STUDY AREA
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:
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 – SUBSIDENCE POOLING
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

LEGEND
- BSW
- HSW
- Stream Within Study Area
- Stream Outside Study Area

Consol Energy
Civil & Environmental Consultants, Inc.
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 experienced intervention
- Median recovery time of all stations was 2.5 years
POST-MINING RECOVERY STATUS

[Map showing post-mining recovery status with various areas highlighted in different colors and labels.]
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