Email of 18.11.15 from Patrick Haley at Magnox Ltd

Hi Bill,
See below my comments and clarifications in red text to some of the questions you highlighted in your email dated 20th October 2015. We are working with HR Wallingford to provide answers to the questions raised regarding the modelling report. The responses below assume that the dilution factors stated in the HR Wallingford reports are all correct.

Your email with our comments and clarification red text

Thank you for agreeing to a meeting. Our basic aim is to have a discussion of the modelling and impact assessment reports provided in the application as part of a process to clarify them for us. But we also need to discuss the latest advice from Natural England about protection of the interest features of the Marine Conservation zones. This is something you couldn't address in the application because it hadn't been published at that stage. I have attached the relevant documents for your information.

At some stage we will probably issue our questions as a formal notice but (given the complexity of the reports) it was obvious that written Q's and A's would not be sufficient for a proper understanding of the issues in this case. We aren't expecting you to have all the answers to the questions below by Friday. They are just to start the process.

Putting it simply, we have to be sure that the modelling and impact assessment demonstrate that the proposed discharges will not pose a risk to any of the sensitivities of the receiving waterbodies. With regards to the metals this means that the relevant EQS's will not be breached outside an 'acceptable' mixing zone and for nitrates it means causing no significant change to the background concentrations in areas of the estuary that are sensitive to eutrophication.
You have attempted to demonstrate this mainly by giving us the results of models that show that there are very large theoretical dilution factors available in the estuary so that the concentrations of metals and nitrates from the discharges will be greatly reduced within it. And also by quoting various distances and plume sizes that the discharges will have an influence over. Our main problem is that we cannot see from the reports how the models interact to produce these dilution factors or plumes. We think the interaction between the CORMIX and Telamac systems is the crux of this, but in any case we do need to know where the dilution factors came from and have much more detail about the size and shape of the mixing zones.

Incidentally we note that some of the EQS's quoted in the report are out of date and that some substances have not been included in the main analysis (the EQSs used in the risk assessment are from the latest H1 Annex D1 guideline published in October 2014. It is our understanding from the H1 Annex D1 guidance that the revised EQSs will be applicable from 22nd December 2015. I have therefore provided 4 tables that show maximum abated metal concentrations that would still meet the insignificant criteria in the EA's H1 Annex D1 assessment i.e. Predicted Environmental Concentration being less than 100% of the EQS. Table 1 and 2 uses the current EQSs as provided in the H1 Annex D1 guidance, whiles Tables 3 and 4 are based on proposed EQSs which come into force from 22nd December 2015. The calculations in the tables have assumed that the dilutions achieved in the estuary and stated in the HR Wallingford Reports remain the same (Dilutions averaged over a period EQS-AA calculations is 48000:1 and instantaneous dilution used in EQS-MAC calculations 240:1)
The table below is a summary of all the relevant substances with the minimum dilutions required for each to meet the appropriate EQS;s based on the tables you provided in the reports. Assuming that all the discharges would not take place on every day of the requested time period, and would in fact be intermittent to various degrees, it is the dilutions to achieve MACs that are the most relevant.

Table 1: PEC Against the Current EQS AA using the Abated Metal Concentrations of Combined FED Effluent

Substance	Concentration of Abated FED Effluent and NOx Scrubber Liquor in the FMDT in µg/l	Process Contribution in µg/l using Dilution Factor 48,000:1 for short discharges	Average Background Concentration in µg/l	Predicted Environmental Concentration (Process Contribution + Background) in µg/l	EQS AA in µg/l	Predicted Environmental Concentration as % of EQS AA in µg/l	Concentration of metals that will still meet insignificant criteria in µg/l (i.e.RC=(0.9*EQS*ID)-(ID*BC))
Boron	86.2	1.80E-03	700	7.00E+02	7000	10	268800000
Cadmium	1.5	3.13E-05	0.04	4.00E-02	0.2	20	6720
Chromium	186.1	3.88E-03	0.50	5.04E-01	0.6	84	1920
Copper	11.2	2.33E-04	1.09	1.09E+00	5	22	163680
Iron	90.7	1.89E-03	50.00	5.00E+01	1000	5	40800000
Lead	2.6	5.42E-05	0.05	5.01E-02	7.2	1	308640
Mercury	5.2	1.08E-04	0.01	1.01E-02	0.05	20	1680
Nickel	226.8	4.73E-03	0.95	9.55E-01	20	5	818400
Zinc	10.9	2.27E-04	1.01	1.01E+00	40	3	1679520

Table 2: PEC Against Current EQS MAC using Abated Metal Concentrations of Combined FED Effluent

Substance	Concentration of Abated FED Effluent and NOx Scrubber Liquor in the FMDT in µg/l	Process Contribution in µg/l using Dilution Factor 240:1	Average Background Concentration in µg/l	Predicted Environmental Concentration (Process Contribution + Background) in µg/l	EQS MAC in µg/l	Predicted Environmental Concentration as % of EQS MAC in µg/l	Concentration of metals that will still meet insignificant criteria in µg/l (i.e. RC=(0.9*EQS*ID)-(ID*BC))
Boron	86.2	3.59E-01	700	7.00E+02	n/a	n/a	n/a
Cadmium	1.5	6.25E-03	0.04	4.63E-02	n/a	n/a	n/a
Chromium	186.1	7.75E-01	0.50	1.28E+00	32	4	6792
Copper	11.2	4.67E-02	1.09	1.14E+00	n/a	n/a	n/a
Iron	90.7	3.78E-01	50.00	5.04E+01	1000	5	204000
Lead	2.6	1.08E-02	0.05	6.08E-02	14	0	3012
Mercury	5.2	2.17E-02	0.01	3.17E-02	0.07	45	12.72
Nickel	226.8	9.45E-01	0.95	1.90E+00	34	6	7116
Zinc	10.9	4.54E-02	1.01	1.06E+00	n/a	n/a	n/a

Table 3: PEC Against Proposed EQS AA using the Abated Metal Concentrations of Combined FED Effluent

Substance	Concentration of Abated FED Effluent and NOx Scrubber Liquor in the FMDT in µg/l	Process Contribution in µg/l using Dilution Factor 48,000:1 for short discharges	Average Background Concentration in µg/l	Predicted Environmental Concentration (Process Contribution + Background) in µg/l	Proposed EQS AA effective from 22nd December 2015, µg/l	Predicted Environmental Concentration as % of EQS AA in µg/l	Concentration of metals that will still meet insignificant criteria in µg/l (i.e. RC=(0.9*EQS*ID)-(ID*BC))
Boron	86.2	1.80E-03	700	7.00E+02	7000	10	268800000
Cadmium	1.5	3.13E-05	0.04	4.00E-02	0.2	20	6720
Chromium	186.1	3.88E-03	0.50	5.04E-01	0.6	84	1920
Copper	11.2	2.33E-04	1.09	1.09E+00	3.76	29	110112
Iron	90.7	1.89E-03	50.00	5.00E+01	1000	5	40800000
Lead	2.6	5.42E-05	0.05	5.01E-02	1.3	4	53760
Mercury	5.2	1.08E-04	0.01	1.01E-02	n/a	n/a	
Nickel	226.8	4.73E-03	0.95	9.55E-01	8.6	11	325920
Zinc	10.9	2.27E-04	1.01	1.01E+00	7.9	13	292800

Table 4: PEC Against Proposed EQS MAC using Abated Metal Concentrations of Combined FED Effluent

Substance	Concentration of Abated FED Effluent and NOx Scrubber Liquor in the FMDT in µg/l	Process Contribution in µg/l using Dilution Factor 240:1	Average Background Concentration in µg/l	Predicted Environmental Concentration (Process Contribution + Background) in µg/l	Proposed EQS MAC effective from 22nd December 2015, µg/l	Predicted Environmental Concentration as % of EQS MAC in µg/l	Concentration of metals that will still meet insignificant criteria in µg/l (i.e. RC=(0.9*EQS*ID)-(ID*BC))
Boron	86.2	3.59E-01	700	7.00E+02	n/a	n/a	n/a
Cadmium	1.5	6.25E-03	0.04	4.63E-02	n/a	n/a	n/a
Chromium	186.1	7.75E-01	0.50	1.28E+00	32	4	6792
Copper	11.2	4.67E-02	1.09	1.14E+00	n/a	n/a	n/a
Iron	90.7	3.78E-01	50.00	5.04E+01	n/a	n/a	n/a
Lead	2.6	1.08E-02	0.05	6.08E-02	14	0	3012
Mercury	5.2	2.17E-02	0.01	3.17E-02	0.07	45	12.72
Nickel	226.8	9.45E-01	0.95	1.90E+00	34	6	7116
Zinc	10.9	4.54E-02	1.01	1.06E+00	n/a	n/a	n/a

Table 1. Calculation of minimum dilutions needed to meet EQS's for MAC or AA

Substance	Max Conc. in abated FED (µg/l)	Max Conc of combined abated FED and NOx (µg/l)	Max Conc in NOx scrubber liquor (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	Minimum dilution to meet EQS based on MAC	Minimum dilution to meet EQS based on AA
Boron	85	86.2	59.5	n/a	7000	n/a	0.0
Cadmium	1.5	1.5	0.5	n/a	0.2	n/a	7.5
Chromium	146.5	186.1	1980	32	0.6	61.9	3,300
Copper	11	11.2	11.9	n/a	3.76 + ..	n/a	n/a
Iron	68.7	90.7	1100	n/a	1000	n/a	1.1
Lead	2.6	2.6	0.3	14	1.3	0.2	2.0
Mercury	5	5.2	10	0.07	n/a	142.9	n/a
Nickel	184.7	226.8	2106	34	8.6	61.9	245
Zinc	10.5	10.9	18.4	n/a	7.9	n/a	2.3
Cobalt	0			3	100		
Silver	48			1	0.5	48	96
Nitrate	35591818						

Another problem for us has been understanding the way in which the discharges will interact within the estuary and being certain that this has been taken account of in the modelling. After receipt of the application we sought clarification about the discharge volumes, contents, and discharge arrangements and a summary of our understanding of this is given below. Assuming it is correct we need to be certain that this accords with the inputs to your models to be confident in its outputs.

1) **FED (including NOX scrubber liquors)**

Volume	Maximum 20 m^3/day (includes NOx liquors up to max of 300 litres/day
Rate	Maximum of 11.1 l/s
Discharge timing	pumped out in 30 minutes on one ebb tide per day between 1 and 2.5 hours after high water
Outlet type	one pipe 180 mm diameter with a 65 mm outlet nozzle situated 5.5 metres above the estuary bed just below the lowest tide level and angled offshore perpendicular to the currents. (Note: the Aqueous discharge will go through the same pipe on a different ebb tide)
Frequency	The permit will allow the discharge to take place over two years but there isn't enough FED waste to generate a daily discharge of 20 m3 every day for two years. The frequency will probably depend on how well the treatment plant runs and it is quite likely that it will be intermittent in practice.
Contents	Nitrates & metals

2) **AQUEOUS also called 'Active' or 'AE' in Wallingford report (radioactive site drainage and void waters, treated in the aqueous discharge abatement plant 'ADAP')**

Volume	maximum 30 m^3 a day (says 40m^3 in the reports but Magnox subsequently quoted 30

	in an email) **Magox comment** the final delay tanks size is approximately 30m^3 and therefore the volume stated in the email is the correct one)
Rate	Maximum of 11 l/s
Discharge timing	pumped on a different ebb tide to the FED discharge over 45 minutes between 1 and 2.5 hours after high water
Outlet type	same pipe as FED discharge
Frequency	Because the influent is rainfall and groundwater dependent there may not be a discharge every day. (*On approximately 2 days a year on average the ADAP plant may treat the 300 litres of NOX scrubber liquors instead of this going to the FED treatment plant)* *.**Magnox Comment** (As described in EN/REP/108 sources of the active effluent are mainly from ad-hoc project related effluents e.g. condensate from ILW drying, decontamination washings etc. and rain falling on the active waste vaults which goes to an active drain ending up in the active effluent. The rest of the site's surface water drains do not go through this route, they go to main drains pit and then discharge on automatic level pumps. Therefore the AE is rainfall dependent but is only a very small proportion of the total rainfall on the site.* *NOx effluent will be treated in FED ADAP and discharge through the FED route and therefore will be part of this effluent. It is anticipated that this effluent will be discharge twice every month on average).*
Contents	Metals *(There will be some nitrates from the NOX liquors but they would have gone through the FED discharge anyway*)

3) **TREATED (non-radioactive) SITE DRAINAGE AND SEWAGE EFFLUENT**

Volume	Rainfall dependent up to a maximum of 50,000m^3 a day. But in dry weather conditions the volume will be 130 m3 a day. Within the 130m^3 a day the site drainage that has been treated in the siltbusters will be a maximum of 20m^3 and the maximum daily volume of treated radioactive effluent will be 30m^3. The 20m^3 of treated site void effluent will therefore be diluted by a minimum of 6.5:1 in clean site drainage and treated sewage effluent.
Rate	maximum 303 l/s
Discharge timing	the site drainage and treated sewage effluent mix in a holding tank which has a pump activated by a float switch set at 1.2 metres. So the discharge is automatic and triggered by water levels generated by rainfall and

	sewage influent. There is no co-ordination with the tides or other discharges.
Outlet type	three pipes of 180 mm diameter close to the estuary bed
Frequency	intermittent based on rainfall and daily sewage effluent volumes
Contents	Metals

In the light of the above we need the following:-

1. Confirmation that our understanding of the way the discharges are made is correct and that they were input into the model accordingly – We are awaiting HR Wallingford report to clarify input of discharges into model. Further clarification regarding effluents has been provided in the preceding effluent description tables.

2. Details of how CORMIX was set up for each of the discharges – Awaiting HR Wallingford's clarification report to respond.

3. To know if the modelling for the FED include the NOX or were they modelled separately? If separately, what buoyancy characteristics were assumed for the NOX? – The FED effluent contains nitrate and therefore are not two different streams but one effluent.

4. To know the reason for the discontinuity in Figure 5.1 and the inflection in Figure 5.3? – Awaiting HR Wallingford report to respond.

5. A Figure similar to Figure 5.6 for the FED discharge - Awaiting HR Wallingford report to answer this question.

6. A Figure showing the distance to where the FED plume reaches the estuary bed in relation to current speed and give the plume dilution at this point. - Awaiting HR Wallingford report to respond.

7. Better linkage between the CORMIX modelling and the Environmental risk assessment is needed. Instances of a lack of clarity are, (a) the Telemac modelling uses an initial dilution from CORMIX of 240:1 while the annual average concentration dedicated discharge report (EBR4908-RT012-R05-00) assumes initial dilutions of either 1000 or 700. (b) Report EBR4908-RT012-R05-00) mentions that the core of the discharge plume is tens of metres across and up to two metres thick close to the estuary bed. Where does this prediction come from? - Awaiting HR Wallingford report to respond.

8. To know the resolution of the Telemac model in the discharge area - Awaiting HR Wallingford report to respond.

9. To know how the negatively buoyant discharge is modelled in PLUME-RW? - Awaiting HR Wallingford report to respond.

10. To know how long it takes to become well mixed in the water column? Awaiting HR Wallingford report to respond.

11. To know how the change of buoyancy of individual particles as they mix is represented in the model? – All polluting substances are in solution in the effluent and therefore are not present as particles. In addition, entrained particles in the effluent are removed as part of the BAT requirement for the radioactive substances permit.

12. The correct depth of water for the AEVF analysis for the 'aqueous' effluent to be used in the H1 screening. There seems to have been an assumption that the whole depth of the estuary

can be used but (because the discharge pipe will be the same as for the FED) it will be made 5 metres above the estuary bed. – See attached document titled EA Further Information AEVF Correction.

13. To know the maximum daily volume of the waste waters from the reverse osmosis treatment of tap water to be used in the FED and ADAP plans. We assume the waste RO waters will be quite dense and that (if the volumes are large) they might affect the dispersion characteristics of the effluent they are discharged in. (The maximum daily waste water from the RO unit depends on FED dissolution activity on site. The maximum anticipated waste water from the RO unit is approximately 5m^3 daily. This goes into the main drains pit which mixes with large volume of treated effluent (treated sewage effluent, treated void effluent and surface water run-offs). The maximum volume of the main drains pit is 360m^3 but at every discharge it removes approx. 130m^3 of effluent to the estuary)

14. To know which effluent stream the RO waste waters will be discharge within ?(the RO water mixes with the treated sewage effluent, treated void effluent, surface water run-offs in the main drains pit)

15. To know accurate plume sizes for all the discharges. We need to be certain that EQS's are not breached in the vicinity of any of the interest features of the SSSI's SACS, SPA's, RAMSAR's or MCZ's. - Awaiting HR Wallingford report to respond.