

Routine assessments are carried out with the assumption of constant rate continuous discharge and a steady state water concentration with time-independent models such as WAT⁽¹⁾.

The time to reach steady state cyclical equilibrium and then variation in concentration through the tidal cycle were investigated with the time-dependent model SERAM⁽²⁾ for constant rate continuous discharge.

Figure 1 shows schematically the transport processes included in WAT and SERAM for this study.

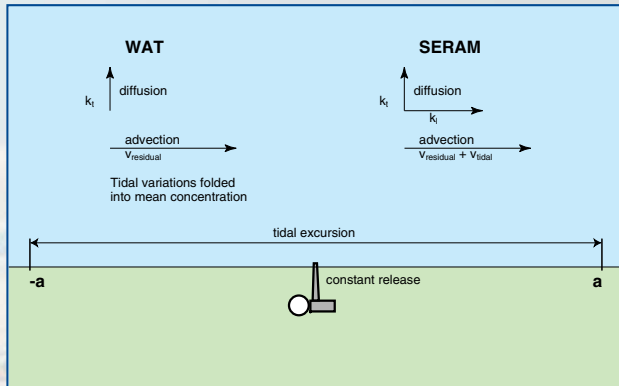


Figure 1: Schematic representation of the main features of WAT and SERAM as used here.

SERAM was run with a range of hydrodynamic parameters covering the range expected at sites to which WAT is applicable, Table 1.

Parameter	Run Identifier							
	a1v1k1	a1v1k2	a1v2k1	a1v2k2	a2v1k1	a2v1k2	a2v2k1	a2v2k2
a (km)	8.9	8.9	8.9	8.9	4.4	4.4	4.4	4.4
V _r (ms ⁻¹)	0.025	0.025	0.05	0.05	0.025	0.025	0.05	0.05
k _t (m ² s ⁻¹)	1	100	1	100	1	100	1	100

Table 1: Parameters for Model Runs

References:

- Round, G D.** Individual doses from discharges of liquid effluents to the sea: water concentration model - WAT. *CEFAS Environmental Tech. Note RL2/98* (1998).
- Aldridge, J N.** CSERAM: A model for prediction of marine radionuclide transport in both particulate and dissolved phases. *Rad. Prot. Dosim.* **75** Nos. 1-4 pp 99-103. (1998).

Acknowledgements:

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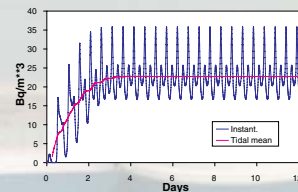


Figure 2a: a2v2k1 at a

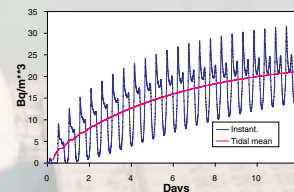


Figure 3a: a1v1k2 at a

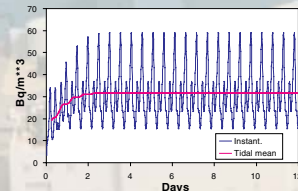


Figure 2b: a2v2k1 at 0

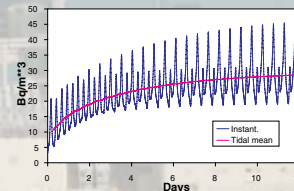


Figure 3b: a1v1k2 at 0

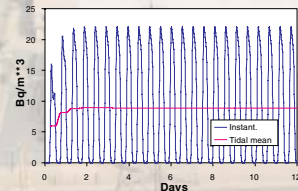


Figure 2c: a2v2k1 at -a

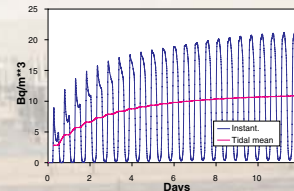


Figure 3c: a1v1k2 at -a

Discharges are represented by a step function starting at $t=0$, of 1 TBq y^{-1} , and a transverse diffusion coefficient of $10 \text{ m}^2 \text{ s}^{-1}$ was used for all model runs.

Evolution of instantaneous concentrations over a twelve day period from $t=0$ can be followed for different positions in the tidal excursion in Figures 2a-2c, and 3a-3c. These represent the parameter combinations with the fastest and slowest times to reach equilibrium respectively.

Times to reach different % of cyclical equilibrium at the different output locations are shown in Table 2 for all combinations of parameters.

% of cyclic equilibrium and location	Time in days for each combination of parameters							
	a1v1k1	a1v1k2	a1v2k1	a1v2k2	a2v1k1	a2v1k2	a2v2k1	a2v2k2
75 -a	2.2	3.7	1.1	1.3	1.1	2.7	0.6	1.0
95 -a	4.3	10.0	2.1	3.3	2.3	8.4	1.1	2.7
100 -a	6.4	28.2	2.8	9.4	4.3	19.9	1.7	8.4
75 0	2.5	3.4	1.1	1.3	1.3	2.2	0.6	0.8
95 0	6.4	10.6	3.2	4.1	3.3	7.7	1.6	2.7
100 0	10.5	28.7	4.8	11.0	5.8	19.8	2.7	8.6
75 a	6.3	7.5	3.1	3.5	3.2	4.4	1.6	2.0
95 a	10.5	16.2	5.3	6.8	5.4	10.8	2.7	4.2
100 a	14.7	30.2	6.9	14.2	7.9	20.2	3.8	10.6

Table 2: Time to Reach Percentages of Cyclical Equilibrium at Each Location

Variation in concentration through the tidal cycle is presented in Table 3 as a normalised range, $R_n = (C_{max} - C_{min})/C_{mean}$.

Location	R_n							
	a1v1k1	a1v1k2	a1v2k1	a1v2k2	a2v1k1	a2v1k2	a2v2k1	a2v2k2
-a	2.2	2.0	2.3	2.1	2.3	1.6	2.5	2.1
0	1.4	1.1	1.6	1.2	1.2	0.69	1.4	0.90
a	0.77	0.56	0.86	0.72	0.72	0.53	0.84	0.59

Table 3: Normalised Range at Different Locations

Cyclical equilibrium is reached most quickly for the case with the parameters a2v2k1 after several days, and most slowly for a1v1k2 after approximately four weeks.

Variation through the tidal cycle is greatest at position -a and least for a, and greatest with parameters a1v2k1, and least for a2v1k2. The range is 2.5 times to 0.5 times mean concentration.

Conclusions:-

- Time-scales to reach steady state concentrations at UK sites are not significant for assessment of annual mean doses.
- Care must be exercised in comparing environmental measurements of water concentration with output from tidal mean time-independent models such as WAT for model validation.