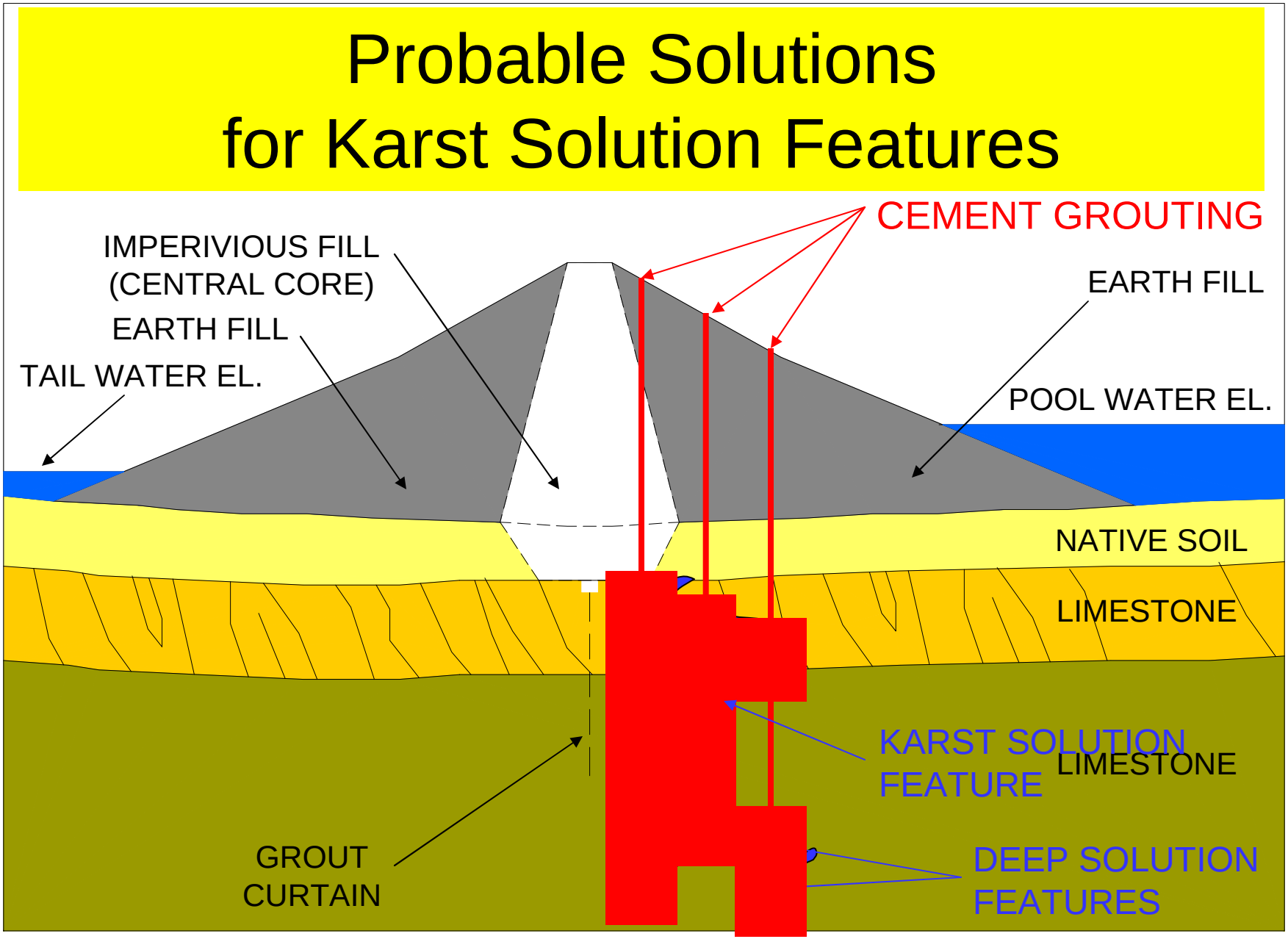
Downstage Water Testing



Downstage Grouting

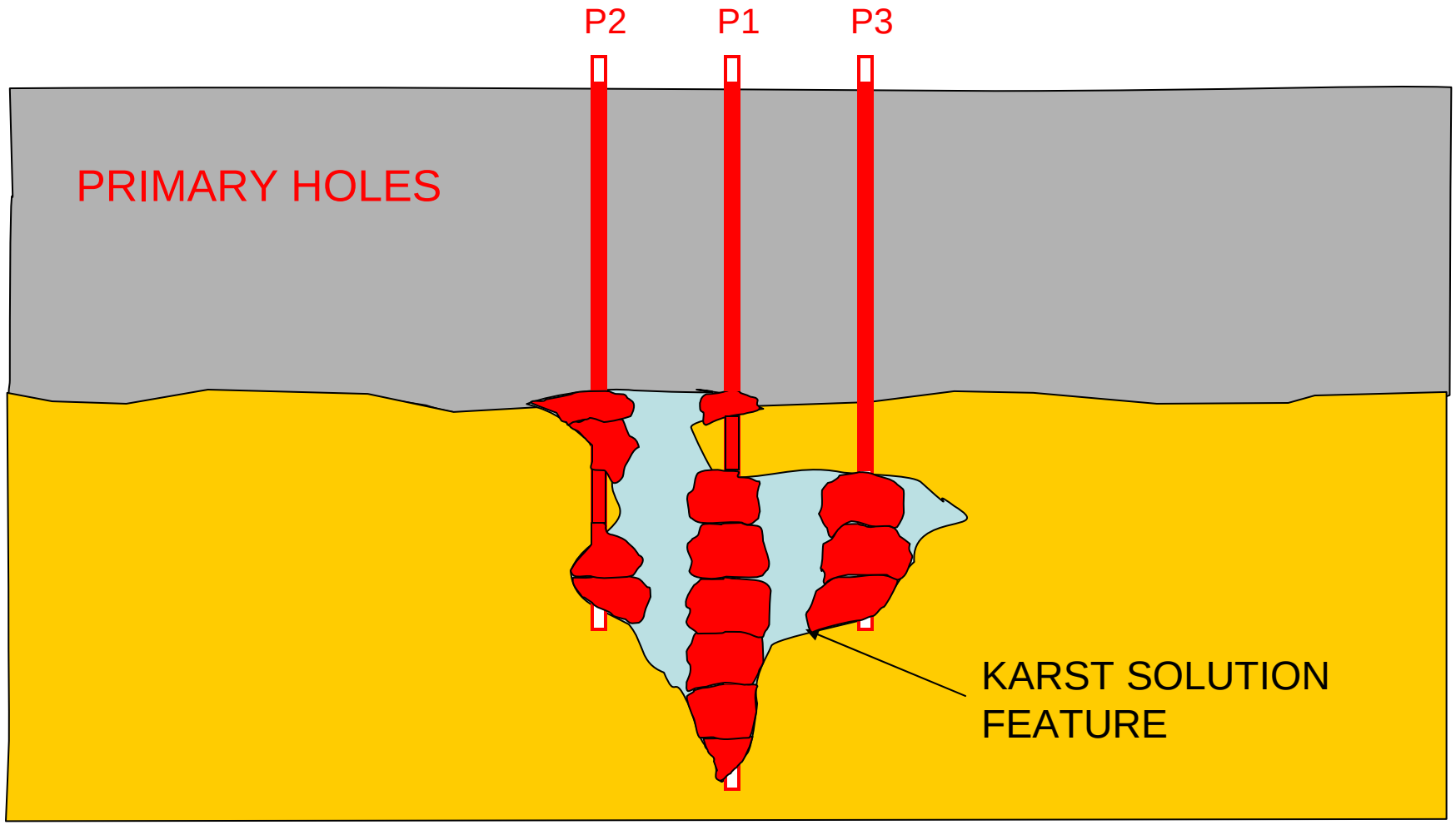


Probable Solutions for Karst Solution Features



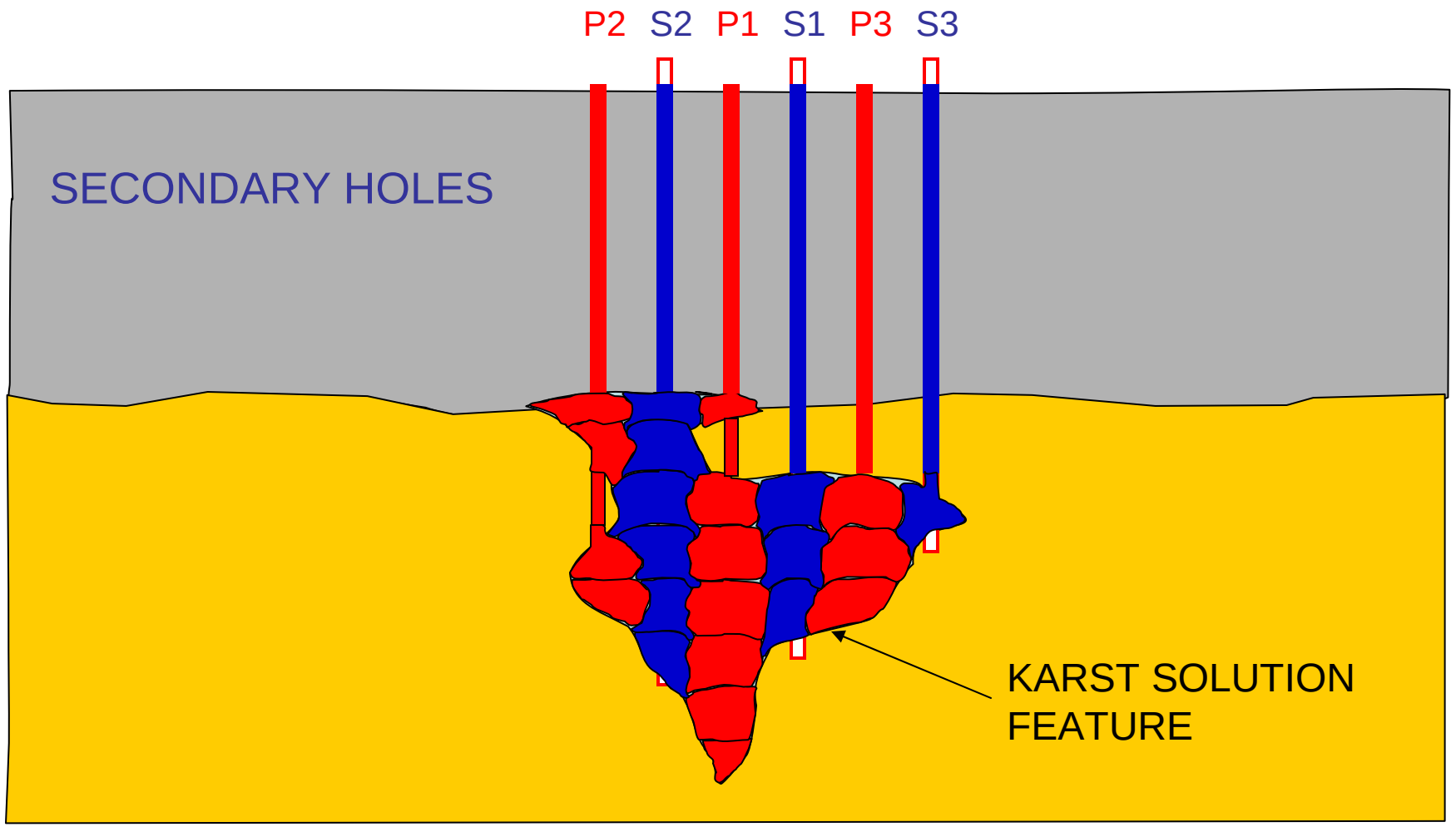
Solution Feature Remediation

(Upstage Casing Extraction (LMG or HMG)



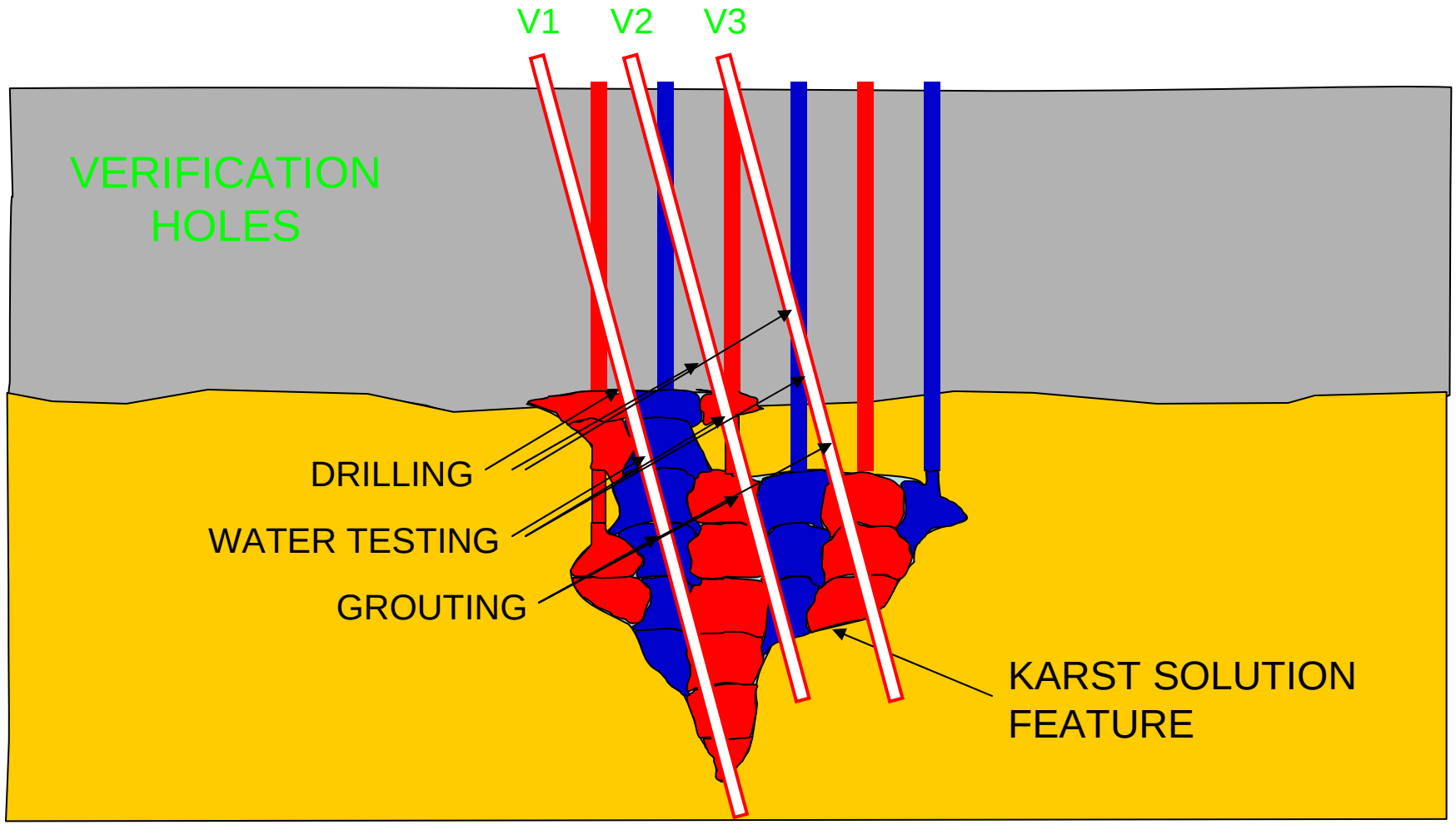
Solution Feature Remediation

(Upstage Casing Extraction (LMG or HMG)



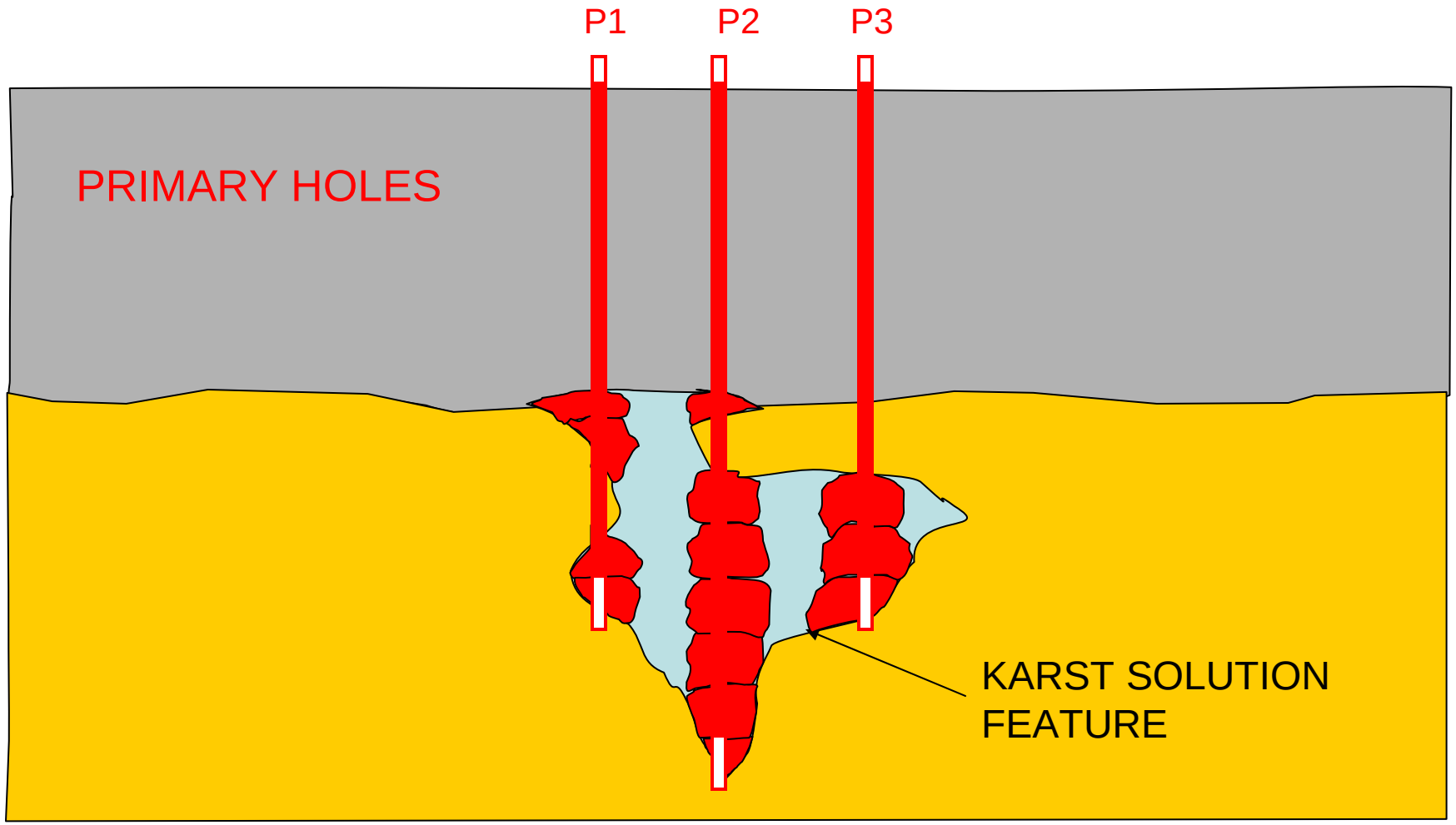
Solution Feature Remediation

(Upstage Casing Extraction (LMG or HMG)



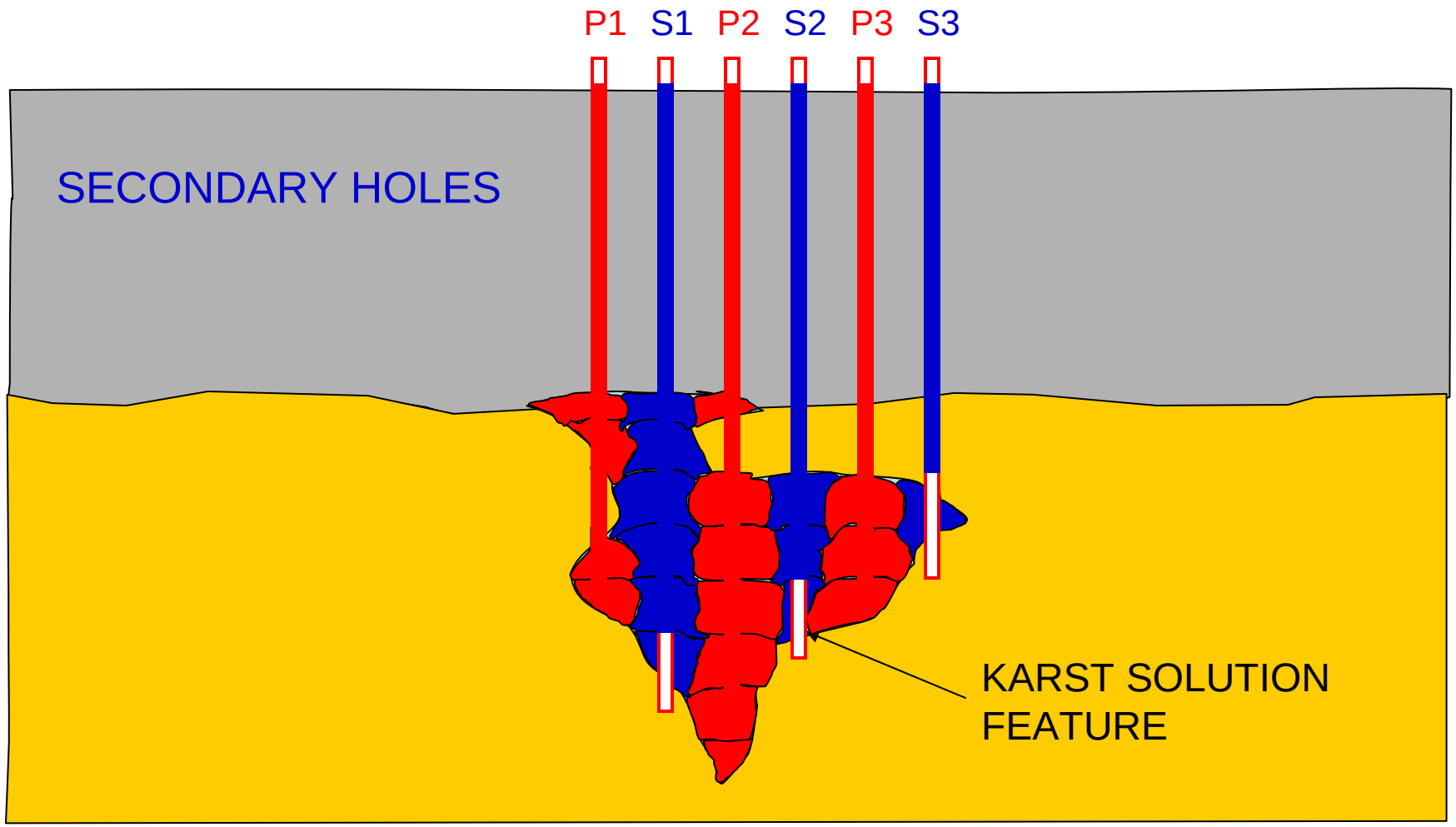
Solution Feature Remediation

(Downstage Grouting (LMG or HMG)



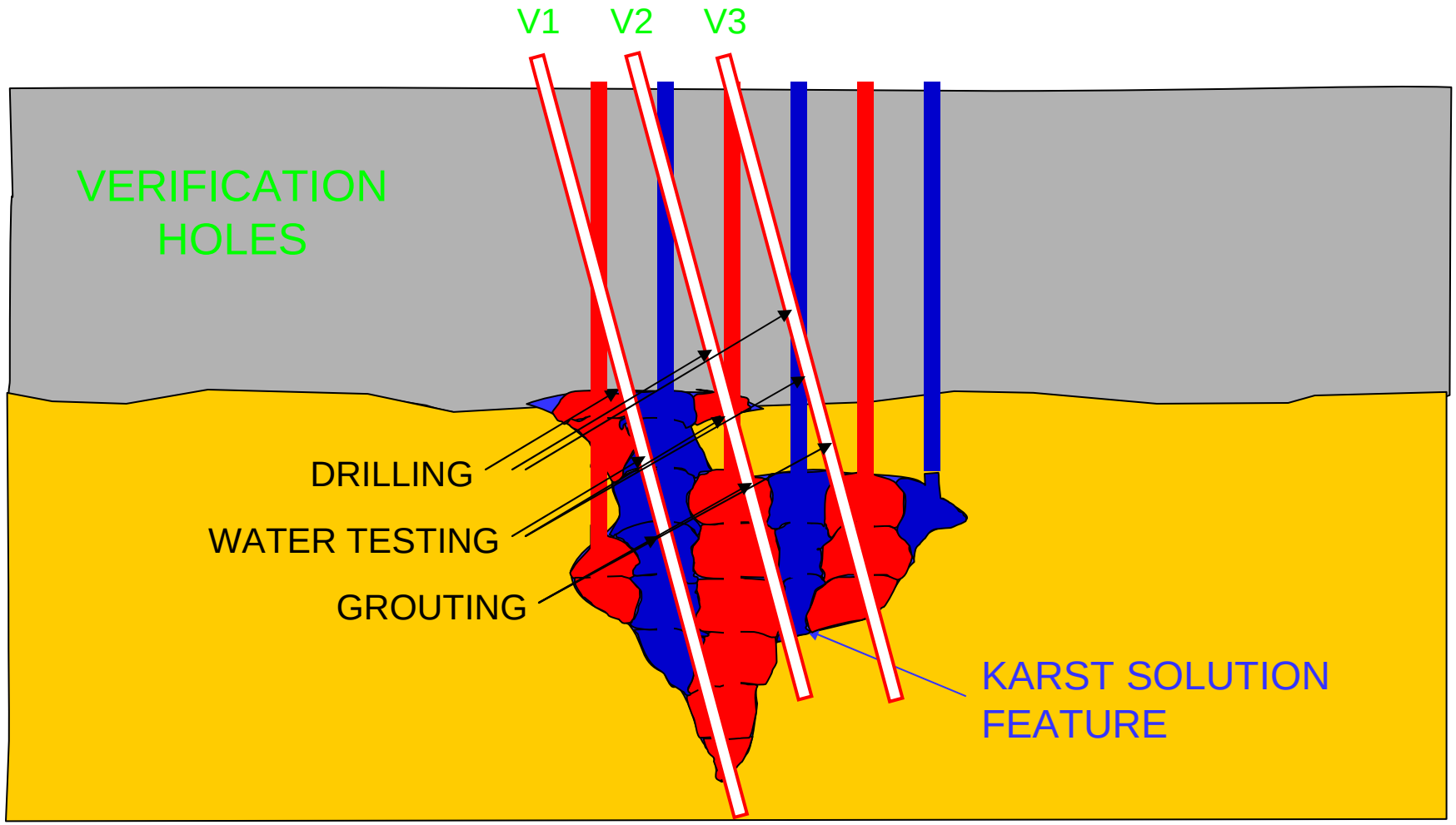
Solution Feature Remediation

(Downstage Grouting (LMG or HMG)



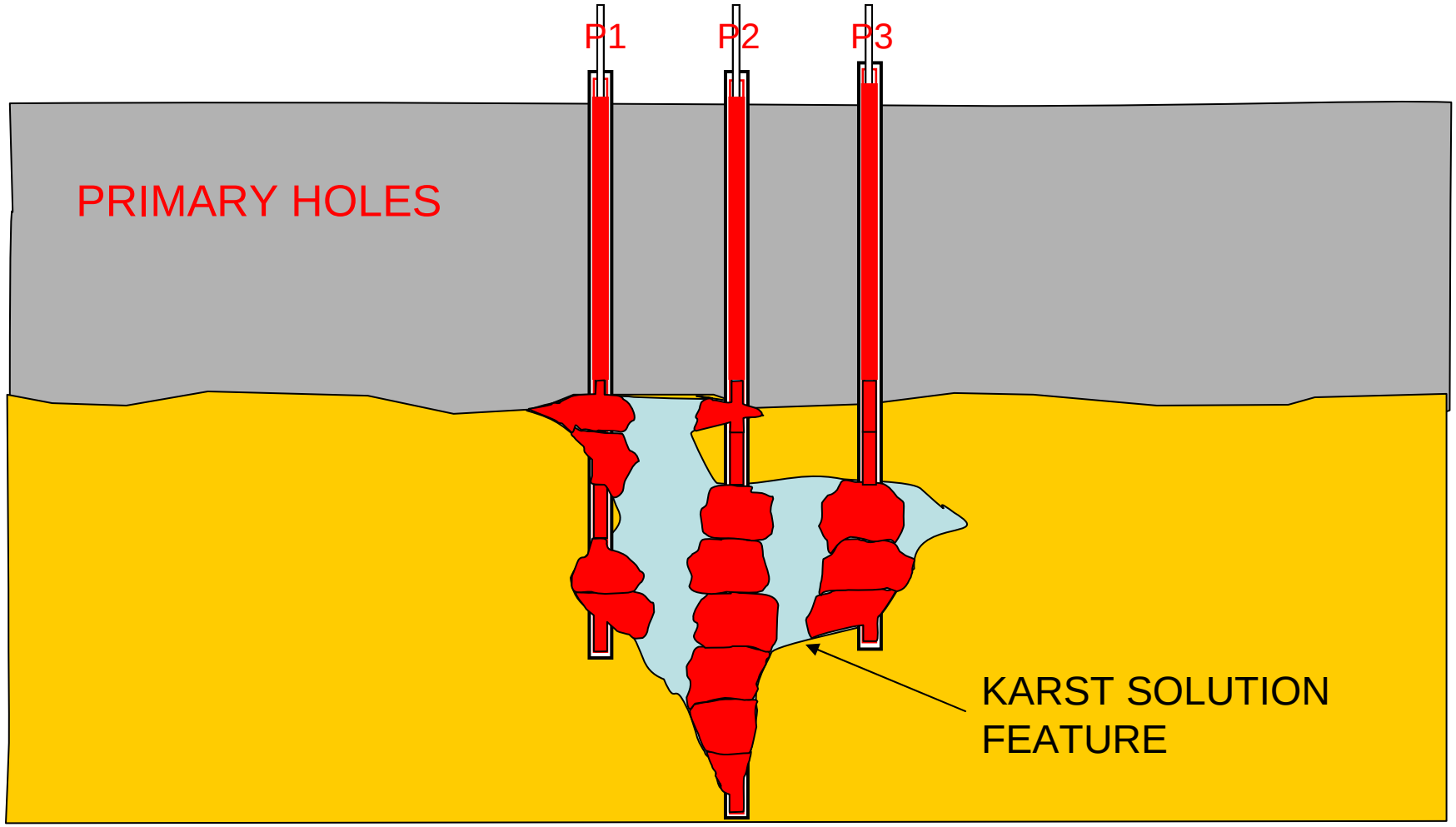
Solution Feature Remediation

(Downstage Grouting (LMG or HMG)



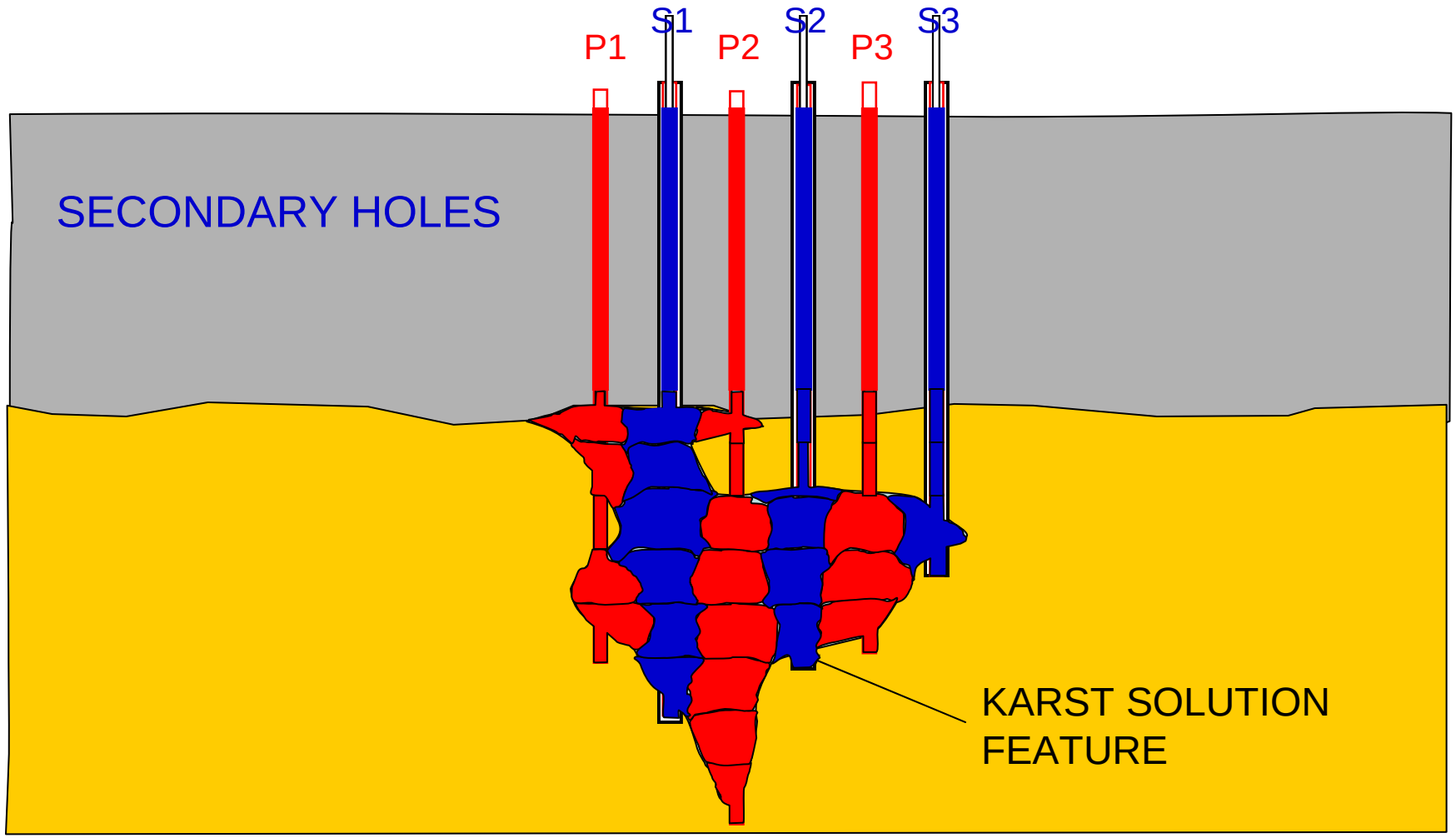
Solution Feature Remediation

(Upstage Sleeve Pipe Grouting (HMG)



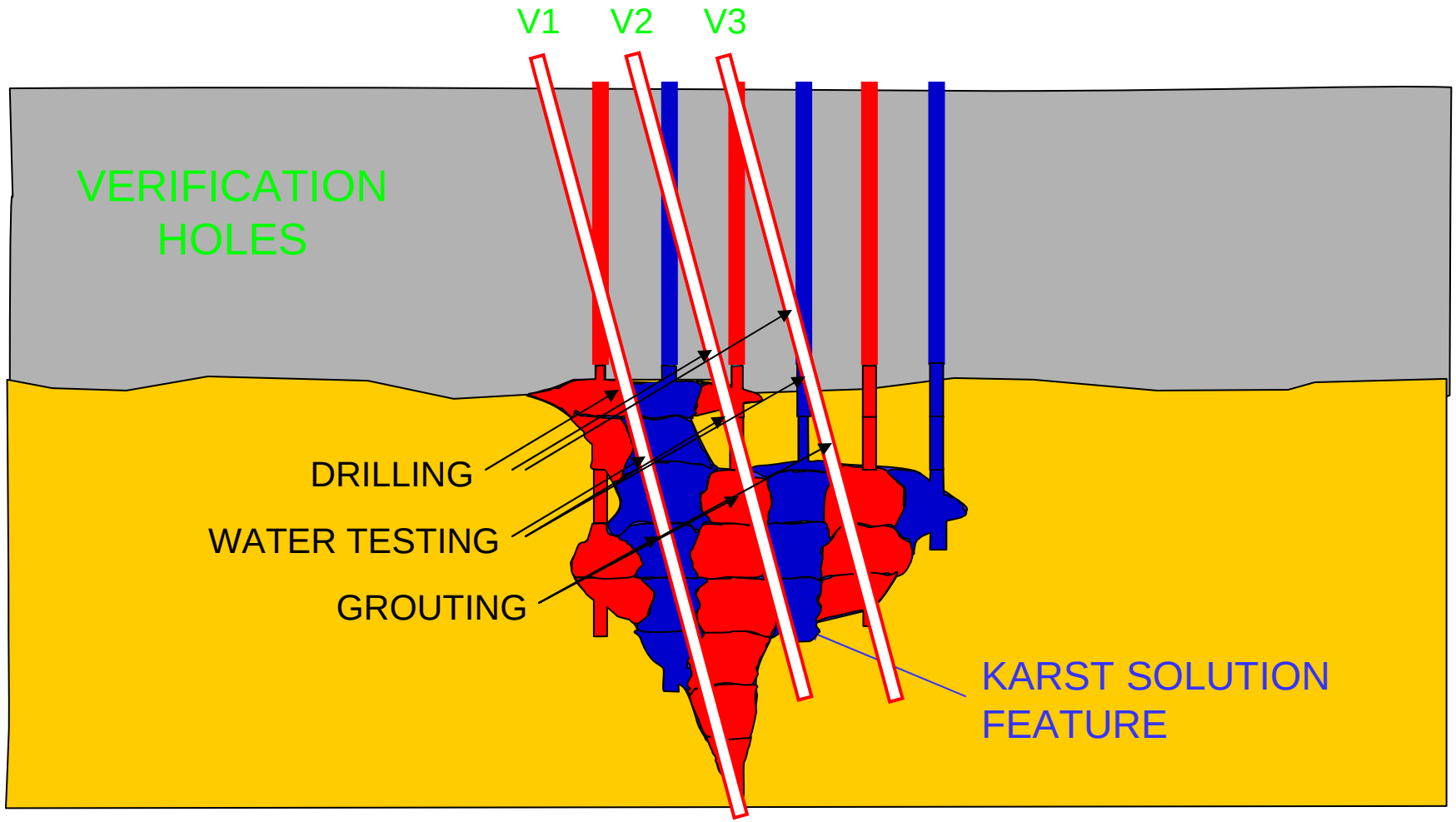
Solution Feature Remediation

(Upstage Sleeve Pipe Grouting (HMG)



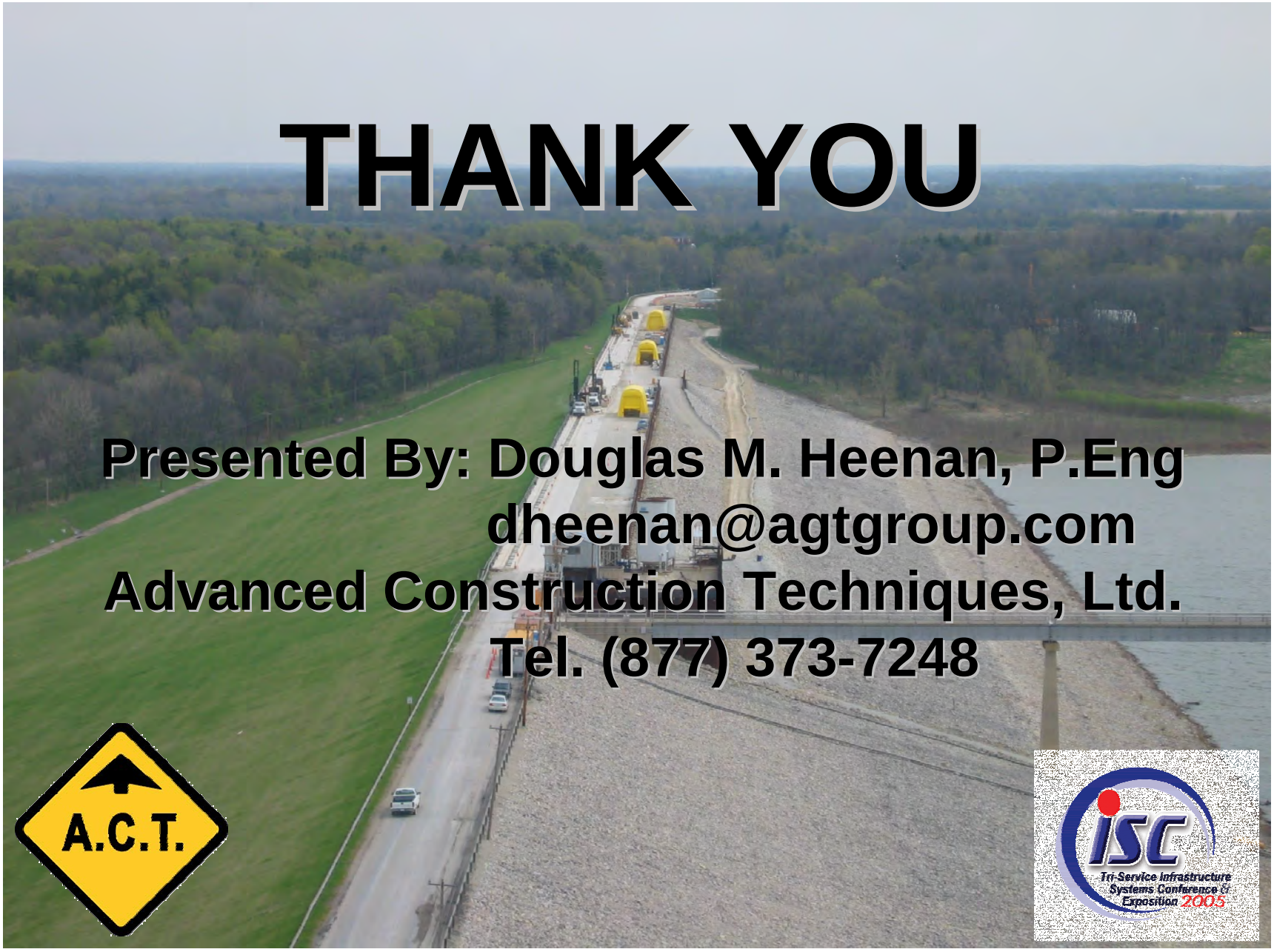
Solution Feature Remediation

(Upstage Sleeve Pipe Grouting (HMG)



Key Elements for Drilling and Grouting Embankment Dams

- Exploration
  - Site Characterization
- Execution
  - Grouting Method
- Verification



THANK YOU

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Tel. (877) 373-7248

A.C.T.

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Tri-Service Infrastructure Systems Conference & Exposition 2005

SECTION 227

Bluff Stabilization along Lake Michigan, using Active and Passive Dewatering Techniques Allegan Co. Michigan

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Eileen Glynn, ERDC, Geotechnical and Structures Laboratory
Ron Chase, WMU Geosciences
Alan Kehew, WMU Geosciences
Jim Selegean, USACE Detroit District

SECTION 227

Presentation Outline

Problem
Previous Studies
Planned solution to problem
Current work & technology
Conclusions
Future Work

Problem:

Bluff recession along Lake Michigan's Coast causes substantial property loss annually.

Recession rates:- 1 to 2 ft/yr at study site over the past 135 years.

Engineered structures consistently fail to deter erosion:

- Typically designed to prevent toe erosion, while precipitation and groundwater discharge from the bluff face may be the governing factor in bluff failure.

Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227

Problem



Bluff Stabilization - Lake Michigan's Coast,
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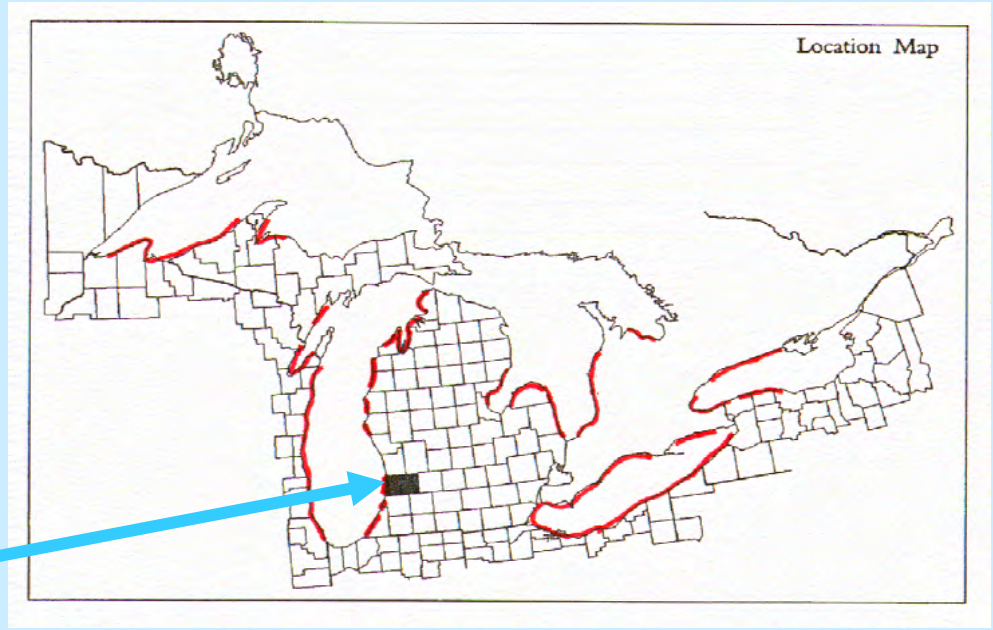




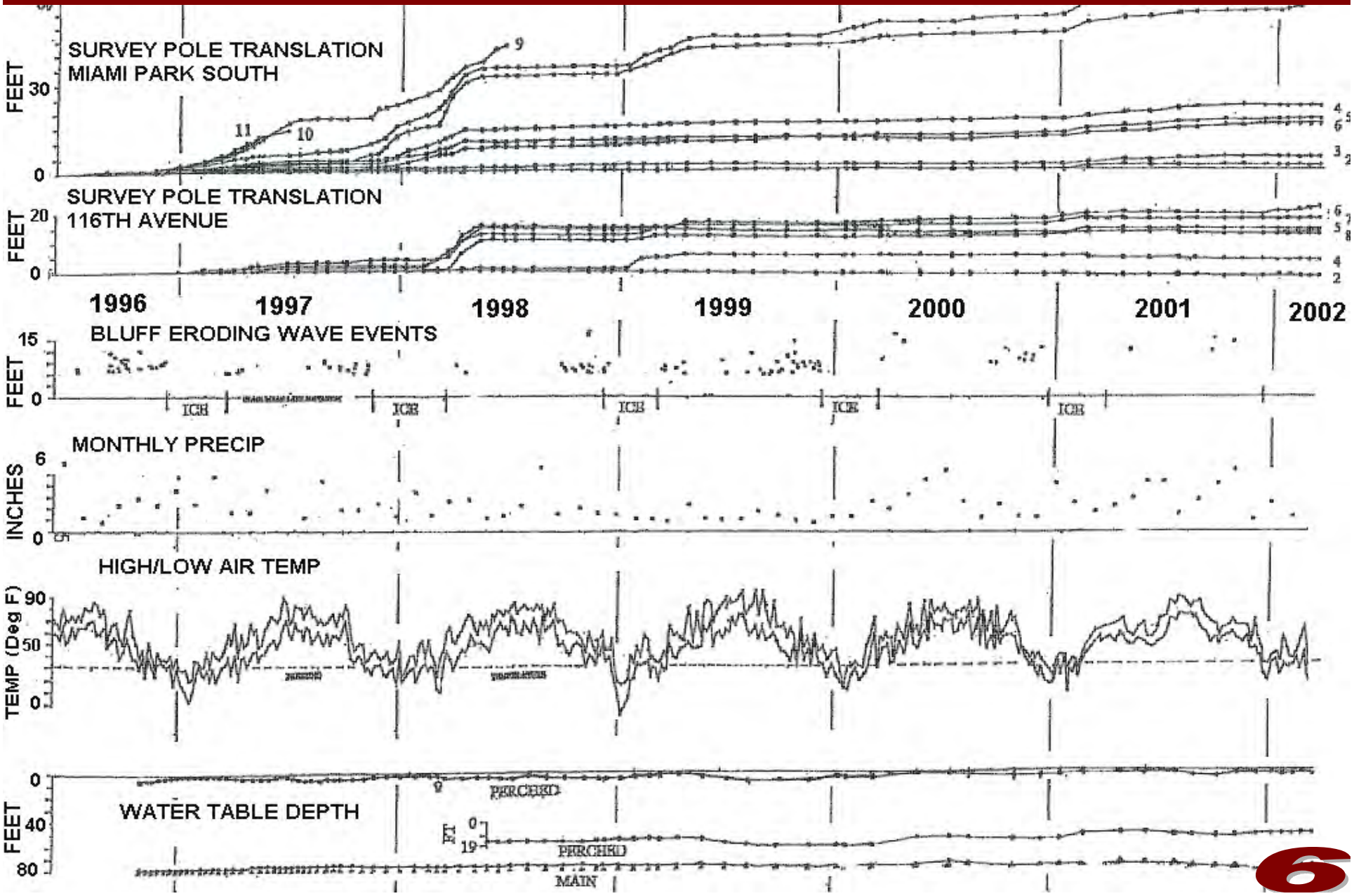
Phase I - Monitoring

Study at Allegan County, Miami Park South

- Through long term **(8 years)** monitoring correlations were made between bluff displacement and climate.



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan



Conclusions of monitoring
1996 to 2002

- **High lake levels** contributed to magnitude of earlier displacements (pre 1999).

- **Bluff movements** ⇔ rises in perched water levels

- Rises in perched water tables & pore pressures ⇔ **bluff face freezing**.

- **Wave erosion**: removal of displaced materials => more slumping.

- Continued slumping despite **little toe erosion**

Phase II - Dewatering the site

- Developed plan to dewater with pumps in vertical wells & passive horizontal wells drilled into bluff face
- Plan included instrumentation of slope for remote monitoring of:-
  - displacement
  - groundwater levels
  - ground temperatures
  - atmospheric conditions
  - bluff face freezing

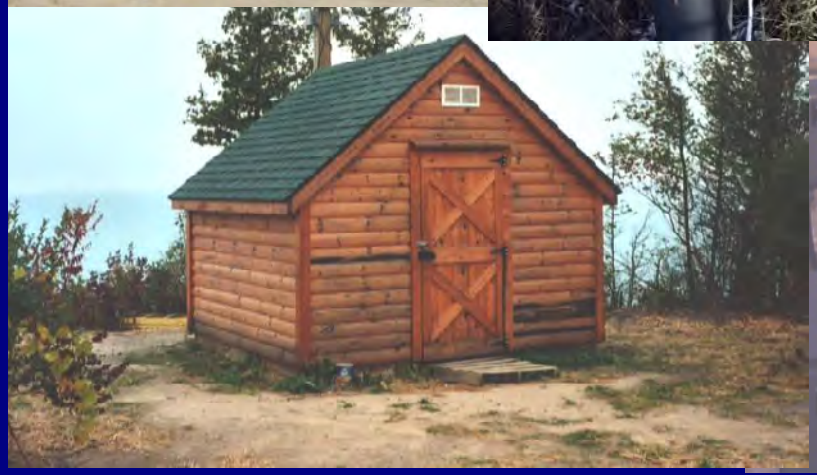
Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

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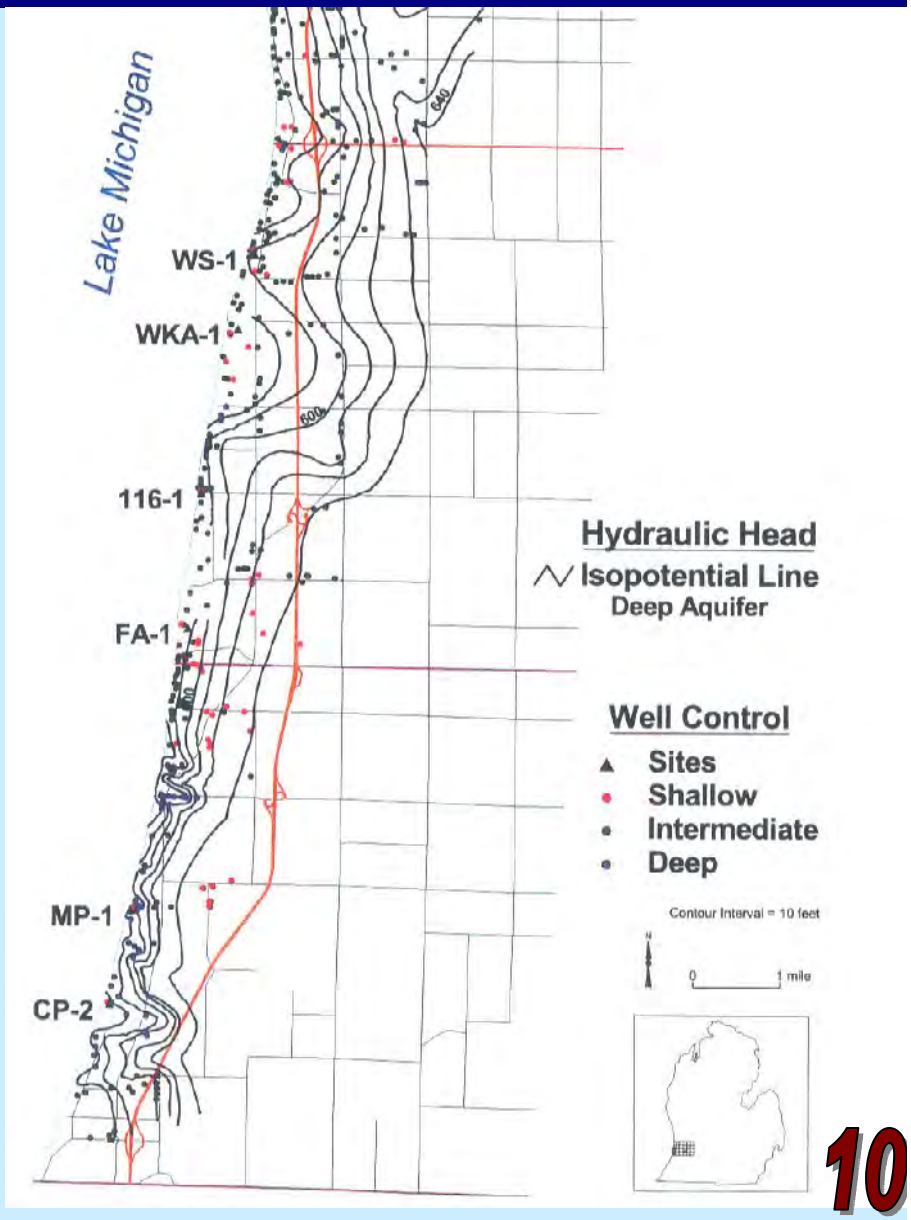


Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

SECTION 227

- Three recognized potentiometric surfaces
  - Deep (extension of lake level
  - Intermediate (perched)
  - Shallow (perched)

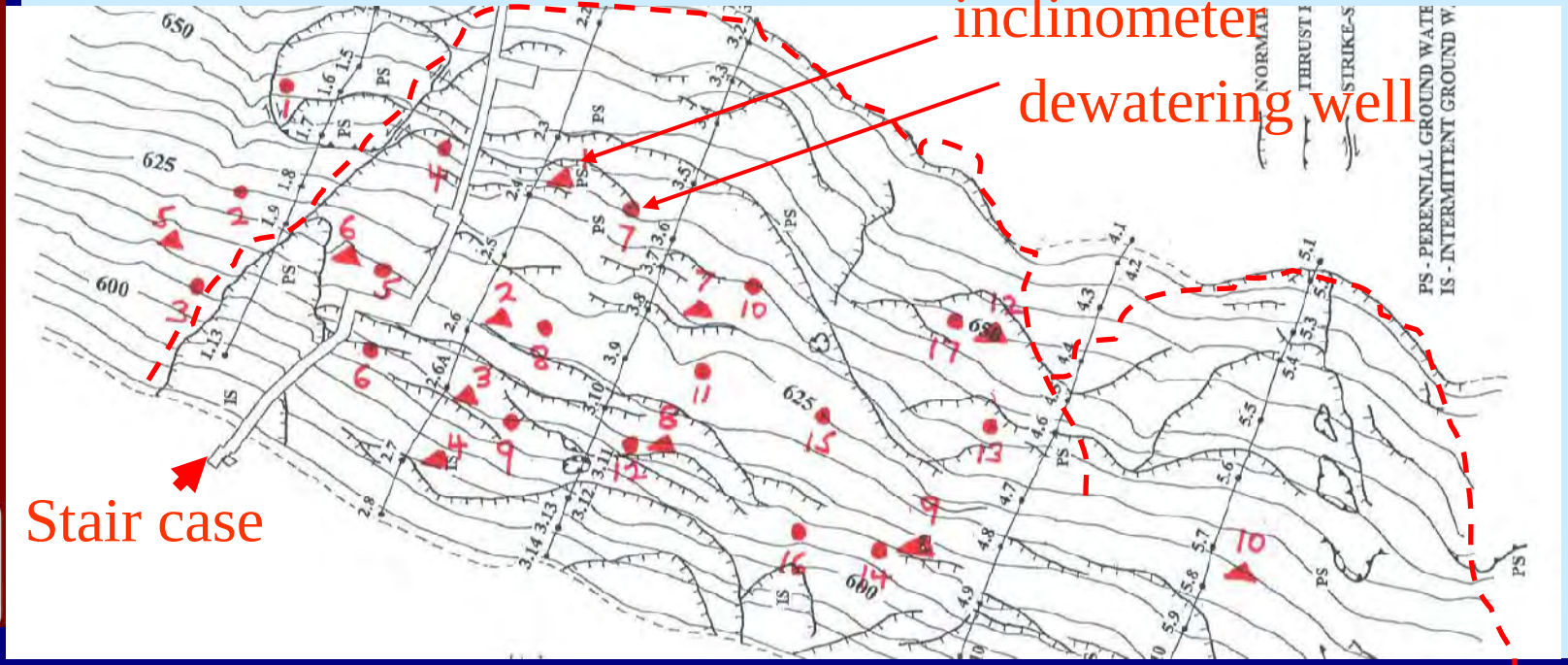
(after Montgomery, 1998)



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

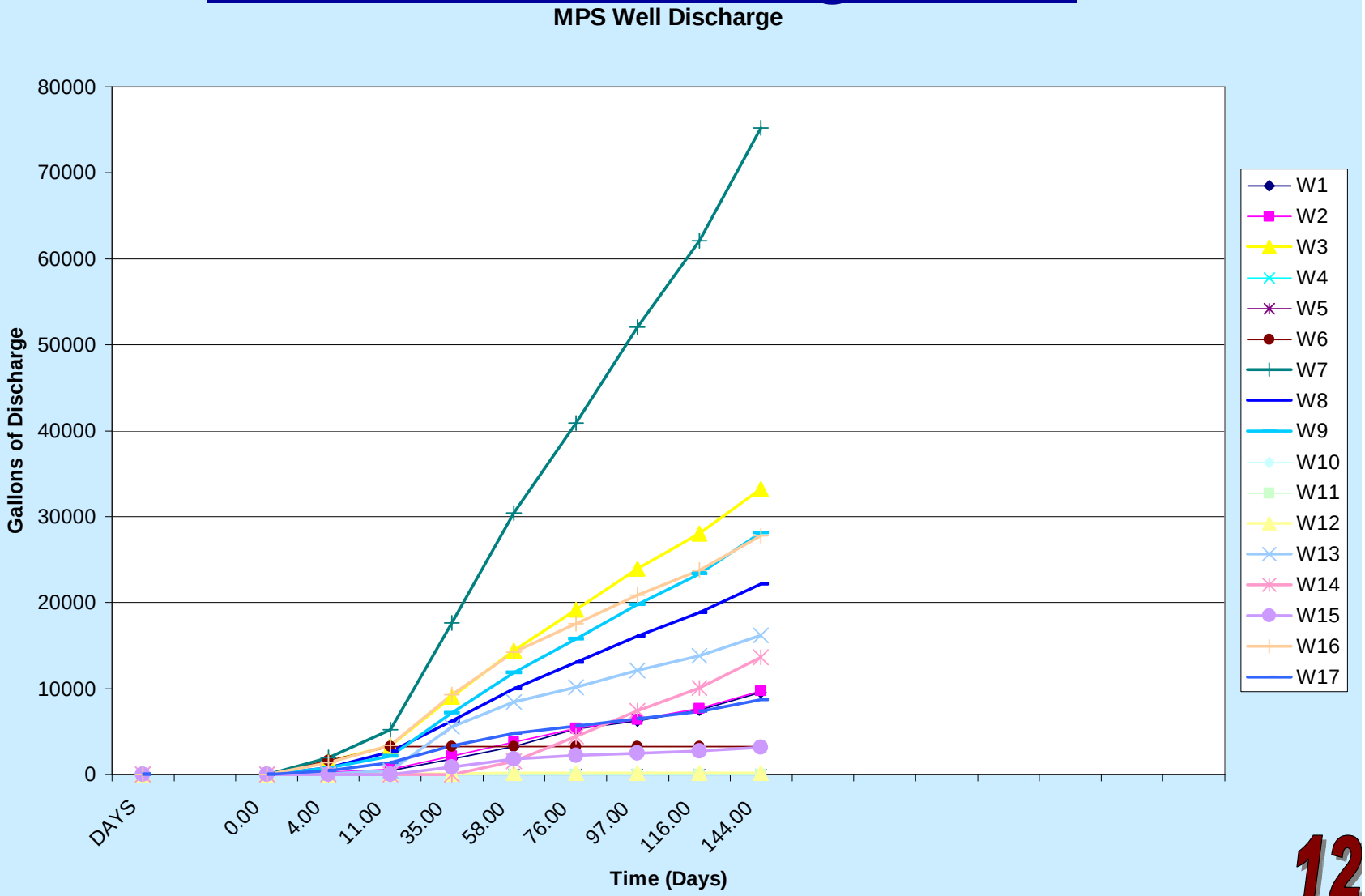
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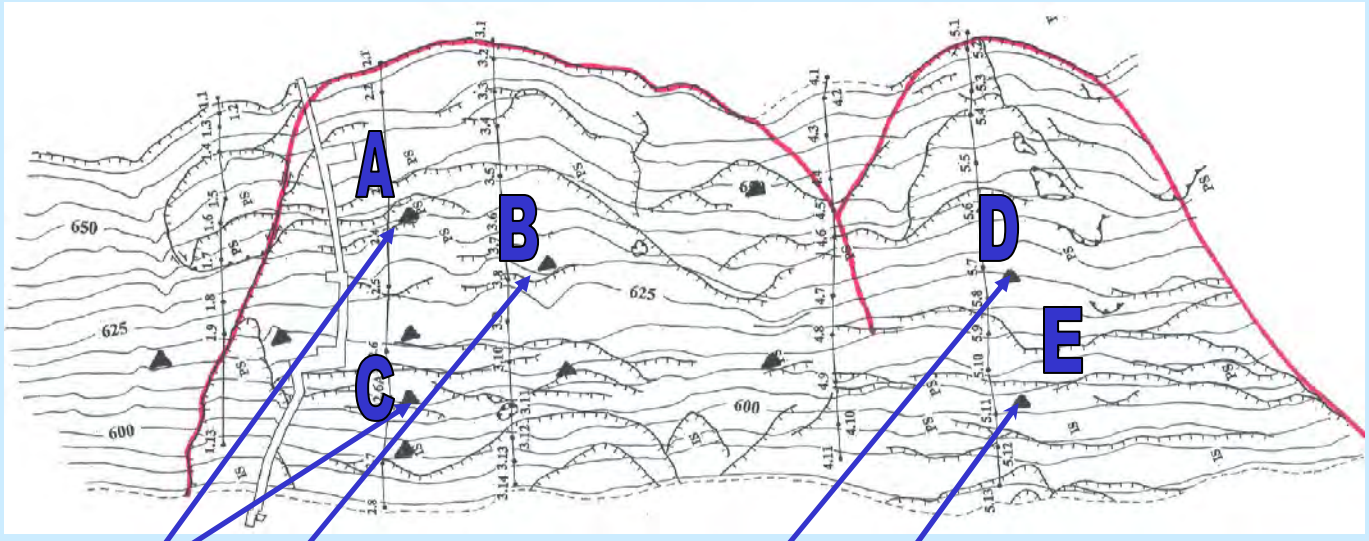
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Phase II - Dewatering the site



Bluff Stabilization - Lake Michigan's Coast,
Allegan Co. Michigan

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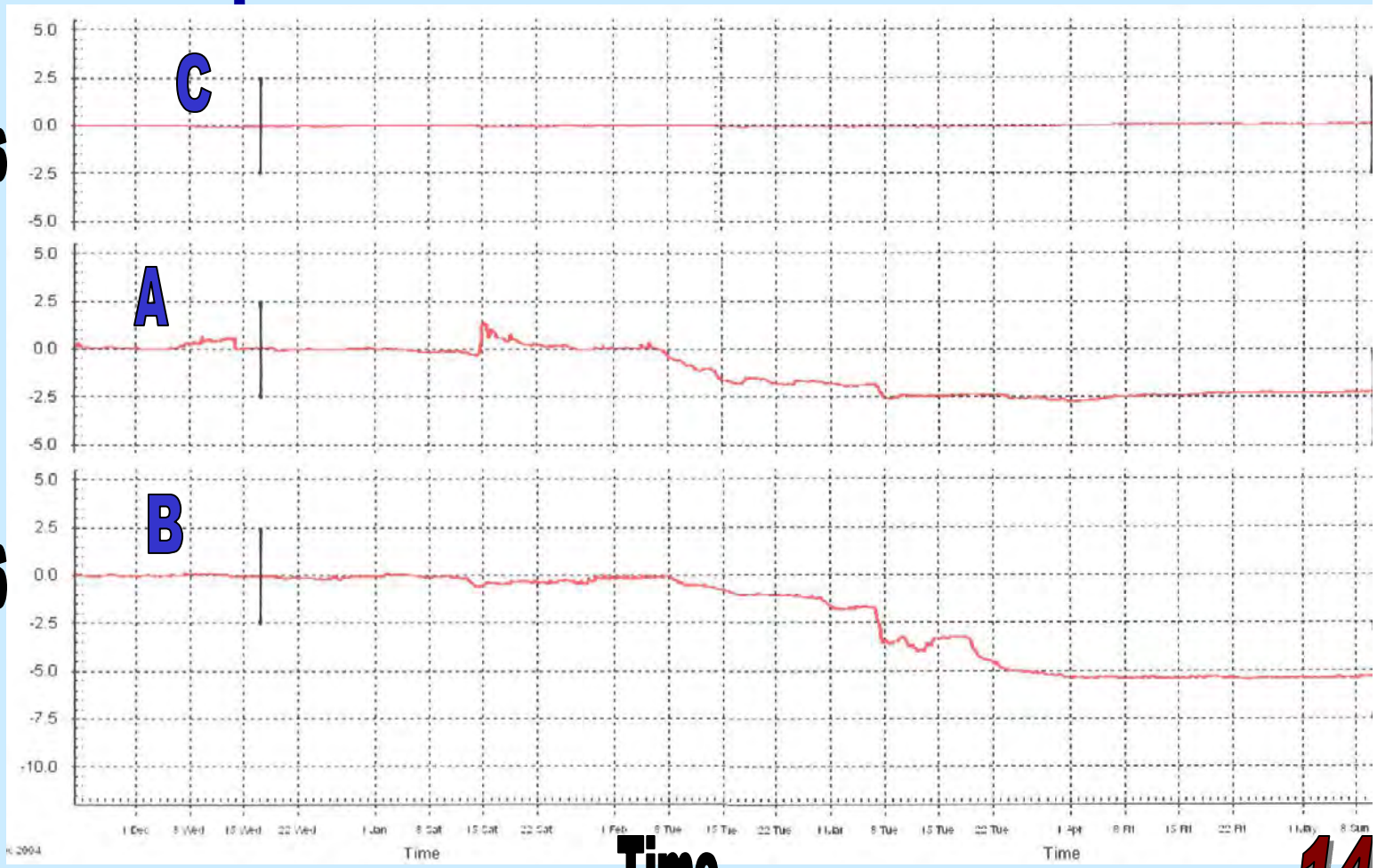


DEWATER

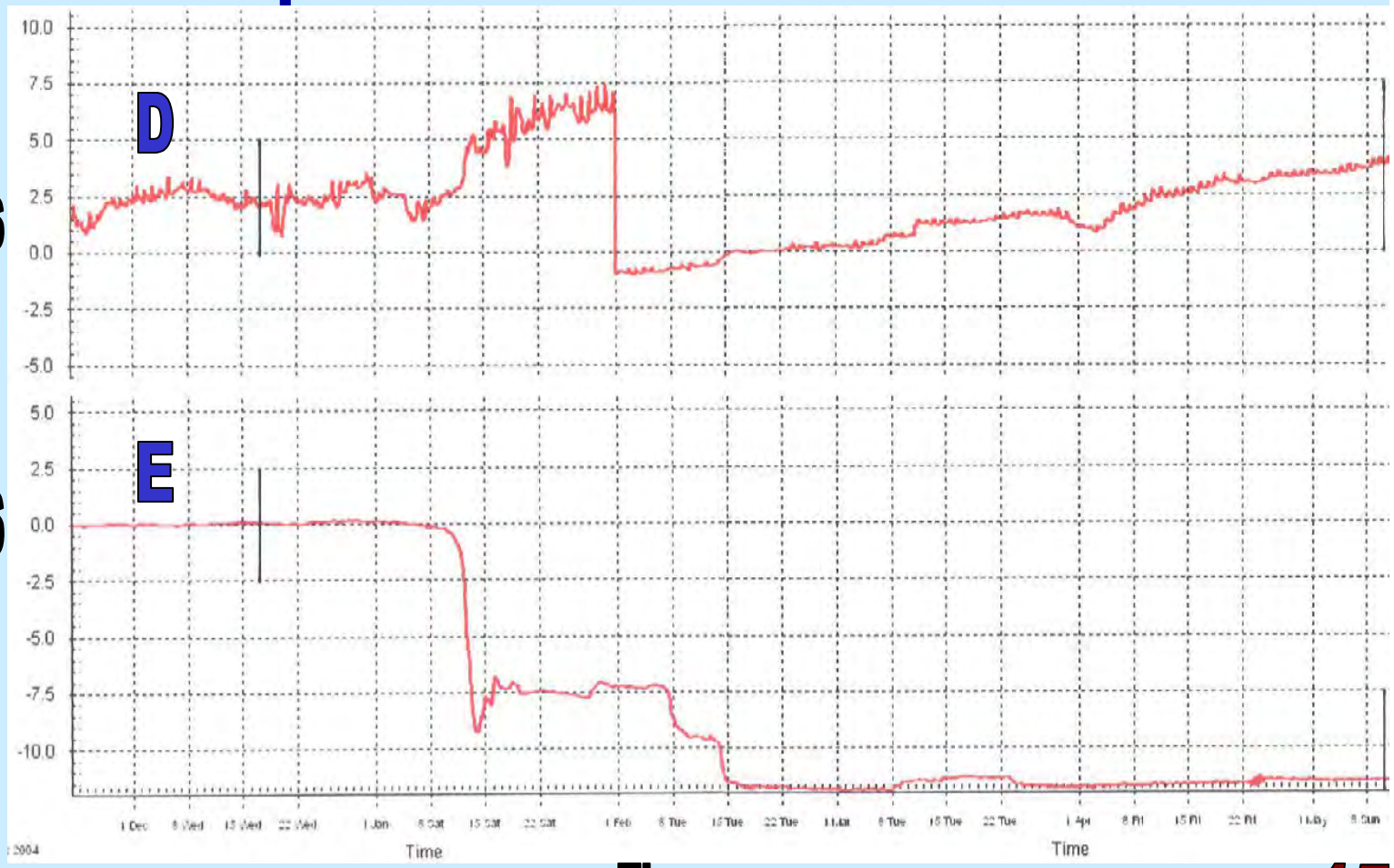
▲ inclinometer

No Water Removal

Effect of Water Removal on local Displacements-dewatered site



Effect of Water Removal on local Displacements-control site

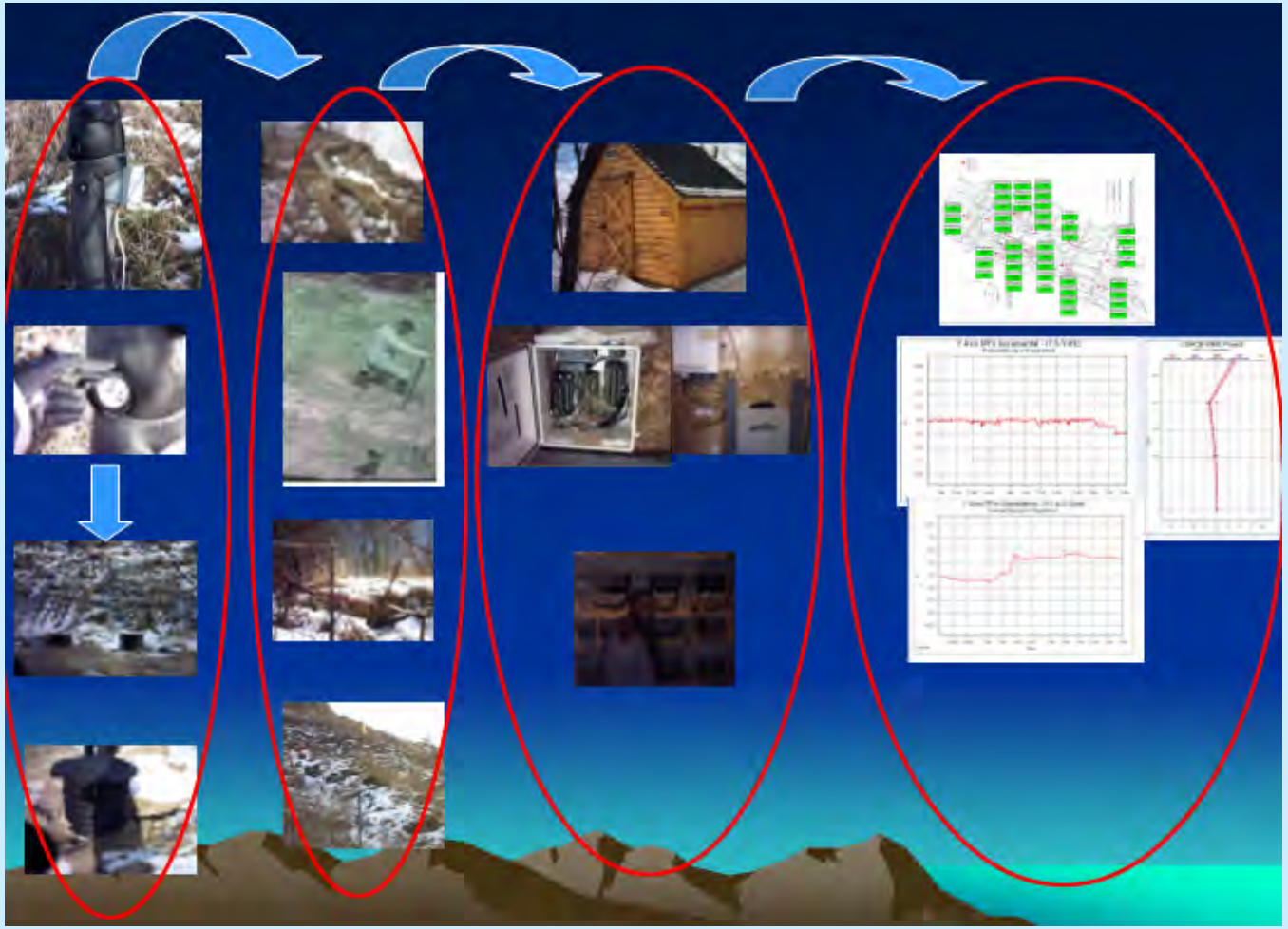


Time

Conclusions of first year's dewatering efforts

- After bluff face froze, groundwater flow direction changed periodically
- Horizontal passive wells not as effective as vertical active wells.
- Mean shear displacement in wells on dewatered site was about 2.83 in. per well
- Mean shear displacement in wells on control site was about 11.50 in. per well
- Removal of perched groundwater during the 2004-05 winter spring cycle created a three times more stable bluff than at control site
- Repeated experiments between now and 2009 will test repeatability of 2004-05 results

Future Work-development of knowledge-based data base system



Acknowledgements

Western Michigan University – for study facilities & personnel support.

U.S. Army Research Office – for supplying funding for investigations into the causes of bluff failure (Phase 1 of this project, 1996 - 1999).

U.S. Army Corps of Engineers – for supplying the funding and geotechnical field support to test the removal of ground water as a failure mitigation strategy (Phase 2 of this project, 2000 – 2009?).

Property owners – (private and government) for allowing unlimited access to the bluff.

SECTION 227

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Chicago Underflow Plan – CUP
McCook Reservoir Test Grout Program

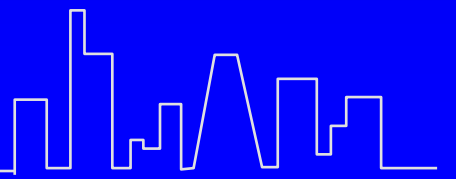
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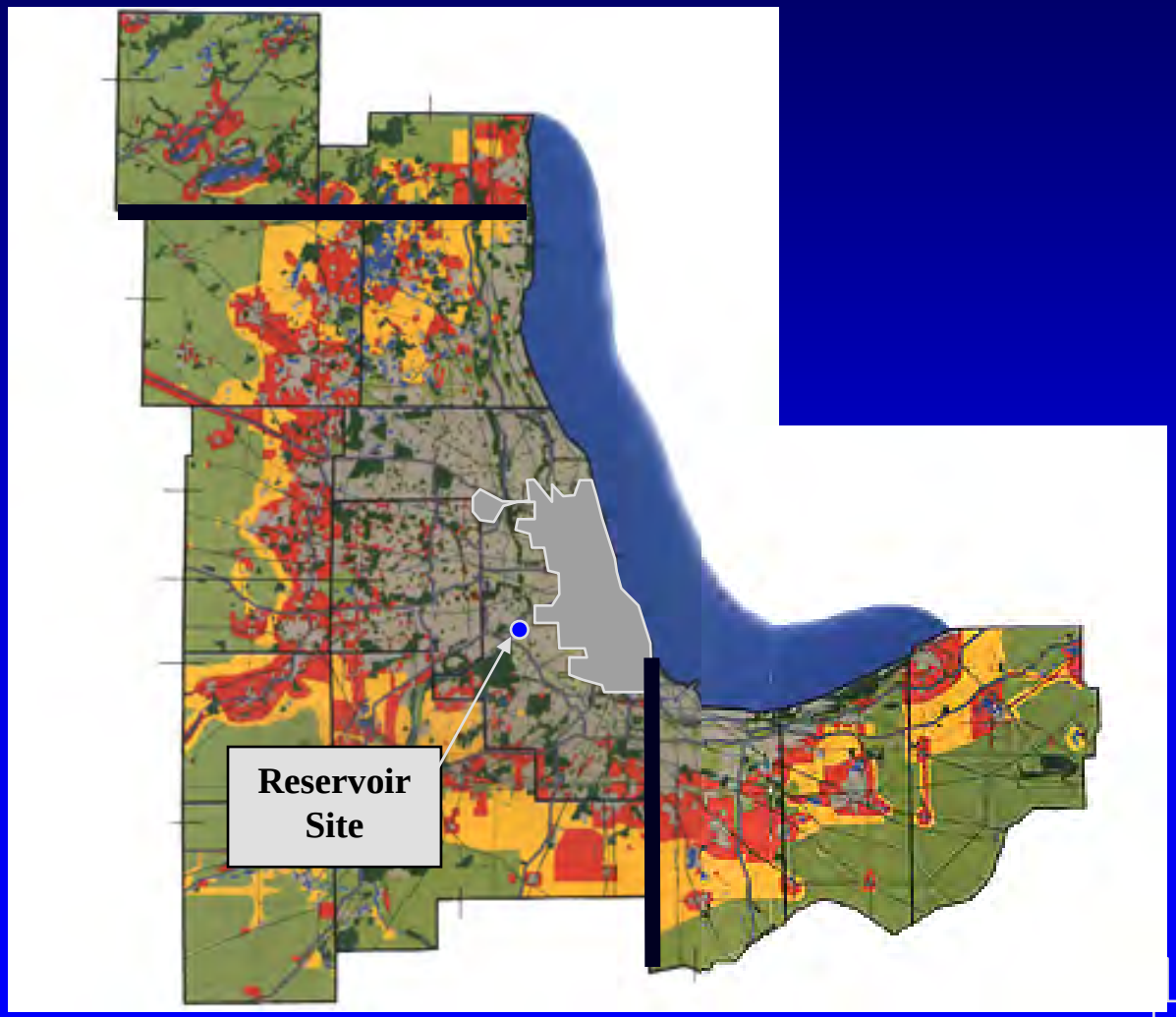
Project Description

- Flood control/CSO reservoir
- Captures CSO from Chicago and 37 suburbs
- Routed through Mainstream and Des Plaines Tunnels and Stickney Plant
- 2 Stages - 21,000 acre-ft (7B gallons)
- 300 ft deep (50 ft soil, 250 ft rock)
- Operational – 2010 (?)
- Project Completion - 2012



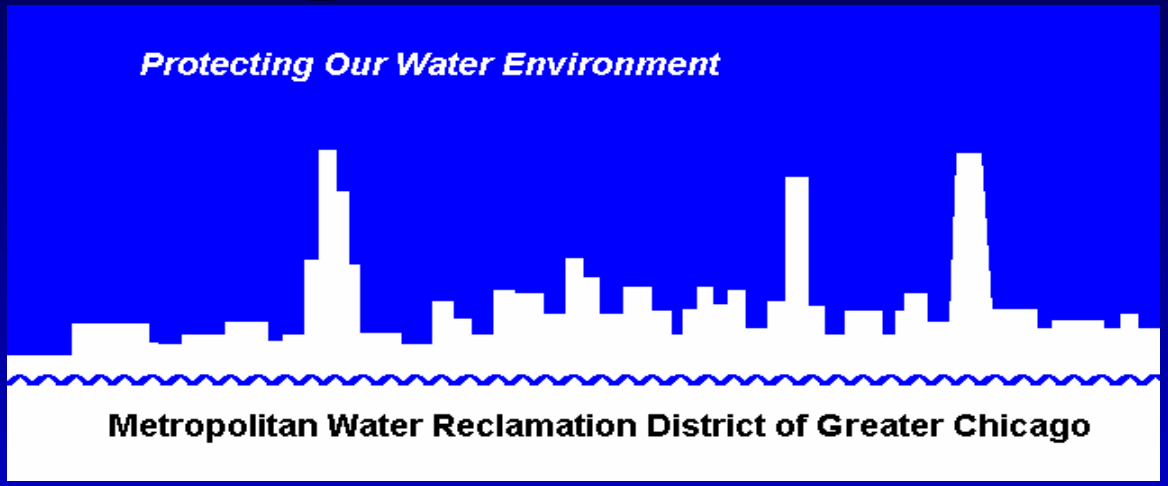
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Project Overview



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Local Sponsor - MWRDGC



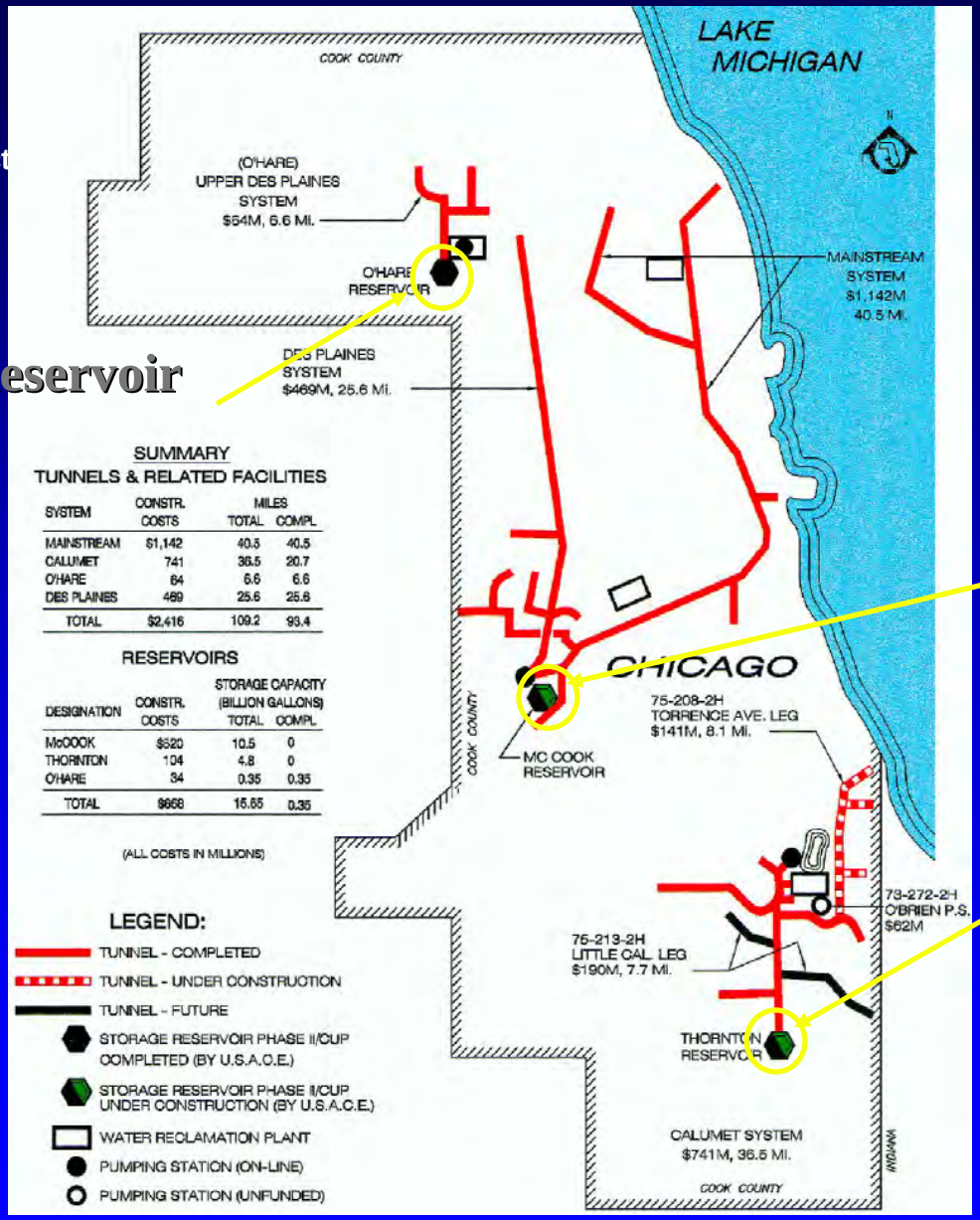
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Chicago Underflow Plan CUP

Tunnel and Reservoir Project - TARP

O'Hare Reservoir



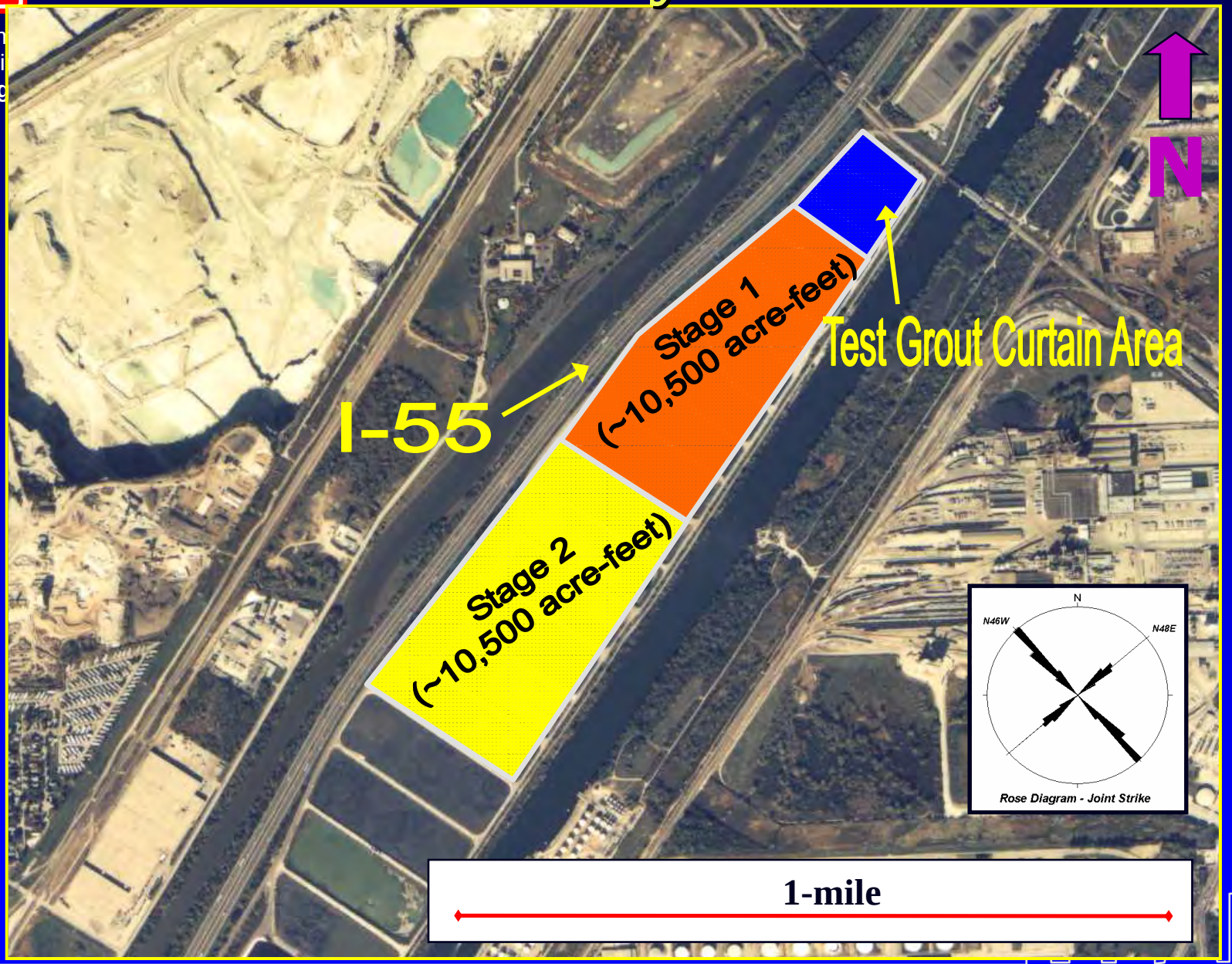
McCook Reservoir

Thornton Reservoir

110 miles of tunnels within system beneath Chicago and surrounding suburbs

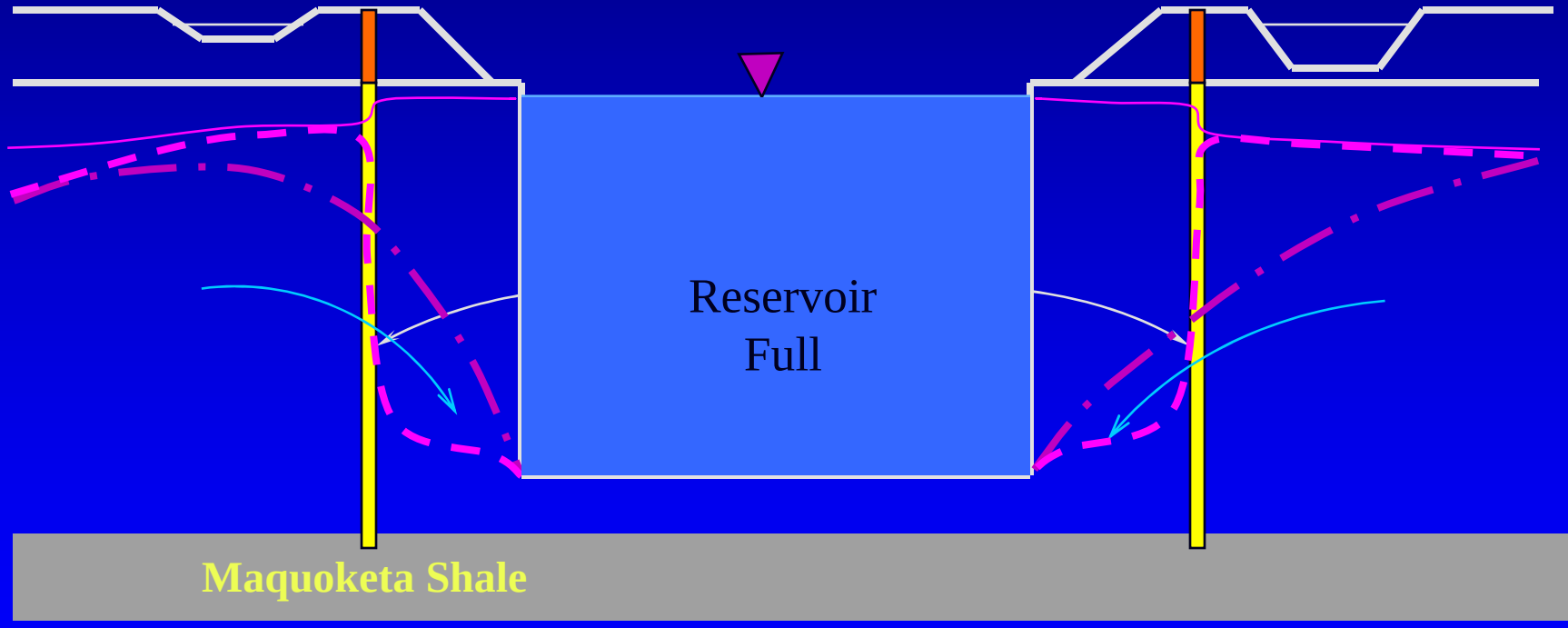
Site Layout

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Groundwater Schematic

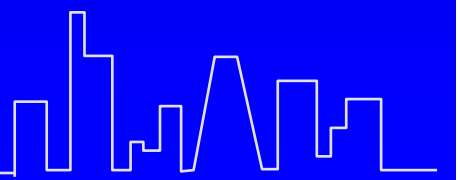


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Grout Curtain Design

Design parameters under consideration:

- Drilling Method
- Hole Size
- Hole Inclination
- Hole Spacing
- Grouting Method
- Grout Mix Design



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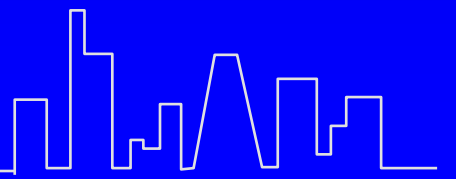
Test Grout Curtain Design

Contractual Vehicle

- Best-Value Contract – RFP
- Technical Factors Outweigh Cost

Technical Evaluation Criteria are <u>Critical</u>

- Too tight and no one qualifies, too vague and everyone qualifies
- Technical Approach
  - Computerized System, Drilling Approach, Grouting Approach
- Experience
- Equipment
- Safety



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Test Grout Curtain Design

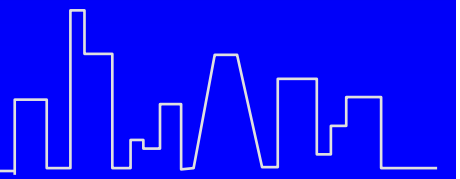
Contract Details

- Value Based Contract – not traditional "Low Bid"
- Contractor-Proposed methods
- Base Bid + Option (if executed)
- Base Bid – 2 parallel legs of curtain
- Option – Optional section to be drilled using one of the two methods demonstrated in Base-Bid
- Cost driven by drilling – up to 130,000 linear feet:
  - 10,000 linear feet overburden (base-bid)
  - 16,000 linear feet overburden (optional phase)
  - Appr. 50,000 linear feet rock drilling (base bid)
  - Appr. 67,000 linear feet rock drilling (optional phase)

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Design Issues

- **Alignment - double-row curtain vs. single row**
- **Drilling Method (Water DTH and Rotary)**
- **Mix Design - Balanced-Stabilized Grout**
  - Permits high solids/water ratio with lower viscosity
  - Include demonstration of Ultra-fine/Micro-fine cement
- **Computer Control of Grouting**



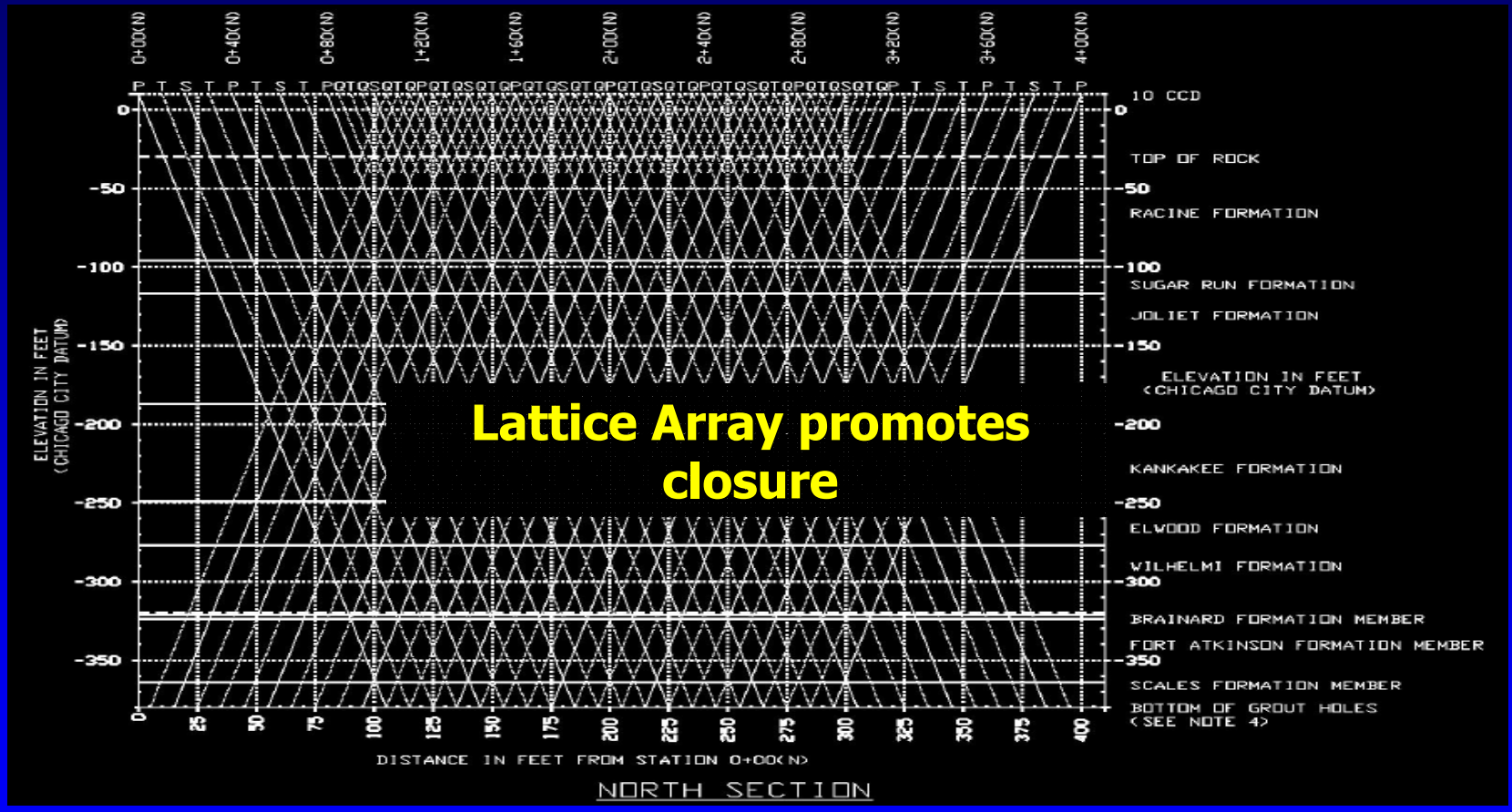
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Test Grout Curtain Design

- **Two double row test grout curtain sections**
  - 1 for testing of percussion and 1 for rotary drilling
  - "Chain link fence" or "lattice" array – rows oriented opposite each other
- **Parallel sections with similar geologic and joint orientations**
- **Each 200-ft long, 15-ft wide**
- **Grout holes angled 15° from vertical, 7.5 ft from centerline of cutoff wall on each side**
- **Primaries 40-ft apart – split spacing down to 5-ft**

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Test Grout Curtain Design

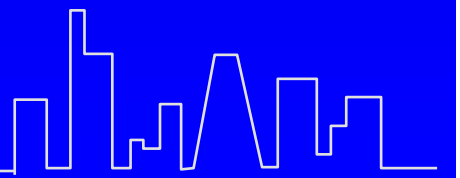


Lattice Array promotes closure

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Design (continued)

- Fully automated (computerized) grouting control and monitoring
- Demonstration section (10-ft rock grouting below overburden-rock interface)
- Verification boreholes (before and after)
- Rock coring
- Borehole camera logs
- Max. allowable deviation < 0.5 inch per foot (inclined) measured by precision instruments



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Design (continued)

- **Primarily upstage (bottom up) grouting**
- **Downstage grouting for top 10-ft and zones of lost circulation**
- **Grout mix – balanced-stabilized mix, adjusted based on "Apparent Lugeon" value**
- **Criteria - no take for 5 min. at max. pressure**
- **Expected closure = 1 Lugeon or less**
  - (1 Lugeon = 1.4 x E-5 cm/sec)
- **Optional section (~ 800 ft)**
- **Lessons-Learned Report**

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Construction

- **Contractor: Advanced Construction Techniques (ACT) / Gannett-Fleming**
- **Started in January 2003**
- **Pad construction completed**
- **Intelligrout™ System Setup**
- **Drill Rig: Cubex-Wassara – Water driven, down-hole hammer**
- **Grout Plant: Fully automated (ACT-Thiessen)**

Full-Scale Test Layout

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Site Access and Curtain Alignment





Unusually good access

Contractor paved surface to assist alignment of drill rig

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Drill Rigs

JKS Boyles Rig – HQ diamond tooling





Cubex-Wassara Rig – 4-inch Water-actuated down-hole-hammer

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Rig Control





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Grout Plant – ACT







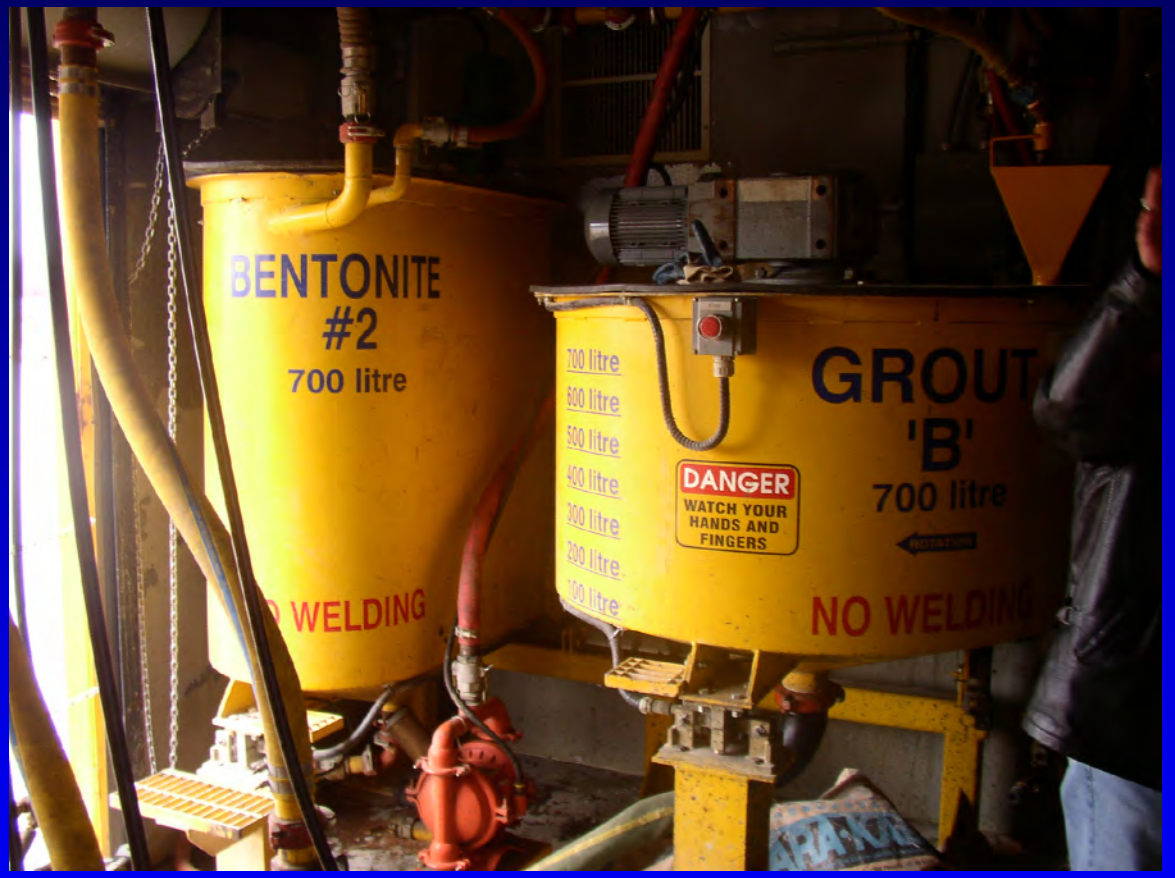
Self-contained mobile plant and control center

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Batching and Mixing







- Tanks designated by mixes and components
- Mixes checked for viscosity and sp. Gravity
- Flow measured by magnetic flow meters
- Mixing tanks equipped with load cells to monitor flow and supply

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Pumps and Control Panel





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Self-contained Mobile Grout Buggy with Flexible-Line Packer Assembly

- Constant in-line volume
- Highly portable
- Insulated lines
- Additional flow meter for Q/C at borehole







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IntelliGrout System**:**

- **Real-time monitoring and controls**
- **Continuous data acquisition**
- **Web-capable**
- ***Computer –linked data presentation system***



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Summary

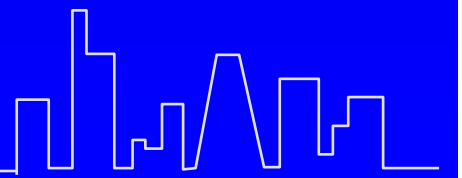
- **Complete Test Grout Construction in 2004**
  - Option section deleted due to funding shortfall
- **Lessons-Learned Report**
  - Combined with groundwater model for design of groundwater control system
- **Complete Design for Entire Perimeter (7,500 ft Stage I and 6,000 ft Stage II) begin 2005**

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Summary

Lessons-Learned

- No detrimental effects on borehole quality by using down-hole water hammer
- 1.0 Lugeon achievable at the site
- Computer system grouting advantages are essential for project of this scale
- Balanced-stabilized mixes improve grout effectiveness



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Summary

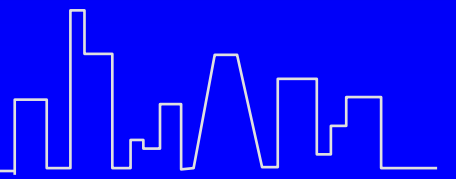
Lessons-Learned Report Combined with Comprehensive Groundwater Model

- Full-perimeter double-row grout curtain
- Curtain grouted to shale unit below base of reservoir
- Opposing orientation of double-rows for improved closure
- 1.0 Lugeon target closure criterion

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Questions/Comments/Feedback???

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Armor Stone Durability In the Great Lakes Environment

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Sources of Stone Recently Used in Chicago District

Valders and Hayton, WI - dolomite

Wausau, WI - blasted and drilled/split granite

Little Current, Ont. - quartzite

Waterloo, WI - quartzite

Bloomington area, IN cut limestone

Ste. Genevieve, MO blasted limestone



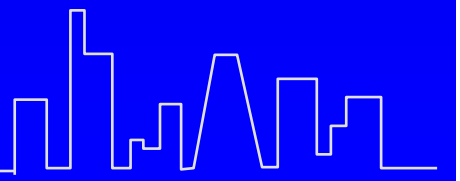
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Stone Types

A-Stone: Large Stone in Direct Contact with Water

B-Stone: Underlayer Stone – Transitional Layer

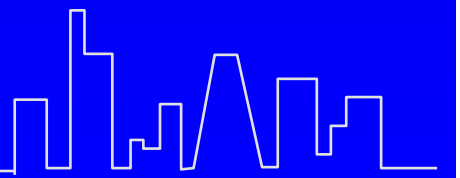
C-Stone: Bedding Between Foundation and B-Stone



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Stone / Rock Types Used in the Chicago District

- Cut Limestone Blocks – Early 1900s to present
- Blasted Limestone and Dolomite – 1960s to present
- Blasted Quartzite – Early 1990s to present
- Blasted Granite – Late 1990s to present
- Drilled and split granite – 2005



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Cut Limestone Blocks







Used initially in “Laid Up” structures

Later used in rubble mound and as capstone

Blasted Dolomite and Limestone

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Blasted Quartzite





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Blasted Granite







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Drilled and Split Granite







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Stone Materials Specifications

Great Lakes Stone Team in late 1990s to address inconsistencies

- **Representatives of 3 Districts, Local Sponsors and Industry**
- **Developed Great Lakes Armor Stone Guide Specification**
- **Included Combination of Visually-verified and Laboratory Criteria**
  - **Laboratory Criteria Based on Concrete Aggregate Tests**
  - **Visual Criteria Subject to Some Discretion**
- **On-Site Meetings at Sources to Establish Mutual Understanding**
  - **Use of Reference/Index Stones at Quarry to Display Features**

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Laboratory Test Criteria

Test	Test Method	Acceptance Criteria
Specific Gravity[3/]	ASTM C 127	2.6 - 3.0
Absorption[1/2]	ASTM C 127	< 1 percent and > 3 percent
Los Angeles Abrasion	ASTM C 535	< 20 percent loss after 500 revolutions
Freeze-Thaw [1/2]	ASTM D 5312	< 2 percent loss after 35 cycles
Wetting-Drying [1/2]	ASTM D 5313	< 2 percent loss after 80 cycles
Petrographic Examination	ASTM C 295	No deleterious materials allowed
Field Examination	ASTM D 4992	No deleterious materials allowed

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Visually Identified Criteria

"…quality to insure permanence of structure in the climate in which it is to be used… …free of features which may tend to increase deterioration from natural causes or breakage during handling, transportation, or placement. "

Vugs: Less than 5% of exposed surface area exhibiting vugs, and vugs shall not be aligned along bedding planes. No vugs greater than 4-inches in diameter.

Stylolites shall not exhibit gaps, separation or clay mineralization or appear likely to separate.

Dimensional aspect ratio 3:1 based on measurements of 3 mutually perpendicular axes when represented within a rectangular "box" orientation.

No fractures or bedding planes that appear likely to cause failure

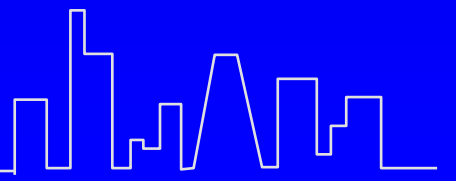
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Factors That Impact Armor Stone Durability

- **Environment and Climate – Nature of Project**

- **Above or Below Water Placement**
  - **Prefer no distinction in acceptance criteria to avoid confusion in field**
  - **Contractors unlikely to charge less for lower quality, so why lower standards?**

- **Production Methods**
  - **Cut Stone – Oolitic Limestone and Sandstone**
  - **Drilled and Split Stone**
  - **Blasted Stone**
  - **Curing and Aging**



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Factors That Impact Armor Stone Durability
Cont'd

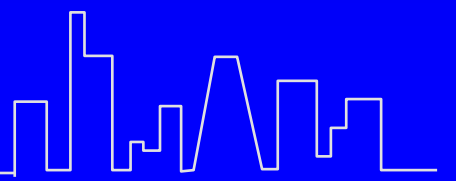
- **Rock Type**

  - Sedimentary rock has inherent anisotropy

  - Carbonates (and any sedimentary rock) vary based on depositional environment. Carbonates are often most readily available

  - Meta-quartzite has uniform mineralogy and crystalline intergrowth

  - Granite includes variation in mineralogy and crystalline intergrowth



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Factors That Impact Armor Stone Durability
Cont'd

Discontinuities, etc.

Fractures – mechanically caused by excavation methods

Joints – naturally occurring as a consequence of lithification and stresses

Bedding – separation planes and clay or oxidized minerals along bedding

Stylolites – suture-like features formed in conjunction with pressure dissolution

Micaceous or mineralized zones – biotite, sericite and clay minerals are weaker than surrounding rock

Vugs – discontinuous voids or bubbles in rock mass

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Fractures

Small fractures require careful inspection to detect

May require wetting stone to aid visibility

Discontinuous fractures of no consequence





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Joints

Often detected during quarrying

May worsen with exposure





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Bedding





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Stylolites







May or may not be a problem

May represent failure surfaces

May be more durable than surrounding rock

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Micaceous / Mineralized Zones



Diseminated softer minerals may cause fracturing during handling and placement



Clay along joints or bedding planes

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Vugs







May or may not be a problem

Act as havens for vegetation

If aligned form plane of weakness

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Factors That Impact Armor Stone Durability
Cont'd

Transportation, Handling and Placement

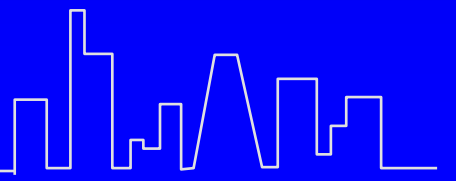




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Quality Control and Quality Assurance

- **Shift from intensive Government Inspection (QA) to Contractor QC**
- **Training and qualifications of Contractor QC personnel**
- **Training and technical support (Design and A/E) for Government QA personnel**
- **Quarry visit to establish acceptance criteria**
- **QC oversight during quarrying, selection and transportation**
- **QA oversight throughout**



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Quarry Visits to Establish Acceptance Criteria



- **Resolve misunderstandings early**
- **Document agreements**

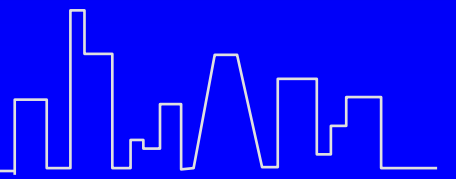
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Ongoing Investigations

Monitoring of Completed Coastal Projects – MCCP

- 1994-1998 study of armor stone in Great Lakes region
- Included investigations in laboratory, quarries and project performance
- 4 Structures in Lake Michigan and one in Lake Erie (Chicago Harbor, Calumet Harbor, Burns Harbor, Calumet Harbor CDF, and Cleveland Harbor)

Monitoring Report produced in 2004-2005 summarizing results



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Ongoing Investigations

Monitoring of Completed Navigation Projects – MCNP

- 2005 – 2010 study of armor stone durability

- Includes investigations in laboratory, quarries and project performance

- 3 Structures in Great Lakes – Lake Michigan, Lake Erie and Lake Superior
  (Burns Harbor, IN; Cleveland Harbor, OH and Keweenaw Harbor, MI)

Study of factors in durability, effects of scale on laboratory tests, develop guidelines for selection criteria, possibly develop testing protocols and guidance documents

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Questions, Comments, Feedback???
(please don't throw stones)



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joseph.a.kissane@usace.army.mil

Small Project, Big Stability Problem
The Block Church Road Experience



August 4, 2005 ISC Conference St. Louis, MO

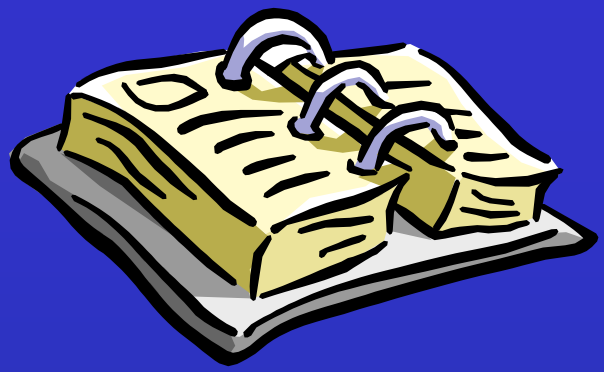
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Jonathan E. Kolber, P.E.

Geotechnical Engineer

US Army Corps of Engineers
Buffalo District

Outline



- Introduction
- Local Soils and Geology
- Town of Amherst Study
- The Block Church Road Project
- Other Impacts to Infrastructure
- Lessons Learned

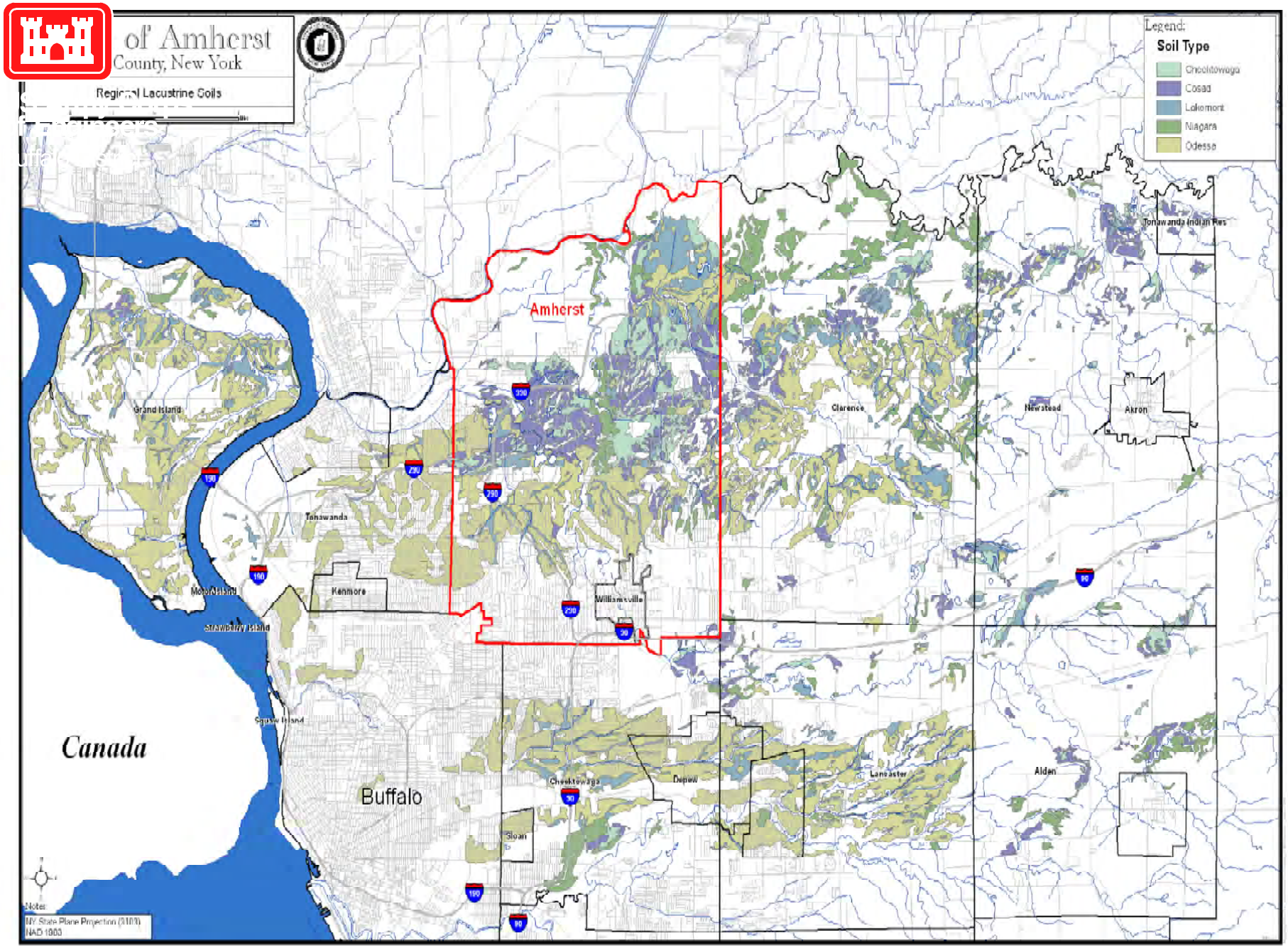
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Past Buffalo District Small Projects

- Streambank erosion
- Simple – no geotechnical issues
- Rip rap design
- Short time frame from initiation to completion (< 3 years)
- 100% federal funding
- Successful over design life

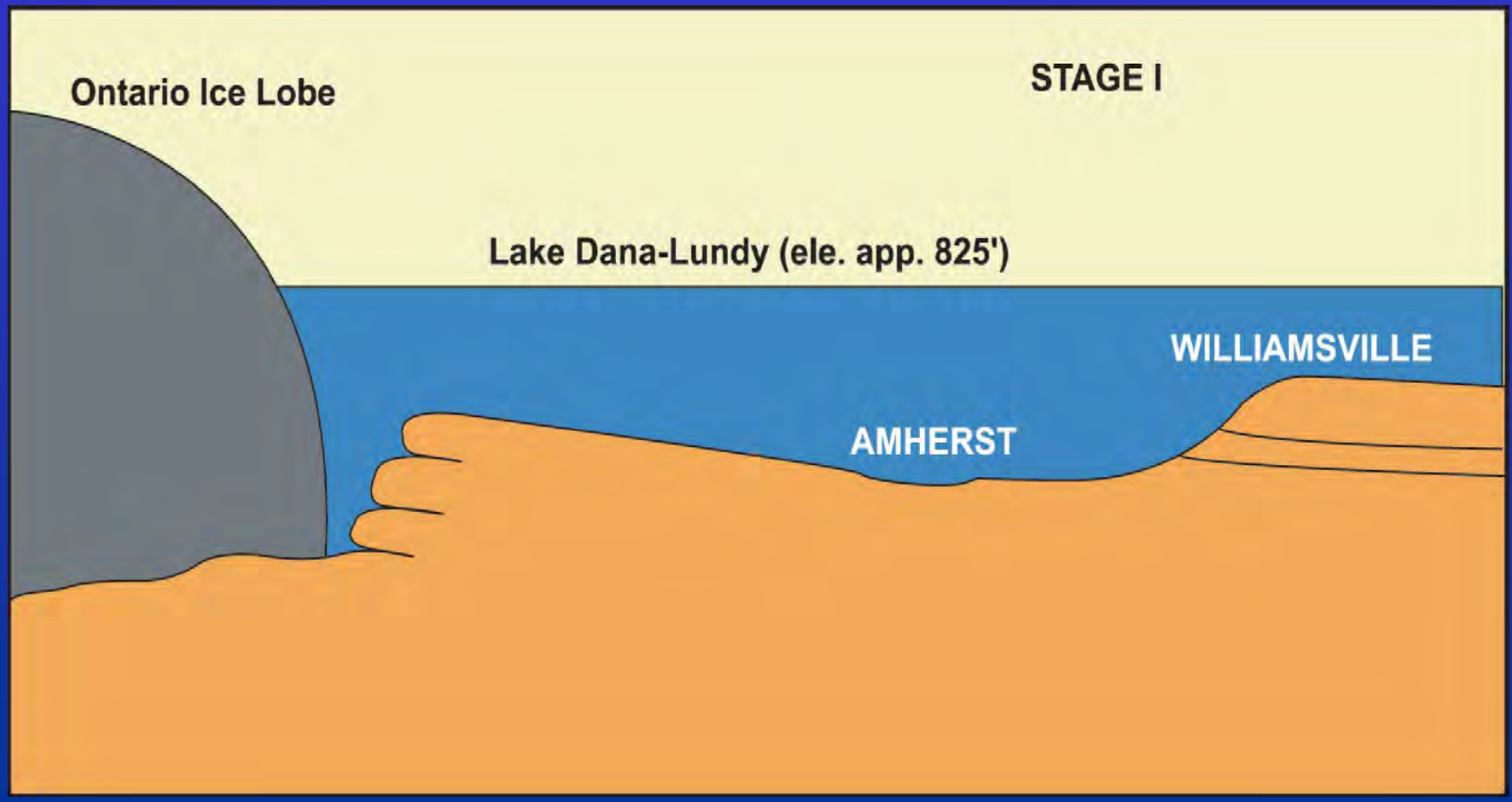
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Local Soils and Geology


of Amherst
County, New York
Regional Lacustrine Soils
Legend:
Soil Type
Cheektowaga
Cosad
Lakemont
Niagara
Odessa
Amherst
Grand Island
Tonawanda
Kenmore
Clarence
Newstead
Akron
Tonawanda Indian Res
Williamsville
Strawberry Island
Squaw Island
Canada
Buffalo
Cheektowaga
Depew
Lancaster
Alden
Sloan
Notes:
NY State Plane Projection (3103)
NAD 1983

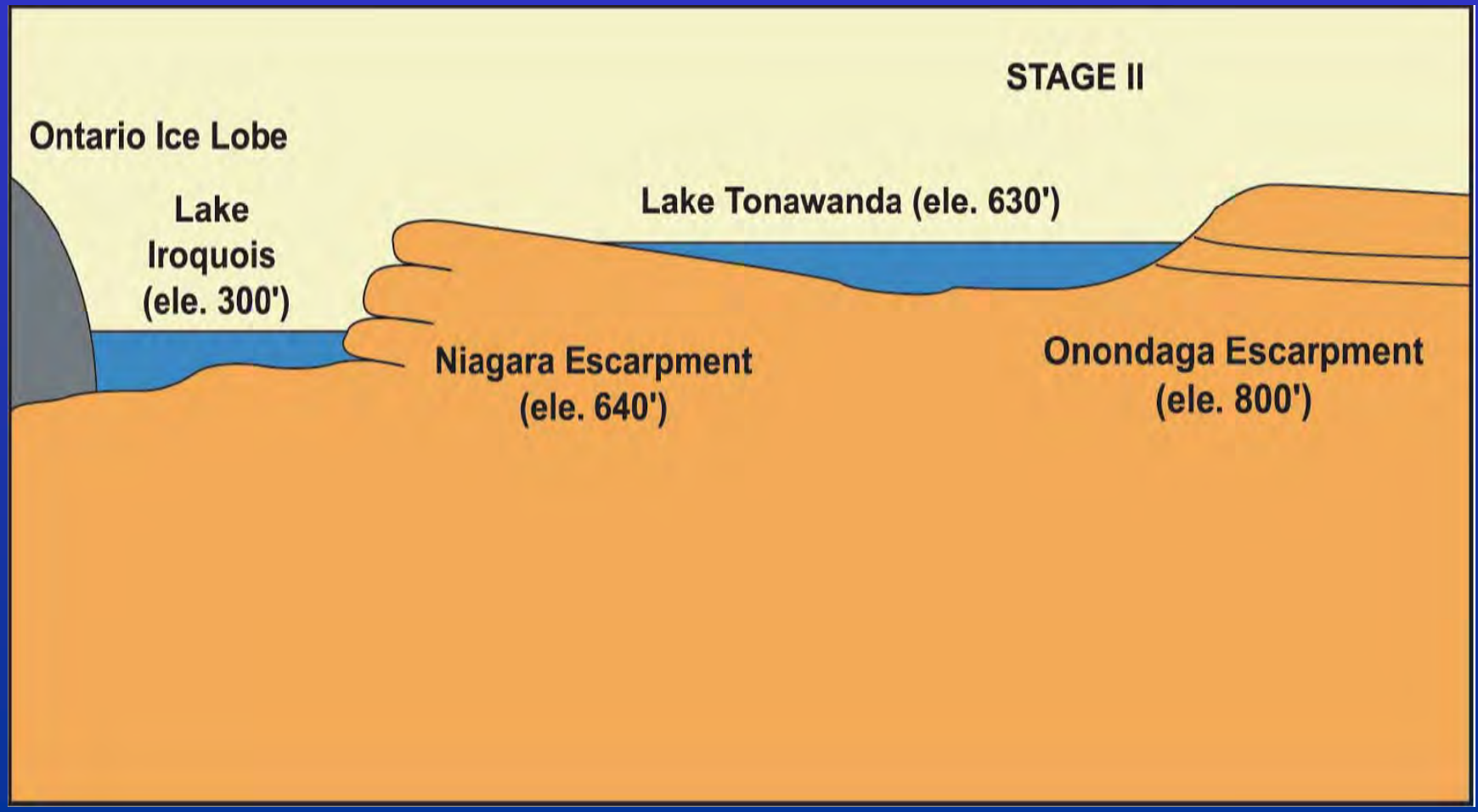
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Lake Dana-Lundy Stage 1

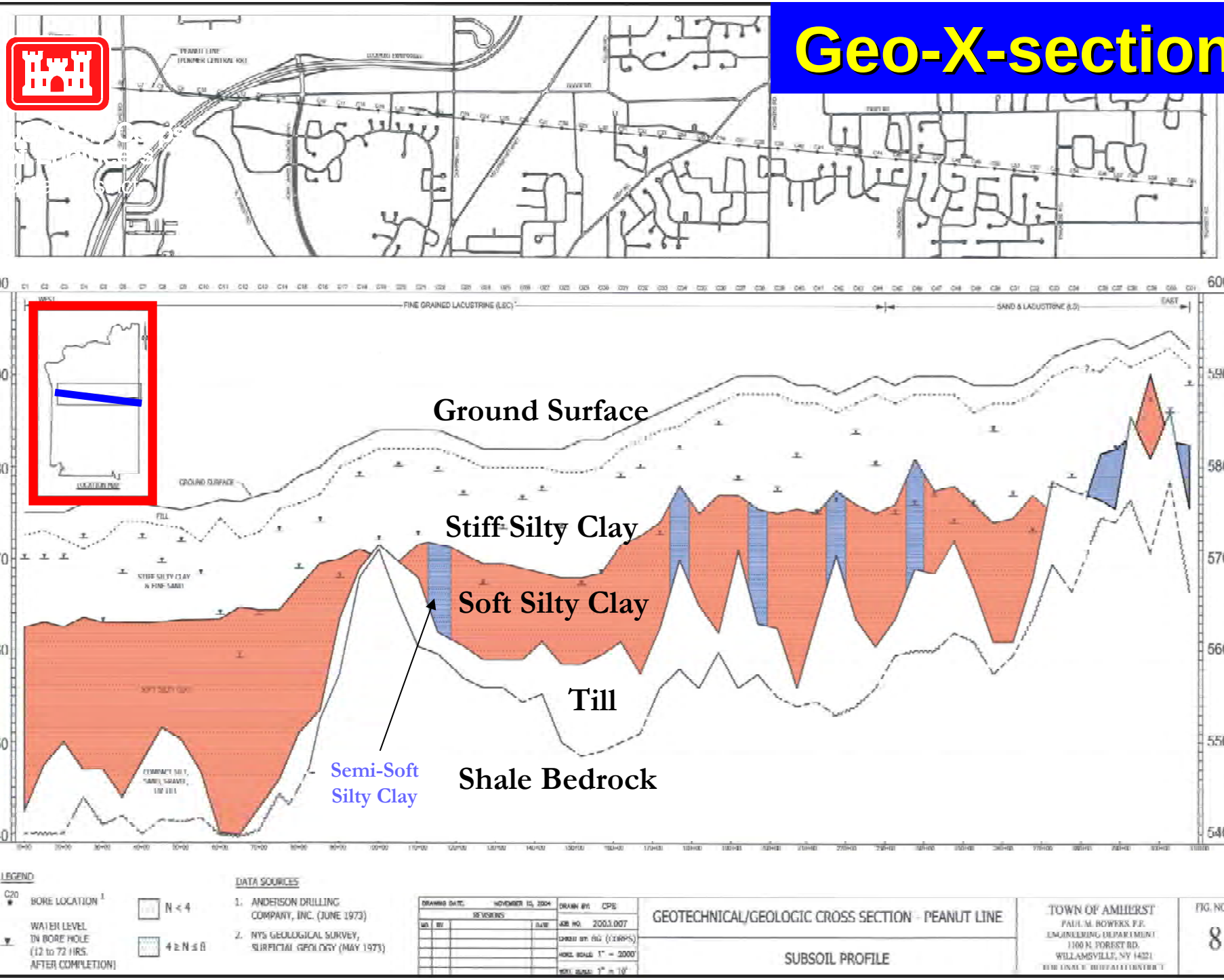


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Lake Dana-Lundy Stage 2



Geo-X-section



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TOWN OF AMHERST
SOILS AND RESIDENTIAL FOUNDATION STUDY



Prepared For:

Town of Amherst
5583 Main Street
Williamsville, NY 14221

Prepared By:

U.S. Army Corps of Engineering
1776 Niagara Street
Buffalo, New York 14207
Phone: (716) 879-4398/4145
Fax: (716) 879-6305

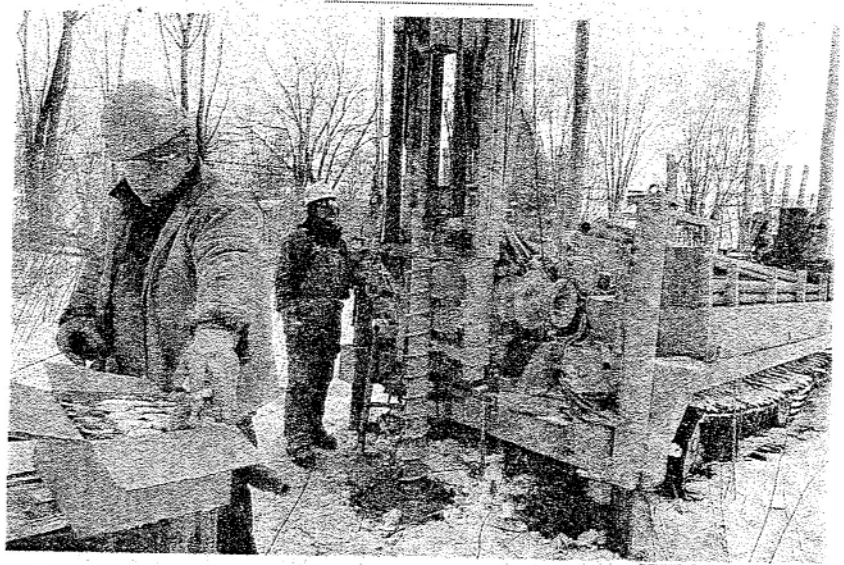
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FOCUS: AMHERST PROPERTIES

Over 1,000 homes sinking, Amherst official tells state

THURSDAY, FEBRUARY 19, 2004

FOCUS: SINKING HOMES



DENNIS C. ENSER/Buffalo News

Michael Benedict, a driller's helper, boxes a soil sample from 25 feet down on a proposed Amherst building site. Brian Fuller, a driller with SJB Services, readies the rig for another sample.

Amherst's soft soil

Subsoil as mushy as chocolate frosting or peanut butter may be a key to the "sinking homes" problem in Amherst — and may help explain the millions of dollars needed to fix the damage

SINKING HOMES

State panel overturns Amherst building law

AMHERST

Builders group now favors 'rebar law'

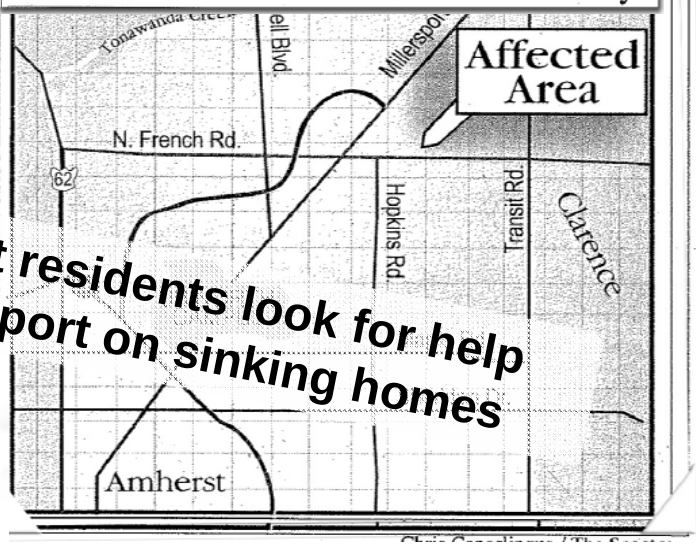
By THOMAS J. DOLAN

Advocates to press for housing moritorium

Town Board to consider moratorium on new housing north of Maple Road

Cracks in American dream

UB Rises Above as Amherst Sinks Slowly



Delaying public hearing delays foundation solutions

Amherst residents look for help in soil report on sinking homes

Sinking into foreclosure

Town not liable for soil issues, judge rules

By THOMAS J. DOLAN

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Soft Lacustrine Clays, Commonly Described as “Peanut Butter”


RUPP
825-6666
avance
PC300LC



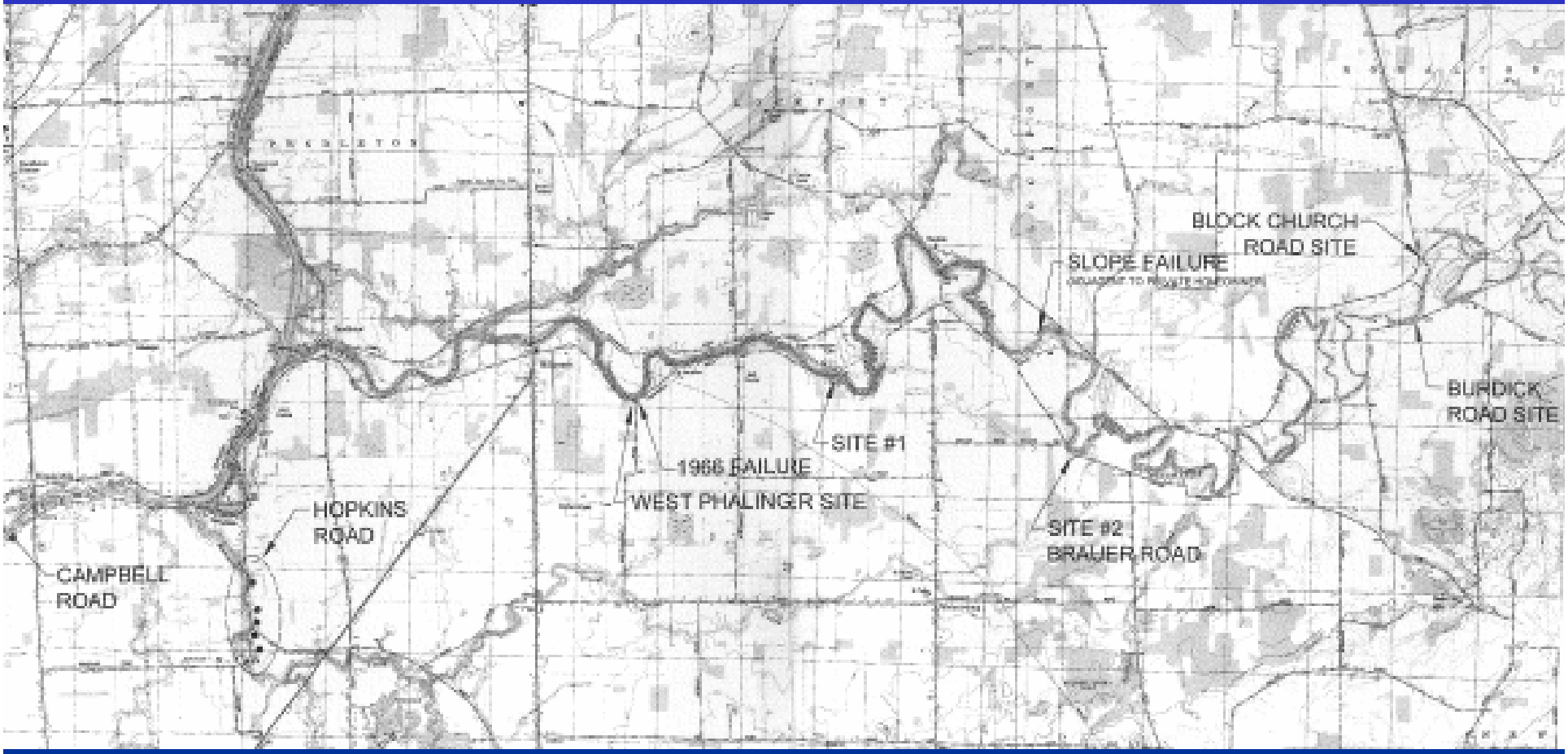
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Geotechnical Properties of the Soft Clay

- N = 0 blows/foot w = 50%
- LL = 50-60 PL = 25 PI = 25-35
- Unit weight (total) = 110 pcf
- Unified classification CL or CH
- Maximum shear strength = 300 psf
- Remolded shear strength = 50 psf
- Sensitivity 2-6.5

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Block Church Road



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Block Church Road Summary

- Recon 1992
- Preliminary design 1994
- Draft plans and specs 1998
- Final plans and specs 2003
- Construction began 9/15/2003
- Slope failure 9/25/2003
- Remedial design 2004
- Remedial construction 2004

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Block Church Road Summary (continued)

- Original cost about $1/4 million
- Final cost about $3/4 million

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Pre-Project Conditions (Low Flow)



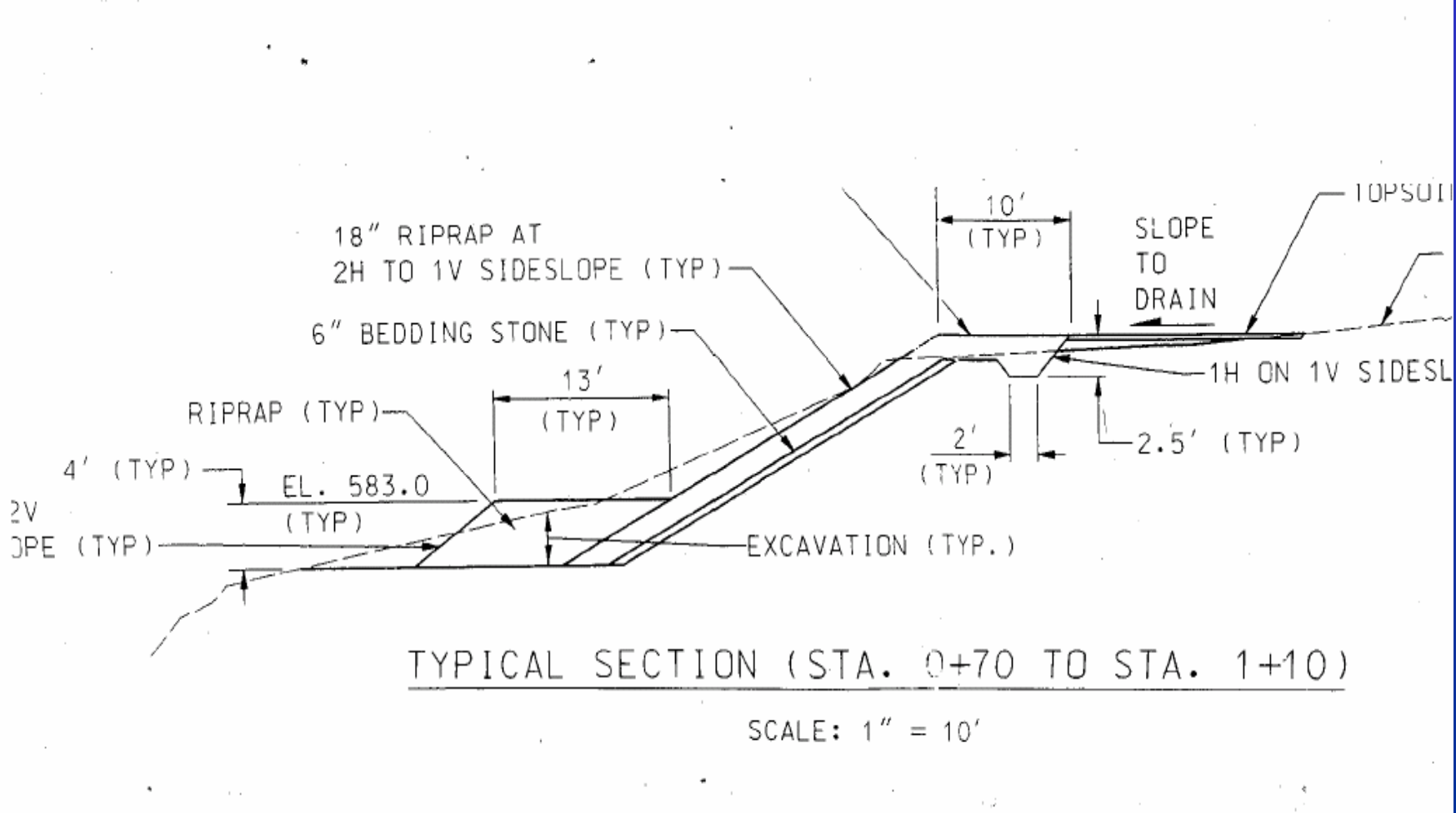
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Pre-Project Conditions (High Flow)



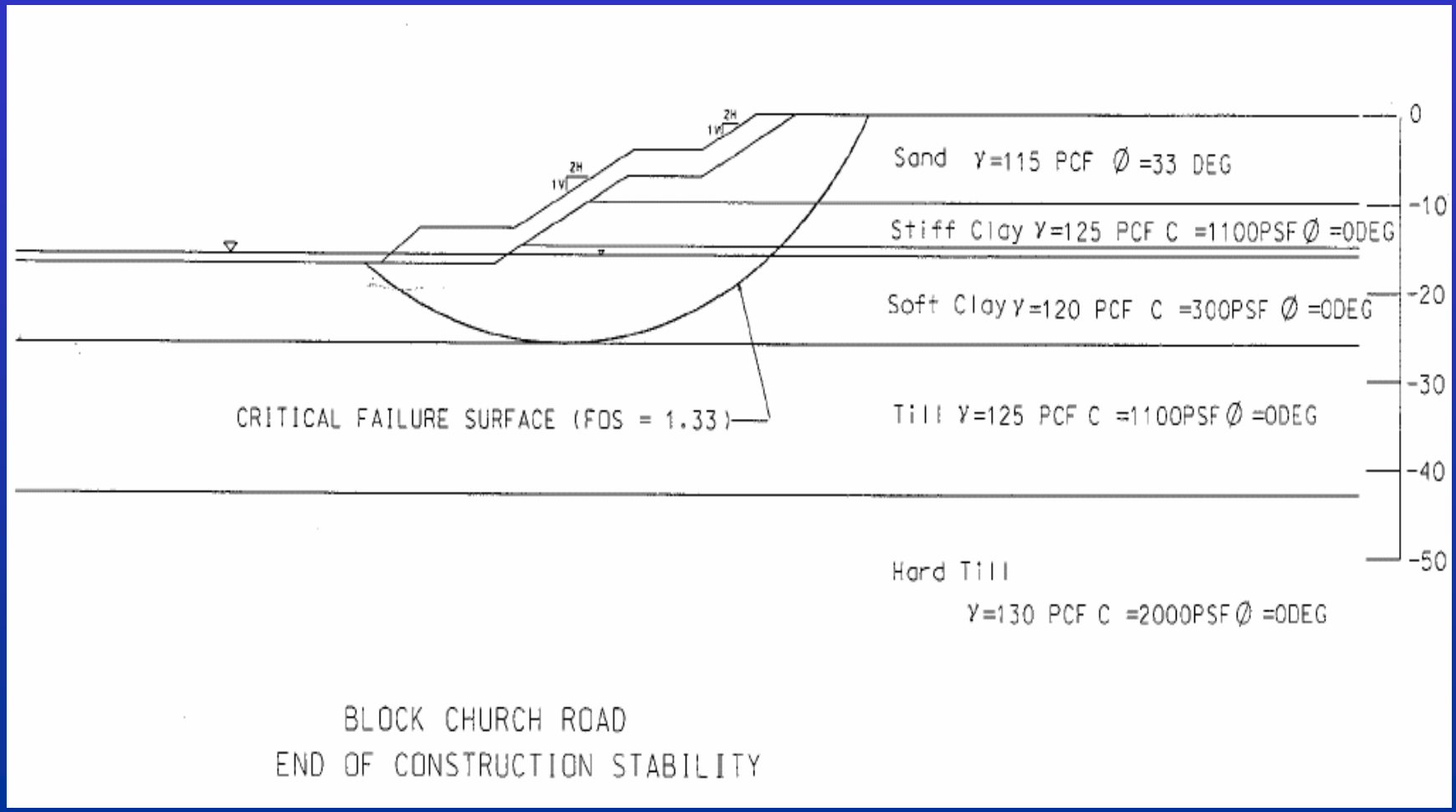
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Original Design Section



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Slope Stability Analysis



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Slope Failure



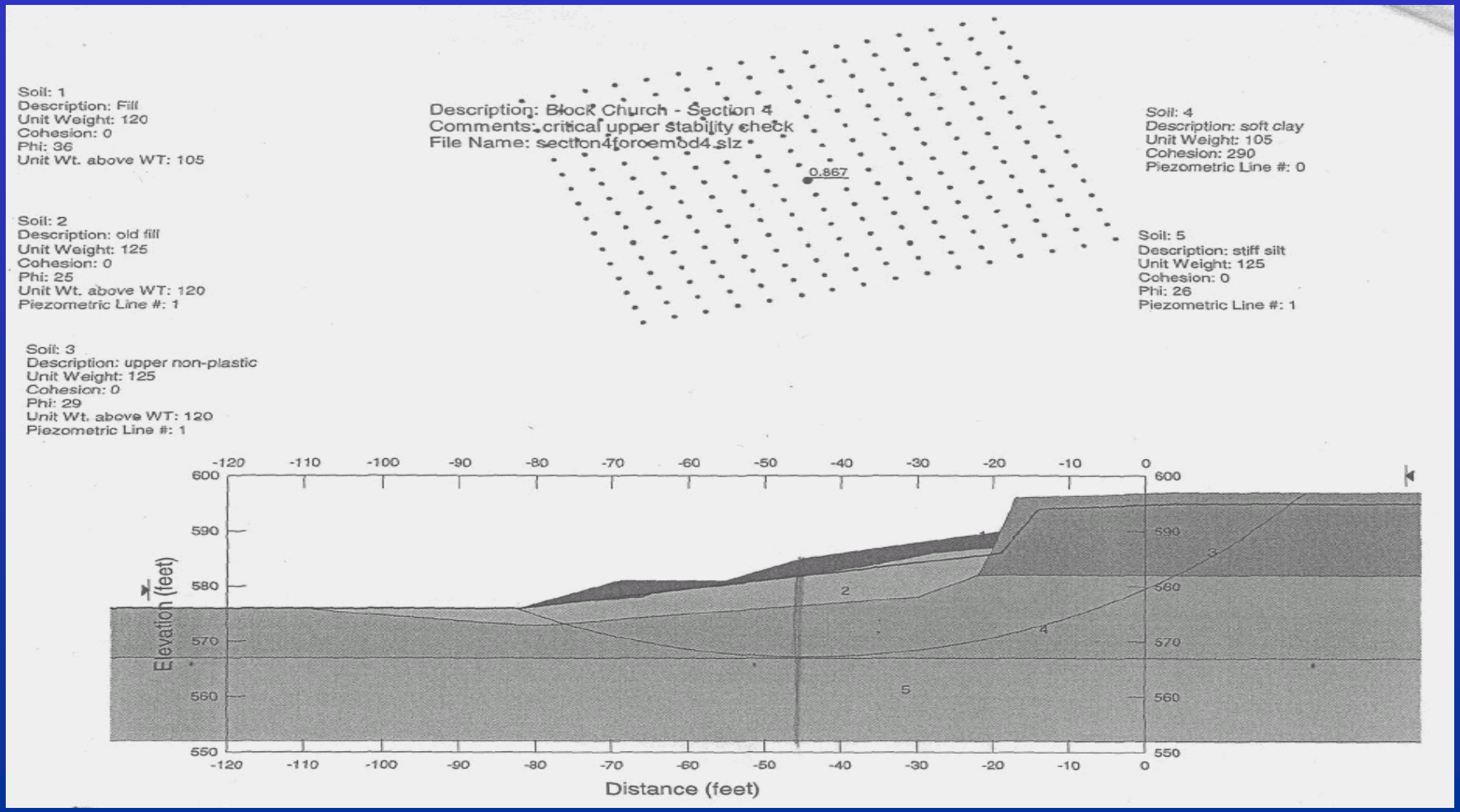
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Factors Which Contributed to the Block Church Road Failure

- Long time frame between start and finish of project (11 years)
- No construction sequence specified
- Non-free-draining backfill
- No pre-construction meeting
- Lack of understanding the mode of failure

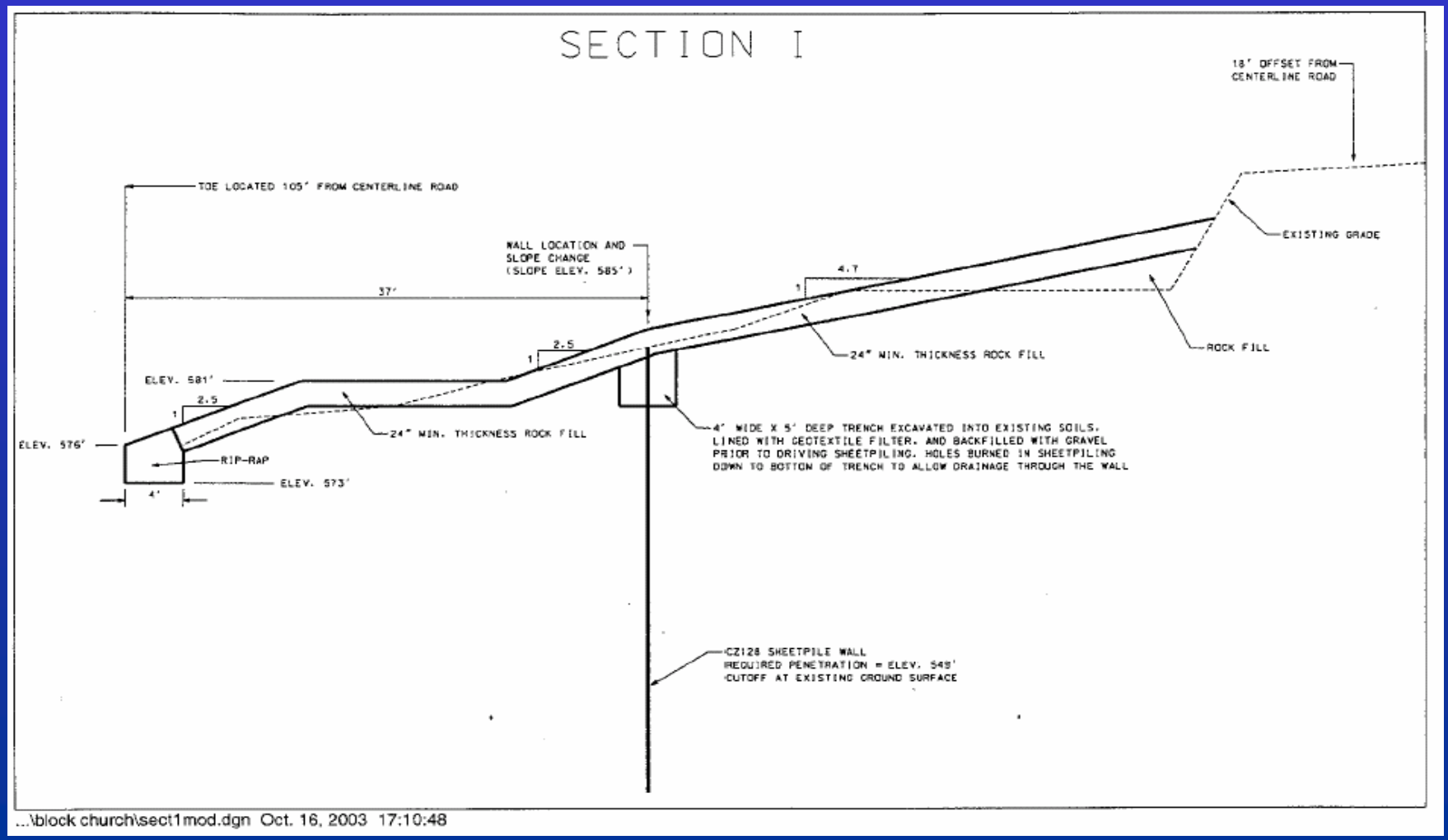
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Slope Stability Analysis (Back-Figure Shear Strength at Failure)



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Remedial Design Section



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Remedial Construction



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Completed Project



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Additional Impacts - Infrastructure

BUFFALO EVENING NEWS

METROPOLITAN PAGE

Friday, June 3, 1977 — Page 5



—News Staff Photographer Roy Russell

N THE EDGE — The wandering path of Tonawanda eek undermined three homes in the Town of Lock- rt Thursday afternoon, but the families, aware of the erosion, escaped. The U. S. Corps of Engineers is assisting local officials in assessing the damage. No injuries were reported.



Erie County Legislator Michael H. Ranzenhofer (R-Clarence) and Town of Clarence Supervisor Kathleen E. Hallock announced today that they will be seeking the assistance of all levels of government in order to repair the fallen section of road on Tonawanda Creek Road.

"We will be utilizing Town, County, State and Federal resources in order to implement a course of action regarding this section c Tonawanda Creek Road," said Ranzenhofer, who pointed out that a similar instance had occurred in 1991 approximately 1 ½ miles from the current collapse. "We are seeking the advice of the engineers from the Erie County Department of Public Works and the Clarence Highway Department on how to proceed."

Canal banks collapse in Pendleton
By Bill Wolcott / bwolcott@gnnewspaper.com
Friday, April 08, 2005

PENDLETON — About 100 yards of the Erie Barge Canal banks slid intc the canal over the last two days, which could postpone the boating seasc on the historic waterway.

The major erosion occurred about a half-mile from the Ship'n'Shore Restaurant near Tonawanda Creek Road. About 25 trees that were standing on the east bank are now floating or standing upright in the mid of the canal. Some ash and willow trees are about 30-feet above water level.

The original erosion was spotted on the west bank Tuesday by Jim Argo deputy superintendent of the Highway Department.

"I have never seen anything like that before," Argo said. "It was a sight. / first, I saw one tree standing in the middle of the canal, then they slid in from the east."

"Over the last 24 hours, the whole other bank caved in," said Jeff Stowel town highway superintendent. "A series of dikes caved in."

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Rough Road: *Collapse in Clarence*



Charles Lewis/Buffalo News

Closed for repairs: Town officials believe ground water pushing out clay soil may have buckled and broken this stretch of Tonawanda Creek Road in Clarence. A 150-foot section of the road, at the northeast edge of the town, began collapsing Friday, forcing at least two families to evacuate their homes.

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Potential Future Projects

Niagara County:

- Minnick Road Section 14

Erie County:

- Hopkins Road Section 14 (5 slides)
- Burdick Road
- Tonawanda Creek Road (2 sites)

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Our main partner in future projects of this type, Erie County, is going through tough fiscal problems these days…

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COUNTY TOILET PAPER ARRIVES

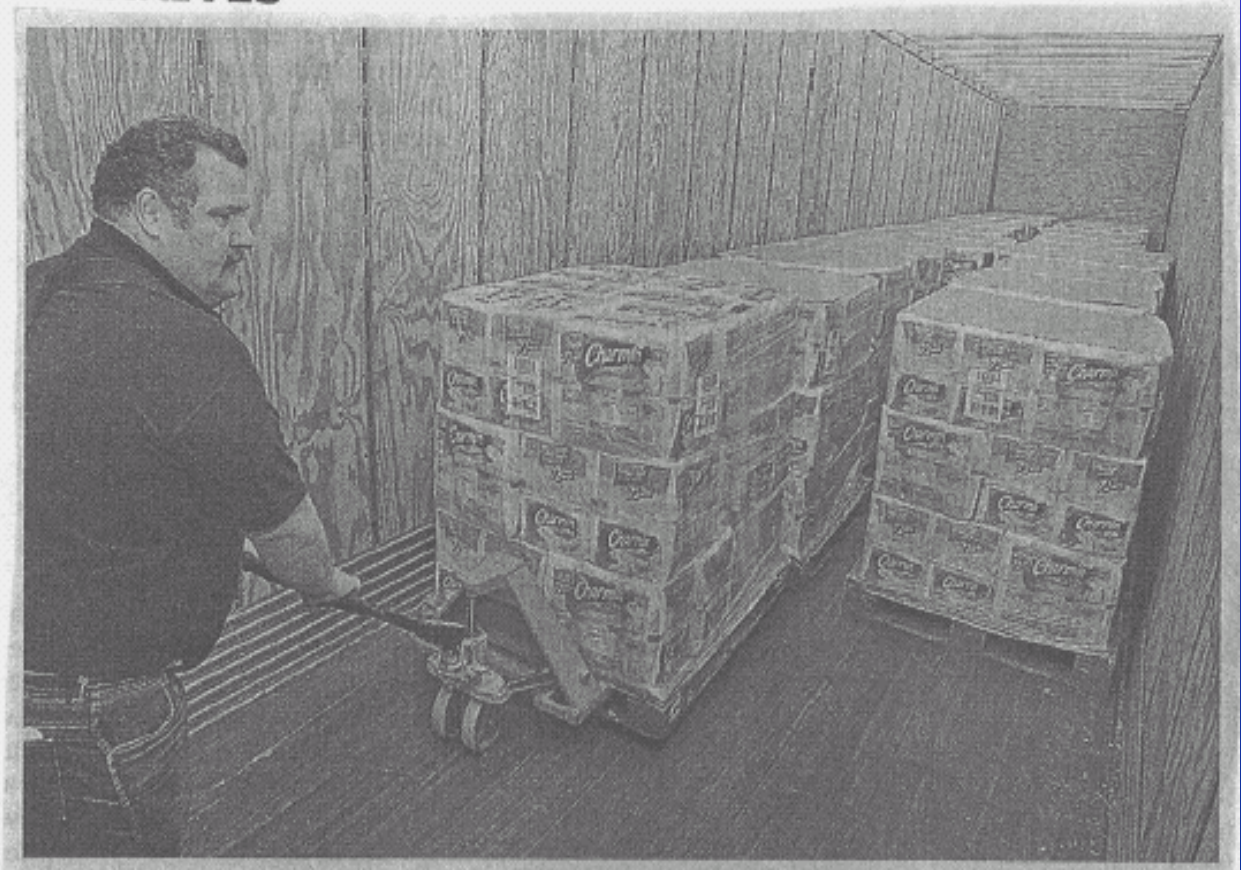
Posted by: Judy Wichrowski, Producer
Created: 3/23/2005 11:12:37 AM
Updated: 3/24/2005 4:14:38 PM

14,000 mega rolls of toilet paper were delivered to the Rath Building this morning.

The toilet paper was donated by Proctor and Gamble. The company heard about the restroom supply shortage at the Rath Building and decided to make the donation.

Erie County's Budget crisis made national news because of a shortage of supplies at the Rath Building.

The donated toilet paper is worth an



Harry Scull Jr./Buffalo News

Erie County is so financially strapped that it accepted a truckload of donated toilet paper, being unloaded here by Jim Ortman, head janitor, yet it ... n't increased property taxes.

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Lessons learned

- Adverse geology has complicated matters
- Need to be careful before making future project commitments which are partnered/cost-shared

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Lessons Learned (continued)

- Long time frames (> 5 years) from initiation to completion of small projects are not conducive to success

- Small projects with big geotechnical issues are no longer small projects

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Questions?



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- Telephone (home) 716-833-6233
- Emergency: Peg Kolber (home)
- Fax 716-879-4355
- Address (business) 1776 Niagara Street, Buffalo, NY 14207
- Address (home) 133 Glenhurst Road, Tonawanda, NY 14150

Determination of Foundation Rock Properties Beneath Folsom Dam



Michael K. Sharp, PhD, PE

José L. Llopis

Enrique E. Matheu, PhD

Geotechnical & Structures Laboratory

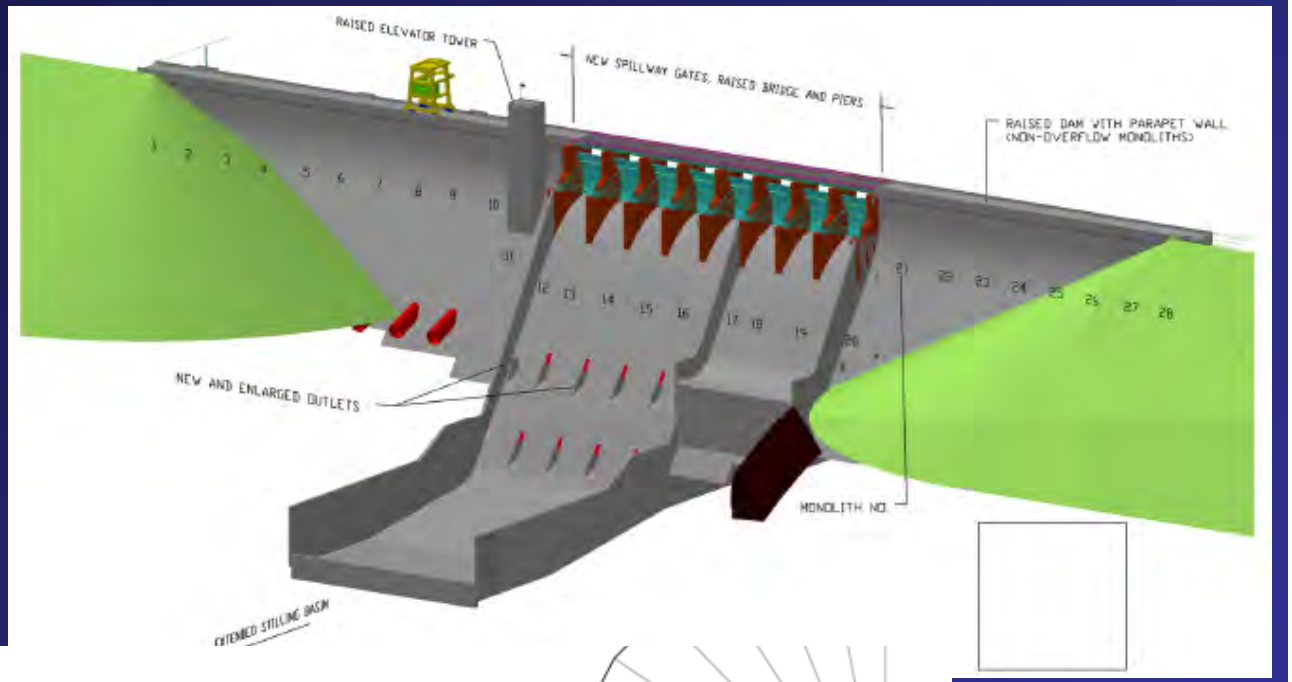
Engineer Research and Development Center

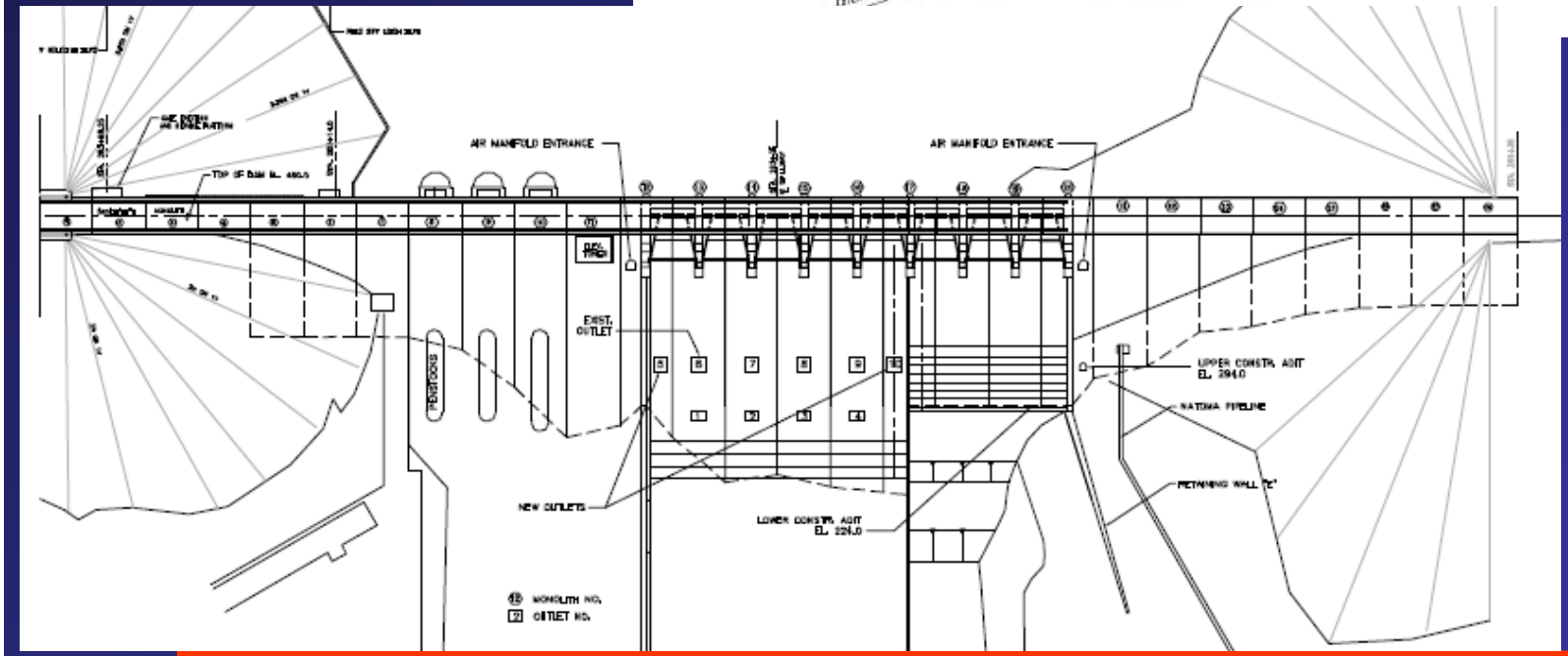
2005 Tri-Service Infrastructure Systems Conference & Exhibition, St. Louis

Background and Purpose

- USACE proposes a flood damage reduction plan for the Lower American River
- A major component of that plan is raising Folsom Dam by seven feet
- As part of this plan a dynamic analysis of the dam-foundation system will be conducted
- The purpose of this study was to determine foundation properties for input into the dynamic analyses program

28 Concrete Monoliths
50 ft wide





Previous Studies

1983 Woodward Clyde

- 6 NX cores and Borehole jacking tests
- Static Young's modulus – 1.6 to 2.1x10^6 psi

1983 ERDC

- Surface seismic refraction, surface vibratory, crosshole and downhole. Estimated density
- Dynamic Young's modulus – 5.8 to 11.x10^6 psi

2001 URS

- Re-evaluation of existing data
- Static Young's modulus – 1.2 to 2.5x10^6 psi

District settled on 7.9x10^6 psi

Measured Insitu Parameters

Compression and Shear wave velocities

Densities



Computed Elastic Parameters

Young's Modulus

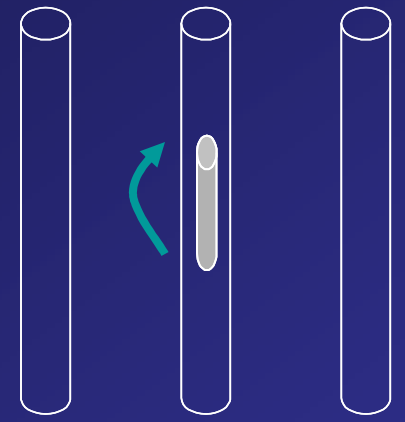
Shear Modulus

Bulk Modulus

Constrained Modulus

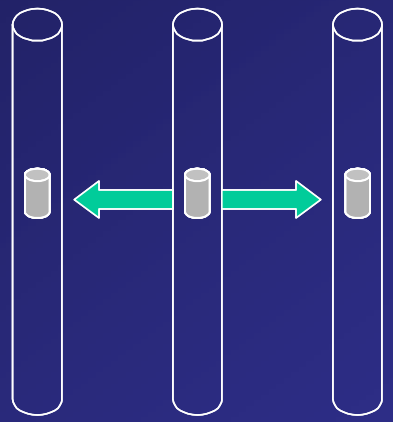
Poisson's Ratio





Sonic logging





Crosshole





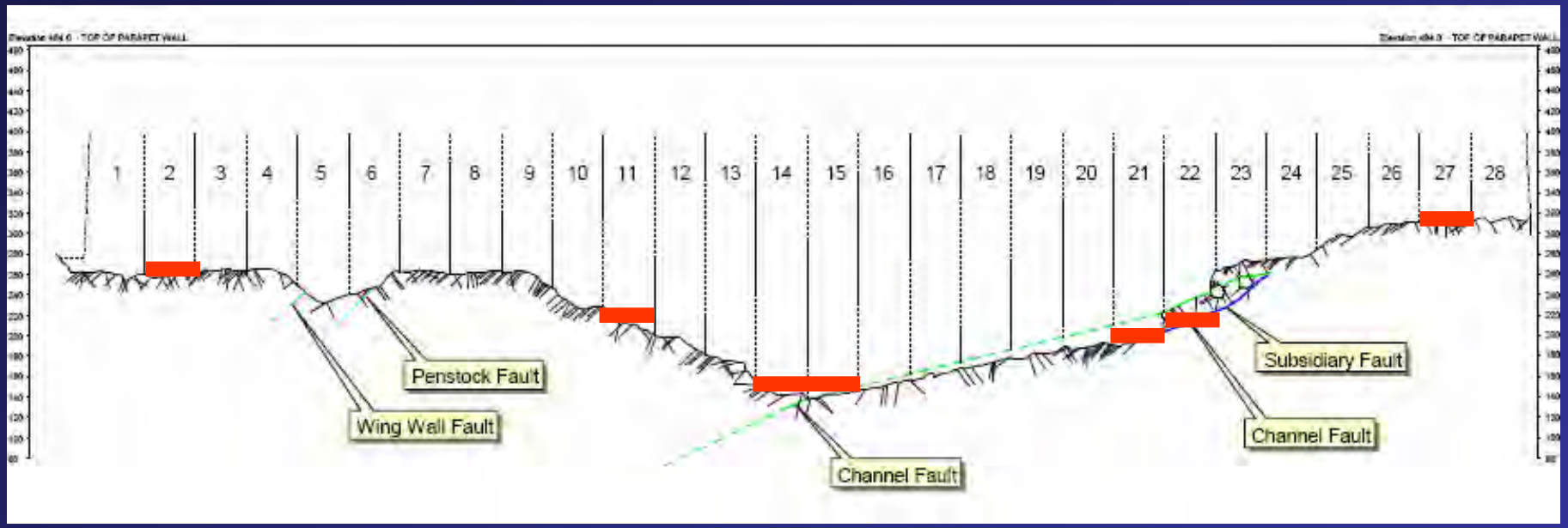
Sonic logging, P and S waves
Density logging

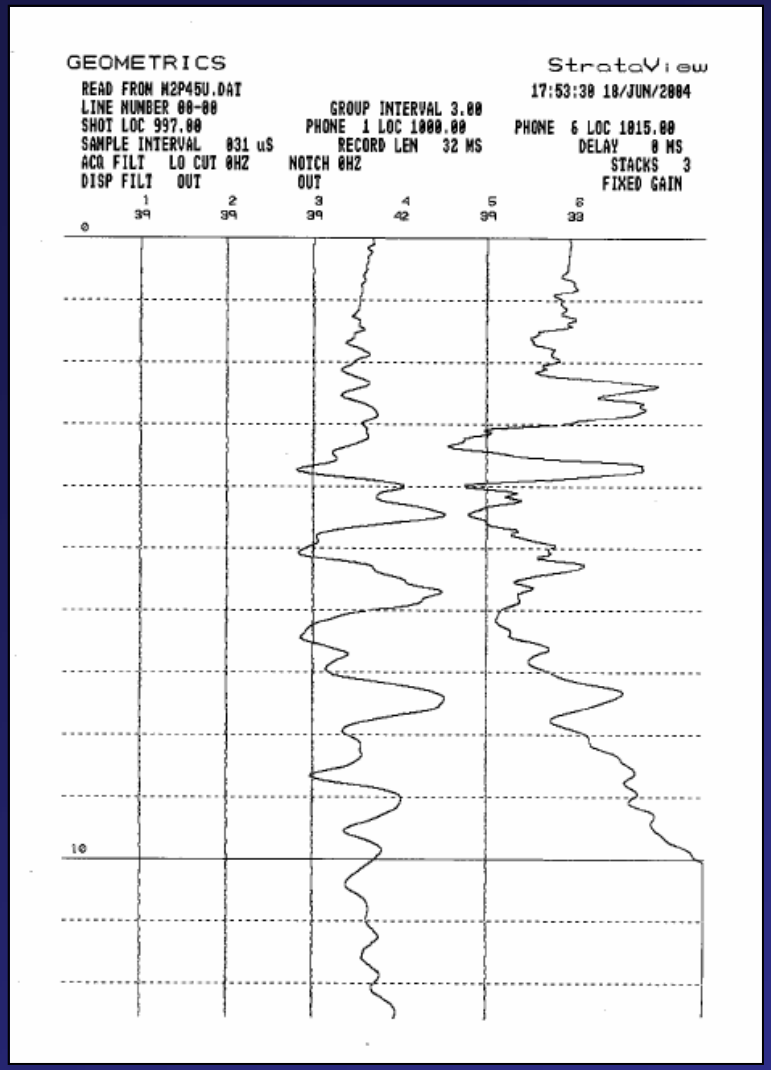


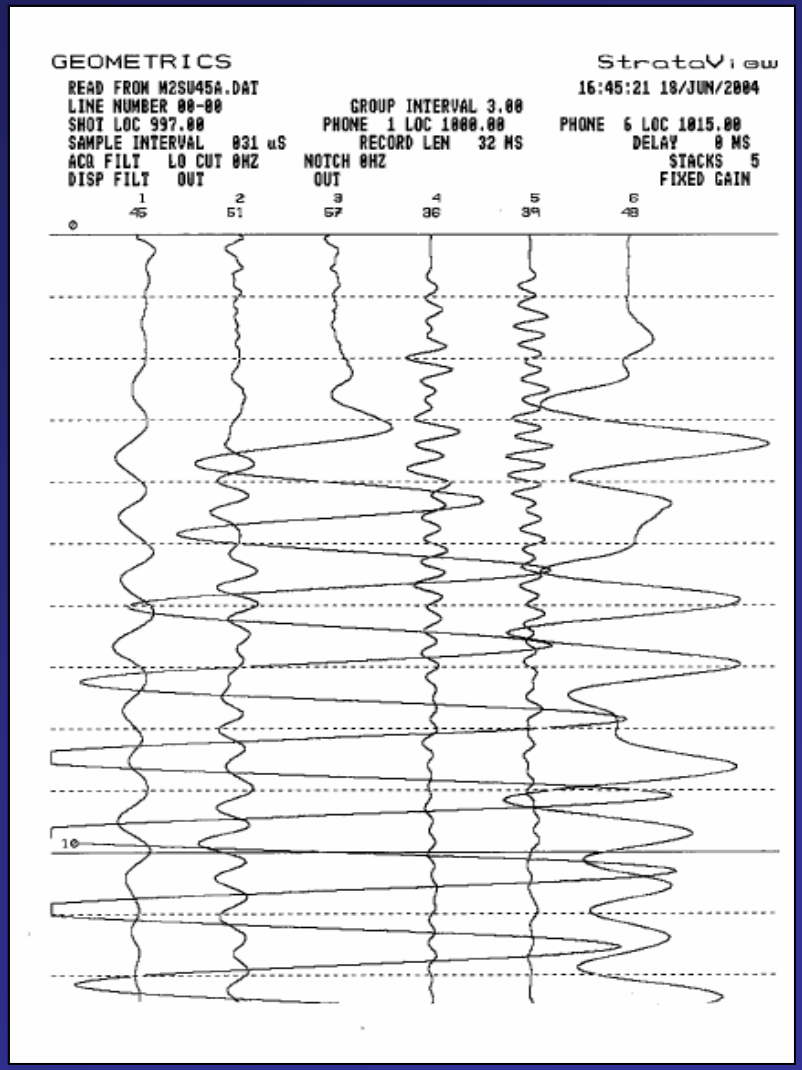


Crosshole, P and S waves

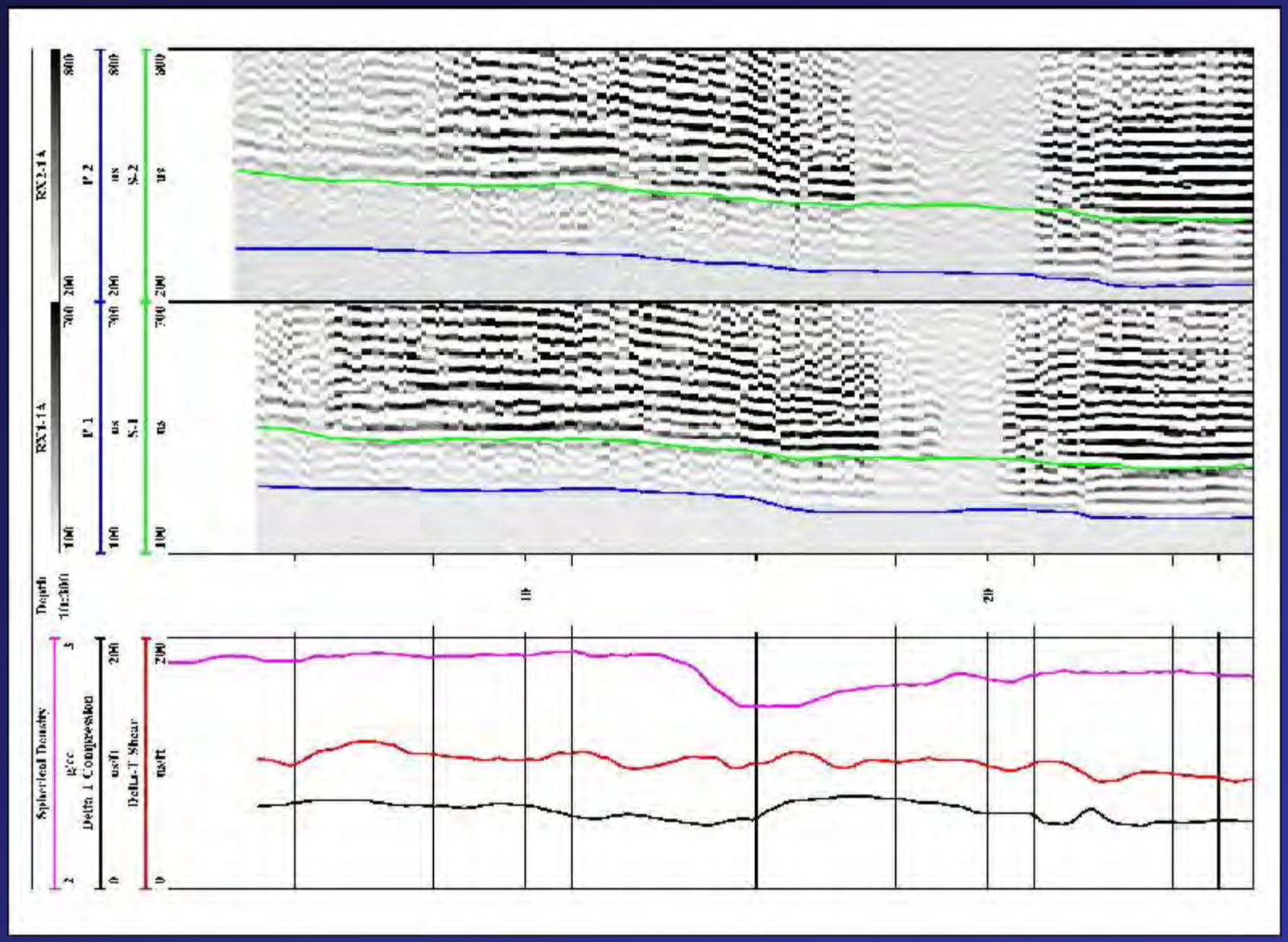
Monoliths tested



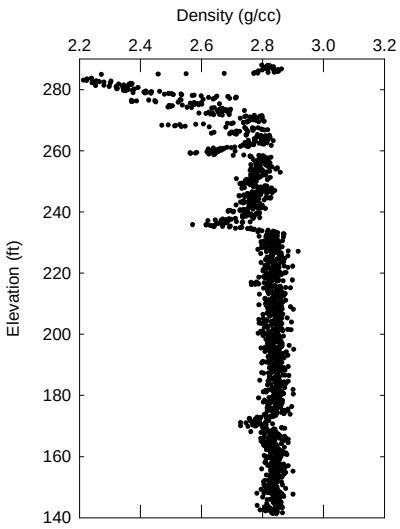


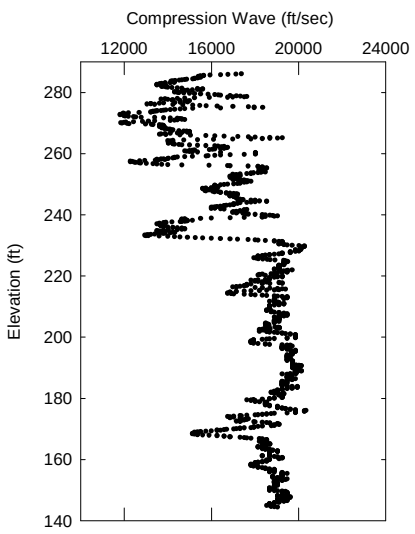


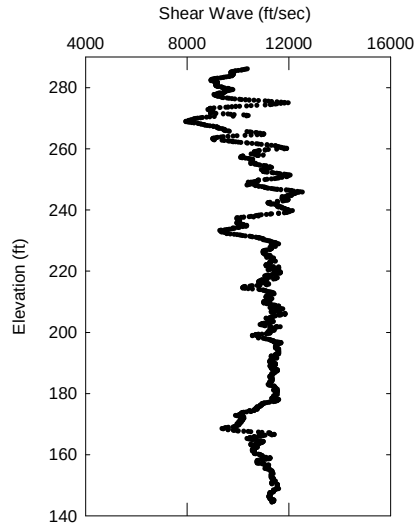
Typical crosshole data

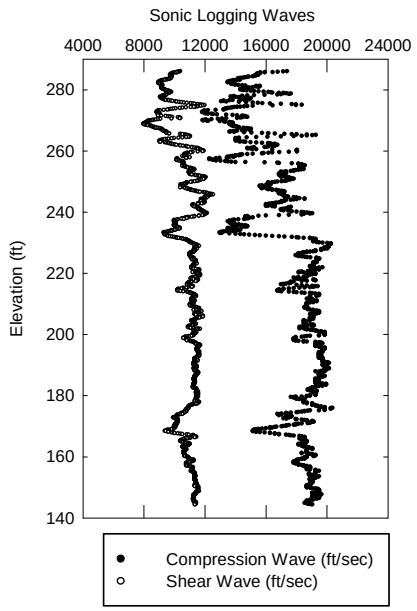


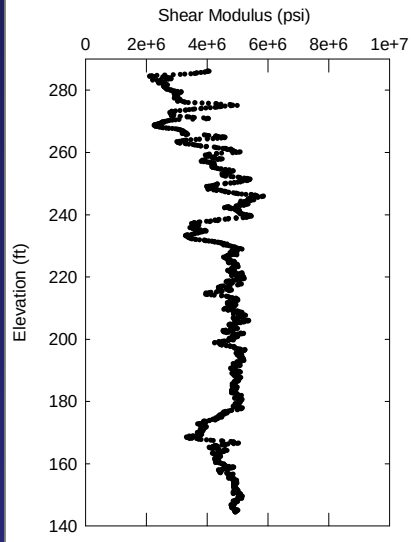
Typical sonic and density logging data

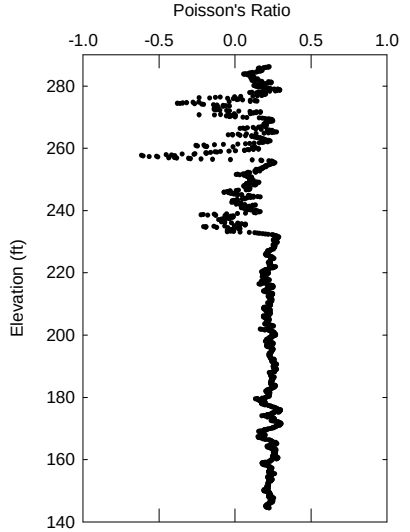

Density (g/cc)
2.2
2.4
2.6
2.8
3.0
3.2
Elevation (ft)
280
260
240
220
200
180
160
140

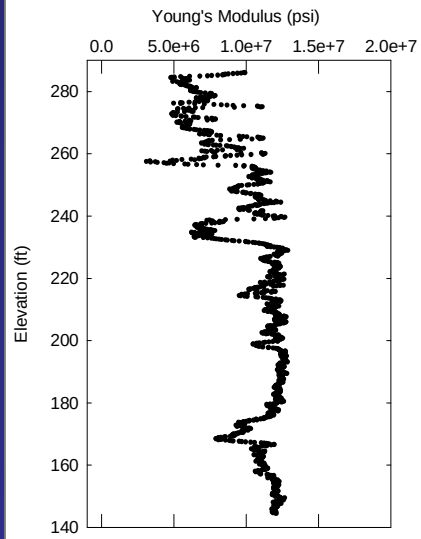

Compression Wave (ft/sec)
12000
16000
20000
24000
Elevation (ft)
280
260
240
220
200
180
160
140

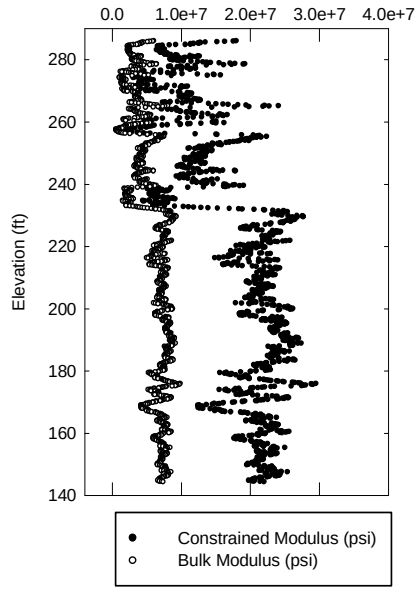

Shear Wave (ft/sec)
4000
8000
12000
16000
Elevation (ft)
280
260
240
220
200
180
160
140


Sonic Logging Waves
4000
8000
12000
16000
20000
24000
Elevation (ft)
280
260
240
220
200
180
160
140
Compression Wave (ft/sec)
Shear Wave (ft/sec)

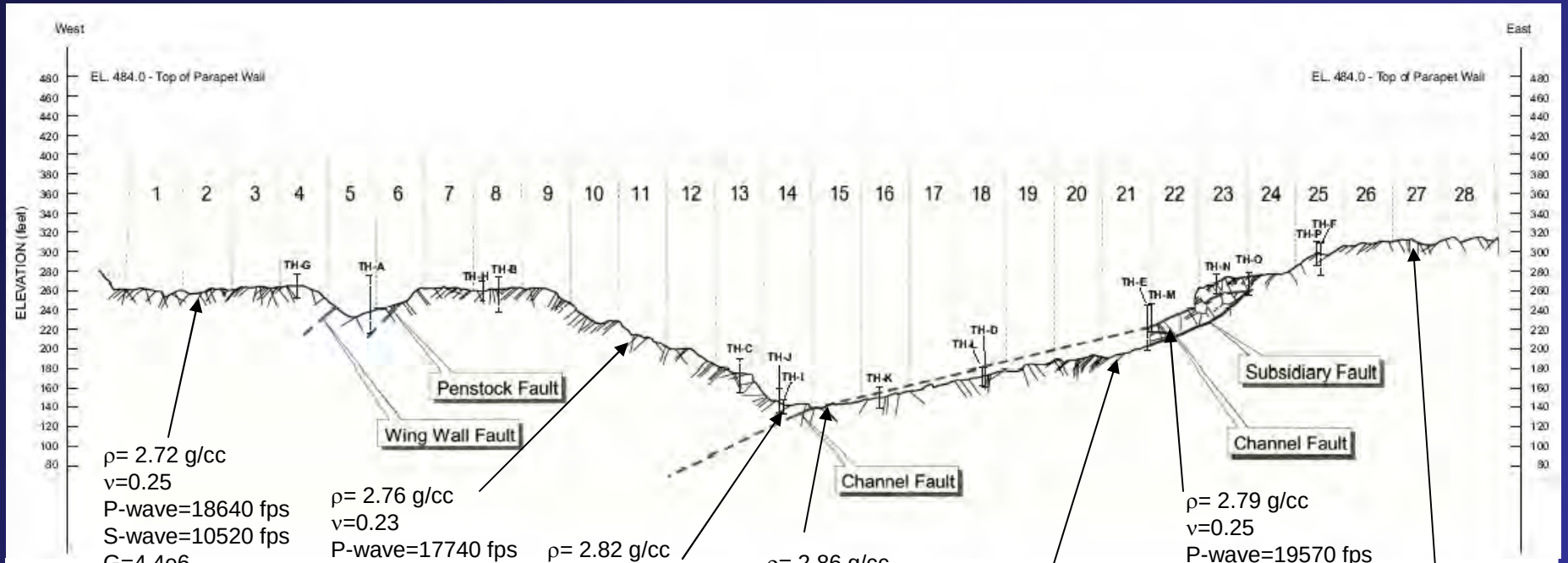

Shear Modulus (psi)
0
2e+6
4e+6
6e+6
8e+6
1e+7
Elevation (ft)
280
260
240
220
200
180
160
140


Poisson's Ratio
-1.0
-0.5
0.0
0.5
1.0
Elevation (ft)
280
260
240
220
200
180
160
140


Young's Modulus (psi)
0.0
5.0e+6
1.0e+7
1.5e+7
2.0e+7
Elevation (ft)
280
260
240
220
200
180
160
140


0.0
1.0e+7
2.0e+7
3.0e+7
4.0e+7
Elevation (ft)
280
260
240
220
200
180
160
140
Constrained Modulus (psi)
Bulk Modulus (psi)

Average Sonic Logging Data and Computed Elastic Parameters								
Mono No.	Density g/cc	P-wave velocity fps	S-wave velocity fps	Poisson's ratio	Shear modulus psi	Young's modulus psi	Constrained modulus psi	Bulk modulus psi
2	2.72	18,650	10,500	0.27	4.037E+06	1.024E+07	2.206E+07	7.354E+06
11	2.76	17,550	10,200	0.24	3.866E+06	9.626E+06	1.887E+07	6.290E+06
14	2.82	18,800	11,300	0.22	4.848E+06	1.180E+07	2.086E+07	6.955E+06
15	2.86	18,850	11,200	0.23	4.830E+06	1.185E+07	2.172E+07	7.242E+06
21	2.76	19,500	11,400	0.24	4.829E+06	1.198E+07	2.307E+07	7.691E+06
22	2.79	19,500	11,450	0.24	4.925E+06	1.218E+07	2.315E+07	7.717E+06
27	2.77	19,450	11,400	0.24	4.847E+06	1.200E+07	2.294E+07	7.646E+06
Average	2.78	18,900	11,064	0.24	4.597E+06	1.138E+07	2.181E+07	7.271E+06



ρ= 2.72 g/cc
ν=0.25
P-wave=18640 fps
S-wave=10520 fps
G=4.4e6
E=1.08e7

ρ= 2.76 g/cc
ν=0.23
P-wave=17740 fps
S-wave=10200 fps
G=4.18e6
E=9.7e6

ρ= 2.82 g/cc
ν=0.21
P-wave=18825 fps
S-wave=11300 fps
G=4.78e6
E=1.18e7

ρ= 2.86 g/cc
ν=0.24
P-wave=18850 fps
S-wave=11200 fps
G=4.93e6
E=1.21e7

ρ= 2.76 g/cc
ν=0.23
P-wave=19500 fps
S-wave=11400 fps
G=4.88e6
E=1.19e7

ρ= 2.79 g/cc
ν=0.25
P-wave=19570 fps
S-wave=11450 fps
G=4.93e6
E=1.2e7

ρ= 2.77 g/cc
ν=0.25
P-wave=19460 fps
S-wave=11380 fps
G=4.86e6
E=1.2e7

ρ = Density
ν = Poisson's Ratio
P-wave = Compression Wave
S-wave = Shear Wave
G = Shear Modulus
E = Young's Modulus

Average Velocity and Elastic Parameter Values for the Foundation Materials Beneath the Concrete Section of Folsom Dam, CA

Density g/cc	P-wave velocity fps	S-wave velocity fps	Poisson ratio	Shear modulus psi	Young's modulus psi	Constrained modulus psi	Bulk modulus psi
2.78	19,300	9,200	0.32	3.3E+06	8.5E+06	2.9E+07	9.9E+06

Summary

- The purpose of this study was to determine foundation properties for input into the dynamic analyses program
- Evaluate potential for use of sonic logging in drain holes
- Comparison of sonic logging and traditional crosshole results was excellent
- Foundation properties consistent with those previously reported


Reconstruction of Deteriorated Concrete
Lock Walls After Blasting and Other
Demolition Removal Techniques
by
STEPHEN G. O'CONNOR
CORPS OF ENGINEERS - St. Louis District
August 4, 2005

US Army Corps of Engineers

St. Louis District



LOCK and DAM 24

US Army Corps of Engineers

St. Louis District

GENERAL INFORMATION

- LOCK and DAM 24
  - approximately 40 miles north of St. Louis, MO.
- CONTRACT WAS A BEST VALUE
  - type of work
  - experience of contractor
- CONTRACT RESTRICTIONS
  - 3 lock closures: 1@ 60 days and 2 @ 90 days
  - river side of the intermediate wall
  - chamber side of the intermediate wall
  - chamber side of the land wall
- PARTNERING CONFERENCE

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CONCRETE REMOVAL

- BLASTING
- MECHANICAL METHODS
  - GRINDERS
  - HYDRUALIC BREAKERS
- DIAMOND WIRE SAW
- CHEMICAL GROUTING
- HAND TOOLS
  - SAW
  - SMALL JACK HAMMERS

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BOOM!!!



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PRE-BLAST PREPARATION



MONITORING EQUIPMENT



JOINT BOLTS READINGS

BEFORE and AFTER BLASTING





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PRE-BLAST DRILLING









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PLACEMENT OF EXPLOSIVES







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BLASTING







SAFETY

BLASTING MATS

CATCH BARGE

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BLASTING PATTERNS







LINE BREAKAGE

EMBEDDED ITEMS

SURFACE REMOVAL

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BLAST DAMAGE







LEDGE DAMAGE

CONTROL HOUSE

COMPLETED SURFACES

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MECHANICAL REMOVAL-GRINDER









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MECHANICAL REMOVAL-GRINDER









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DUST CONTROL





DUST CONTROL



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MECHANICAL REMOVAL-GRINDER





LOCK FLOOR-SHALE REMOVAL

NEW FLOOR-SUMP AREA

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MECHANICAL REMOVAL-HYDRUALIC BREAKERS









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DIAMOND WIRE SAW







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DIAMOND WIRE SAW







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CHEMICAL GROUTING







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HAND TOOLS-SMALL JACK HAMMERS







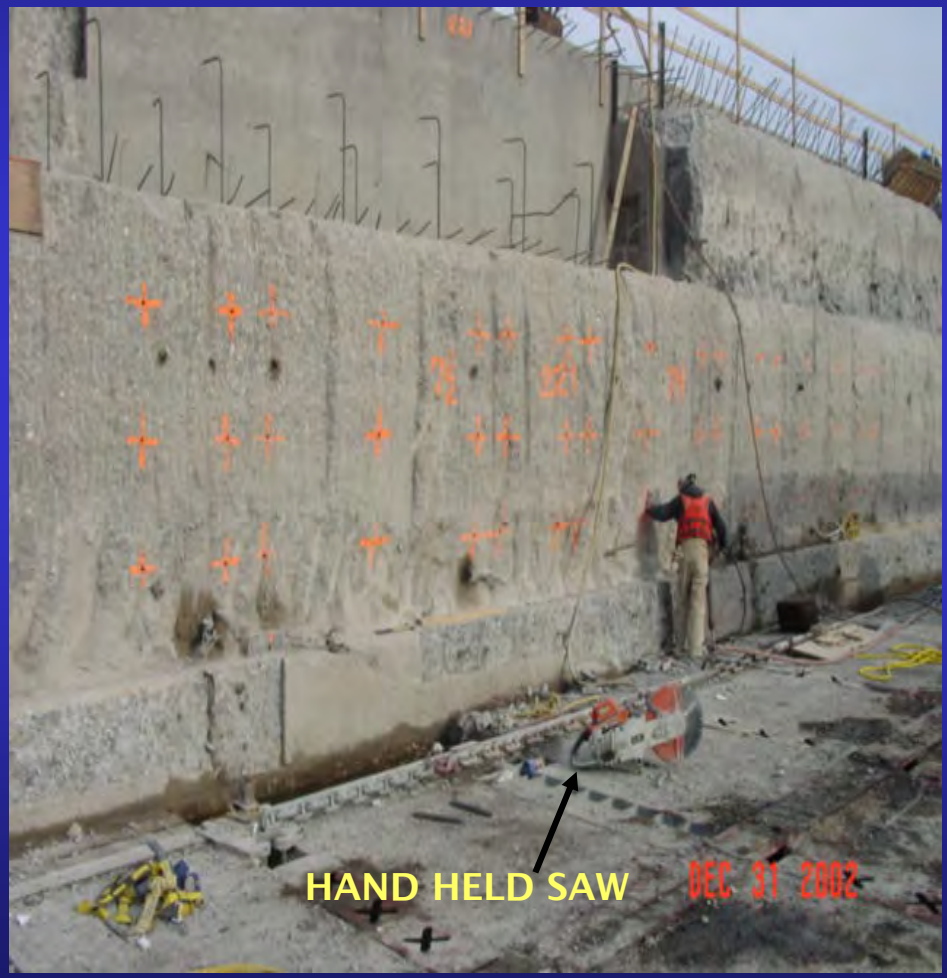
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HAND TOOLS-SAW







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OH NO!!!









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CLEAN UP







LOCK FLOOR-EACH CLOSURE PERIOD

RIVER SIDE-INTERMEDIATE WALL

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CLEAN UP







MATERIAL HAULED OFF SITE FOR DISPOSAL

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QUANTITIES of CONRETE REMOVAL

BLASTING: 2,900 CY

MECHANICAL: 2,600 CY

TOTAL: 5,500 CY

SAW CUTTING: 4,700 LF

DIAMOND WIRE SAWING: 3 LOCATIONS

CHEMICAL GROUTING: 3 LOCATIONS

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QUANTITIES of CONCRETE RECONSTRUCTION

CAST IN PLACE CONCRETE:	*8,850 CY*
INFILL CONCRETE (BEHIND PANELS):	*270 CY*
TOTAL CONCRETE:	*9,120 CY*
PRE CAST CONCRETE PANELS:	*29,960 SF*

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LOCK and DAM 24



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St. Louis District

STEPHEN G. O'CONNOR

US ARMY CORPS of ENGINEERS

Stephen.G.Oconnor@mvs02.usace.army.mil

314-331-8425

US Army Corps of Engineers
Louisville District

Next Stop, The Twilight Zone

Louisville District

2004-05 Flood Duty Response

Troy S. O'Neal, P.E.

Situation

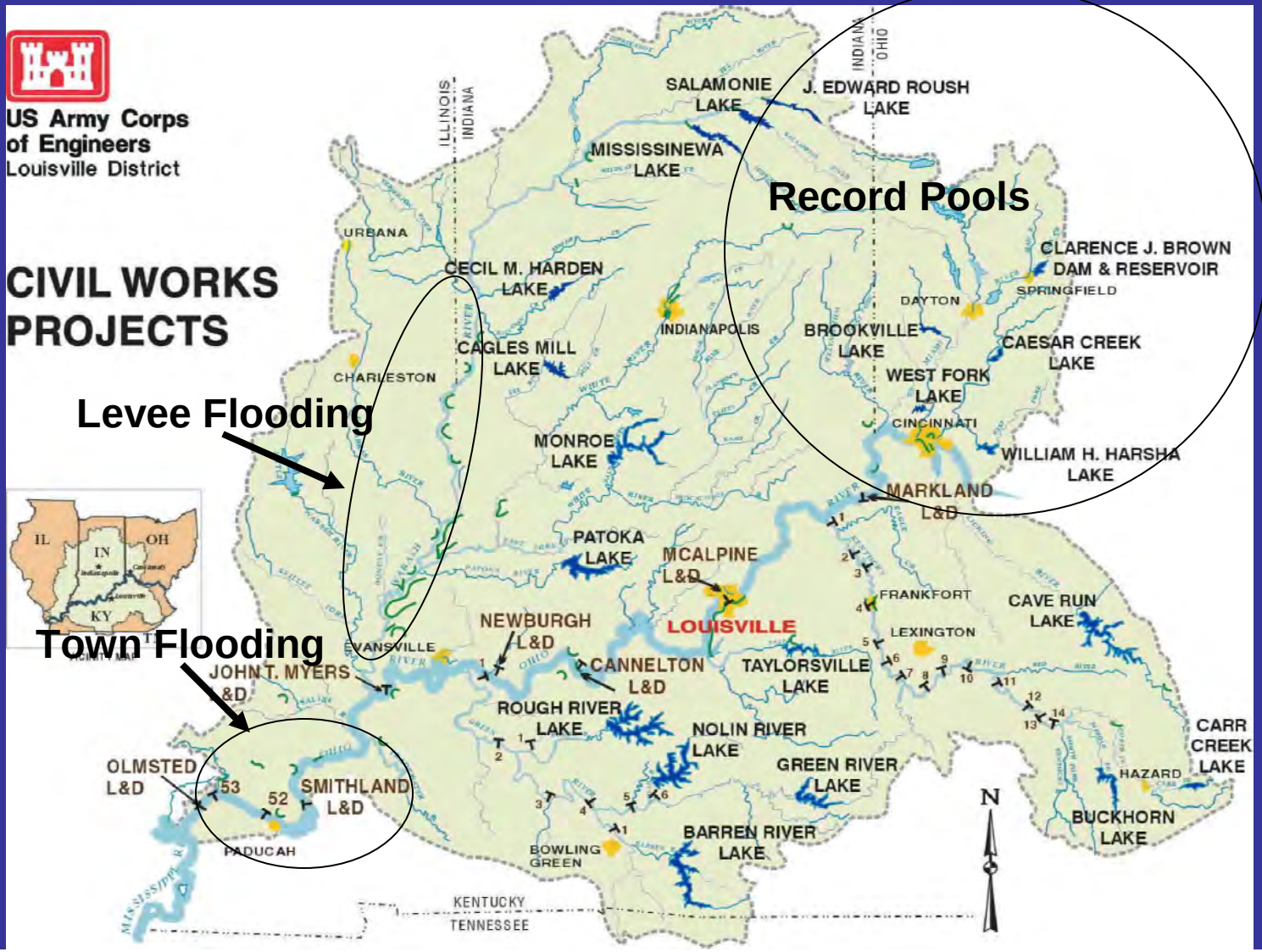
Heavy rains caused river banks to flood endangering levee systems.

District dams held water to reduce river inflow resulting in record pools.

District Emergency Operation Center activated.

US Army Corps
of Engineers
Louisville District

Flood Duty Response



Take Away Points

Before Flood

Have prepared “Fly Away” kit

Resolve communications ahead of time

- Cell phone with camera
- Computer with internet
- Establish district chain of communication

During Flood

Drive 4X4

Always try to take decent mapping of area

Evaluate safety of people and yourself first upon arrival

Think logistics (sandbagging)

Be prepared for media

Make a plan and execute it

Martinsville, IN Flood

1. Possible levee overtopping in next 12 hours.
2. Consequences – Flooding of town and local agriculture.

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of Engineers
Louisville District

Flood Duty Response



US Army Corps
of Engineers
Louisville District

Flood Duty Response



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of Engineers
Louisville District

Flood Duty Response



Paducah, KY Flooding

1. Seepage reported 100 ft below flood wall.
2. Void opened up in adjacent parking lot.

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of Engineers
Louisville District

Flood Duty Response



US Army Corps
of Engineers
Louisville District

Flood Duty Response



US Army Corps of Engineers
Louisville District

Flood Duty Response



Solution

1. Attempted to place gravel/sand around headwall to clog.
2. Supplement existing pump house with two 6-inch portable pumps.
3. Fix headwall after water recedes.



Smithland, KY Flooding

1. Rising Ohio River threatens to flood town within three days.
2. Previous sandbagging in 1986 (500,000 bags).

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of Engineers
Louisville District

Flood Duty Response



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Louisville District

Flood Duty Response



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Terre Haute, IN Flooding



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Flood Duty Response



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Hazelton, IN

1. Remote agricultural levee in threat of overtopping.

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Flood Duty Response



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Flood Duty Response



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Flood Duty Response



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Flood Duty Response



J. Edward Roush Dam, IN

US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

J. Edward Roush Dam **Flood Duty Response**

July 2005 high pool event (pool elevation of 799.9)





J. Edward Roush Dam **Flood Duty Response**

July 2005 high pool event (pool elevation of 799.9)





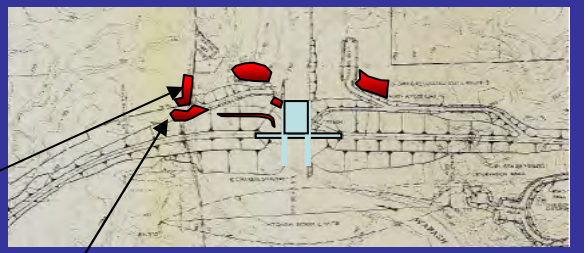
US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

J. Edward Roush Dam

Flood Duty Response

New seepage locations at downstream toe near residence.







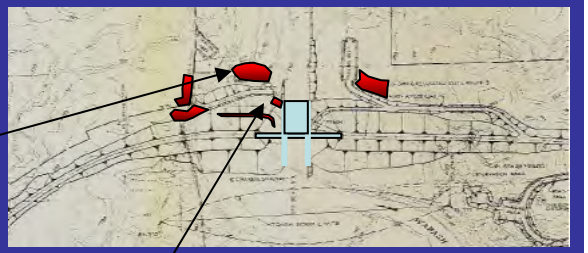
US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

J. Edward Roush Dam

Flood Duty Response







Questions?



Tri Services ISC - Geotechnical Track 6
Wednesday, August 3, 2005
Room 227

State of the Art in Grouting

Dams on Solution Susceptible
or
Fractured Rock Foundations

Arthur H. Walz, Jr., P.E.

Gannett Fleming
ENGINEERS AND PLANNERS

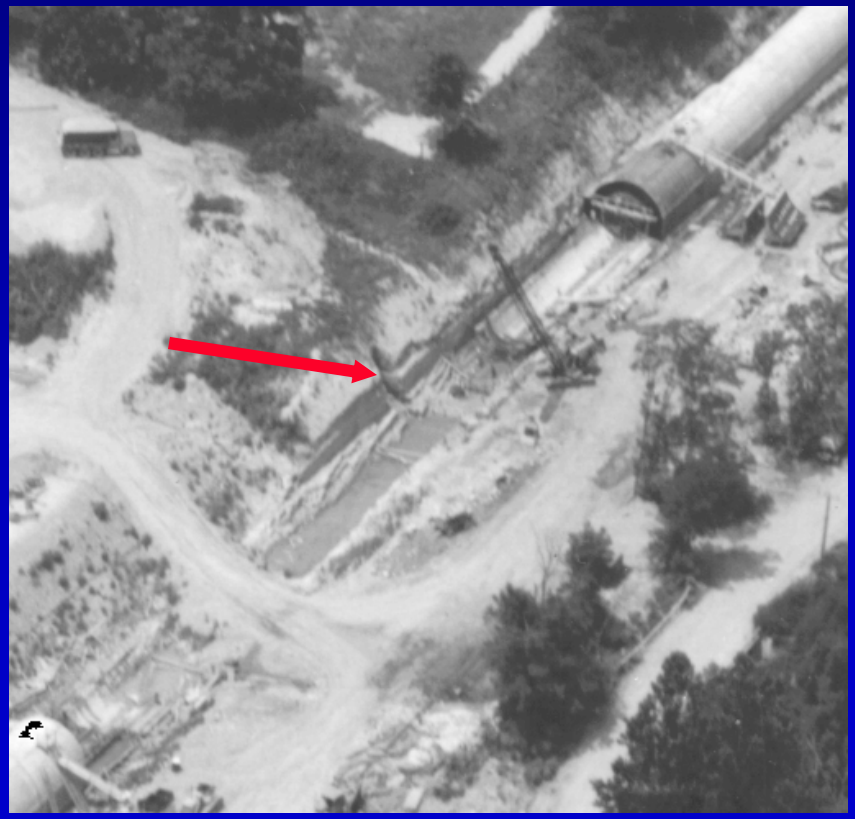
Track 6

- Overview of USACE dams on solution susceptible or fractured rock foundations
- Special drilling and grouting techniques for remedial work in embankment dams
- Composite grouting and cutoff wall solutions
- State of the art in grout mixes
- State of the art computer control, monitoring and analysis of grouting
- Quantitatively engineered grout curtains

Solution Susceptible Rock Foundation



Indiana Limestone



Solution Susceptible Rock Foundation



Indiana Limestone

Solution Susceptible Rock Foundation





Boone Formation
Beaver Dam, AK

Fractured Rock Foundation



Fractured Rock Foundation



Western Maryland

Rock Foundation at Clearwater Dam



Fractured Rock Foundation



Basic Technical Requirements
for an
Embankment Dam

- Must have sufficient spillway and outlet capacity as well as adequate freeboard to prevent over topping by the reservoir
- Must be stable under all loading conditions
- Dam and "foundation" must be sufficiently watertight and have adequate seepage control for safe operation

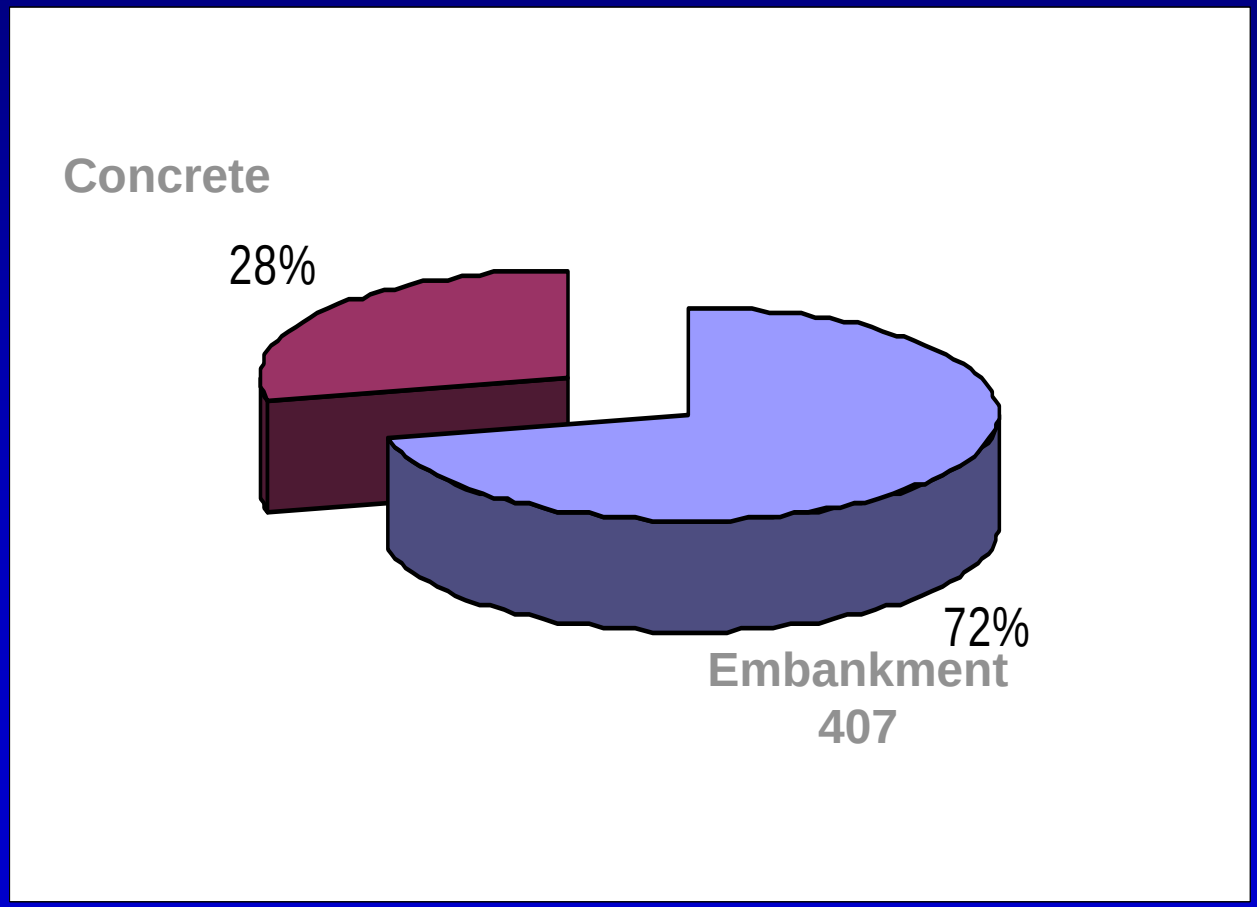
Causes of Dam Failures in the United States
Embankment Dams *

	Cause	1955	Current
1.	Inadequate spillway capacity	30%	40%
2.	Seepage/piping	25%	37%
3.	slides	15%	6%
4.	Conduit leakage	13%	
5.	Slope protection	5%	→ 17%
6.	Unknown	12%	

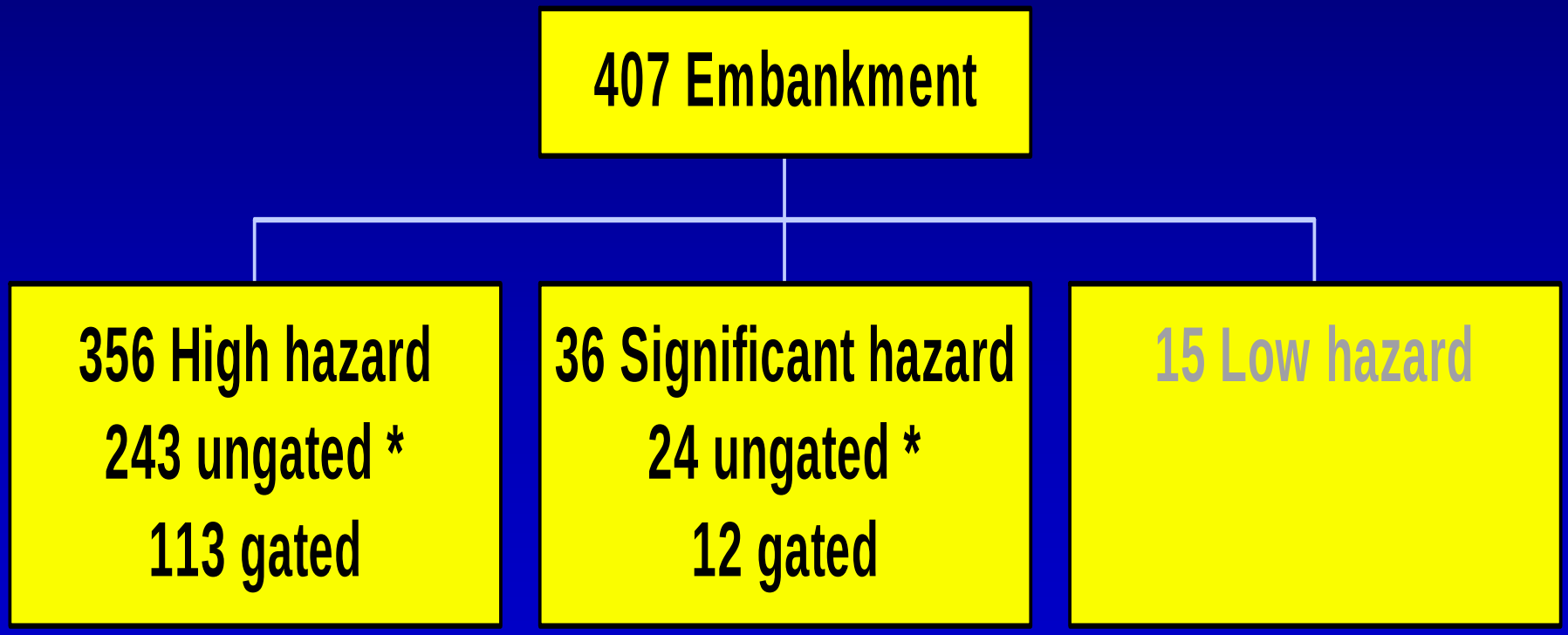
* Source – National Inspection of Dams Program, Corps of Engineers survey and Bureau of Reclamation survey

Corps of Engineers Dams

569 Total dams (2000)

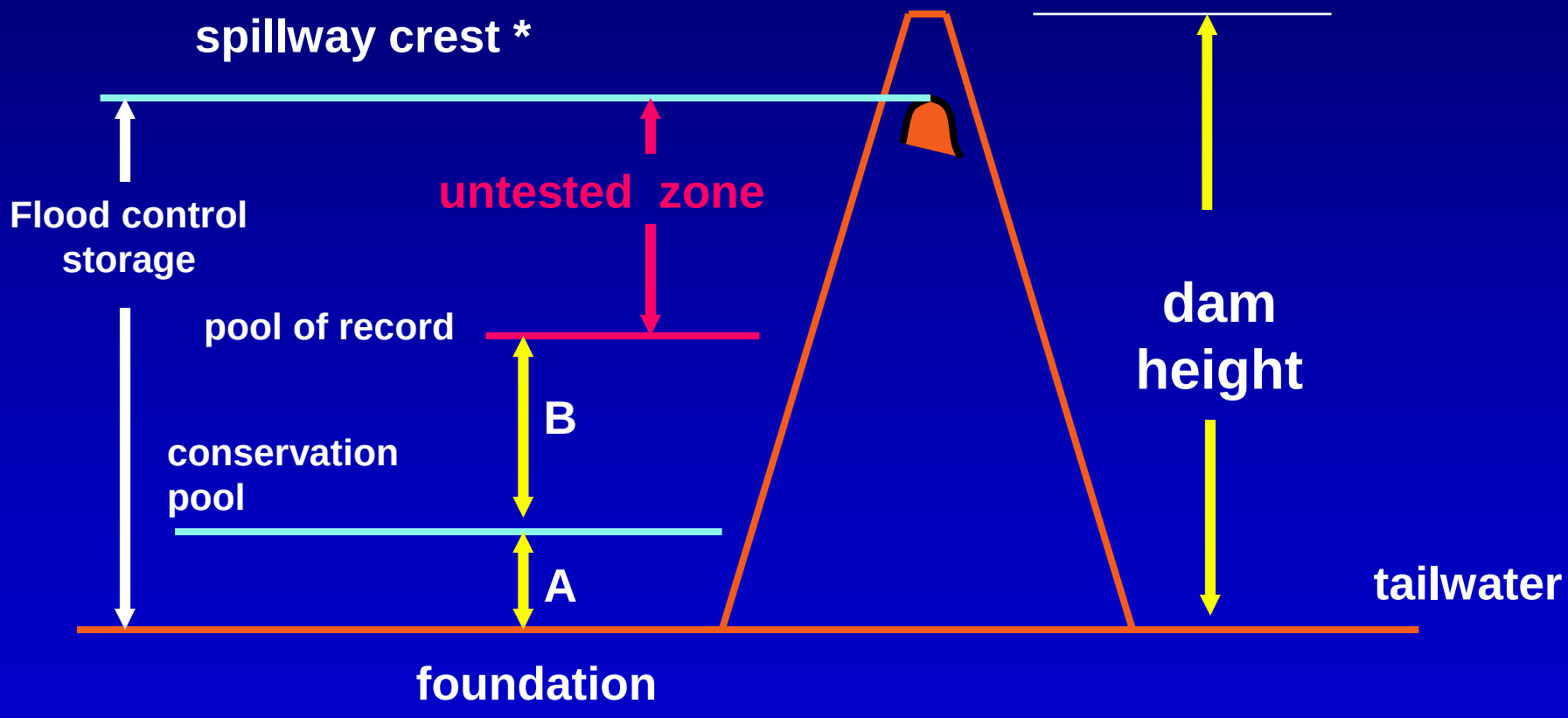


Corps of Engineers Embankment Dams
by
Hazard Classification & Spillway Operation



* Flood control loading in feet of head is greatest for ungated dams

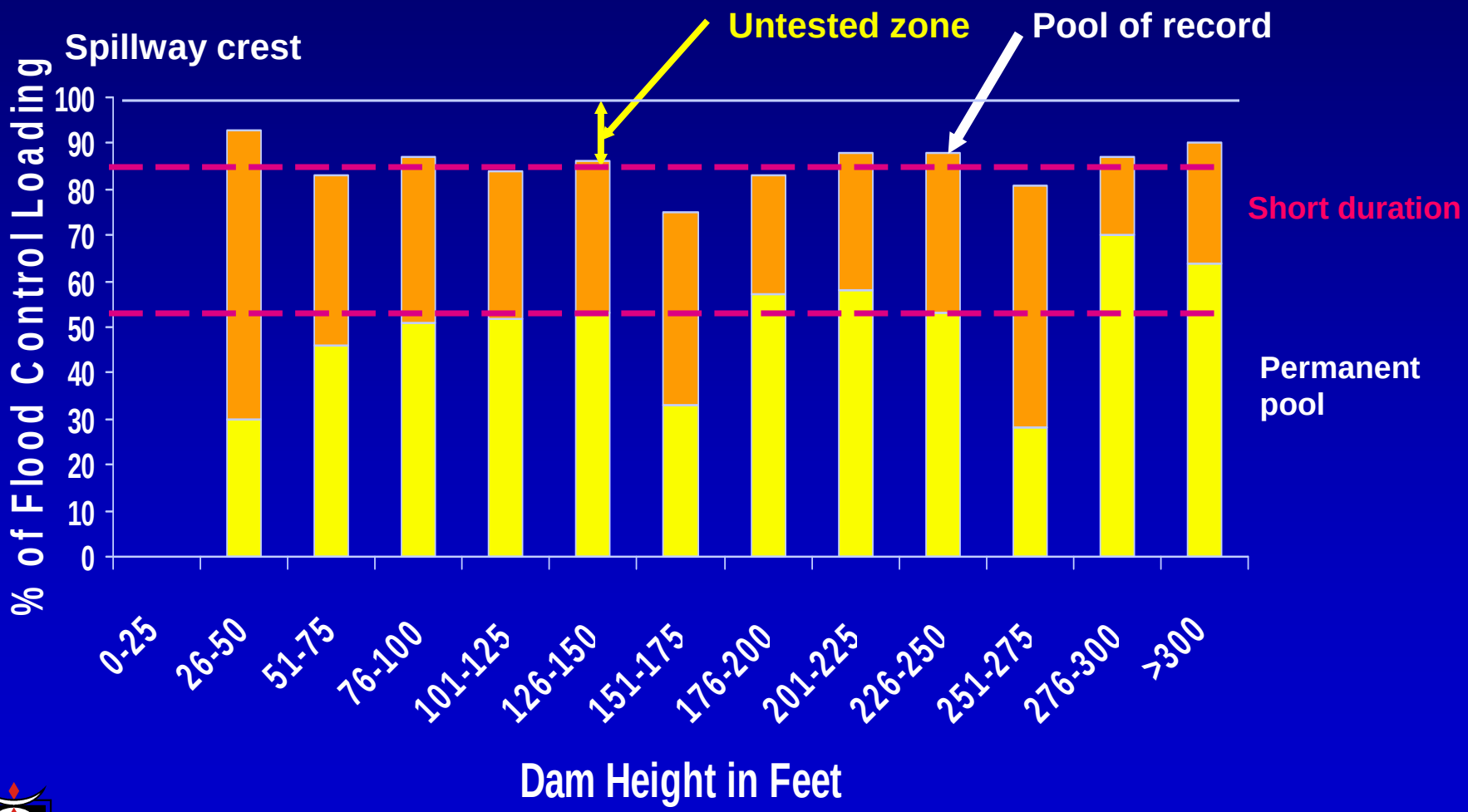
Schematic of an Ungated Flood Control Dam



Total Loading History

High Hazard Ungated Dams

as of 2000



41 0f the 243 have experienced spillway flow

Uplift in Rock and Seepage



Reservoir at 35% storage capacity

Summary of 1976 HQ Survey

MSC	Solution	Fractured	Both
LRD			
LRL	2		
LRN	5		
LRB		1	
NAD			
NAB			1
NAO	1		
MVD			
MVK	1		
MVR	1		
MVS	1		1
NWD			
NWK	5		1
NOW			3
NWW		1	

MSC	Solution	Fractured	Both
SAD			
SAJ	1		
SAM	1	1	
SPD			
SPA	1		
SPK	1	1	
SWD			
SWF	6		
SWL	5		
SWT	4		1

	Solution	Fractured	Both
USACE Total	35	4	7

Some Recent Corps Experiences with Existing Dams That Required or will Require Modification

- **Hartwell Dike, SC –** cutoff wall
- **Beaver Dam, AK –** secant pile cutoff
- **Patoka Dam, IN** - grouting
- **Mississineau Dam, IN –** grouting and then panel wall
- **Walter F. George, GA –** grouting with panel wall
- **Clearwater Dam, AK –** emergency grouting then permanent grouting and then cutoff wall
- **Wolf Creek, TN –** report with recommendations being submitted to headquarters

Considerations in Selecting the Type of Cutoff for Seepage Control

- Exploration and investigations
- Site characterization
- Physical properties of the fractured or solution susceptible rock foundation
- Establishing the depth and length of cutoff
- Contracting procedure

  IFB, RFP and Best Value

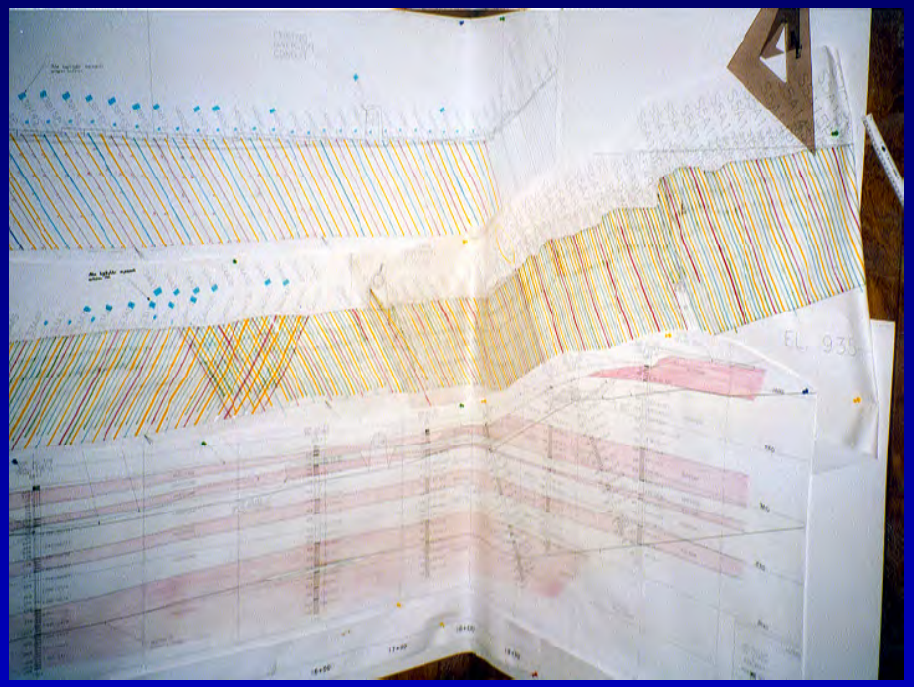
Conventional Grouting



Dipstick measurements



Mechanical gages and
manual monitoring



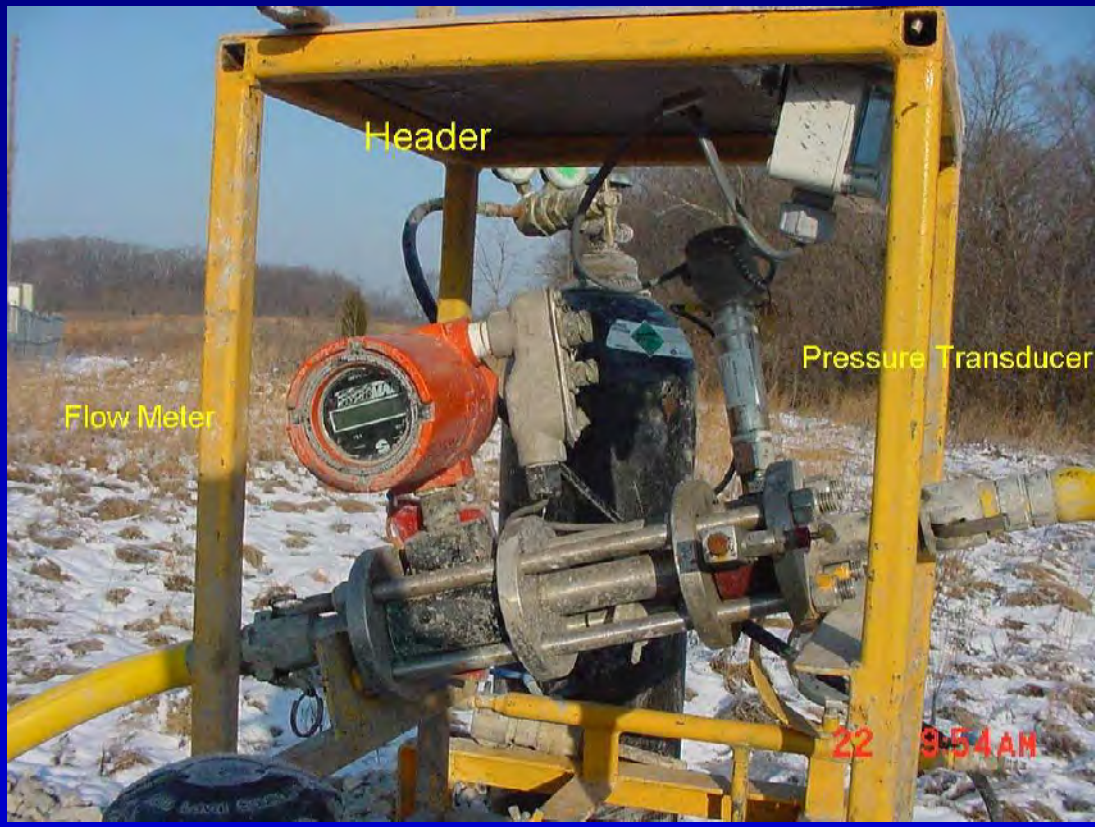
Time consuming
manually prepared charts


RESULTS ??
$$$
General Impression of Conventional Grouting

Recent Development in Grouting Materials, Equipment and Procedures

1. Drilling and grouting techniques





Recent Development in Grouting Materials, Equipment and Procedures

2. State of the art Grout mixes



Neat Cement



Balanced Stabilized

Recent Development in Grouting Materials, Equipment and Procedures

2. State of the art Grout mixes



Computer controlled batch plant

Recent Development in Grouting Materials, Equipment and Procedures

3. Composite grouting and cutoff walls

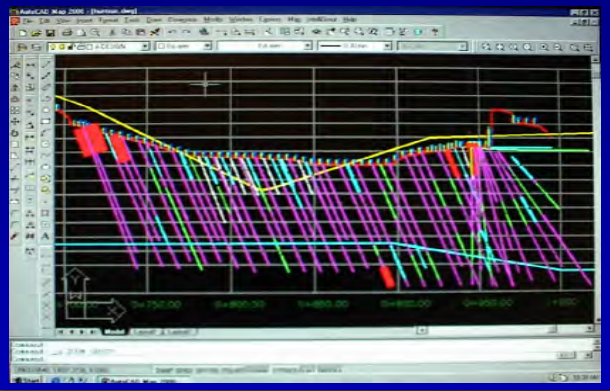


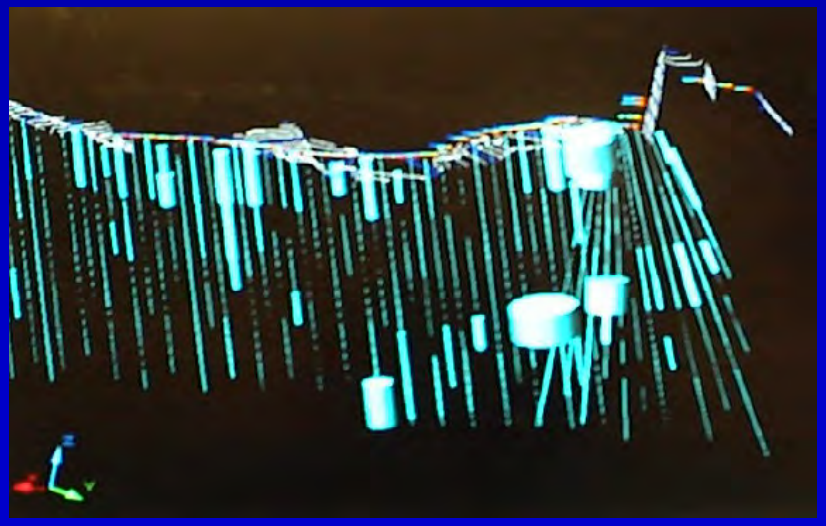


Recent Development in Grouting Materials, Equipment and Procedures

4. State of the art computer control, monitoring and analysis of grouting



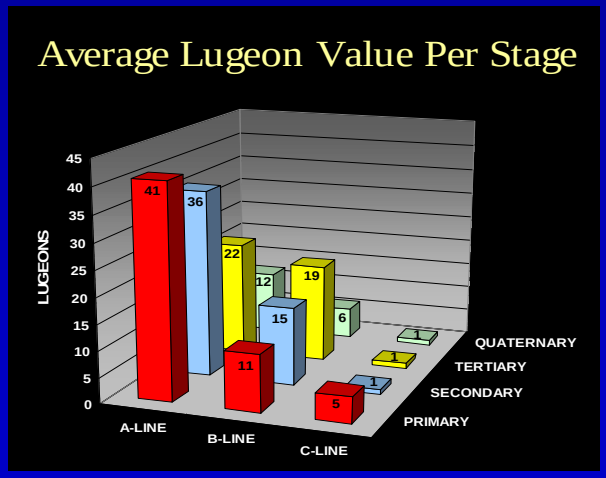




Recent Development in Grouting Materials, Equipment and Procedures

5. Quantitatively engineered grout curtains

- Evaluation of geologic conditions
- Detailed site characterization
- Design of grout curtains as an intergral part of the project to achieve specific results
- Best value contracting



Summary

Establishing the initial or remedial seepage cutoff for a water resources project can be difficult, expensive and requires monitoring and future evaluation

Recent advances in grouting technology, materials, practices and procedures have made multiple line grouting a reliable and cost effective method to control seepage or the flow of groundwater



Critical Information
for
Flood Control Operation of Dams

- Inflow predictions
- Projected reservoir levels
- Corresponding storage
- Predicted performance of the dam and structures
- Threshold for changes in monitoring program
- Threshold for potential operational changes due to structural performance
- Draw down capability
  - with full bank discharge capacity
  - with full discharge

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Chicago District

Armor Stone Durability In the Great Lakes Environment

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Sources of Stone Recently Used in Chicago District

Valders and Hayton, WI - dolomite

Wausau, WI - blasted and drilled/split granite

Little Current, Ont. - quartzite

Waterloo, WI - quartzite

Bloomington area, IN cut limestone

Ste. Genevieve, MO blasted limestone



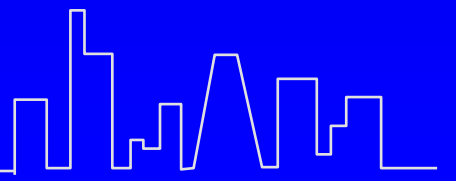
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Stone Types

A-Stone: Large Stone in Direct Contact with Water

B-Stone: Underlayer Stone – Transitional Layer

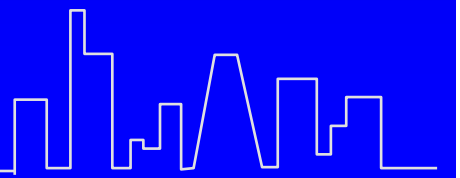
C-Stone: Bedding Between Foundation and B-Stone



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Stone / Rock Types Used in the Chicago District

- Cut Limestone Blocks – Early 1900s to present
- Blasted Limestone and Dolomite – 1960s to present
- Blasted Quartzite – Early 1990s to present
- Blasted Granite – Late 1990s to present
- Drilled and split granite – 2005



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Cut Limestone Blocks







Used initially in “Laid Up” structures

Later used in rubble mound and as capstone

Blasted Dolomite and Limestone

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Blasted Quartzite





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Blasted Granite







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Drilled and Split Granite







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Stone Materials Specifications

Great Lakes Stone Team in late 1990s to address inconsistencies

- **Representatives of 3 Districts, Local Sponsors and Industry**
- **Developed Great Lakes Armor Stone Guide Specification**
- **Included Combination of Visually-verified and Laboratory Criteria**
  - **Laboratory Criteria Based on Concrete Aggregate Tests**
  - **Visual Criteria Subject to Some Discretion**
- **On-Site Meetings at Sources to Establish Mutual Understanding**
  - **Use of Reference/Index Stones at Quarry to Display Features**

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Laboratory Test Criteria

Test	Test Method	Acceptance Criteria
Specific Gravity[3/]	ASTM C 127	2.6 - 3.0
Absorption[1/2]	ASTM C 127	< 1 percent and > 3 percent
Los Angeles Abrasion	ASTM C 535	< 20 percent loss after 500 revolutions
Freeze-Thaw [1/2]	ASTM D 5312	< 2 percent loss after 35 cycles
Wetting-Drying [1/2]	ASTM D 5313	< 2 percent loss after 80 cycles
Petrographic Examination	ASTM C 295	No deleterious materials allowed
Field Examination	ASTM D 4992	No deleterious materials allowed

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Visually Identified Criteria

"…quality to insure permanence of structure in the climate in which it is to be used… …free of features which may tend to increase deterioration from natural causes or breakage during handling, transportation, or placement. "

Vugs: Less than 5% of exposed surface area exhibiting vugs, and vugs shall not be aligned along bedding planes. No vugs greater than 4-inches in diameter.

Stylolites shall not exhibit gaps, separation or clay mineralization or appear likely to separate.

Dimensional aspect ratio 3:1 based on measurements of 3 mutually perpendicular axes when represented within a rectangular "box" orientation.

No fractures or bedding planes that appear likely to cause failure

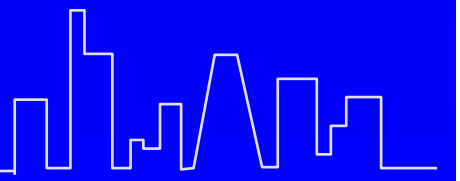
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Factors That Impact Armor Stone Durability

- **Environment and Climate – Nature of Project**

- **Above or Below Water Placement**
  - **Prefer no distinction in acceptance criteria to avoid confusion in field**
  - **Contractors unlikely to charge less for lower quality, so why lower standards?**

- **Production Methods**
  - **Cut Stone – Oolitic Limestone and Sandstone**
  - **Drilled and Split Stone**
  - **Blasted Stone**
  - **Curing and Aging**



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Factors That Impact Armor Stone Durability
Cont'd

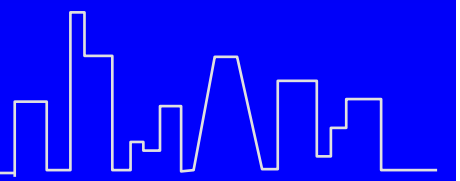
- **Rock Type**

  - Sedimentary rock has inherent anisotropy

  - Carbonates (and any sedimentary rock) vary based on depositional environment. Carbonates are often most readily available

  - Meta-quartzite has uniform mineralogy and crystalline intergrowth

  - Granite includes variation in mineralogy and crystalline intergrowth



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Factors That Impact Armor Stone Durability
Cont'd

Discontinuities, etc.

Fractures – mechanically caused by excavation methods

Joints – naturally occurring as a consequence of lithification and stresses

Bedding – separation planes and clay or oxidized minerals along bedding

Stylolites – suture-like features formed in conjunction with pressure dissolution

Micaceous or mineralized zones – biotite, sericite and clay minerals are weaker than surrounding rock

Vugs – discontinuous voids or bubbles in rock mass

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Fractures

Small fractures require careful inspection to detect

May require wetting stone to aid visibility

Discontinuous fractures of no consequence





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Joints

Often detected during quarrying

May worsen with exposure





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Bedding





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Stylolites







May or may not be a problem

May represent failure surfaces

May be more durable than surrounding rock

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Micaceous / Mineralized Zones



Diseminated softer minerals may cause fracturing during handling and placement



Clay along joints or bedding planes

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Vugs







May or may not be a problem

Act as havens for vegetation

If aligned form plane of weakness

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Factors That Impact Armor Stone Durability
Cont'd

Transportation, Handling and Placement

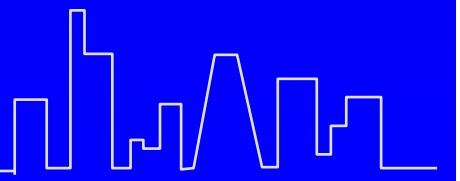




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Quality Control and Quality Assurance

- **Shift from intensive Government Inspection (QA) to Contractor QC**
- **Training and qualifications of Contractor QC personnel**
- **Training and technical support (Design and A/E) for Government QA personnel**
- **Quarry visit to establish acceptance criteria**
- **QC oversight during quarrying, selection and transportation**
- **QA oversight throughout**



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Quarry Visits to Establish Acceptance Criteria



- **Resolve misunderstandings early**
- **Document agreements**

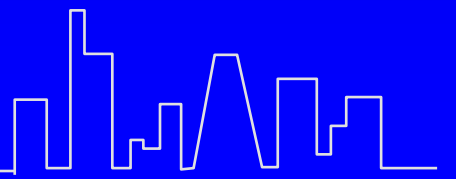
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Ongoing Investigations

Monitoring of Completed Coastal Projects – MCCP

- 1994-1998 study of armor stone in Great Lakes region
- Included investigations in laboratory, quarries and project performance
- 4 Structures in Lake Michigan and one in Lake Erie (Chicago Harbor, Calumet Harbor, Burns Harbor, Calumet Harbor CDF, and Cleveland Harbor)

Monitoring Report produced in 2004-2005 summarizing results



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Ongoing Investigations

Monitoring of Completed Navigation Projects – MCNP

- 2005 – 2010 study of armor stone durability

- Includes investigations in laboratory, quarries and project performance

- 3 Structures in Great Lakes – Lake Michigan, Lake Erie and Lake Superior
  (Burns Harbor, IN; Cleveland Harbor, OH and Keweenaw Harbor, MI)

Study of factors in durability, effects of scale on laboratory tests, develop guidelines for selection criteria, possibly develop testing protocols and guidance documents

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Questions, Comments, Feedback???
(please don't throw stones)



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Soil-Bentonite Cutoff Wall Through Dense Alluvium with Boulders into Bedrock, McCook Reservoir

Tri-Services Infra-Structure Conference

2-4 August 2005

(St. Louis, MO)

William A. Rochford, P.E.

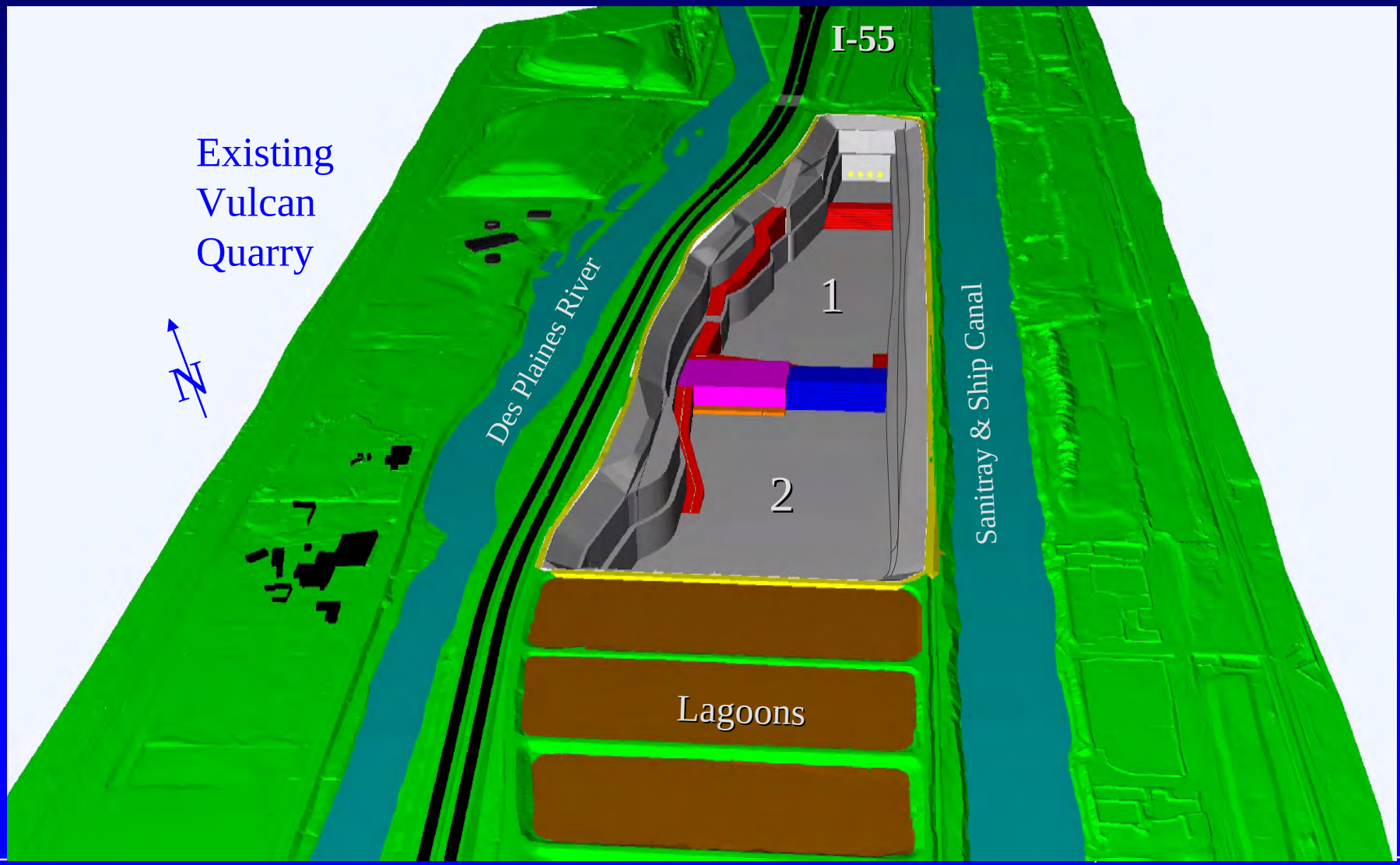
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Outline

- Reason for Cutoff Wall
- Test Section
- Demonstration Section
- Verification
- Lessons Learned

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Reservoir Plan Schematic



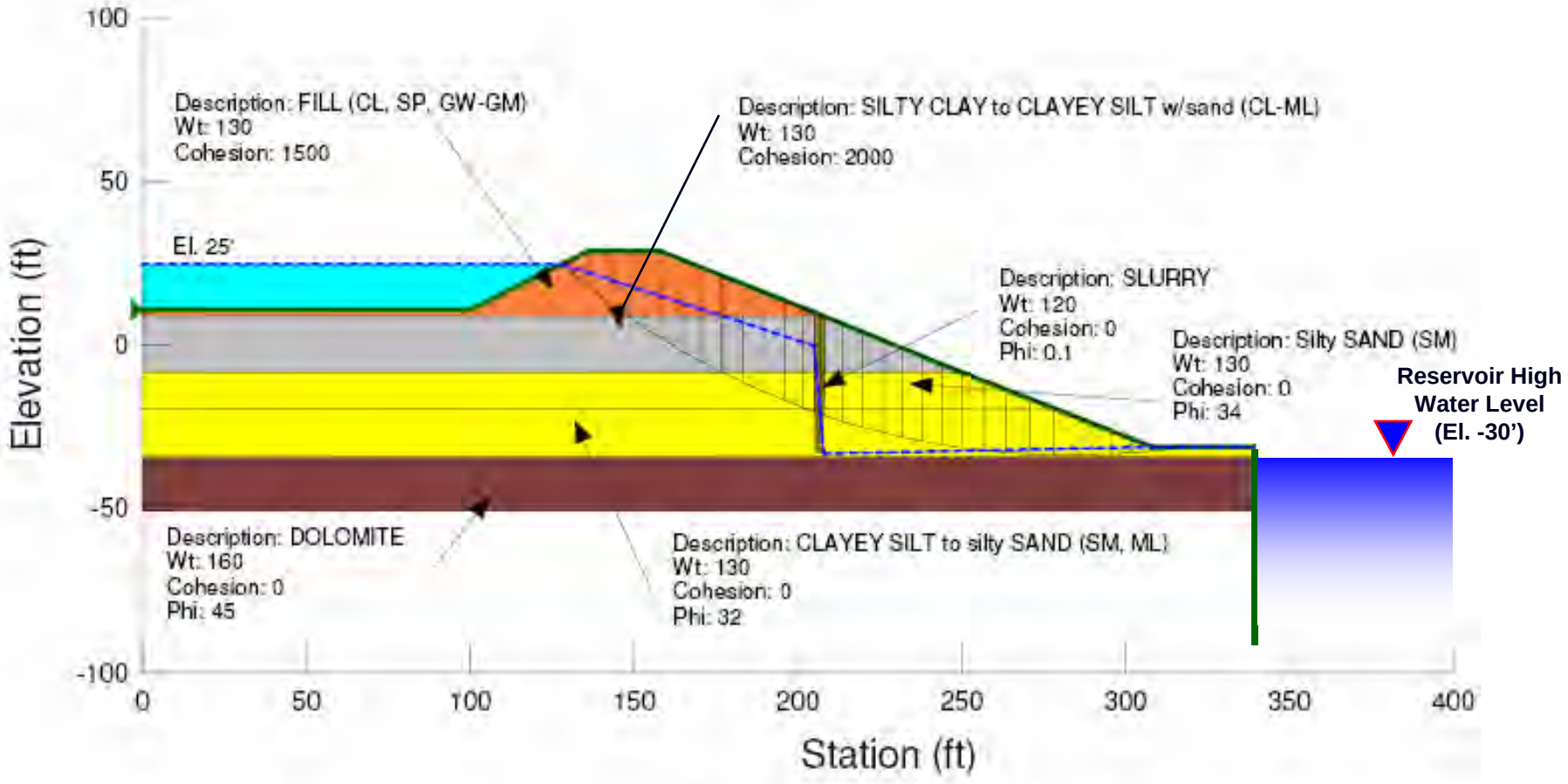
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Historic River Channel



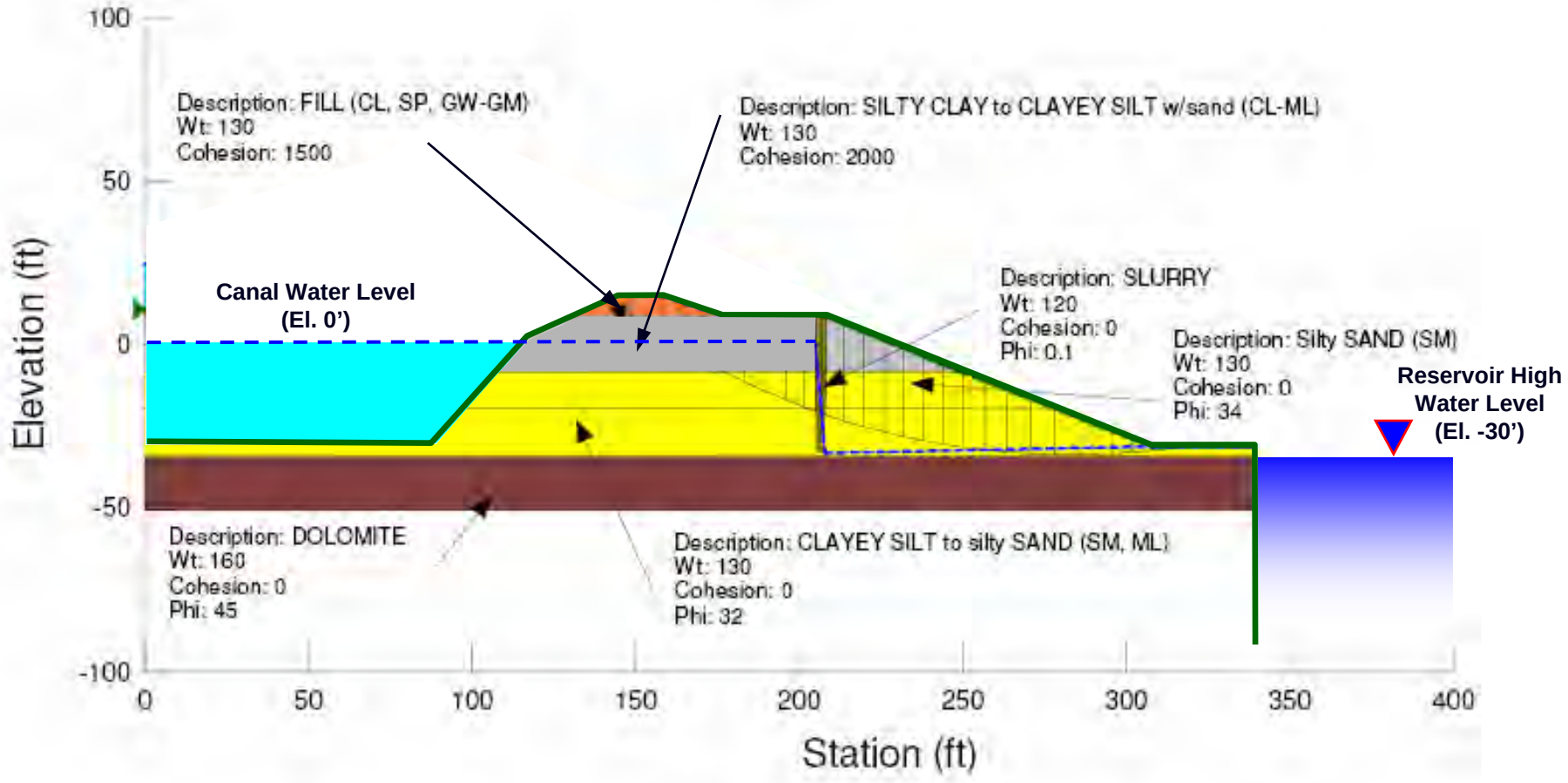
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Riverside & Lagoon Cross-Section



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Canalside Cross-Section



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Slope Erosion



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Test Section

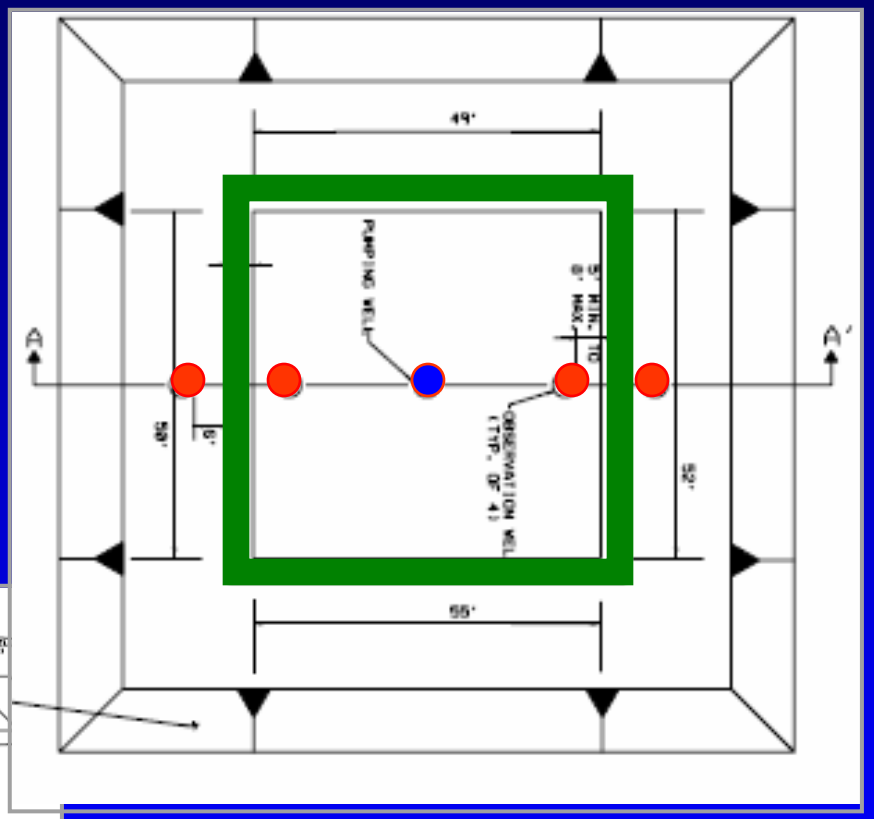
- Construction – July-Aug 2000
- 4-sided Box (50’ x 50’)
- Pump Test

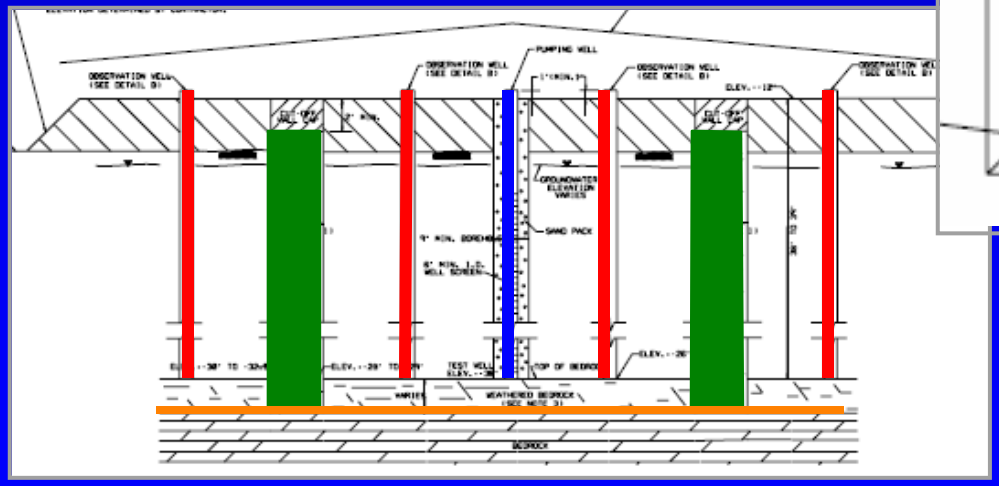


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Test Section







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Excavator







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Boulders





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Hardpan



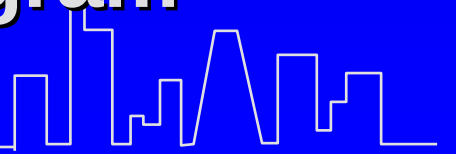


Soil Type	USCS Classification	Moisture Content w_c%	Dry Density γ_d	Specific Gravity G_s
Clayey Silt	ML	9.8	133.3	2.75

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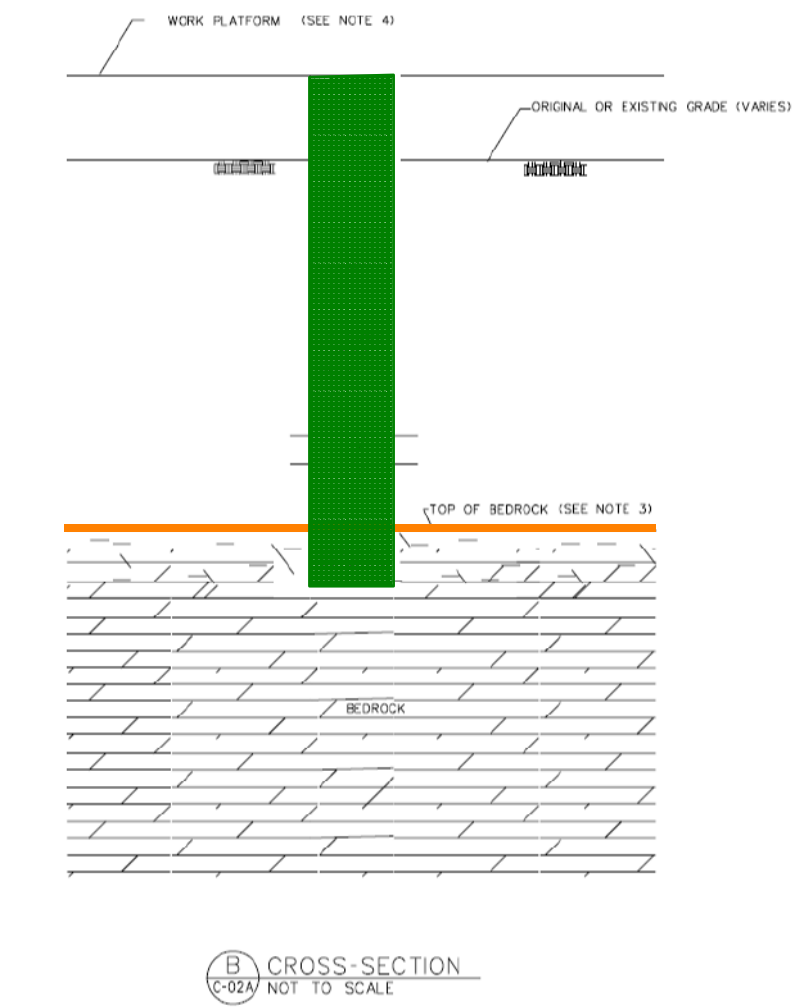
Demonstration Section & Initial Wall Construction

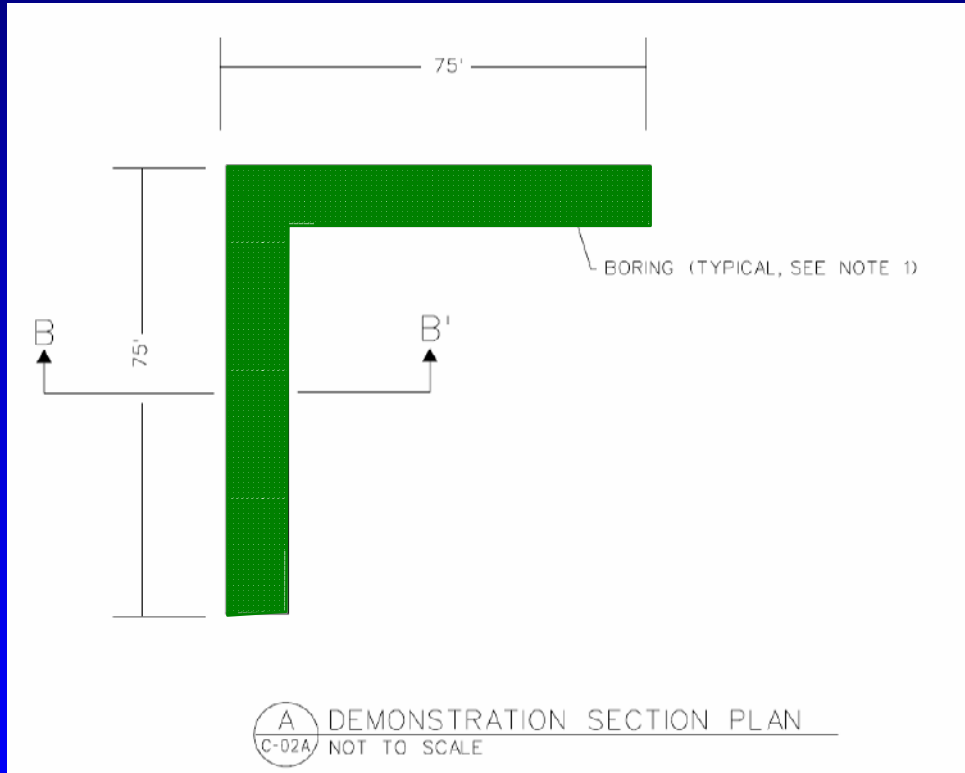
- Modified Contract to Demonstrate Alternate Method to Penetrate Hardpan and Bedrock
- Conducted Investigation of Completed Section
- Developed More Stringent & Intensive QA Inspection Program



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Demonstration Section Modification





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Chisel





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Initial Wall Construction



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Initial Wall Construction



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Investigation





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Probing for Cutoff Wall



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Backfill Sampling

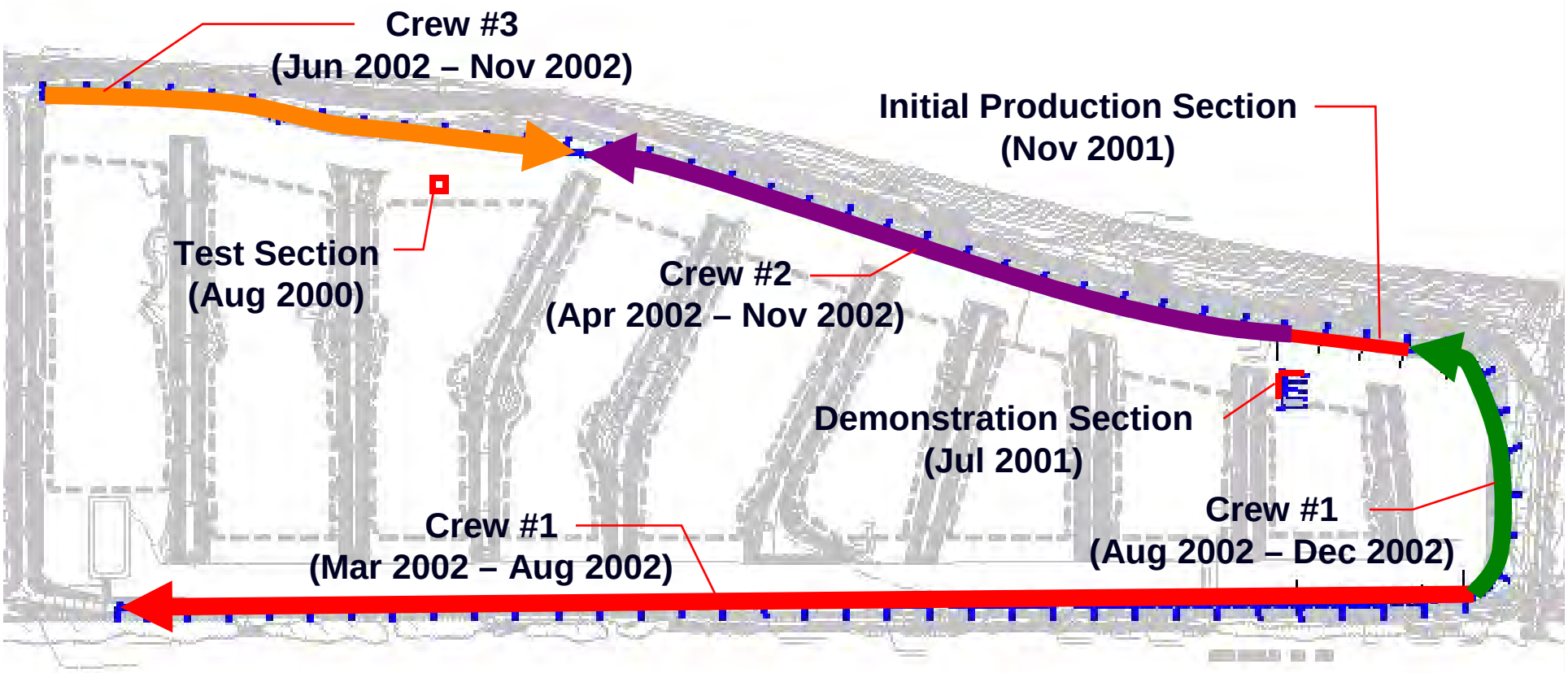






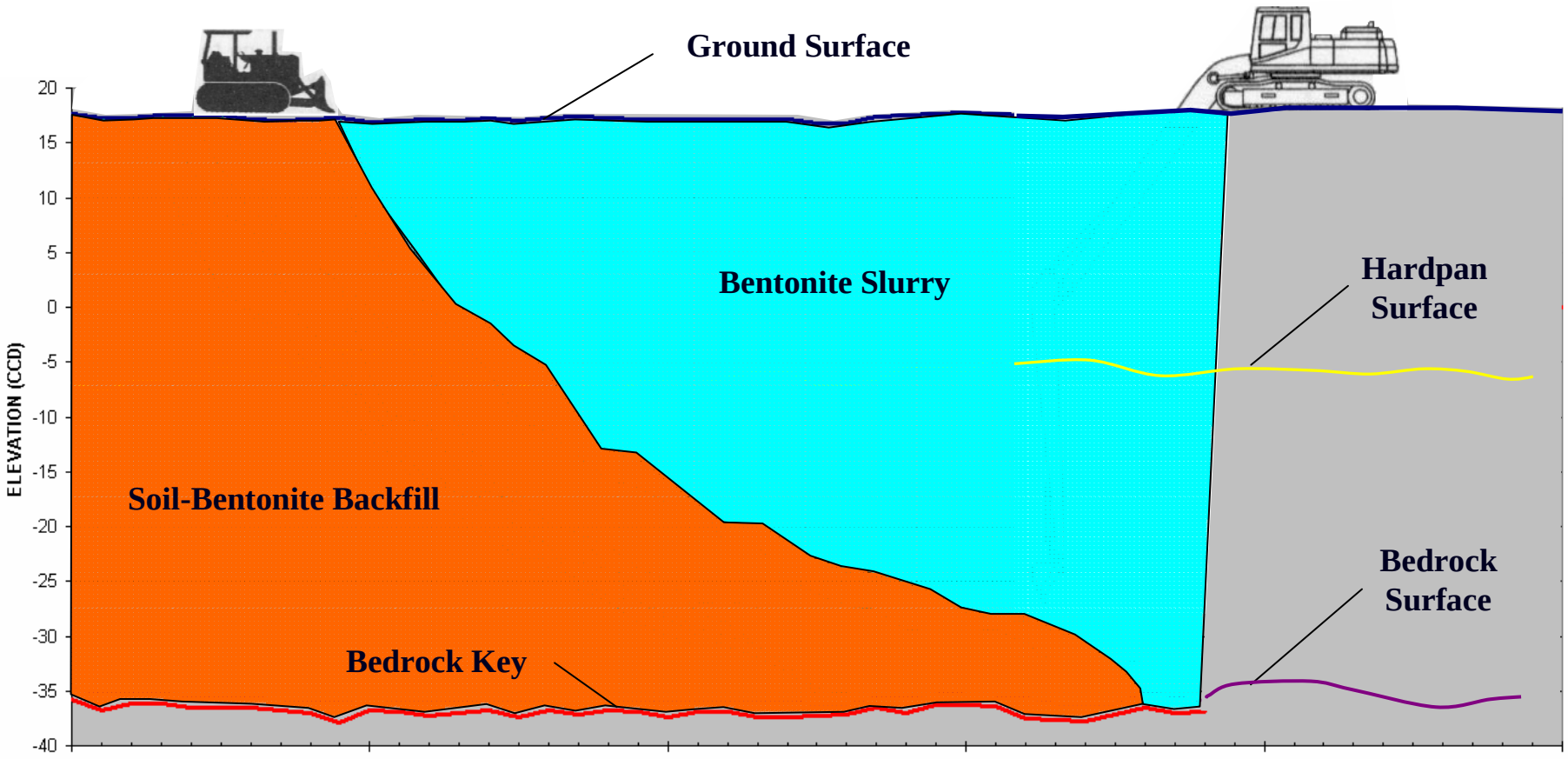
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Cutoff Wall Construction



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Cutoff Wall Construction



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Cutoff Wall Construction





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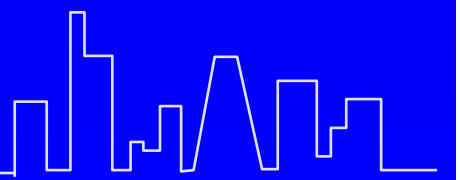
Cutoff Wall Construction



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QA/QC Verification

- Depth Measurements During Excavation
- Bedrock Key Verification
- Post-Construction Depth Measurements



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Depth Measurements



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Bedrock Key Verification





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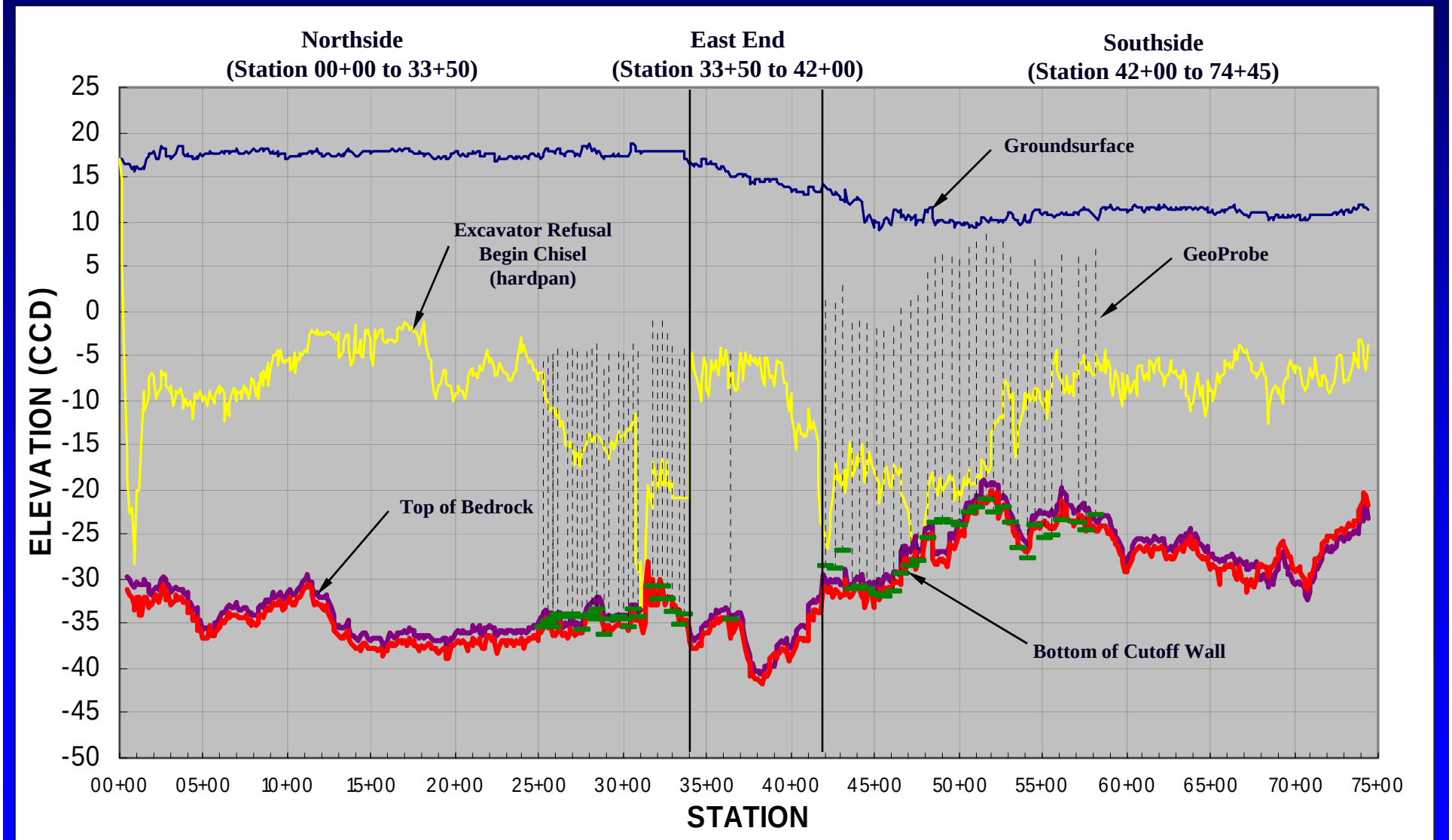
Depth Verification





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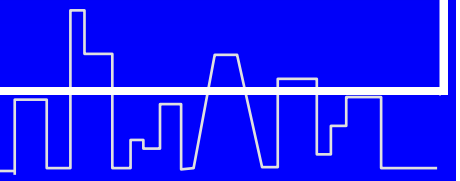
Wall Profile



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Construction Summary

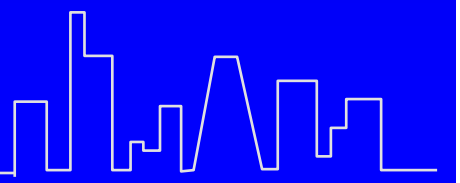
	Estimated (Square Feet)	Actual (Square Feet)	
Trench @ $6.25/sf	263,000	182,706	w/Excavator
Trench @ $48.42/sf	14,880	145,375	w/Chisel
Bedrock Key @ $48.42/sf	7,440	7,271	w/Chisel
Total	285,320	335,352	

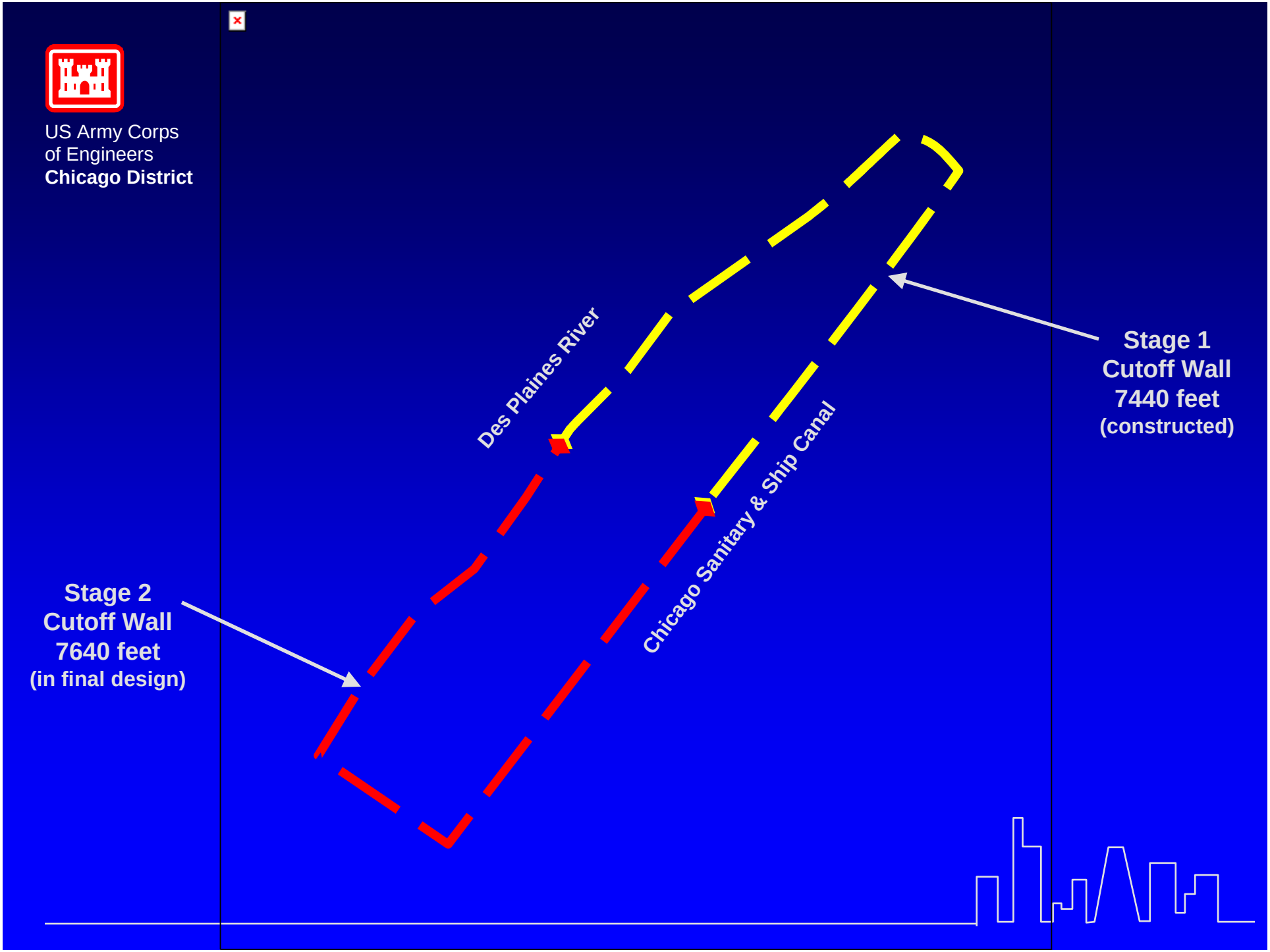


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Lessons Learned

- **Ensure Thorough Site Investigations**
- **Cutoff Walls MUST be keyed into Underlying Layer for Seepage Control, VERIFY**
- **Subsurface Construction Requires a High Level of QA/QC, especially at Start-Up**
- **Keep Close Coordination between Design and Construction**
- **Perform a Test Section**




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Des Plaines River
Chicago Sanitary & Ship Canal
Stage 1
Cutoff Wall
7440 feet
(constructed)
Stage 2
Cutoff Wall
7640 feet
(in final design)

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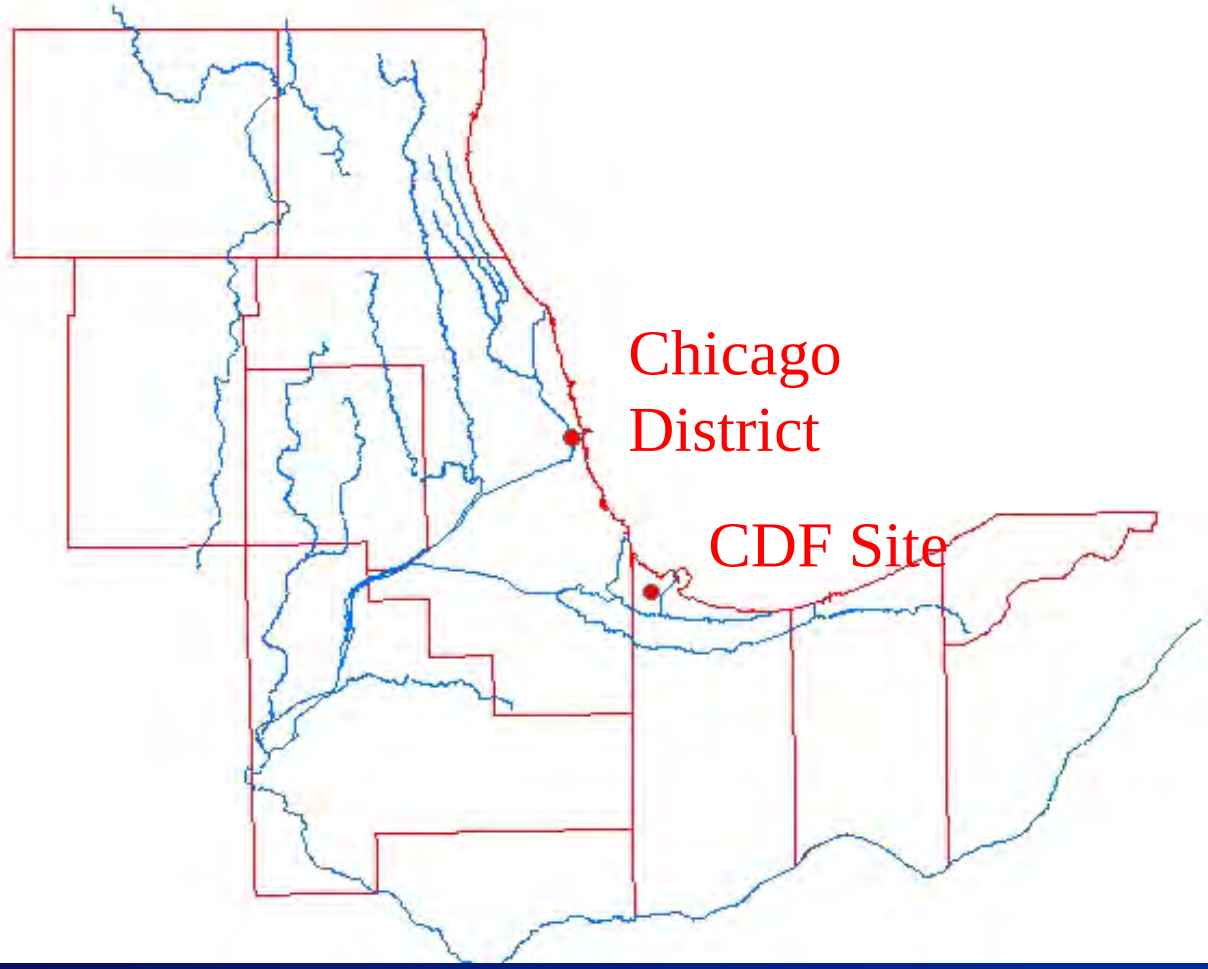
Soil-Bentonite Cutoff Wall Through Free-Product at Indiana Harbor CDF



Joe Schulenberg, Ph.D., P.E.
John Breslin, P.E.
Geotechnical Section, Chicago District

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Project Location



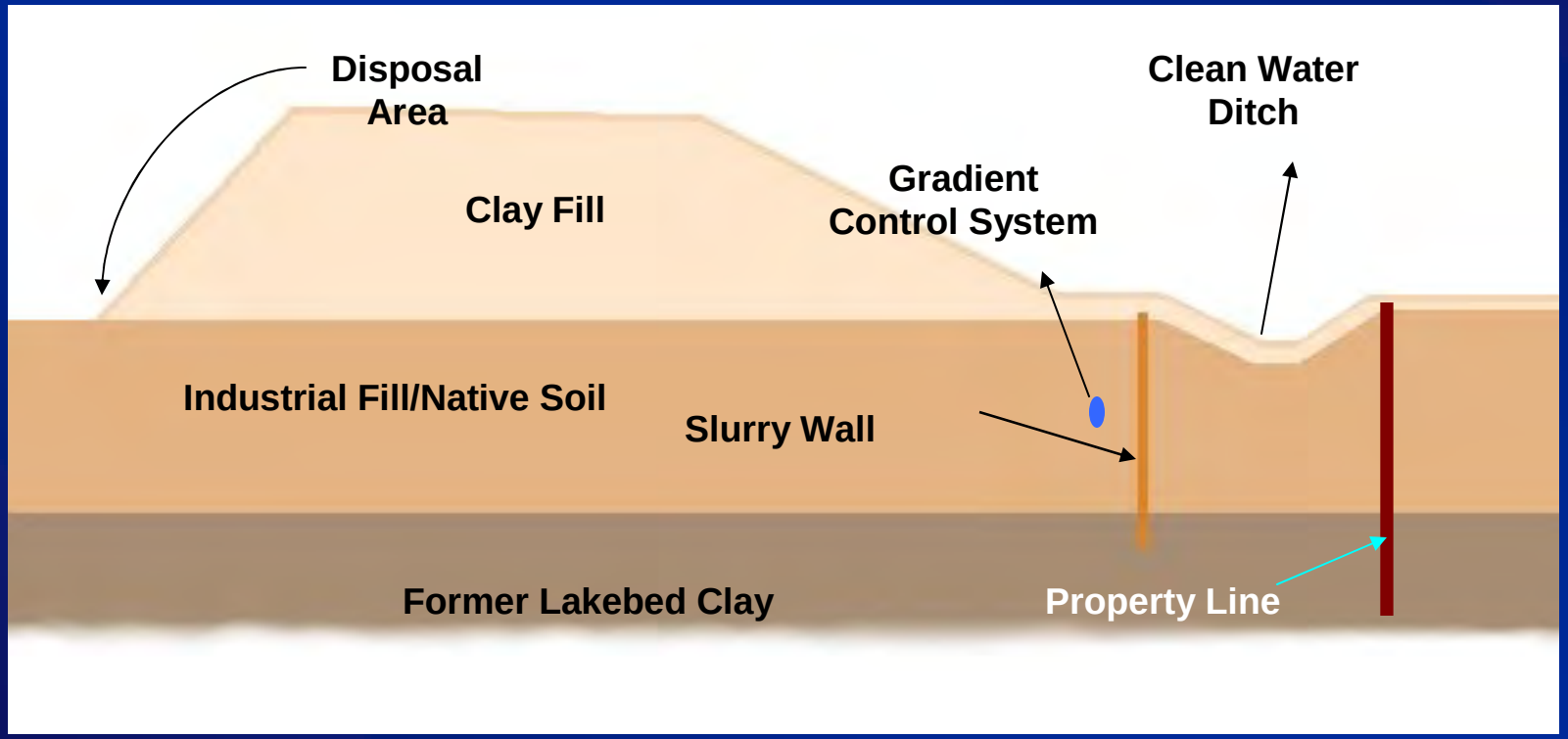
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Site Rationale



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Site Geology and Design Purpose



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Cutoff Wall Construction

Step 1.



Step 2.





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Implementation Steps

- Soil Borings
- Compatibility Testing
- Test Section
- Obstruction Removal
- Cutoff Wall Construction Quality Control/Quality Assurance

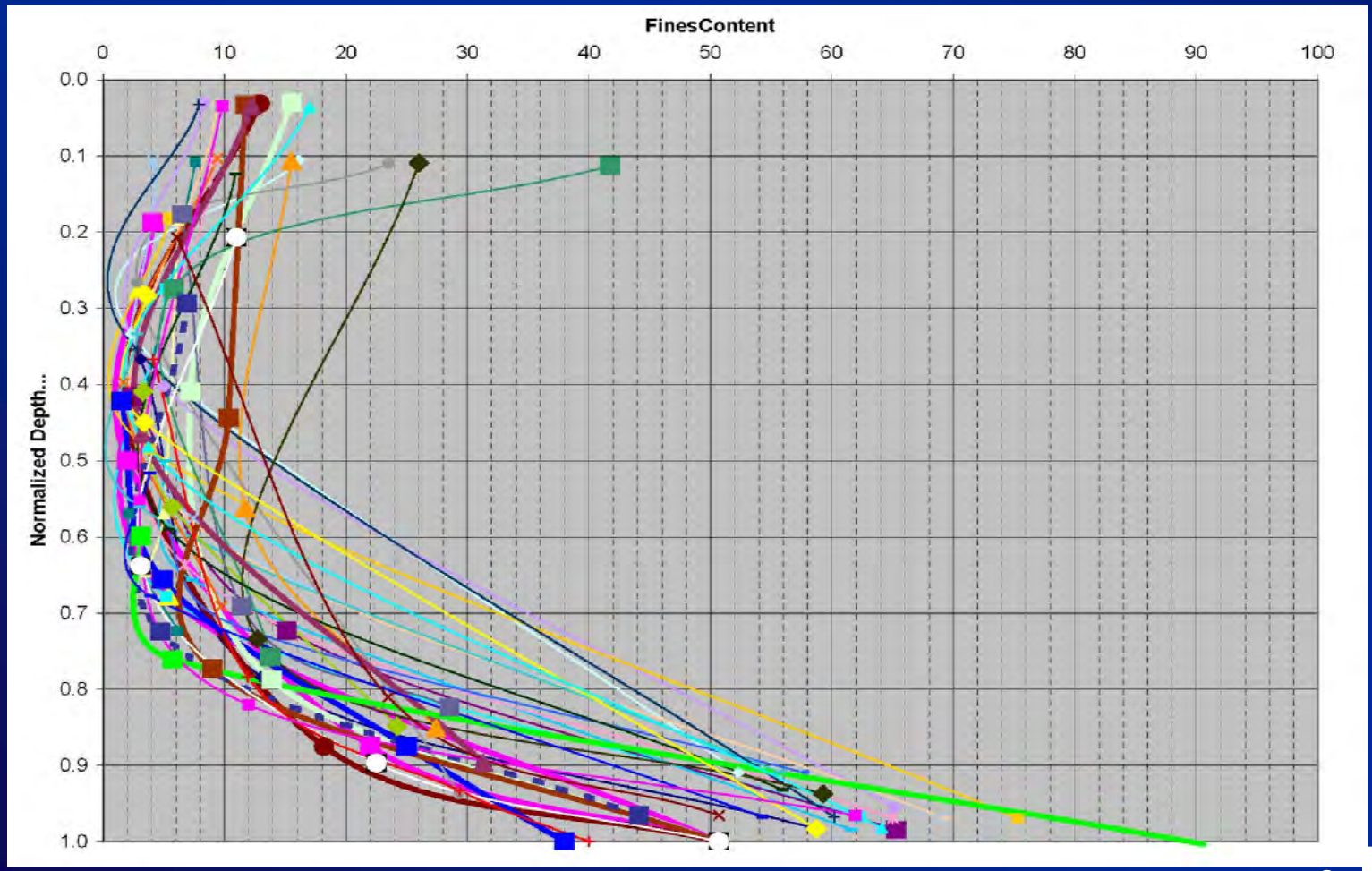
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Soil Borings



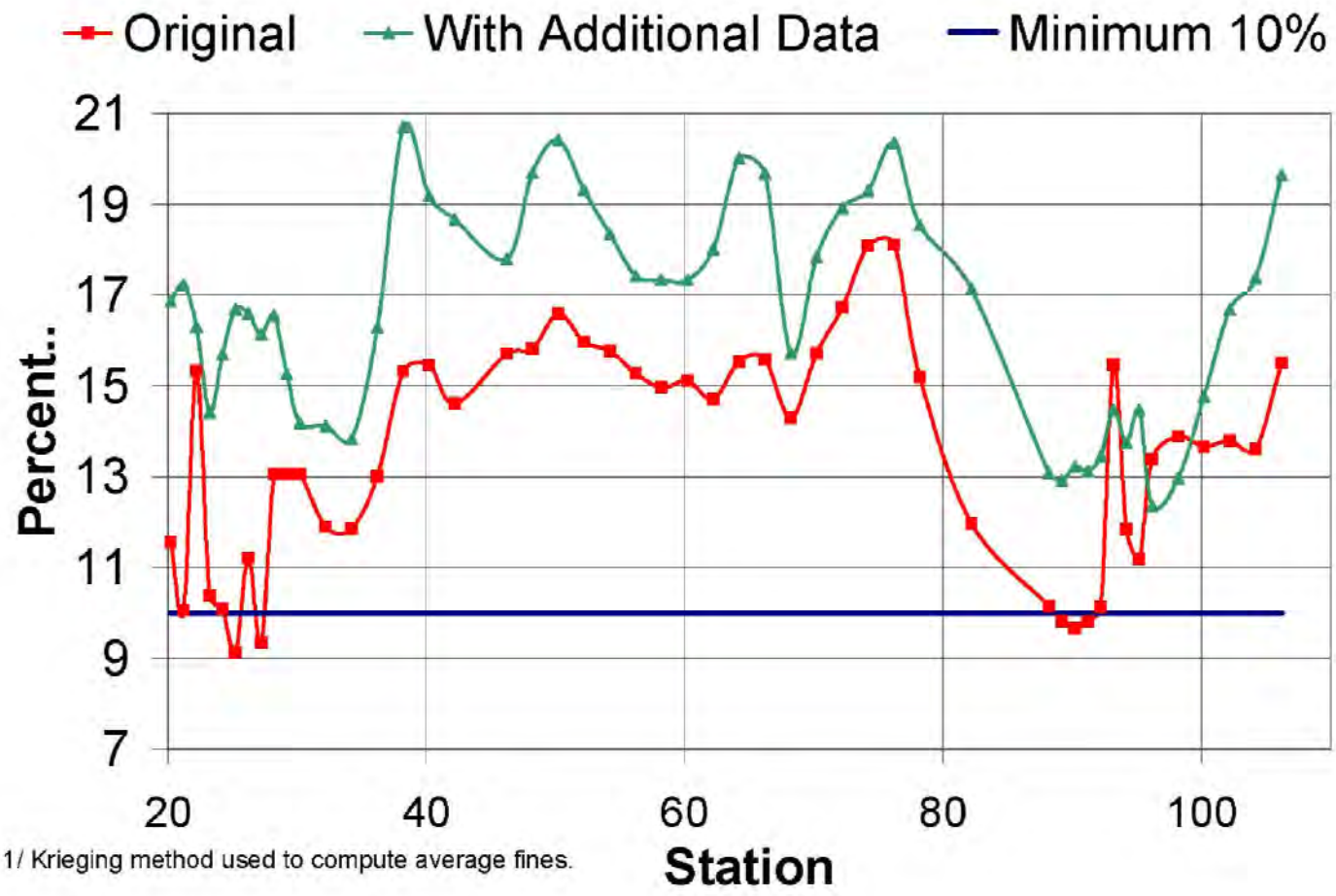
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Fines Vs. Depth



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Average Fines



1/ Krieging method used to compute average fines.

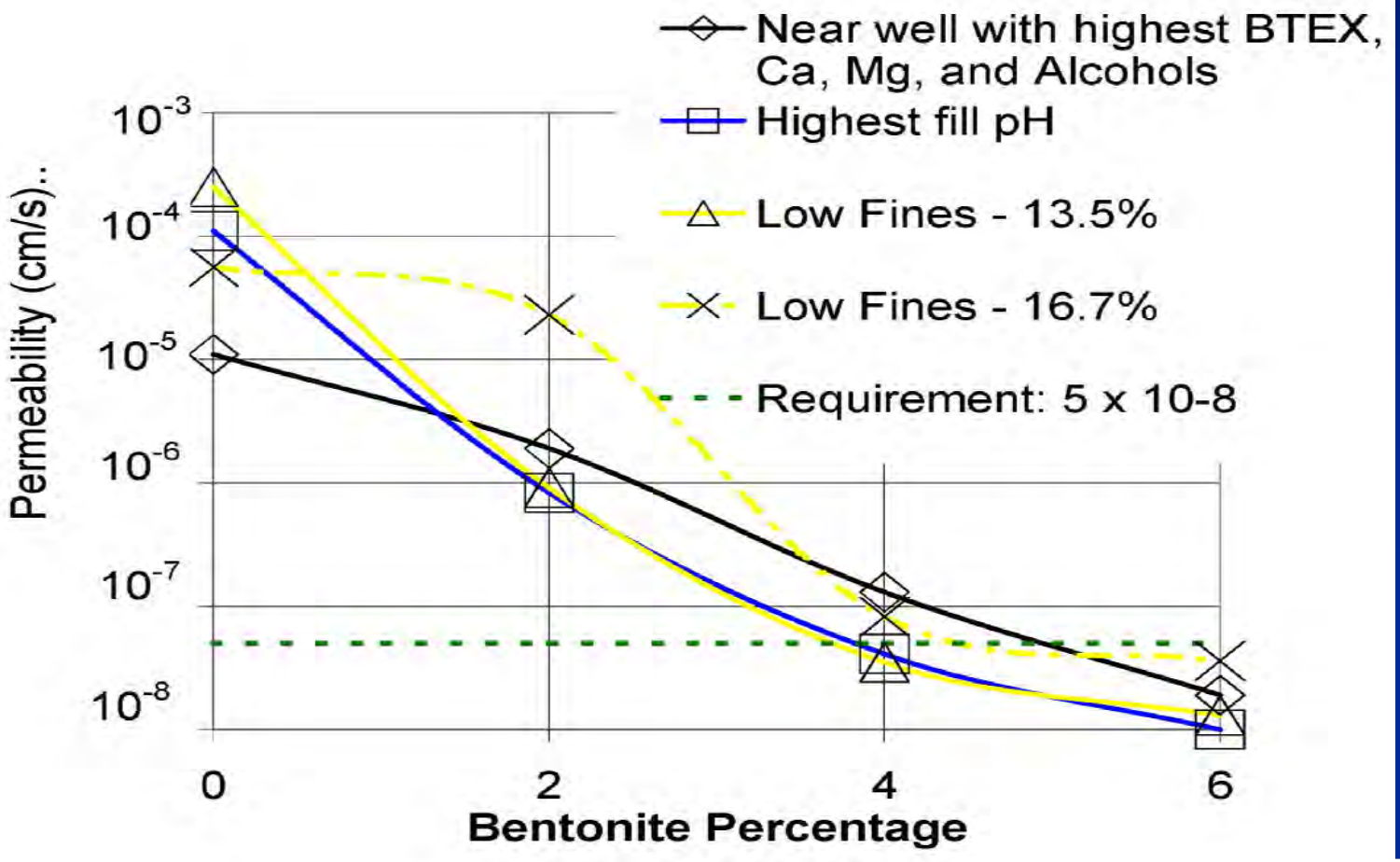
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Compatibility Testing



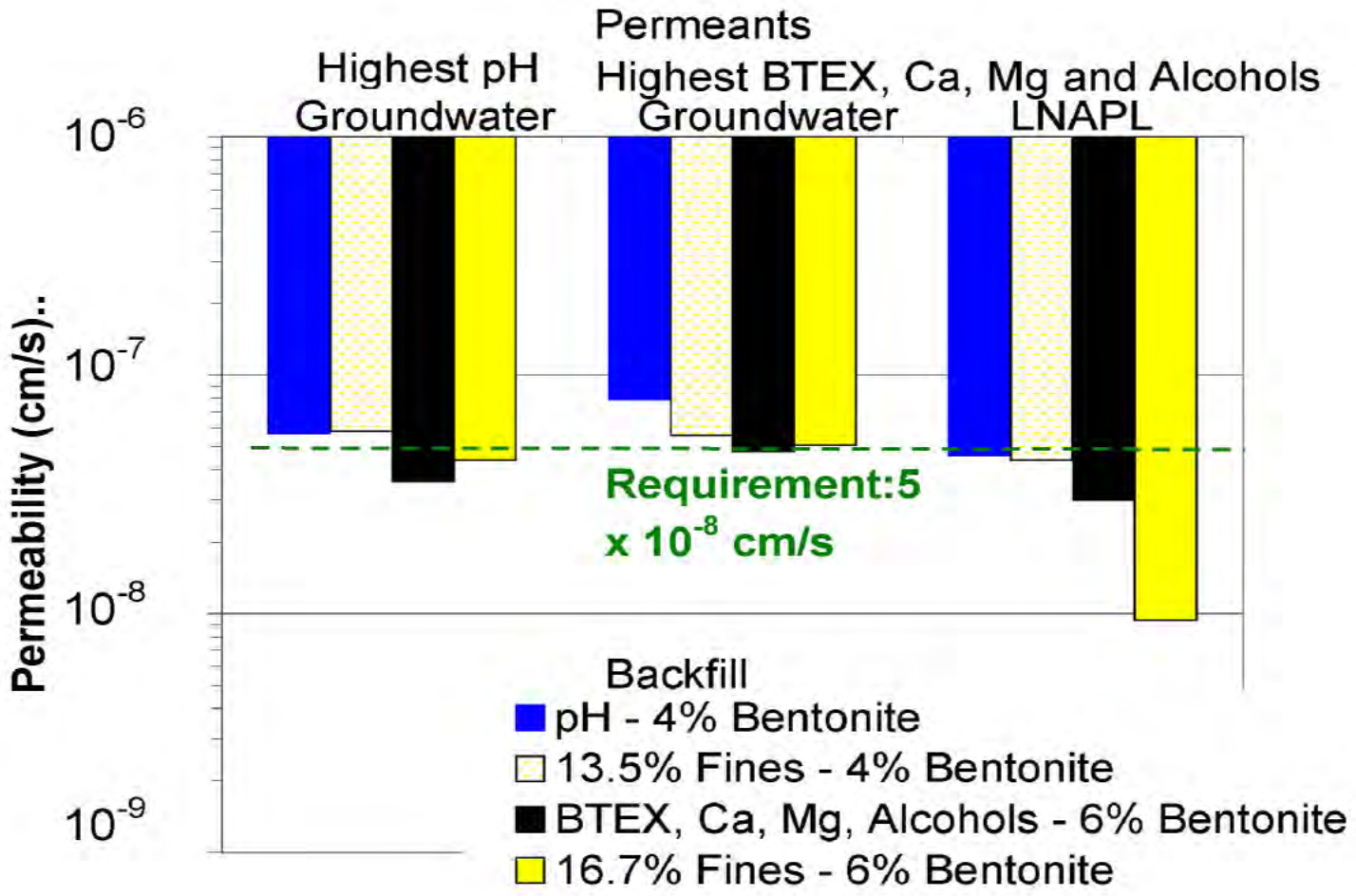
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Short Term Compatibility



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Long Term Compatibility



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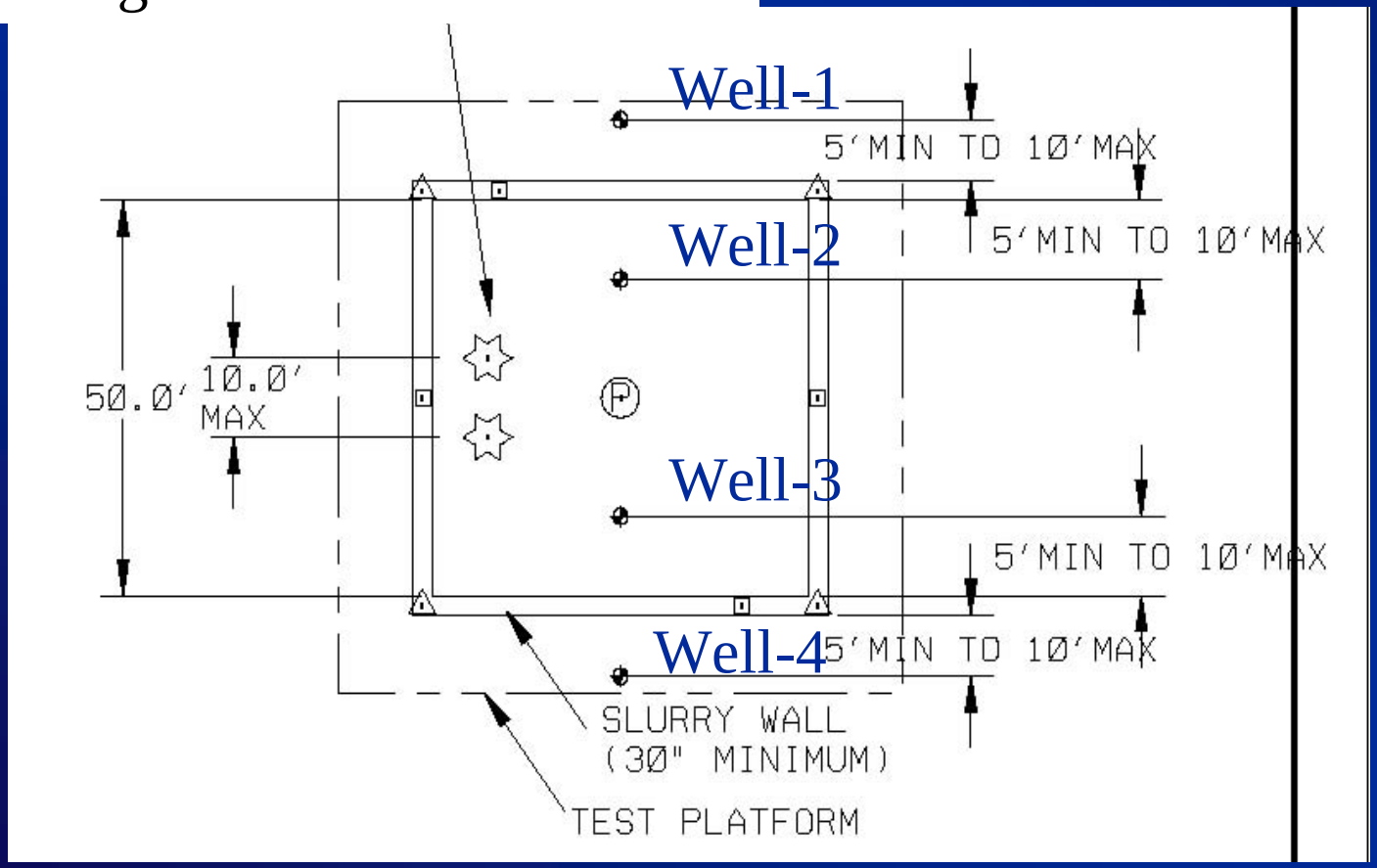
Test Section



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Test Section

Casagrande Piezometers



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Obstruction Removal Dewatering



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Obstruction Removal Oil-Water Separator



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Obstruction Removal - Pipes



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Obstruction Removal – Concrete Foundations



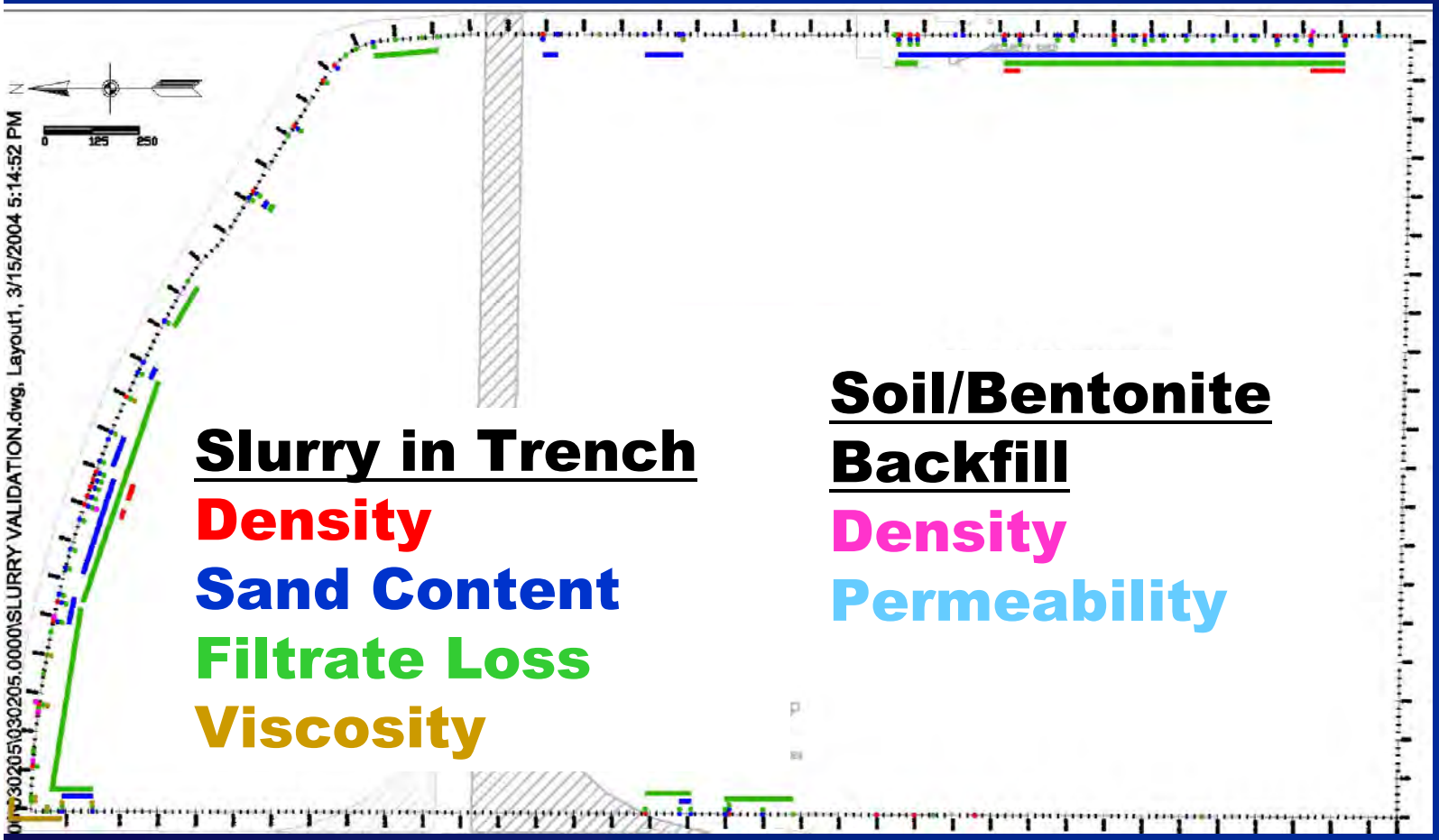
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Quality Control/Quality Assurance



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Quality Control Issues

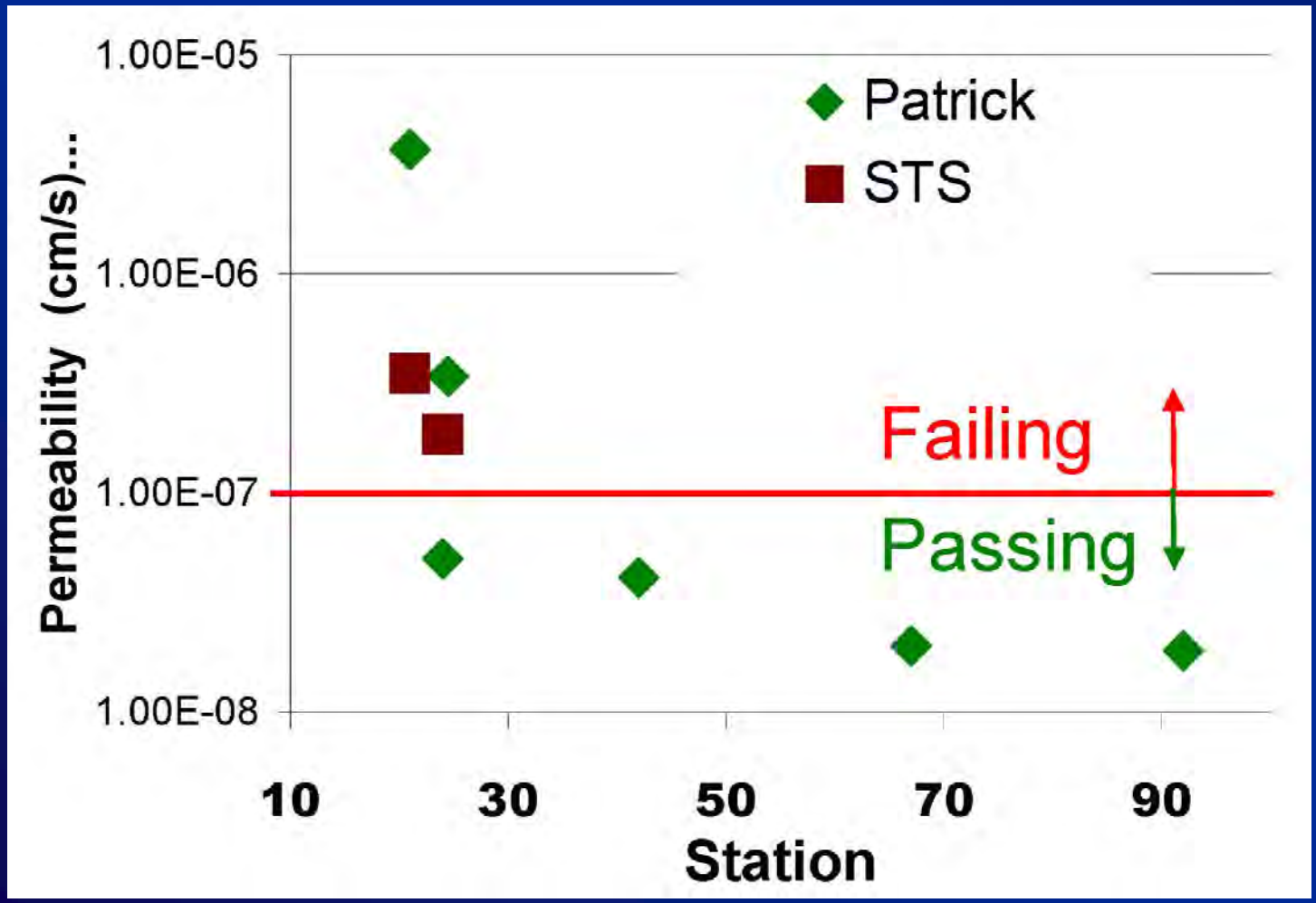


Slurry in Trench
Density
Sand Content
Filtrate Loss
Viscosity

Soil/Bentonite Backfill
Density
Permeability

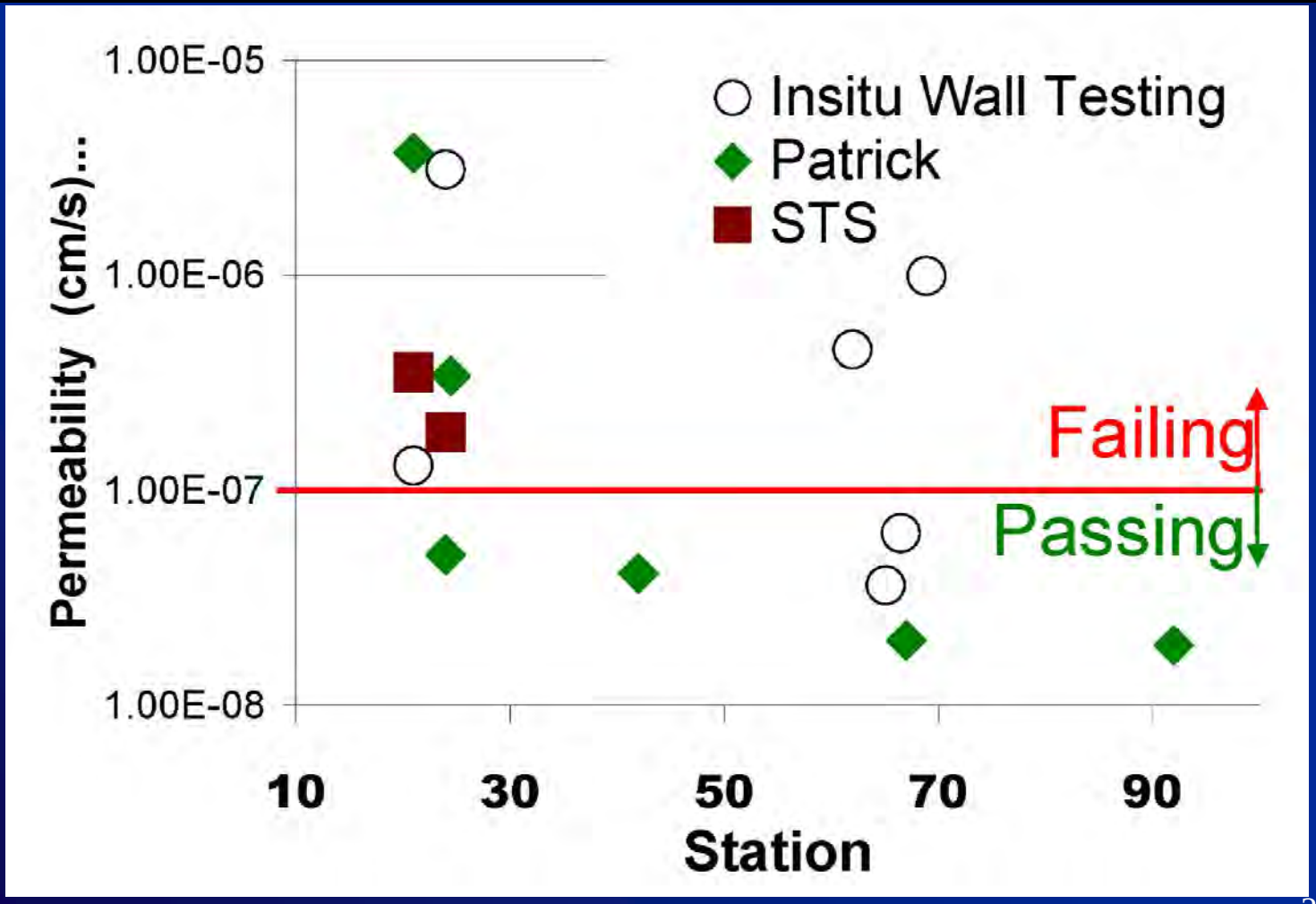
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Quality Assurance – Duplicate Permeability



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Quality Assurance – Duplicate Permeability



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Conclusions

- Required 6% Bentonite to Achieve 10^{-7} cm/s permeability
- Quality Control/Quality Assurance Vital
- Design Staff Should be Involved in Implementation

Questions?

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Quality Control - Slurry

Test	Requirement	Rationale
Density	15 pcf < backfill	Displace Slurry
Sand Content	30%	Keep sand in suspension
Viscosity	40 – 90 s	Keep trench open, slurry displaceable
Filtrate Loss	< 25 cm^3	Maintain filter cake

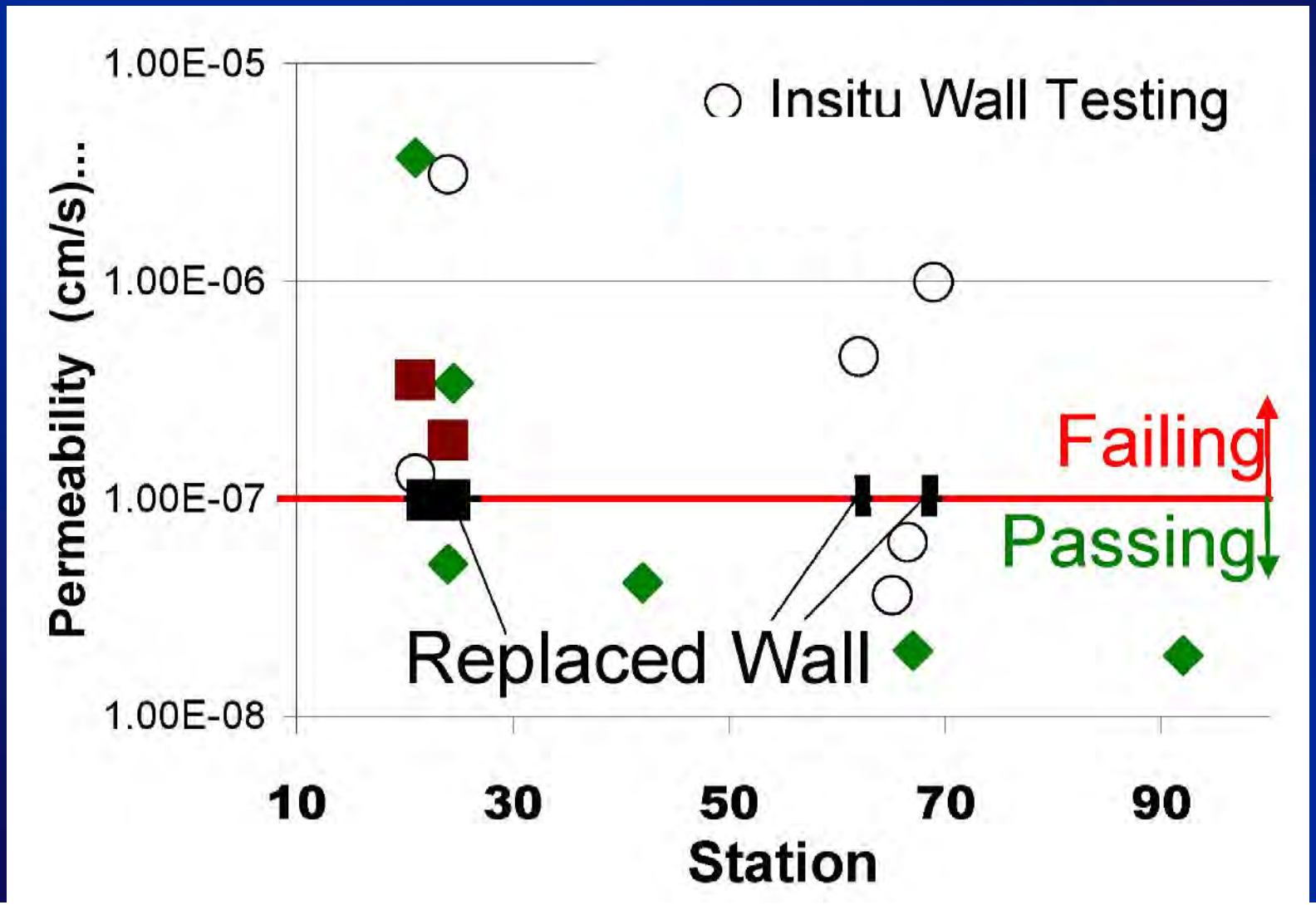
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Quality Control - Backfill

Test	Requirement	Rationale
Density	15 pcf > slurry	Displace slurry
Permeability	< 1 x 10-7 cm/s	Reduce flow through wall

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Quality Assurance – Wall Repair Summary



Flood Fighting Structures Demonstration and Evaluation Program (FFSD)

George Sills

Infrastructure Conference

August 2005

US Army Corps of Engineers

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Geotechnical and Structures Laboratory

Flood Fighting Structures Demonstration and Evaluation Program (FFSD)

1. Background
2. Product Selections
3. Laboratory Testing
4. Field Testing
5. Product Summaries

Not a New Problem
Lake Chicot Sand Boil (1973)





Background





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Background





Flood Fighting Structures Demonstration and Evaluation Program (FFSD)

Authorization

2004 Energy and Water Development Bill

"The conferees therefore direct the Corps of Engineers to act immediately to devise real world testing procedures for Rapid Deployment Flood Wall (RDFW) and other promising alternative flood fighting technologies."

FFSD Study Team Leaders

Laboratory Testing

Dr. Johannes Wibowo (GSL)

Perry A. (Pat) Taylor (GSL)

Dr. Donald Ward (CHL)

Field Testing

George Sills (GSL)

Fred Pinkard (CHL)

Product Selections

1. Congressional Directive – Rapid Deployment Flood Wall (RDFW)

2. Standard for Comparison - Sandbags



RDFW



Sandbag Structure

Product Selections

1. Develop Evaluation/Selection Criteria
2. Issue Solicitation for Technical Proposal
   - 9 Proposals Received
   - Categories – Product Type

   Impermeable Liner (with or without frame)

   Granular Filled Container

   Water Filled Bladder
3. Evaluate Proposals and Make Selections
   - Based on Technical Merit

Product Selections

- **Competitive Technical Proposals**



Portadam



Hesco Bastion

Evaluation Parameters

1. Product Requirements

- Footprint and ROW requirements
- Durability
- Ease of Construction and Removal
  - Time / Manpower/ Equipment
- Adaptability to Varying Terrain
- Seepage
- Fill Requirements
- Cost
- Repair and Reusability
- Ability to Raise During Flood

2. Tests

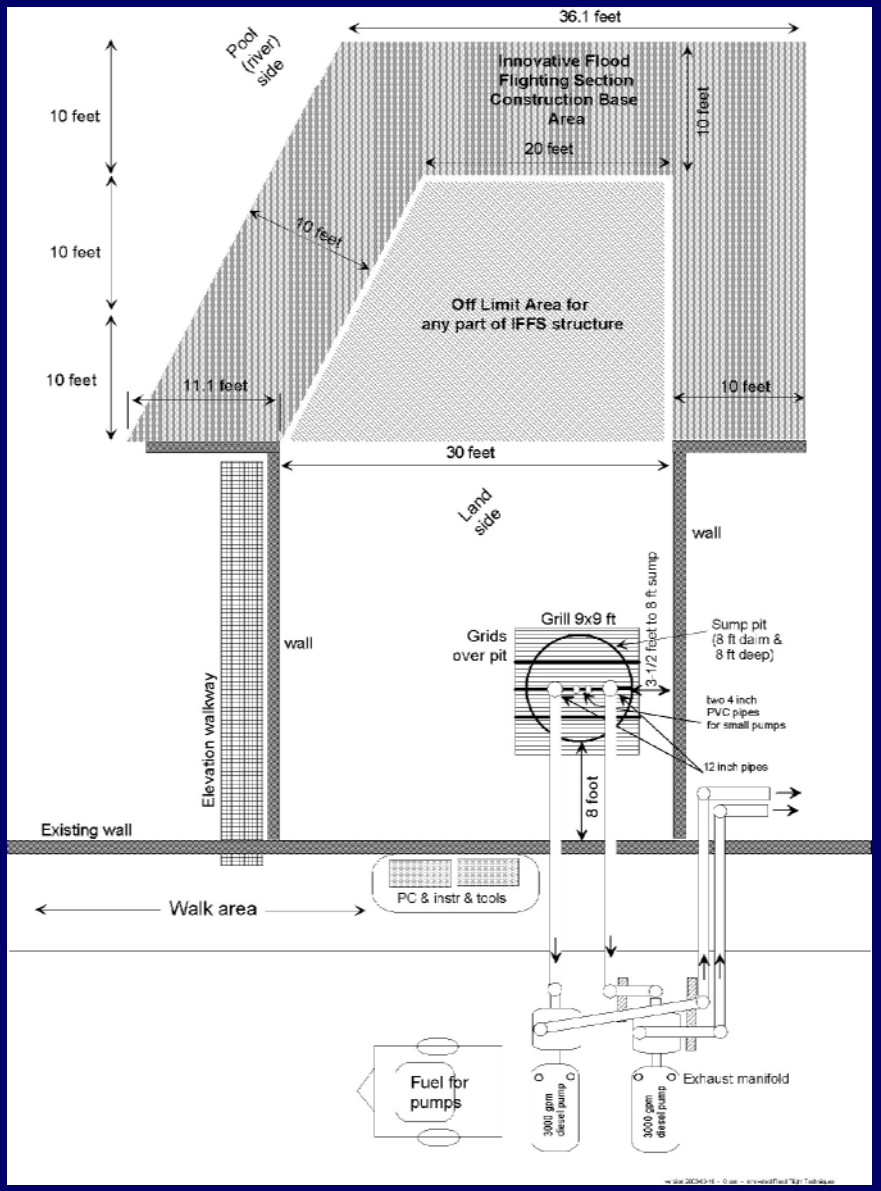
- Static Loading
- Overtopping
- Wave Impact
- Debris Impact

3. Performance on Various Surfaces

- Freshly Graded
- Grass / Weeds
- Finished Concrete

Laboratory Testing

Construction Footprint



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Laboratory Testing



Sandbag Structure

RDFW



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Laboratory Testing

Debris Impact





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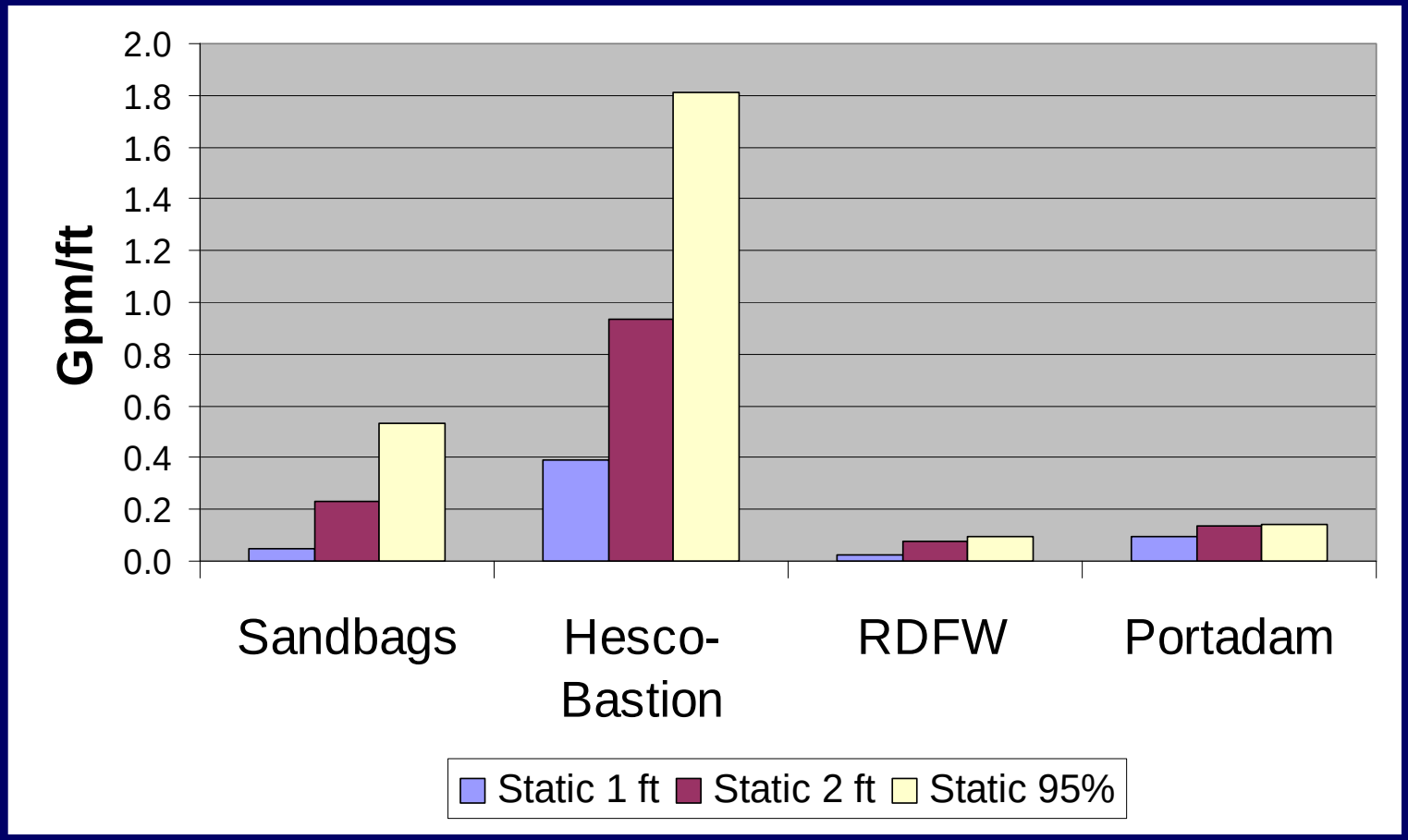
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Geotechnical and Structures Laboratory

Laboratory Results

Structure	Construction Effort (man hours)	Removal Effort (man hours)
Portadam	24.4	4.4
Hesco	20.8	13.4
Sandbags	205.1	9.0
RDFW	32.8	42.0

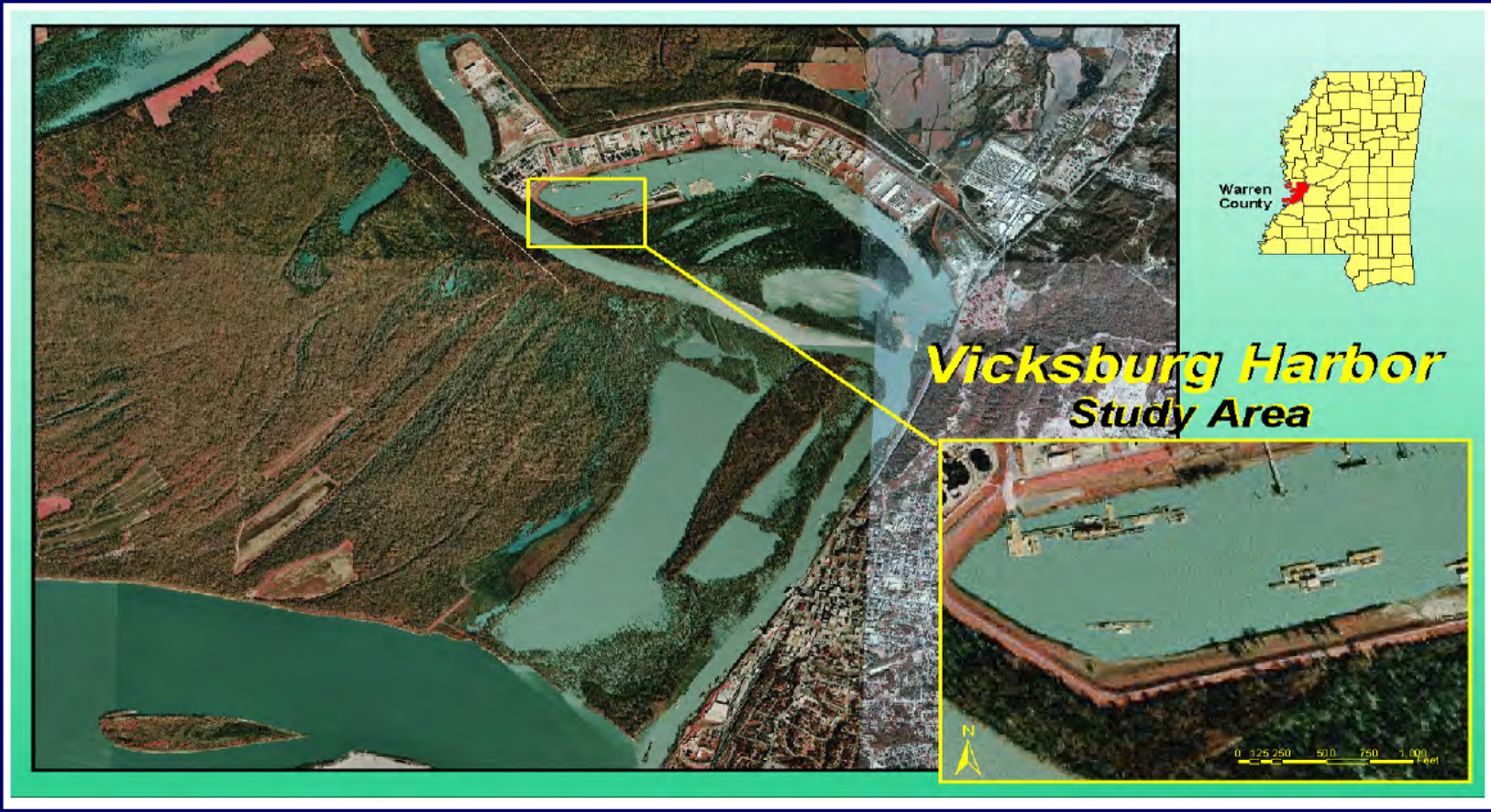
Laboratory Results

Seepage



Field Testing

Site Selection



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Portadam Structure









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Hesco Bastion Structure



Testing





Construction



Removal

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Hesco Bastion
Installation Modification





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Sandbag Structure









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Geotechnical and Structures Laboratory

RDFW Structure









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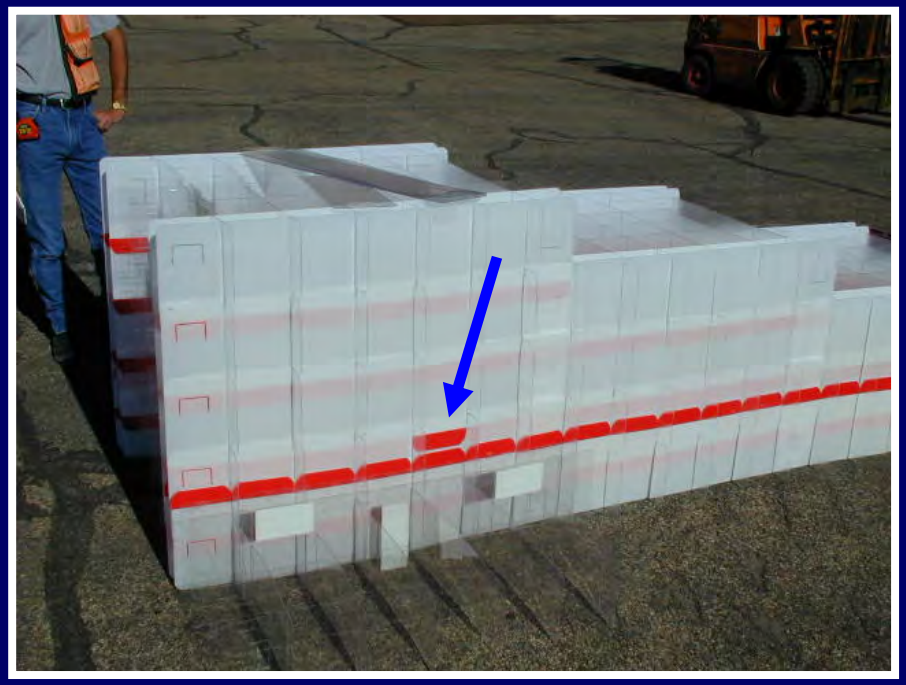
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RDFW

Post Testing Modifications





- Color Coded for Accurate Installation
- Rounded Corners
- Suction Trailer Available to Expedite Removal

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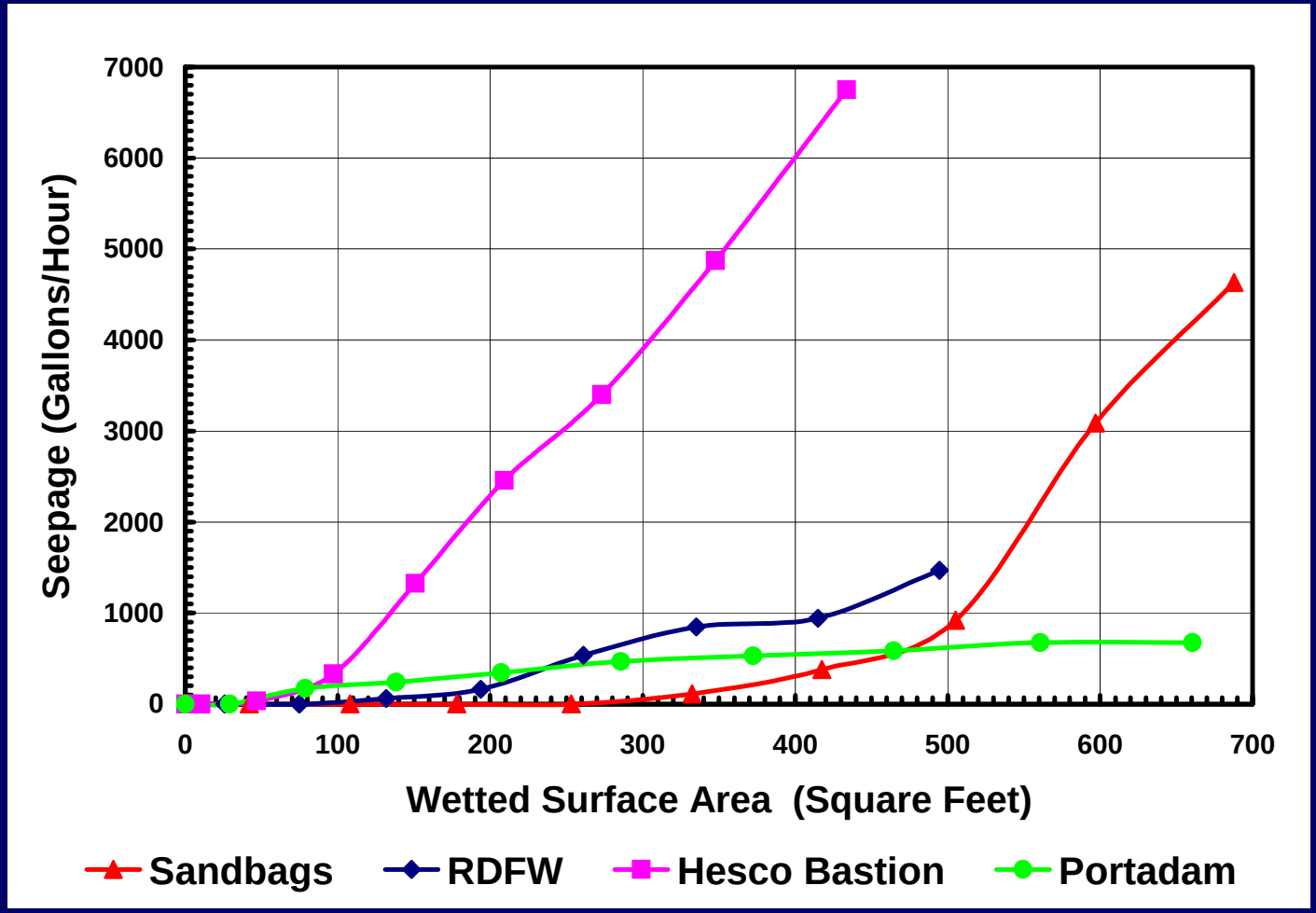
Coastal and Hydraulics Laboratory
Geotechnical and Structures Laboratory

Field Testing
Construction and Removal

Structure	Construction Time (hours)	Construction Effort (man hours)	Removal Time (hours)	Removal Effort (man hours)
Portadam	5.1	26.2	2.9	12.6
Hesco Bastion	8.9	57.5	8.7	36.3
Sandbags	30.5	453.1	2.6	3.5
RDFW	7.5	48.4	17.3	113.4

Field Testing

Seepage



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Geotechnical and Structures Laboratory

Field Testing - Damage

Portadam

None - 100% reusable

Hesco Bastion

Bent some panels and coils
Over 95% reusable

Sandbags

Bags began to deteriorate
All sandbags disposed

RDFW

Broke some unit pieces
95% of pieces reusable





Portadam Summary

Strengths

- Ease of Construction/Removal (Time, Manpower, Equipment)
- Low seepage rates
- No fill required
- High degree of reusability
- Least ROW Required

Weaknesses

- Punctured during debris impact test
- Can’t be raised in typical application

Hesco Bastion Summary

Strengths

- Ease of Construction/Removal (Time, Manpower)
- Low cost
- High degree of reusability
- Can be raised

Weaknesses

- Significant ROW required due to granular fill
- Highest seepage rates

Sandbag Summary

Strengths

- Cost (volunteer / prison labor)
- Conforms well to varying terrain
- Low seepage rates
- Can be raised

Weaknesses

- Very labor intensive
- Not reusable

RDFW Summary

Strengths

- Ease of construction (Time, Manpower)
- Low seepage rates
- High degree of reusability
- Can be raised (8 inch units)

Weaknesses

- Significant ROW required due to granular fill
- High cost
- Most difficult to remove

Remaining Work

1. Place testing data and results on publicly accessible web page.

2. Conduct pilot tests at 3 locations around the country.
   - Philadelphia / Baltimore Districts
   - Omaha District
   - Sacramento District

3. Use purchased products in actual flood events.

Flood Fighting Structures Demonstration and Evaluation Program



US Army Corps of Engineers

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Coastal and Hydraulics Laboratory
Geotechnical and Structures Laboratory

Tri Services ISC - Geotechnical Track 6
Wednesday, August 3, 2005
Room 227

State of the Art in Grouting

Dams on Solution Susceptible
or
Fractured Rock Foundations

Arthur H. Walz, Jr., P.E.

Gannett Fleming
ENGINEERS AND PLANNERS

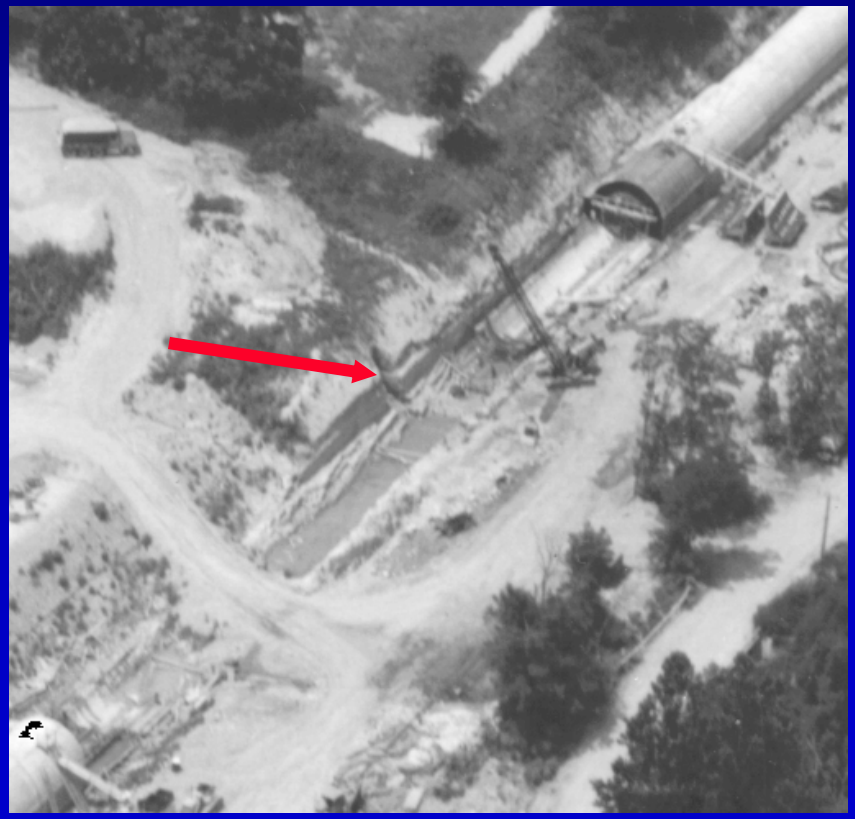
Track 6

- Overview of USACE dams on solution susceptible or fractured rock foundations
- Special drilling and grouting techniques for remedial work in embankment dams
- Composite grouting and cutoff wall solutions
- State of the art in grout mixes
- State of the art computer control, monitoring and analysis of grouting
- Quantitatively engineered grout curtains

Solution Susceptible Rock Foundation



Indiana Limestone



Solution Susceptible Rock Foundation



Indiana Limestone

Solution Susceptible Rock Foundation





Boone Formation
Beaver Dam, AK

Fractured Rock Foundation



Fractured Rock Foundation



Western Maryland

Rock Foundation at Clearwater Dam



Fractured Rock Foundation



Basic Technical Requirements
for an
Embankment Dam

- Must have sufficient spillway and outlet capacity as well as adequate freeboard to prevent over topping by the reservoir
- Must be stable under all loading conditions
- Dam and "foundation" must be sufficiently watertight and have adequate seepage control for safe operation

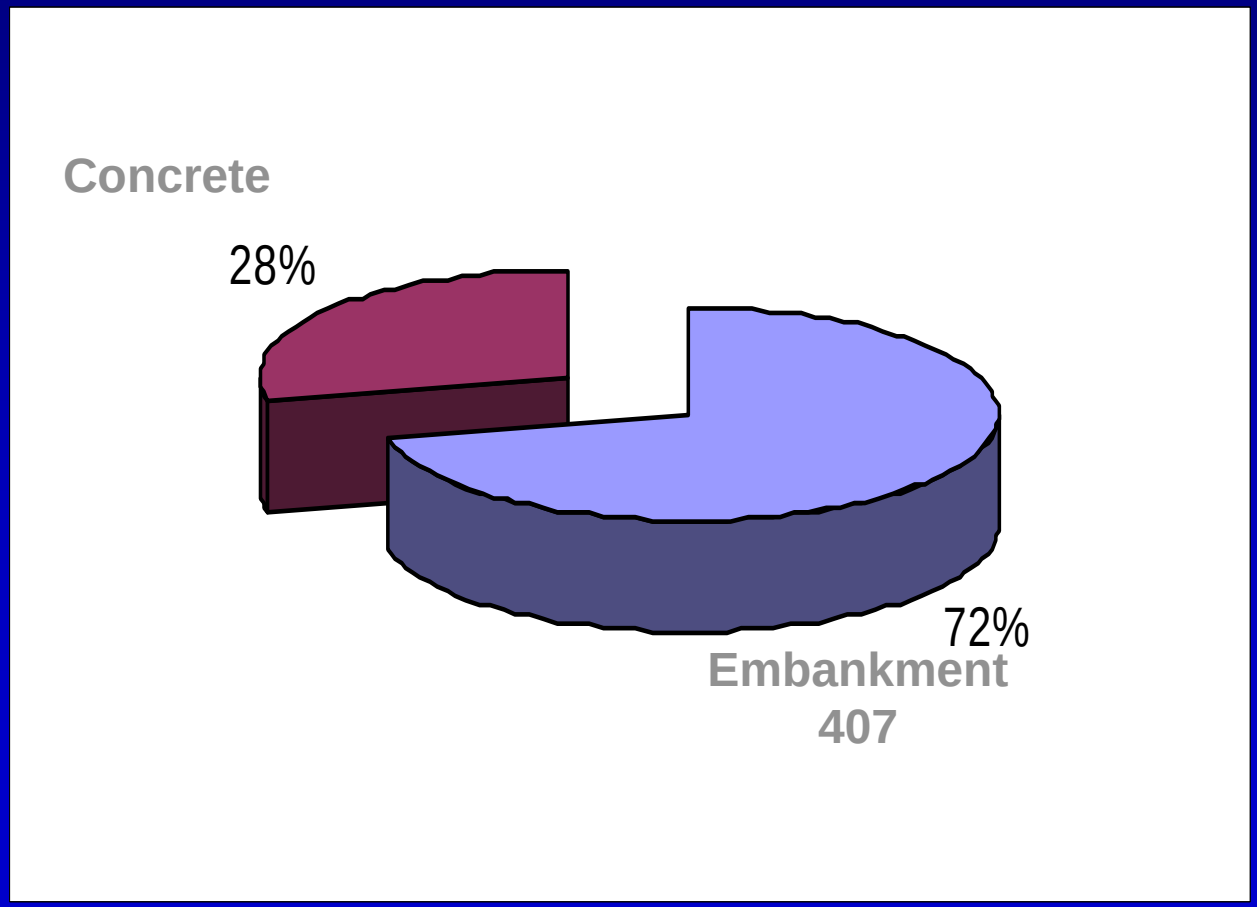
Causes of Dam Failures in the United States
Embankment Dams *

	Cause	1955	Current
1.	Inadequate spillway capacity	30%	40%
2.	Seepage/piping	25%	37%
3.	slides	15%	6%
4.	Conduit leakage	13%	
5.	Slope protection	5%	→ 17%
6.	Unknown	12%	

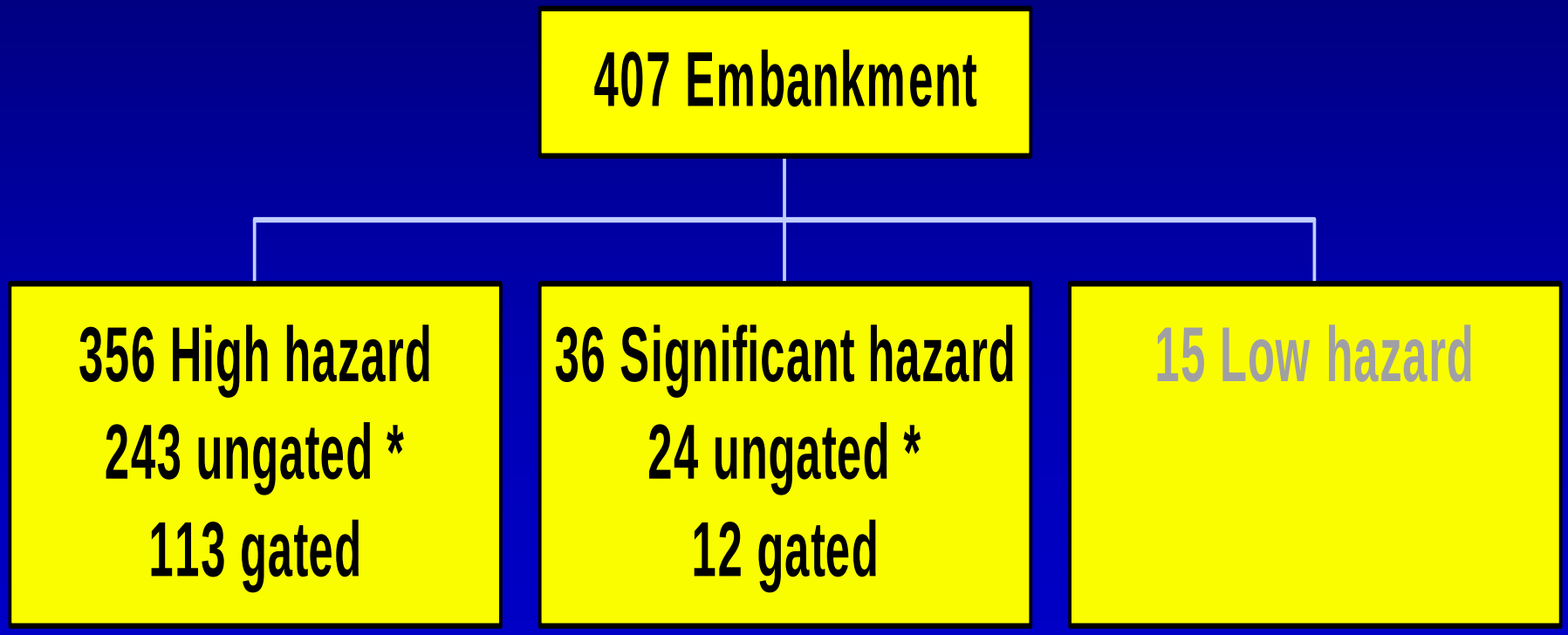
* Source – National Inspection of Dams Program, Corps of Engineers survey and Bureau of Reclamation survey

Corps of Engineers Dams

569 Total dams (2000)

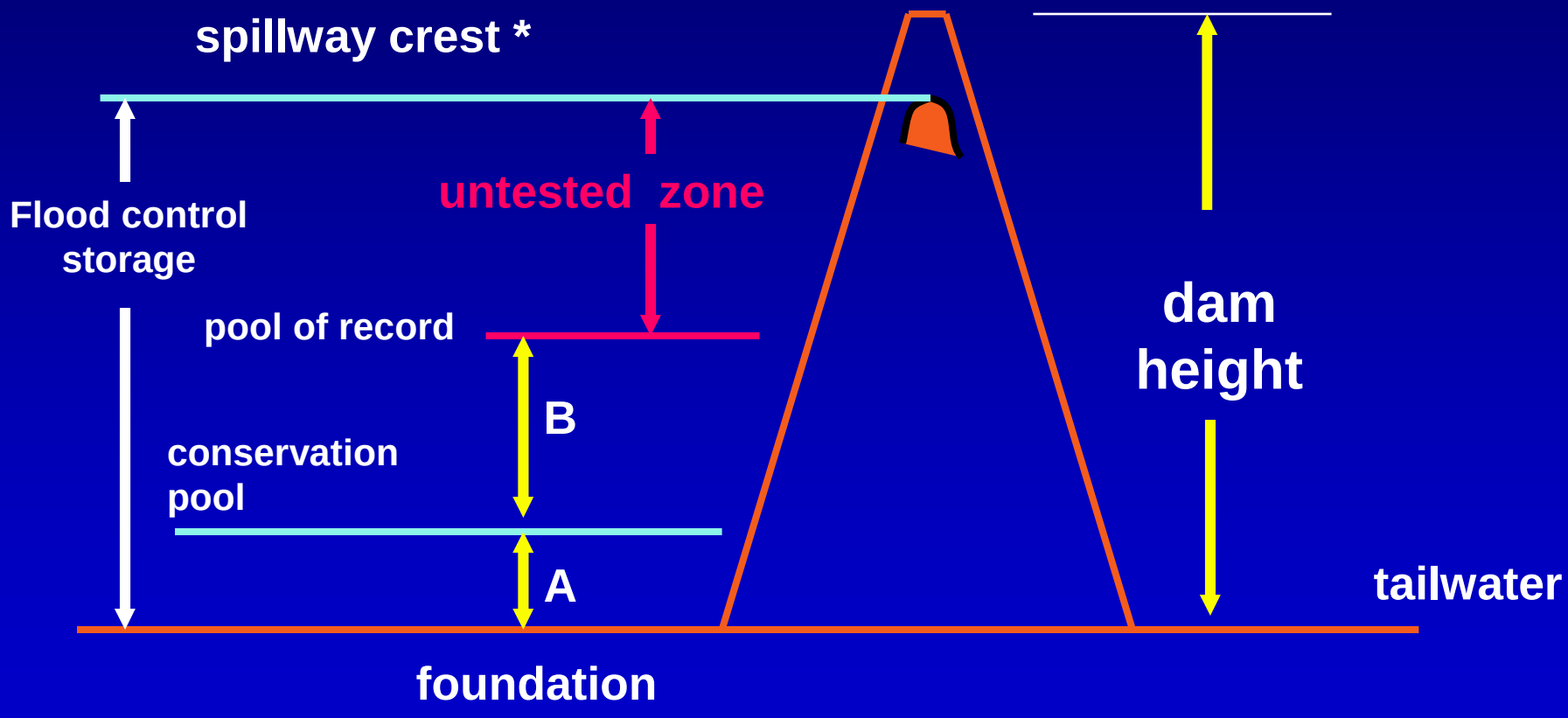


Corps of Engineers Embankment Dams
by
Hazard Classification & Spillway Operation



* Flood control loading in feet of head is greatest for ungated dams

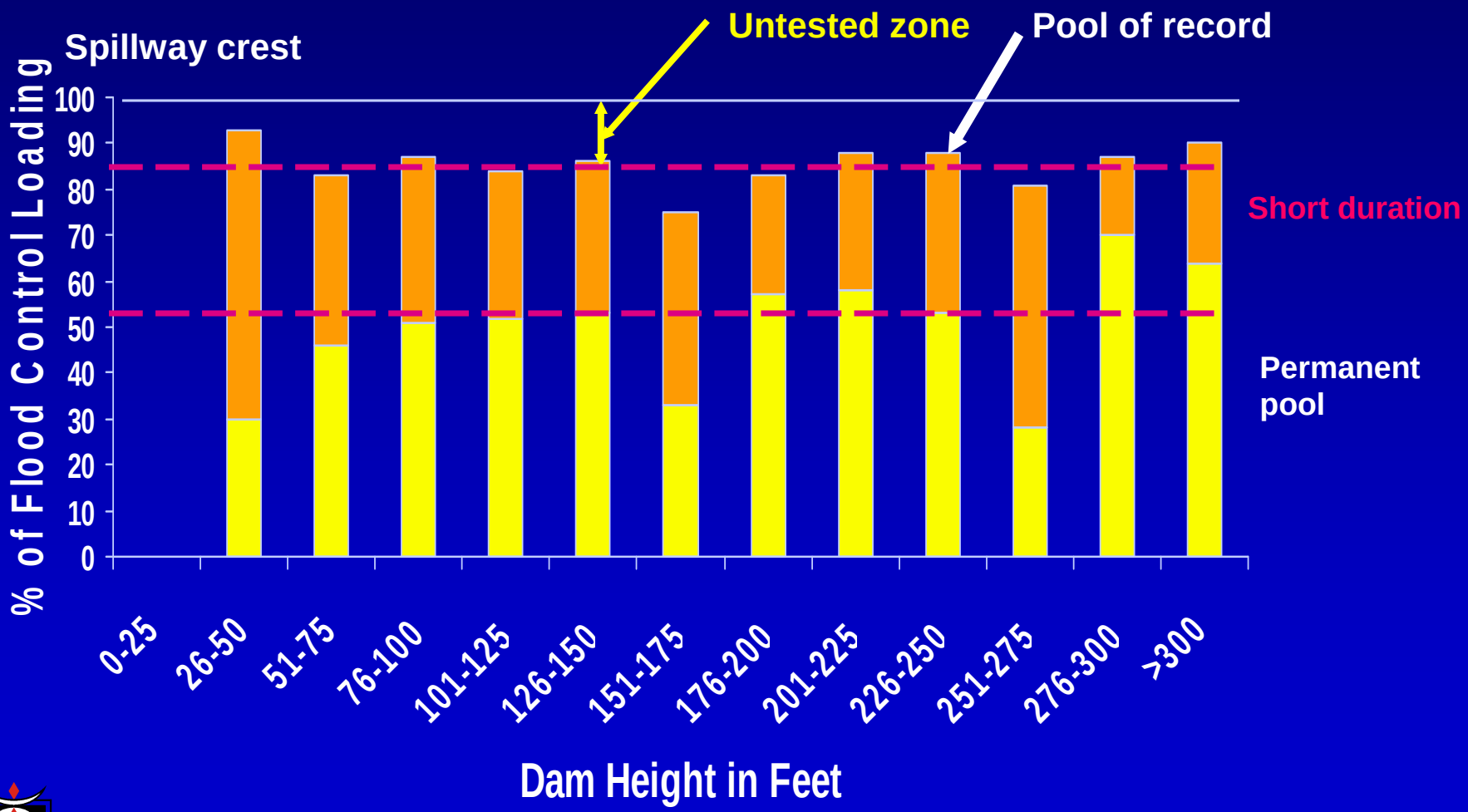
Schematic of an Ungated Flood Control Dam



Total Loading History

High Hazard Ungated Dams

as of 2000



41 0f the 243 have experienced spillway flow

Uplift in Rock and Seepage



Reservoir at 35% storage capacity

Summary of 1976 HQ Survey

MSC	Solution	Fractured	Both
LRD			
LRL	2		
LRN	5		
LRB		1	
NAD			
NAB			1
NAO	1		
MVD			
MVK	1		
MVR	1		
MVS	1		1
NWD			
NWK	5		1
NOW			3
NWW		1	

MSC	Solution	Fractured	Both
SAD			
SAJ	1		
SAM	1	1	
SPD			
SPA	1		
SPK	1	1	
SWD			
SWF	6		
SWL	5		
SWT	4		1

	Solution	Fractured	Both
USACE Total	35	4	7

Some Recent Corps Experiences with Existing Dams That Required or will Require Modification

- **Hartwell Dike, SC –** cutoff wall
- **Beaver Dam, AK –** secant pile cutoff
- **Patoka Dam, IN** - grouting
- **Mississineau Dam, IN –** grouting and then panel wall
- **Walter F. George, GA –** grouting with panel wall
- **Clearwater Dam, AK –** emergency grouting then permanent grouting and then cutoff wall
- **Wolf Creek, TN –** report with recommendations being submitted to headquarters

Considerations in Selecting the Type of Cutoff for Seepage Control

- Exploration and investigations
- Site characterization
- Physical properties of the fractured or solution susceptible rock foundation
- Establishing the depth and length of cutoff
- Contracting procedure

  IFB, RFP and Best Value

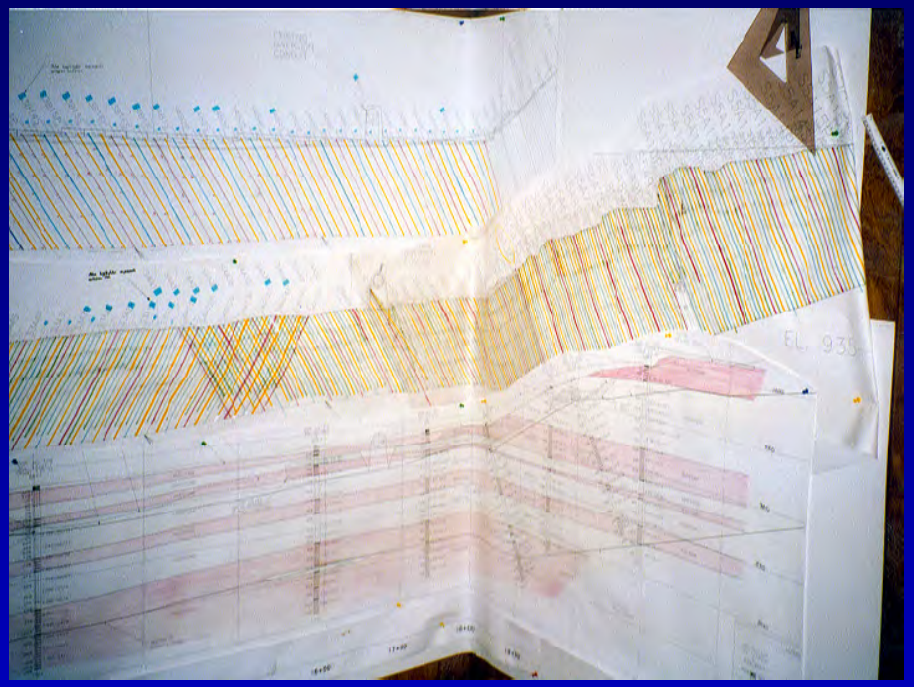
Conventional Grouting



Dipstick measurements



Mechanical gages and
manual monitoring



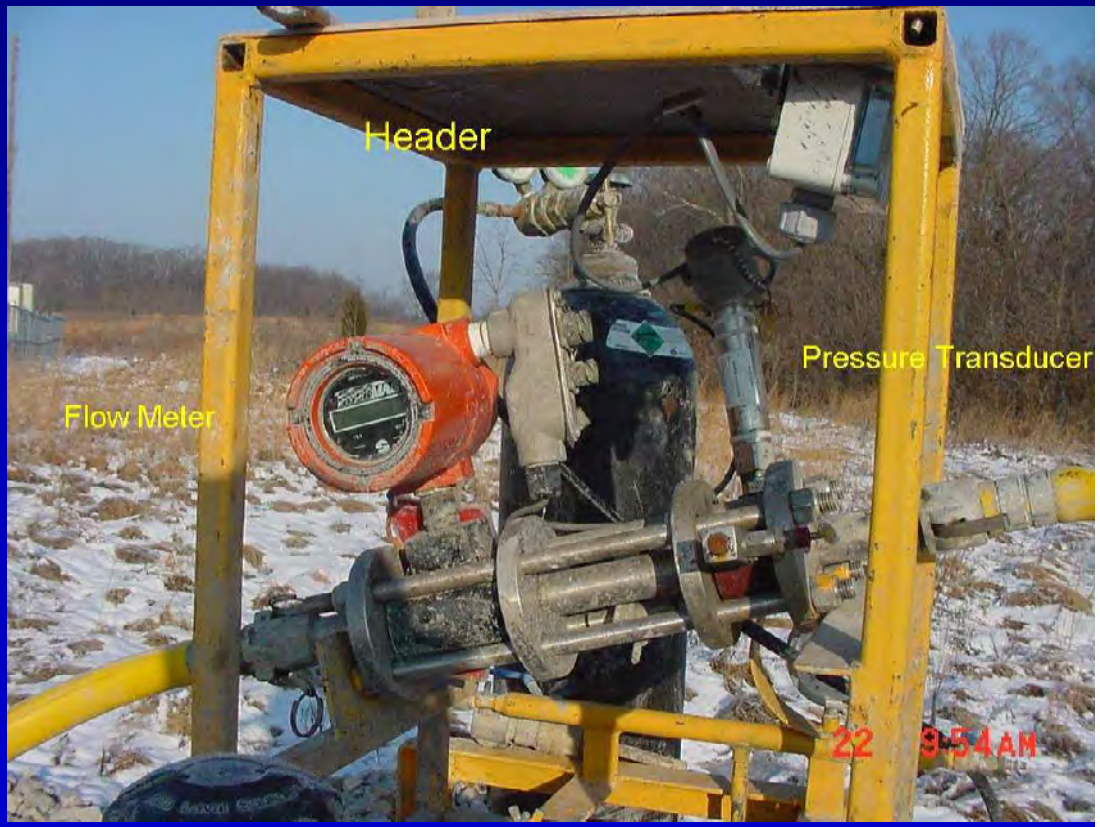
Time consuming
manually prepared charts


RESULTS ??
$$$
General Impression of Conventional Grouting

Recent Development in Grouting Materials, Equipment and Procedures

1. Drilling and grouting techniques





Recent Development in Grouting Materials, Equipment and Procedures

2. State of the art Grout mixes



Neat Cement



Balanced Stabilized

Recent Development in Grouting Materials, Equipment and Procedures

2. State of the art Grout mixes



Computer controlled batch plant

Recent Development in Grouting Materials, Equipment and Procedures

3. Composite grouting and cutoff walls

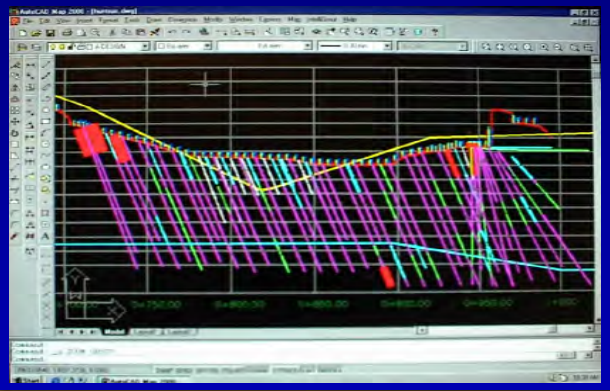


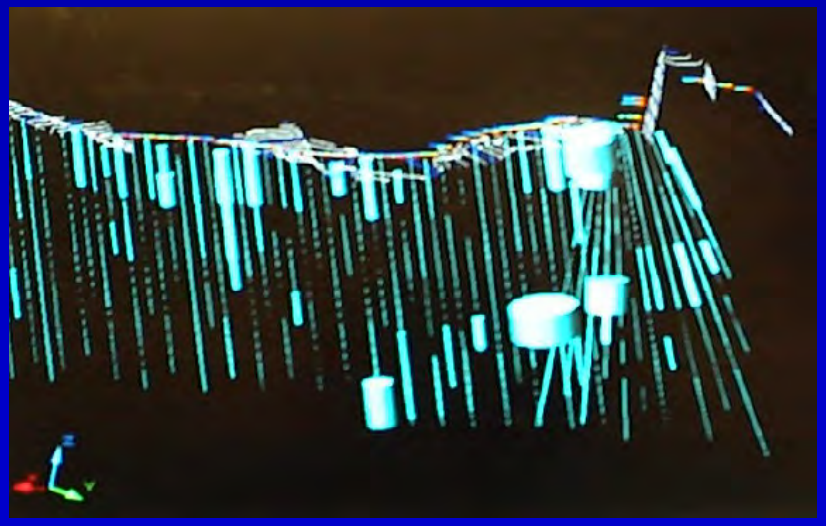


Recent Development in Grouting Materials, Equipment and Procedures

4. State of the art computer control, monitoring and analysis of grouting



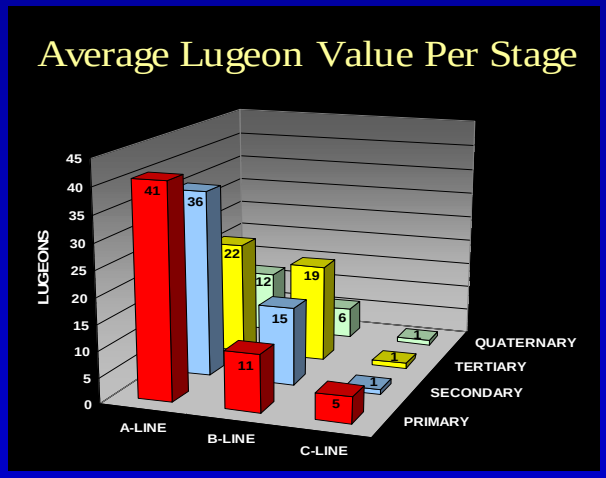




Recent Development in Grouting Materials, Equipment and Procedures

5. Quantitatively engineered grout curtains

- Evaluation of geologic conditions
- Detailed site characterization
- Design of grout curtains as an intergral part of the project to achieve specific results
- Best value contracting



Summary

Establishing the initial or remedial seepage cutoff for a water resources project can be difficult, expensive and requires monitoring and future evaluation

Recent advances in grouting technology, materials, practices and procedures have made multiple line grouting a reliable and cost effective method to control seepage or the flow of groundwater



Critical Information
for
Flood Control Operation of Dams

- Inflow predictions
- Projected reservoir levels
- Corresponding storage
- Predicted performance of the dam and structures
- Threshold for changes in monitoring program
- Threshold for potential operational changes due to structural performance
- Draw down capability
  - with full bank discharge capacity
  - with full discharge

Laboratory Testing of Flood Fighting Structures





Johannes L. Wibowo, GSL

Donald L. Ward, CHL

Perry A. Taylor, GSL



Engineer Research and Development Center

Laboratory Testing of Flood Fighting Structures

Outline

- *Laboratory Facility*
- *Testing Protocol*
- *Laboratory Testing*



Engineer Research and Development Center

Laboratory Testing of Flood Fighting Structures

Laboratory Facility



Engineer Research and Development Center

Unique Test Facility

- 115 ft by 185 ft basin, 4 ft deep
- Modified with an 8-ft-diameter sump
  - Wing walls extend from rear wall of basin on both sides of sump
  - Test structure ties into wing walls to seal off in front of sump
- Full Instrumentation

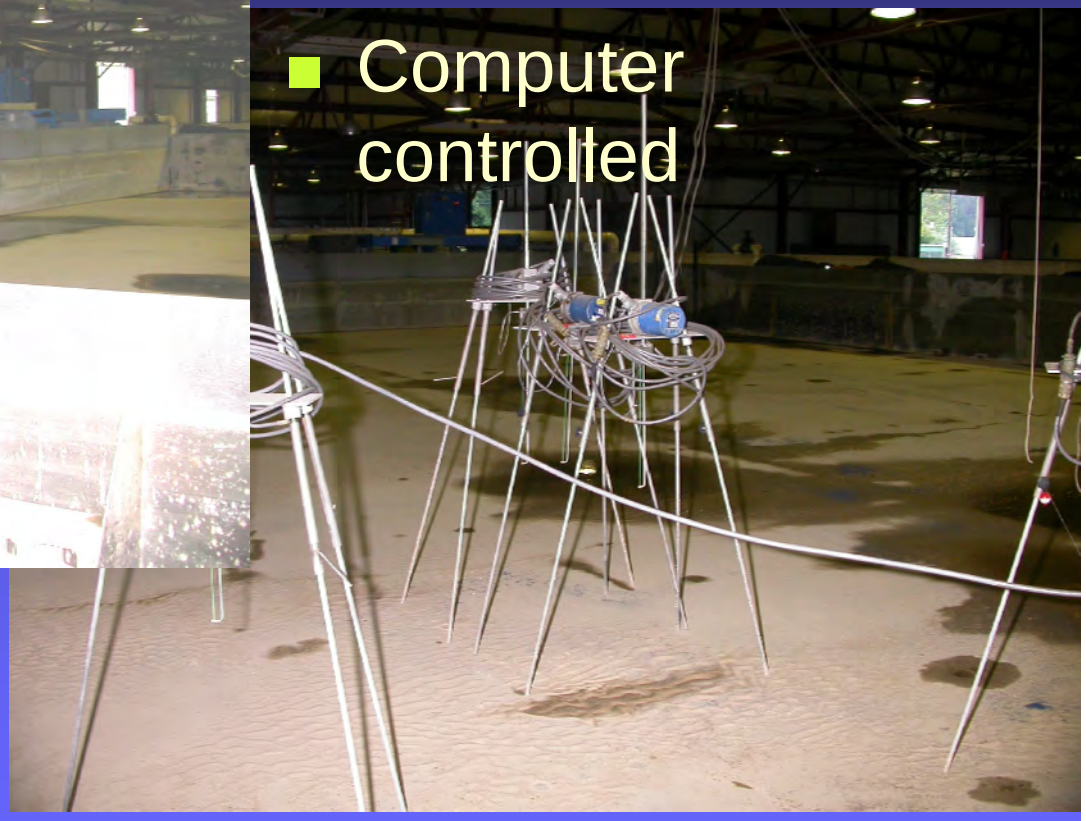


Engineer Research and Development Center

Three 25-ft-wide wave generators



- Synchronized
- Spectral or monochromatic
- Computer controlled



Engineer Research and Development Center

8-ft-diameter sump



- Two 4-in pumps
- Two diesel pumps



Engineer Research and Development Center

Impact Tests

- 12-in and 16-in-diameter logs
- 5 mph





Instrumentation



- Wave gauges
- Laser displacement measurements
- Pool elevation
- Pump discharge
- Webcams







Engineer Research and Development Center

Laboratory Testing of Flood Fighting Structures

Test Protocol



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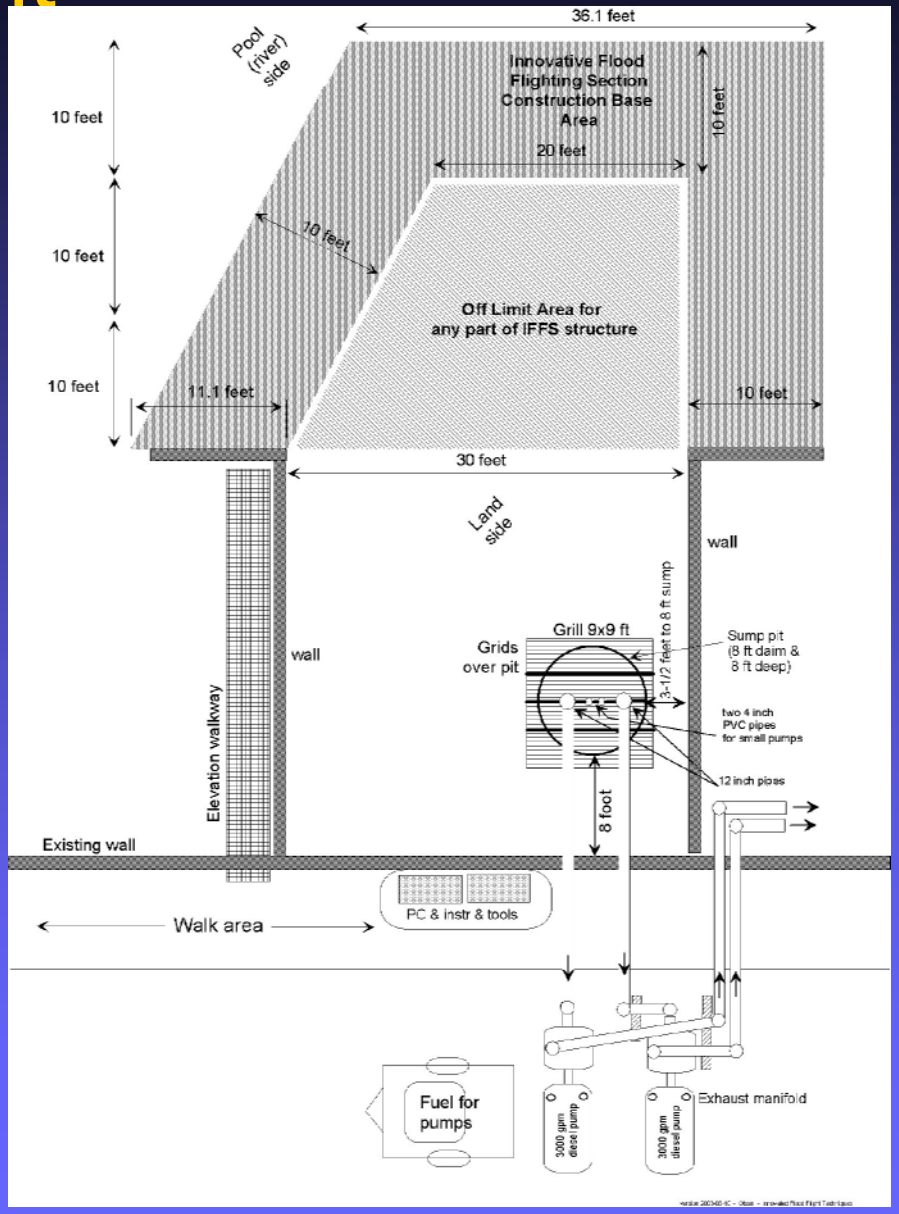
Standardized Test Protocol

- Construction, Repair, Removal
- Static Head
- Dynamic Wave
- Overtopping
- Debris Impact
- Reusability
- Environmental Evaluation



Construction Footprint

- One 90 degree angle
- One 60 degree angle
- Tie into one wall perpendicularly
- Tie into one wall at angle



Construction and Removal

- Total man-hours
- Equipment used
- Materials and supplies



Engineer Research and Development Center

Static Head Tests

- Test cases:
  - 1 ft head
  - 2 ft head
  - 95% of design height
  - 22 hrs each
- Measurements
  - Seepage rate
  - Displacement
  - Damage



Dynamic Wave Tests



- 2 inch Waves for 7 hours
- 6-8 inch Waves for 30 min
- 10-12 inch Waves for 10 min
- All waves at 67%H and 80%H

Overtopping Test

- 1 inch Head for 1 hour
- Damage and Survivability Test



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Debris Impact Test

- 12-in-diameter log, 5 mph
- 16-in-diameter log, 5 mph

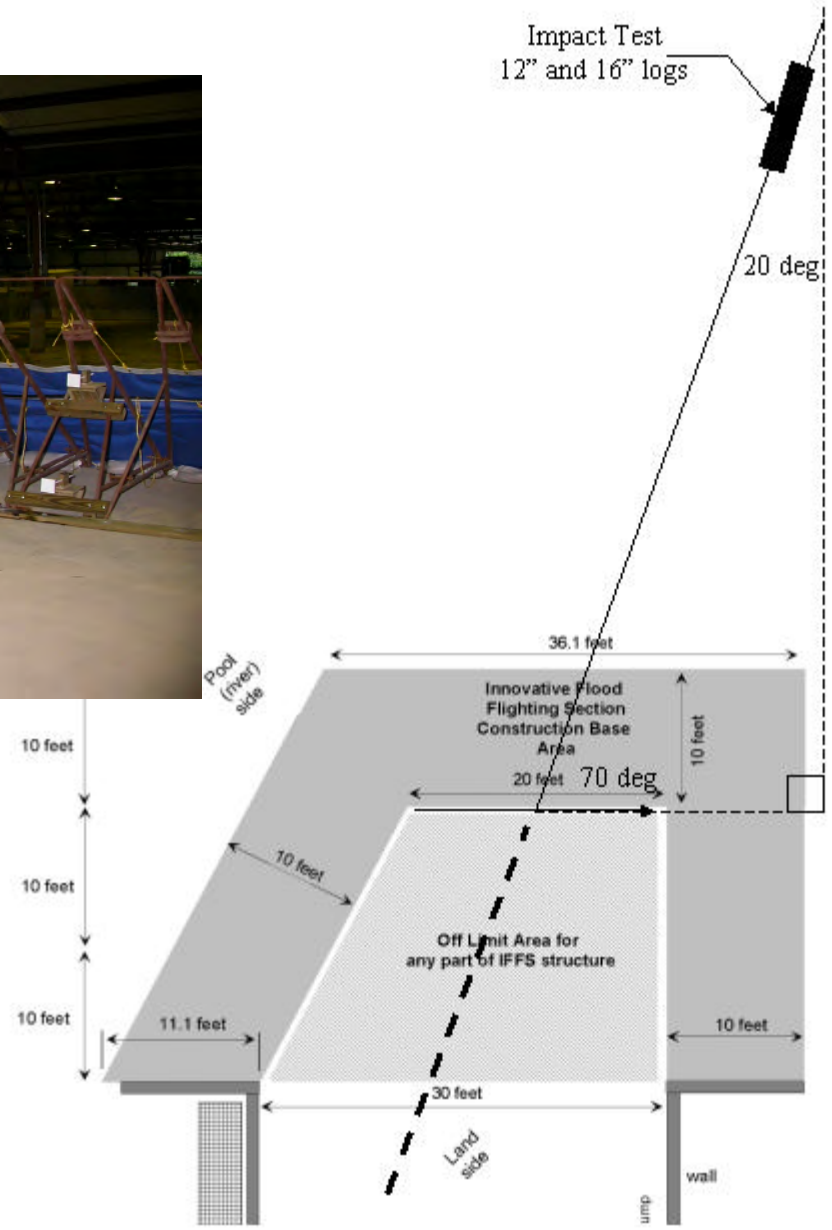




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Impact Tests





Repairs

- Up to three repairs allowed
- 30 minute maximum
- 4 person maximum
- Only at conclusion of specific tests



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Reusability

- Special equipment needed to clean unit
- Time needed for clean up unit
- Damages of structures
- Storage needed



Environmental Evaluation

- Disposal Concerns
- Contamination





Laboratory Testing of Flood Fighting Structures

Laboratory Testing

Test Parameters

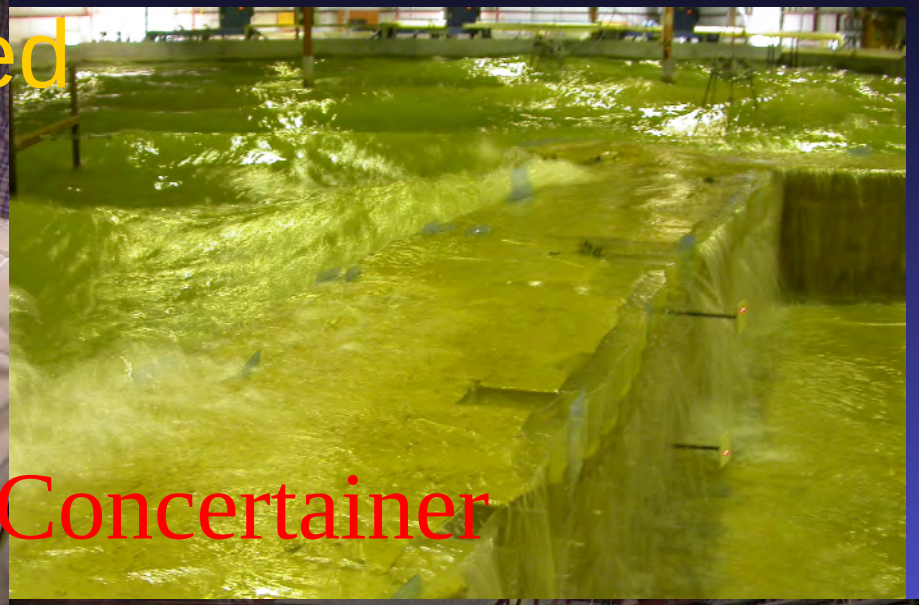
- Constructability
- Hydrostatic Load
- Wave-induced Hydrodynamic Load
- Overtopping
- Debris Impact
- Repairs to Flood-Fight Structures
- Removal of Structures
- Reuseability
- Environmental Evaluation



Structures Evaluated



Sandbags



Hesco-Bastion Concertainer

Geocell Systems RDFW



Portadam



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Sandbag Levee - Construction





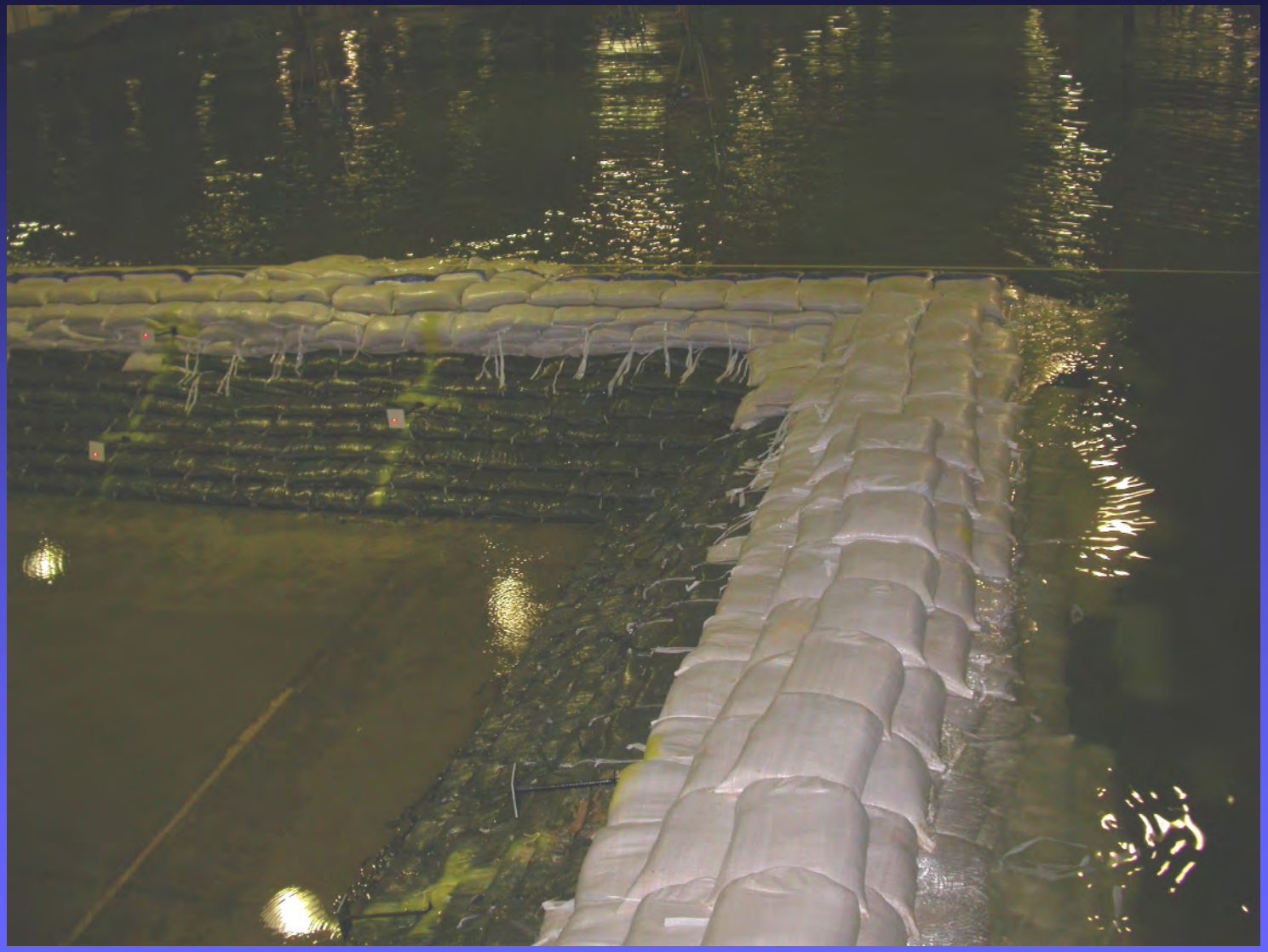
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Sandbag Levee - Construction



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Sandbag Levee - Static



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Sandbag Levee – Overtopping



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Sandbag Levee – Overtopping



Construction and Removal Summary

Construction:

- 205.1 Man-hours
- Equipments:
  - Front-end loader
  - Manual sandbagger
  - Cones
- Materials
  - Sandbags
  - Sand

Removal:

- 9 Man-hours
- Front-end loader



Repair Summary

- Repair 1: 2.0 Man-hours
  - Repaired wave damage
  - Leveled top surface
- Repair 2: 2.0 Man-hours
  - Repaired wave damage
- Repair 3: 2.0 Man-hours
  - Repaired wave damage
- Rebuild: 44 Man-hours
  - Placed heavier, tied sandbags on surface

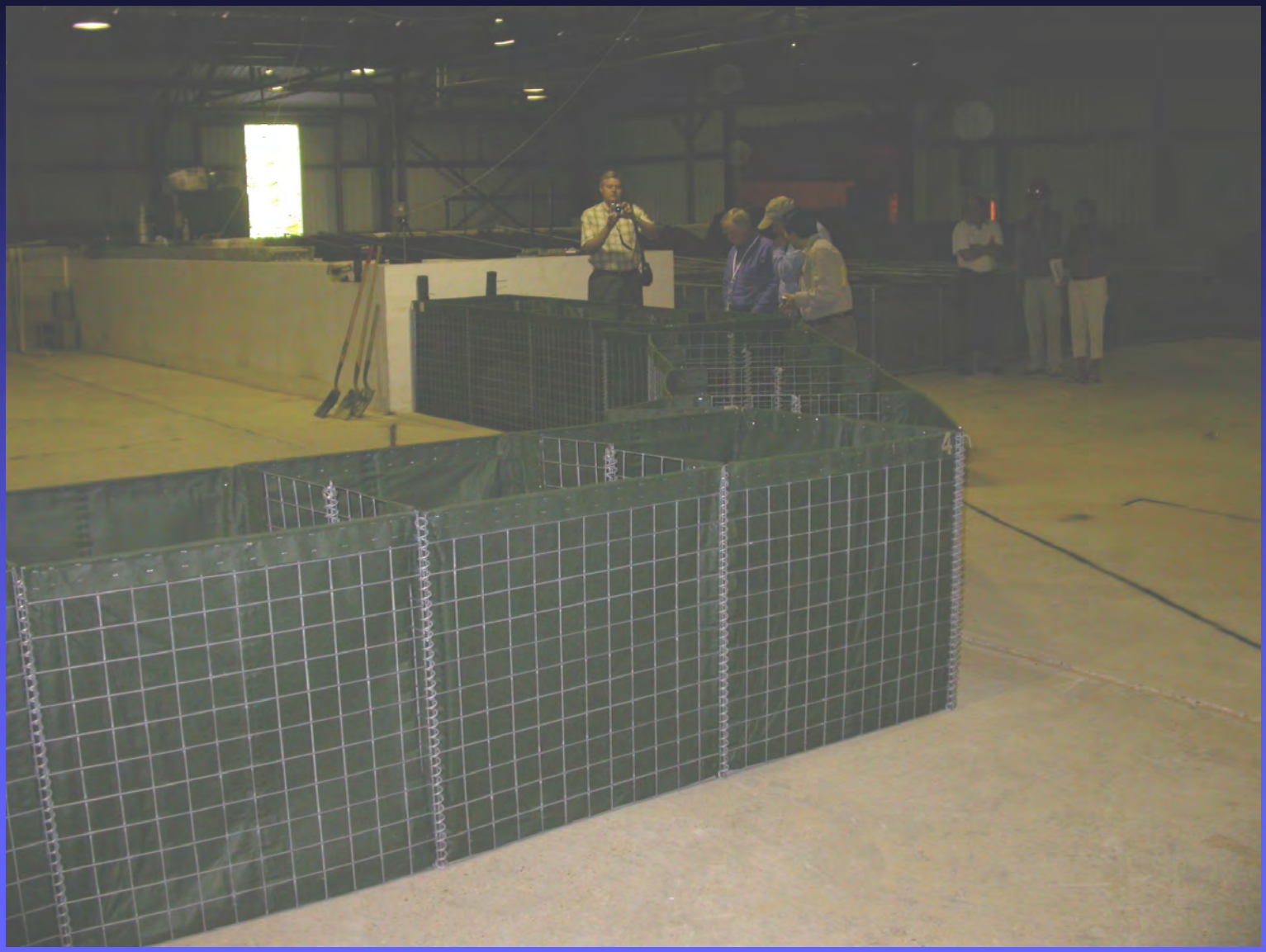


Hesco-Bastion Concertainer Construction



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Hesco-Bastion Concertainer Construction



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Hesco-Bastion Concertainer Construction



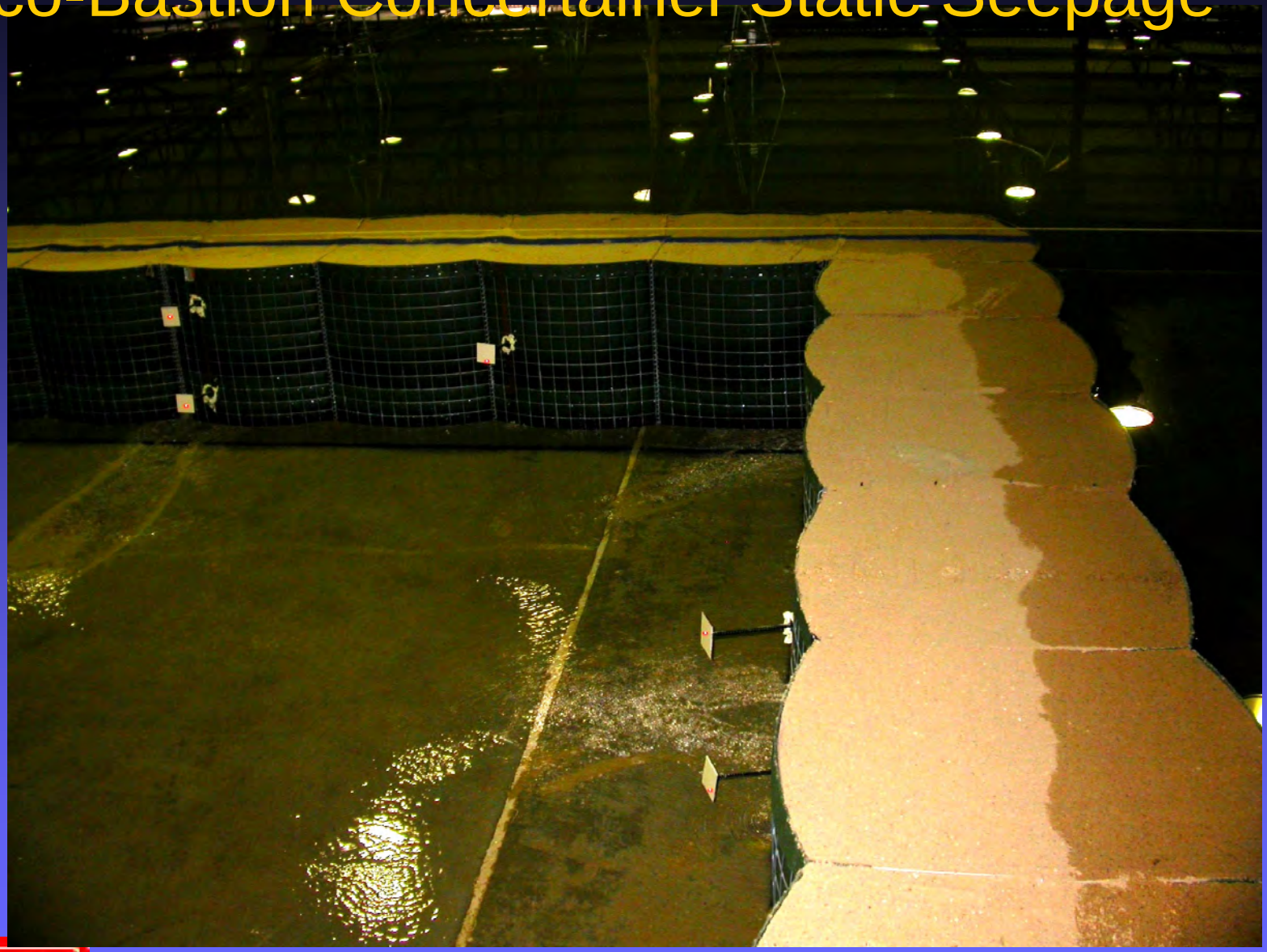
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Hesco-Bastion Concertainer Construction



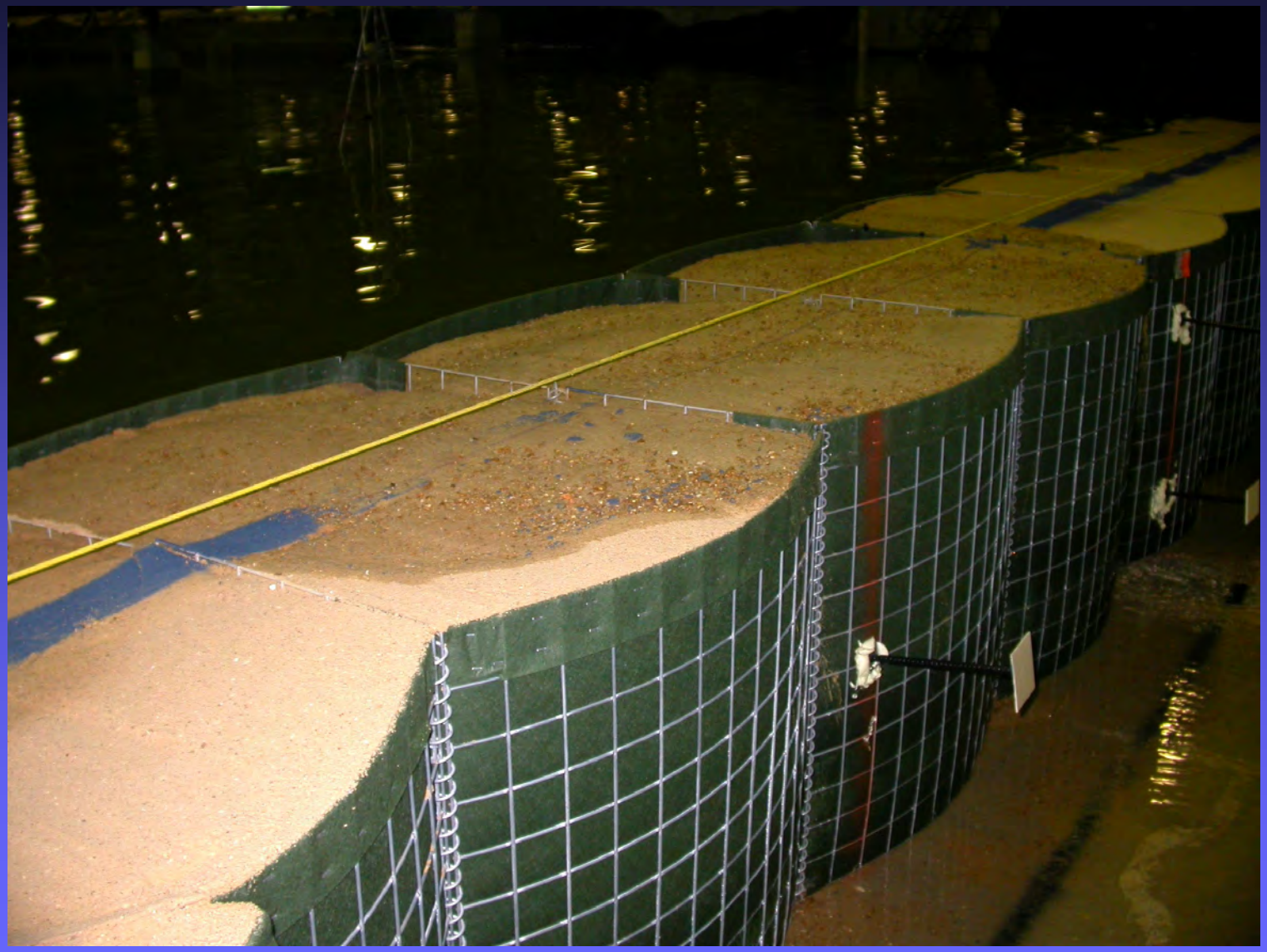
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Hesco-Bastion Concertainer Static Seepage



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Hesco-Bastion Concertainer – Wave Damage

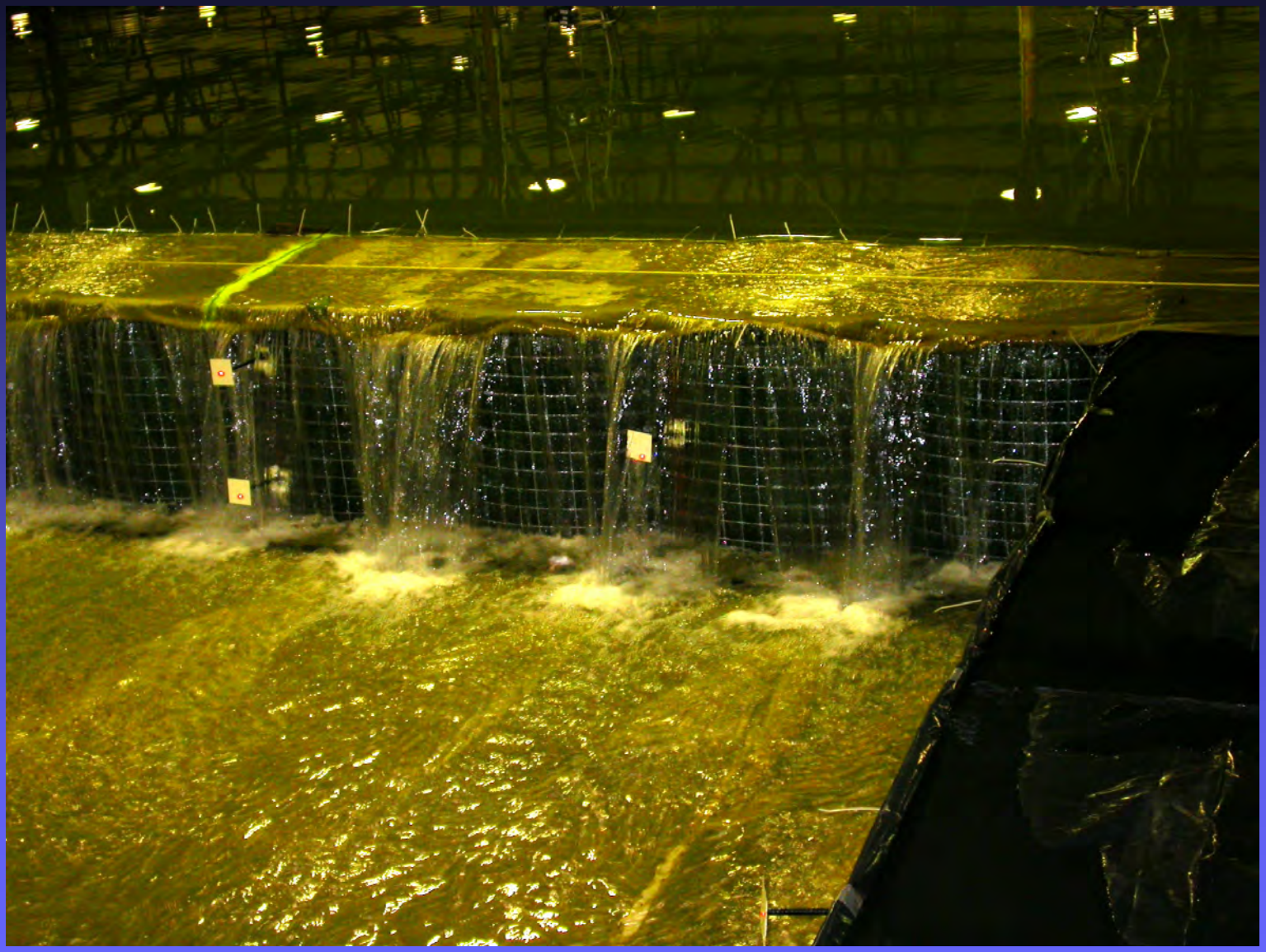


Hesco-Bastion Concertainer – Cover Installation



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Hesco-Bastion Concertainer – Overtopping



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Hesco-Bastion Concertainer – Removal



Hesco-Bastion Concertainer – Removal



Construction and Removal Summary

Construction:

- 20.8 Man-hours
- Equipments:
  - Front-end loader
- Materials
  - Concertainers
  - Sand, 5 Sandbags
  - Insulating Foam
- Comments
  - 6-man crew took 3 hr 28 min

Removal:

- 13.4 Man-hours
- Front-end loader



Repair Summary

- Repair 1: 1.6 Man-hours
  - Added membrane over surface
- Repair 2: 0.2 Man-hours
  - Placed sandbags along toe
- Repair 3: N/A



Geocell RDFW – Construction



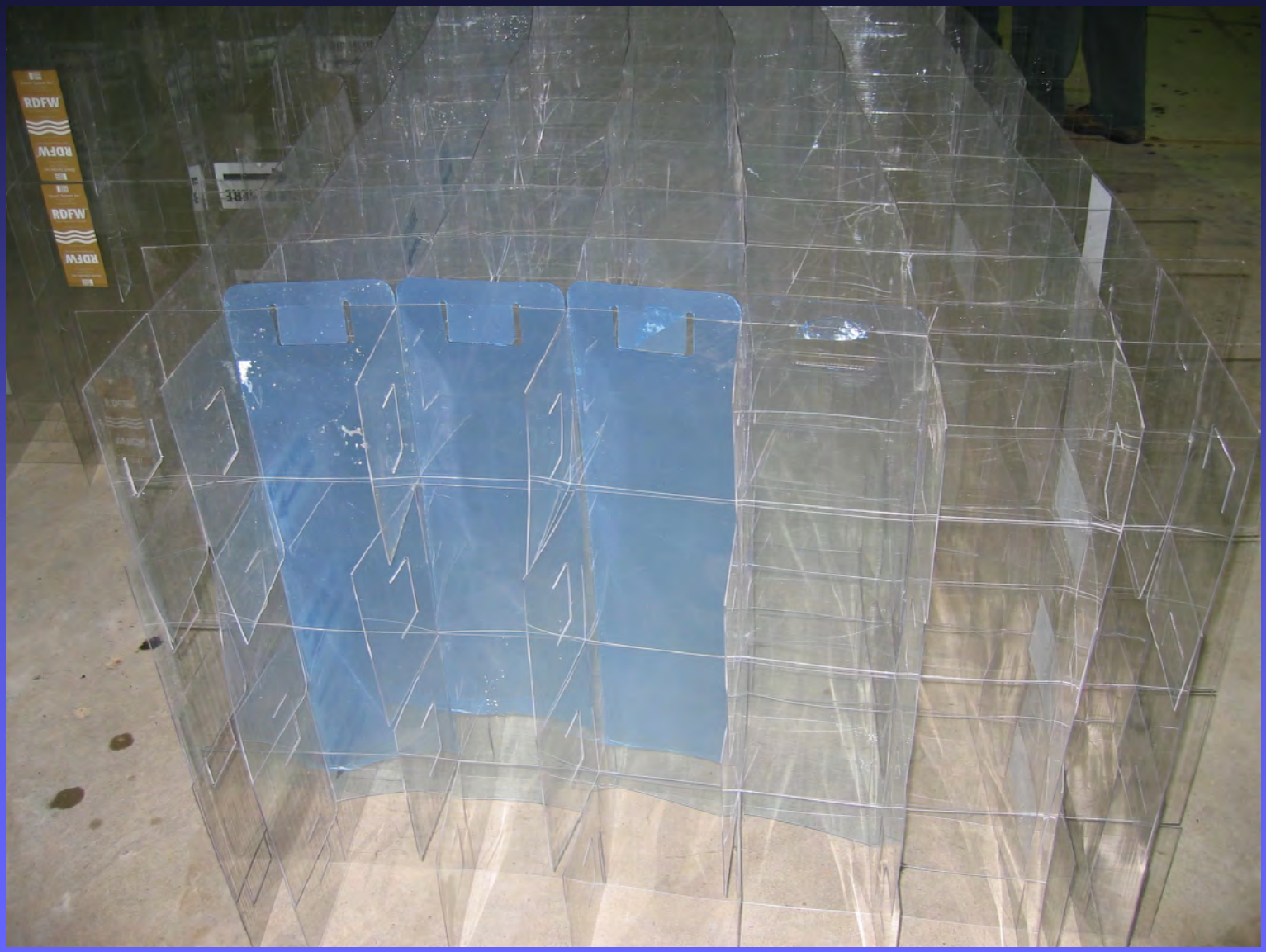
Geocell RDFW – Construction



Geocell RDFW – Construction



Geocell RDFW – Construction



Geocell RDFW – Construction



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Geocell RDFW – Construction



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Geocell RDFW – Construction



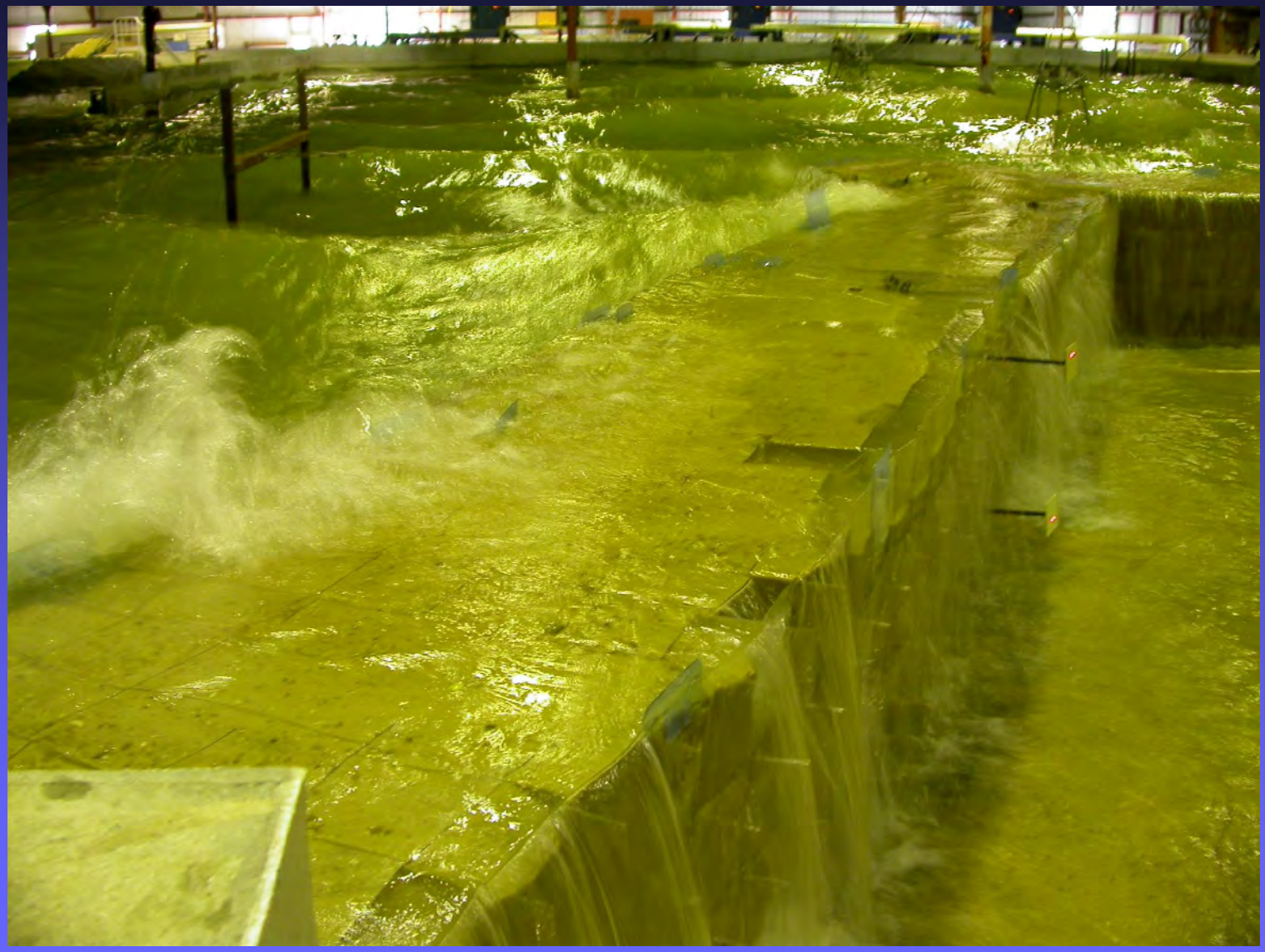
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Geocell RDFW – Static Damage



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Geocell RDFW – Wave Action



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Geocell RDFW – Wave Damage



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Geocell RDFW – Repair



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Geocell RDFW – Log Impact



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Geocell RDFW – Damage



Geocell RDFW – Removal



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Geocell RDFW – Removal



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Geocell RDFW – Removal



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Geocell RDFW – Removal



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Construction Summary

- Construction:
- 32.8 Man-hours
- Equipments:
  - Front-end loader
  - Bobcat
  - Forklift
- Materials
  - RDFW Units
  - Sand
  - Cement
- Comment
  - 6 man-crew, took 5 hr 28 min

- Removal:
- 42 Man-hours
  - Bobcat
  - Forklift
  - Shop vacuums



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Repair Summary

- Repair 1: 1.9 Man-hours
  - Added sand along top surface
- Repair 2: 0.7 Man-hours
  - Added reinforcing strips
- Repair 3: 1.9 Man-hours
  - Added additional sand



Portadam - Construction



Portadam - Construction



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Portadam - Construction



Portadam - Waves



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Portadam - Overtopping



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Portadam – Log Impact Damage



Portadam - Removal







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Construction Summary

- Construction:
  - 24.4 Man-hours
  - Equipment:
    - Hyster Forklift
  - Materials
    - Portadam frames and cover
    - Sand bags and sand
    - Insulating foam
    - Tape, Rope
  - Comments
    - 6-man crew, 2 only filled sandbags
- Removal:
  - 4.4 Man-hours
  - Equipment:
    - Hyster Forklift

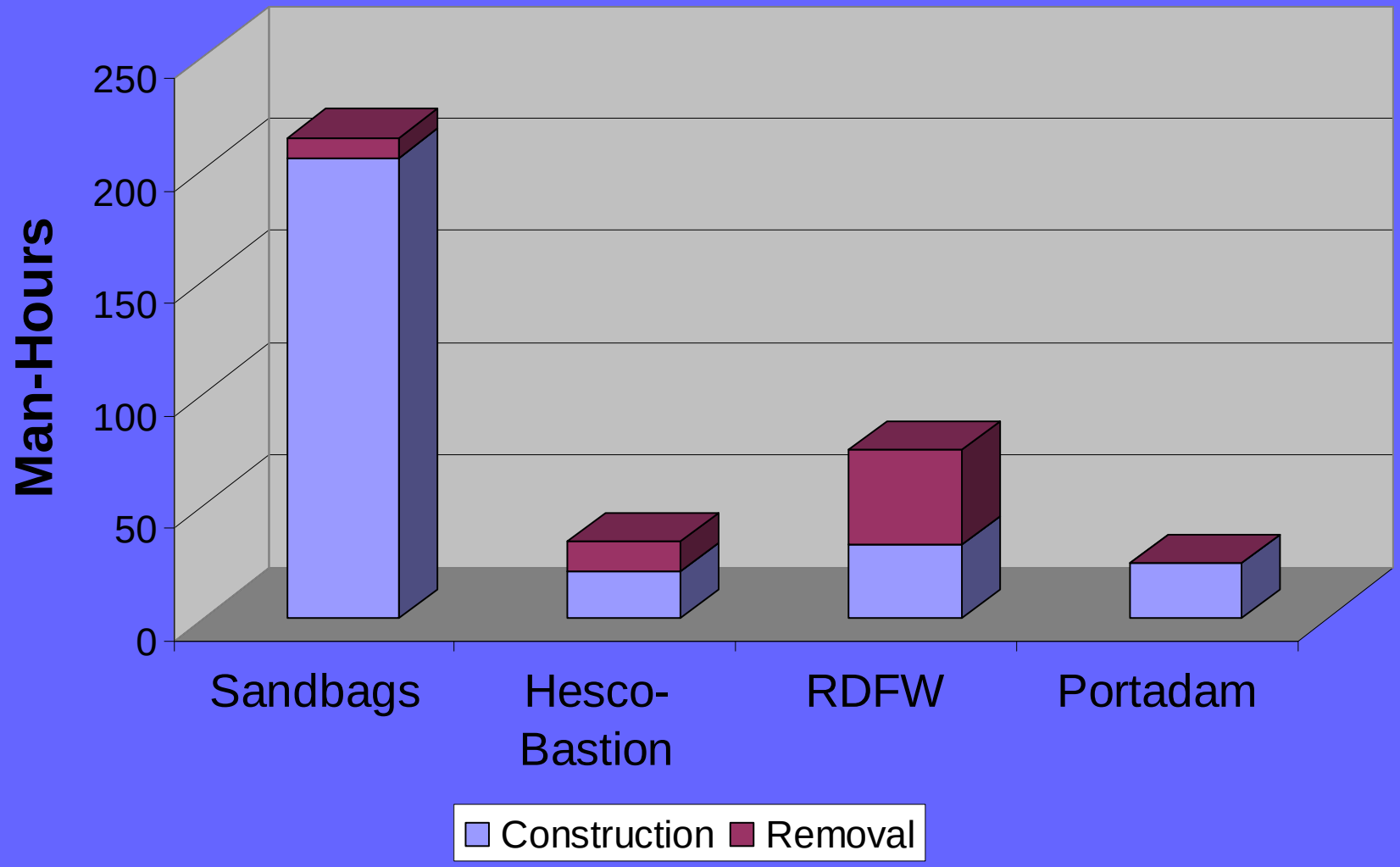


Repair Summary

- Repair 1: 0.5 Man-hours
  - Placed sandbags over bubbles under skirt
- Repair 2: 1.5 Man-hours
  - Improved seal along wall
- Repair 3: N/A



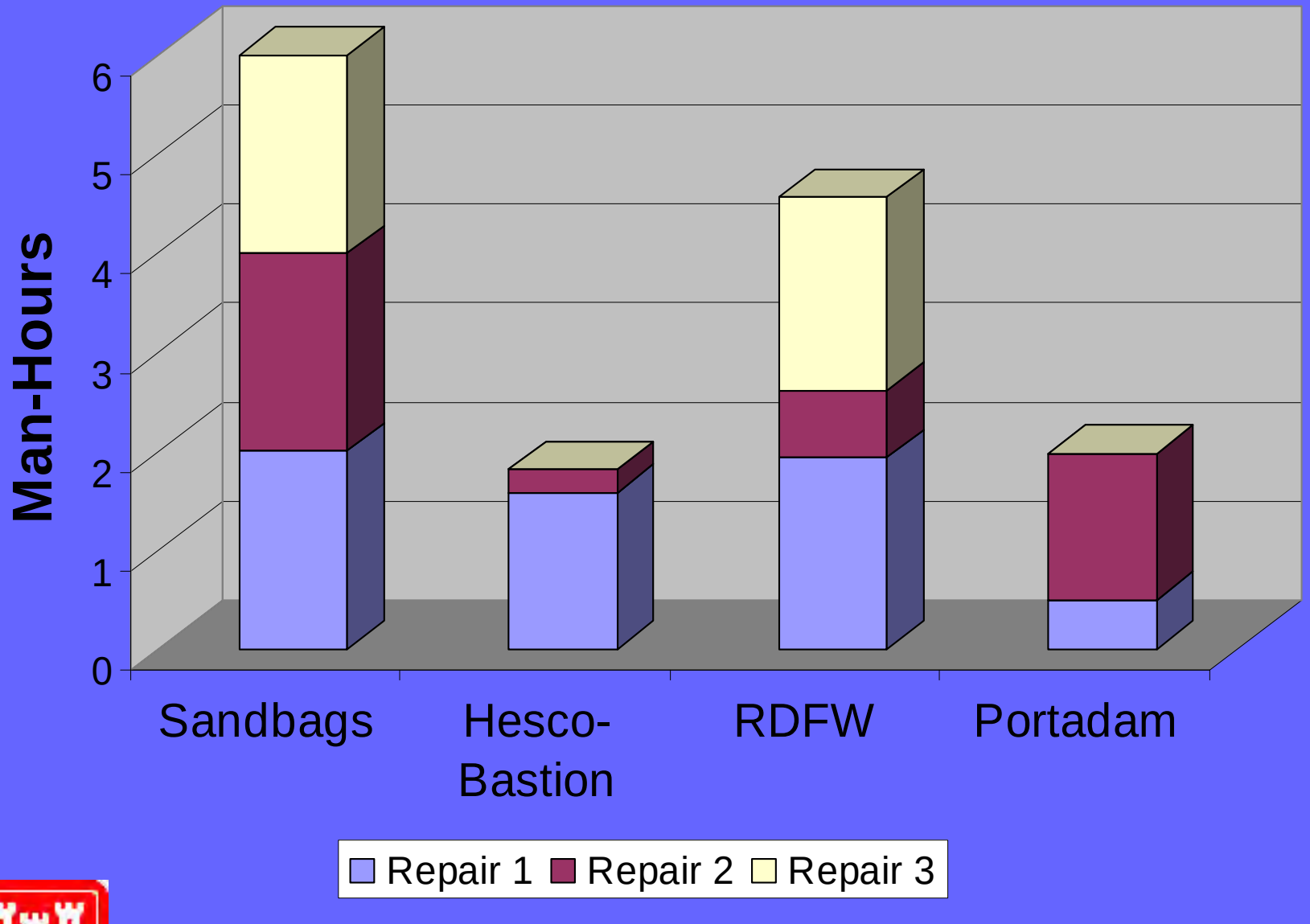
Construction and Removal Summary





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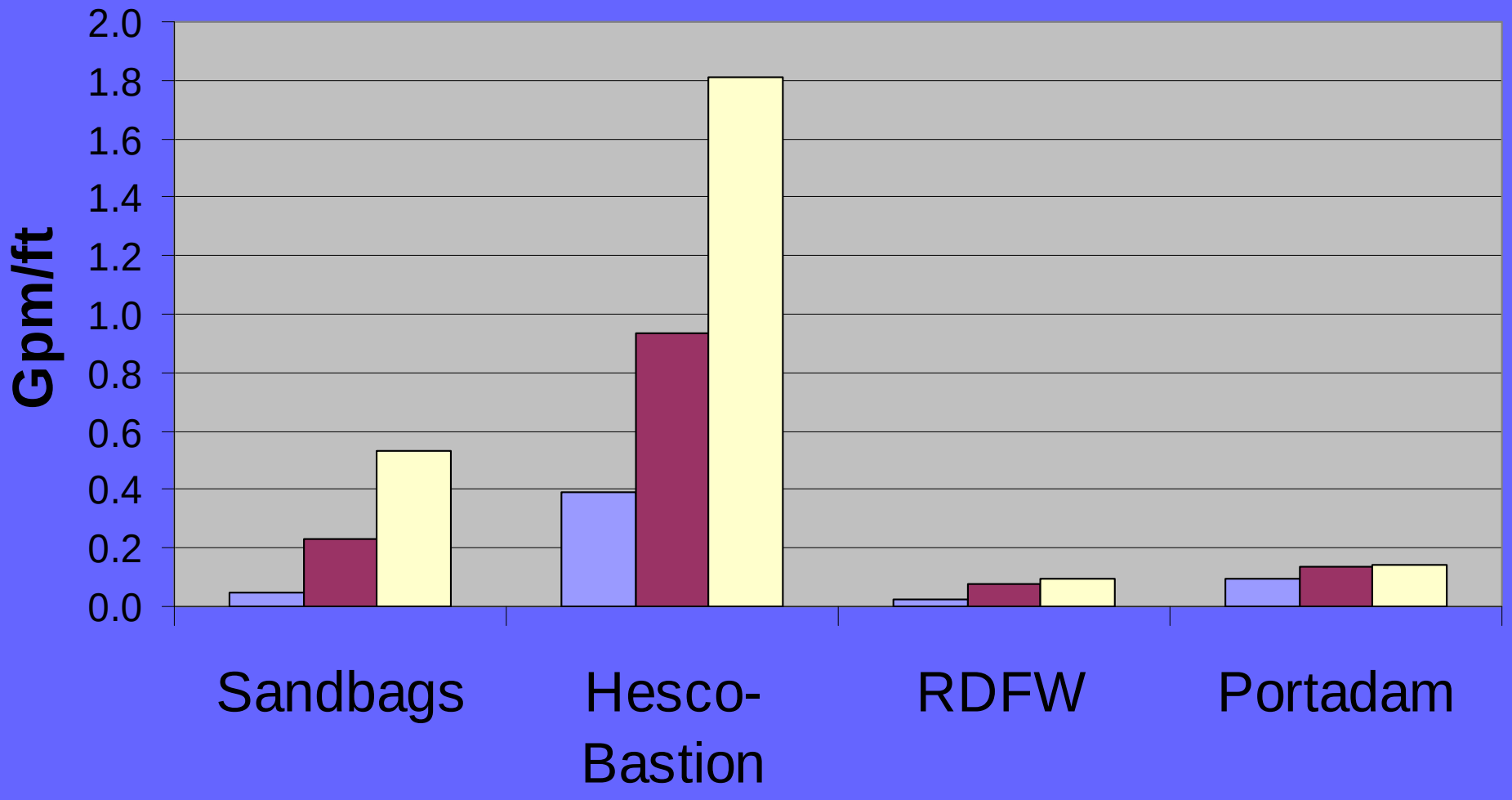
Repair Summary





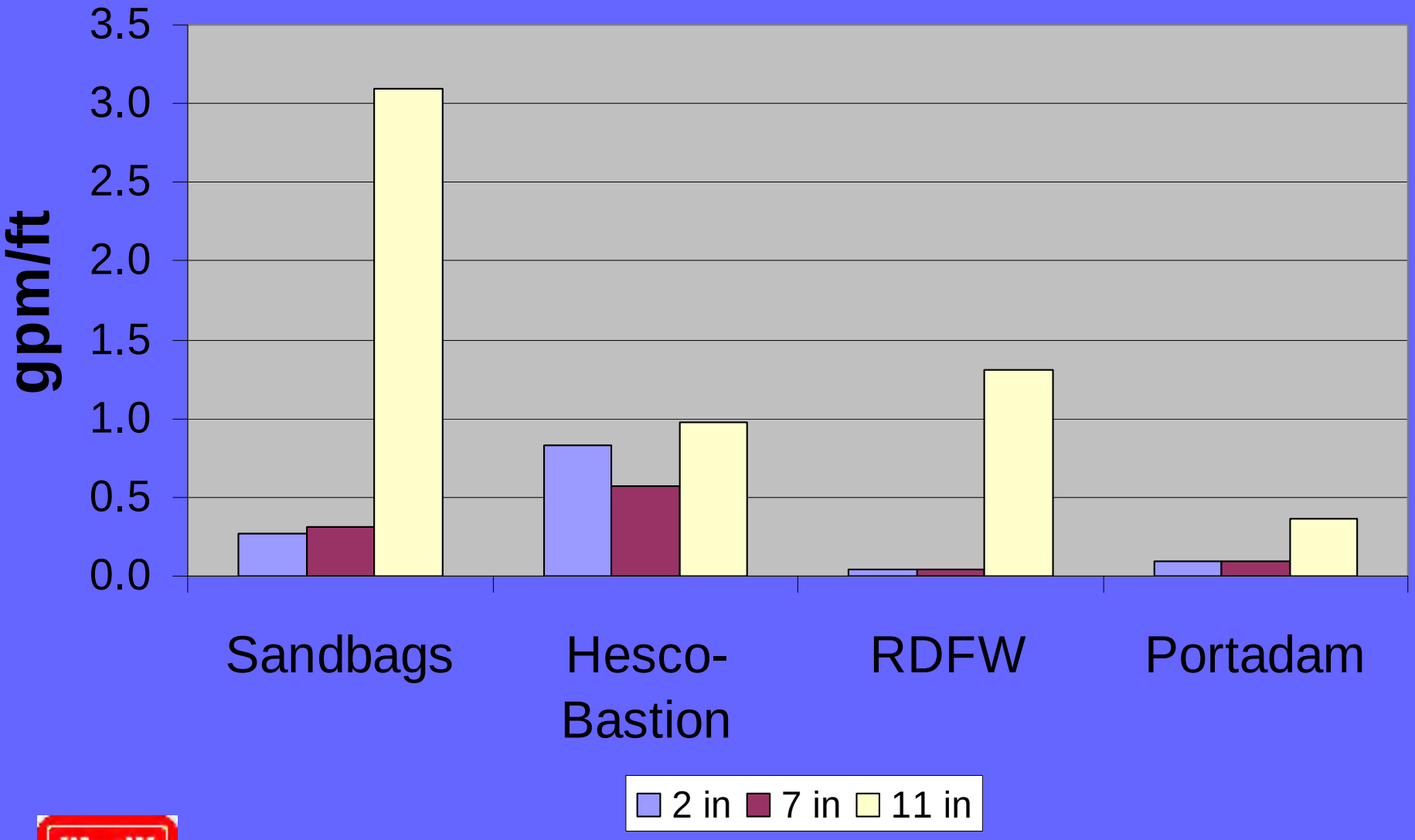
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Static Head Seepage Rates Summary



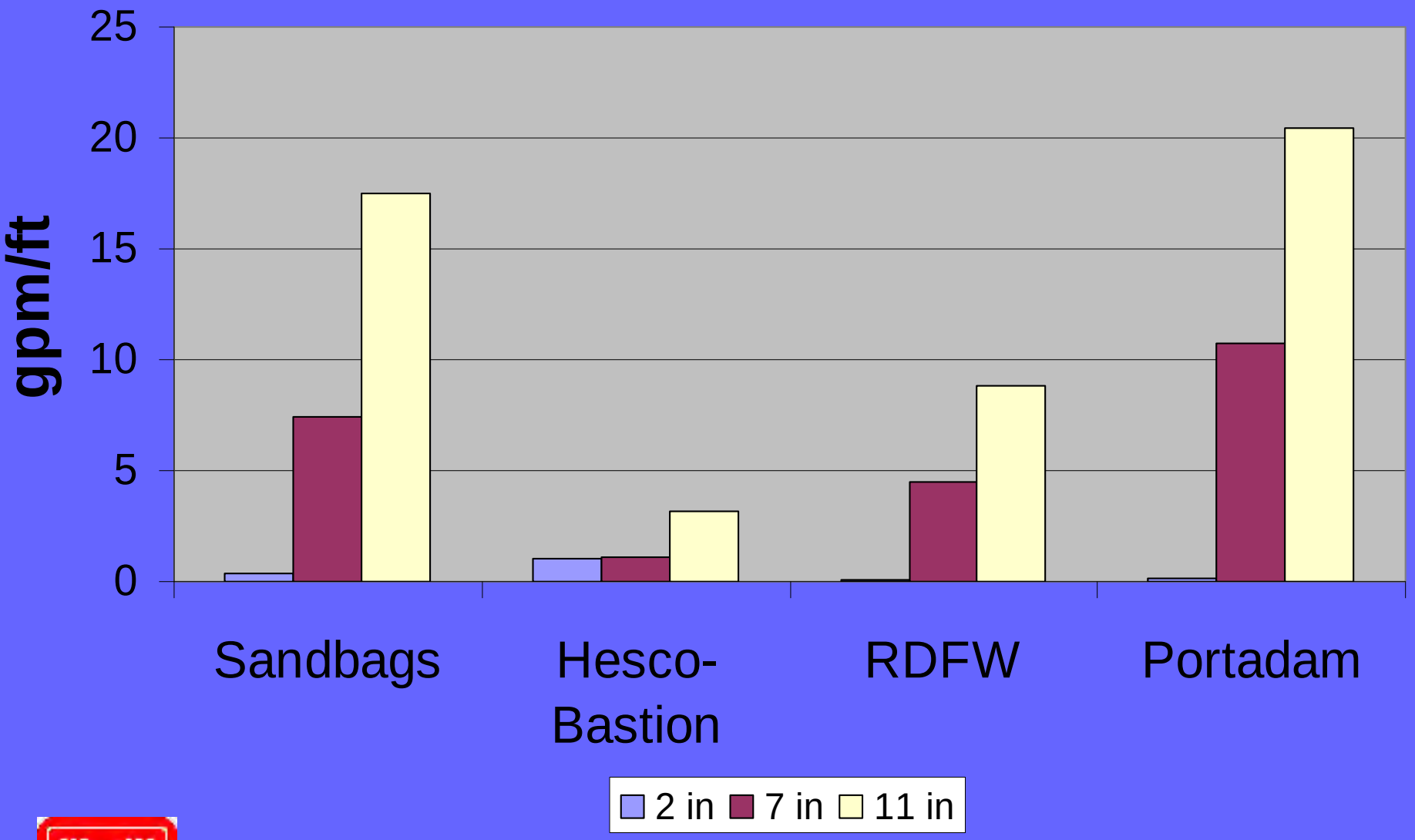
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Dynamic Wave Loading at 67%H Seepage



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Dynamic Wave Loading at 80%H Seepage



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Damage Summary

- Sandbags
  - Repeatedly damaged by waves
  - Failed during overtopping
- Hesco-Bastion Concertainer
  - Some sand settling and washout (minor)
  - Wire bent by log impact

Damage Summary (concluded)

- Geocell Systems RDFW
  - Minor sand settling
  - Significant washout along edges and toe
  - Toe damaged during large waves or overtopping
  - 10% of structure broken
- Portadam
  - Fabric torn during impact tests

Reusability



- Sandbags
  - Possible, but not practical
  - Entire structure discarded
- Hesco-Bastion Concertainers
  - Reusable
  - May be difficult to clean muck from fabric
  - End pieces must be replaced

Reusability (concluded)

- Geocells Systems RDFW
  - Reusable
  - Structure can be hosed off
  - Replace broken pieces – time consuming
- Portadam
  - Reusable
  - Hose off fabric
  - Designed for rental use – reused many times
- Disassembly times did not include times to prepare for reuse



Test Summary

Observed Product Strengths and Weaknesses

Product	Strengths	Weaknesses
Sandbags	1. Low Cost – generally constructed by volunteer labor	1. Very labor intensive and time consuming to construct
	2. Conforms well to varying terrain	2. Not reusable
	3. Low seepage rates	
	4. Can be raised if needed	
Hesco Bastion	1. Low Cost 2. High degree of reusability	1. Significant ROW required due to granular fill
	3. Can be raised if needed	2. Highest Seepage Rates
RDFW	1. Low seepage rates 2. High degree of reusability	1. Significant ROW required due to granular fill
	3. Can be raised if needed	2. High cost
		3. Most difficult to remove
Portadam	1. Ease of Construction (time, manpower, equipment)	1. Punctured during laboratory debris impact test
	2. Low seepage rates 3. No required fill	2. Can't be raised in a typical application
	4. High degree of reusability	
	5. Least ROW required	

Questions?





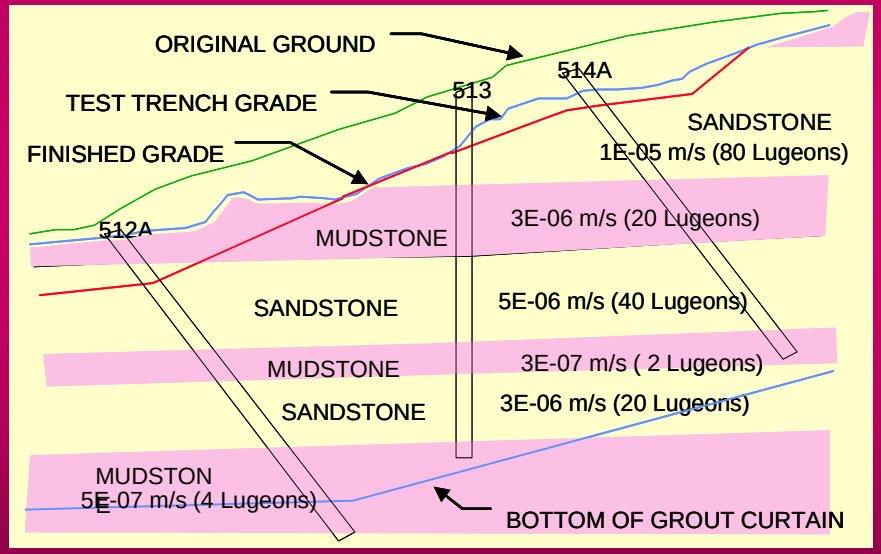


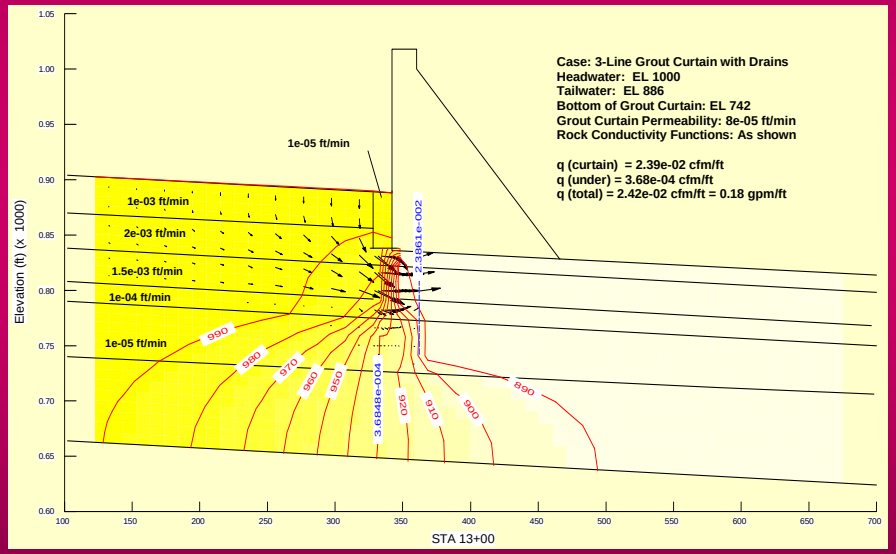
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2005 Tri-Service Infrastructure Conference

"Re-Energizing Engineering Excellence"

Quantitatively Engineered Grout Curtains





David B. Wilson, P.E.

Trent L. Dreese, P.E.

Gannett Fleming

Introduction

Grouting – It Seems So Simple !



Interesting Grouting Comments

- *"The foundation wasn't groutable"*
- *"Grouting isn't reliable as a long-term solution"*
- *"There's no way to know how the grouting will perform until we fill it up."*
- *"The only person that can understand the grouting work is the guy onsite that's in charge of the program"*
- *"We spent $2,000,000 and didn't accomplish anything. I don't think we'll ever be authorized to try grouting again."*
- *"We grouted until we ran out of budget and then we quit."*

Grouting Program Failures

- *Inability to reliably predict performance in advance*
- *Unsatisfactory initial performance*
- *Unsatisfactory long-term performance*
- *Cost overruns, project delays, & claims*
- *Inability to effectively communicate need for grouting, amount of grouting required, and results of grouting*

The Central Question

Is There Something Fundamentally Wrong with Grouting, or Does the Grouting Precisely Reflect How We Approach & Execute the Work ?

Grouting 2005

- *Grouting results can be predicted*
- *Grouting can be designed, modeled, specified, and verifiably constructed to achieve quantitative results*
- *Grouting results can be clearly understood and communicated*
- *Contracting alternatives exist that will provide incentives for quality equipment and workmanship and which will prevent cost growth and claims*
- *Grouting is a reliable & cost effective method for seepage control*

Tools Enabling Successful Quantitative Design and Construction

- *Quantitative site characterization, quantitative modeling, and quantitative design of grouting*
- *Balanced stable grouts*
- *Electronic monitoring and control of operations*
- *Computer analysis & presentation of results*
- *Best Value Contracting and Partnering*

Quantitative Design & Construction of Grouting

What Do We Need for Quantitative Design & Construction ?

- *Thorough understanding of site geology*
- *Pre-grouting permeabilities*
- *Workable model for pre- and post-grouting conditions*
- *Performance requirements*
- *Design parameters for grouting (width & permeability)*
- *Real-Time Analysis & Verification to Evaluate Results and Provide Basis for Required Program Modifications in Field*
- *Ability to Communicate Results to All Project Participants*

Site Geology

Site Geology Information Required

- *Regional & Site Specific Geologic Information*
- *Fracture Information for <u>each</u> geologic unit or sub-unit*
  - *Fracture orientations*
  - *Fracture widths*
  - *Fracture spacings*
  - *Fracture continuity*
  - *Fracture filling*
- *Special Conditions*
  - *Conditions at interface at which grouting is to start*
  - *Special geologic conditions (i.e. karst features; non-lithified zones; concentrated fracture zones; water loss zones; artesian zones; etc)*

Geologic Data Collection


Outcrop Mapping and
Conventional Coring

McCook Reservoir Test Grouting – Chicago District USACE



Pre-Grouting Permeabilities
&
Flow Regimes

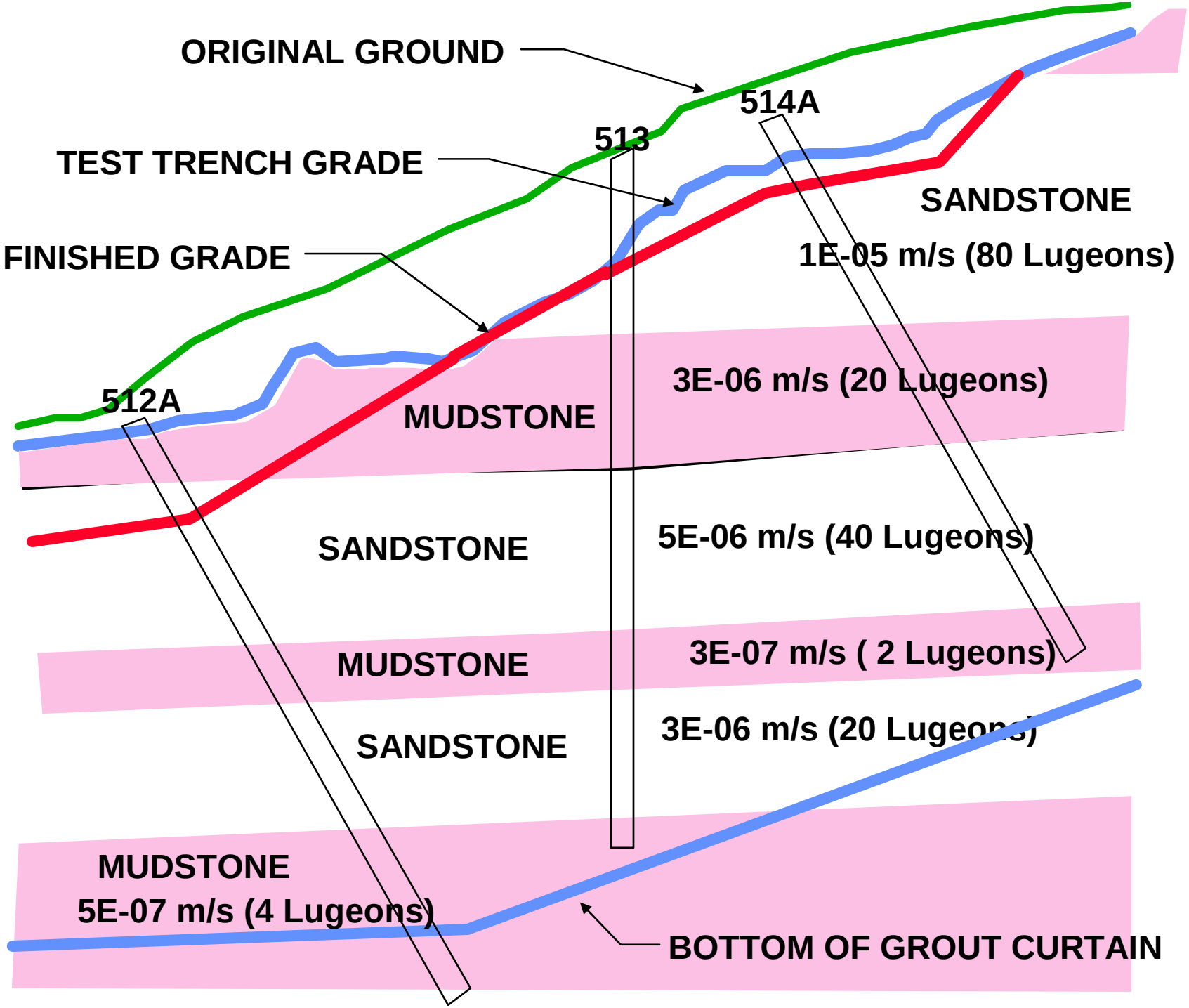
Data Sources

Permeability & Flow Regime Data Sources

- *Geologic Information*
- *Piezometer Data*
- *Boundary Conditions (HW, TW, Seepage Exit Points)*
- *Short Stage Pressure Tests in Holes with Appropriate Orientations*

Data Validation & Integration

- *Validate the available data*
- *All valid data must be integrated*
- *Study it until it truly makes qualitative and quantitative sense. In most cases, sufficient valid data exists to do a model that and produces a reasonable representation of current conditions.*
- *Don't ignore anomolies. Something is going on.*


ORIGINAL GROUND
TEST TRENCH GRADE
FINISHED GRADE
512A
513
514A
SANDSTONE
1E-05 m/s (80 Lugeons)
3E-06 m/s (20 Lugeons)
MUDSTONE
SANDSTONE
5E-06 m/s (40 Lugeons)
MUDSTONE
3E-07 m/s (2 Lugeons)
SANDSTONE
3E-06 m/s (20 Lugeons)
MUDSTONE
5E-07 m/s (4 Lugeons)
BOTTOM OF GROUT CURTAIN

Grouting Models

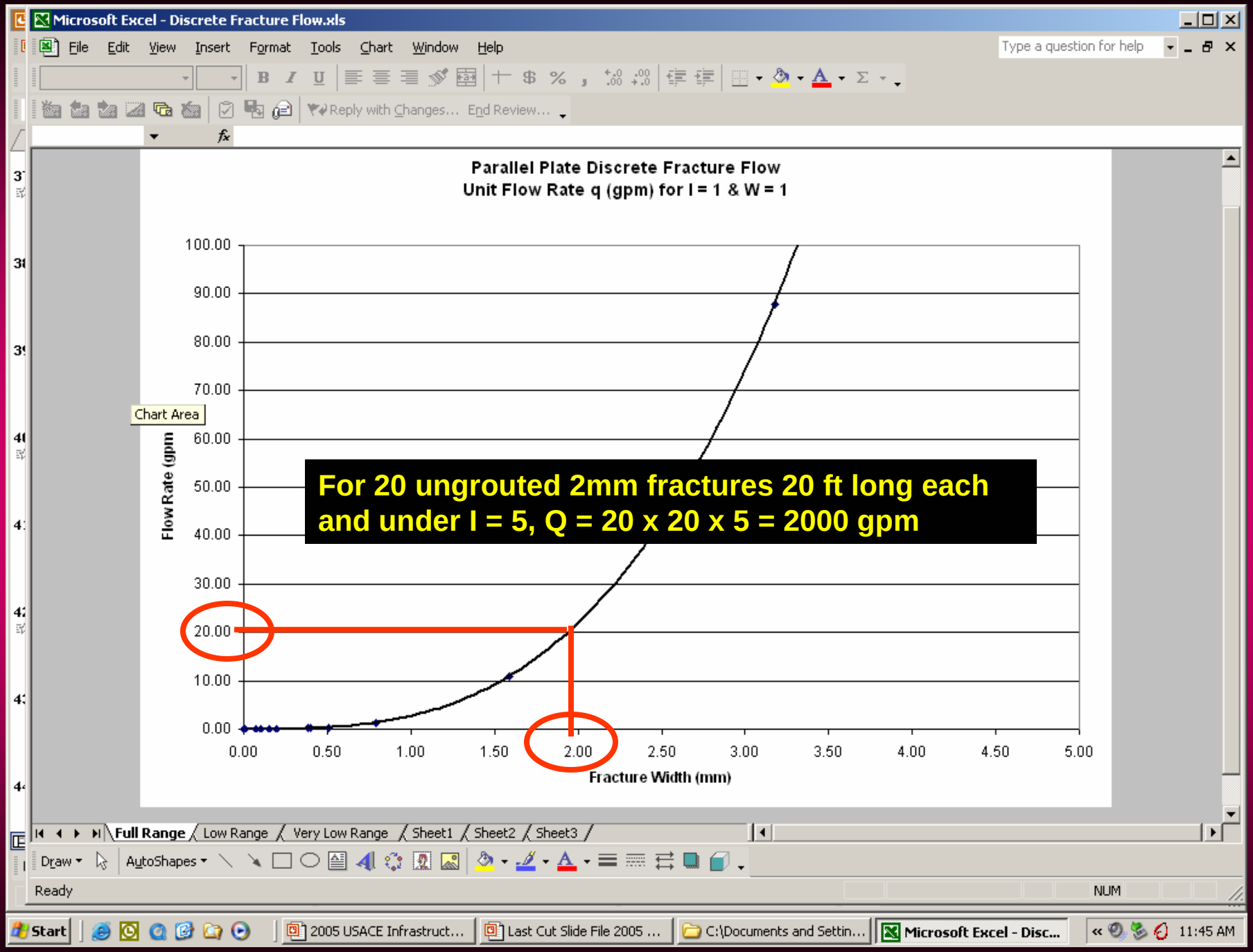
Discrete Fracture Flow Models
vs.
Porous Media Flow Models

Flow through Rock is Discrete Fracture Flow

Discrete Fracture Models

- *Based on flow through parallel plates*

- $Q = W\boldsymbol{g}b^3 i / 12\boldsymbol{m}$
  - ***b = fracture width***
  - ***W = fracture access length***
  - ***i = gradient from entry to exit boundary points***
  - ***g = unit weight of water***
  - ***m = dynamic visosity of water***


Microsoft Excel - Discrete Fracture Flow.xls
File Edit View Insert Format Tools Chart Window Help
Type a question for help
Reply with Changes... End Review...
Parallel Plate Discrete Fracture Flow
Unit Flow Rate q (gpm) for I = 1 & W = 1
Chart Area
Flow Rate (gpm)
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
Fracture Width (mm)
For 20 ungrouted 2mm fractures 20 ft long each
and under I = 5, Q = 20 x 20 x 5 = 2000 gpm
Full Range Low Range Very Low Range Sheet1 Sheet2 Sheet3
Draw AutoShapes
Ready
NUM
Start
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Microsoft Excel - Disc...
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Microsoft Excel - Discrete Fracture Flow.xls

File Edit View Insert Format Tools Chart Window Help

Type a question for help

Arial 10

Reply with Changes... End Review...

Value (Y) axis

Formula Bar

Parallel Plate Discrete Fracture Flow
Unit Flow Rate q (gpm) for I = 1 & W = 1



Q = 700 gpm per ft of length
(Under i = 1)

Flow Rate (gpm)

1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00

0.00 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00

Fracture Width (mm)

Full Range | Low Range | Very Low Range | Sheet1 | Sheet2 | Sheet3

Draw AutoShapes

Ready NUM

Start | Inbox - Microsoft ... | C:\Documents and... | Third Draft 2005 U... | Last Cut Slide File ... | Microsoft Excel ... | 1:03 PM

So Why Not Use Discrete Fracture Models ?

- *Fractures aren't parallel plates*
- *Fracture width "b" is extremely difficult to ascertain.*
- *Generally don't know fracture continuity, which is essential for "W" term*
- *Requires knowing number fractures in each fracture set as well as size distribution*

Porous Media Flow Models

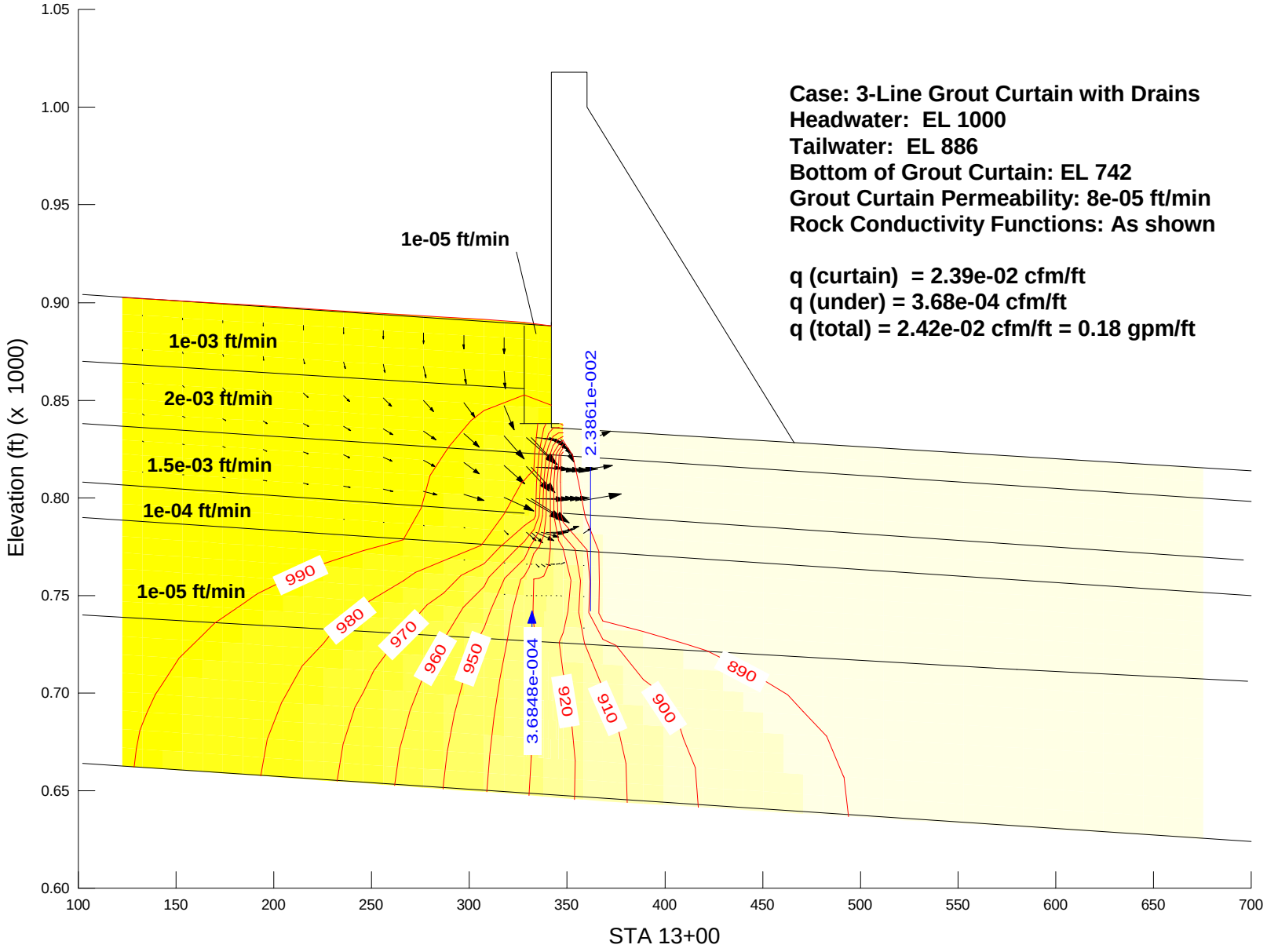
Why Porous Media Models Work

- *Scale of problem is generally ok (i.e. fracture density relative to volume being modeled is such that it approximates a porous media).*
- *Data easy to get – packer tests determine equivalent rock mass permeability*
- *For well-grouted rock, the residual permeability is comprised of very small flow paths that very closely approximates a porous media*
- *After grouting, assuming we achieve about a two-order magnitude of permeability reduction, the ungrouted rock on either side does not control behavior.*

Examples of Porous Media Models

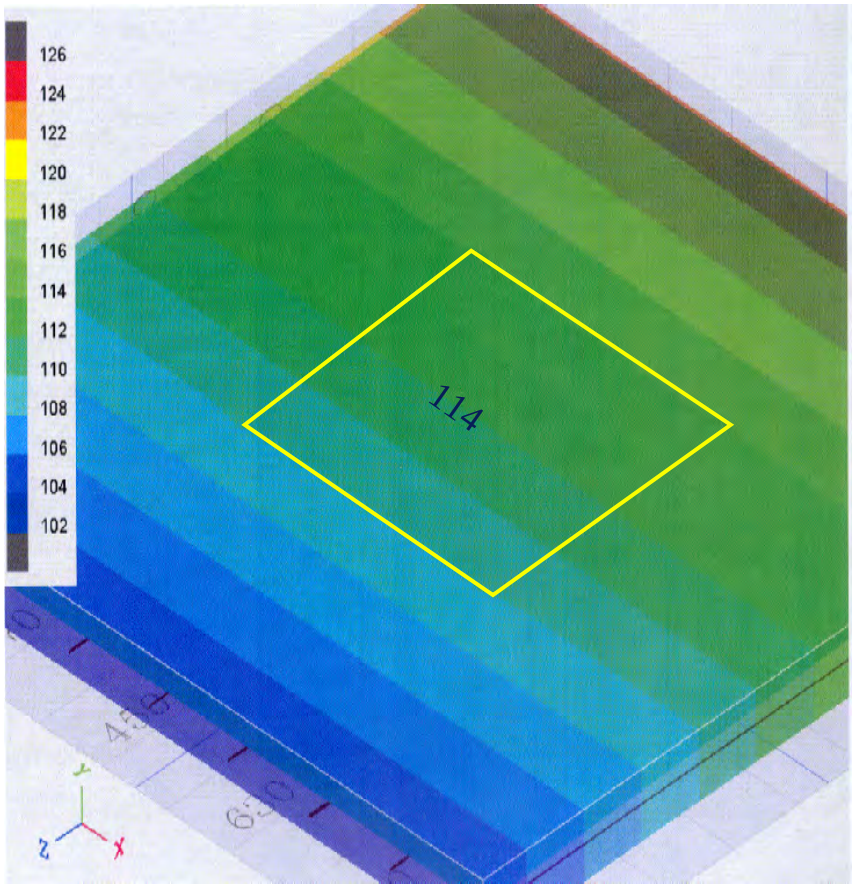
PENN FOREST DAM REPLACEMENT PROJECT

FINAL GROUT CURTAIN - VALLEY SECTION

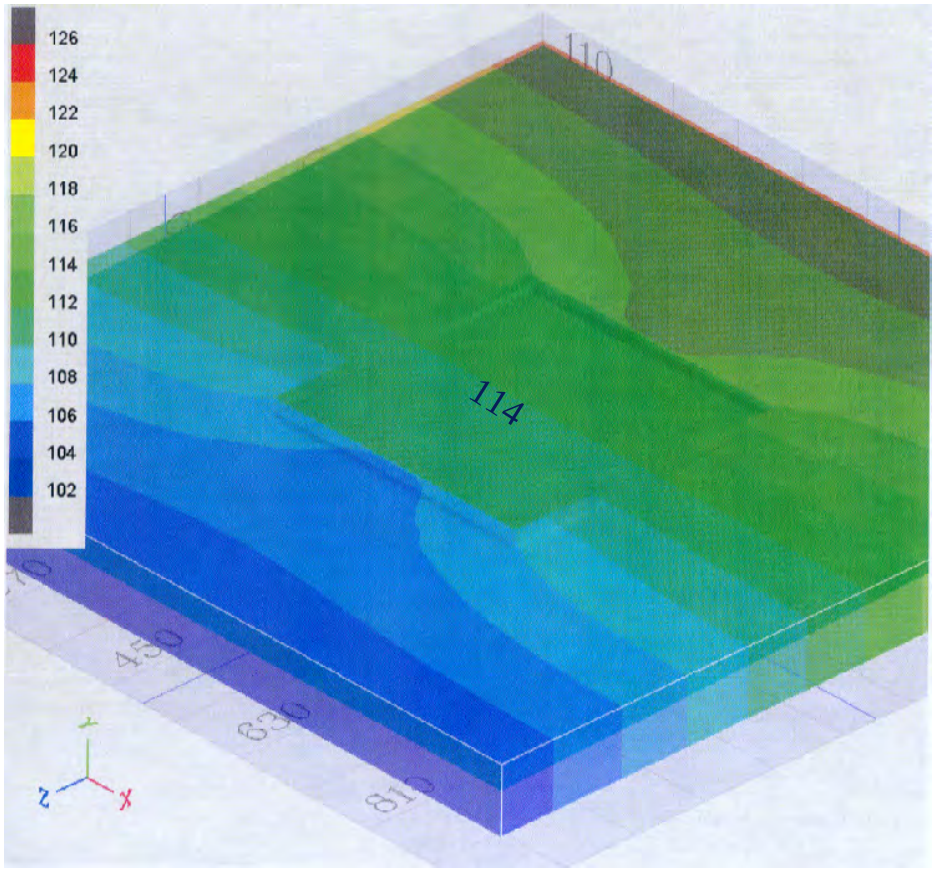


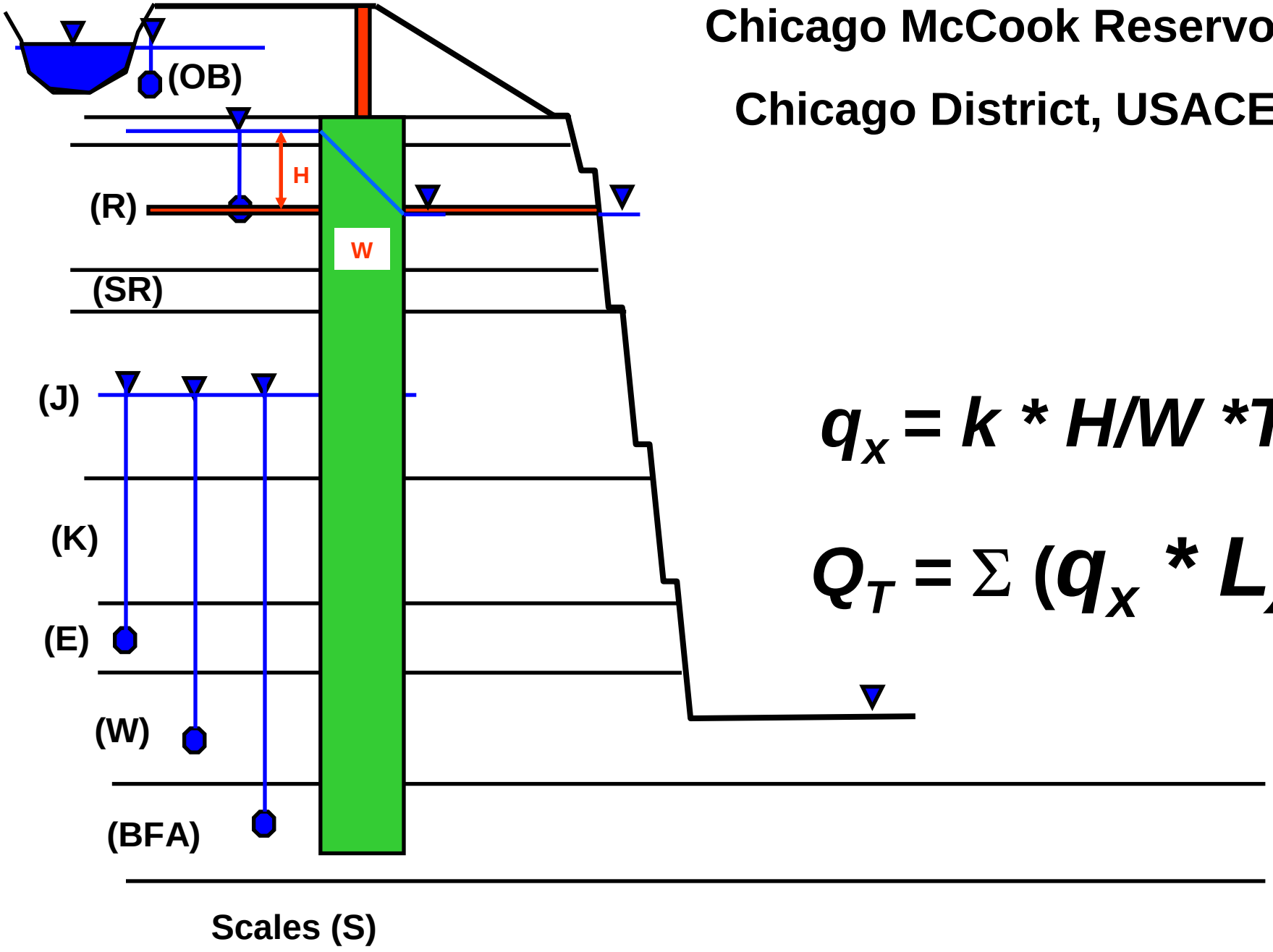
Sophisticated 3D Flow Model

No Containment System



1-Lu Grout Curtain





Chicago McCook Reservoir

Chicago District, USACE

$$q_x = k * H/W * T$$

$$Q_T = \Sigma (q_x * L)$$

Things to Remember

- *The sophistication of the model is far less important than the quality of the data and the fundamental correctness of the model*

- *Defective grouting (i.e. missed fractures) may leak very badly due to discrete fracture flow rules and is further aggravated by increased gradients. Essential to directly access all fractures at appropriate interval while grouting.*

- *Poor grouting (i.e. partially unfilled fractures) will leak proportionally to the residual fracture thickness cubed. Essential to go to very tight refusal criteria and use non-bleed grouts.*

Establishing Project Performance Requirements

Methods for Setting Performance Requirements

- *Permissible total seepage rates or unit seepage rates*
- *Desired pressure distributions*
- *Gradient limitations*
- *Residual fracture widths*
- *Cost-benefit analyses*
- *Compatibility with other elements in combined cutoff systems*
- *Environmental considerations*

Examples of Project Performance Requirements


Penn Forest
Replacement Dam
• Length = 2500 ft
• Head = 180 ft
• Design Total Residual Seepage < 200 gpm
• Required Residual Permeability = 3 Lugeon

Hunting Run Dam
Pump Storage Drought Supply
Incremental Cost Benefit Analysis – Grouting Cost vs. Water Value
5 Lu Criteria Selected



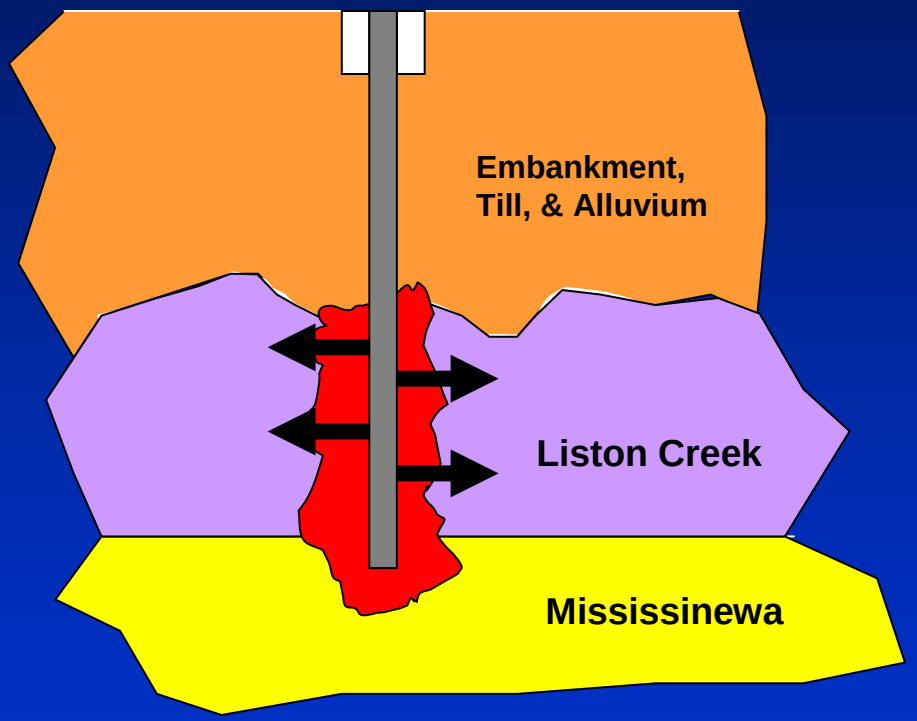
Table 6.3
Benefit of Seepage Reduction vs. Cost of Grouting - $25 Million Project
Cost of Seepage per MGD = $3,125,000

Curtain Configuration and Performance Characteristics	Estimated Seepage Quantity (MGD)	Total Value of Residual Seepage	Cost Benefit Achieved by Alternative	Construction Cost for Alternative	Benefit Cost Ratio	Incremental Benefits for Increased Intensity	Incremental Costs for Increased Intensity
Ungrouted w/ Drains	1.27	$3,969,000					
1-Line Curtain (5 Lu)	0.46	$1,438,000	$2,531,000	$1,335,000	1.90	$2,531,000	$1,335,000
3-Line Curtain (3 Lu)	0.23	$719,000	$3,250,000	$2,410,000	1.35	$719,000	$1,075,000
3-Line Curtain (1 Lu)	0.08	$250,000	$3,769,000	$2,870,000	1.31	$519,000	$460,000

Table 6.4
Benefit of Seepage Reduction vs Cost of Grouting - $30 Million Project
Cost of Seepage per MGD = $3,750,000

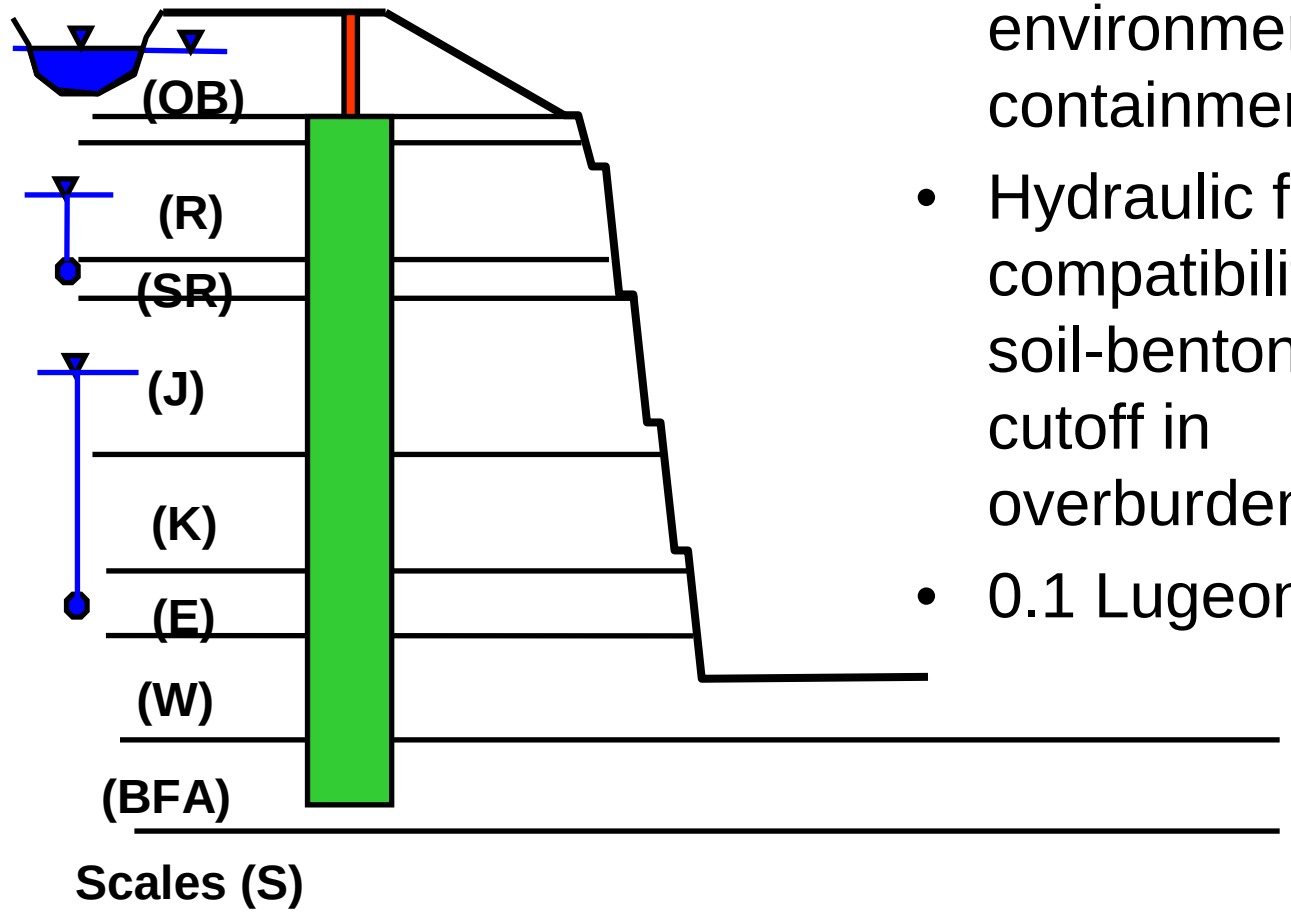
Curtain Configuration and Performance Characteristics	Estimated Seepage Quantity (MGD)	Total Value of Residual Seepage	Cost Benefit Achieved by Alternative	Construction Cost for Alternative	Benefit Cost Ratio	Incremental Benefits for Increased Intensity	Incremental Costs for Increased Intensity
Ungrouted w/ Drains	1.27	$4,763,000					
1-Line Curtain (5 Lu)	0.46	$1,725,000	$3.038,000	$1,335,000	2.28	$3,038,000	$1,335,000
3-Line Curtain (3 Lu)	0.23	$862,500	$3,900,500	$2,410,000	1.62	$862,500	$1,075,000
3-Line Curtain (1 Lu)	0.08	$300,000	$4,463,000	$2,870,000	1.56	$562,500	$460,000

Mississinewa Dam
Slurry Wall Pre-Grouting



- Prevent catastrophic loss of slurry during panel excavation
- Minimum grouting necessary
- Entire 12-ft width grouted to 10 Lu to limit routine slurry loss to manageable rates

Chicago McCook CSO Storage Reservoir Perimeter Grouting



- Grout as tightly as possible for environmental containment
- Hydraulic flux compatibility with soil-bentonite cutoff in overburden
- 0.1 Lugeon Goal

Grouting Design Parameters

Parameters Required for Grouting Design

- *Width of grouted zone for single and multiple line configurations*
  - *Radius of spread varies with fracture size, pressure, duration, mix*
  - *Reasonable to assume 5 ft effective radius of spread*
- *Realistically achievable residual permeability for single and multiple line configurations*

"This is where it gets a bit dicey"

Generally Available Design Guidelines

- *Readily groutable materials*
  - *k > 1 x 10-3 cm/sec (> 100 Lugeons)*
  - *Reductions of 1-3 orders of magnitude (depending on a number of factors)*
- *Marginally groutable materials*
  - *k = 1 x 10-4 cm/sec (10 Lugeons)*
  - *Reductions of 1-2 orders of magnitude (depending on a number of factors)*
- *Barely groutable materials*
  - *k < 1 x 10-5 cm/sec (1 Lugeon)*
  - *Require special measures*

Given the potential range of residual permeabilities, is expected Q = 10 gpm or 100 gpm or 1,000 gpm or 10,000 gpm, and what are the "factors" that determine the results we should reasonably expect?

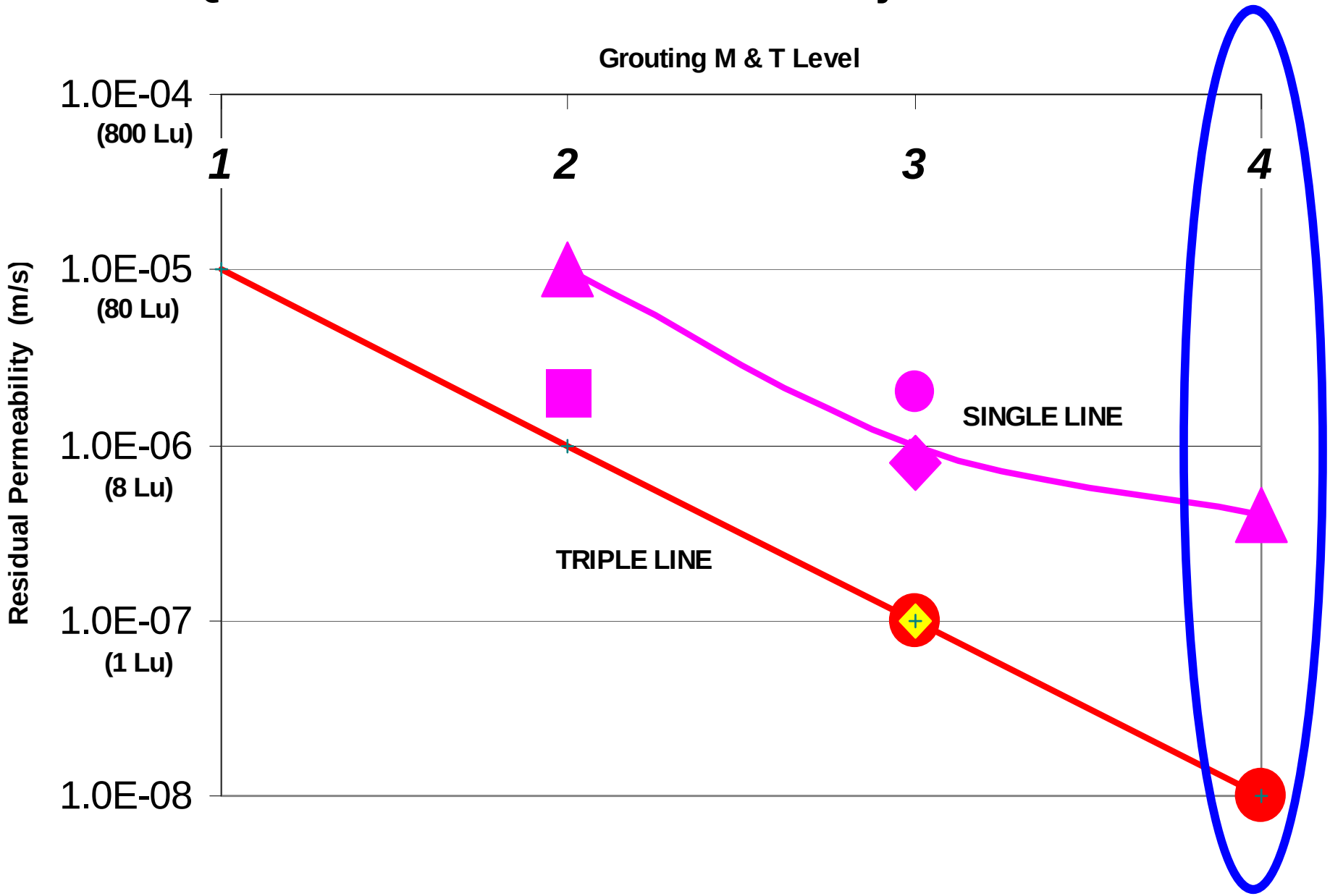
Factors Affecting Grouting

- *Geology*
- *Drilling technique*
- *Grout Materials*
- *Grout Mixes*
- *Mixing Equipment*
- *Hole Washing*
- *Grout Pumping Equipment*
- *System Setup*
- *Valves and fittings*
- *Bleed*
- *Grouting technique*
- *Hole spacing*
- *Hole depth*
- *Hole sequencing*
- *Hole staging*
- *Pressures*
- *Contractor experience*
- *Refusal criteria*
- *Contract incentives & disincentives*
- *Inspection & control*
- *Testing & analysis*

Realities of Grouting

- *Grouting results are absolutely affected by all of the factors*
- *Some variables have been essentially eliminated in current industry practice*
- *Remaining variables can be grouped into various design / construction performance levels*

QEGC Predicted Results vs. Project Results



Real-Time Analysis & Verification and Communication of Results

IntelliGrout Control & Analysis Center



Contracting Issues

Contracting for Performance

- *Must structure and prepare contract documents to ensure that you get the end products and services desired*

- *Quality of equipment and personnel is critical*

- *Contracts must not contain disincentives to achieving quality results*

- *Low bid contracting doesn't work – operating at this level is not a commodity*

- *Best Value Selection is being used by USACE and is best option*

Special Recognition

Mike Klosterman, Geologist, HQ USACE

Steve Hornbeck, Geologist, Louisville District

Tim Flaherty, Geologist, Louisville District

Kevin Jefferson, Contracting Officer, Louisville District

Bill Rochford, Engineer, Chicago District

Joe Kissane, Geologist, Chicago District

Larry Green, Contracting Officer, Chicago District

Mark Harris, Geologist, Little Rock District

Pat Jordan, Geologist, Little Rock District

Jon Wedgeworth, COR, Little Rock District

R. Leroy Arnold, Engineer, Little Rock District



Gannett Fleming



Thank You

David B. Wilson P. E.

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dwilson@ gfnet.com

Limitations in the Back Analysis of Shear Strength from Failures



Rick Deschamps,
and Greg Yankey

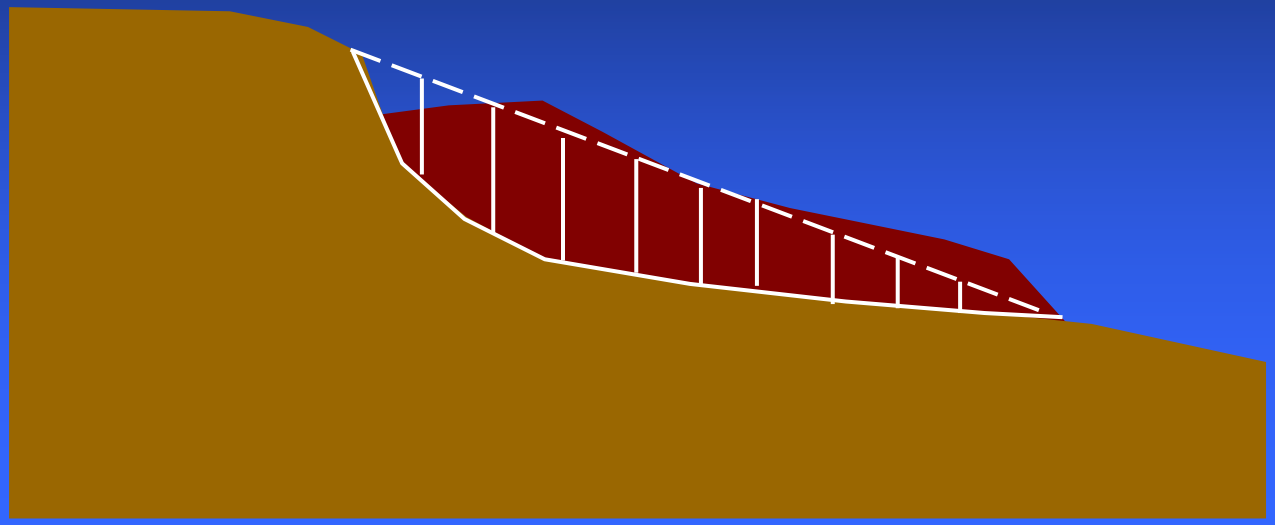
Presentation Overview

- Background
- Examples from Case Histories
  - Grandview Lake Dam
  - Marmet Lock and Dam
  - Kentucky River Lock and Dam No. 10
- Summary



Back-Analysis

- Find Strength assuming SF = 1.0



Back-Analysis of Strength

- Commonly Used by Profession
- Often Believed to Provide Best Estimate of Strength
- Can Lead to Significant Errors!!

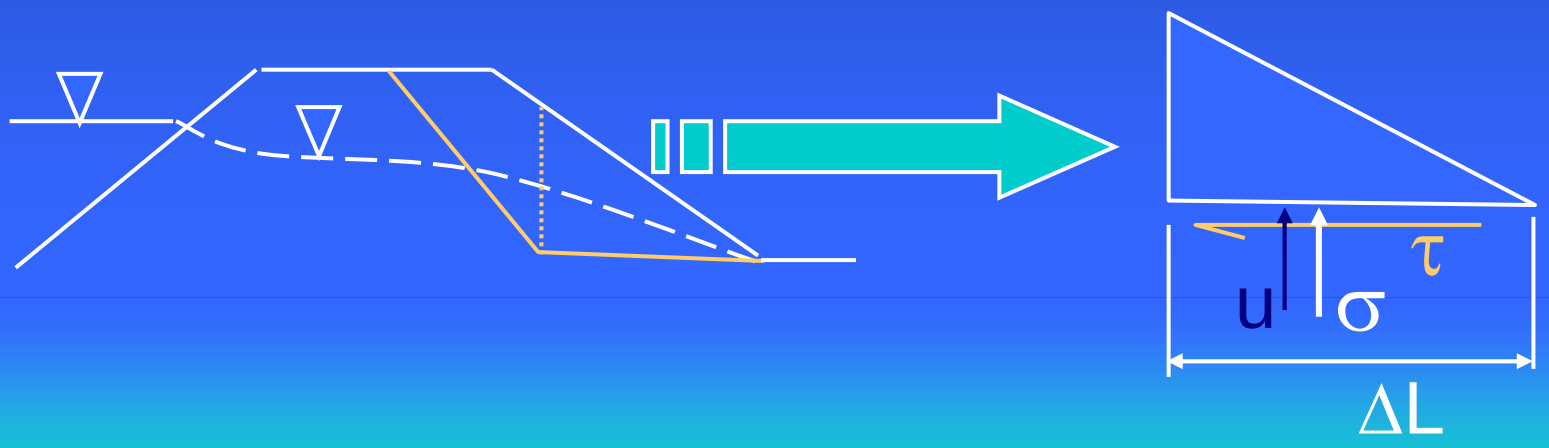
Presentation Goals

- Illustrate Limitations of Back-Analysis
- Show that Conservative Design Assumptions are Unconservative in Back-Analysis

Simple Example

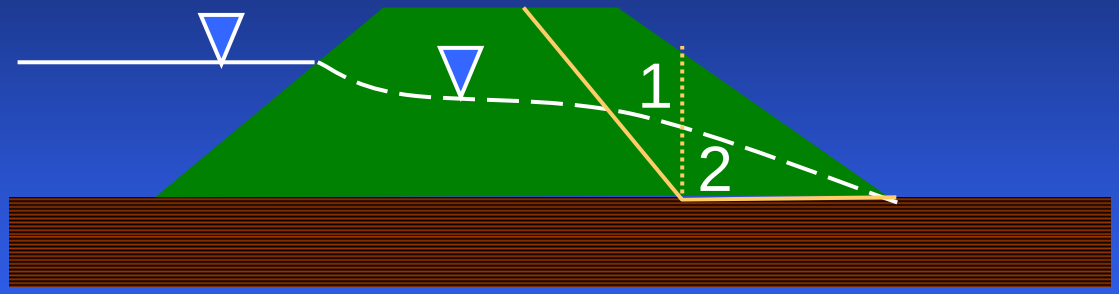
$$SF = \frac{\text{Resisting Forces}}{\text{Driving Forces}}$$

$$SF = \frac{\Sigma\{ c + (\sigma - u) \tan \phi \} \Delta L}{\Sigma \tau_{\text{mobilized}} \Delta L} = 1.0$$



Resisting Forces = Driving Forces

$$\Sigma\{c + (\sigma\text{-}u)\tan\phi\}\,\Delta L = \Sigma\,\tau_{\text{mobilized}}\,\Delta L$$

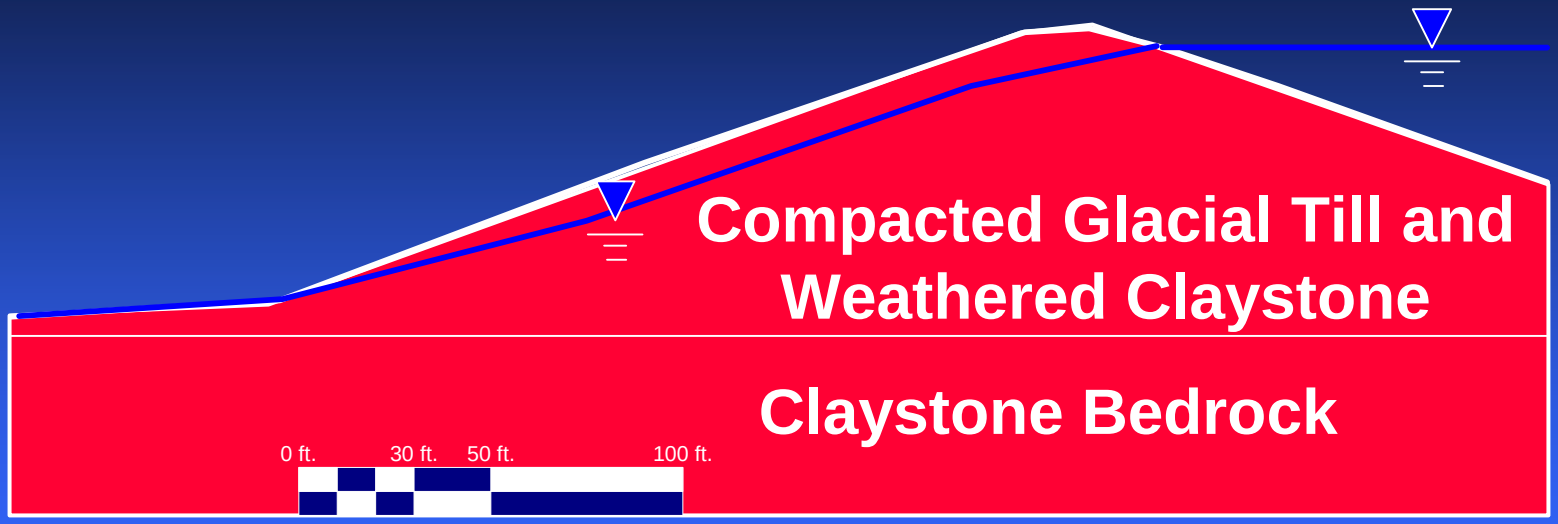


$$\{(\sigma_1\text{-}u_1)\tan\phi_1\}\Delta L_1 + \{(\sigma_2\text{-}u_2)\tan\phi_2\}\Delta L_2 = \tau_1\Delta L_1 + \tau_2\Delta L_2$$

Factors Influencing Interpretation

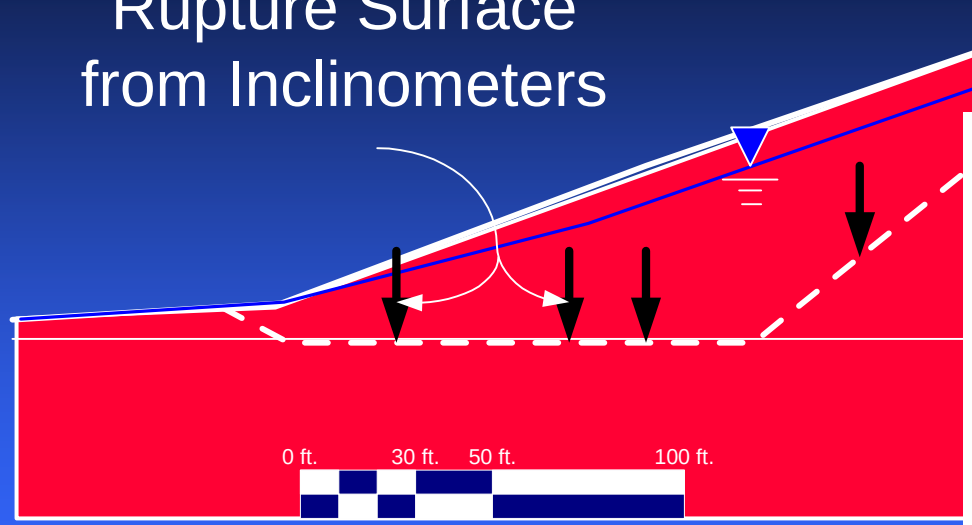
- Strength of Various Materials ✓
- Slip Surface Location ✓
- Pore Pressure Distribution ✓
- Three Dimensional Effects ✓
- Progressive or Retrogressive Failure
- Strength in Terms of ϕ and/or c

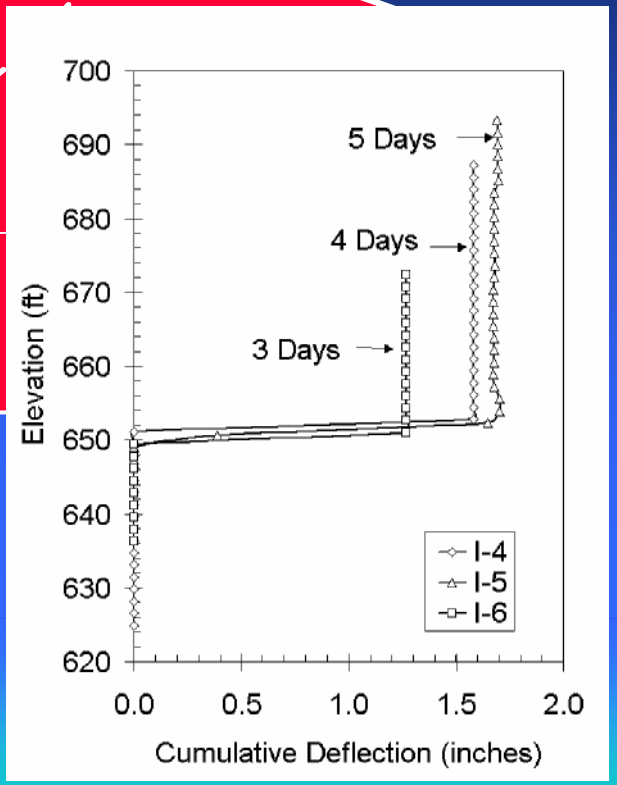
Grandview Lake Dam



Grandview Lake Dam

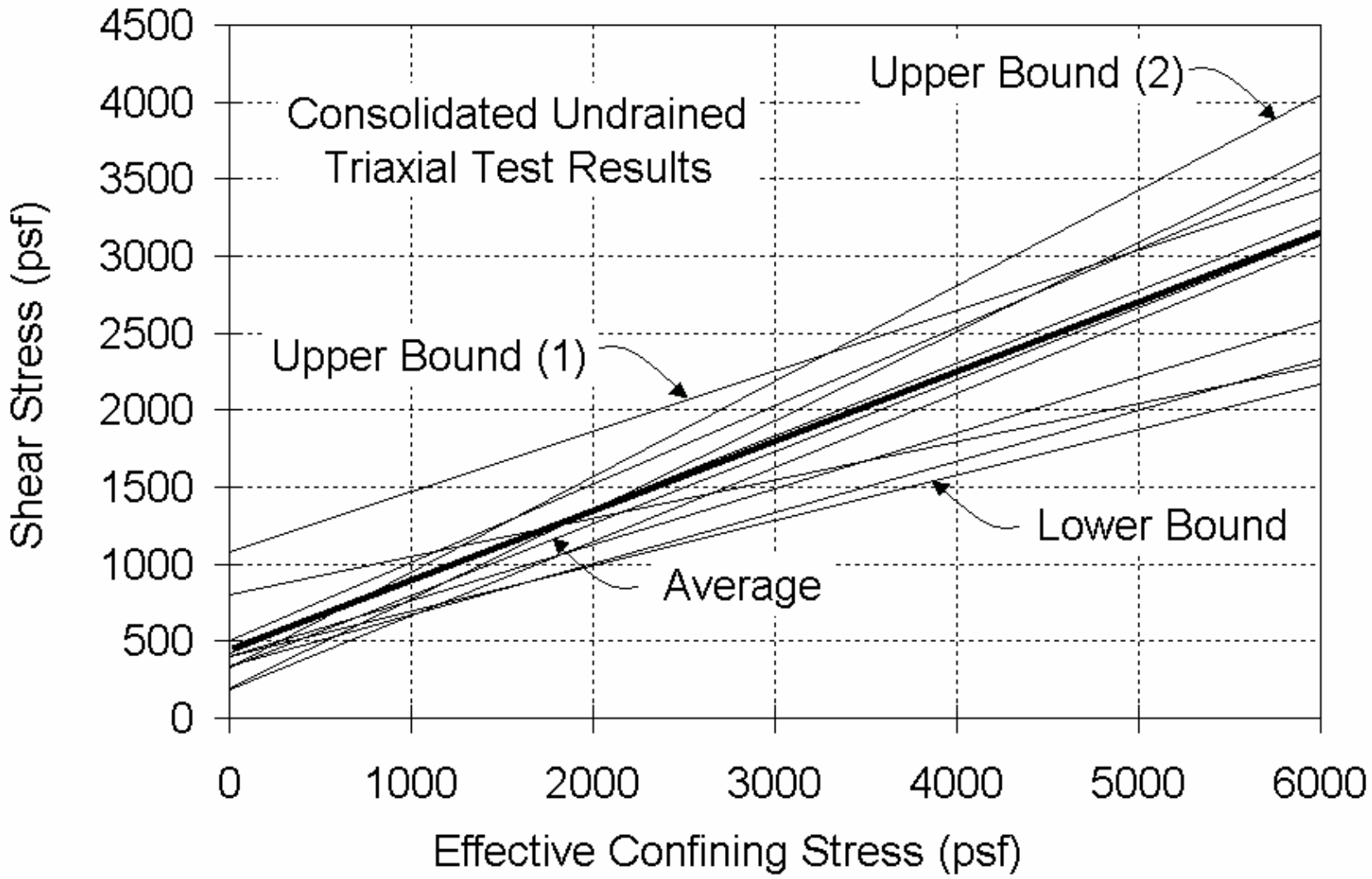
Rupture Surface
from Inclinometers



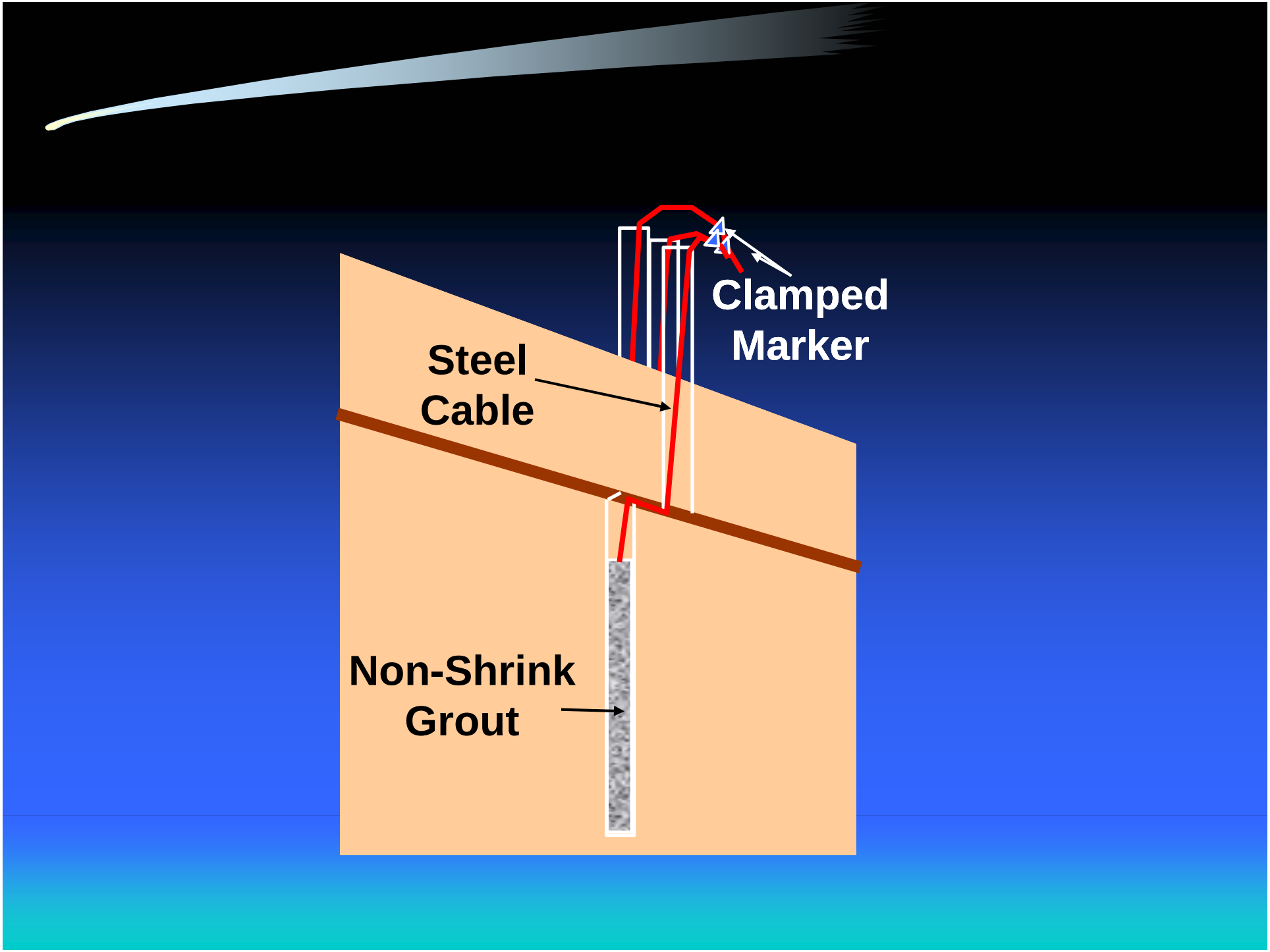


Failure in Seam in Bedrock

- What strength parameters are applicable?
- How can they be determined?


Consolidated Undrained
Triaxial Test Results
Upper Bound (2)
Upper Bound (1)
Lower Bound
Average
Shear Stress (psf)
Effective Confining Stress (psf)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
1000
2000
3000
4000
5000
6000

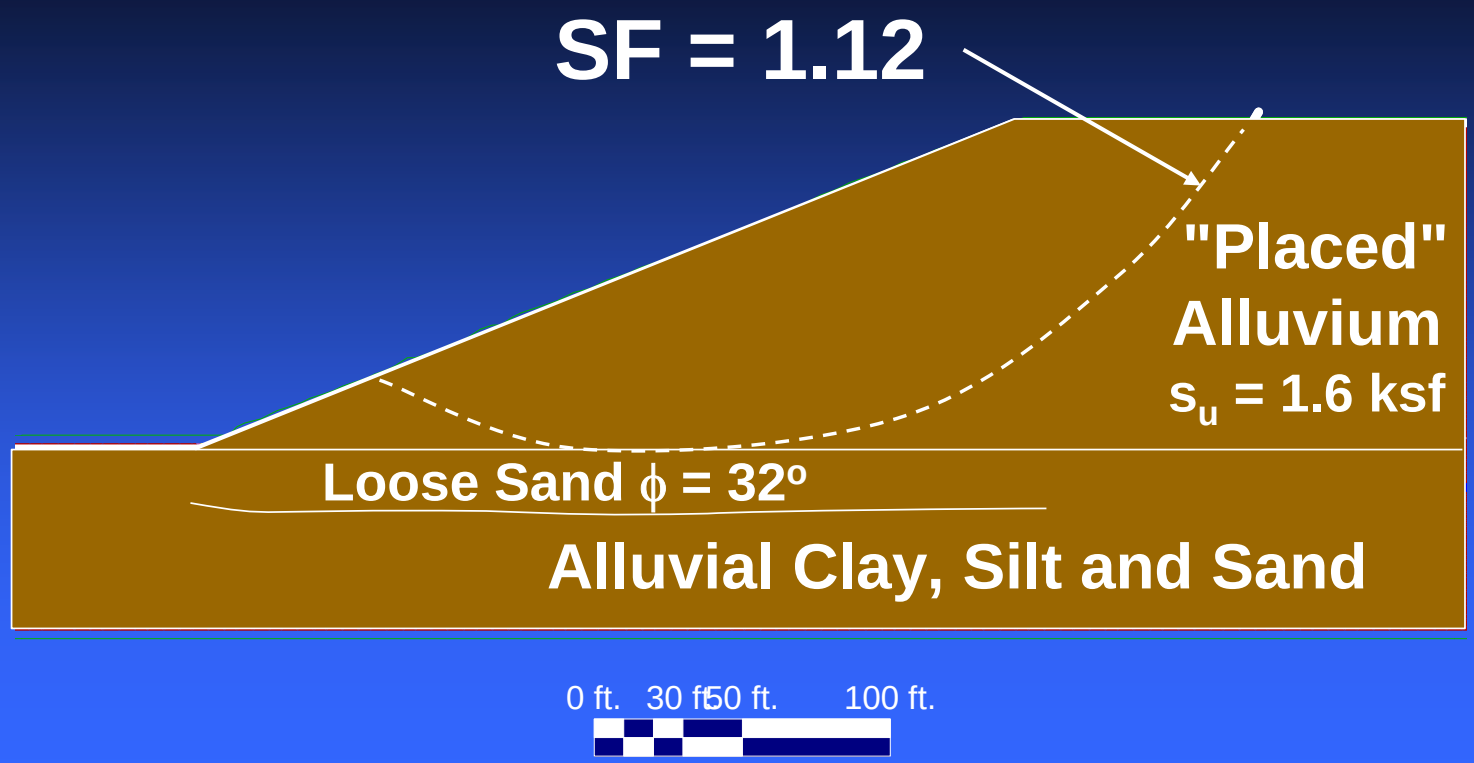
Back-calculated strength.	
Embankment Strength	**Back Calculated Friction Angle**
Lower Bound	23
Upper Bound (High Friction)	16
Upper Bound (High Cohesion)	11
Average	18


Clamped
Marker
Steel
Cable
Non-Shrink
Grout

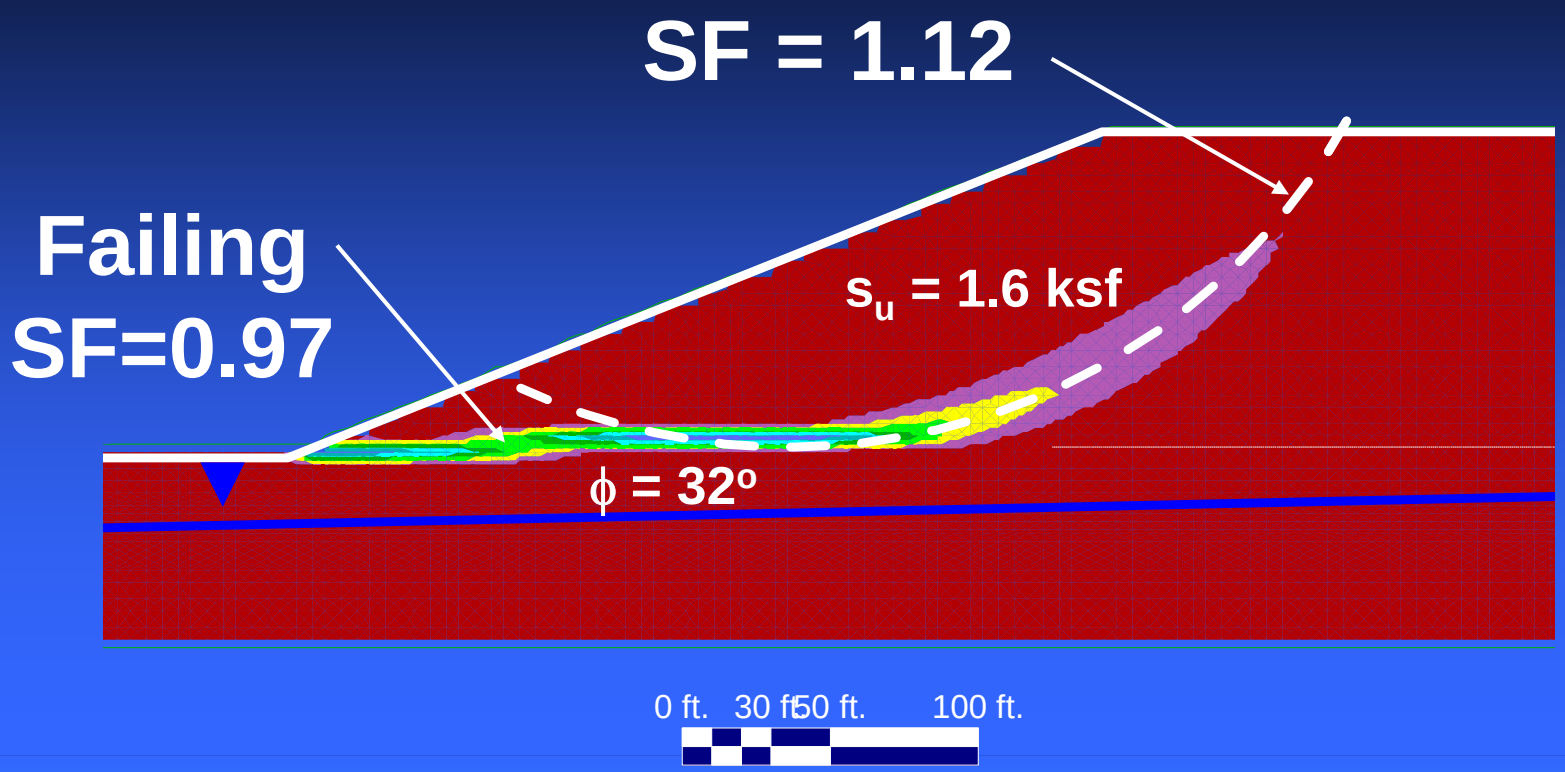
Marmet Lock & Dam, WV



Critical Section - Design

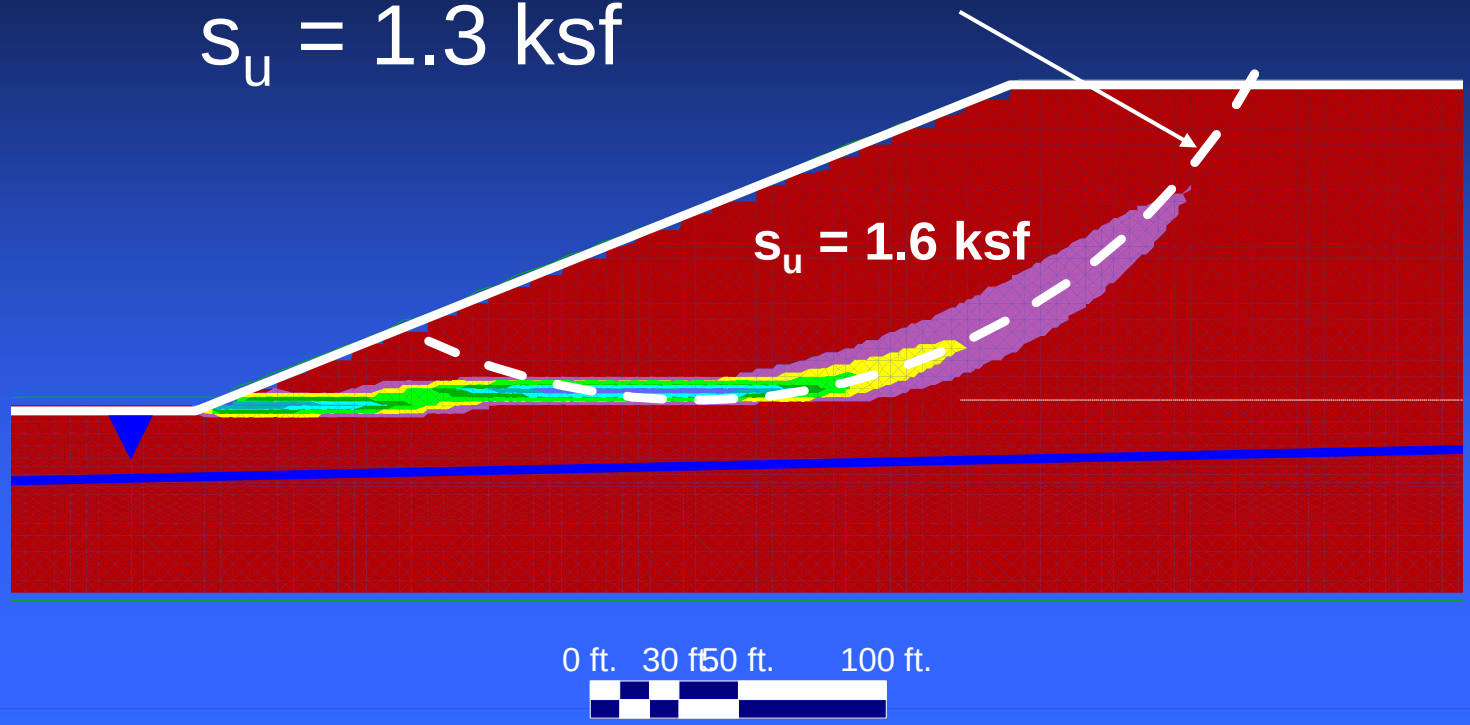


Critical Section - Actual



Back-calculated strength

s_u = 1.3 ksf

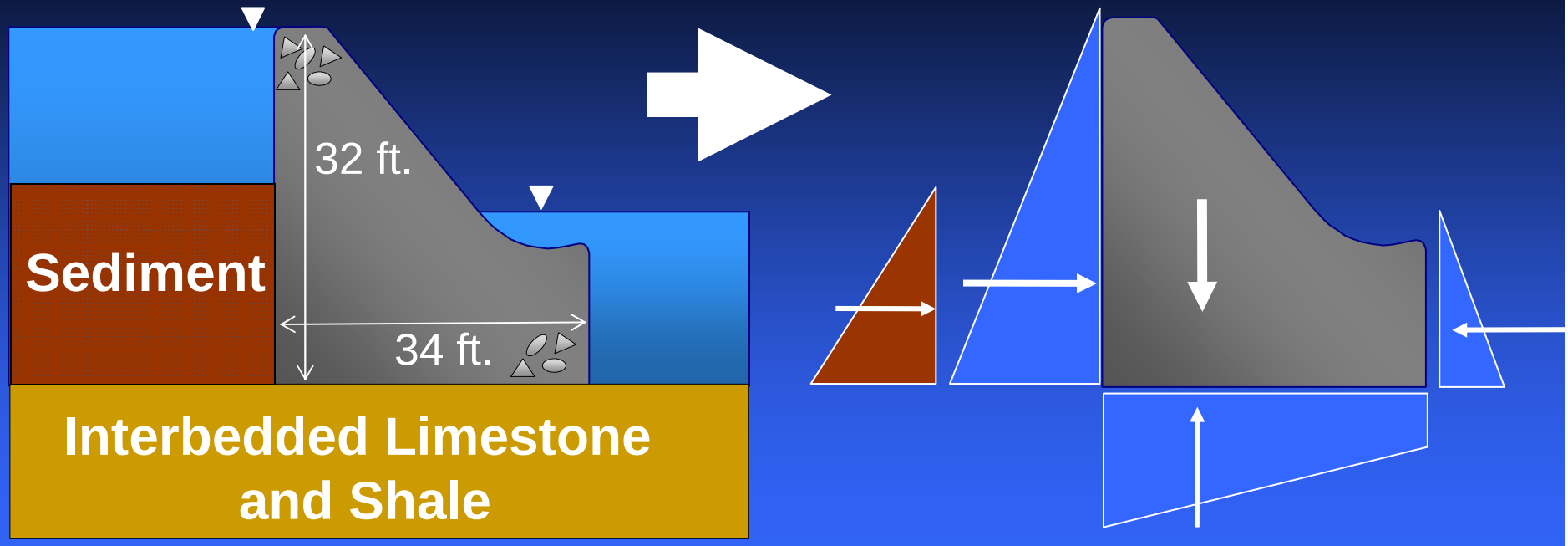


Kentucky River Lock & Dam 10

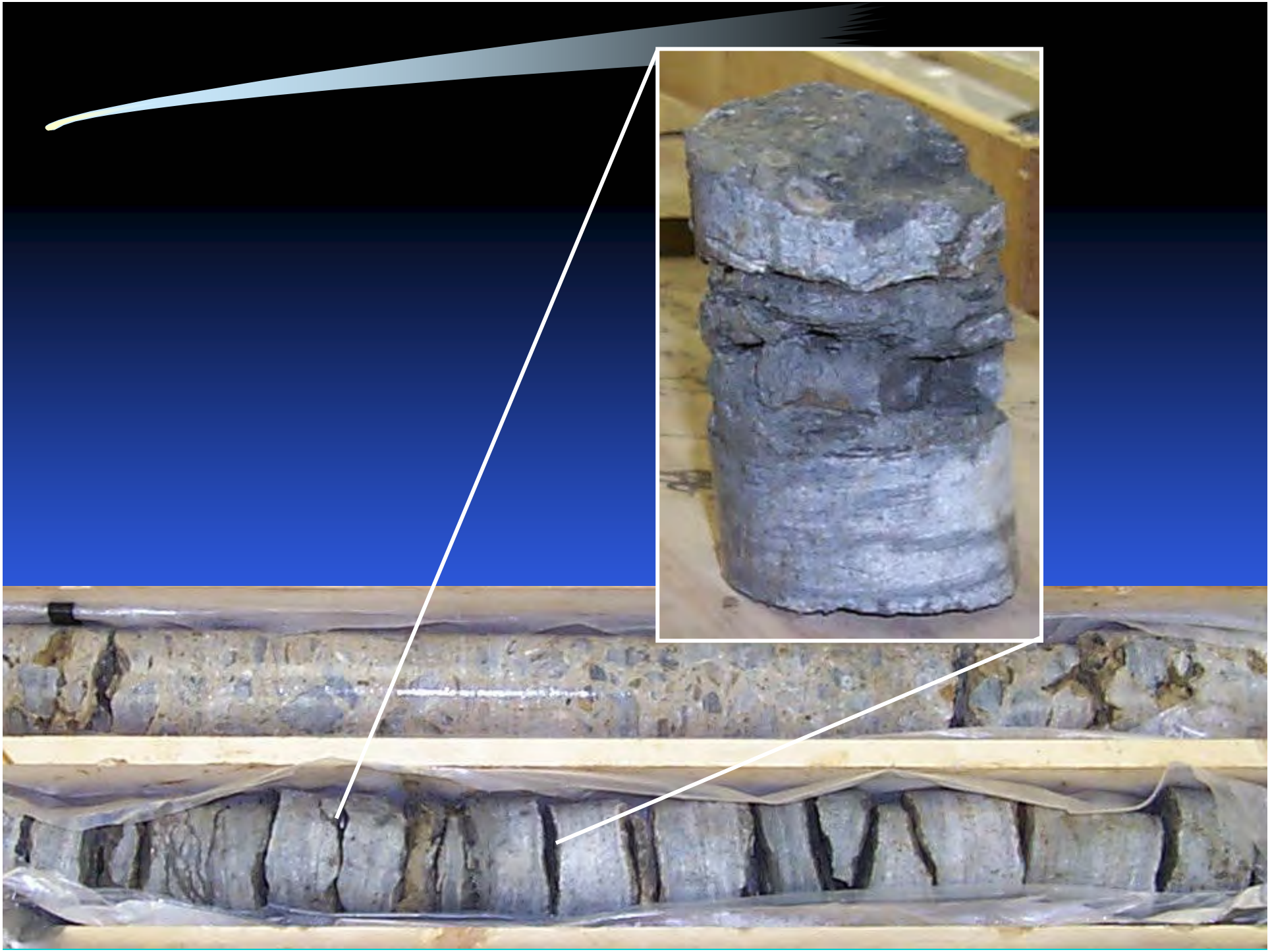


Louisville District

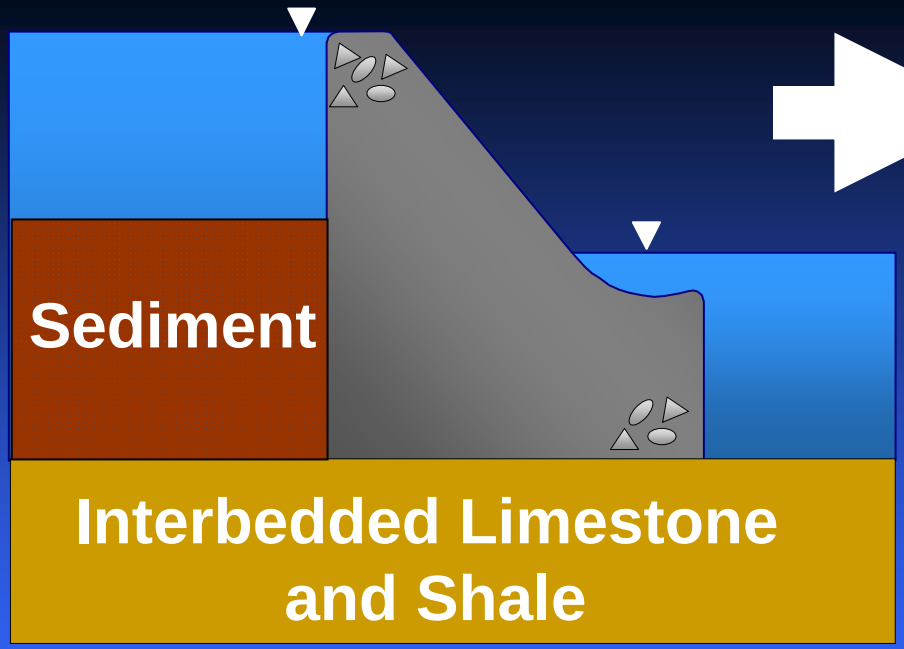
Importance of Accurate Model

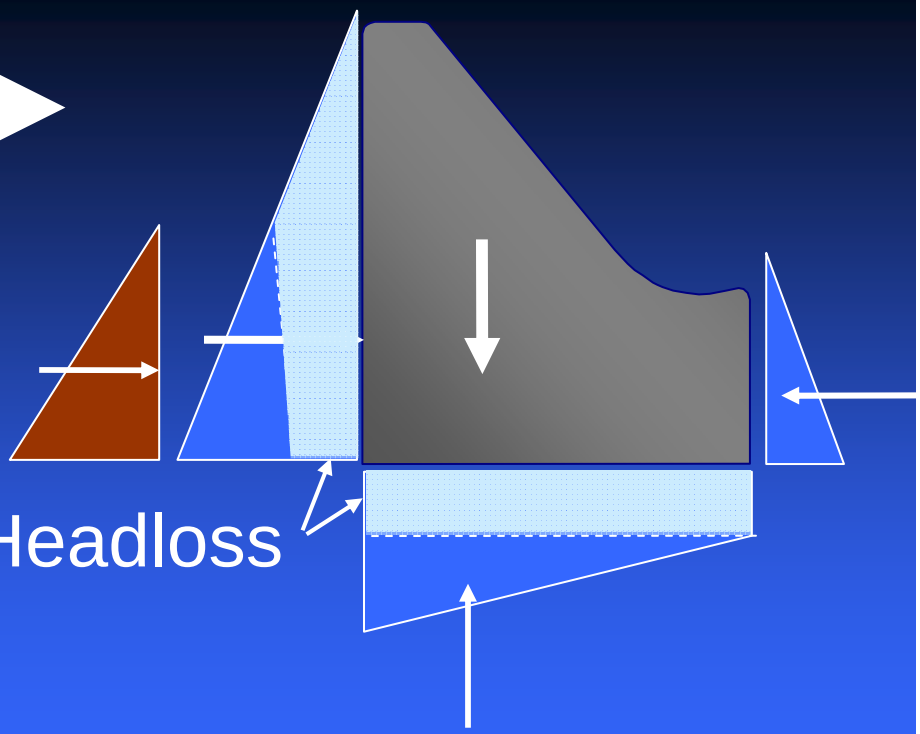


$\phi = 43^{o}$ for SF = 1.0



Idealized Model

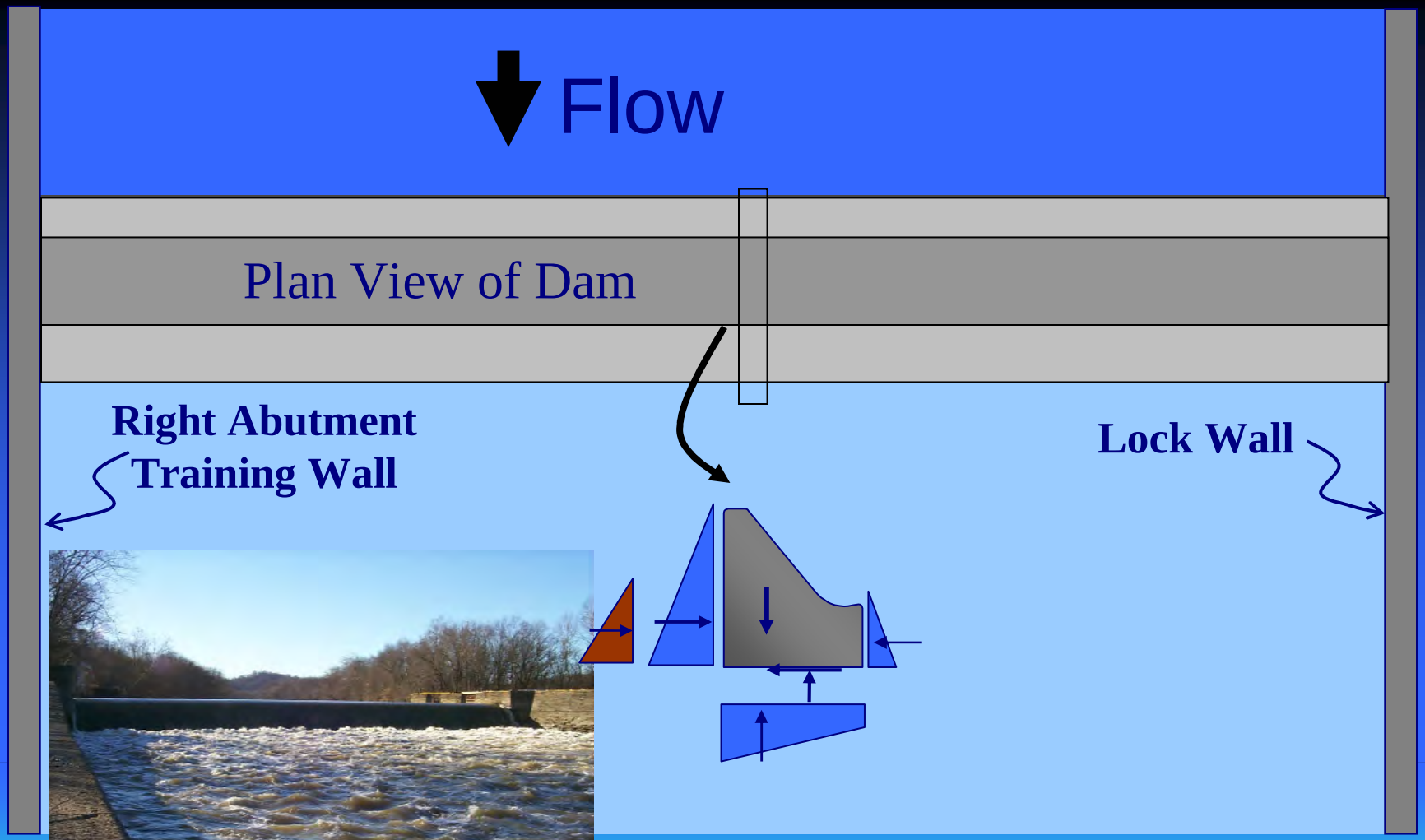




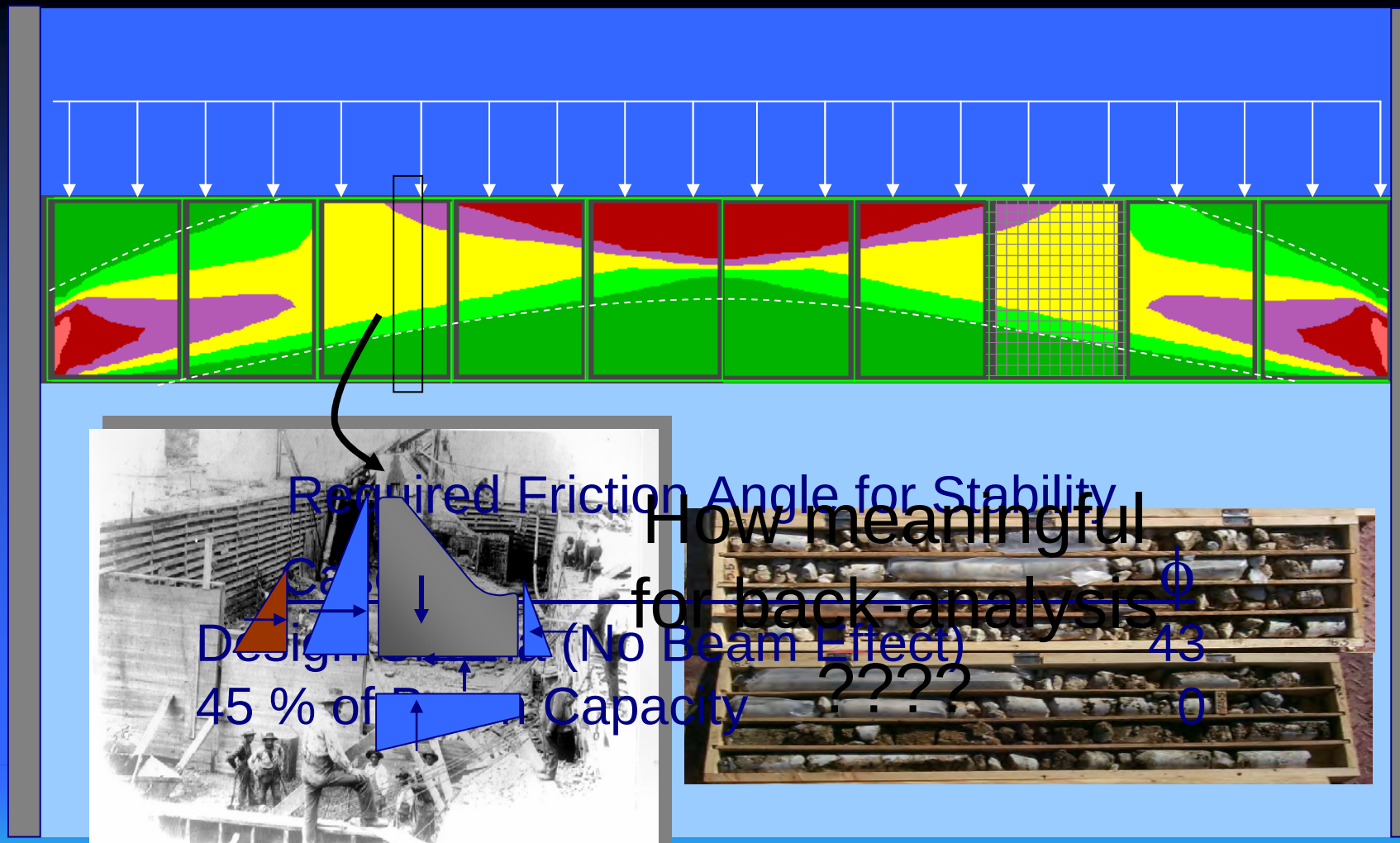


Now ϕ = 24º for SF = 1.0

3-D Effects


Flow
Plan View of Dam
Right Abutment
Training Wall
Lock Wall

3-D Effects (cont.)



3-D Effects (cont.)

- 3D effects in soil slopes add ≈ 5 to 25 % to stability.
- This leads to overestimation of soil strength, if not accounted for somehow.

Summary

- Back-Analysis is a Useful Tool **Only** When Assumptions and Models are Accurate



Recommendations

- Narrowly Bound Input Parameters
- Account for Model Limitations
- Assess Upper and Lower Bound
- Judge Usefulness of Results

Remember

- Conservative Design Assumptions are Unconservative if used in Back-Analysis
- Inherently Conservative Models are Unconservative if used in Back-Analysis

"I am inclined to compare the functions of theory with those of a walking stick in rugged country. It reduces the risk of stumbling, but the walking has to be done with the legs."

Karl Terzaghi



- Rick Deschamps
- Thursday 1:30 pm – Geotechnical Track 6c
- 412-221-4500 x202 (Office)
- 412-215-0892 (cell)
- Nicholson Construction Company
- rdeschamps@nicholsonconstruction.com