# Model Evaluation Overview

*Groundwater Modeling Group Working Group (GWMWG) Meeting*

*DRAFT 10/12/2021 With MJT/EPA*

*DRAFT 10/1/2021 With DOH edits - blue slides and latest changes highlighted*

# Presentation Context

- The Navy submitted the revised Groundwater Flow Model Report in March 2020.
- The Regulatory Agencies (RAs) are working to determine the best path forward given the AOC schedule.
- Despite efforts made by Navy since the 2018 interim model, the Navy's current models need substantial modification to better represent field conditions and complexity.
- The RA SMEs are using this opportunity to present and discuss some of their previous and current 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 models and improve understanding of the directions and rates of flow within aquifers around the Facility (*after AOC, 2015*):
  - To accomplish this, representation of geologic conditions must be revised and better understood in light of new data not available to prior modeling efforts
  - Those improvements are intended to provide suitable foundations for (a) modeling the dissolved-phase aspects of CF&T and (b) informing fuel-transport understanding and evaluation.
- The GWFMs would then be used to evaluate potential impacts of, and mitigation strategies for, releases at RHBSF and help inform TUA/IRR decisions.

# Regulator Perspective on GWFMs

- The GWFMs do not at this time provide a reliable basis to evaluate potential aquifer impacts or the risk posed from releases at RHBSF.
- This is, in part, due to simplified representations of geologic conditions and complexity using equivalent porous media (EPM) and uniformity assumptions.

# Modeling and Decision Support

- It is important to understand that the GWFMs cannot alone address fuel (product) migration and mitigation:
  - Risk and mitigation strategies will be driven by fuel release conditions
  - Simplified representation of RH ridge and steady-state approach limit utility
  - Hydraulic containment is not the only potential mitigation strategy
- Reliable evaluations need a link 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 6&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
- Evaluating a tracer study as described in 3.6 of the 2016 GWM SOW

**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

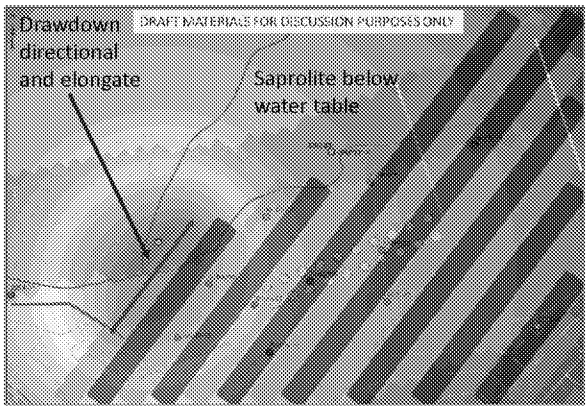
- Knowledge of the subsurface has advanced considerably since the execution of the AOC. Still, the GWFMs are not ready to support decision making and planning:
  - Conditions and patterns close to RHBSF are not accurately reproduced
  - No single model incorporates all potentially important features, 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 and emphasize 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 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

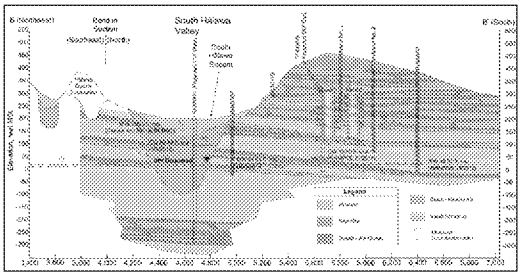
- There is abundant evidence for hydraulic property contrasts in basalt. The Navy represents this with an EPM, directional anisotropy and - for some models - pilot points.
- Alternative methods for representing basalt-character heterogeneity should be considered that provide more realistic parameter fields.
- Additional field data could potentially validate flow rates and directions - such as in-well and inter-well tracer tests.

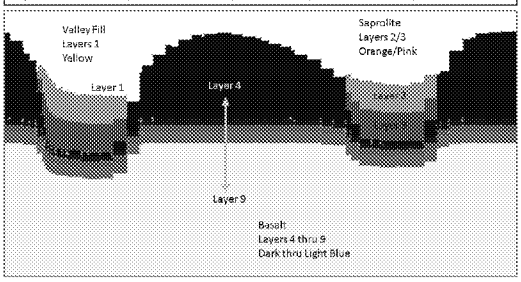



Schematic lava flows
(dense interiors vs clinker)

# Example: Model Layering

- Use of topographic and structure-following layer approach may have some unintended consequences for transport pathways.
- Evaluate alternate methods to represent transitions between Hydro-stratigraphic units (HSUs) and role of saprolite.





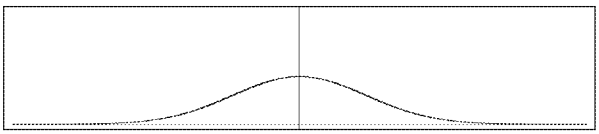
# Comparing Model Output with Actual Data

- If model results compare unfavorably with observations, then it can be concluded that something is wrong in the model
- If model results compare favorably with observations, this does not necessarily guarantee that the model is reliable

*Oreskes, N., K. Shrader-Frechette, and K. Belits. 1994. Verification, validation, and confirmation of numerical models in the earth sciences. Science 264, 641-646*

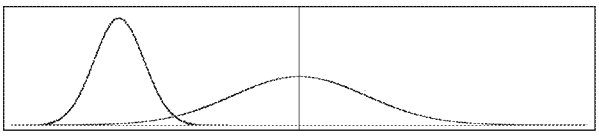
# Comparing Model Output with Actual Data

- We don't know gradient and flow directions with high confidence: they present as a wide, flat normal curve.
- The data are what they are.



"Data"

- But we can know if the model outputs reasonably correspond with the measured data
- The normal curves only show marginal overlap.



"Model" "Data"

# Technical Presentation Overview

- On Day 2, the RAs and SMEs will (a) review key CSM assumptions that do not align with field data and (b) provide a technical presentation to illustrate one approach to evaluating certain features of the local 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.