35th Annual Meeting of the American Society of Mining & Reclamation

Quantitative Evaluation of Flow Restoration Associated with Undermined Streams at the Bailey Mine in Southwestern Pennsylvania

Presented By:

Joshua M. Silvis | CONSOL Energy, Inc. | Canonsburg, PA

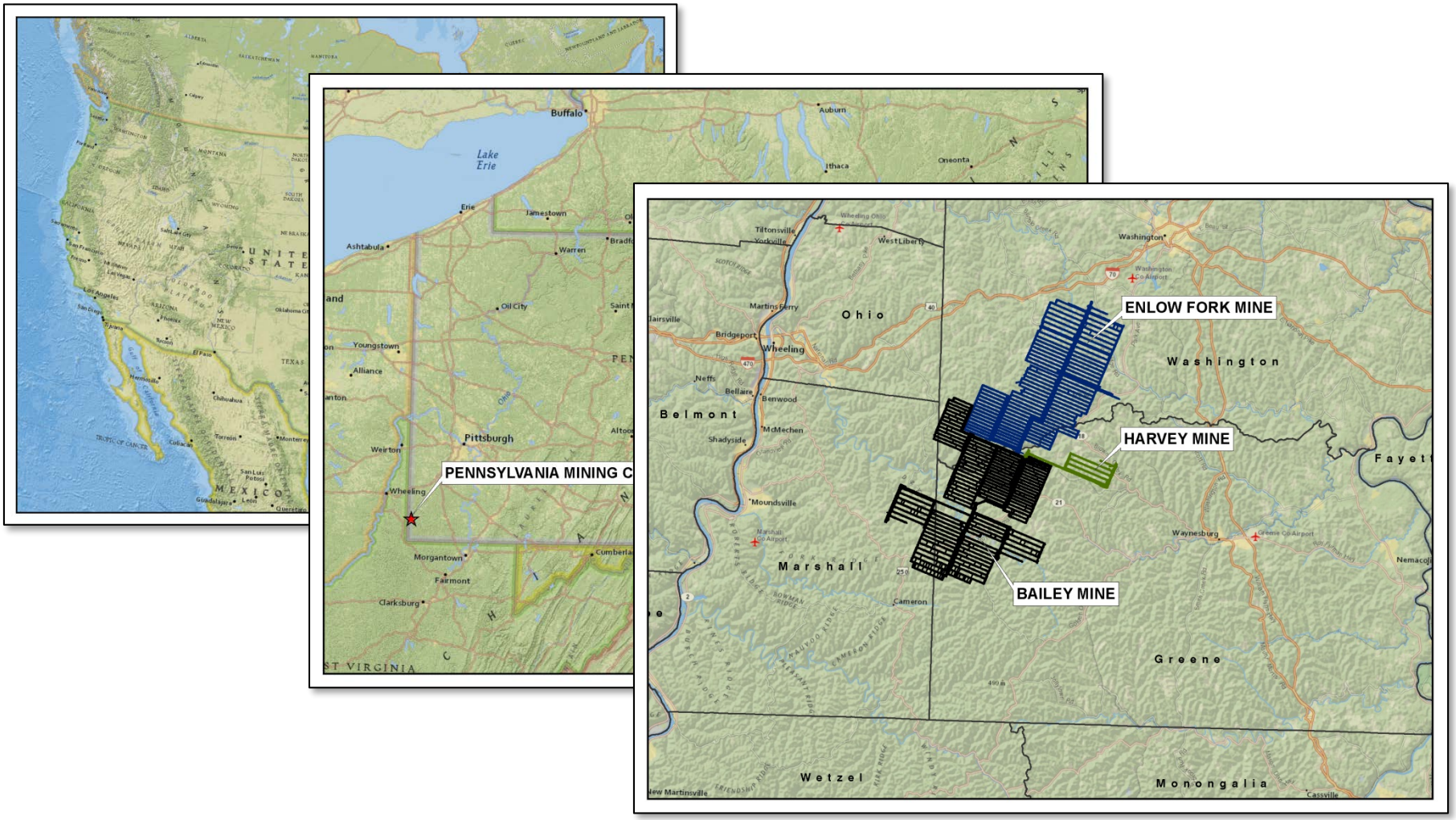
Michael L. Shema | Civil & Environmental Consultants, Inc. | Pittsburgh, PA

CONSOL ENERGY

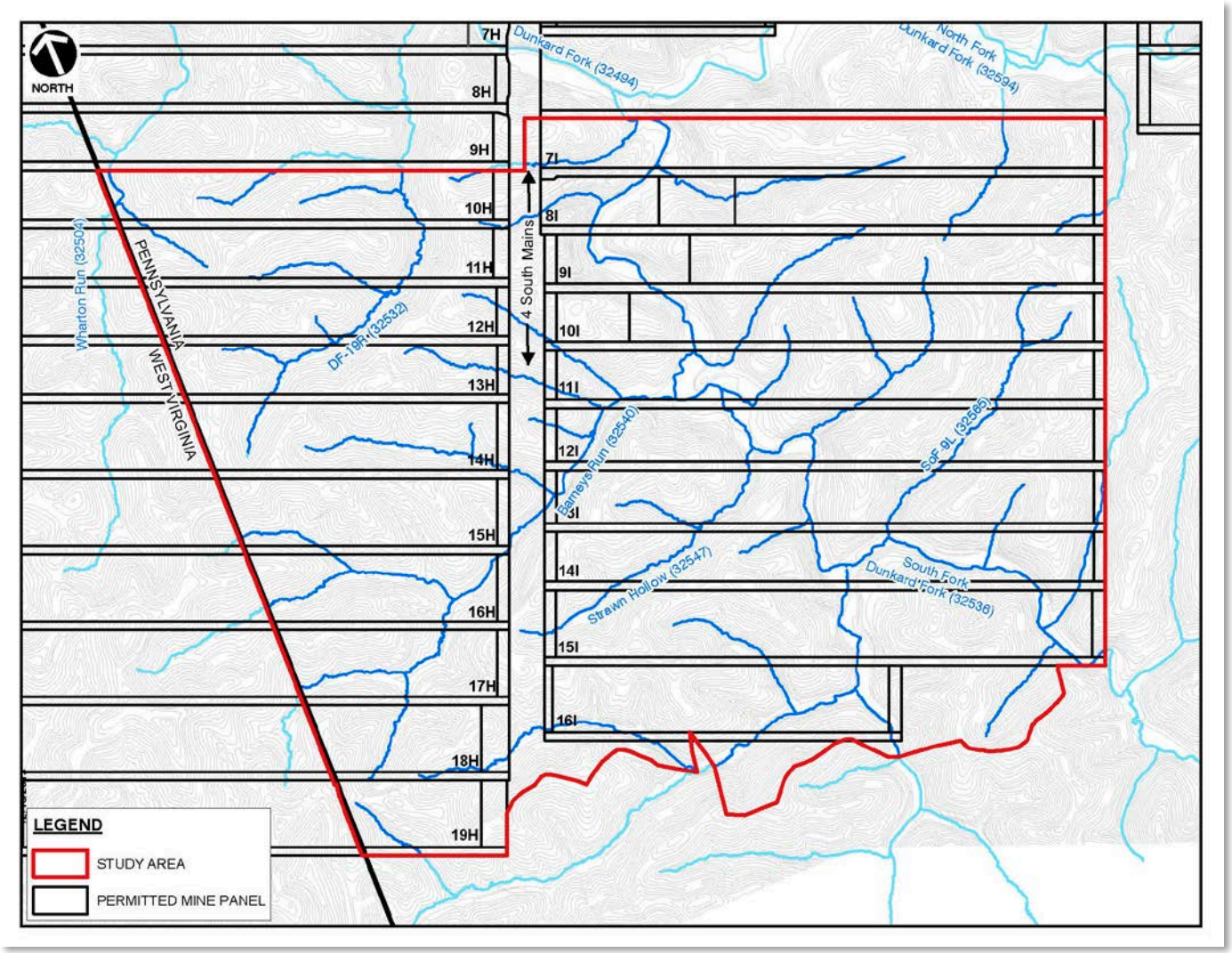
June 6, 2018

Civil & Environmental Consultants, Inc.

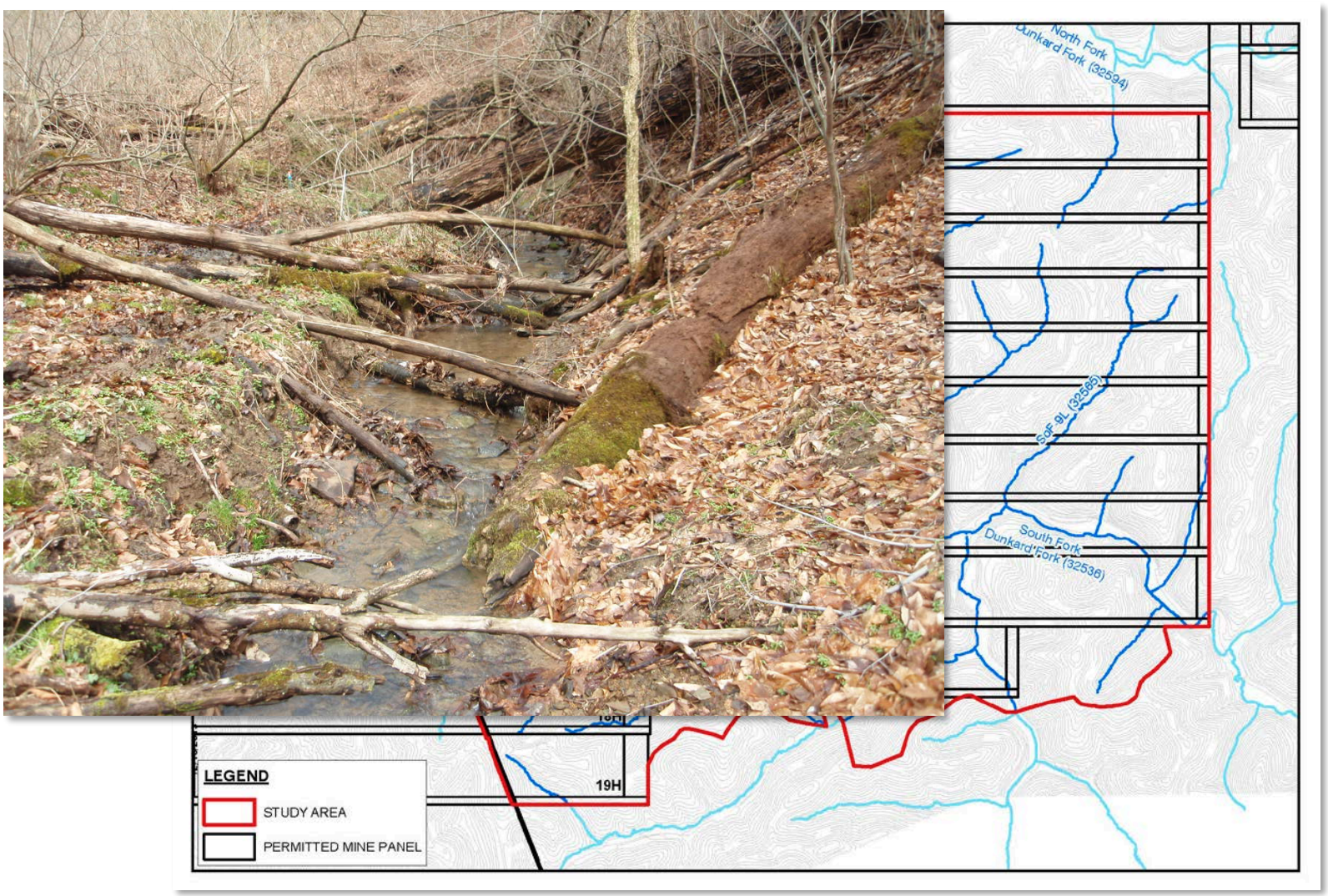
STUDY AREA


Buffalo
Lake Erie
Auburn
Ithaca
Oneonta
Erie
Jamestown
Ashtabula
Warren
Oil City
Youngstown
Alliance
Pittsburgh
Weirton
Wheeling
PENNSYLVANIA MINING C
Morgantown
Fairmont
Clarksburg
ST VIRGINIA
Tiltonsville
Yorkville
Wheeling Ohio Co Airport
Washington
Martins Ferry
Ohio
Bridgeport
Wheeling
Neffs
Bellaire
Benwood
Belmont
McMechen
Shadyside
Moundsville
Marshall Co Airport
Marshall
Cameron
Washington
Washington Co Airport
ENLOW FORK MINE
HARVEY MINE
BAILEY MINE
Waynesburg
Greene Co Airport
Greene
Wetzel
Monongalia
Cassville
New Martinsville

STUDY AREA (6,605 Acres)



STUDY AREA (6,605 Acres)



STUDY AREA (6,605 Acres)

STUDY AREA (6,605 Acres)

REGULATORY DRIVERS

- **Pennsylvania Regulations:**
  - Mine Subsidence Act
  - Clean Streams Law
  - Chapters 86, 87, 89, 93, and 105 of Title 25 of the Pennsylvania Code
- **Pennsylvania Department of Environmental Protection Technical Guidance Document:**
  - Technical Guidance Document No. 563-2000-655 (Streams TGD), entitled “Surface Water Protection Underground Bituminous Coal Mining Operations”

PROVISIONS OF STREAMS TGD

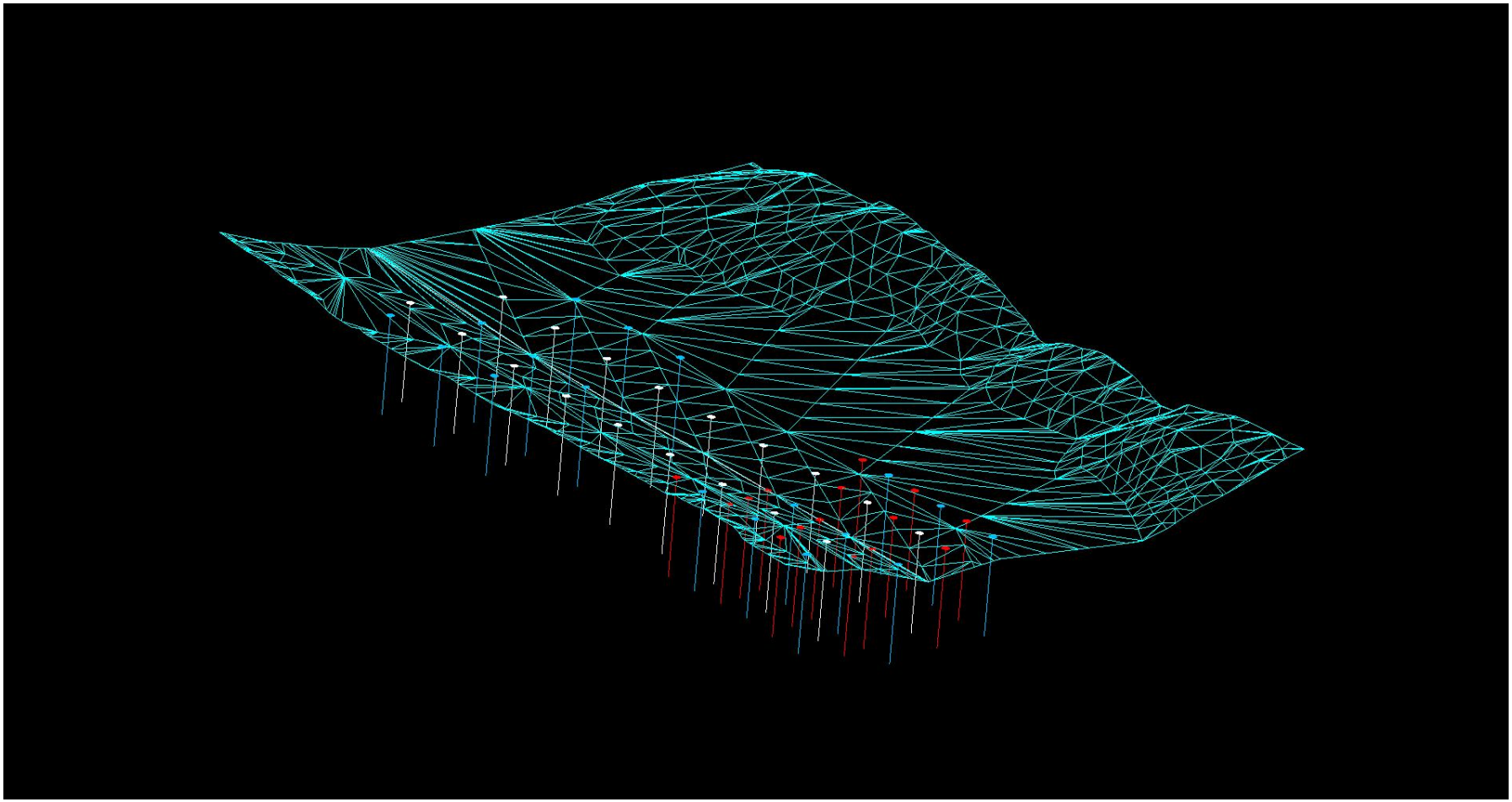
- Pre- and post-mining monitoring of streams
- Monitoring frequency and reporting
- Performance standards for determining effects
- Intervention measures if post-mining flow loss or subsidence pooling occurs

LONGWALL EFFECTS ON STREAMS

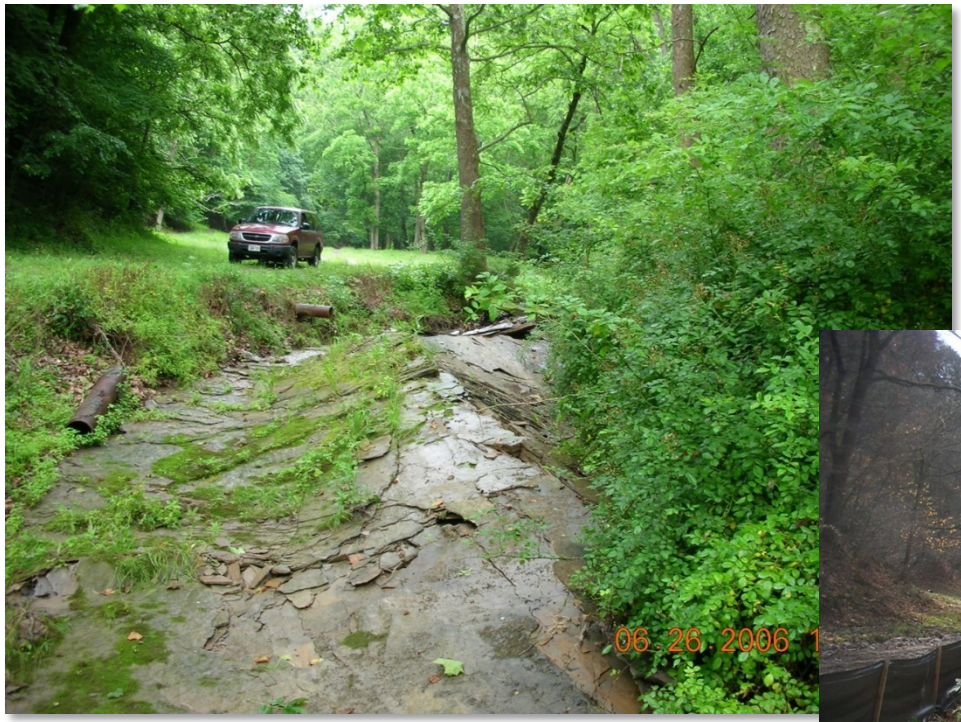
LONGWALL EFFECTS AND INTERVENTION – FLOW LOSS

LONGWALL EFFECTS AND INTERVENTION – FLOW LOSS

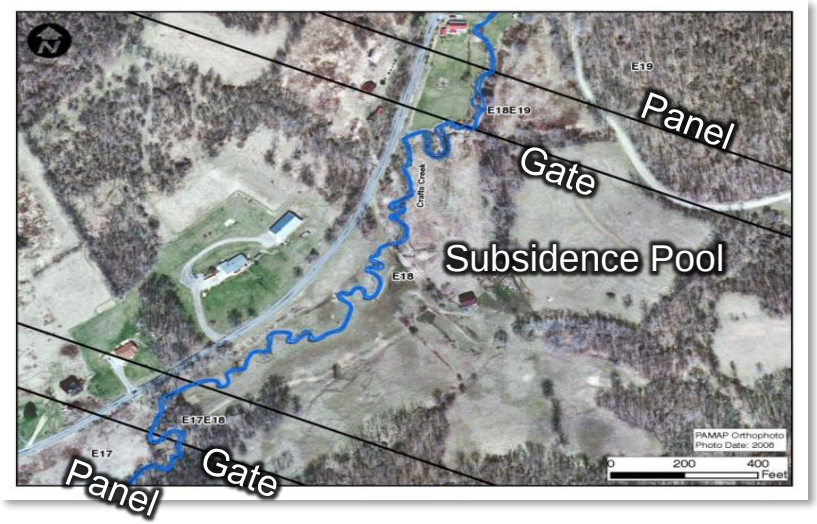
LONGWALL EFFECTS AND INTERVENTION – FLOW LOSS

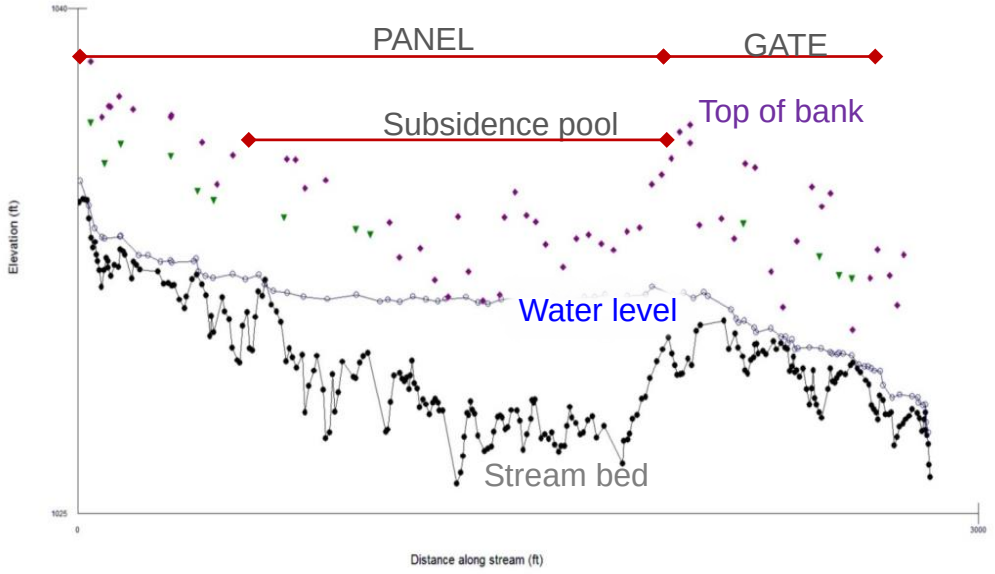


LONGWALL EFFECTS AND INTERVENTION – FLOW LOSS

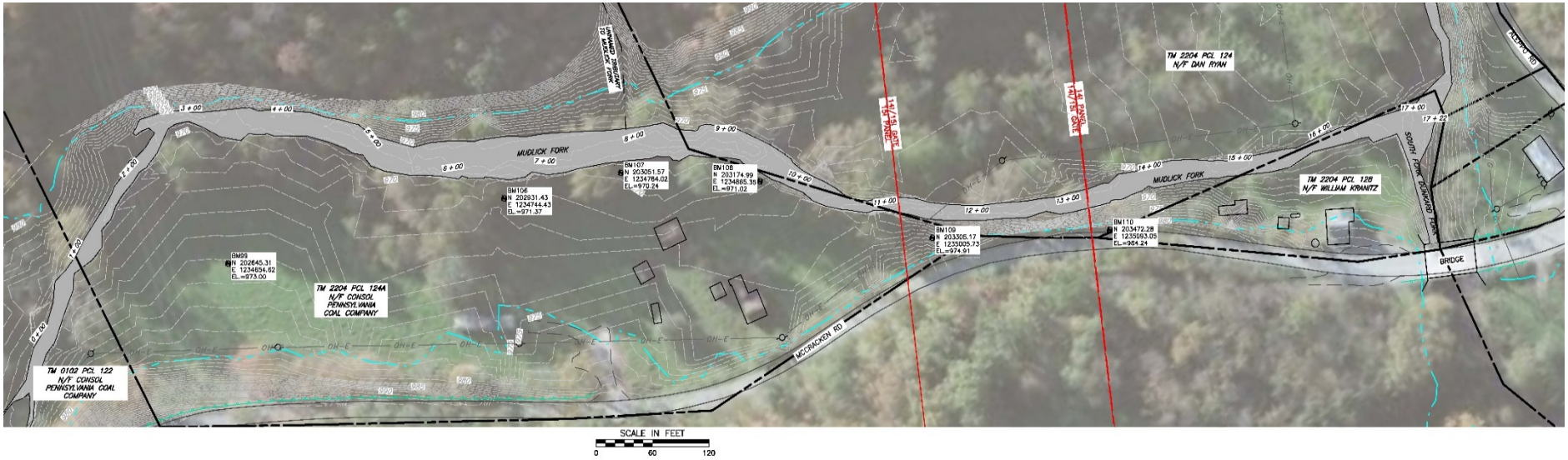


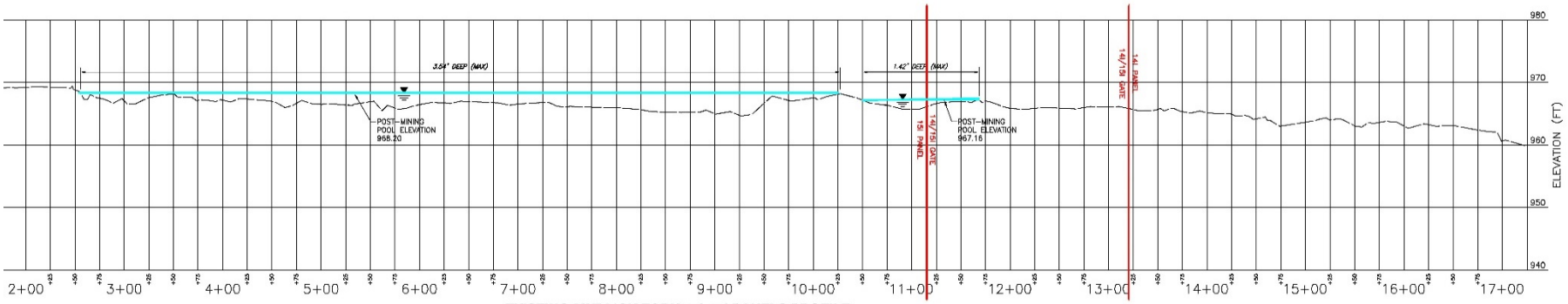
LONGWALL EFFECTS AND INTERVENTION – SUBSIDENCE POOLING





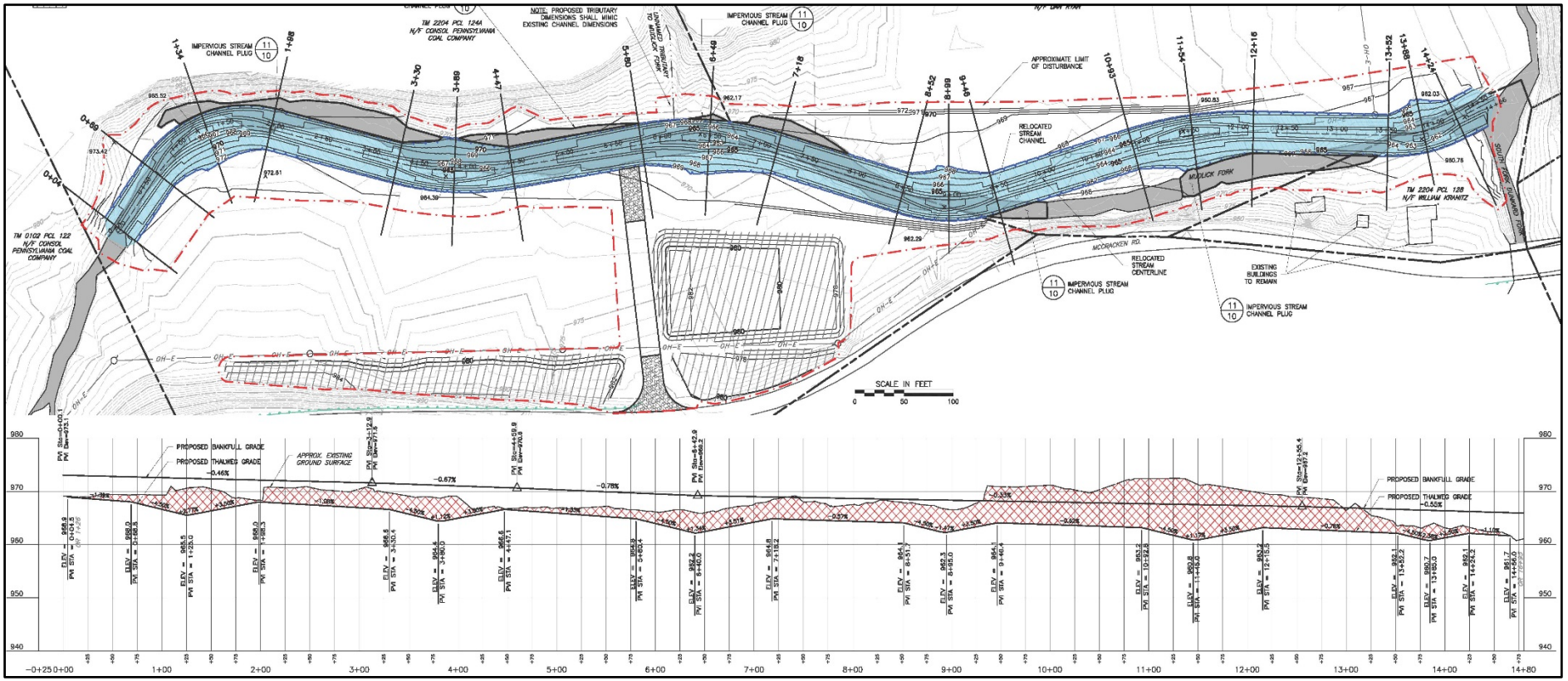
LONGWALL EFFECTS AND INTERVENTION – SUBSIDENCE POOLING



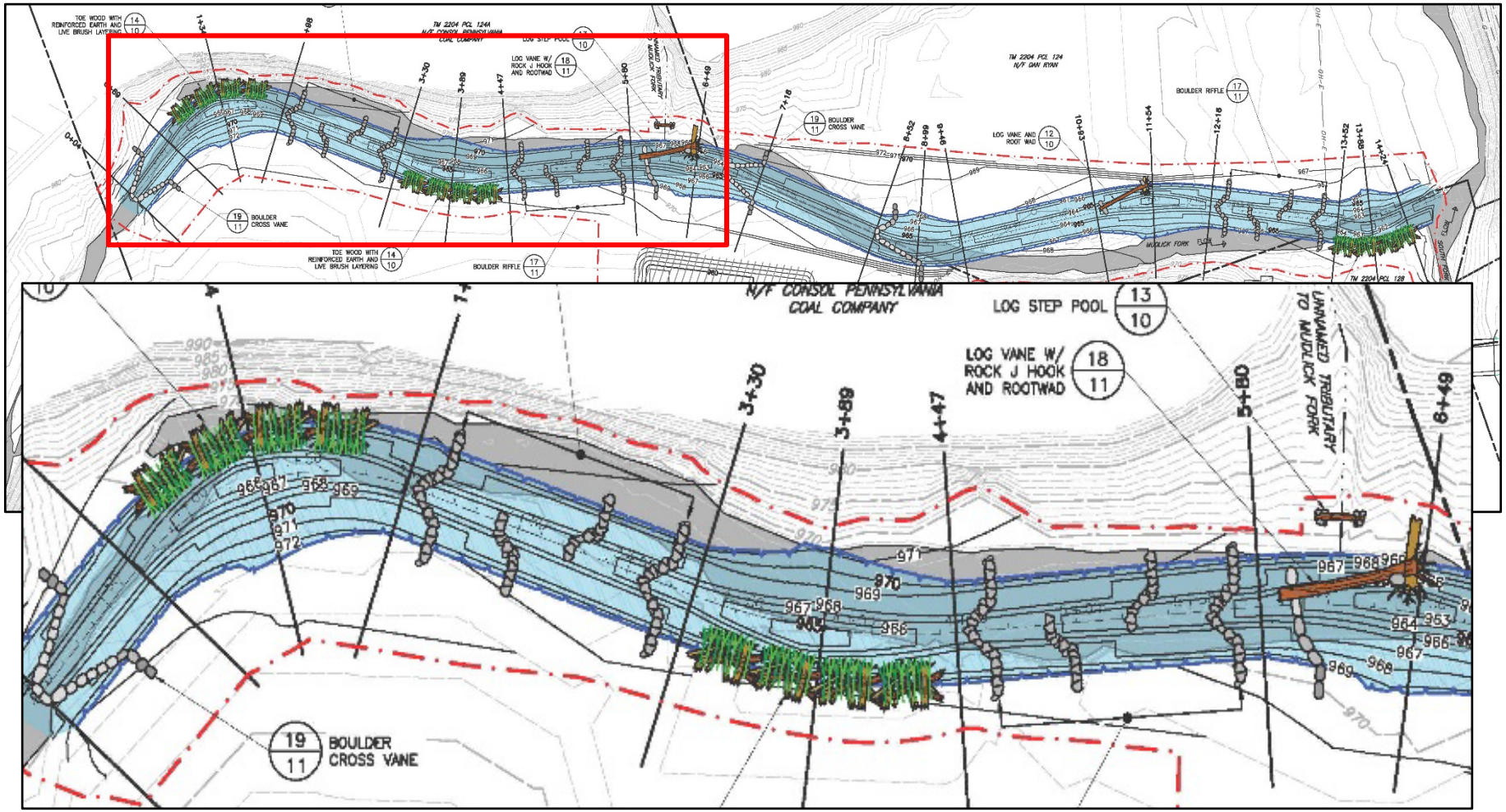


EXISTING MUDLICK FORK 14I-15I PANELS PROFILE

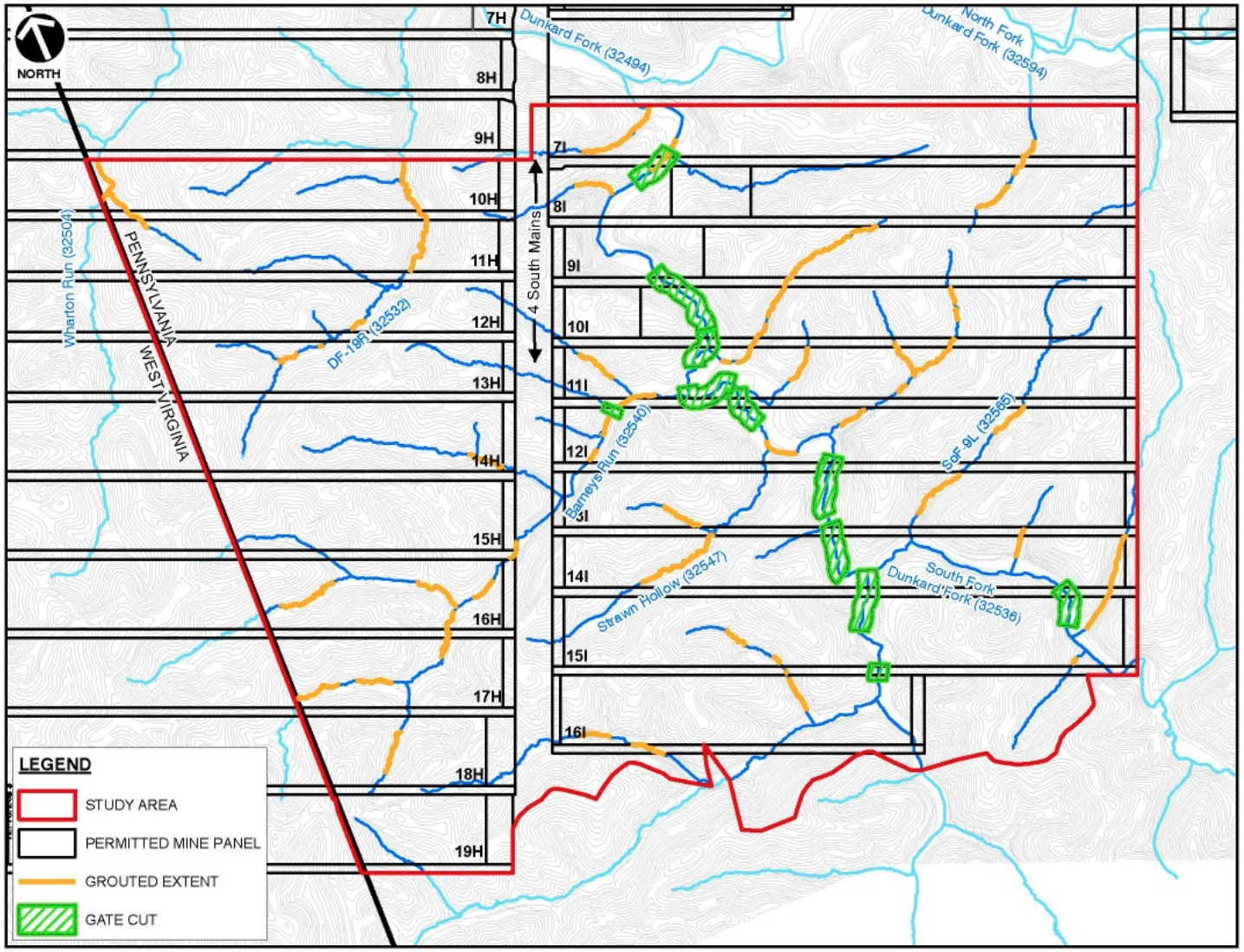
LONGWALL EFFECTS AND INTERVENTION – SUBSIDENCE POOLING



LONGWALL EFFECTS AND INTERVENTION – SUBSIDENCE POOLING



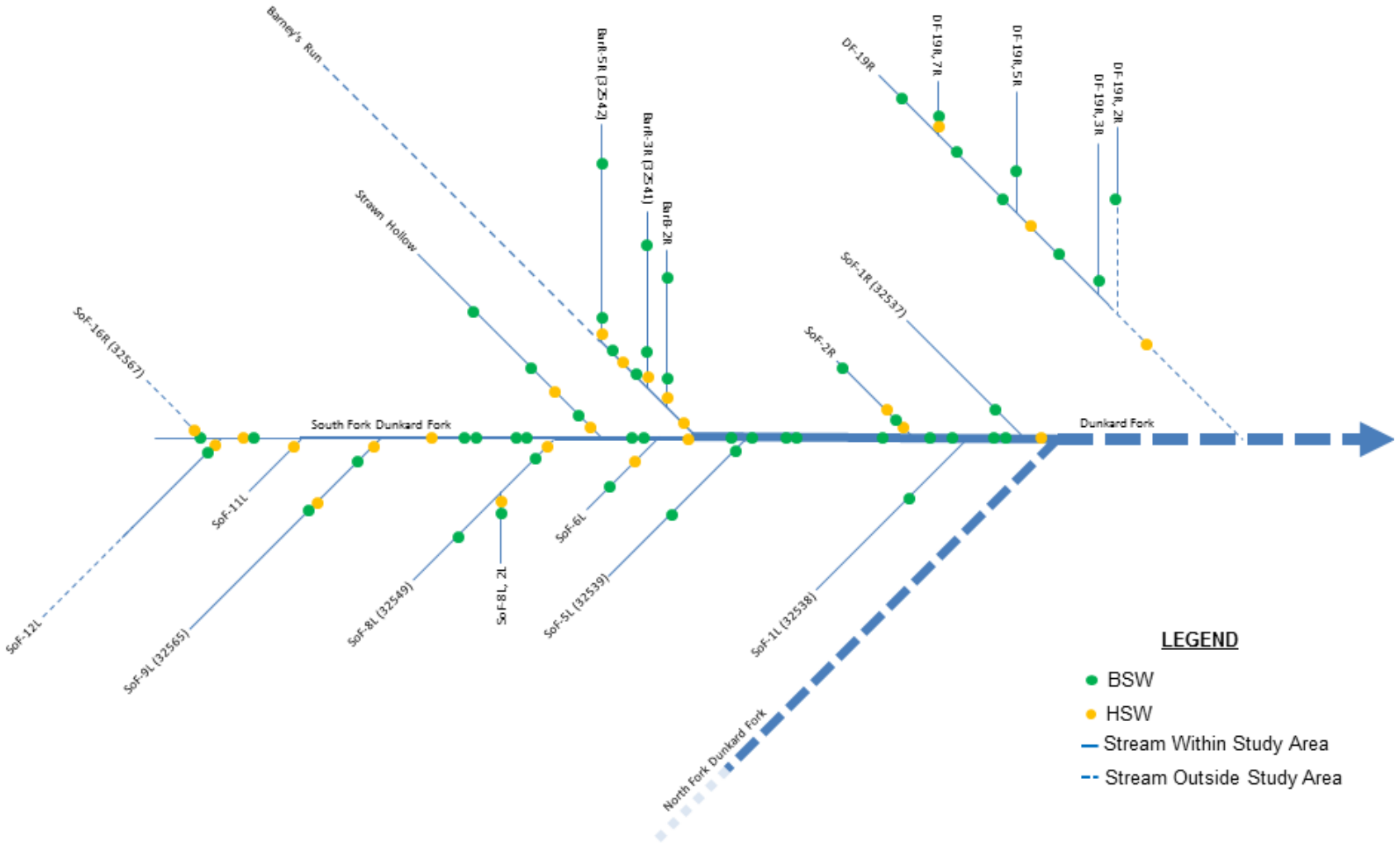
INTERVENTION MAP - GROUTED EXTENTS AND GATE CUTS



HYDROLOGIC AND BIOLOGIC MONITORING DATA

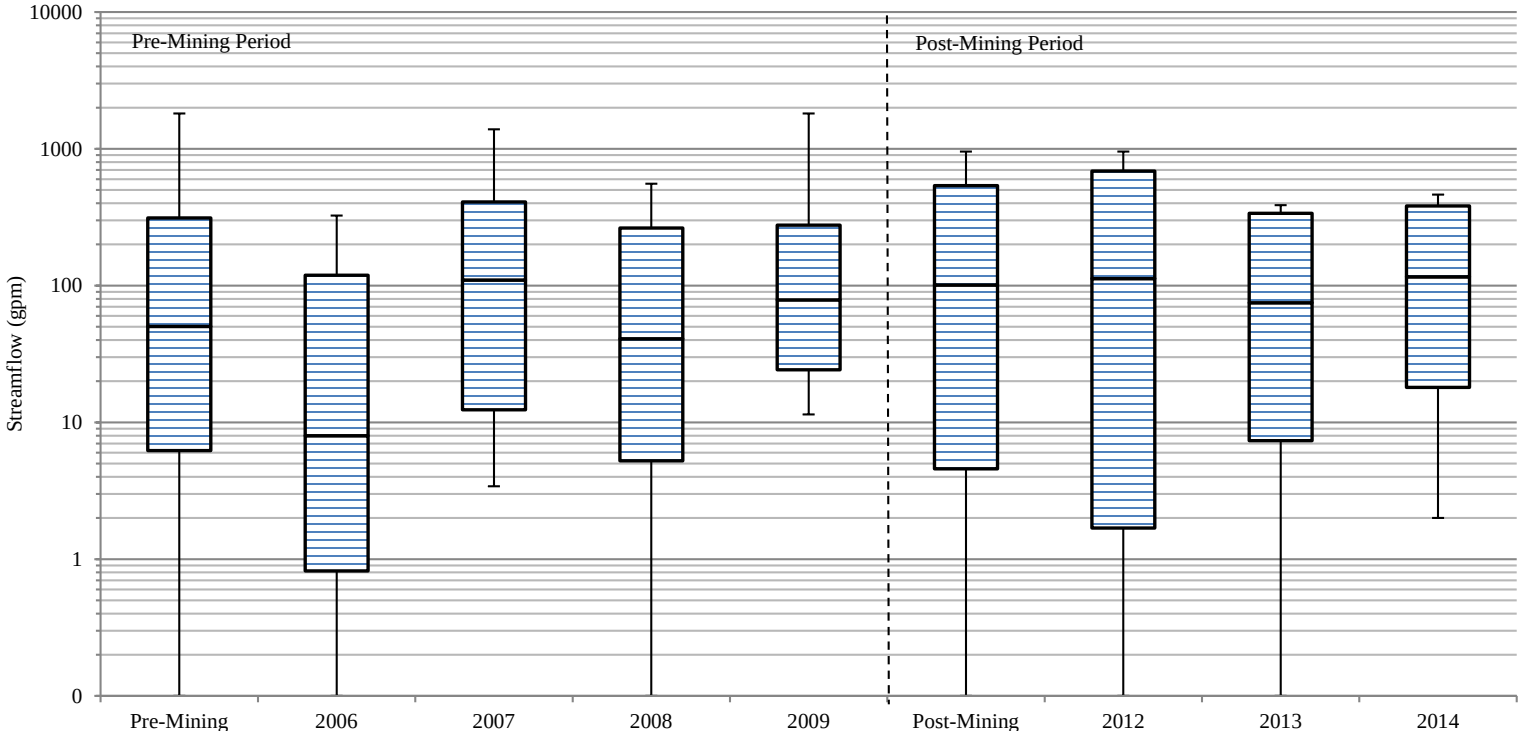
- **HYDROLOGIC**
  - Discharge Measurements (point specific)
  - Flow Loss Observations (linear)
- **BIOLOGIC**
  - Stream Biological Monitoring (point specific)
  - Stream Classification (linear)

HYDROLOGIC AND BIOLOGIC MONITORING NETWORK



STATISTICAL ANALYSIS OF DISCHARGE

- **Developed Hydrologic Recovery Criteria**
  - Descriptive statistics determine measures of central tendency and variance
  - Summary statistics can be viewed with exploratory data analysis tools
  - Visual representation of baseflow conditions
  - Confirmed through hypothesis testing



FLOW LOSS MONITORING

Flow Loss Monitoring

- Flow loss defined as the absence of water on streambed surface
- Extent mapped from field observation
- Quantified as a percent of total monitored length

POST-MINING STREAM RECOVERY (BIOLOGICAL USE)

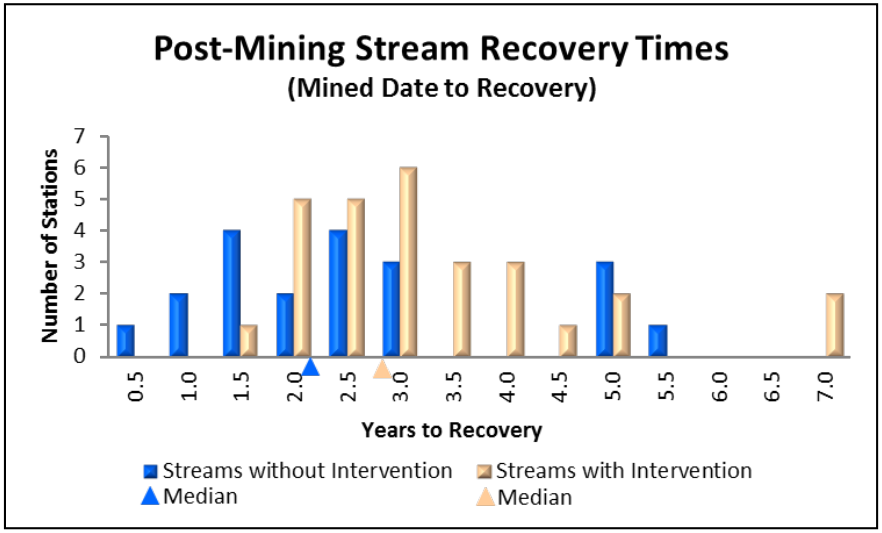
- **Stream Biological Monitoring**
  - Representative Network of Stations
  - Use Benthic Macroinvertebrates to Calculate IBI
  - Redundant Sampling
- **Stream Classification**
  - Use Benthic Macroinvertebrates to determine perennial extent
  - One pre- and one post-mining survey

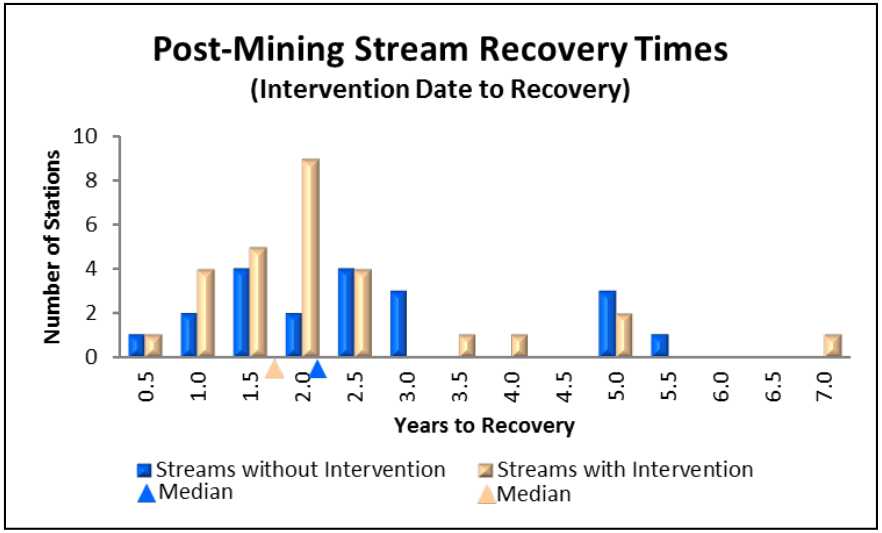
HYDROLOGIC AND BIOLOGIC RECOVERY RESULTS

- **HYDROLOGIC**
  - Discharge Measurements = 91 - 94% of drainage area recovered
  - Flow Loss Observations = 97% of length maintained
- **BIOLOGIC**
  - Stream Biological Monitoring = 96% recovered
  - Stream Classification = 97% of length maintained

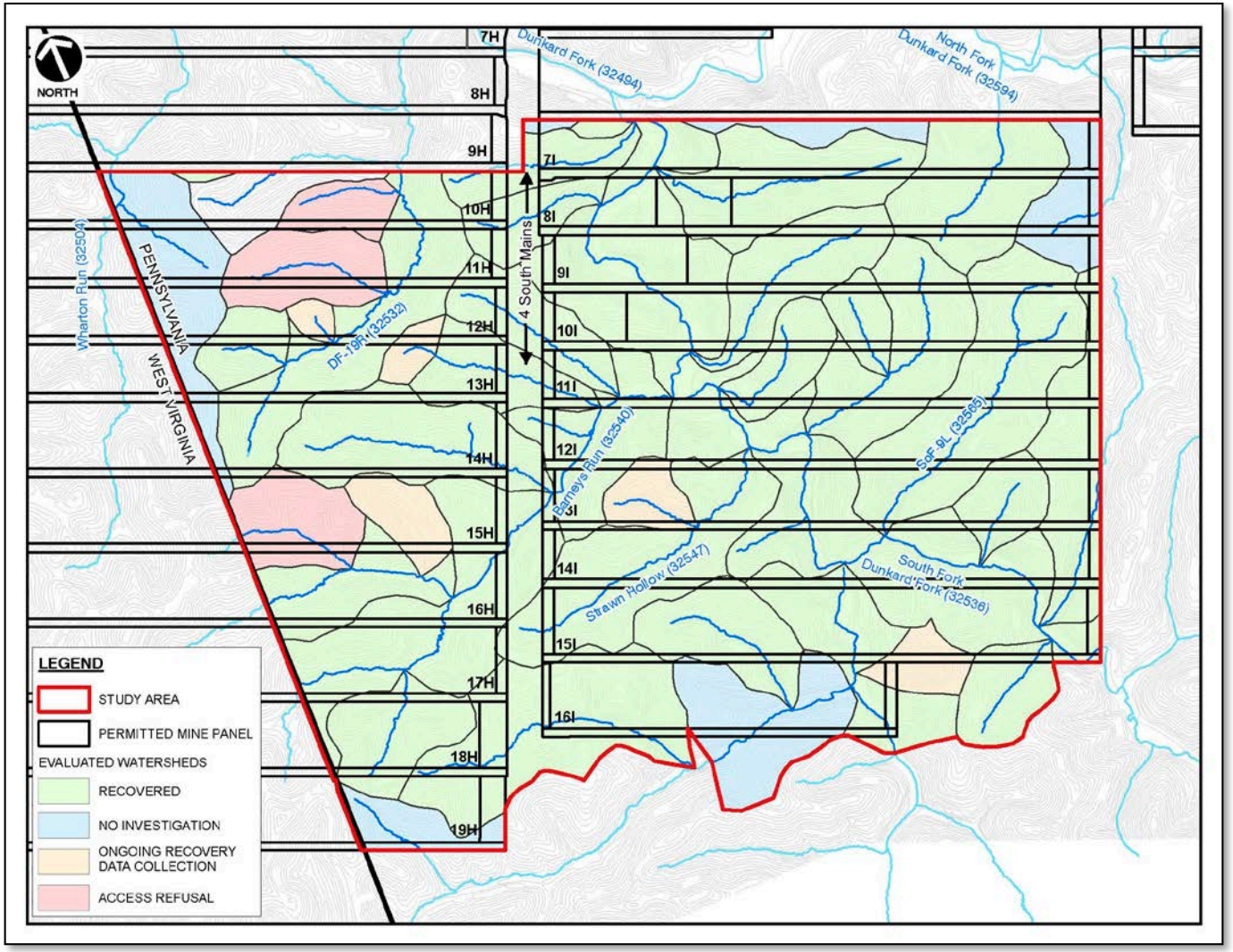
POST-MINING STREAM RECOVERY (BIOLOGICAL RECOVERY TIME)

- **Of the 50 stations that showed biological recovery**
  - 21 stations experienced no intervention
  - 29 stations experience intervention
  - Median recovery time of all stations was 2.5 years





POST-MINING RECOVERY STATUS



SUMMARY

INTERVENTION TECHNIQUES EFFECTIVE AT RESTORING FLOW AND BIOLOGICAL COMMUNITIES

BIOLOGICAL RECOVERY TIME OF STREAMS WITH INTERVENTION EQUAL OR BETTER THAN STREAMS WITH NO INTERVENTION

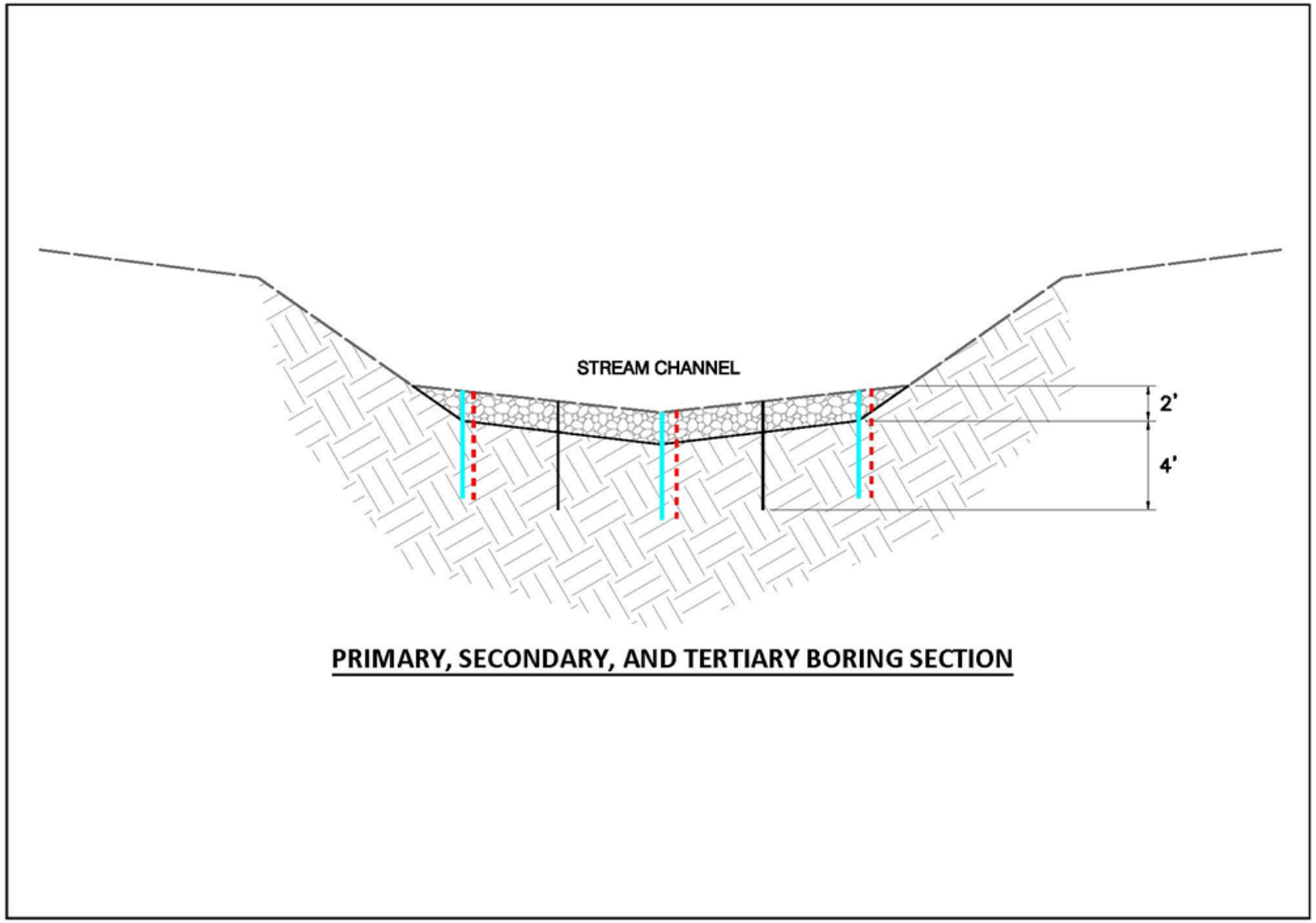
MAINTAINED COMPLIANCE WITH PENNSYLVANIA REGULATIONS

QUESTIONS?

Joshua M. Silvis
CONSOL Energy, Inc.
Canonsburg, PA
JoshuaSilvis@consolenergy.com

Michael L. Shema
Civil & Environmental Consultants, Inc.
Pittsburgh, PA
mshema@cecinc.com

LONGWALL EFFECTS AND INTERVENTION – FLOW LOSS



PRIMARY, SECONDARY, AND TERTIARY BORING SECTION