Beavers, Cromer, Gardner Viral Die-off Model

Site Address	Scenario 1

Input Data

Input Data		Source
Groundwater temperature (°C)	13.00	Mean minimum air temperature (BoM)
Orders of magnititude reduction	7.00	From Cromer et al. (2001) for wastewater treatment level
Days required for viral reduction	80.00	Figure 1 of Cromer et al. (2001) and reproduced below
Bulk density of soil (p_b) (g/m^3)	1.80	Table 2.19 of Hazelton & Murphy (2016)
Saturated hydraulic conductivity (m/day)	3.00	Table 4-7 of Guidelines
Groundwater gradient (fraction)	0.05	From the results of the SSE
Vertical drainage before entering groundwater (m)	1.00	From the results of the SSE

Calculate the predicted travel distance using Equation 4 from Cromer *et al.* (2001).

$$D_g = (t - dv \times P \div K) \div (P \div K \times i)$$

Time in days	t =	80.00	days
Effective porosity of soil (fraction)	P =	0.32	
Saturated hydraulic conductivity	K =	3.00	m/day
Groundwater gradient (fraction)	i =	0.05	
Vertical drainage before entering groundwater	d_v =	1.0	m

Setback Distance	Distance travelled in groundwater	d_g =	37.4	m

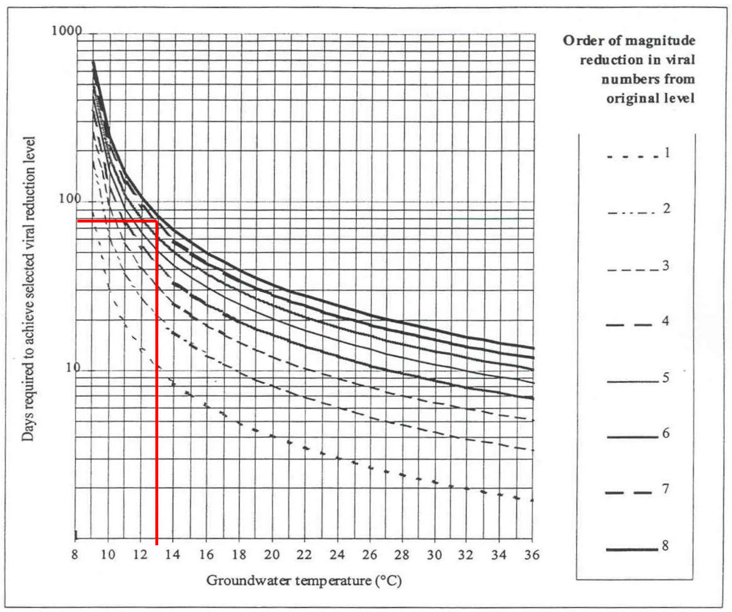

Figure 1. Relationship between Groundwater Temperature and Viral Die-Off Time for Various Order-of-Magnitude Reductions in Viral Numbers

(Figure 1 taken from Cromer et al., 2001)

Supporting Notes

A. Order of Magnitude	
Primary treatment	7
Secondary treatment (no disinfection)	3
Secondary treatment (with disinfection)	2

From Cromer et al. (2001).

B. Bulk Density of Soil	
Sand/Sandy loam	1.8
Fine sandy loam	1.7
Loam and clay loam	1.6
Clay	1.4

From Hazelton & Murphy (2016) Table 2.19

1. Enter property address next to 'site address'
2. Enter the groundwater temperature or mean minimum air temperature as a proxy sourced from the closest BoM station to the property into input data.
3. Enter the orders of magnitude reduction based on the level of treatment and Table A into input data.
4. Use Figure 1 to select the number of days required for viral reduction based on the order of magnitude reduction required and enter into input data.
5. Select the bulk density of the soil based on soil texture and Table B above and enter into input data.
6. Enter the saturated hydraulic conductivity of the soil into input data based on the upper limit value provided by Table 5.2 of AS/NZS 1547:2012 and soil category.
7. Enter the groundwater gradient of the site into input data based on the results of the SSE (i.e. surface gradient).
8. Enter the vertical drainage available between the base of the EAA and the termination of the test pit / borehole from the SSE into input data.
9. The spreadsheet can be set up to calculate the porosity of the soil based on the equation from Hazelton & Murphy (2016) where the specific gravity of soil particles (p_s) remains constant:

Porosity $= 1 - p_b \div p_s$ $p_s = 2.65$

10. The spreadsheet can be set up to calculate the distance viruses travel in groundwater using the equation from Cromer et al. (2001):

Distance travelled in groundwater $(d_g) = (t - d_v \times P \div K) \div (P \div K \times i)$