Aqueous Effluent Discharge Assessment Revision

This is a revision to TraC Screening Phase 1 Test 5 assessment (part of the Environment Agency's H1 Annex D1 assessment) carried out to support an environmental permit application PRT2SE10760C for non-radioactive and radioactive effluent discharges for Magnox, Bradwell site.

The changes made in this assessment include:

- Use of an estimated tide height for radioactive and non-radioactive effluents during their respective discharging times;
- Use of different discharge port heights for radioactive and non-radioactive discharges; and
- Use of proposed EQSs which is scheduled to be effective from 22nd December 2015 in the effective volume flux (EVF) calculation.

In this revised assessment, the difference in height between the discharge point and the tide height at the time of discharge has been used as the mixing column within the estuary for buoyant effluent. The mixing column is thus calculated as below.

The heights of the discharge ports for radioactive and other non-radioactive effluents are 5.5m and 2.34m above the estuary bed level respectively. The Chart Datum around the outfall structure is estimated to be approximately 5.8m above the estuary bed level.

The Neap High Water tide height at Bradwell is approximately 9.0m[1] above the estuary bed. Therefore, the approximate height of the tide during the discharge period (an hour to two and half hours after High Water) will be slightly lower than at High Water tide. The tide height at two and half hours after High Water has been estimated from figure 1 to be approximately 8.6m above the estuary bed.

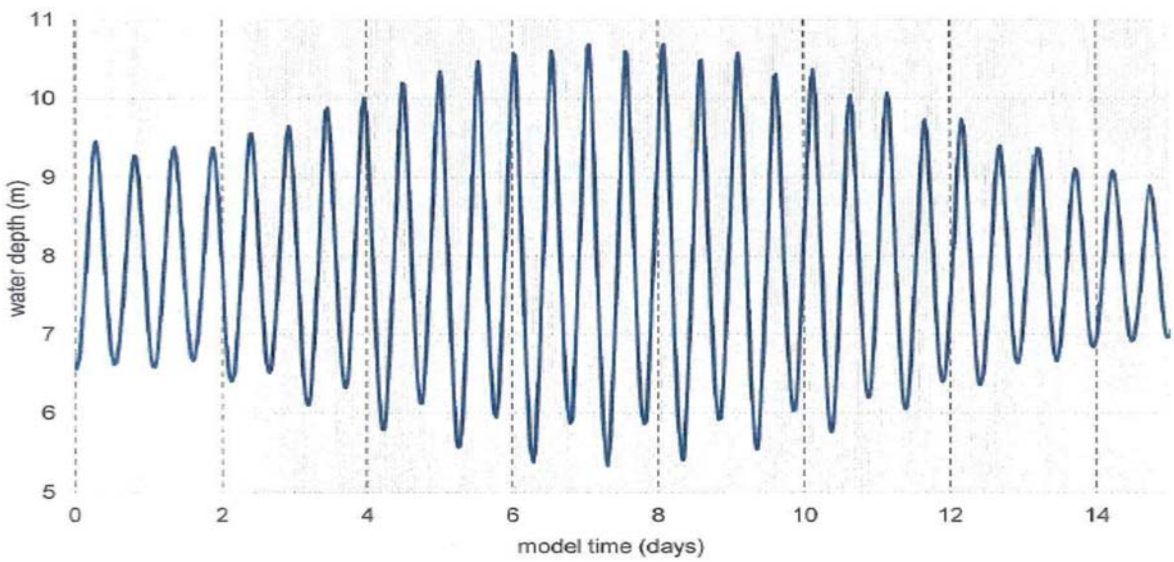

Figure 1: Water Depth at Bradwell

For radioactive buoyant effluent discharging at 5.5m above the bed level, the water column mixing will be the difference between the height of the tide at 2.5hours after high water and the height of the discharge port (i.e. 8.6m – 5.5m = 3.1m) as shown in figure 2.

[1] HR Wallingford, March 2014. Bradwell Power Station Effluent Discharge Arrangements: Initial Dilution

For other non-radioactive effluent discharging at any time into the estuary, the mixing column in the water is calculated as the difference between the heights of lowest astronomical tide and the discharge port (i.e. 5.8m – 2.34m = 3.46m) as shown in figure 2. This assumes that the effluent goes out at the lowest tide (worst case scenario) where the tide height is zero i.e. Chart Datum.

In the H1 Annex D1 guidance, the Allowable Effective Volume Flux (AEVF) in m^3/s is equal to the water depth in meters or for buoyant effluents, the difference in height between the discharge point and the tide height in meters up to a maximum of 3.5m. The AEVF then becomes $3.1m^3/s$ and $3.46m^3/s$ for the radioactive and other non-radioactive discharges respectively.

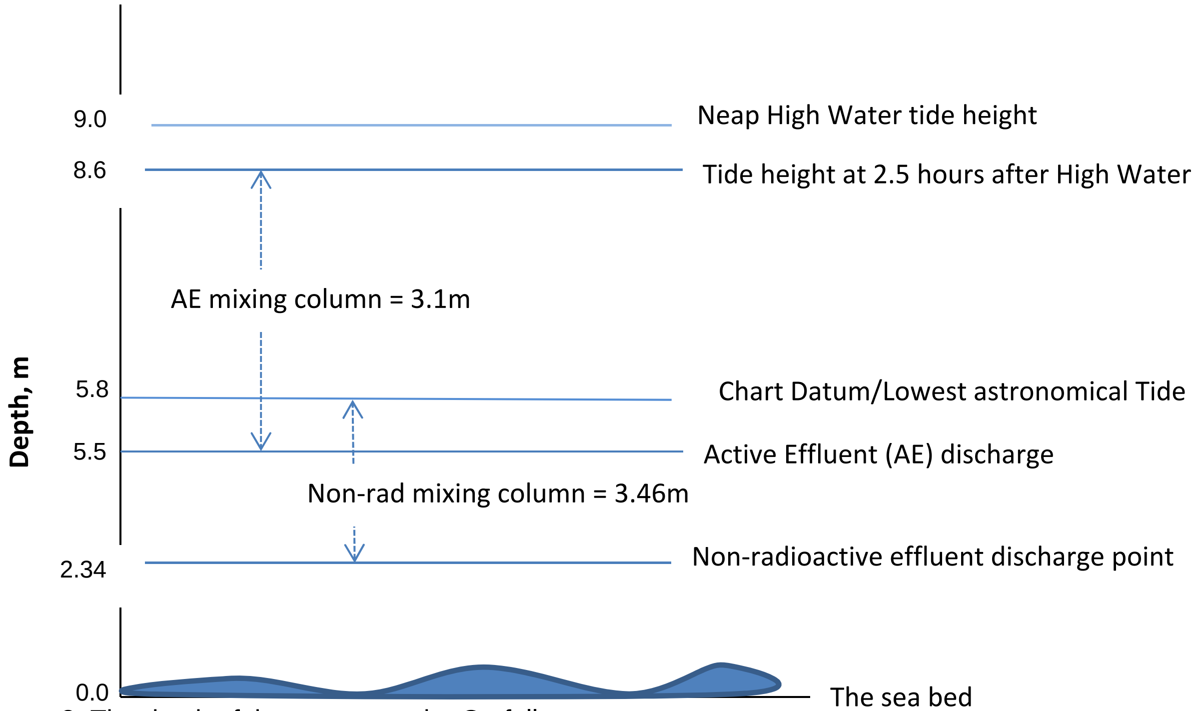

Figure 2: The depth of the estuary at the Outfall structure

Non-radioactive effluent

With the proposed EQSs which comes into effect on 22nd December 2015[2], all the metals in the non-radioactive effluent except Chromium will still be below 100% of the EQSs as can be seen in Table1. TraC Screening Phase 1 tests 2 to 4 remain the same for the effluent as described in the original risk assessment[3]. However, test 5 will change and this has been re-assessed as below and the results shown in Table 2.

Table 1: Effluent Concentrations and EQS-MAC and EQS-AA

Substance	Actual Maximum Release Concentration(Abated), (µg/l)	Actual Average Release Concentration following dilution (µg/l)	Proposed EQS-MAC (µg/l) effective from 22nd December 2015	Proposed EQS-AA (µg/l) effective from 22nd December 2015
As	1.08	0.77	N/A	25
Cu	11.54	3.23	N/A	3.76

[2] Environment Agency October 2014. H1 Annex D1 Assessment of hazardous pollutants within surface water discharges
[3] BRAD/EN/REP/108 Environmental Risk Assessment for Aqueous Effluent.

Cr	6.77	3.38	32	0.6
Pb	1.54	0.46	14	1.3
Ni	4.92	1.54	34	8.6
Zn	5.23	1.54	N/A	7.9

<u>TraC Screening Phase 1 Test 5</u>

This test compares the EVF (a measure of pollutant load) with the AEVF for buoyant effluents. Providing the EVF is less than the AEVF then the discharge can be considered insignificant.

The EA's H1 Annex D1 Assessment of hazardous pollutants within surface water discharges defines the EVF as:

EVF = (EFR x RC) / (EQS-BC) m^3/s

EFR - Effluent discharge rate for EQS-AA in m^3/s is 0.0015 m^3/s
(EFR for EQS-AA is calculated as $5.4m^3$ volume pumped per hour / 3600 (seconds)
RC - Release concentration, µg/l
EQS - EQS-AA, µg/l
BC - Background concentration, µg/l

Table 2: Effective Volume Flux Average Release Concentration

Substance	Avg. Effluent Flow Rate, m^3/s	Average Release Conc., µg/l	EQS-AA, µg/l	Background Conc., µg/l	EVF (EQS-AA), m^3/s
Cr	0.0015	3.38	0.6	0.5	0.0508

As stated above, the AEVF is $3.46m^3/s$. At $3.46m^3/s$, the AEVF is greater than the EVF of $0.0508m^3/s$ for Chromium so it can be screened out and no further modelling is required for this effluent.

<u>Radioactive Effluent</u>

Again, using the proposed EQSs, the concentrations of Chromium, Nickel, Copper, Zinc, Cadmium, Lead and Mercury were all above 100% of the EQSs and therefore fail the TraC Screening Phase 1 Test 1 assessments as shown in Table 3. The subsequent tests 2 to 4 remain the same, however the substances will have to be re-assessed under test 5. Test 5 assessments were carried out for all the substances that failed test 1 and the results are shown in Table 4. Table 5 shows the EVF calculations using the current EQSs.

Table 3: Radioactive effluent concentrations

Substance	Pre-abatement Maximum Concentration in the Effluent (µg/l)	Post-abatement/Release concentration, (µg/l)	Proposed EQS-MAC (µg/l) effective from 22nd December 2015	Proposed EQS (AA) / µg/l effective from 22nd December 2015
B	2,258	879	n/a	7,000
Cr	26	23	32	0.6
Fe	666	485	n/a	1,000
Ni	37	14	34	8.6
Cu	37	30	n/a	3.76
Zn	854	122	n/a	7.9
Cd	4	2	n/a	0.2
Pb	11	5	14	1.3
Hg	3	2.1	0.07	n/a

EFR - Effluent discharge rate in m^3/s ($0.008 m^3/s$)
(EFR calculated $30m^3$ volume pumped per hour / 3600 (seconds) i.e. Maximum pumping capacity)

Table 4: Effective Volume Flux using Proposed EQS which comes into effect on 22nd December 2015

Substance	Effluent Flow rate, m3/s	Release concentration, (µg/l)	Proposed EQS (AA) / µg/l effective from 22nd December 2015	Proposed EQS-MAC (µg/l) effective from 22nd December 2015	Background Concentration, µg/l	EVF (EQS-AA), *m^3/s*	EVF (EQS-MAC), *m^3/s*
Cr	0.008	23	0.6	32	0.5	1.84	0.006
Ni	0.008	14	8.6	34	0.95	0.01	0.003
Cu	0.008	30	3.76	n/a	1.09	0.09	-
Zn	0.008	122	7.9	n/a	1.01	0.14	-
Cd	0.008	2	0.2	n/a	0.04	0.10	-
Pb	0.008	5	1.3	14	0.05	0.03	0.003
Hg	0.008	2.1	n/a	0.07	0.01	-	0.280

Table 5: Effective Volume Flux using Existing EQSs

Substance	Effluent Flow Rate, m^3/s	Release Concentration, µg/l	EQS-AA, µg/l	EQS-MAC, µg/l	Background Concentration, µg/l	EVF (EQS-AA), *m^3/s*	EVF (EQS-MAC), *m^3/s*
Cu	0.008	30	5	N/A	1.09	0.06	-
Cr	0.008	23	0.6	32	0.50	1.84	0.006
Zn	0.008	122	40	N/A	1.01	0.03	-
Cd	0.008	2	0.2	1.5	0.04	0.10	0.011
Hg	0.008	2.1	0.05	0.07	0.01	0.42	0.280

The AEVF for radioactive discharges ($3.1m^3/s$) at Bradwell is greater than the EVFs for all the metals listed in Table 4 and 5 so they can be screened out and no further modelling is required for this effluent.