AIRFLOW DISTRIBUTION PATTERNS AT A LONGWALL MINE DEPICTED BY CFD ANALYSIS AND CALIBRATED BY A TRACER GAS FIELD STUDY

Robert B. Krog M.Sc. PE
Steven J. Schatzel PhD PG
Heather N. Dougherty PE

CDC Workplace Safety and Health

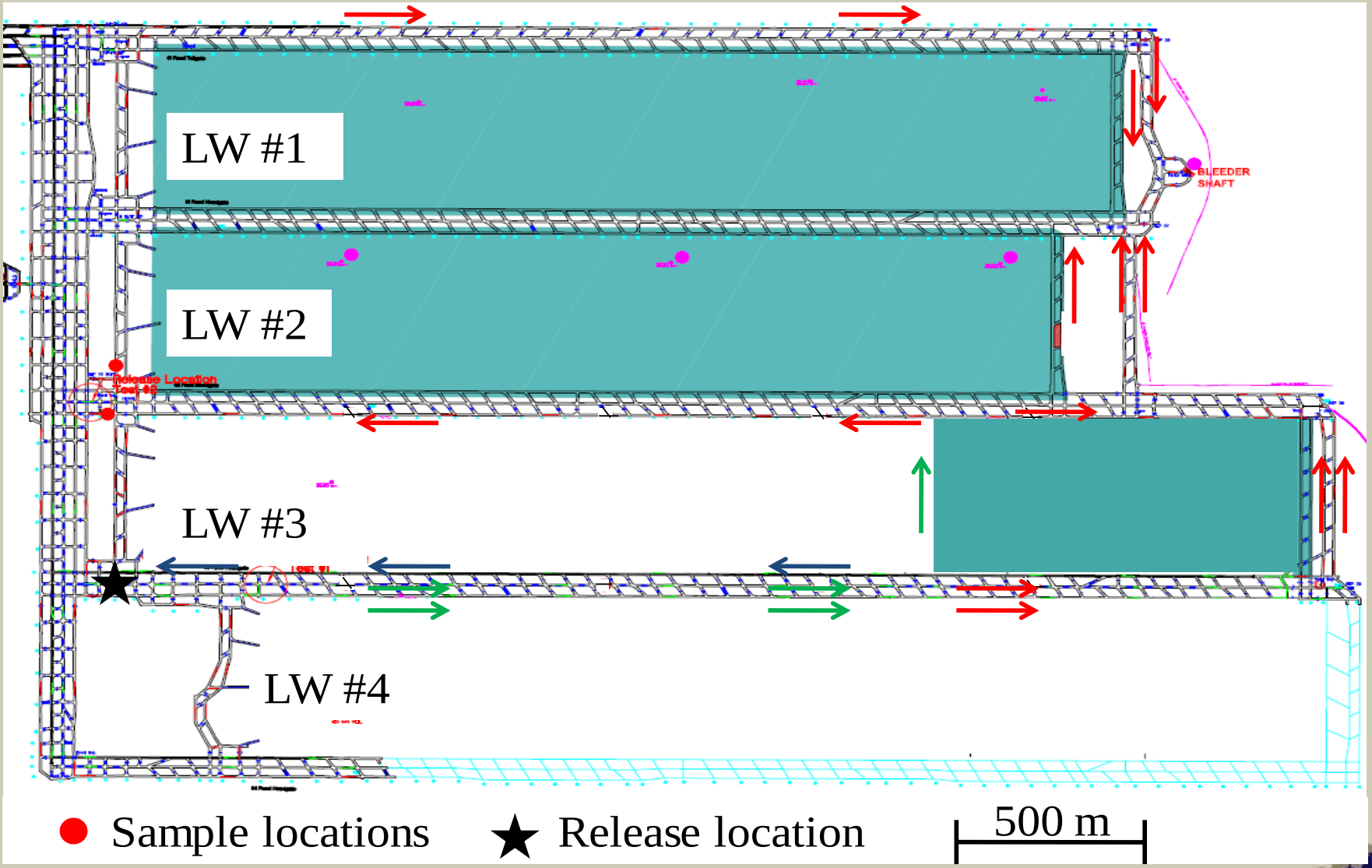
National Institute for Occupational Safety and Health NIOSH

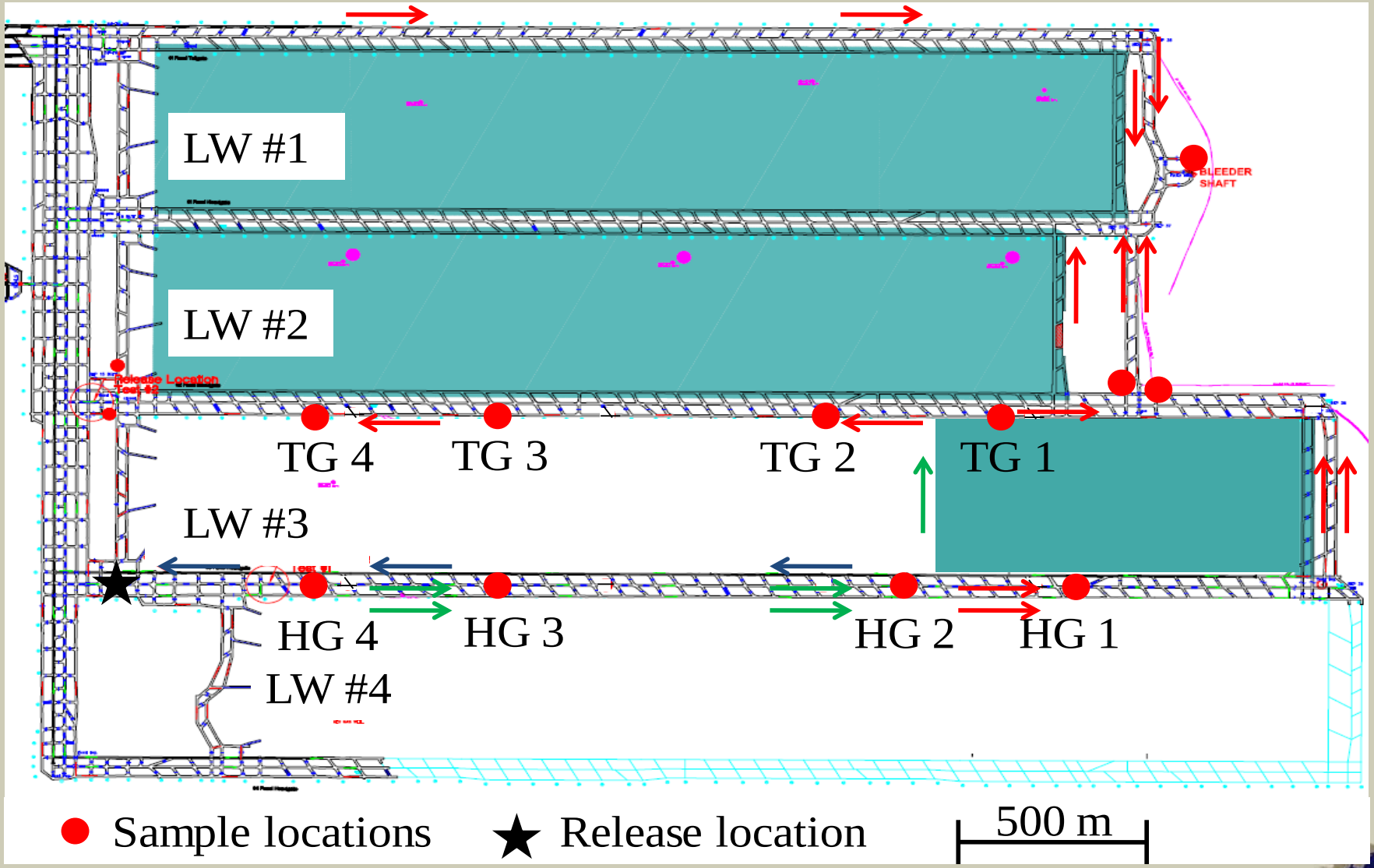
Introduction

- Summary of work
- Test layout and methods
- Tube sampling system
- Tracer gas results
- Wire frame model
- CFD model
- Model comparison
- Conclusions

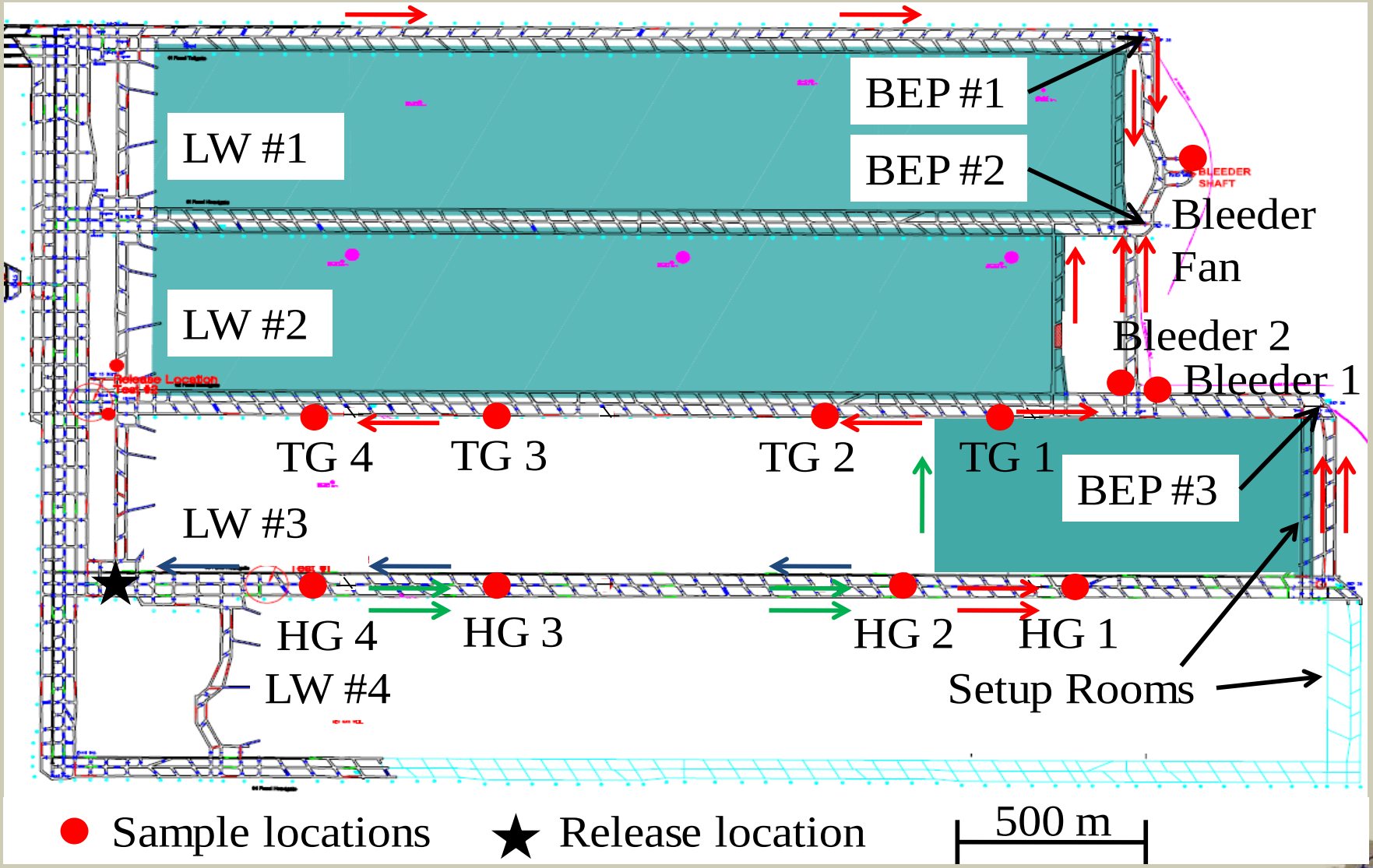
Summary of Work

- Goal to determine the airflow patterns around longwall panels
- Quantify airflow quantity and velocity in the tailgate bleeder system (inaccessible locations)
- Determine airflow pathways around the gob and within a district


LW #1
LW #2
LW #3
LW #4
BLEEDER SHAFT
Release Location
Sample locations
Release location
500 m

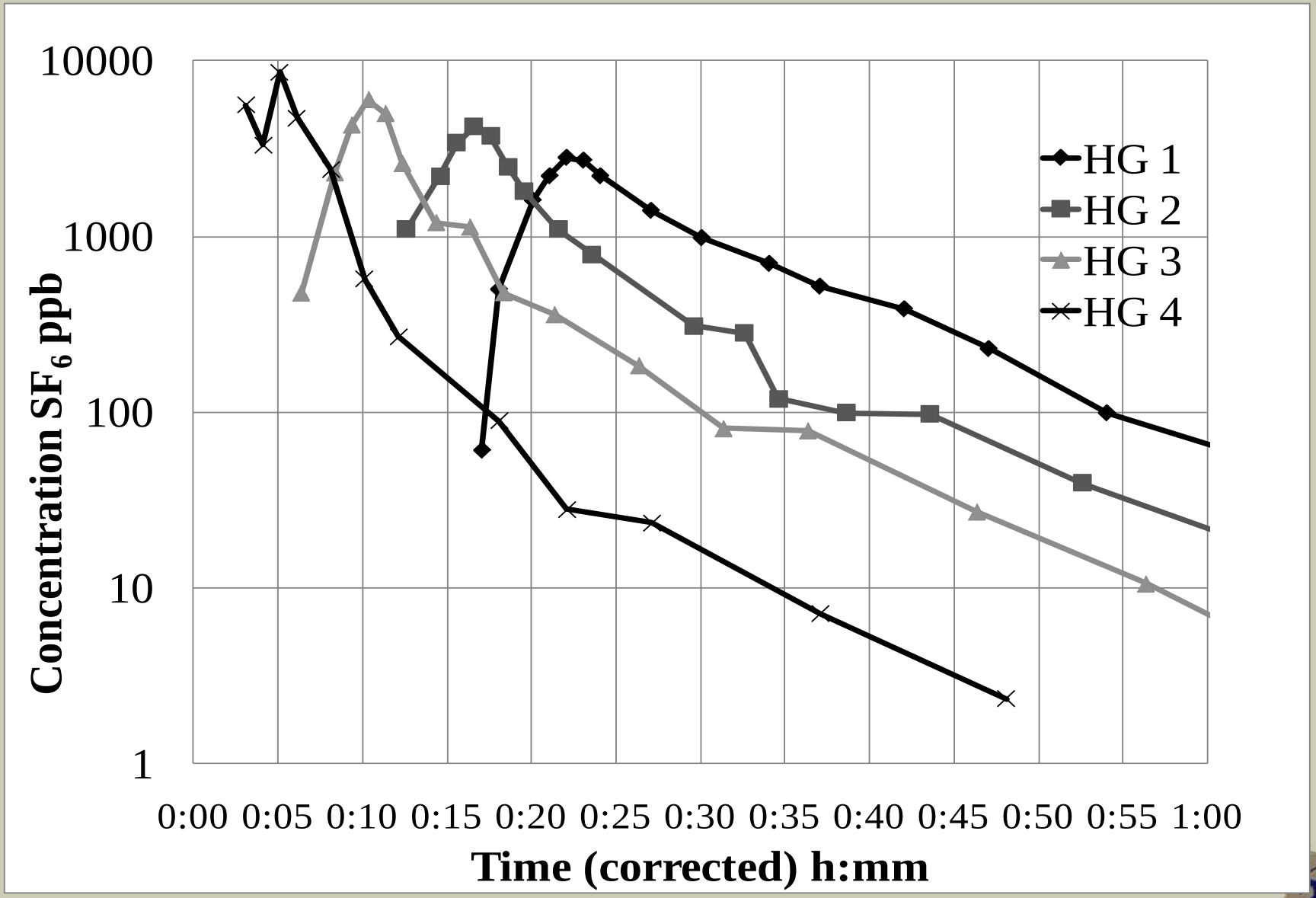

LW #1
LW #2
LW #3
LW #4
BLEEDER SHAFT
TG 4
TG 3
TG 2
TG 1
HG 4
HG 3
HG 2
HG 1
Sample locations
Release location
500 m

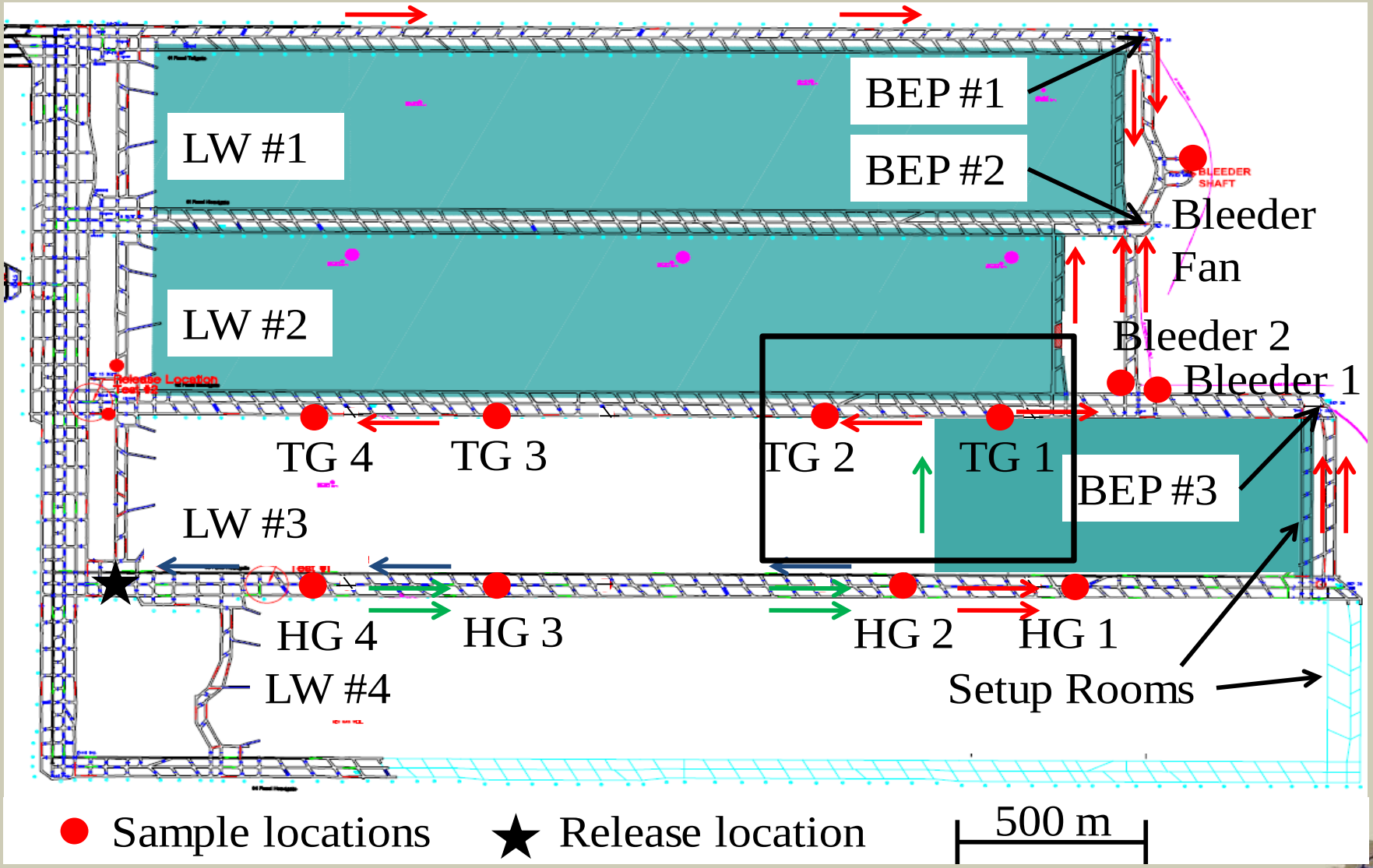
Tube Sampling System

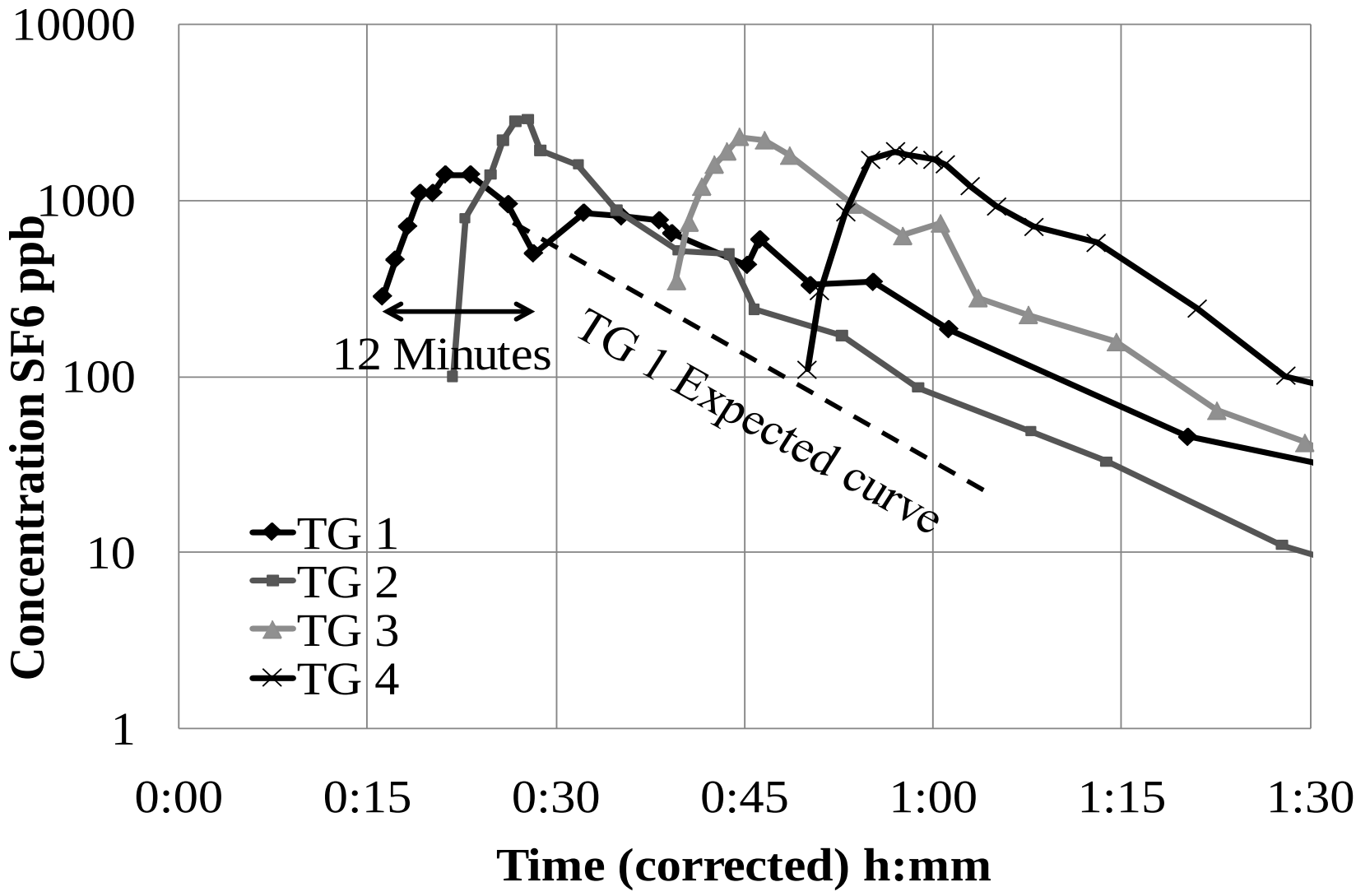

LW #1
LW #2
LW #3
LW #4
BEP #1
BEP #2
BEP #3
Bleeder
Fan
Bleeder 2
Bleeder 1
BLEEDER SHAFT
Release Location
TG 4
TG 3
TG 2
TG 1
HG 4
HG 3
HG 2
HG 1
Setup Rooms
Sample locations
Release location
500 m

Tracer Gas Results

- Raw data
- Transit time in tube sampling lines
- Remove minor regulator leakage


10000
1000
100
10
1
Concentration SF_6 ppb
HG 1
HG 2
HG 3
HG 4
0:00 0:05 0:10 0:15 0:20 0:25 0:30 0:35 0:40 0:45 0:50 0:55 1:00
Time (corrected) h:mm


LW #1
LW #2
LW #3
LW #4
BEP #1
BEP #2
BEP #3
Bleeder
Fan
Bleeder 2
Bleeder 1
BLEEDER SHAFT
Release Location
TG 4
TG 3
TG 2
TG 1
HG 4
HG 3
HG 2
HG 1
Setup Rooms
Sample locations
Release location
500 m

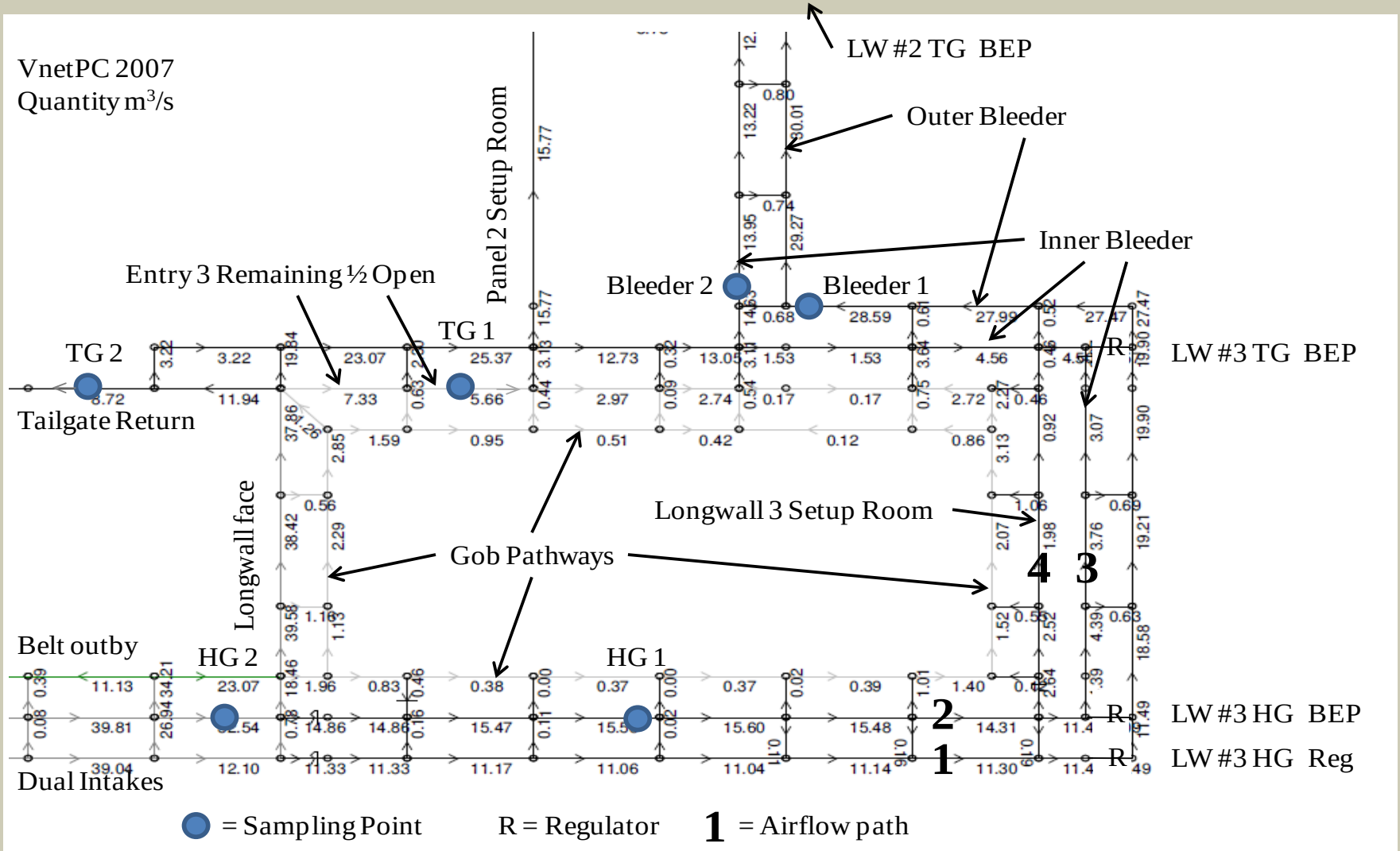

10000
1000
100
10
1
Concentration SF6 ppb
12 Minutes
TG 1 Expected curve
TG 1
TG 2
TG 3
TG 4
0:00
0:15
0:30
0:45
1:00
1:15
1:30
Time (corrected) h:mm

Tracer Gas Results

- 230 meter inby the longwall tailgate corner, half the airflow comes down the inner entry the rest from behind the shields about 20 minutes later
- Is this good?

Wire Frame Model

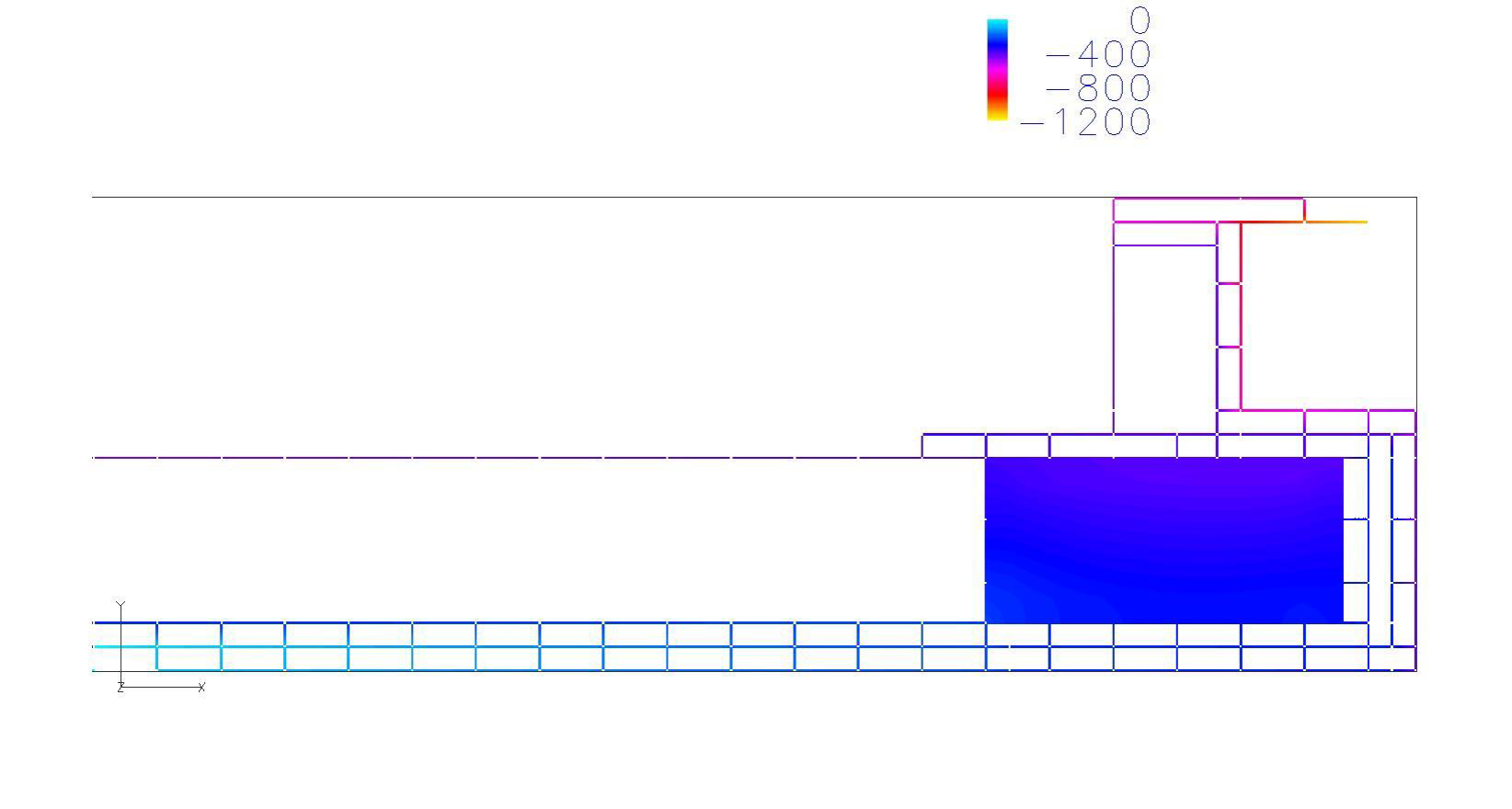
- Calibrated from collected field measurements and from ventilation controls
- Standard k factors and entry dimensions


VnetPC 2007
Quantity m3/s
LW #2 TG BEP
Outer Bleeder
Inner Bleeder
Panel 2 Setup Room
Entry 3 Remaining ½ Open
Bleeder 2
Bleeder 1
TG 2
TG 1
R
LW #3 TG BEP
Tailgate Return
Longwall face
Longwall 3 Setup Room
Gob Pathways
4
3
Belt outby
HG 2
HG 1
2
R
LW #3 HG BEP
1
R
LW #3 HG Reg
Dual Intakes
= Sampling Point
R = Regulator
1 = Airflow path

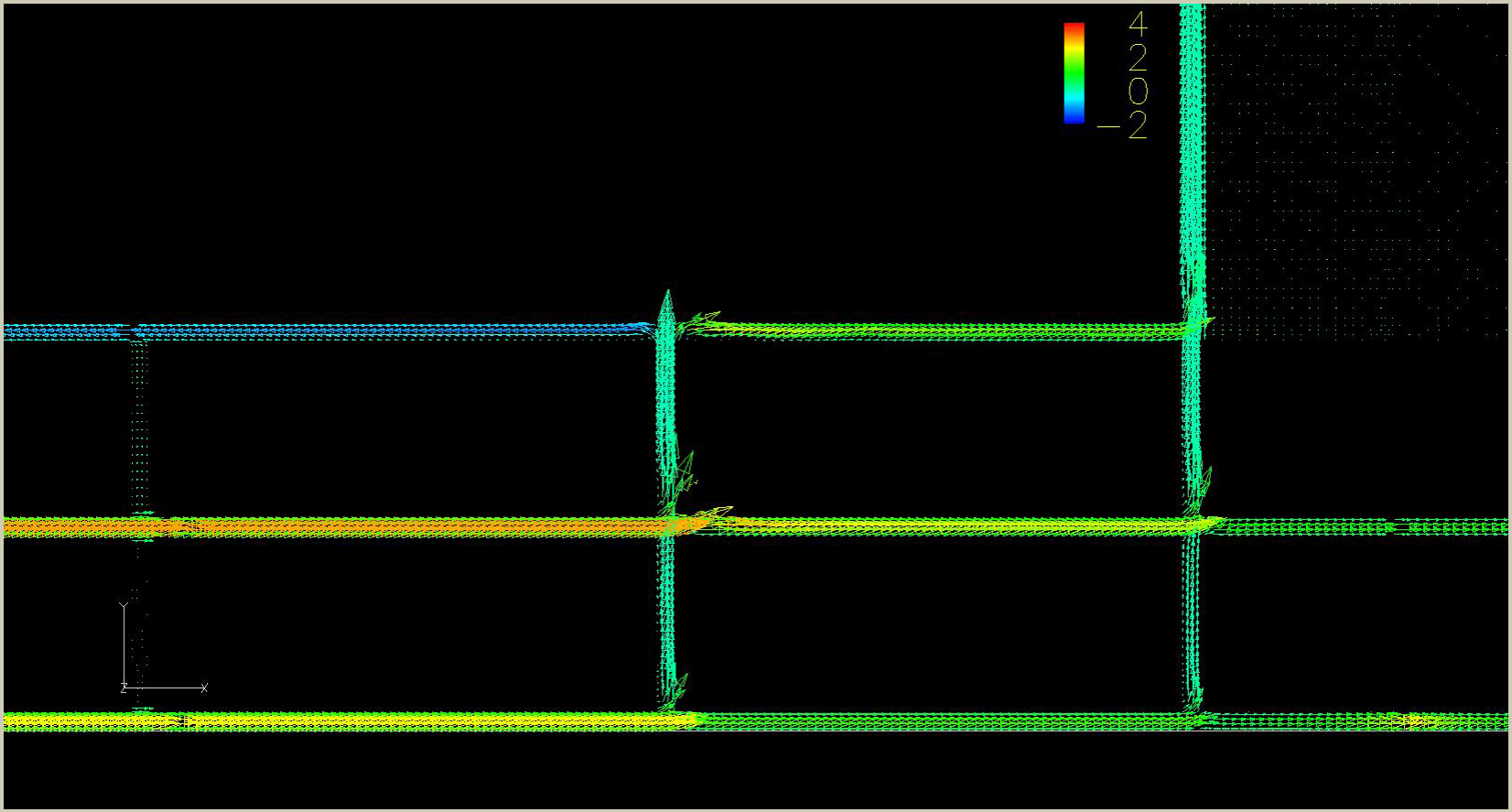
CFD Model

- Porous media blocks used to model the gob and stoppings (laminar flow)
- Regulators also used porous media blocks (this will be corrected)
- Results matched measure values but model needs to be upgraded with a combination of laminar and turbulent flow resistances

Pressure Drop Pa



Velocity X Direction m/s



Model Comparison

- All three sets of measurements are similar
- Tracer gas (First arrival and Peak)
- Wireframe network model
- Actual recorded measurements

Model Comparison

Start	Finish	Distance (m)	Delta Time First Arrival (min)	Velocity First SF_6 (m/s)	Velocity Peak SF_6 (m/s)	Velocity Network (m/s)
LW Tail	TG 1	229	0:03	1.3	1.3	1.2
TG 1	Bleeder 2	274	0:07	0.7	0.9	1.0
Bleeder 2	Bleeder Fan	640	0:10	1.1	0.9	1.1

Conclusions

- Tracer gas was able to determine airflow paths cross-sectional areas and retentions times in the inaccessible parts of the gob
- Wireframe matched field measurements
- CFD can explain the multiple peaks recorded in the tracer gas results
- Velocity inby longwall tailgate is 0.7-1.3 m/s
- The longwall's tailgate corner was being sweeped into the bleeder system as designed

The findings and conclusions in this presentation are those of the authors and do not necessarily represent the views of NIOSH. Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention

Thank You

Presented by: Robert Krog
Contact info: (412) 386-6729 RKROG@CDC.GOV
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