Quantifying Flood-Induced Risk to Tailings Embankment Stability: Avoiding the Alarmist Model

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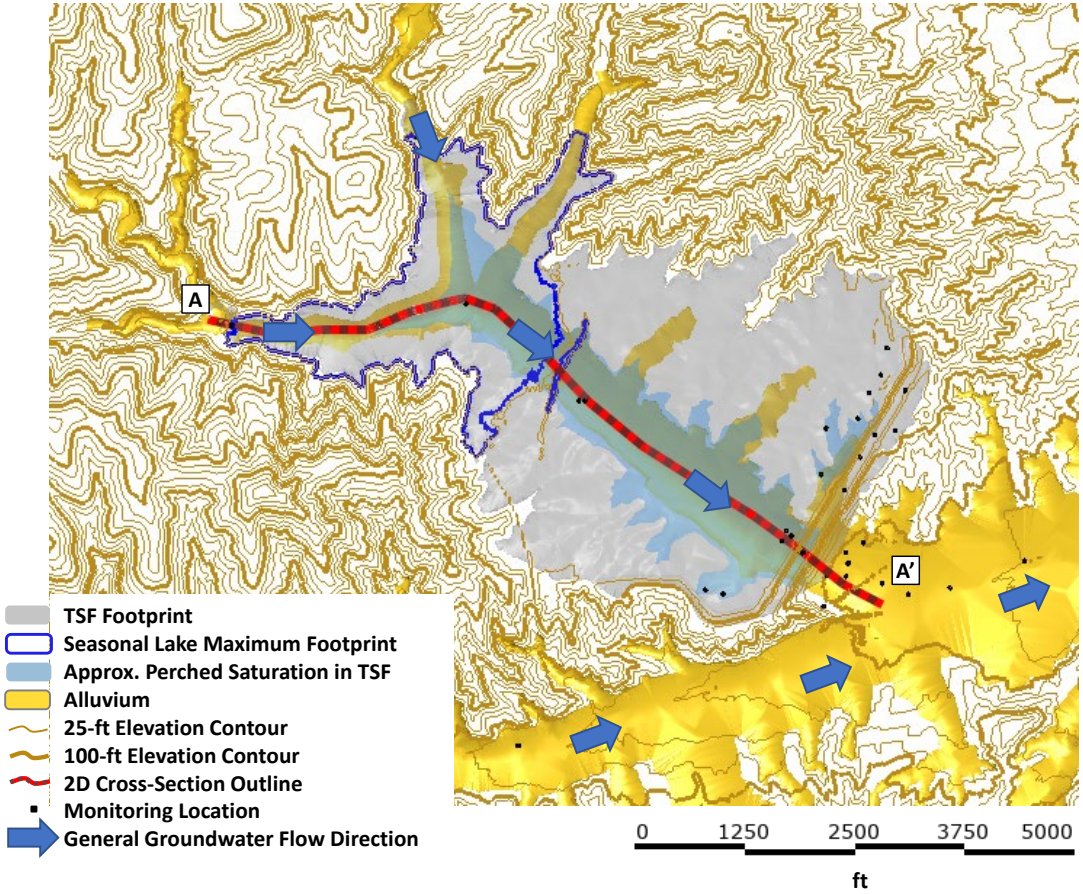
Perception of Risk is Subjective

- Consultant consult.
- Mine owners make decisions.
- Consultants need to provide mine owners with tools to make informed decisions.

Site

- Closed tailings facility
- Residual moisture within TSF despite >60 years of inactivity
- Concerns:
  - Embankment Stability
  - Flooding of impoundment



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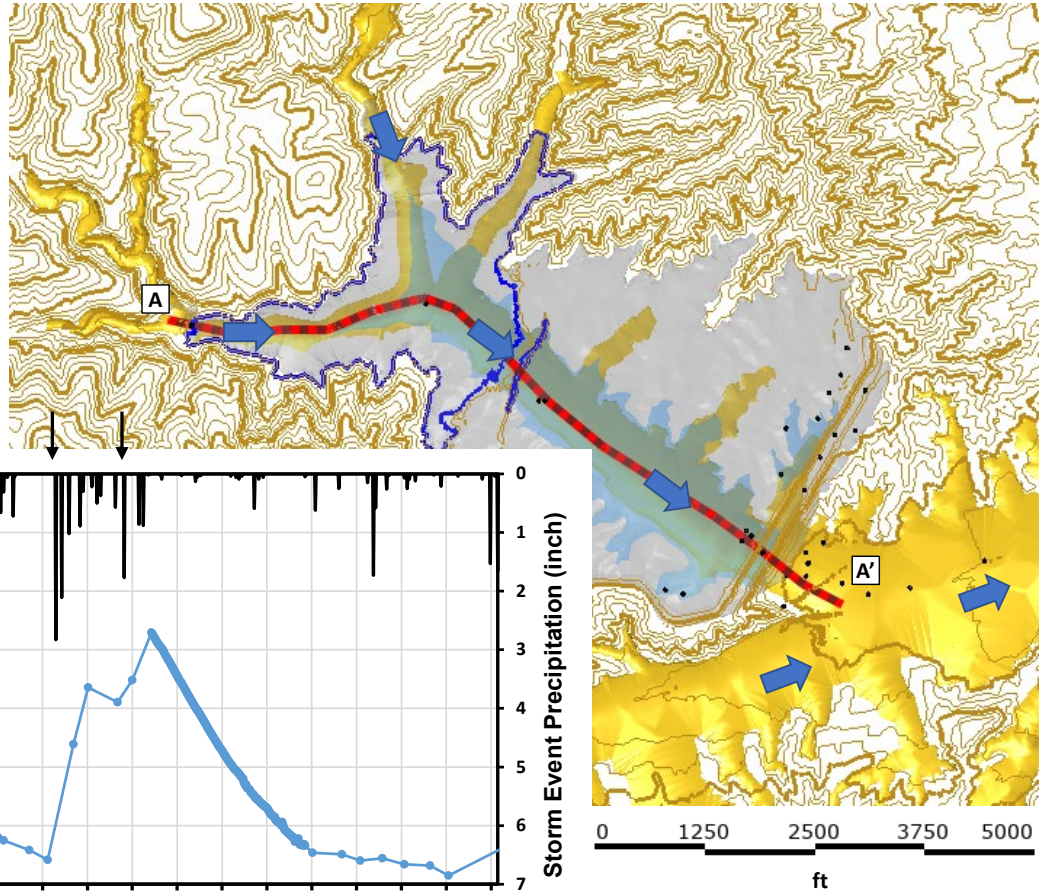
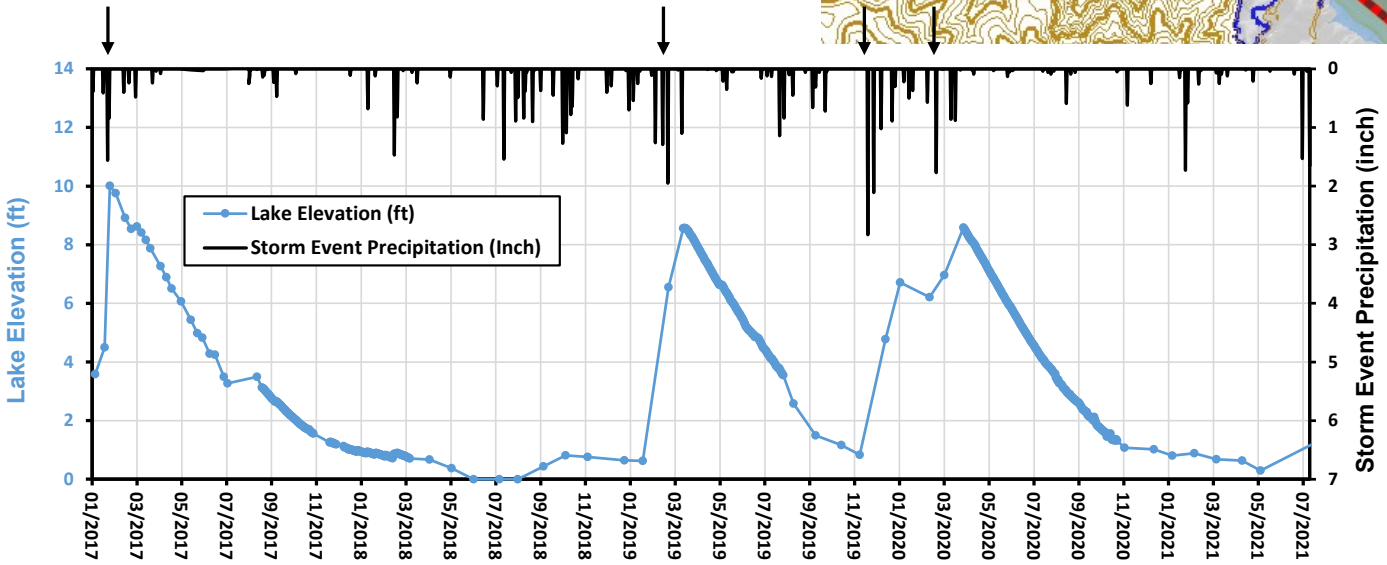
Floods





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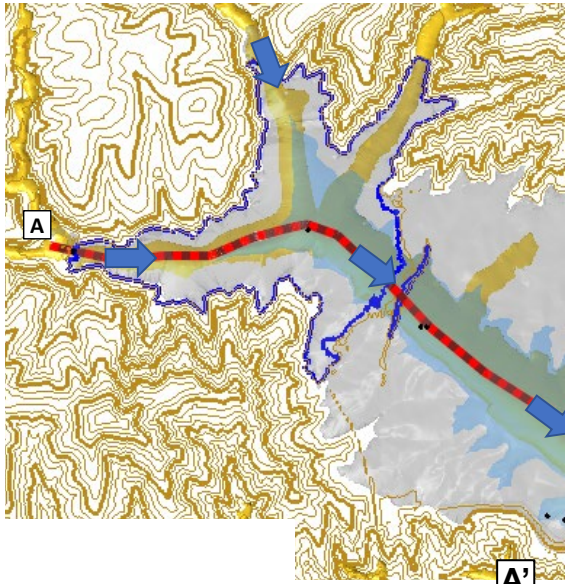
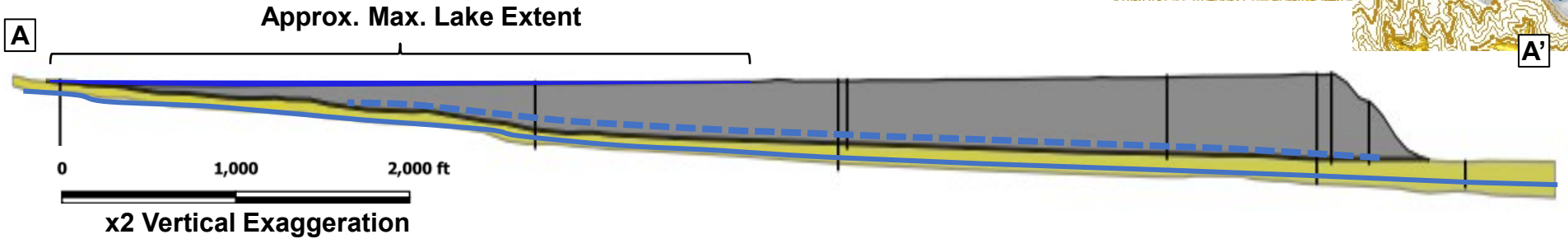
Cross-Section





- TSF
- Alluvium
- Seasonal Lake Maximum Footprint
- Approx. Perched Water Table in TSF
- Groundwater Table
- Borehole / well

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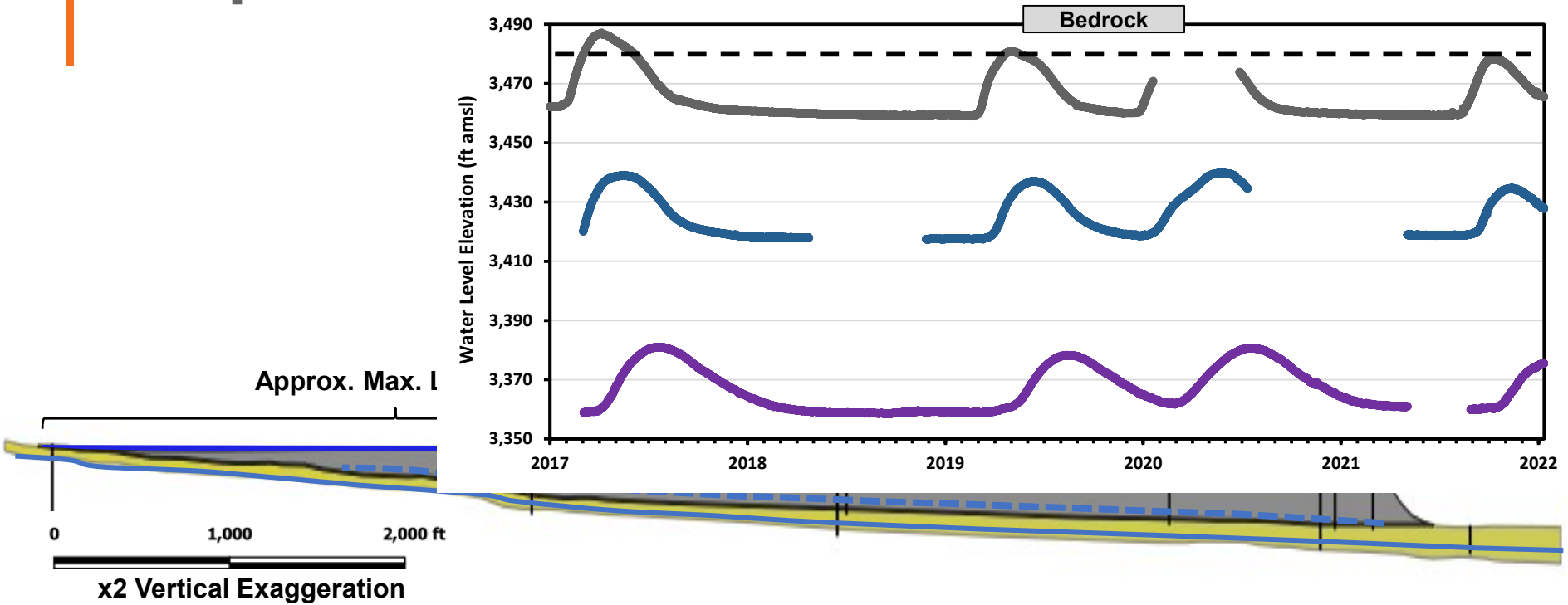
Response to Floods: Groundwater



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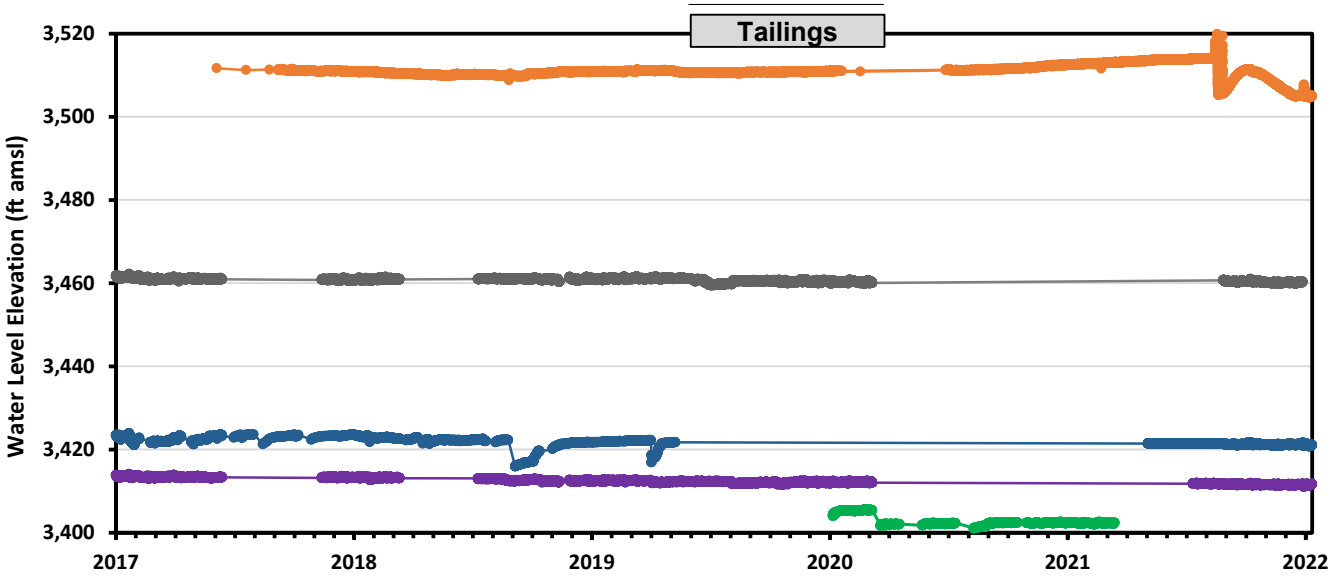
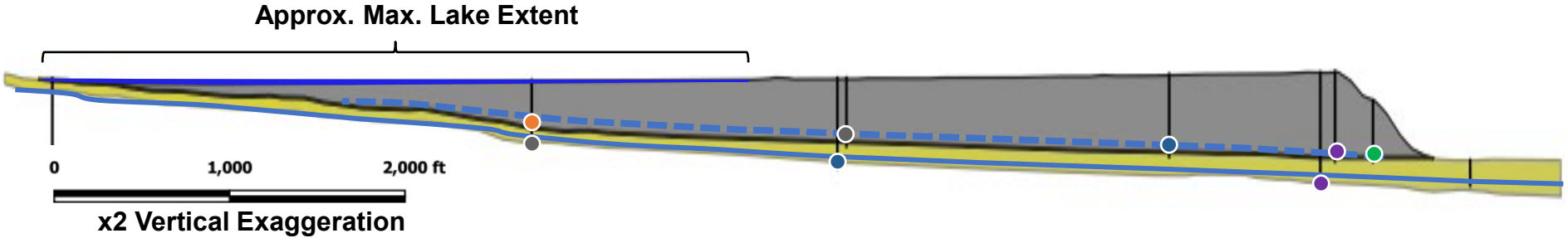
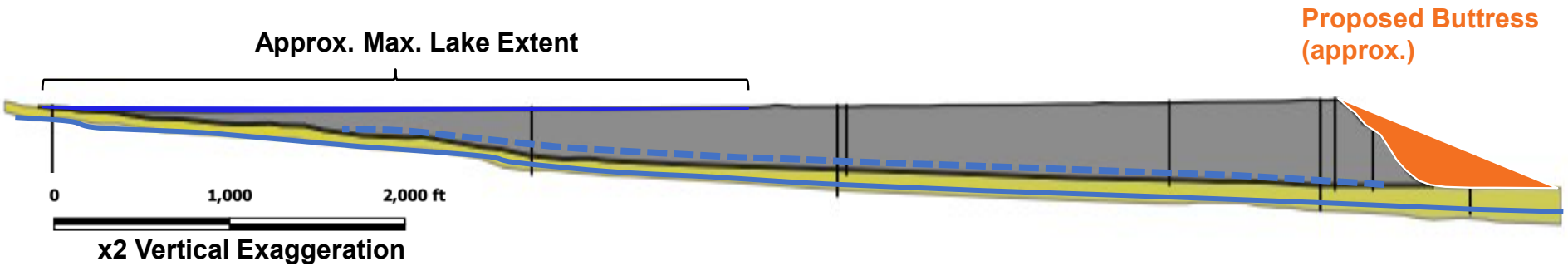
Response to Floods: Tailings



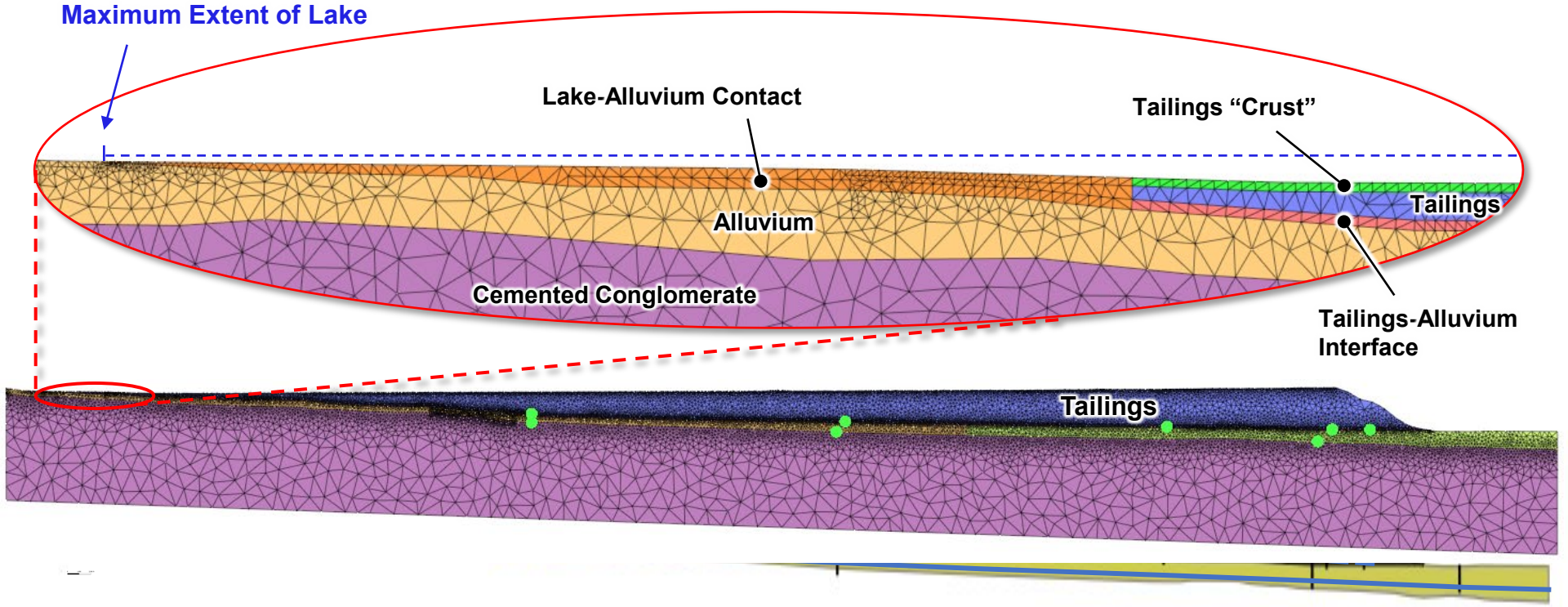


Engineering-Design Support

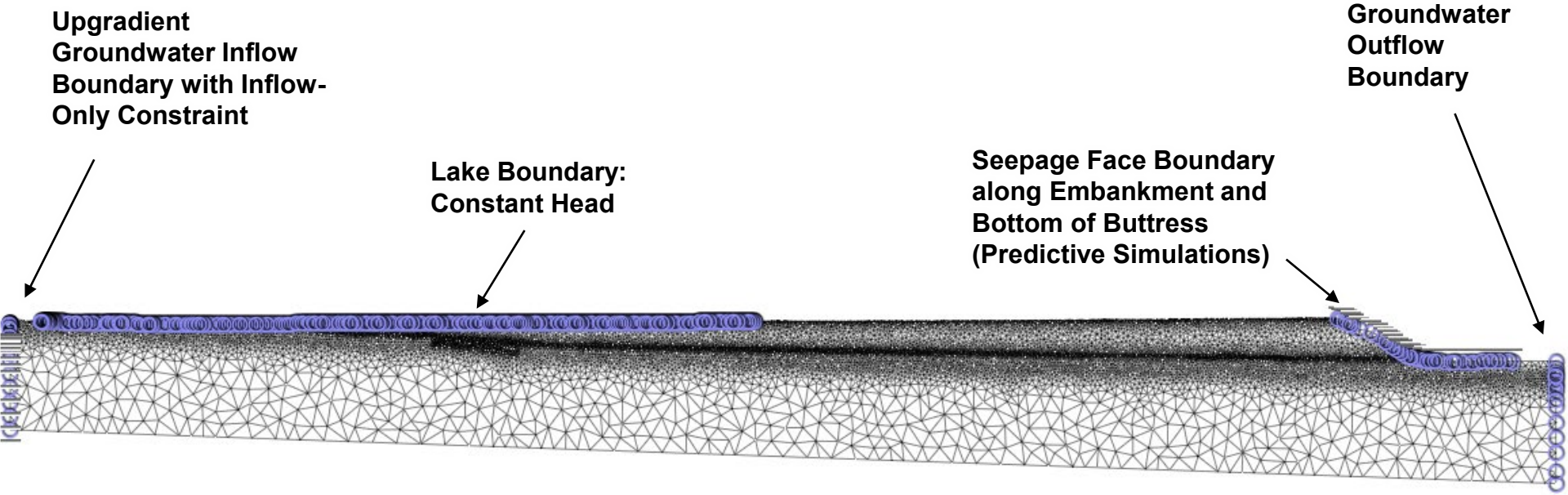
- What are potential pressure increases below current embankment?
- What are expected drain discharge rates?



2D Groundwater Model

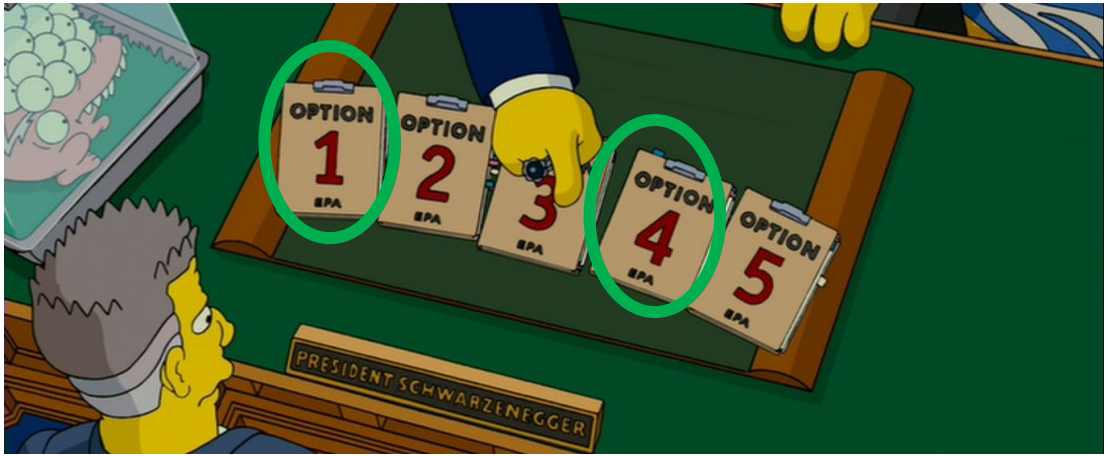


2D Groundwater Model

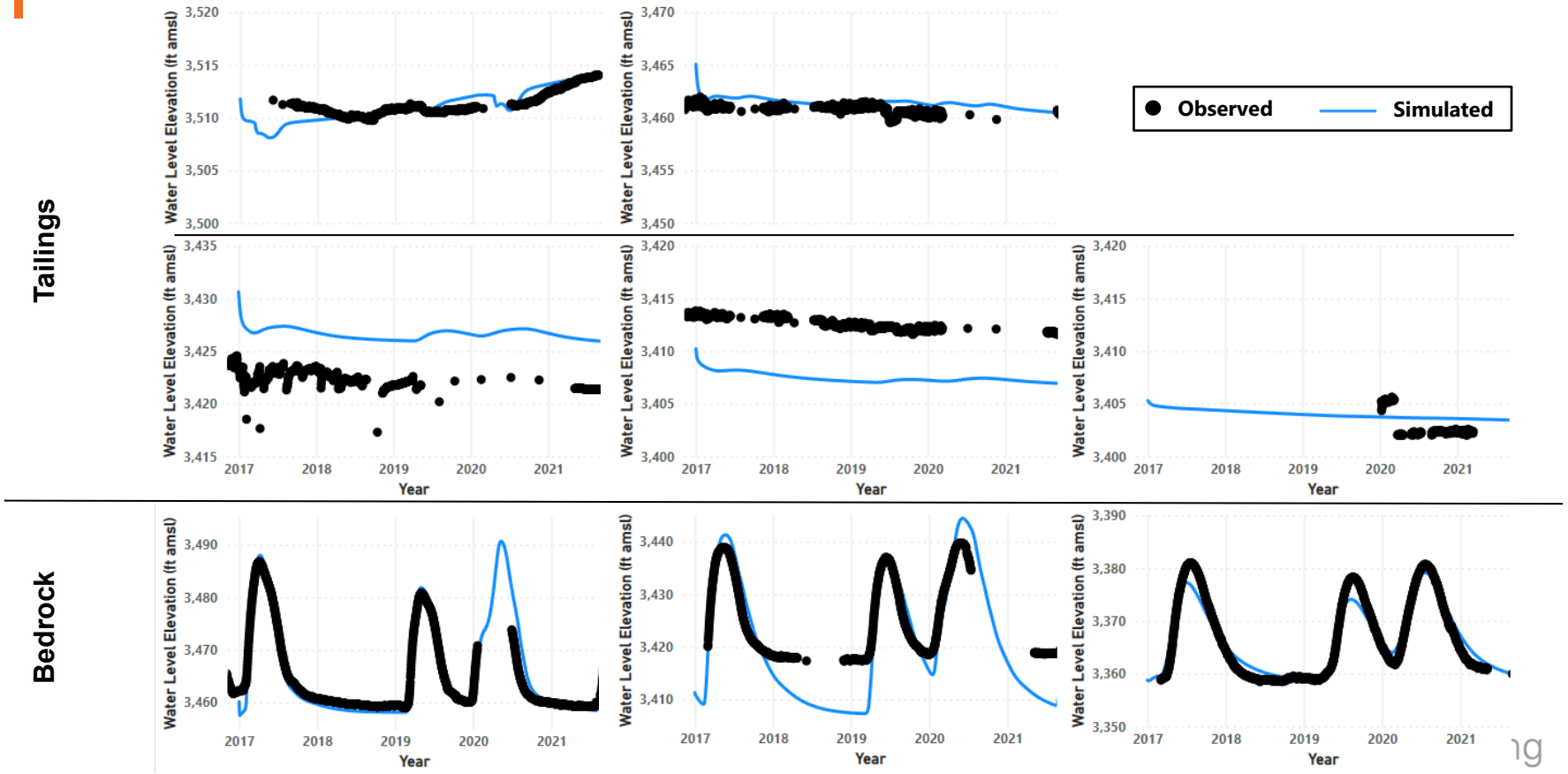


2D Groundwater Model

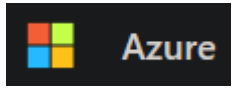
- Deterministic model
- Stochastic simulations:
  - “Pre-calibration”
  - Predictive



Deterministic Calibration



Stochastic Simulations



14,984 Model Runs
(parameter combinations)

64 Cores
16 Simultaneous Simulations

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16 Simultaneous Simulations

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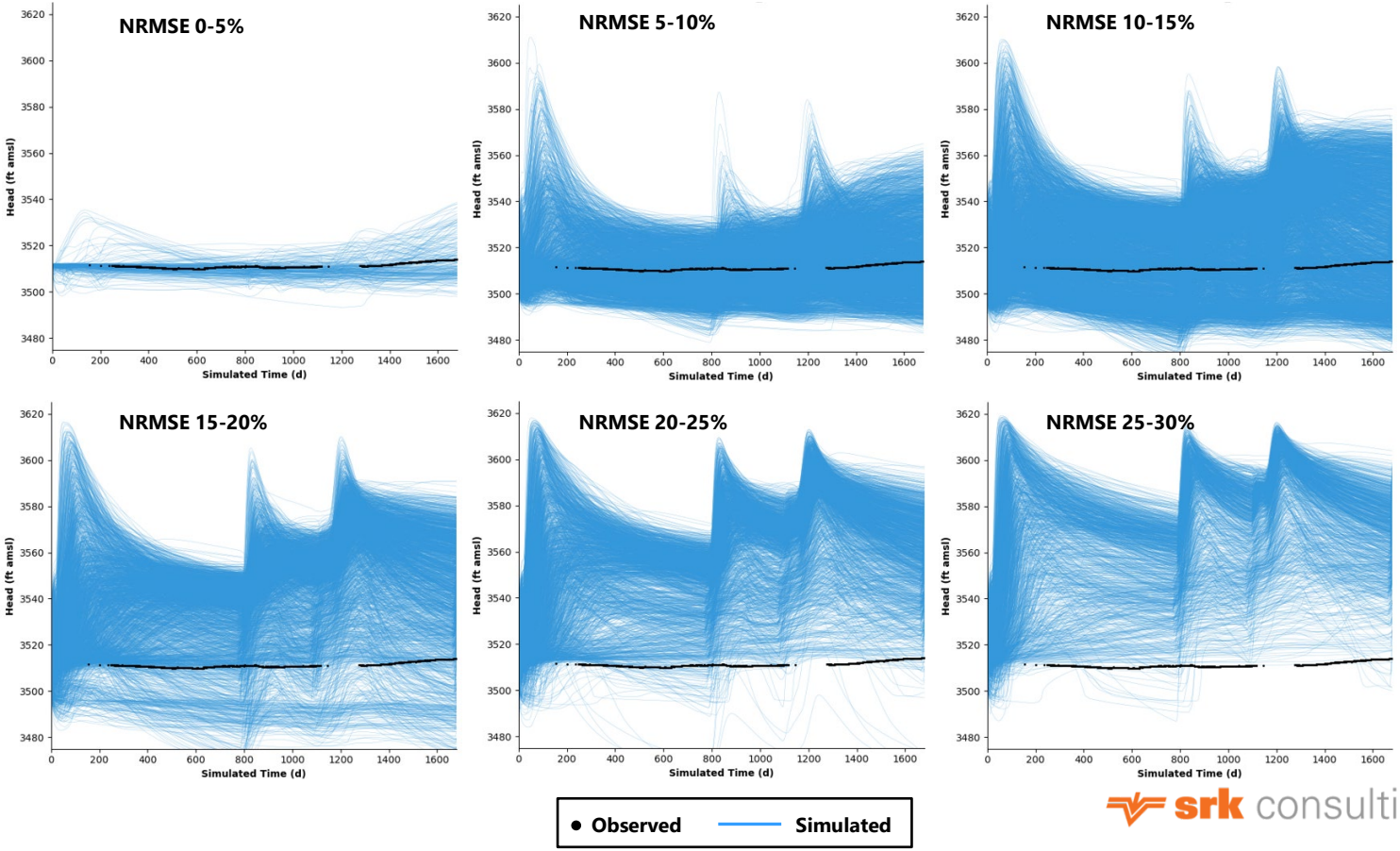
Stochastic Pre-Calibration



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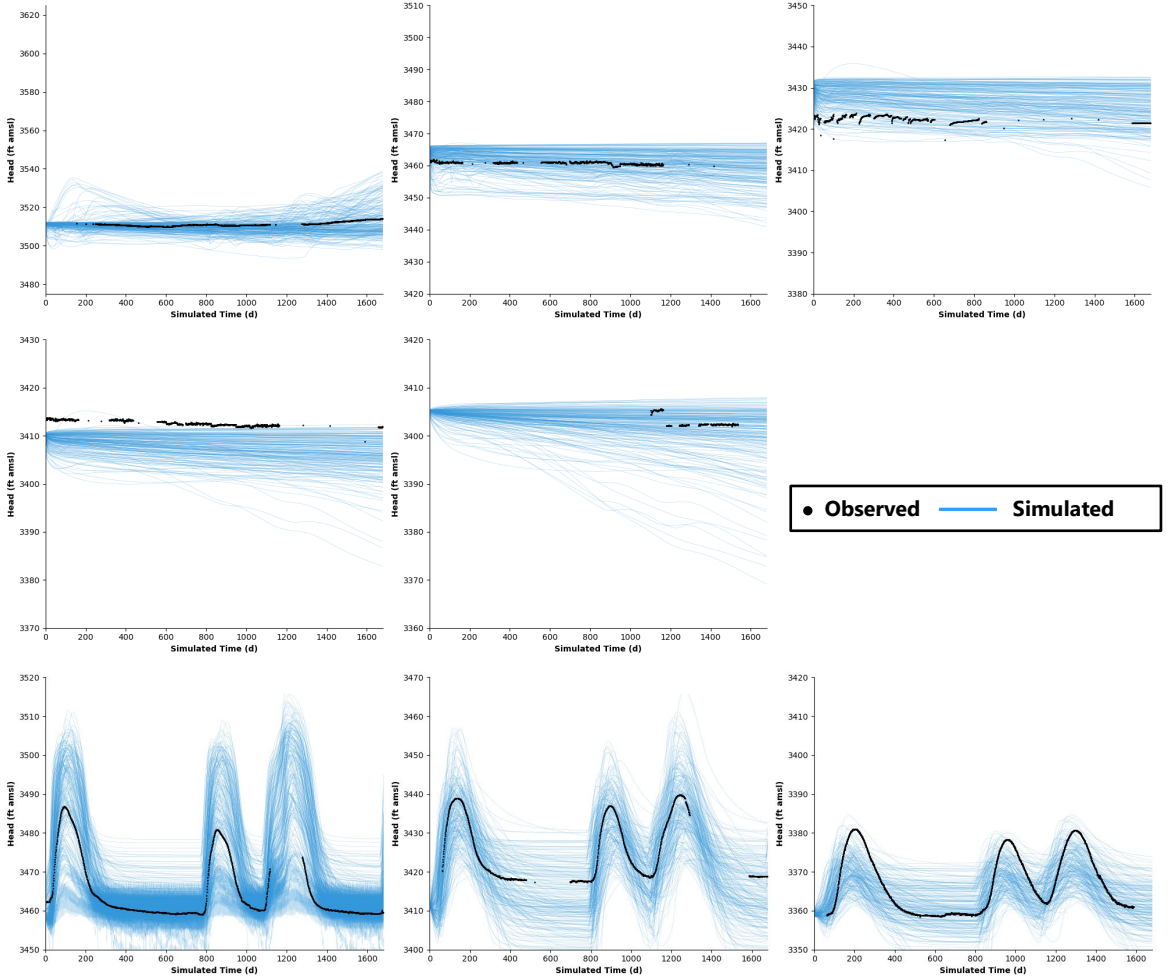
Stochastic Pre-Calibration

- 0-5% NRMSE Shown
- 319 / 14,984 = 2%



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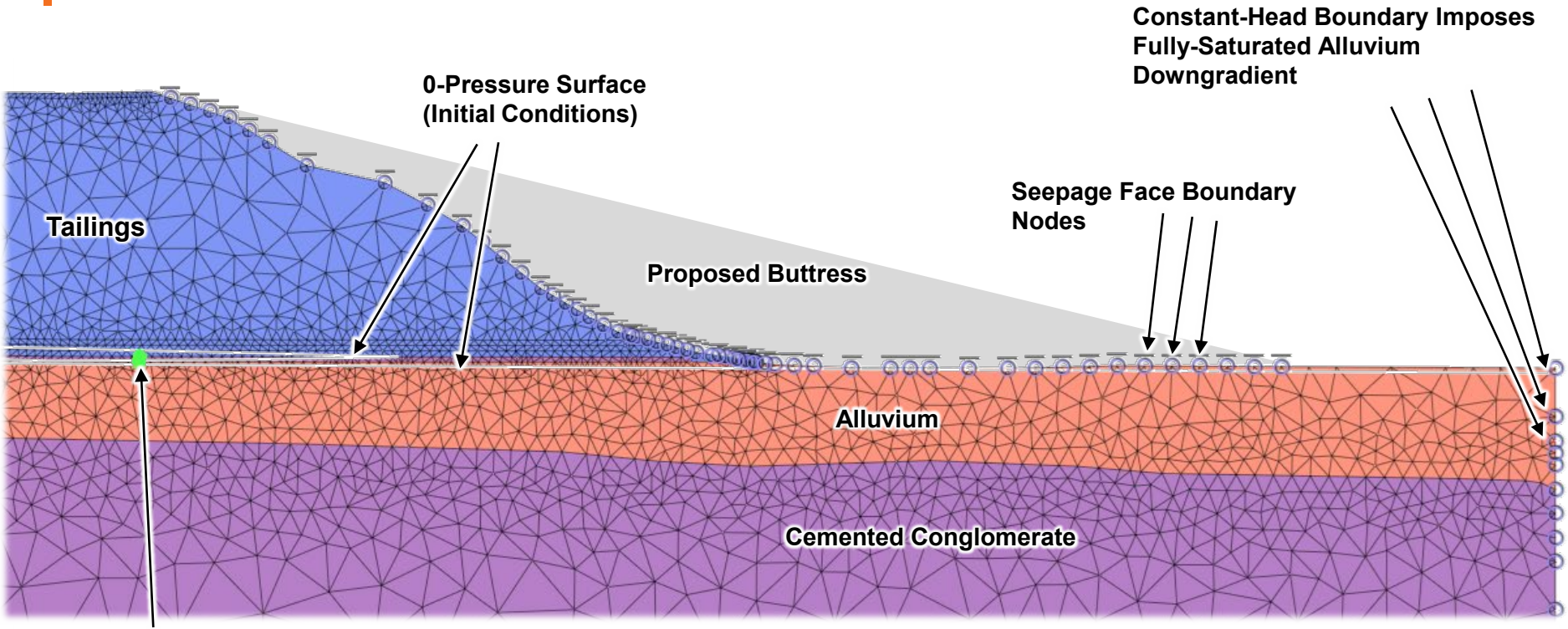
Stochastic Prediction Setup



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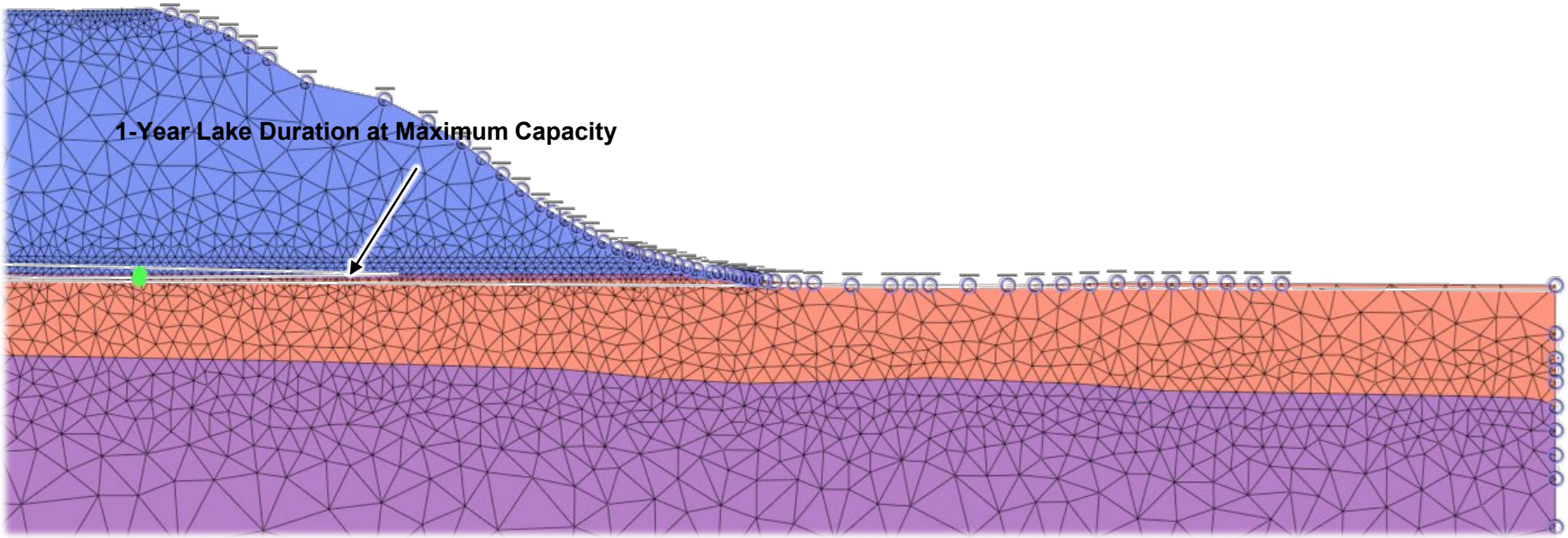
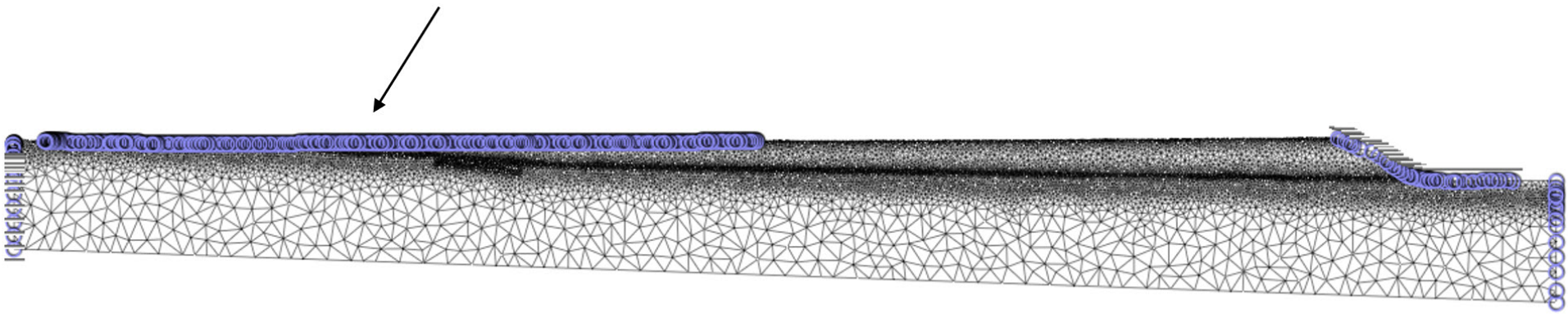
Stochastic Prediction Setup

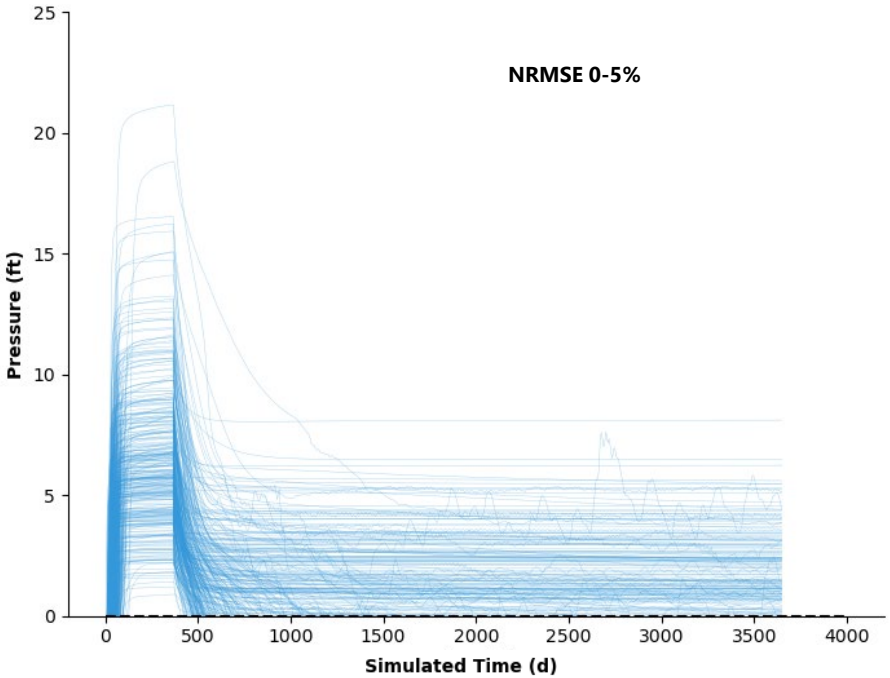


Stochastic Prediction Setup

1-Year Lake Duration at Maximum Capacity



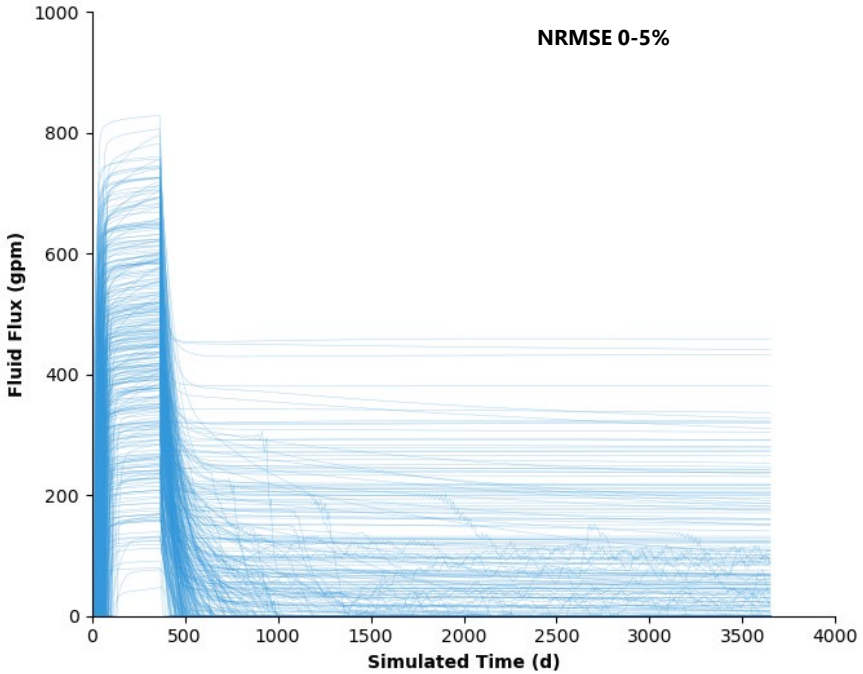
Stochastic Prediction Results



- Pressure increase below the embankment was predicted to be less than 25 ft.

Stochastic Prediction Results

- Flow rates to drains below proposed buttress could be up to ~800 gpm



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Conclusions

- A simplified 2D model was able to reproduce main processes observed in a 3D system.
- The model was deterministically calibrated to refine conceptual model.
- Stochastic analysis was performed to explore further unknowns, primarily hydraulic parameter combinations that could result in similar calibration.
- Best-fitting model subsets were used to generate predictions in support of engineering decision-making.

Questions?

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