[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	6 (Select the number from "Areas of Technologies Requested")
Title	Comprehensive Groundwater Flow Model for Planning and Optimizing Hydraulic Measures
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1. Overview of Technologies (features, specification, functions, owners, etc.)

Development of a comprehensive geohydrologic groundwater flow model of the 1F site area is proposed that honors the observed data and the assumed boundary conditions as well as the dynamics of the freshwater-saltwater interface. The TOUGH2 family of codes, a multi-phase flow simulator developed by LBNL, will be used for forward simulation as well as optimization and uncertainly quantification. The model will be utilized to evaluate/compare the effectiveness of various hydraulic counter measures (sub-drain pumping, groundwater bypass, trenches, cryogenic barrier, impervious walls, paving) to reduce the groundwater flow into the contaminated site and into the sea. The model is able to assess the inevitable landward movement of the seawater due to the lowering of the water table at the site. The ability of estimating the salinity distribution is also important because the transport behavior of radio-nuclides is strongly influenced by ionic strength.

The first step in building a reliable conceptual model is to utilize the year-to-year and season-to-season data of groundwater levels in the past. Such groundwater monitoring data, including the pump test data, that have been collected at the site will be qualified and re-evaluated first before they are incorporated into the model. The next step is to conduct model calibrations using available characterization and monitoring data utilizing the inverse modeling and optimization framework iTOUGH—part of the TOUGH2 family of codes. The calibrated model will then be used to probe and compare the performance of various hydraulic mitigation measures. In this process, iTOUGH can be used to optimize such measures; e.g., the optimal locations of pumping and monitoring wells as well as pumping rates. The uncertainties of the calibrated model can be quantified as well. The model can be used to examine alternative conceptual models including the case where the silty low permeability layers are not hydrologically isolated. We note that the calibrated groundwater flow model can serve as a base of the reactive transport model separately proposed by LBNL.

We envision that the comprehensive groundwater flow model will also be used to test the effectiveness of additional hydraulic countermeasures that are currently not considered. One potentially effective measure to reduce the amount of groundwater flow at 1F is to install a semi-horizontal drain oriented north to south, potentially outside of the site. The drain can be installed using the horizontal drilling technology. It will capture uncontaminated groundwater, which can be drained to the sea by gravity, thus avoiding the need for long-term maintenance and eliminating the possibility of pulling in the contaminated water from the 1F site. The drain can also be equipped with the innovative sensors proposed by Rohit Salve of LBNL.

It is also suggested that the direct push technology (DPT) be used in place of drilling for additional groundwater and geologic data collection where feasible. The DPT does not produce cuttings and can collect samples and deploy sensors rapidly. In addition, it is recommended that the monitoring sensors are networked wirelessly to minimize worker exposures.

2. Notes (Please provide following information if possible.)

- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)

The TOUGH2 family of codes developed by LBNL is widely used in the world for various applications including modeling a nuclear waste repository and environmental remediation.

- Challenges

The scarcities of data, uncertainties of the parameters, other assumptions and boundary conditions to be used in the model may greatly affect the outcome of the model prediction.

- Others (referential information on patent if any). NO RELATED PATENTS

Finsterle, S., Multiphase inverse modeling: Review and iTOUGH2 applications. Vadose Zone J., 3: 747–762, 2004.

Pruess, K., The TOUGH codes—a family of simulation tools for multiphase flow and transport processes in permeable media. Vadose Zone J., 3: 738–746, 2004.