GOLDER

TECHNICAL MEMORANDUM

DATE   September 29, 2020

TO   Gail Lipfert, PhD, C.G. - MEDEP

CC   Linda Butler, Kathy Tarbuck - MEDEP, Sherwood McKenney - WMDSM

FROM   Alistair Macdonald, C.G. and Brendan Lennon, P.G.

RE: **FOLLOW-ON RESPONSE TO MEDEP COMMENT 17**

MEDEP requested a comparison of the current Phase 14 time of travel parameters to the parameters used in Gerber's 1996 groundwater model. Common input parameters used in the time of travel calculations and the groundwater model include hydraulic conductivity and effective porosity.

The following provides a comparison of the calibrated hydraulic conductivity values (i.e., final values after model calibration) used in the Gerber model and the range of values (average and high-end) used in the Phase 14 time of travel calculations:

- Stiff upper clay horizontal hydraulic conductivity (Kh):

    - Gerber model value: 1.3×10^{-4} cm/sec

    - Phase 14 time of travel: 1.19×10^{-6} cm/sec (average) to 1.77×10^{-5} cm/sec (high end).

- Stiff upper clay vertical hydraulic conductivity (Kv):

    - Gerber model value: 6.49×10^{-4} cm/sec

    - Phase 14 time of travel: 1.87×10^{-7} cm/sec (average) to 8.99×10^{-7} cm/sec (high end).

- Soft lower clay vertical hydraulic conductivity (Kv):

    - Gerber model value: 4.34×10^{-8} cm/sec

    - Phase 14 time of travel: 1.87×10^{-7} cm/sec (average) to 8.99×10^{-7} cm/sec (high end).

- Glacial till horizontal hydraulic conductivity (Kh):

    - Gerber model value: 8.88×10^{-4} cm/sec

    - Phase 14 time of travel: 2.06×10^{-4} cm/sec (average) to 2.93×10^{-3} cm/sec (high end).

The following provides a comparison of the effective porosity values used in the Gerber model and the range of values (average and high end) used in the Phase 14 time of travel calculations:

- Stiff upper clay:

  - Gerber model value: 0.10

  - Phase 14 time of travel values: 0.15 (average) and 0.10 (high end[1]).

- Soft lower clay:

  - Gerber model value: 0.40

  - Phase 14 time of travel values: 0.40 (average) and 0.30 (high end).

- Glacial till:

  - Gerber model value: 0.20

  - Phase 14 time of travel values: 0.28 (average) and 0.15 (high end).

The calibrated horizontal and vertical hydraulic conductivity values used in the Gerber model for the stiff upper clay are higher than those used for the Phase 14 time of travel calculations. Conversely, the calibrated vertical hydraulic conductivity value used in the Gerber model for the soft lower clay is lower than the range of values used for the Phase 14 calculations. The hydraulic conductivity value used in the Gerber model for the glacial till falls within the range of values used for Phase 14 time of travel calculations.

Gerber (1996) indicates that the calibrated (modeled) hydraulic conductivity values "are greater than average site wide data" and notes that they are higher than those used for their "hand" (analytical) calculations. This seems to be particularly true for the upper stiff clay, when comparing the 1996 model calibrated values to the Phase 14 calculations. Gerber (1996) indicates that "the final calibrated values are dependent on the scale of the discretization of the model and the overall combination of parameters used to calibrate the model". Golder interprets this as meaning that even though the model calibrated values are higher than average (field measured) values, the differences do not impact results when averaged across the horizontal and vertical domains of the model.

The effective porosity values used in the model and the range of porosity values used in the Phase 14 time of travel calculations are very similar.

The 1996 model and the Phase 14 travel time calculations indicate travel times greater, and in most cases much greater, than the 6-year requirement. This consistency results from the similarity of the porosity and till hydraulic conductivity values used in both evaluations, and because the differences in the clay hydraulic conductivity values would tend to average out across the entire clay sequence (i.e., where Gerber (1996) used higher values for the upper stiff clay, Golder used higher values for the lower soft clay and vice versa).

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[1] Lower values of effective porosity are referred to as "high end" because use of a lower effective porosity value increases the calculated seepage velocity and results in a shorter calculated travel time.