COLORADO SCHOOL OF MINES

CONTROL OF EXPLOSIVE ZONES AND OXYGEN PENETRATION IN LONGWALL GOBS THROUGH NITROGEN INJECTION

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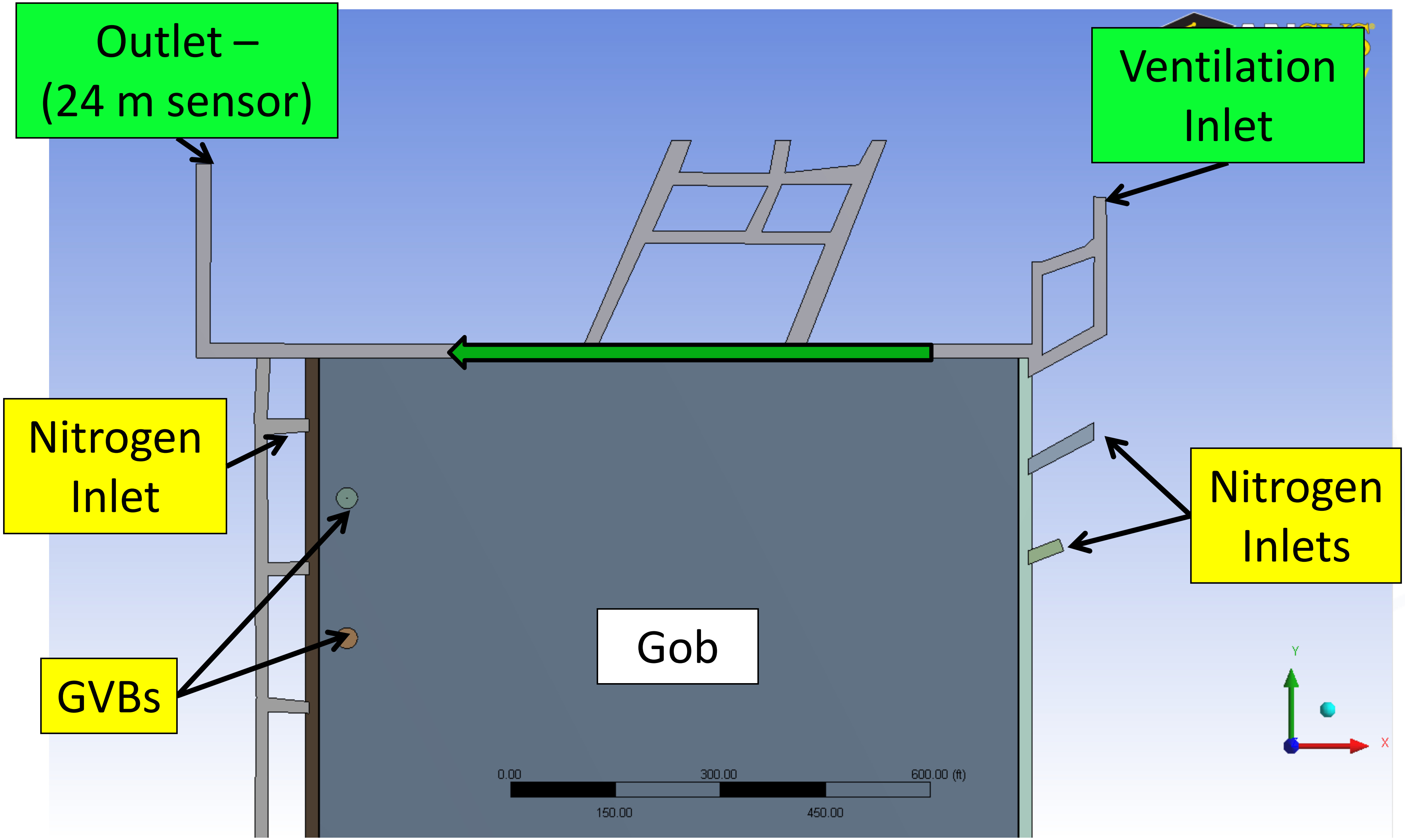
Outline

- Project Design
  - Research Goals
  - Model Description and Assumptions
  - Model Validation
  - Hazardous Gas Mixtures
- Hazard Mitigation
  - Modeling Parameters
  - N_2 Injection and Explosive Mixtures

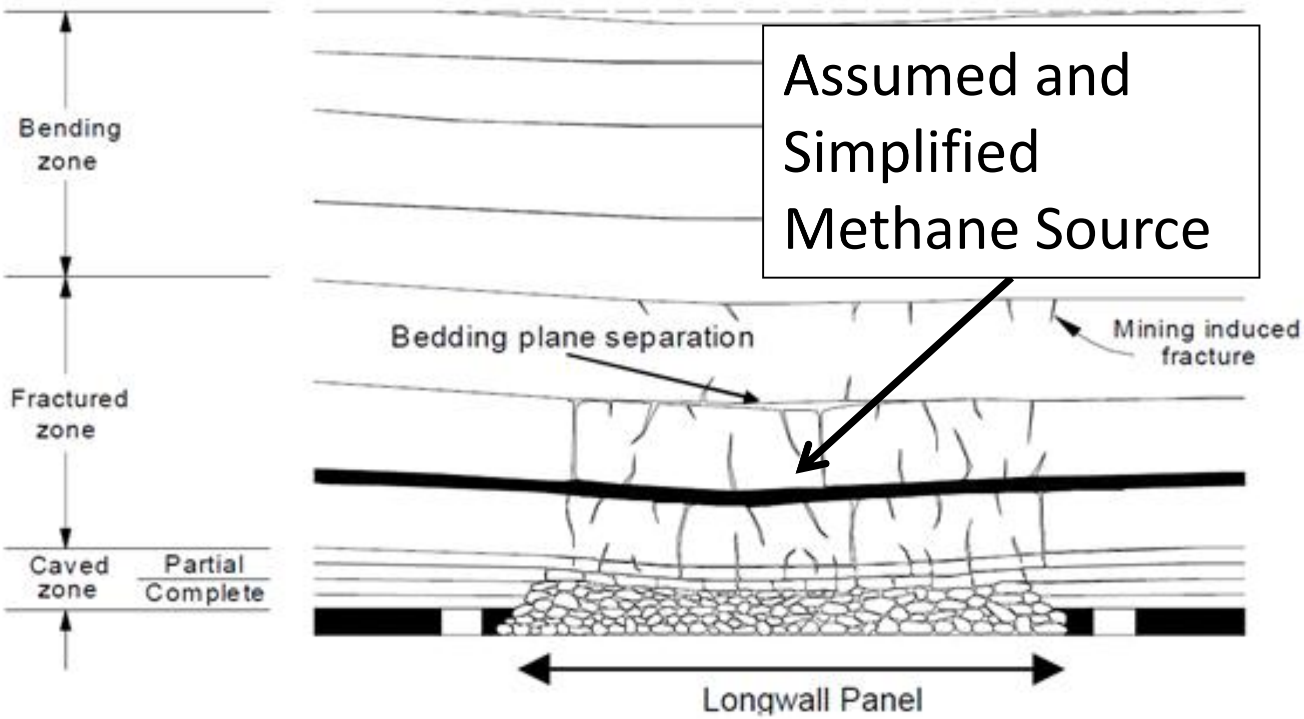
Research Goals

- Modeling of stratigraphy of longwall panel to establish gob resistance to gas flow
- Modeling of sealed longwall panel – sealed, progressive nitrogen inertization, and gob vent boreholes
- Validation of model utilizing available measurements
- Explosive zones identified in the ventilated areas and gob
- Partnerships with mines

Plan View – Sample Mine



FLAC 3D Modeling

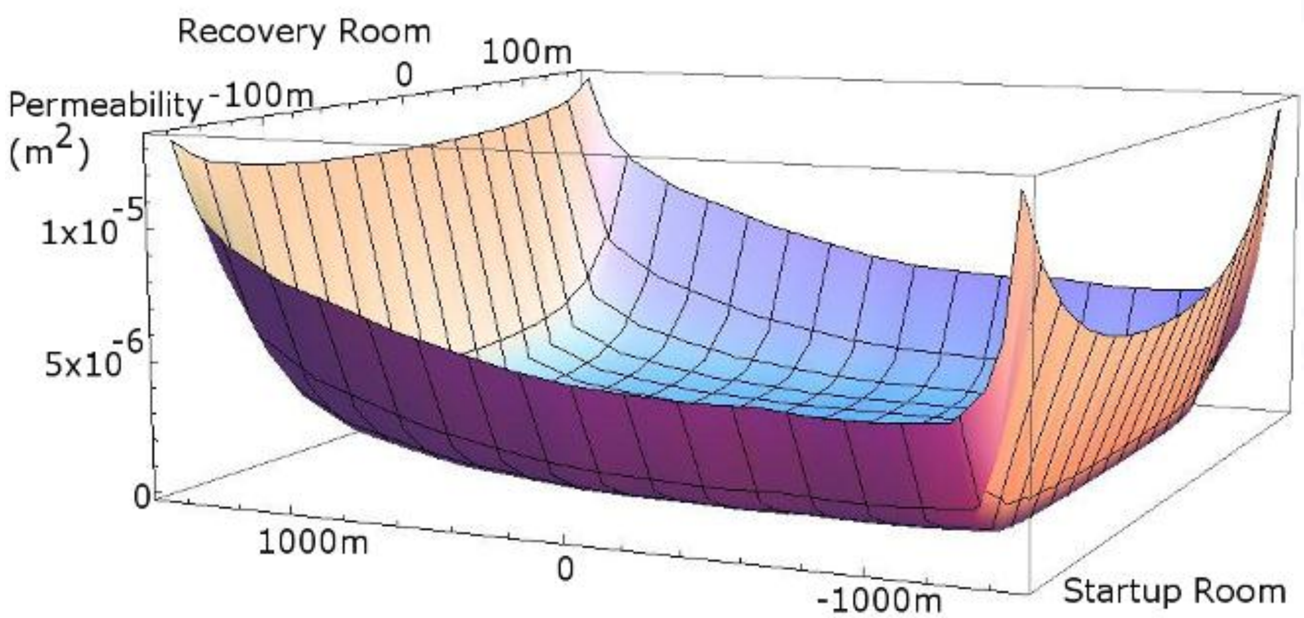


Vertical cross section of bed displacement and gob formation

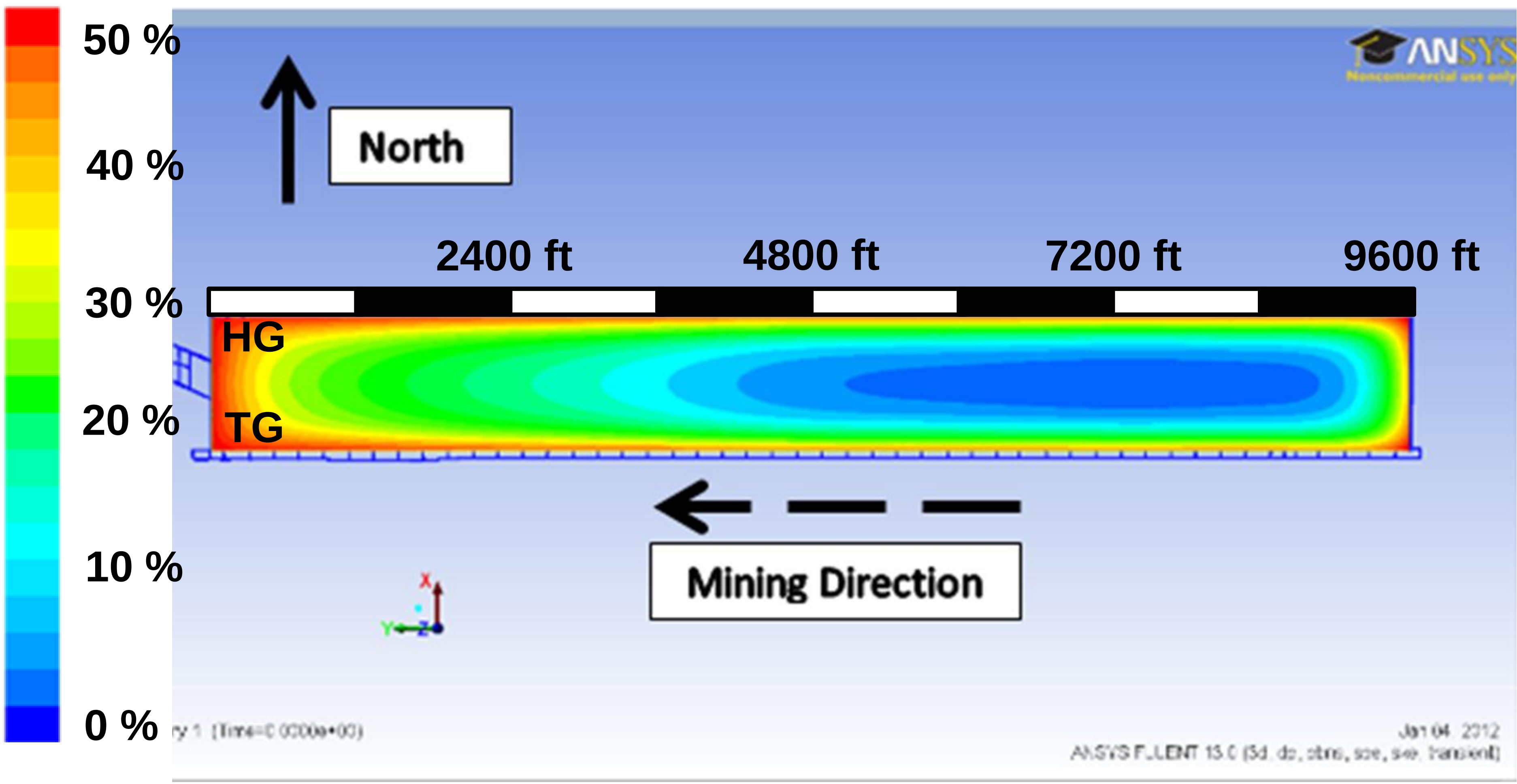
- FLAC 3D used to model permeability and porosity in the gob.
- Potential flow of gases in overlying strata – used as methane source in FLUENT.

FLAC 3D Modeling – Permeability Output

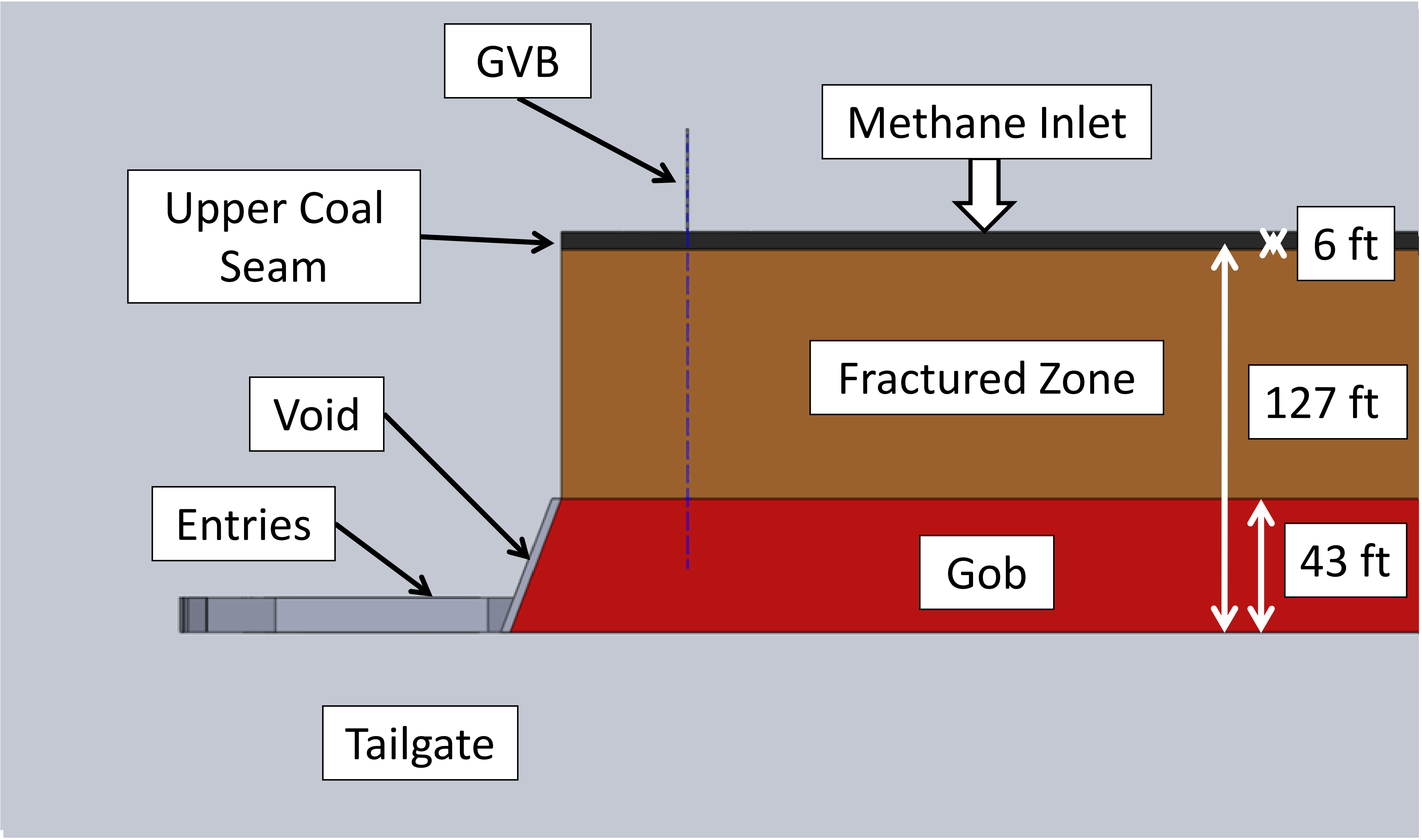
- FLAC 3D Model takes into account overburden material strengths to determine stress and strain distribution in gob.
- Converts stress and strain to porosity and then permeability distribution.



Full Panel Resistance – FLAC to FLUENT



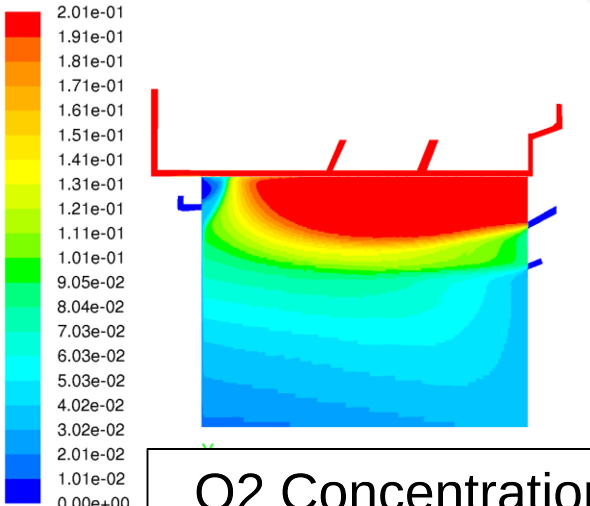
Final Cross Sectional Geometry



Model Validation

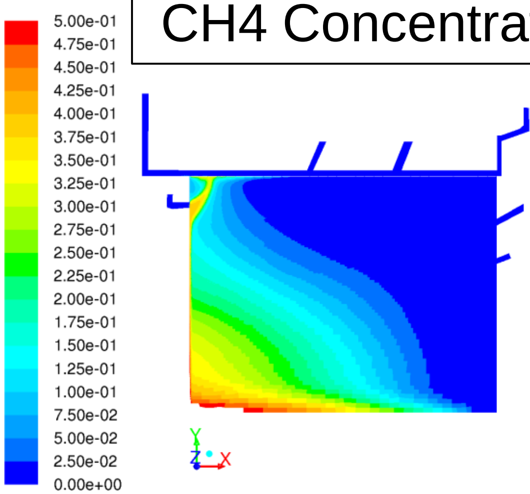
- Quantity and gas concentration readings at ventilation network evaluation points (intake, face, return)
- Sampling ports at seals (O_2, N_2, CO, CO_2, CH_4)
- Gob ventilation boreholes (O_2, N_2, CO, CO_2, CH_4, flow)
- Tracer gas studies (NIOSH)

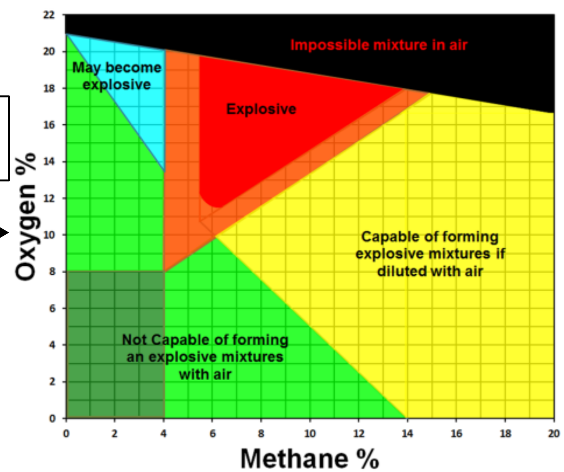
Gob Gas Explosibility Color Coding

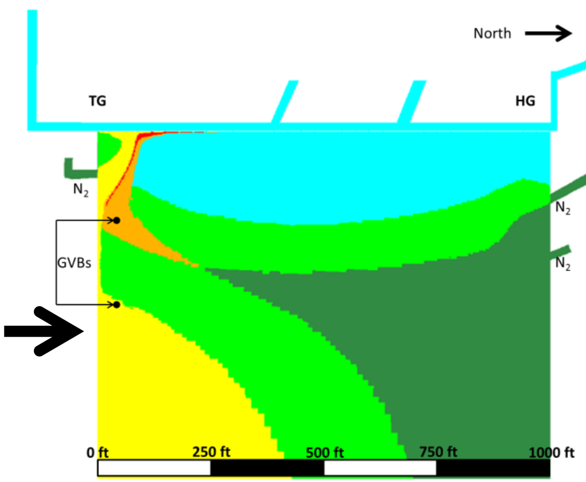


O2 Concentration

CH4 Concentration







TG

HG

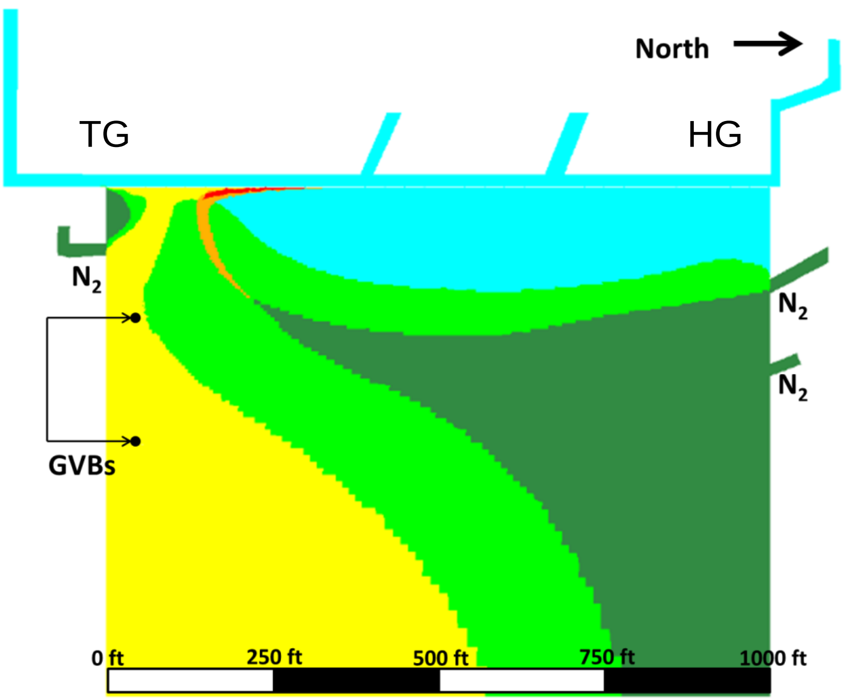
Plan View

Hazard Mitigation Parameters

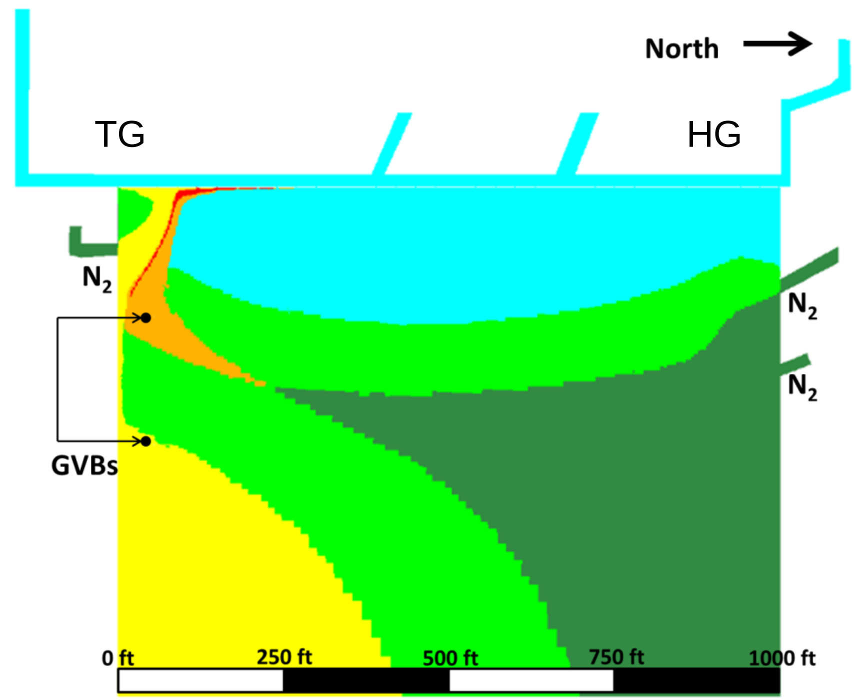
- Face Ventilation Rates
  - Hazardous Gas Mixture
  - Oxygen Ingress and Spon Com Risk Assessment
- Nitrogen Injection Studies
  - Hazardous Gas Mixture
  - Oxygen Ingress and Spon Com Risk Assessment
- Gob Caving Characteristics

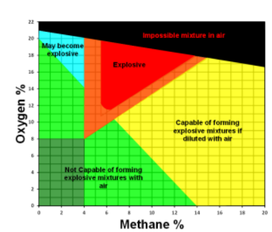
Face Ventilation Quantity Impact

40,000 cfm

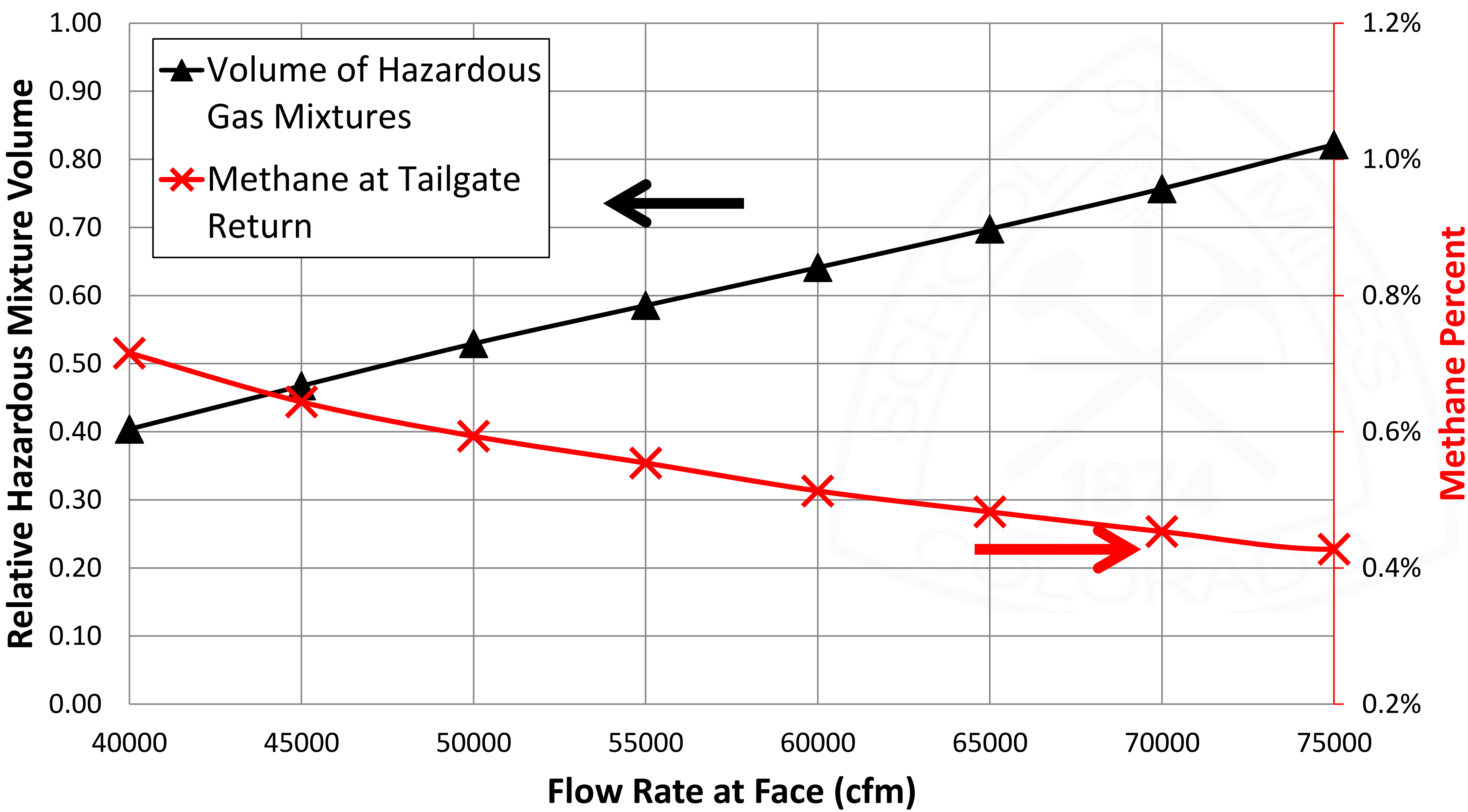


70,000 cfm

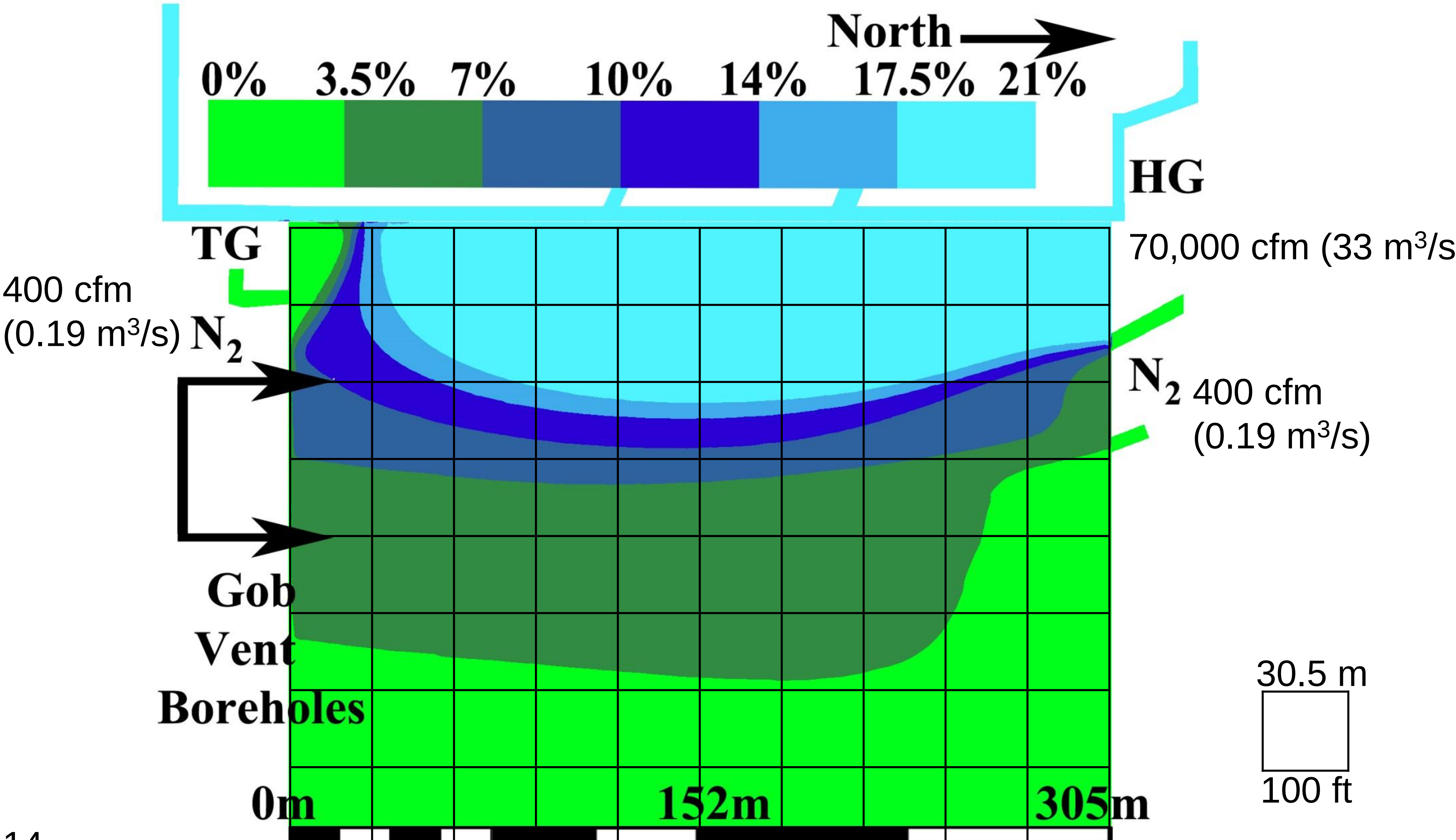




Higher Face Quantities Increase Explosive Mixture Volume in the Gob

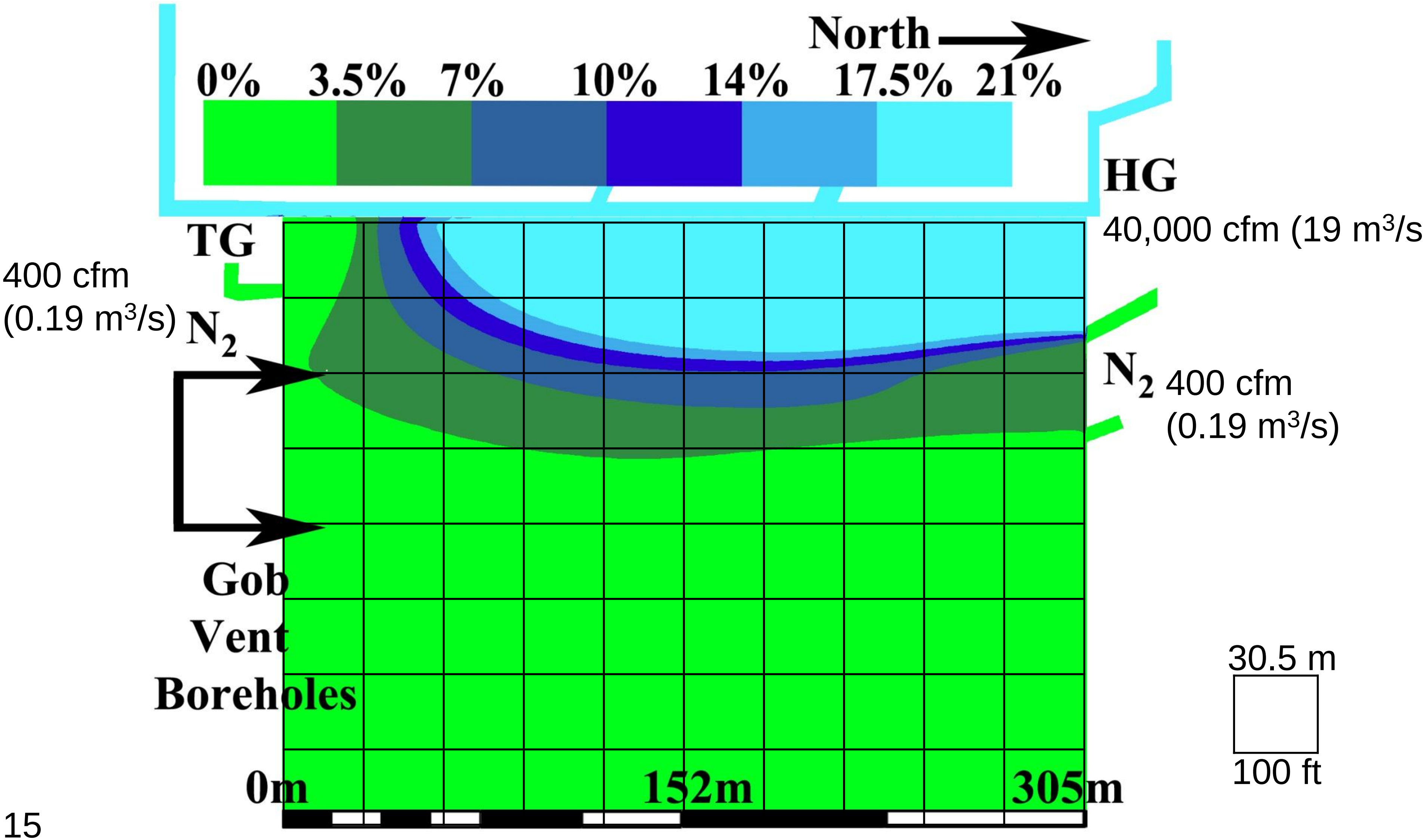


Oxygen Ingress – Face Quantity



Oxygen Ingress – Face Quantity

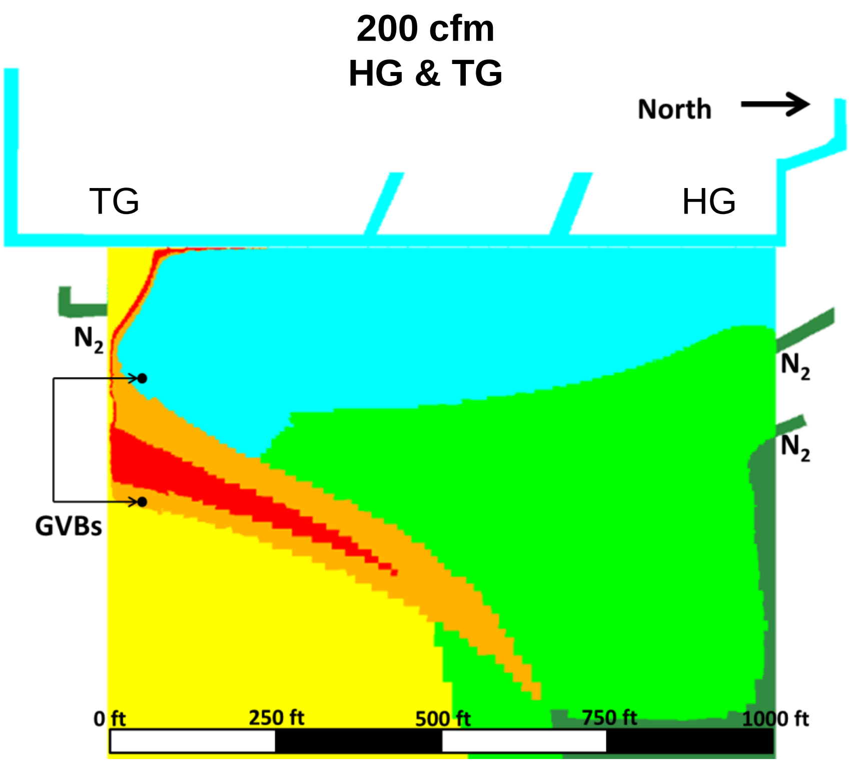
Face Ventilation Quantity of 40,000 cfm (19 m³/s)

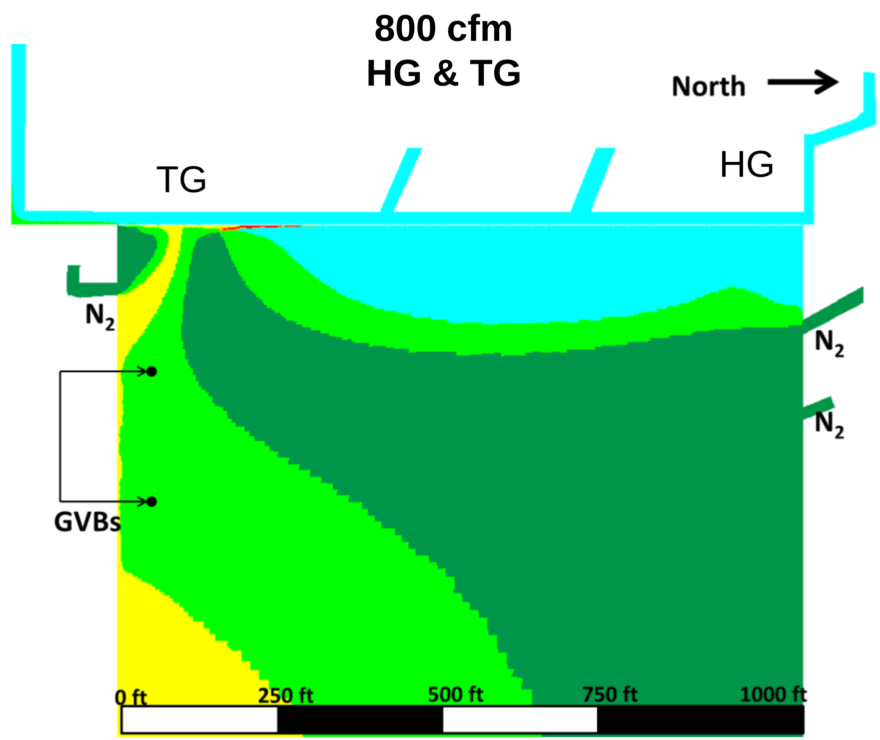


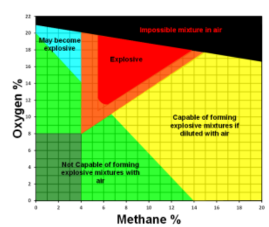
Nitrogen Injection Effect

- Base case used 70,000 cfm of face ventilation and 400 cfm of nitrogen injection HG and TG
- Evaluated impact of nitrogen injection
  - Quantity (200 - 1600 cfm)
  - Location (HG vs. TG)
- Purpose is to minimize volume of explosive methane-air mixture

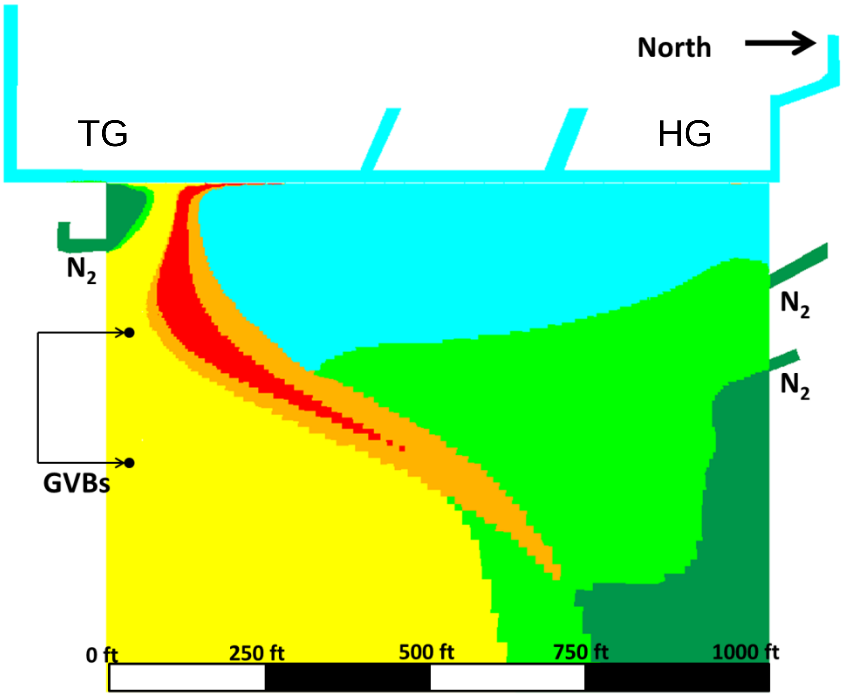
Nitrogen Injection Rate Study



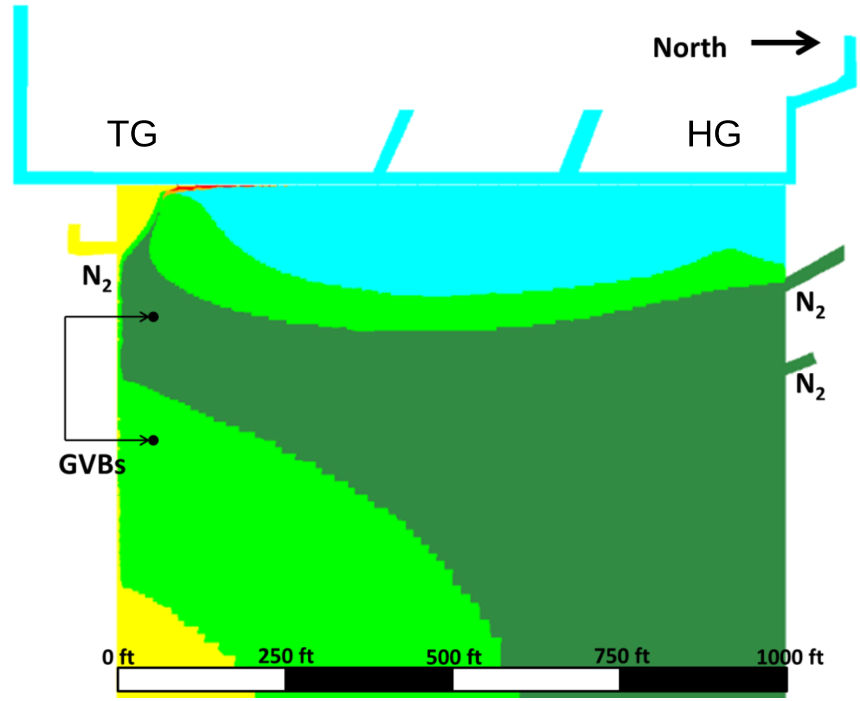




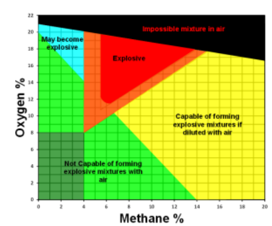
Nitrogen Injection Location Study



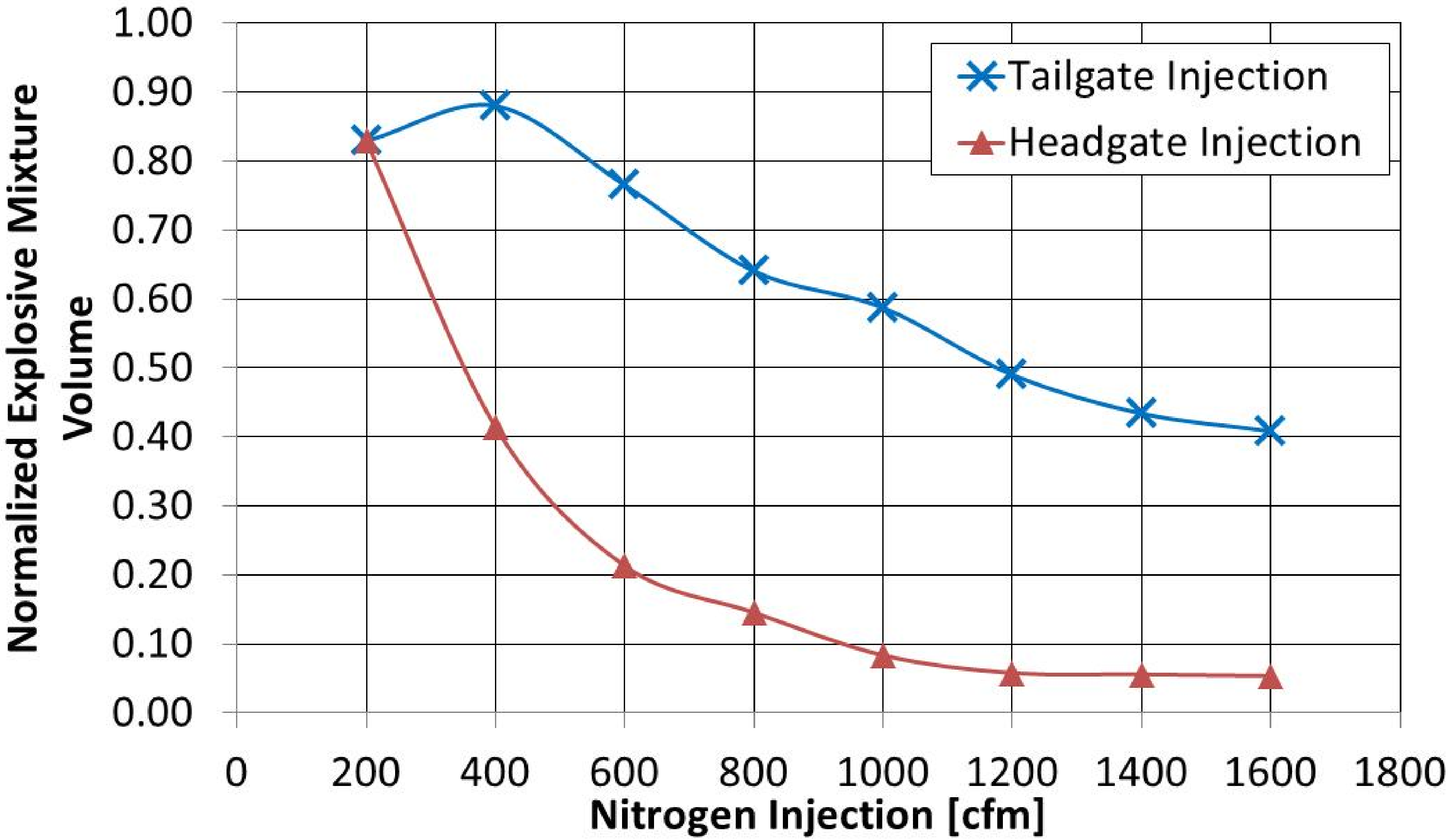
800 cfm	N2 Injection	200 cfm



200 cfm	N2 Injection	800 cfm

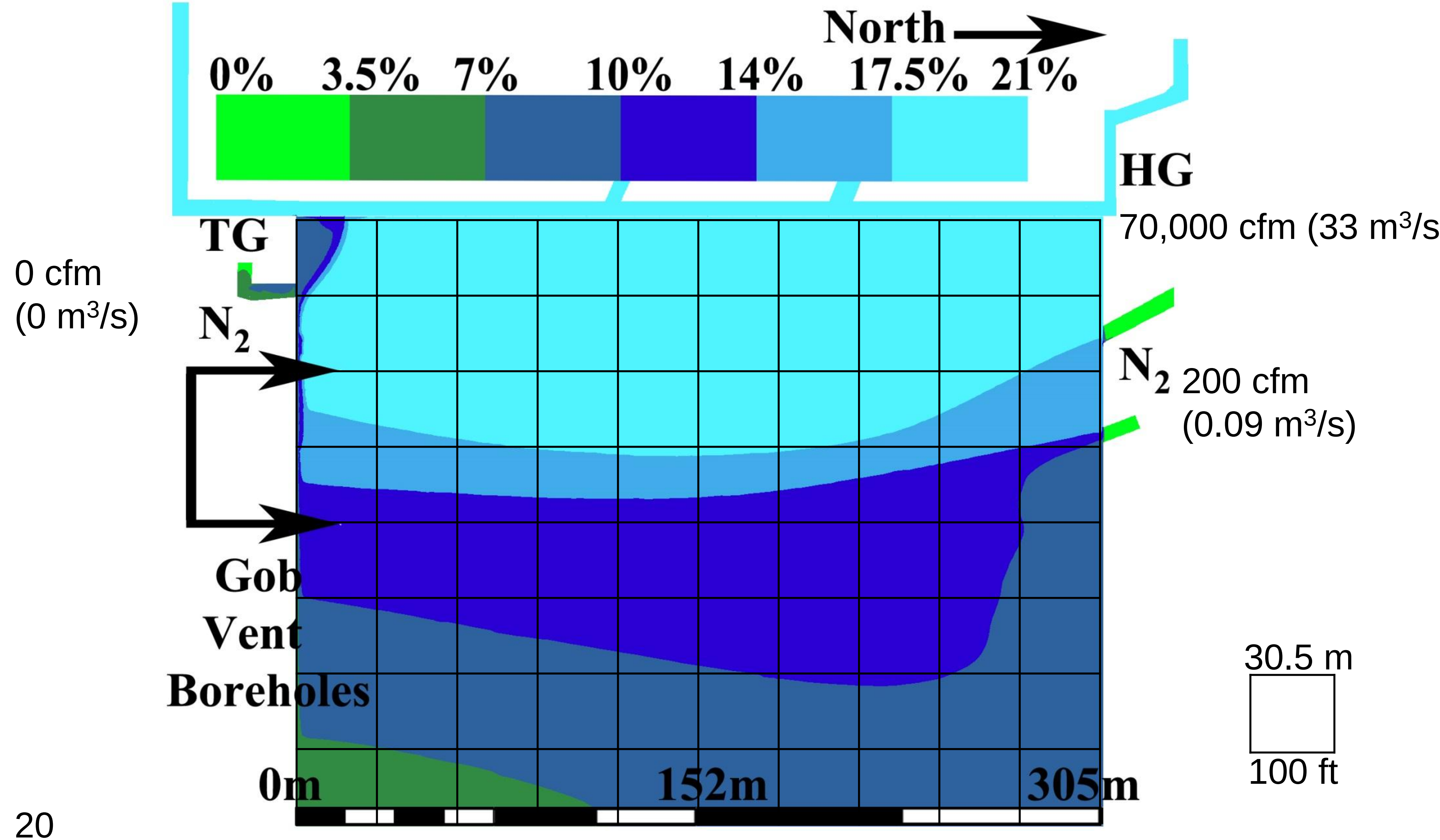


Nitrogen Injection Parameters



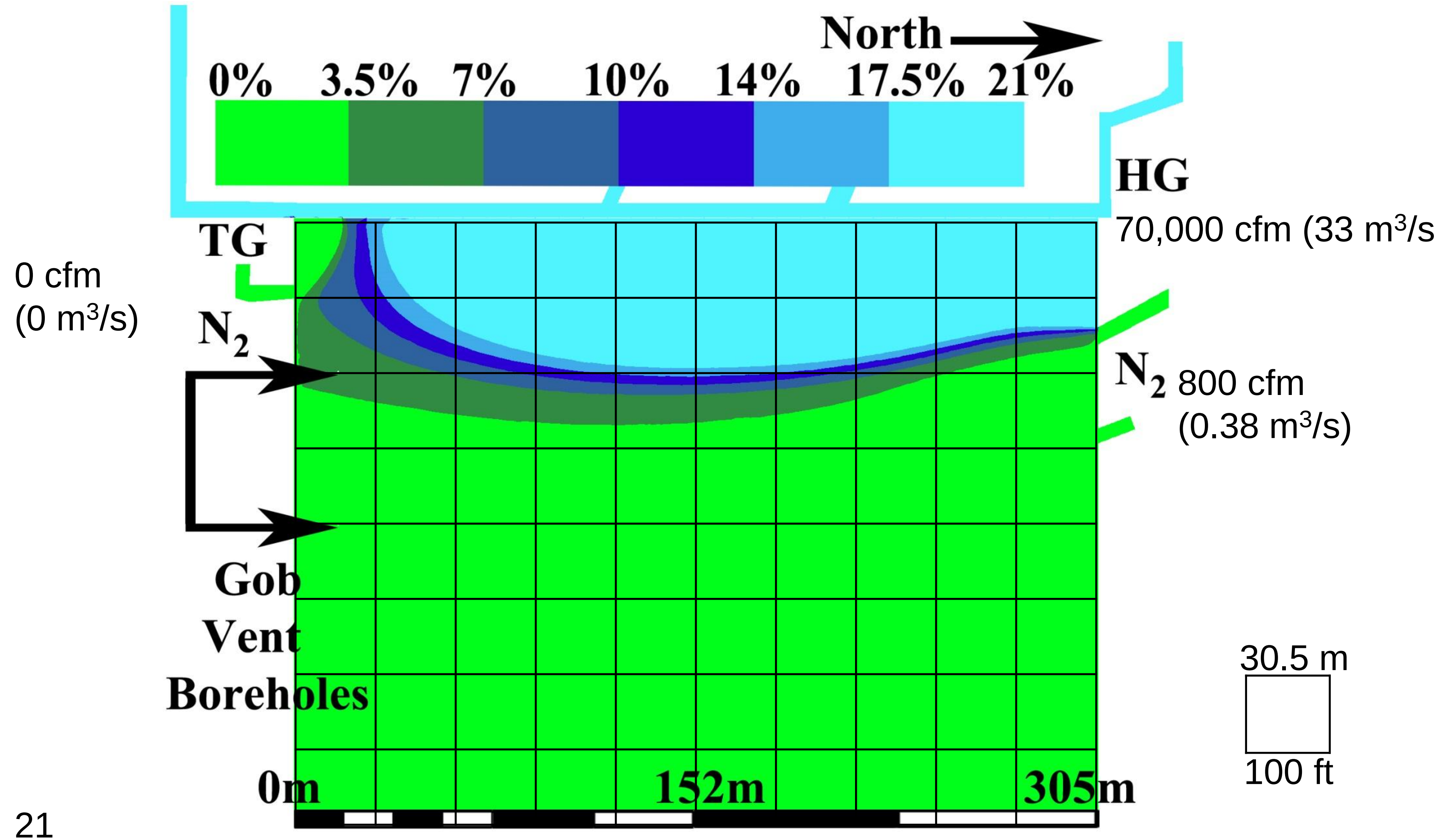
Oxygen Ingress – Nitrogen Injection Rates

Headgate ONLY Nitrogen injection – HG = 200 cfm (0.09 m³/s)



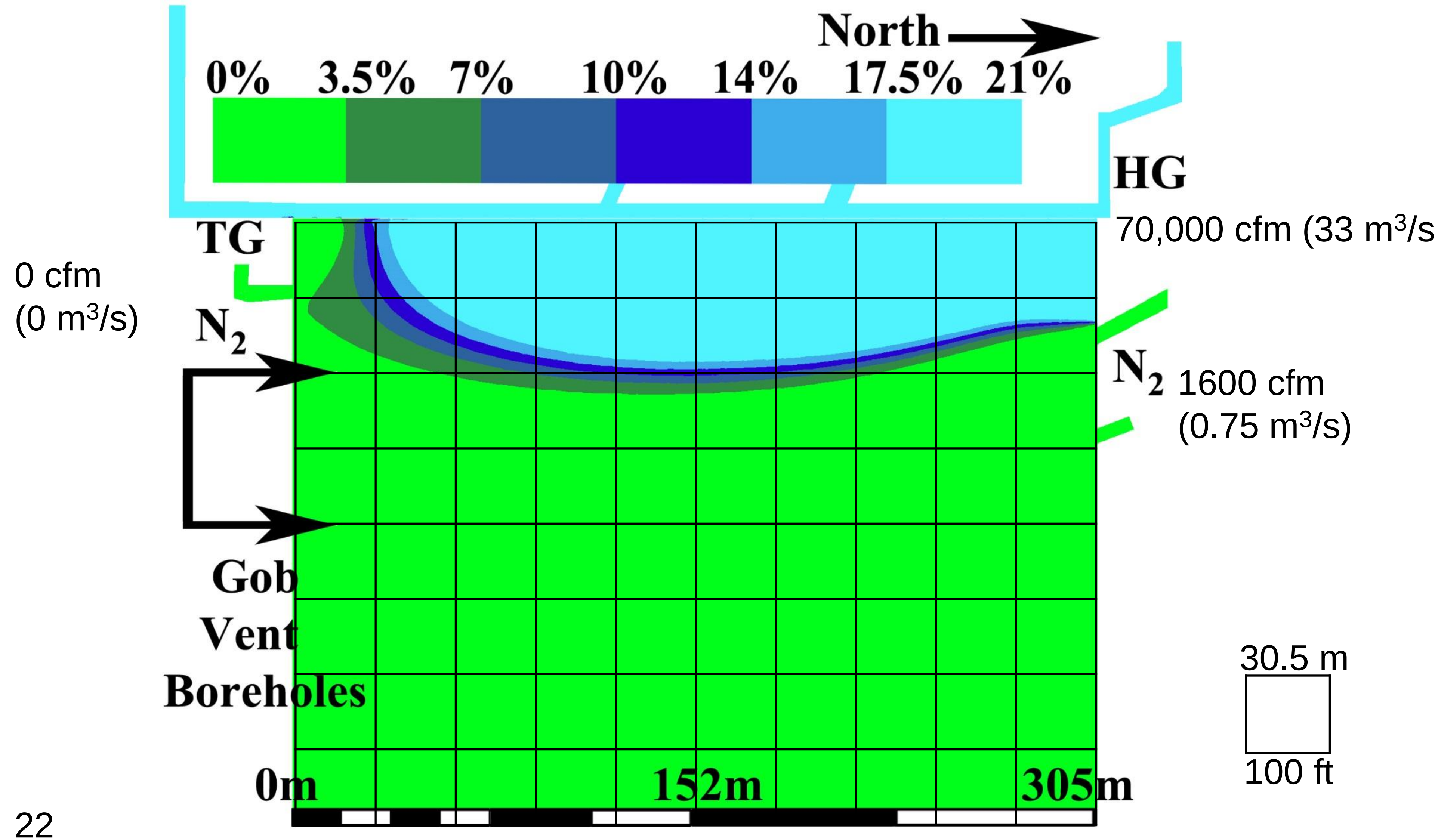
Oxygen Ingress – Nitrogen Injection Rates

Headgate ONLY Nitrogen injection – HG = 800 cfm (0.38 m³/s)



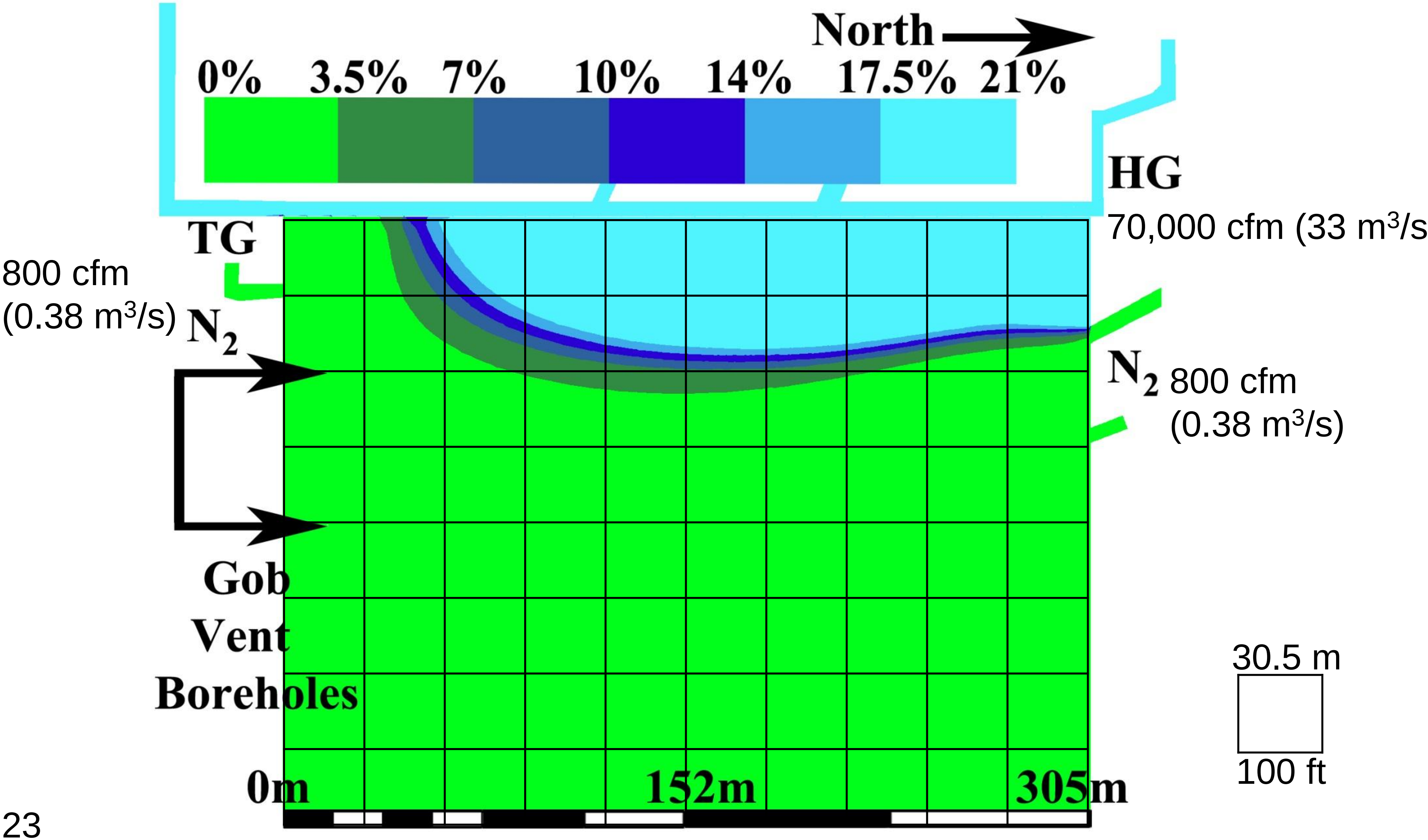
Oxygen Ingress – Nitrogen Injection Rates

Headgate ONLY Nitrogen injection – HG = 1600 cfm (0.75 m^3/s)



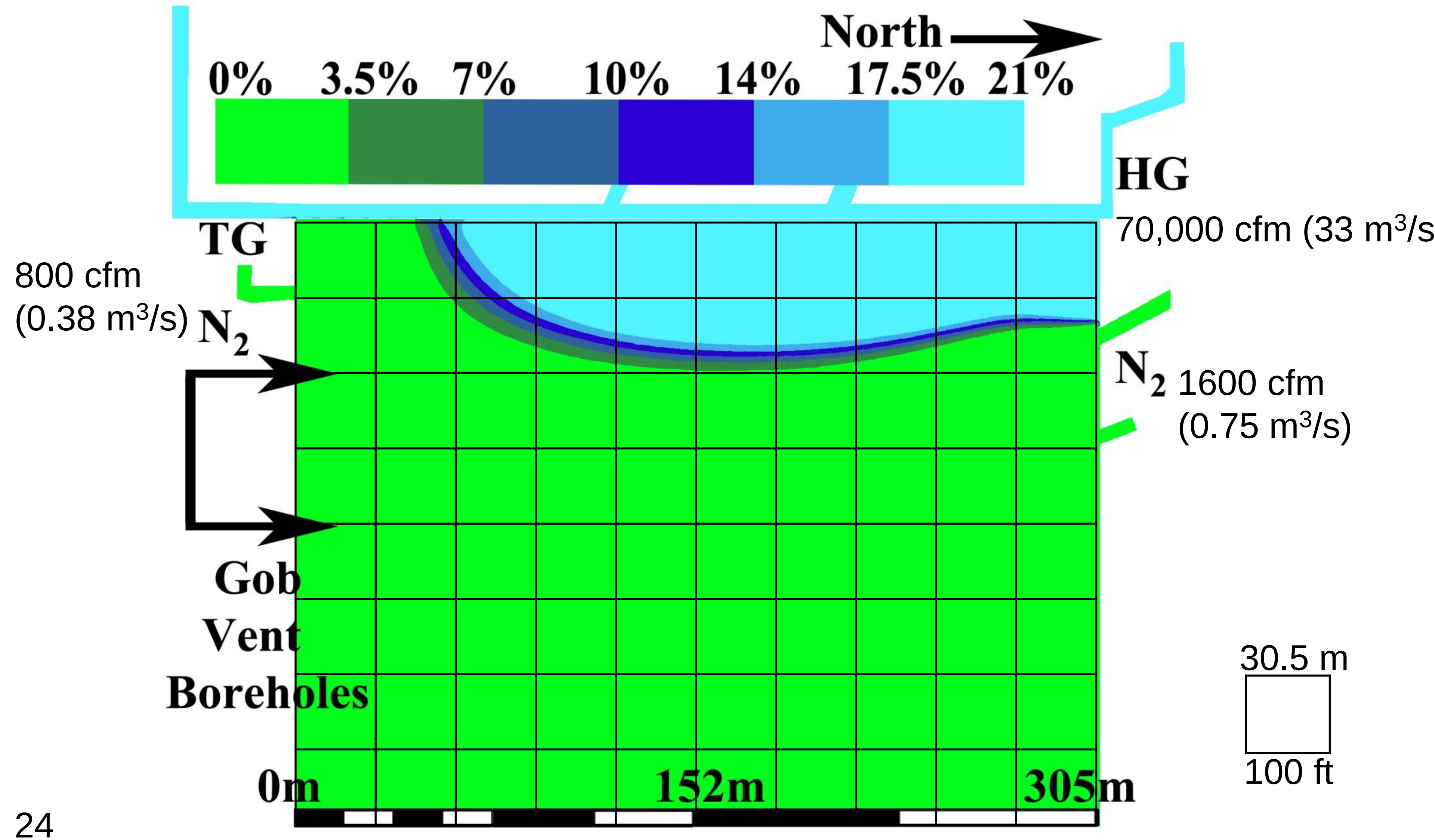
Oxygen Ingress – Nitrogen Injection Rates

High Nitrogen injection rate – HG = 800 cfm (0.38 m^3/s), TG = 800 cfm (0.38 m^3/s)



Oxygen Ingress – Nitrogen Injection Rates

High Nitrogen injection rate – HG = 1600 cfm (0.75 m³/s), TG = 800 cfm (0.38 m³/s)



Conclusions

- Increasing the face ventilation quantity pushes oxygen further into the gob
  - This may increase the volume of explosive gases
  - This may increase spon com tendencies
- Injecting nitrogen to inertize is most effective from the headgate but some nitrogen should also be injected on the tailgate side
  - Nitrogen will reduce explosive gas volume
  - Nitrogen will reduce spon com hazard

Questions or Comments

Thank You

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