



Memorandum

To: David Larkowski (DWD), Maura Callahan (Callahan Consulting)

From: Karilyn Heisen (CDM Smith)

Date: May 14, 2025

Subject: Bob Crowell Road Supplemental Simulation

This technical memorandum (TM) documents the model simulation requested by the Dennis Water District (DWD). The requested model simulation is in addition to model simulations required to complete the Bob Crowell Road Hydrogeologic Evaluation which are documented in the TM to MassDEP entitled “*Bob Crowell Road Hydrogeologic Evaluation (22-WP83-0009-APP) Additional Model Simulations and Proposed Groundwater Monitoring Plan*”. The TM to MassDEP is attached for your convenience.

The groundwater flow model documented in the November 2022 Hydrogeologic Evaluations for the Bob Crowell Road Site (22-WP83-0009-APP) was utilized in the work presented herein to simulate particle tracks. Based on discussions with the DWD, the DWD water supply well pumping rates were updated to reflect the 2011 to 2023 average annual pumping rates at each well. In addition, all pumping at the Main Station Wellfield will be applied to layer 1 and spread evenly across the 5 pumping locations associated in the Main Station Wellfield. A table of average annual pumping rates is provided in the attached TM.

The requested scenario from the DWD utilizes 2004 pumping at the Main Station Wellfield and Well GP-5 plus 10% Buffer. It is a conservative simulation which includes the maximum recharge of 0.5 MGD at the Bob Crowell Road Site. The scenario is shown in **Table 1** along with the scenarios simulated in the attached TM.

The flow fields generated from the the long-term steady-state for the requested scenario was used to examine the flowpaths associated with water originating the Bob Crowell Road Site, with the objective of understanding under what conditions recharged water at the site will be pumped out at the DWD Main Station Wellfield. To perform these runs, the particle tracking code MODPATH, developed by the United States Geological Survey (USGS), was used to simulate the advective flowpath of 200 particles released at the water table at the Bob Crowell Road Site. An additional variable, effective porosity, is needed for these simulations to determine seepage velocities and times of travel. An effective porosity of 0.30 was used in all particle tracking scenarios, which is consistent with unconsolidated glacial sediments and values used by USGS¹. The pathlines generated for the 2004 Q + 10% buffer is shown in **Figure 1**.

¹ Walter, D.A., and Whealan, A.T., 2005, Simulated Water Sources and Effects of Pumping on Surface and Ground Water, Sagamore and Monomoy Flow Lenses, Cape Cod, Massachusetts: U.S. Geological Survey Scientific Investigations Report 2004-5181, 85 p.

Model simulation show that even with the conservative simulation utilizing 0.5 MGD at the Bob Crowell Road Site, maximum historic pumping from 2004, plus a 10% buffer, particles which originate the Bob Crowell Road Site discharge to Kelley’s Bay and adjacent wetlands.

The attached TM to MassDEP shows in order for one particle to be captured by a public water supply well, the Main Station Wellfield needs to be operated at an average annual rate of 0.49 MGD. This is 3.3 times the average annual pumping rate from 2011 to 2023 at this wellfield.

Table 1: Model Scenarios

Scenario #	Description	BCR Recharge Rate (MGD)	Main Station Wellfield Pumping ^{1, 4} (MGD)	Well GP-5 Pumping (MGD)	Time of Travel to Main Station Wellfield	Percentage of Particles Captured by Main Station Wellfield
0	Baseline	0	0.15	0.10	No impact ²	No impact ²
1	Baseline + 0.4 MGD @ BCR	0.4	0.15	0.10	No impact ²	No impact ²
2	Max. 12-month at MS1	0.4	0.24	0.10	No impact ²	No impact ²
3	Threshold Main Station Wellfield ³	0.4	0.49	0.10	3.4	0.5%
4	Max. month at Main Station Wellfield	0.4	0.50	0.10	3.1	1.0%
DWD0	2004 Pumping	0	0.30	0.11	No impact²	No impact²
DWD1	2004 Q + 10% buffer	0.5	0.33	0.12	No impact²	No impact²

Notes:

- (1) Model simulated pumping total at all other DWD wells uses average annual pumping (see Table 2)
- (2) No impact - All particles which originate at the Bob Crowell Road Site discharge to Kelley’s Bay.
- (3) Threshold scenario is determined by increasing pumping at the Main Station Wellfield until one particle is captured. The intent of the scenario is to provide identify the pumping rate above which potential impacts might occur.
- (4) Maximum permitted average annual pumping at the Main Station Wellfield is 0.58 MGD based on the ASR reports.

Groundwater Monitoring Plan

The attached TM to MassDEP includes a revised groundwater monitoring plan. This plan includes one additional downgradient well, one additional upgradient well and two sentinel well locations to be placed between the Bob Crowell Road site and the Main Station wells.

Two sentinel well locations are proposed in Johnny Kelley Park based on the particle that is captured by the Main Station Wellfield in Scenario 3. Proposed location SENTINEL-1 (to be renumbered after installation) is located at an approximately 2-year time of travel to the Main Station Wellfield. SENTINEL-2 (to be renumbered after installation) is located at an approximately 1-year time of travel to the Main Station Wellfield. Based on the simulated particle depth, the proposed screens would be installed to span 35 to 45 feet below ground surface (ft bgs) at SENTINEL-1 and 45 to 55 ft bgs at SENTINEL-2.

The location, depth, parameters and sample frequency will be discussed in future meetings with the DWD and the Town of Dennis.

Figure 1: Particle Pathlines for 0.5 MGD at Site 2 - 2004 Pumping + 10% Buffer at Main Station Wellfield and Well GP-5

