Integrating Predictive Hydrogeologic and Geochemical Assessments in Pit-Lake Regulation and Reclamation in Nevada

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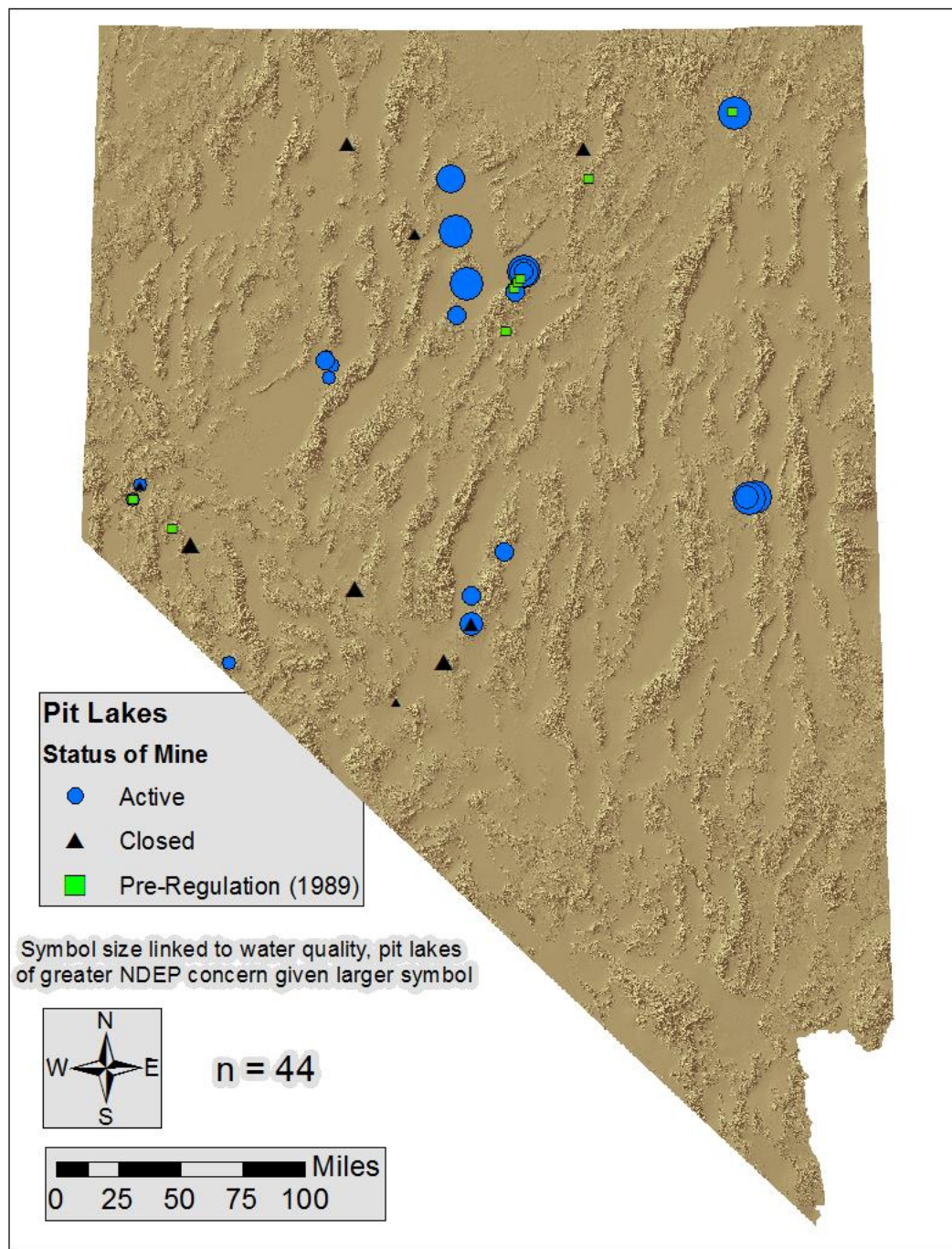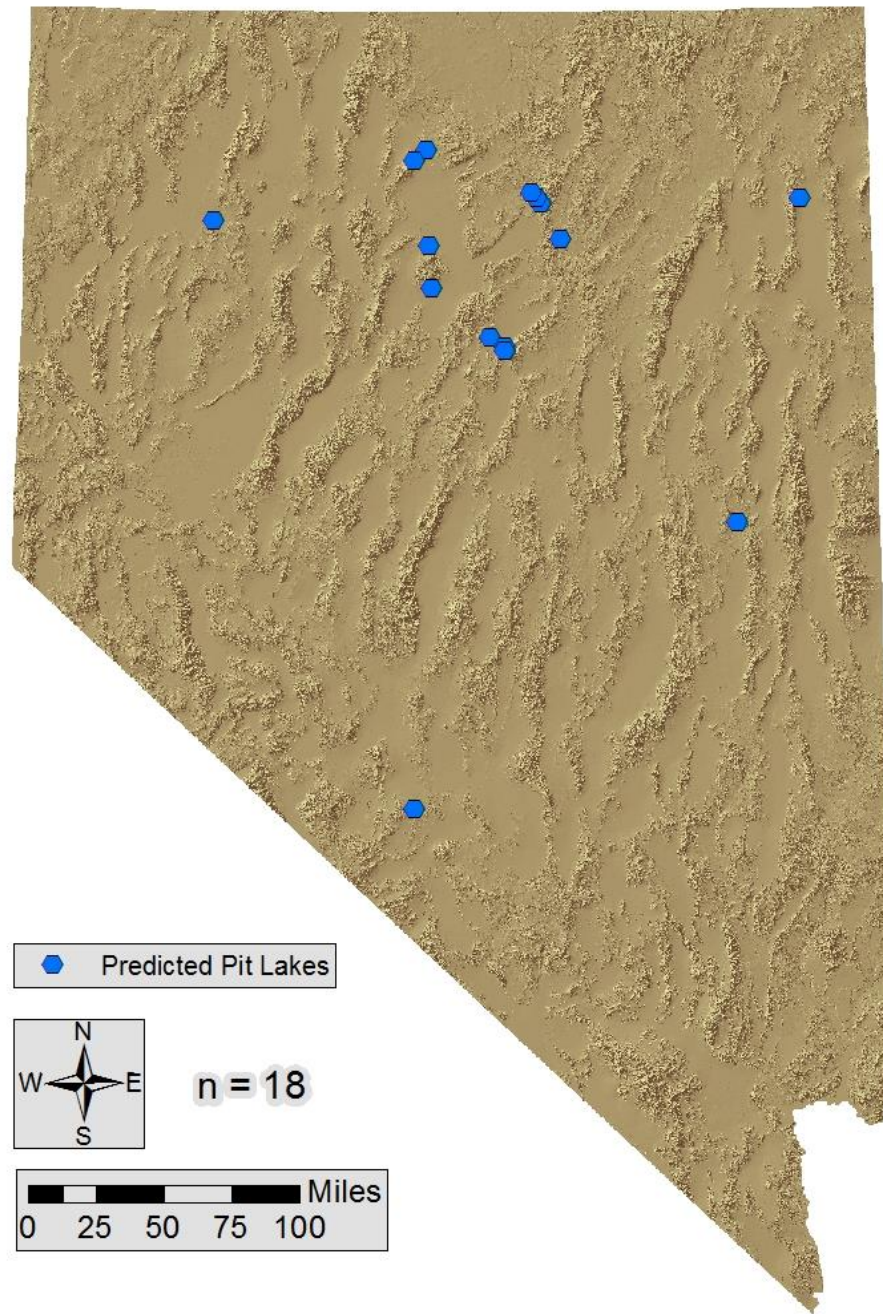September 25th, 2016

NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION

Currently Existing or Recently Dewatered Pit Lakes

Pit Lakes
Status of Mine

- ● Active
- ▲ Closed
- ■ Pre-Regulation (1989)

Symbol size linked to water quality, pit lakes of greater NDEP concern given larger symbol

n = 44

Miles
0   25   50   75   100

Predicted Pit Lakes

Predicted Pit Lakes
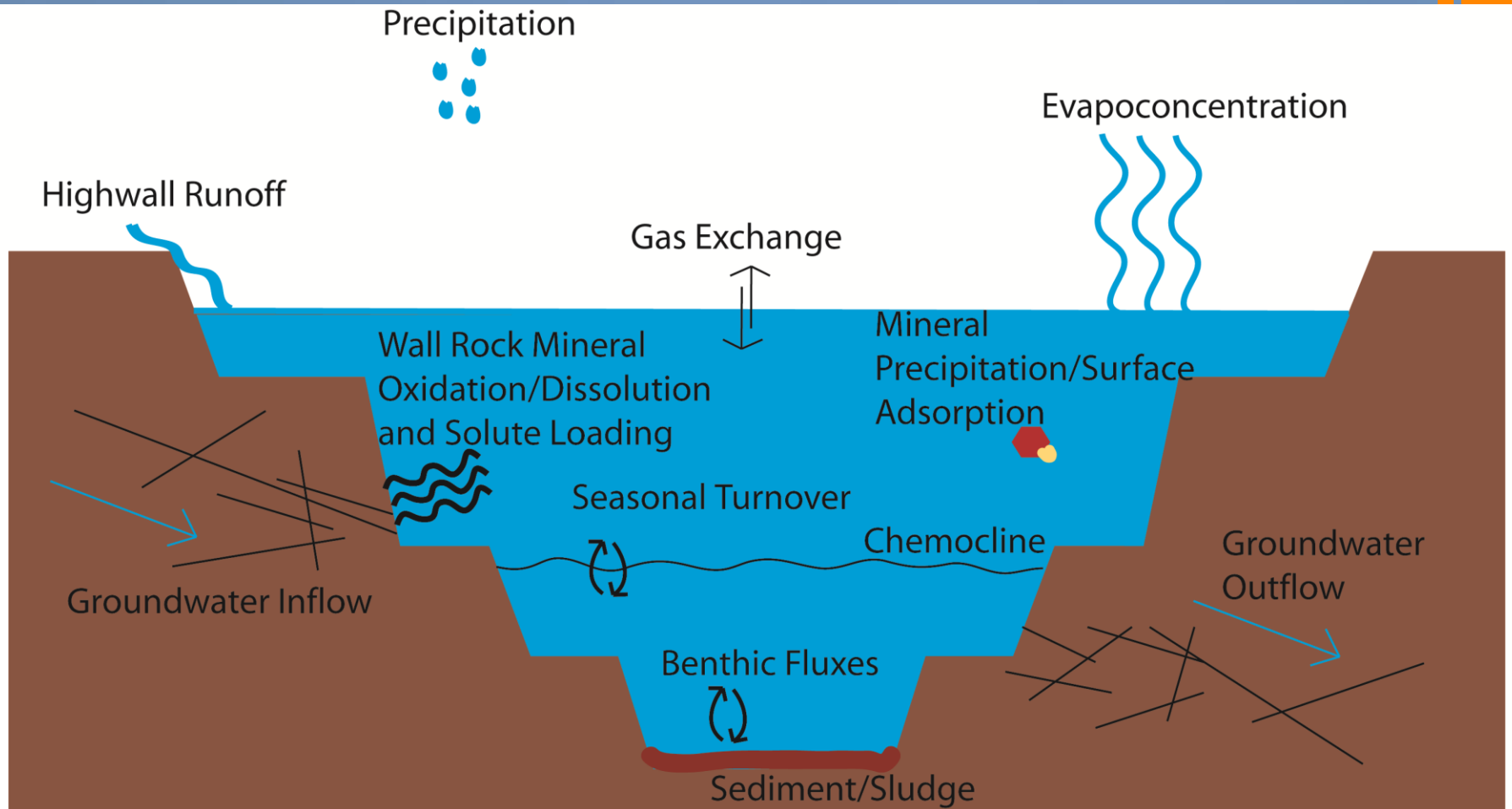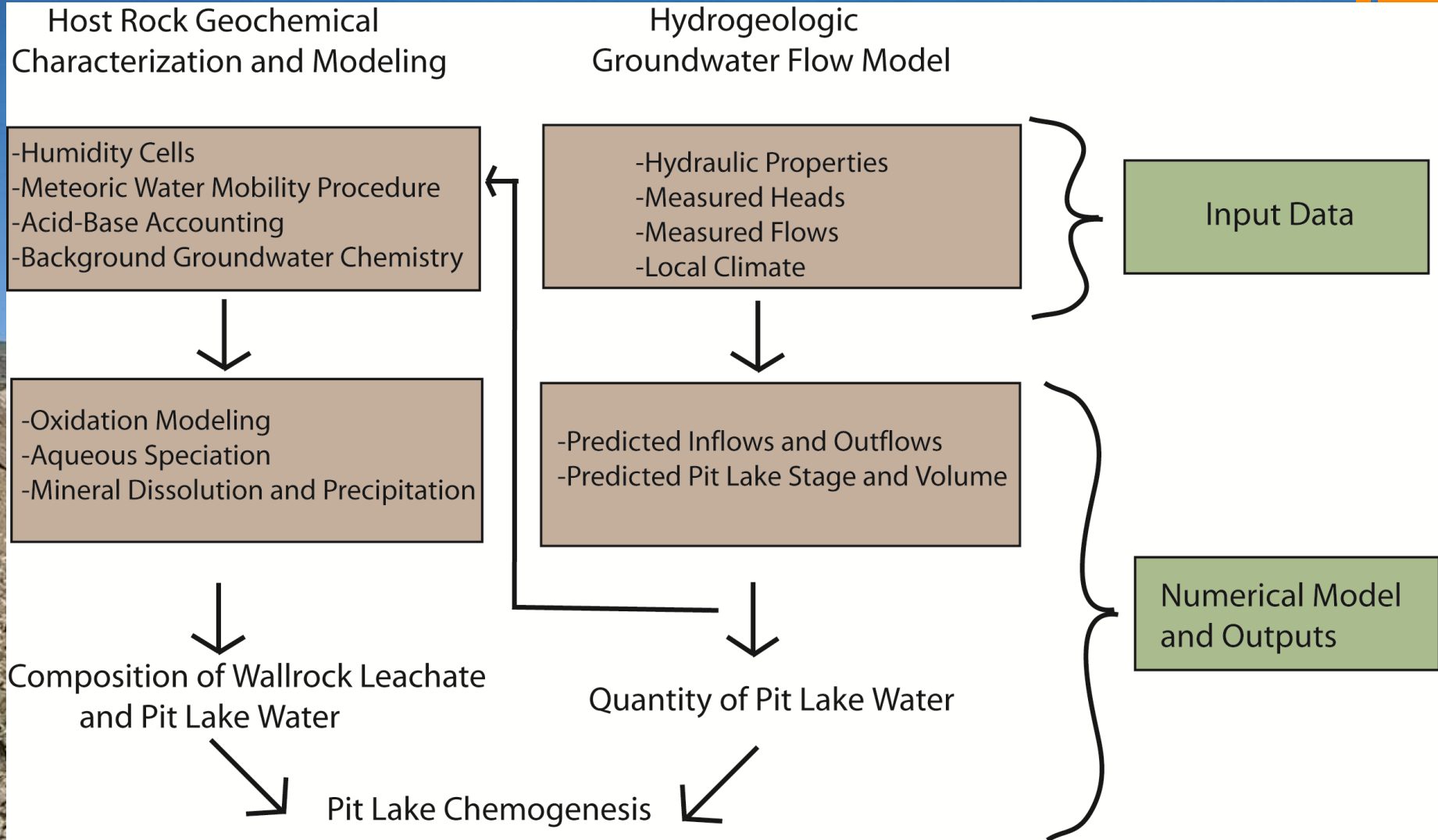
n = 18

Miles
0   25   50   75   100

Why are pit lakes regulated?

- The Nevada Administrative Code mandates the State regulate mine waters that may degrade groundwater according to NAC 445A.429:
  - Bodies of water which are a result of mine pits penetrating the water table must not create an impoundment which:
  - (a) Has the potential to degrade the groundwaters of the State;

    or
  - (b) Has the potential to affect adversely the health of human, terrestrial or avian life.
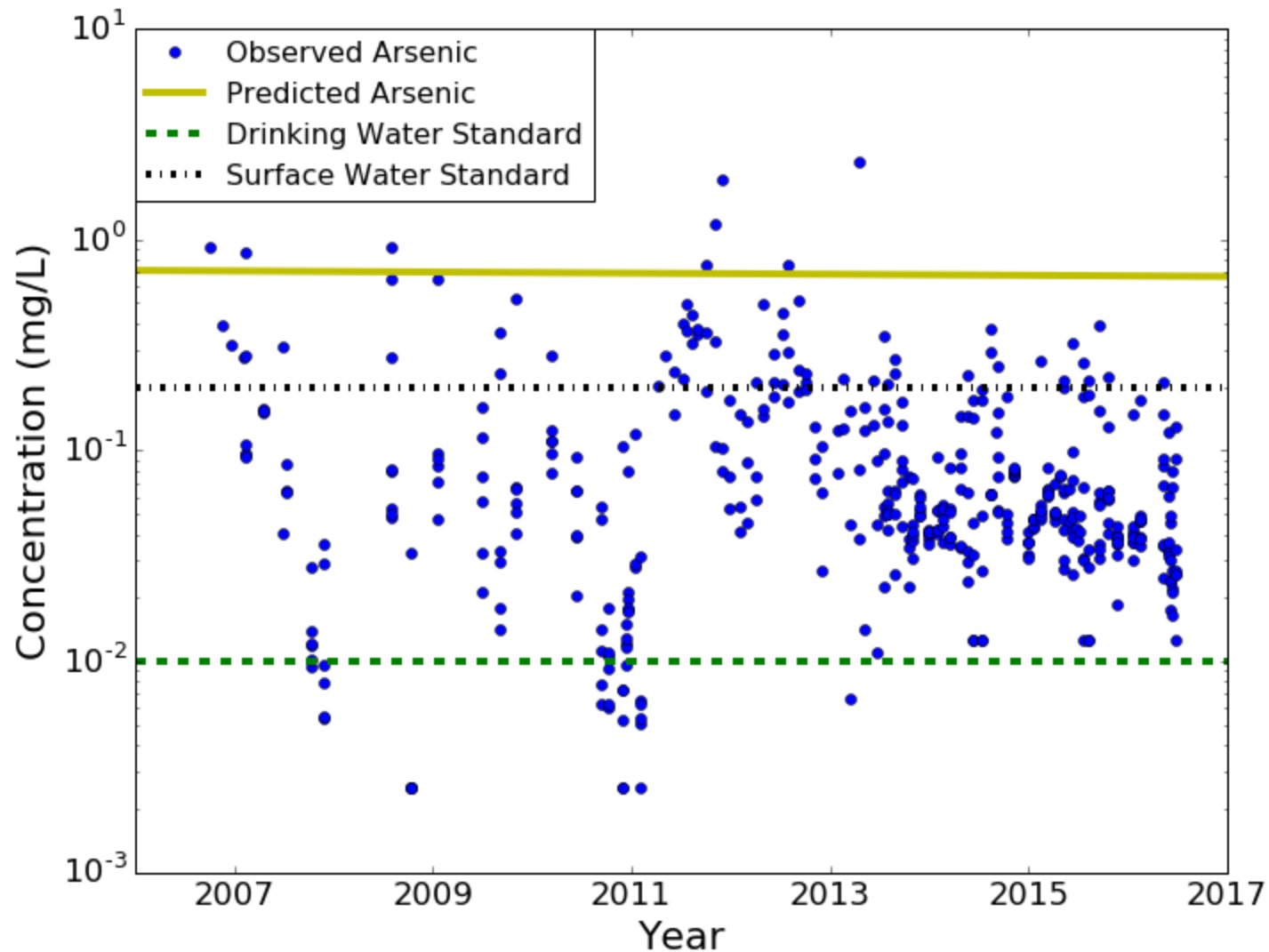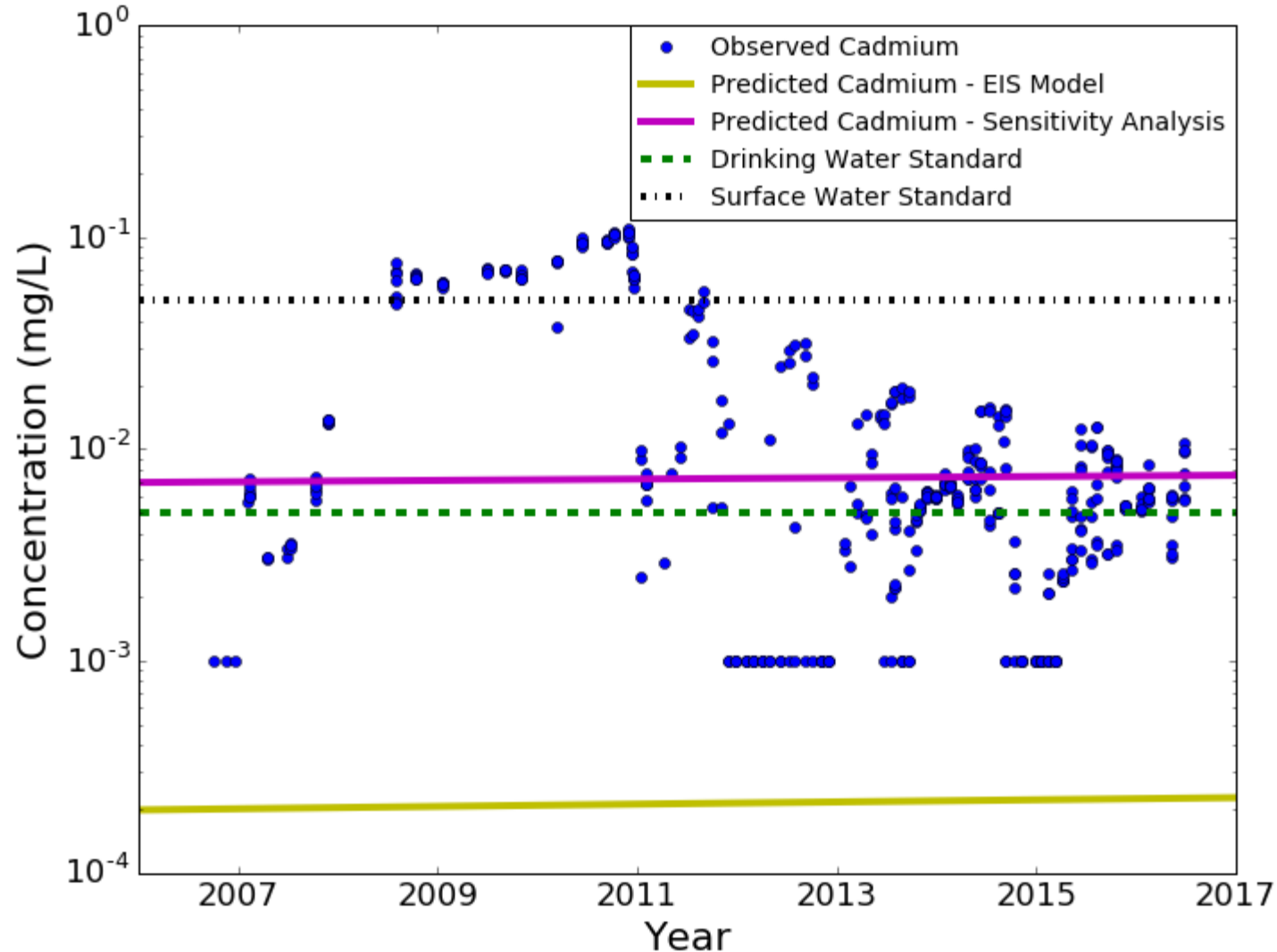
Pit Lake Conceptual Models

Pit Lake Prediction

Host Rock Geochemical Characterization and Modeling

Hydrogeologic Groundwater Flow Model

-Humidity Cells
-Meteoric Water Mobility Procedure
-Acid-Base Accounting
-Background Groundwater Chemistry

-Hydraulic Properties
-Measured Heads
-Measured Flows
-Local Climate

Input Data

-Oxidation Modeling
-Aqueous Speciation
-Mineral Dissolution and Precipitation

-Predicted Inflows and Outflows
-Predicted Pit Lake Stage and Volume

Numerical Model and Outputs

Composition of Wallrock Leachate and Pit Lake Water
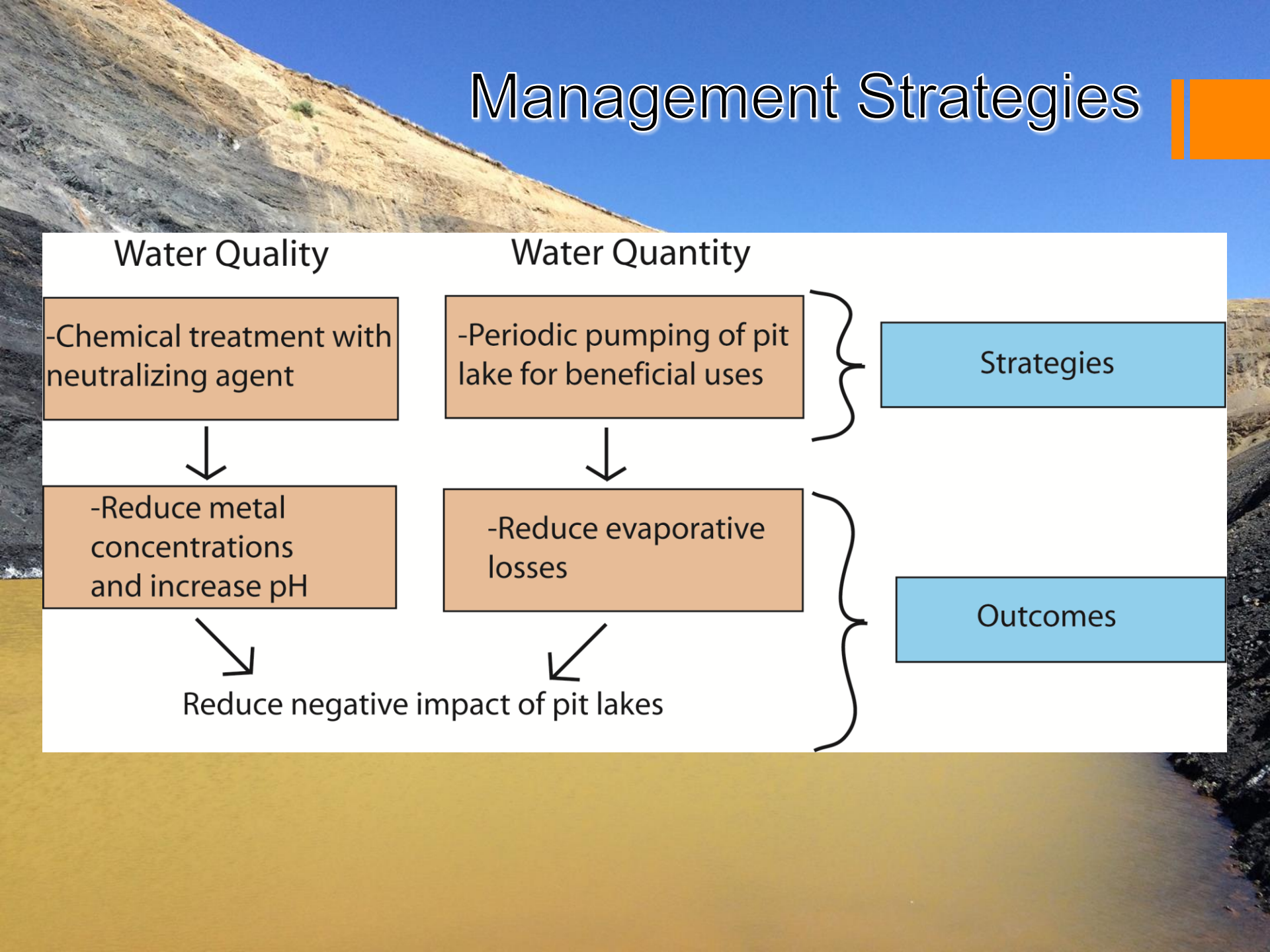
Quantity of Pit Lake Water

Pit Lake Chemogenesis

Case Study #1 – Modeling Predictions

Comparison of Observed and Predicted Arsenic
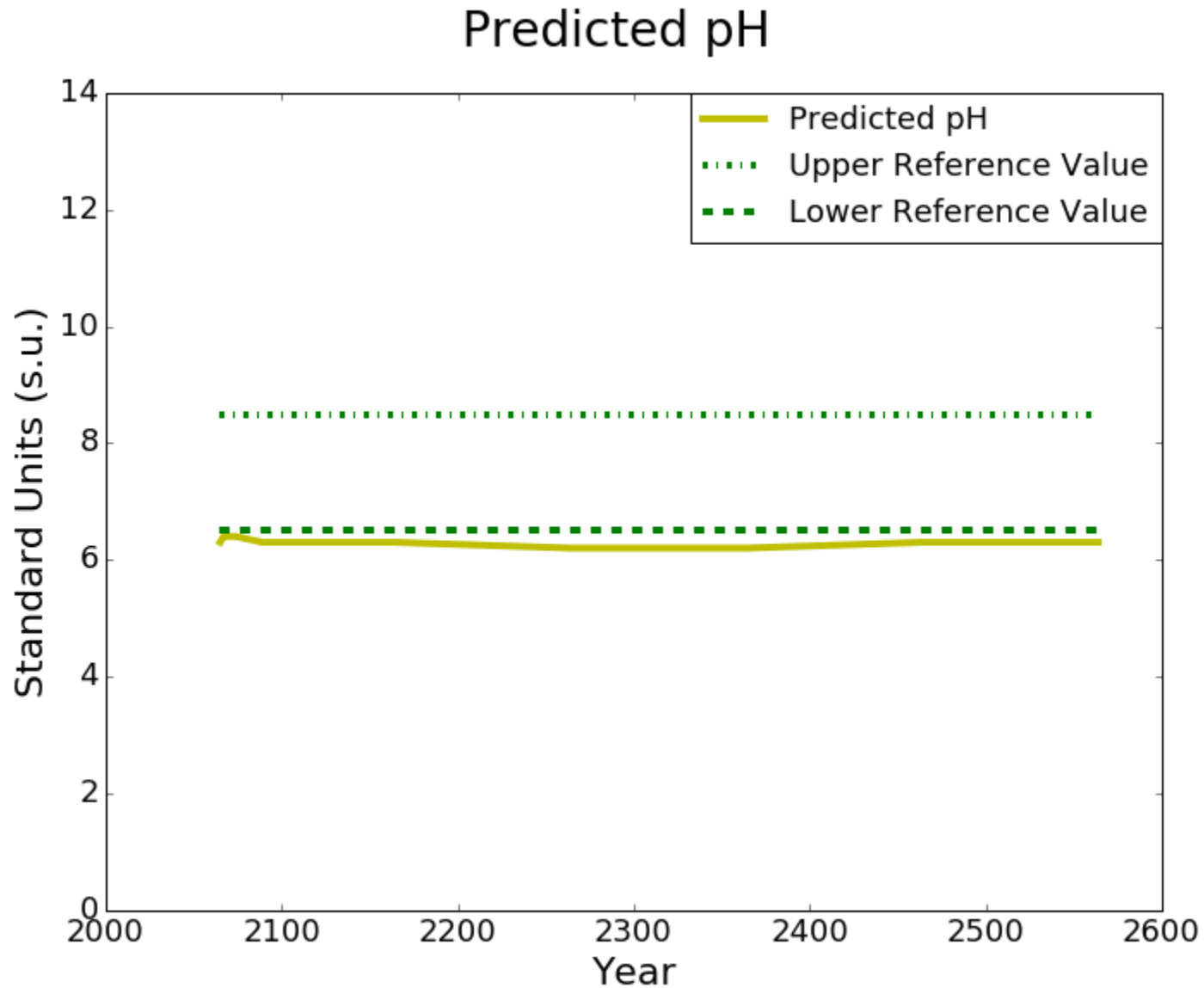
Case Study #1 – Modeling Predictions

Comparison of Observed and Predicted Cadmium
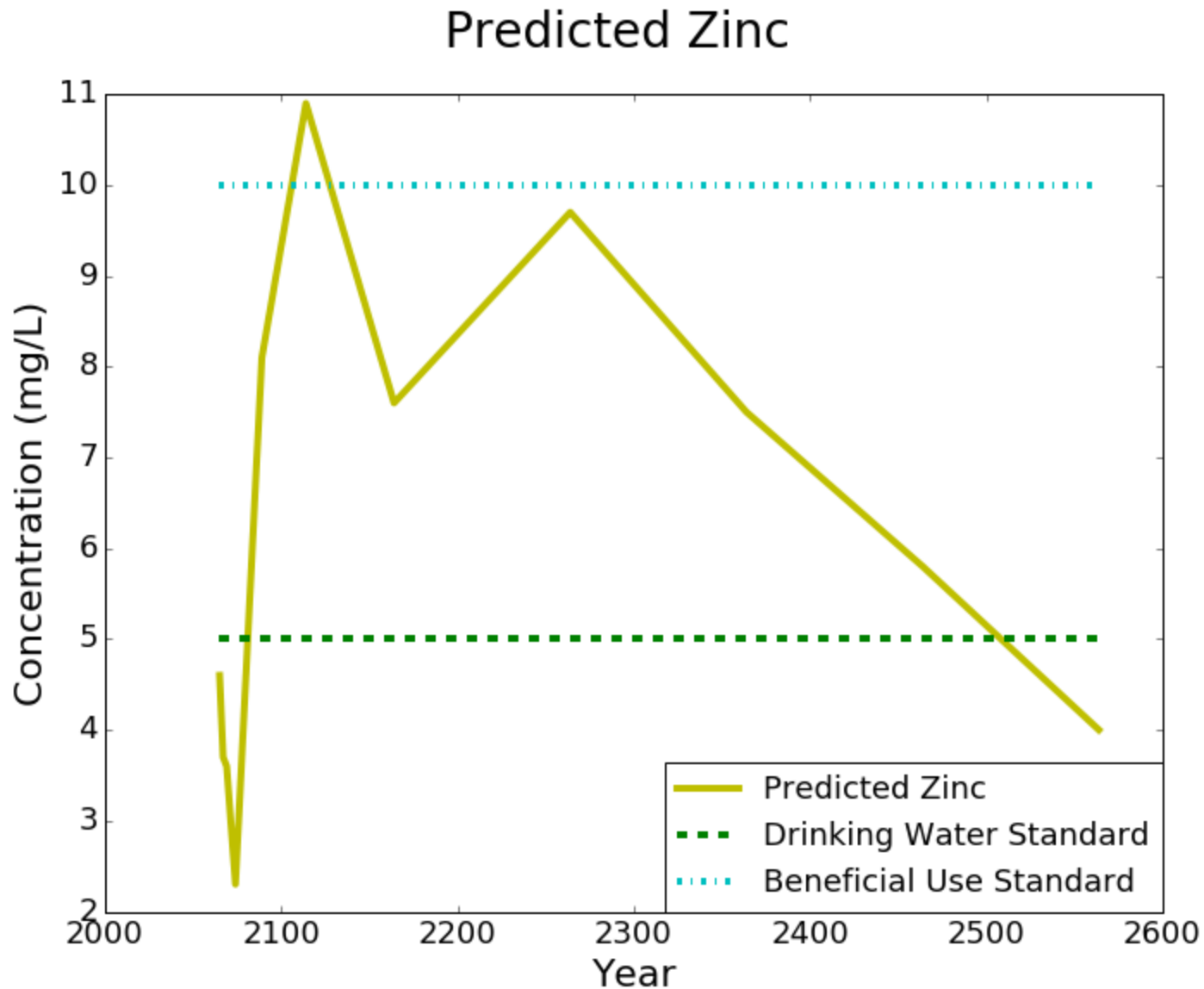
Legend:
- Observed Cadmium
- Predicted Cadmium - EIS Model
- Predicted Cadmium - Sensitivity Analysis
- Drinking Water Standard
- Surface Water Standard

Y-axis: Concentration (mg/L)
X-axis: Year (2007, 2009, 2011, 2013, 2015, 2017)

Management Strategies

Water Quality

-Chemical treatment with neutralizing agent

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-Reduce metal concentrations and increase pH

Water Quantity

-Periodic pumping of pit lake for beneficial uses

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-Reduce evaporative losses

Strategies

Reduce negative impact of pit lakes

Outcomes

Case Study #2 - Neutralization

Case Study #2 - Neutralization

Predicted Zinc

Case Study #2 – Pit-Lake Pumping

Predicted Evaporation
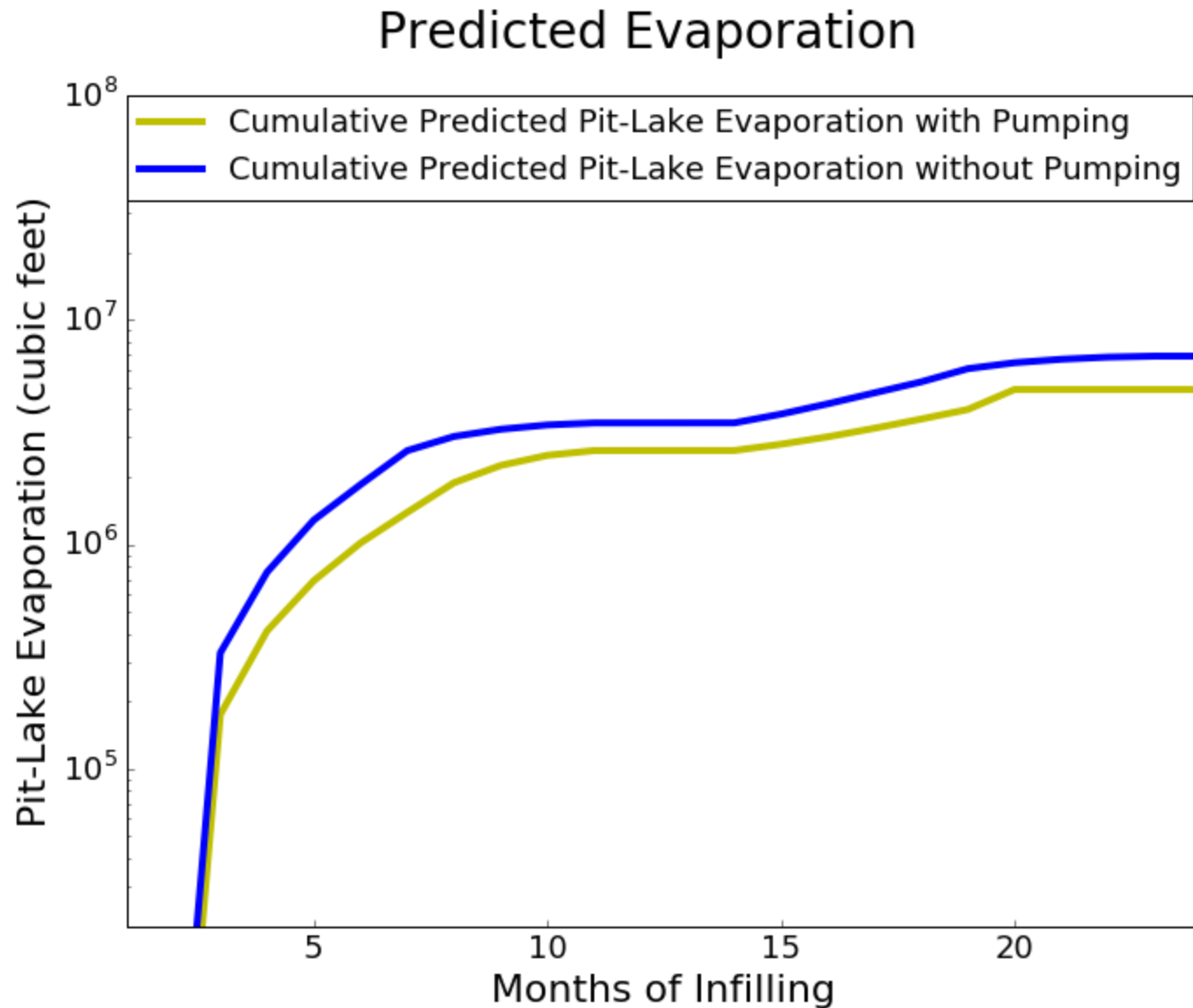
Summary

- Pit lakes are an important issue in Nevada due to water availability

- There are numerous pit lakes in Nevada of widely ranging water quality

- There are predicted to be at least 18 more pit lakes in Nevada

- Pit lake prediction and regulation require interdisciplinary approaches

- Predictions of pit-lake water quality MUST include sensitivity analyses, and should generally be conservative

- Management strategies, if required, should be included in predictive models

Thank you!

Questions?

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