Model Evaluation Overview

Groundwater Modeling Group Working Group (GWMWG) Meeting

September 27, 2021

DRAFT 10/1/2021 With DOH edits - blue slides and latestchanges highlighted

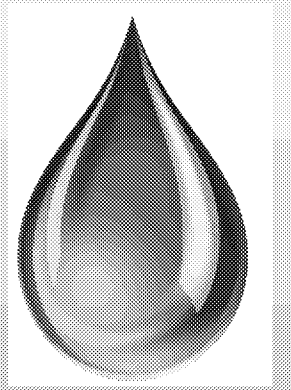
$\Sigma^2\Pi$

S.S. Papadopulos & Associates, Inc.

Presentation Context

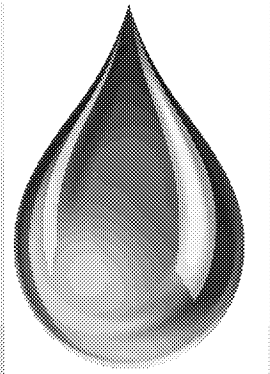
- The Navy submitted the Groundwater Flow Model Report in March 2020
- The Regulatory Agencies are working to determine the best path forward given the AOC schedule
  - **Navy models need substantial modifications to better represent field conditions & complexity**.
- In the interim, the Regulatory Agencies SMEs are using this opportunity to present and discuss some of their comments and concerns from their review of the Groundwater Flow Model Report and accompanying model files.

Key Overarching Goal



- The purpose of the flow modeling is to refine past groundwater flow models and improve the understanding of the direction and rate of groundwater flow within the aquifers around the Facility (AOC, 2015)
  - *To do this, the underlying geologic conditions must be refined and better understood in light of new data not available to prior modeling*
- *Those improvements are intended to allow a model foundation for the dissolved-phase aspects of CF&T & to inform the fuel-transport conditions.*
- *For reasons to be discussed, the Navy GWFMs fail to achieve these objectives*

The Impact of the GWFM Deficiencies



- *The Navy GWFMs cannot inform TUA/IRR decisions*
- *The GWFMs do not explore adequacy of EPM and uniformity assumptions in the models*
- *The GWFMs are unreliable for risk and CF&T because they do not account for the known scale of geologic complexity*
- *The GWFMs are inadequate to inform fuel release impacts*
  - *I.E., no basis for fuel transport or potential aquifer impacts*
  - *And they do not provide a basis for risk evaluations*
- *The refinements required by the AOC are not present*
  - *Navy GWFMs output is not "better" than prior modeling*
  - *Transient verification results are non-standard and do not actually verify that the GWFMs calibrate to test conditions*
- *The GWFMs alone cannot address fuel mitigation aspects*
  - *Mitigation and risk will be driven by fuel release conditions*
  - *The poor representation of RH ridge complexity and steady-state approach limit utility*
  - *Related, g.w. capture is not the only credible mitigation strategy*
    - *And no approach can be considered absent linkage to fuel transport*

Project Overview and Timeline

2014

Navy reports a fuel leak of approximately 27,000 gallons from Tank 5

2015

EPA, DOH, Navy/DLA reach enforceable agreement, Administrative Order on Consent (AOC). Section 7 of SOW includes:

- Site characterization, evaluations, and modeling
- Update the Existing Groundwater Model. Flow modeling to provide one basis for fate-and-transport modeling
- Site characterization, evaluations and modeling
- IRR and revisions to Groundwater Protection Plan
- Develop CF&T Model
- Tracer Study commitment as described in 7.1.2 of GWM SOW (Still tracking down the document to confirm)

2016

Approval of revised final SOW for AOC Sections 6 and 7: Investigation and Remediation of Releases; Groundwater Flow Modeling; Contaminant Fate and Transport (CF&T) Modeling; and Groundwater Monitoring Well Network

2017

- Interim GWFM development underway.
- EPA and DOH provide comment on CSM development

2018

- Delivery of interim GWFM report (Navy)
- EPA and DOH offer comments on interim CSM, GFM, and CFT

2019

- GWMWG and TWG meetings
- Delivery of preliminary updated models (Navy) using multi-model approach and CSM updates

2020

- DOH offers comments on CSM update
- Delivery of GWFM report (Navy) and accompanying model files
- Review of report and model files by EPA and DOH
- EPA and DOH SMEs collaborate to define and assess outstanding questions regarding local-scale groundwater flow conditions

2021

- Local-scale analyses by EPA and DOH to support recommended model improvements presented to Navy TWG

Summary of EPA/DOH Review of GWFMR and Files

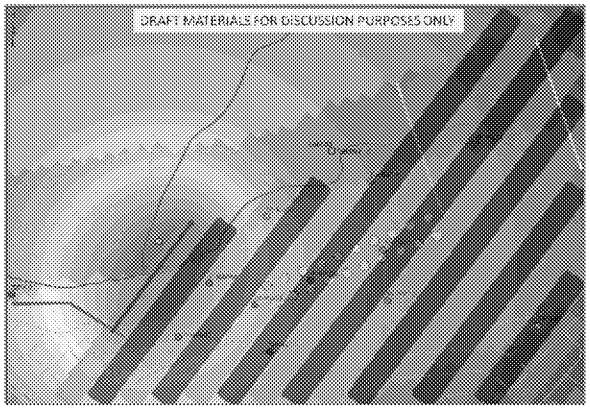
- Knowledge of the subsurface has advanced considerably since the execution of the AOC. Still, the GWFMs are not ready to support decision making and planning:
  - Conditions and patterns close to RHBSF are not accurately reproduced
  - No single model incorporates all potentially important features, events, and processes **at a scale & complexity appropriate to the Red Hill hard-rock setting**
  - Correspondence between models and data must improve to produce "behavioral" models for capture and transport analysis & **focus on transient conditions**
  - Lessons learned require further analysis, discussion, and integration
- For example: the Navy's TUA proposal states that modeling demonstrates that RHS can capture water beneath RHBSF if pumped at a rate of 5-10 MGD:
  - **Groundwater capture is undemonstrated and alone, does not encompass all of the regulatory concerns regarding groundwater protection measures**
  - Though the current models may provide insights into regional conditions, they are not ready to represent transport and risk at RHBSF
  - Limited, local-scale analysis may help understand conditions to "feed back" to the Navy models

Summary of EPA/DOH Review of GWFMR and Files

- Below are primary concerns that the Regulators share regarding (a) the CSM and (b) the GWFMs, that should be the focus of the next iteration of work:
  - Extent, role, and representation, of saprolites (*item 2 of "Top Ten Regulatory Concerns"*). Work has been performed on this but a best-estimate extent and configuration of saprolite features has not been determined, and their representation in the models may not reflect their actual role on migration.
  - Role of heterogeneity and preferential pathways on mixing, transport, fate, and capture (*items 4 and 5 of "Top Ten Regulatory Concerns"*).
  - Calibration to groundwater head differences (gradients), absolute heads (*item 6 of "Top Ten Regulatory Concerns"*), and transient head responses.
  - Correspondence between simulated flow patterns and groundwater chemistry data (*item 9 of "Top Ten Regulatory Concerns"*).
  - **Lack of adequate justification for model parameter ranges far outside of Hawaiian norms**
- Resolving these concerns is challenged by monitoring data **spatial** sparsity and conflicts between observed chemistry and (presumed) groundwater flow rates and directions.

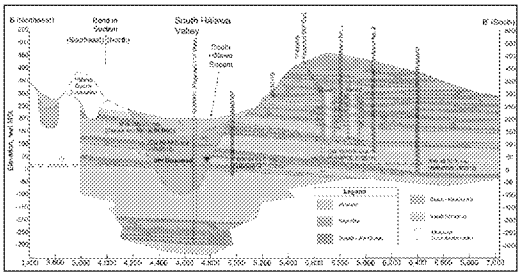
Example: Representation of Subsurface Heterogeneity

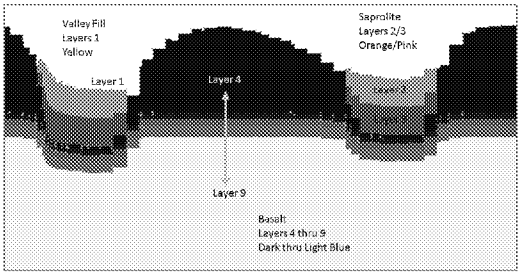
- There is abundant evidence for hydraulic property contrasts in basalt. The Navy represents this with an EPM, directional anisotropy plus (for some models) pilot points.
- Alternative methods for representing basalt-character heterogeneity should be considered that provide more realistic parameter fields.
- Collect additional field data to potentially validate groundwater flow rate and direction (in wells tests and possible tracer study)



Example: Model Layering

- Use of topography- and structure-following approach may have some unintended consequences.
- Evaluate alternate methods to represent transitions between HSUs.





Next Steps

- Determine specific technical GW modeling objectives for CSM and GWFMs:
  - Initiate AOC party SME "small group" meetings to address specific objectives.
- [*In small group meetings*] Determine areas of Navy / regulator SME concurrence and dissent on CSM / GWFMs:
  - Prioritize areas of disagreement to consolidation and meeting modeling objectives.
- Identify qualitative and quantitative model acceptance criteria
- Presuming successful model consolidation: identify method(s) for evaluating and communicating parameter and prediction sensitivity and uncertainty.
- Undertake technical modeling tasks laid out in small group meetings:
  - Consolidate groundwater models accordingly.
  - Conduct model simulations and evaluations.
  - Undertake uncertainty analysis.
  - Produce results and recommendations.

Technical Presentation Overview

- On Day 2, team **will <u>review key CSM assumptions that do not align with field data and present</u>** a technical presentation to illustrate one approach to evaluating certain features of the local-area CSM.
- Although the work that will be presented uses modeling techniques, it is not a replacement for Navy model, rather a collaborative effort by the regulator SMEs to evaluate certain challenging aspects of the local groundwater system.