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www.marinet.org.uk

Dr. Charles Beardall
Area Manager Essex, Norfolk and Suffolk
Environment Agency
Area Office, Iceni House
Cobham Road
Ipswich
Suffolk IP3 9JD

Stephen Eades
Director, Marinet Limited
Cedar Lodge
Allington
Chippenham
Wiltshire SN14 6LW
T. 01249 653972
E.stephen.marinet@btinternet.com

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Dear Dr. Beardall,

Bradwell Site, Magnox Limited : Expiry of Permits EPR/DP3127XB (Non-Radioactive), PR2TSE10760 (Surface Water and Sewage) and EPR/ZP3493SQ (Radioactive); and, Permit Variation Applications EPR/DP3127XB (Non-Radioactive), PR2TSE10760 (Surface Water and Sewage) and EPR/ZP3493SQ (Radioactive).

These are the comments of Marinet Limited regarding the existing permits whose original time limit has expired but which the licensing authority, the Environment Agency, has not sought to enforce and has allowed to continue to operate; and, the new permit variation applications which are currently open to public comment before determination by the licensing authority, the Environment Agency.

Executive Summary.

The Fuel Element Debris Dissolution (FED) component of the existing permits should be terminated, and their time expiry enforced. The Fuel Element Debris Dissolution component of the new variation applications should be refused.

The reasons for these decisions are as follows:

- Best Practical Environmental Option (BPEO) : The FED process for the handling of historic fuel element debris was, at the time of the Decommissioning Permit in 2002, the encapsulation of these materials in cementitious grout (encased in concrete). This policy was changed in 2006 as a result of a BPEO study which recommended, in preference to other options, the dissolution of the fuel element debris in carbonic acid, the extraction of the radioactive elements in solid form for storage in accordance with Nirex (Nuclear Industry Radioactive Waste Executive) requirements, and the discharge of the dissolution liquor and any contamination into the Blackwater estuary.

The current FED dissolution process is no longer in accord with the 2006 BPEO. This is because it dissolves the fuel element debris in nitric acid, not carbonic acid, which results in nitrate discharges into the Blackwater estuary. Nitrates have an entirely different environmental impact on the estuary compared to carbonates. Therefore the existing FED permit and new variation permit are in breach of the original BPEO unless the nitrate impact on the estuary can be authorised as negligible. It is our contention, evidenced below, that it cannot and that therefore the existing and proposed FED permits are in breach of the 2006 BPEO authorisation.

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● Nitrate Pollution : For the FED process to be in accordance with environmental regulations (BPEO Regulations, Water Framework Directive Regulations, Habitats Directive Regulations, Marine and Coastal Access Act [MCCA] Regulations) the nitrates discharged into the Blackwater estuary as a result of the FED process must be able to demonstrate no adverse impact in accordance with the specific requirements of each set of Regulations. Breach of any one of these Regulations would mean that the existing FED permit and its variation could not be authorised.

It is our contention, evidence below, that the nitrate discharges are in breach of the BPEO and Water Framework Directive Regulations and, this being so, are also likely to be breach of the Habitats Directive and the MCCA Regulations.

● Heavy Metals Pollution : For the FED process to be in accordance with environmental regulations (BPEO Regulations, Water Framework Directive Regulations, Habitats Directive Regulations, Marine and Coastal Access Act [MCCA] Regulations) the heavy metals discharged into the Blackwater estuary must be able to demonstrate no adverse impact in accordance with the specific requirements of each set of Regulations. Breach of any one of these Regulations would mean that the existing FED permit and its variation could not be authorised.

It is our contention, evidenced below, that the discharge of certain heavy metals, notably Chromium but also possibly others, are in breach of the Environmental Quality Standard Annual Average levels (EQA AA) of the Water Framework Directive; and, will impact adversely on sediments in the estuary which are currently in exceedance of the Effects Range Low (ERL) levels for Chromium and also possibly other heavy metals; and, because these discharges will likely elevate these levels further, will very probably lead to a determination of adverse impact under an "appropriate assessment" and thus, if permitted, will likely lead to a breach of the BPEO, Habitats Directive and MCCA Regulations.

● Radioactive Pollution : For the FED process to be in accordance with environmental regulations (BPEO Regulations, Habitats Directive and Marine and Coastal Access Act [MCCA] Regulations) the radionuclides discharged into the Blackwater estuary must be able to demonstrate no adverse impact in accordance with the specific requirements of each set of Regulations. Breach of any one of these Regulations would mean that the existing FED permit and its variation could not be authorised.

It is our contention that the full nature and quantity of specific radionuclides discharged into the Blackwater estuary as a result of the FED process is unspecified and undeclared. The existing and new variation FED permits fail to monitor and so safeguard the native oyster (*Ostrea edulis*) in the estuary, and so are in contravention of the MCCA Regulations which have the native oyster and its habitat (sediments) a protected feature of the Blackwater, Crouch, Roach and Colne Estuaries Marine Conservation Zone (Blackwater MCZ) under the Marine and Coastal Access Act (MCCA) 2009. In addition, the existing and new variation FED permits fail to monitor and so safeguard the oyster fishermen for adverse impact from these discharges, and so are in breach of the licensing authority's (Environment Agency) national guidance (*Technical Guidance Note 2 – Environmental Radiological Monitoring. Environment Agency, December 2010*). These foregoing contraventions will therefore also likely lead to a breach of the BPEO, Habitats Directive and Water Framework Directive Regulations.

Evidence in support of each of the above contentions regarding the lawfulness or otherwise of the FED component of the existing and new variation permit application is now presented below.

Best Practical Environmental Option (BPEO).

The 2006 BPEO specifies "*Dissolution of the Magnox waste and associated Magnox corrosion products by complete dissolution in carbonic acid, resulting in a magnesium bicarbonate liquor* and *the*

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magnesium bicarbonate liquor is processed to reduce radioactive discharges to Blackwater Estuary by sand pressure filtration to remove insoluble residues and ion-exchange to remove soluble radionuclides." (Ref. BPEO Study, September 2006, Option 1a, Dissolution at Bradwell).

In order for this BPEO Option (1a) to be overridden to allow nitric acid to be used in preference to carbonic acid, and hence for nitrates in the waste FED treated liquor to be discharged into the Blackwater Estuary in preference to carbonates, Magnox Limited had under the EIA Decommissioning Regulations 1999 to make a declaration known as a "Finding of No Significant Effect" (FONSE).

The FONSE, 7th December 2010, declared:

Nitrate discharges would only take place in accordance with the current RSA93 discharge consent conditions, i.e. on the ebb tide. This would also be the optimum time period as regards minimising the accumulation of nitrates in the estuary.

A modification to the site's Water Resources Act authorisation will be required, as dissolution is not one of the listed site processes within the site's current consent. Within the amended authorisation the Environment Agency may impose conditions relating to nitrates, and may re-iterate by condition their legal right to require that discharges cease should they have any significant concerns.

The Bradwell estuary has several international designations for ecological value, and the Environment Agency has a statutory duty to monitor and protect the estuary from significant harm, and to assess whether significant harm may be incurred in advance of granting consents. It is therefore considered that there are sufficient safeguards against dissolution having a significant adverse environmental impact on the ecology of the Blackwater Estuary.

The Biological Oxygen Demand in the receiving waters may change post discharge but only as a result of the increased nitrates, as discussed above.

Therefore is clear that Magnox, in order to obtain its original FED permit and to obtain a future variation to this FED permit, would have to firstly obtain a modification to the site's Water Resources Act authorisation from the Environment Agency; and secondly, demonstrate that no significant harm would be caused to the estuary or its protected features (SAC, SPA, MCZ and SSSI) before that consent could be granted.

Marinet Limited has examined the papers released to it under a Freedom of Information request to the Environment Agency and the Office of Nuclear Regulation in respect of the existing FED permit and, at the present time, Marinet has not seen the required authorisation under the Water Resources Act in the papers that have been released. Nor has this document been observed by Marinet in the documents released by the Environment Agency in connection with the current public consultation on the FED permit variation.

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The question therefore must be asked : does this specific authorisation exist ?

If not, the lawfulness of the existing FED permit must be questionable under the BPEO Regulations; and, the same applies to the current application for a FED permit variation.

Further, if the impact of the nitrate discharges both from the existing FED permit and under its permit variation application is adverse upon the Blackwater estuary as defined by the Water Framework Directive, then no such Water Resources Act authorisation could be issued and the FED permit, both existing and future, would not be lawful under the BPEO Regulations.

Questions therefore exist as to whether the FED permit, both in its existing and proposed forms, is lawful under the BPEO Regulations.

Nitrate Pollution.

The existing permit (whose time expiry has not been enforced by the licensing authority, the Environment Agency) and the new variation to the permit application are both granted/pre-disposed to be granted (ref. draft Decision Document EPR/DP3127XB) on the basis that the nitrate loading on the Blackwater estuary arising from the FED process will cause "**no significant adverse effect"** – the significance of this effect being defined under the terms of the Water Framework Directive Regulations.

To the contrary, we assert that a significant adverse effect will be caused. We base this assertion in relation to the applicant's statement of evidence in connection with the following matters:

• Firstly, the evidence from the applicant and its consultants – and thereby the Environment Agency through its acceptance of the evidence in this form – has understated the nitrate load on the estuary. In other words, the full extent of the nitrate load from the FED process has not been used in the calculation of whether the nitrate load has a significant adverse effect on the Blackwater estuary.

• Secondly, the calculation of whether there exists a significant adverse nitrate load (notwithstanding the matter of the load's understatement, ref. matter above) has been made for the purpose of determining the permit on the basis of the load during one day of discharge. A calculation on this basis records an adverse load of between 7% and 9%, which is compliant with the Water Framework Directive Regulations which require that the uplift in the adverse load upon the estuary should not exceed 10%.

However the nitrate load is cumulative, with a proportion of the load that is being discharged on the ebb tide (discharging on the ebb tide is a permit requirement) being returned on the returning flood tide. Thus there is not a 100% flushing of the estuary.

This means that when the FED discharge is made on the following day the load on the estuary is not just the **one day** discharge, **but also** the proportion returning on the flood tide from the previous day. This process is cumulative from day to day, and the **full load** for the purposes of determining whether there is significant adverse impact is not reached (assuming daily discharges) until after around two months.

When the nitrate load is measured after 50 day and 57 days (ref. *HR Wallingford, FED Discharge Arrangements : Far-Field Dispersion, March 2014*) it is clear that nitrate loads in the mid and outer estuary, measured on average day-long levels, exceed the 10% deterioration threshold of the Water Framework Directive Regulations over a substantial part of the mid and outer estuary.

We now consider the evidence relating to each of these matters in more detail.

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Unrecorded FED Nitrate Load.

The models for the FED nitrate load, both in the existing and variation permit application EPR/DP3127XB, are based on the nitrate liquor arising from the FED dissolution tanks with a small amount of nitric acid liquor, 50 litres per batch, added from the NOX scrubbers which clean the gaseous emissions (ref. *FED Environmental Risk Assessment, Chapter 4, July 2015*). It is this nitrate load that it used to calculate the nitrate load on the Blackwater estuary. This discharge amounts to 20 m^3 per discharge (20,000 litres) which occurs daily.

However there is an additional nitrate burden from the FED process which is not wholly incorporated into the applicant's model of the nitrate burden on the estuary. This derives, in part, from the surplus nitric acid arising as a product of the NOx scrubbers which is not recycled into the FED dissolution process.

Whilst the Applicant's Environmental Statement gives attention to this waste stream, full details as to its nature (nitric acid concentration, and thus nitrate concentration) and as to its quantity (volume in m^3 or litres) are imperfectly recorded. In the case of the acid concentration (the nitrate concentration) nothing precise is recorded in the ES or subsequent documents. Regarding the volume, details are imprecise.

The applicant states (Report titled: *Annual average concentration – dedicated discharge, Executive Summary, dated January 2015*)

The discharges may include an occasional discharge of effluent containing treated NOx scrubber liquors. This discharge is likely to occur around twice a year, but the modelling is based on a frequency of 28 days; this assumption is pessimistic because should the discharge of NOx scrubber liquor be on a longer interval the dilution factor will increase accordingly. The discharge will be made on separate days to the FED dissolution discharges, which will usually be made on a daily basis. The working assumption is that the intermittent discharge will be made within the same volume of effluent as the FED (20 m^3) and its density is similar; we have therefore assumed that its initial dilution will be the same as for the FED.

However, what is the actual volume of NOx scrubber liquid arising daily ? This is not stated in the main documents, but does appear to emerge from an email exchange between Magnox Limited and the Environment Agency, dated 1st September 2015 (Document titled: *Email of clarification of discharges*):

• The app states that 50 litres of NOX effluent will be added to a batch of 2,450 litres of acid FED bath. Does this mean that you will need to do 8 batches of FED a day to achieve the maximum 20 m3 of treated effluent?
In practice we are targeting six dissolution batches each day. The extra volume will be made up from caustic solution added for neutralisation in the abatement plant.

• How much NOX effluent is produced each day?
300litres per day absolute maximum. This will vary depending upon how much NOx liquors are needed to be removed from the scrubber to regulate pH. At present we are finding the dissolution reaction is clean, producing low gaseous NOx and therefore the NOx liquor pH in the scrubbers is constant, so there has not been a need to bleed and feed at all for many weeks.

• The application states that approximately twice a year the NOX liquors will bypass the FED acid bath and go strait into treatment. What volumes of NOX liquors would be involved in these bypasses?
300litres per day but in practice we would only do this in an outage situation our preferred option is re-use of the acid in dissolution.

Thus it would appear that the NOx scrubber acid liquor, which arises at a volume of c.300 litres daily, is being recycled on a daily basis into the FED dissolution liquor at a rate of 50 litres per batch (6 batches @ 50 litres per batch = 300 litres).

A later email, dated 18th November 2015, from Magnox Limited to the Environment Agency (Document titled: *Clarification of discharge details*) states:

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Volume: Maximum 20 m3/day (includes NOx liquors up to max of 300 litres/day
Frequency: 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)*

This exchange of emails appears to confirm that, broadly, NOx liquor is being recycled into the FED process and is being calculated, for purposes of assessing the nitrate burden, in the FED abated dissolution discharge.

However this exchange of emails does also record that this recycling is not necessarily total, and that surplus NOx liquor will accumulate. When ultimately discharged, this will be done within the daily FED discharge and that its "density" will be broadly similar. Nevertheless what remains ambiguous is the actual quantity (volume) of this surplus which is nowhere specified, as well as the actual frequency of the discharge – being cited as twice a year, once every 28 days, or twice a month depending of the document concerned (all cited above).

The exact additional "surplus" nitrate load (i.e. not recycled into the FED dissolution liquor) from the NOx scrubber process upon the Blackwater estuary is not stated, and hence unknown. It does not appear considerable, but it's imprecision along with the uncertainty over the frequency of discharge does leave a question mark hanging over the model of the true (full) nitrate burden on the estuary.

This uncertainty as to the full quantification of the nitrate load on the Blackwater estuary arising from Bradwell is made still more uncertain by a further additional question. This is whether Active Effluent (AE) – radioactive site drainage and void waters, treated in the aqueous discharge abatement plant (ADAP) – is incorporated into the model of the nitrate burden on the estuary ?

The applicant's Environmental Risk Assessment (ref. Document titled: *Annual average concentration – dedicated discharge, Executive Summary, January 2015*) states:
Active effluent (AE) will be discharged through the same structure as FED, but using a different discharge period of 45 minutes (and on different tides). The AE has a different density from FED and its initial dilution has been considered previously in Report EBR4908-RT009. The working assumption for the volume of the AE discharge batch is 28 m^3 (compared with 20 m^3 for the FED) and it will be discharged over a longer period of 45 minutes. A reference discharge period starting at HW+1 and running to HW+1.75 gives the dilutions summarised below.

However there is no evidence in the Environmental Statement that the nitrate burden in this Active Effluent has been quantified, nor that it has been incorporated into the model of the nitrate burden on the estuary.

Advice from Magnox to the Environment Agency, 18th November 2015 (ref. Document titled: *Clarification of discharge details*) states that the influent to this particular waste stream is weather dependent, so a discharge may not occur every day. Nevertheless the volume of each discharge is significant – a maximum of 30 m^3 – hence the absence of knowledge as to its nitrate load casts a question over the accuracy of the full nitrate load in the HR Wallingford model. It is true that this discharge does not arise as a result of the FED process. However this discharge is part of the overall nitrate burden which Bradwell is placing on the estuary. It therefore needs to be incorporated into the HR Wallingford model for the nitrate burden to be accurately calculated; and, it is to be noted that the volume of the discharge arising from this waste stream is significant. It is also to be noted that this effluent stream – Active

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Effluent – appears to be part of permit EPR/DP3127XB, and so requires to be involved in the HR Wallingford nitrate burden model.

Moreover, there is a still further potential nitrate load which needs to be part of the model, and this is "Treated Site Drainage and Sewage Effluent" arising from Bradwell – presumably recorded under permit PR2TSE10760 for which no draft Decision Document appears to have been published by the Environment Agency in connection with this public consultation.

The volume of this waste stream is weather dependent, but can reach a maximum of 50,000 m^3 per day (ref. Document titled: *Clarification of discharge details*, *18th November 2015*). Once again, this waste stream is not part of the FED process, but its nitrate load could have significance in determining the true overall nature of the nitrate burden of Bradwell on the Blackwater estuary. Hence it needs to be part of the HR Wallingford model, although its inclusion appears not to have been the case.

Conclusion:

Marinet Limited believes for a variety of reasons, recorded and evidenced above, that the applicant's EIA Risk Assessment Model **is understating the nitrate load on the estuary**. Further, this conclusion applies not just to the permit variation application, but also to the existing permit (whose expiry has not been enforced by the licensing authority [Environment Agency] and which remains active).

This understatement and failure to fully document is **significant** in terms of determining the permit variation application (and whether to enforce the expiry of the existing permit) because the model of the nitrate burden on the estuary is showing that the FED process with added NOx scrubber liquor is approaching a 9% adverse impact level on the estuary, when the threshold for unacceptable adverse impact is 10%.

Consequently the apparent exclusion of the "surplus" NOx scrubber liquor, the 30m^3 probable daily Active Effluent discharge, accompanied by the probable daily Site Drainage and Sewage Effluent discharge could bring the nitrate burden **over** the 10% adverse impact threshold. This deficiency in the Environmental Statement and EIA's evidence and modelling brings the integrity of the permit application into doubt; and, it must also be noted that although the Active Effluent and Site Drainage are not part of the FED process, the EIA Regulations do require all of these discharges and their nitrate loads to be evaluated **in combination.** This combined evaluation appears **not** to have occurred.

Compliance of Nitrate Discharges with Water Framework Directive (WFD) Regulations.

As has been stated, to comply with the WFD Regulations the nitrate burden from the existing permit and the permit variation application must not cause a deterioration of 10% or greater in the existing dissolved nitrate levels in the estuary's waters.

Measurements of the background nitrate concentrations (mg/l) in the upper, mid and outer Blackwater estuary have been undertaken by Magnox Limited (ref. *HR Wallingford, FED Discharge Arrangements : Far-Field Dispersion, March 2014, Table 4.1 Section 4.2 Far-field concentrations*). From these measurements, the 10% threshold is as follows: (ref. *Table 4.1, HR Wallingford, March 2014*).

Concentration (mg/l)	Comment
0.25	EQS value (coastal waters)
0.078	10% of average background value, upper estuary
0.039	10% of average background value, mid estuary
0.035	10% of average background value, outer estuary

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What this means is that if the concentration of nitrate in the outer estuary rises by 0.035 mg/l or more in the outer estuary due to the FED discharges, then the 10% threshold of adverse impact having occurred under the WFD Regulations is triggered. In the case of the mid estuary the rise that indicates that this 10% threshold has been triggered is 0.039 mg/l or more, and in the upper estuary the rise triggering this threshold is 0.078 mg/l or more.

The ES and EIA studies undertaken by HR Wallingford for the applicant, in particular the study titled: *HR Wallingford, FED Discharge Arrangements : Far-Field Dispersion, March 2014*, assess whether this threshold has been triggered.

The applicant's ES asserts that this threshold has not been triggered in any meaningful sense in either the upper, mid or outer Blackwater estuary. This assertion is based on Figure 4.3 (*HR Wallingford, Far-Field Dispersion, March 2014*) and related analysis where the predicted nitrate concentrations averaged over one day (spring tide) have been modelled. Apart from a small limited area of exceedance which is plume shaped in the mid and outer estuary, the statement that the threshold has not been triggered is true. In the case of the upper estuary, compliance with the WFD threshold is unambiguous. Thus no adverse effect from the FED nitrate discharges can reasonably be recorded, as the ES and EIA have done.

However due to the flushing characteristics of the estuary and the point of discharge (mid estuary) and the time of discharge (ebb tide), a proportion of each day's discharge is returned into the estuary on the flood tide, affecting primarily the mid and outer estuary. Whilst this return characteristic for each day will dilute progressively over subsequent days, it is cumulative. Thus if the discharge is made daily, as is the case with the FED nitrate discharges, then a retained burden builds up in the estuary based on the discharges made during earlier days. Consequently assessment of the nitrate burden based solely on a single day's discharge is misleading, and the true state of affairs – the true nitrate burden – has to be determined based on a measurement of an increased nitrate burden in the estuary after around 50 days, or longer. This is what HR Wallingford has done in Figure 6.1 – predicted nitrate concentrations averaged over one day on a spring tide after 50 days' discharge; and, Figure 6.2 – predicted nitrate concentrations averaged over one day on a neap tide after 57 days' discharge (*HR Wallingford, Far-Field Dispersion, March 2014*).

This reveals a very different reality.

After **50 days** on a spring tide the exceedance of the threshold in the **mid estuary**, based on Fig.6.1 is:

Range of 10% exceedance or more, mg/l	**Approximate exceedance area in mid estuary**
0.039 – 0.078	Around 60%
0.078 – 0.25	Around 5%

and,

After **50 days** on a spring tide the exceedance of the threshold in the **outer estuary**, based on Fig.6.1 is:

Range of 10% exceedance or more, mg/l	**Approximate exceedance area in outer estuary**
0.039 – 0.078	Around 20%
0.078 – 0.25	Around 5%

also,

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After **57 days** on a neap tide the exceedance of the threshold in the **mid estuary**, based on Fig.6.2 is:

Range of 10% exceedance or more, mg/l	Approximate exceedance area in mid estuary
0.039 – 0.078	Around 60%
0.078 – 0.25	Around 25%

and,

After **57 days** on a neap tide the exceedance of the threshold in the **outer estuary**, based on Fig.6.2 is:

Range of 10% exceedance or more, mg/l	Approximate exceedance area in outer estuary
0.039 – 0.078	Around 40%
0.078 – 0.25	Around 25%
0.25 - 1	Less than 1%

In the case of the upper estuary, compliance with WFD threshold at both 50 days (spring tide) and 57 days (neap tide) was demonstrated. This compliance is probably primarily due to the higher background nitrate level in the upper estuary (average background level 0.78 mg/l) and the fact that the FED discharge is made at a point in the mid estuary on the ebb tide, thus preventing any substantial levels of nitrate returning to the upper estuary on the flood tide.

Thus it is abundantly clear that when the FED originating nitrate burden on the mid and outer estuary is modelled after 50 and 57 days, there is substantial and widespread exceedance of the WFD 10% threshold throughout these sections of the Blackwater estuary.

The observations of HR Wallingford (the applicant's consultant which has prepared this model to determine whether the threshold of 10% deterioration in the nitrate burden on the Blackwater estuary is likely to occur as a result of the FED discharges), are: (ref. *Section 4.2.1 HR Wallingford, Far-Field Dispersion, March 2014*) : " *On both spring and neap tides there is a large area of pale blue* [0.038-0.078] *which indicates that the average nitrate concentration produced by the discharge is over 10% of background nitrate for the outer and middle estuary but below 10% of background for the upper estuary. On the neap tide, with the smaller tidal excursion, the areas of impact is shorter but concentrations within the footprint are higher, but still within the same range* [0.038-0.078]. *In all simulated cases, there is a small area of yellow* [0.078-0.25] *where the excess concentration is just above 10% of background for the upper estuary.*"

Conclusion:

- The cumulative load of the FED discharge after 50 days (spring tide) and 57 days (neap tide) is predicted by the HR Wallingford model to be in excess of the 10% deterioration threshold under the WFD Regulations for very substantial areas of the mid and outer Blackwater estuary.

- This exceedance of the standards of WFD Regulations means that the BPEO/FONSE requirement to show that no significant deterioration in the nitrate burden is likely to occur cannot be fulfilled. Accordingly, the Environment Agency cannot issue a Water Resources Act authorisation which would legitimate the FED dissolution process switching from carbonic acid to nitric acid. Hence under the BPEO Regulations neither the permit variation nor the existing permit (EPR/DP3127XB) can be lawfully issued nor its expiry fail to be enforced.

● The understatement of the full (true) nitrate load on the estuary arising from the FED process and other site activities, evidenced earlier, affirms concern that permit EPR/DP3127XB is and would be operating unlawfully if additional understated loads were to be brought into the calculation of the total nitrate burden on the estuary.

● Widespread exceedance of the WFD Regulations in respect of the nitrate burden in the mid and outer estuary means that assessments under the Habitats Directive and Marine and Coastal Act Regulations would be unlikely to sustain a verdict of no adverse impact on the protected features.

Pollution due to Metals.

The applicant's Environmental Statement and related EIA Risk Assessment assert that metals, primarily heavy metals, released into the Blackwater estuary as a result of the FED dissolution process do not breach the Environmental Quality Standard Annual Average (EQS AA) levels or the EQS Maximum Allowable Concentration (EQS MAC) levels of the Water Framework Directive Regulations; and that the discharges of these metals will not cause unacceptable levels to occur in estuary sediments. Compliance with the Habitats Directive and Marine and Coastal Access Act Regulations is dependent upon each of these assertions being true.

We examine each assertion in turn.

Compliance with WFD Regulations EQS AA and EQS MAC levels.

The levels of metals (Boron, Cadmium, Mercury, Copper, Iron, Lead, Mercury, Nickel, Zinc) being discharged into the Blackwater estuary as a result of the FED dissolution process are recorded in *HR Wallingford, Environmental Risk Assessment BRAD/EN/REP/130/FED for variation to permit EPR/DP3127XB, July 2015.*

The question is : are the discharges of various metals , specifically heavy metals, into the estuary within safe environmental limits ?

Let us examine Mercury as the first working example. The concentration of Mercury in the combined abated FED effluent with NOx scrubber liquid is 5.2 µg/l (*Table 2, HR Wallingford EPR/DP3127XB, July 2015* op. cit.).

It is known that the FED input into the river from this source (FED effluent and NOx scrubber liquid) is 4000 m^3 per year (*Section 5.4 HR Wallingford EPR/DP3127XB, July 2015* op. cit.) which is equivalent to 10,958 litres per day (4000 x 1000 ÷ 365).

This creates an annual load of Mercury on the river of 0.021 kg per year (10,958l x 5.2 µg/l = 56981.6 µg = 56.9816 mg = 0.05698 g = 0.000056 kg x 365 days = 0.021 kg per year).

Two important facts become operative at this juncture in the evaluation of impact.

Firstly, the FED effluent and NOx scrubber discharge (4000 m^3 per year) does not contain the full metals load. This fact is evidenced earlier in this submission where it is recorded that there will be an intermittent discharge of "surplus" NOx scrubber liquid (i.e. not incorporated into the FED dissolution process), although the quantity of this "surplus" is nowhere precisely stated in the ES or EIA Risk Assessment. This "surplus" NOx scrubber liquor also contains the full suite of metals present in the daily

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FED discharge and, in the case of Mercury at an abated concentration of 10 µg/l (*Table 3, HR Wallingford July 2015* op. cit.) which is a level twice as high as the level in the combined abated FED effluent with NOx scrubber liquor (*Table 2, HR Wallingford July 2015* op. cit.), namely 5.2 µg/l.

Additionally, the Mercury load will be increased by the "Active Effluent" discharge which is recorded as containing metals, and by the "Treated Site Drainage and Sewage Effluent" which is also recorded as containing metals (ref. *Advice from Magnox to the Environment Agency, 18th November 2015,* Document titled: *Clarification of discharge details*). However nowhere in this document, nor in the applicant's ES and EIA Risk Assessment, are the levels and quantities of these additional metals recorded.

Secondly, in contrast to the annual discharge load for Mercury of 0.021kg per year based on the Table 2 concentration (µg/l) and the annual discharge of 4000 m^3, HR Wallingford states in Table 5 (*Table 5, HR Wallingford EPR/DP3127XB, July 2015* op. cit.) that the annual significant load for Mercury on the Blackwater estuary from the FED discharge is 3.80E-02 (0.038 kg per year).

Table 5: Screening Test Part B Critical Load of Priority Hazardous Substances in Combined FED Effluent against the Critical Load

Substance	Concentration of Abated Combined FED Effluent in the FMDT ug/l	Significant Load		Annual Significant Load from Discharge in kg/yr	Annual Significant Load in kg/yr
		ug/day	kg/day		
Cadmium	1.5	3.00E+04	3.00E-05	1.10E-02	5
Mercury	5.2	1.04E+05	1.04E-04	3.80E-02	1

As can be observed, there is a difference between these two discharge figures for Mercury (0.021 kg/year and 0.038 kg/year) of 0.017 kg/year.

In other words, Table 5 is saying the actual discharge load of Mercury is 0.017 kg/year greater than the figure based on Table 2.

How does this discrepancy arise ? Also, is this discrepancy (increased load on the estuary) significant in determining compliance with the WFD regulations EQS AA ?

The HR Wallingford report does not explain this discrepancy. However it is to be noted – see above – that the full arisings of NOx scrubber liquor (the full arisings are neither specified in *HR Wallingford, July 2015* op. cit., or elsewhere) are not wholly discharged daily with the FED effluent, and so require additional intermittent discharges – i.e. the "surplus" referred to above; and, the only fact recorded in the Report (*HR Wallingford, July 2015* op. cit.) is that, in the case of Mercury, the concentration in this "surplus" NOx scrubber liquor is 10 µg/l as opposed to 5.2 µg/l in the FED effluent.

Therefore there appears to be <u>additional Mercury discharges</u>, and the same is true for all the other heavy metals.

Can the size of this additional discharge (kg/year) be calculated ? The answer is, as demonstrated, yes. It is 0.017 kg/year (0.038 kg/y – 0.021 kg/y).

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For the purposes of both the existing and permit variation application (EPR/DP3127XB), this means that that the actual discharge of Mercury from Bradwell into the Blackwater estuary is understated in the calculation of the FED discharge based on Table 2 and 4000 m^3 (0.021 kg/year) by 81% (0.017 as a % of 0.021).

This is important. It is important because it means that the assessment of the Predicted Environmental Concentration (PEC) of each metal (e.g. Mercury) against the Environmental Quality Standard Annual Average (EQS AA – the legal standard – ref. EA Guidance H1 Annex D1 Guidance) using the Abated Metal Concentrations of the Combined FED Effluent – namely, *Table 7, HR Wallingford EPR/DP3127XB, July 2015* op. cit – is erroneous.

Table 7 is recording the PEC as a % of the EQS AA – in other words, whether the resulting concentration (PEC) of each metal in the estuary following discharge meets with the legal standard. In the case of Mercury, Table 7 is saying that the level of Mercury in the estuary following discharge is only elevated to 20% of the EQS AA for that metal. That is to say, the FED discharge conforms with the law by a margin of 80%.

However Table 7 is based on the Table 2 calculation (0.021 kg/y) and not the Table 5 calculation (0.038 kg/y). If one compensates for this discrepancy - an understatement of the actual discharge by 81% - by uplifting the compliance figure for Mercury against the EQS AA then the figure will rise by around four-fifths (81%) and compliance with the EQS AA will no longer be 20% of the legal standard but nearer 40% (by a lower margin of 60% rather than 80% as asserted in Table 7).

True, Mercury still complies with the EQS AA even after all these discrepancies are taken into account.

However, is this true of the other heavy metals present in the discharges to the estuary from Bradwell and as a result of the FED process ?

When it comes to these other metals (Boron, Cadmium, Chromium, Copper, Iron, Lead, Nickel and Zinc) the same discrepancy applies – an understatement of the quantity discharged – and a similar procedure of recalculation can be applied.

Following this recalculation all of the metals, except one, are still discharged under permit from Bradwell and the FED process at a level which will not exceed the EQS AA. The exception is Chromium.

When discharged at the level consistent with Table 2, namely 186.1 µg/l and at a volume of 4000 m^3 (Table 2 and Section 5.4 *HR Wallingford, July 2015* op. cit), the amount of Chromium discharged is 7.4 kg/year.

This level (7.4 kg/y) constitutes 84% of the EQS AA standard (Table 2, *HR Wallingford, July 2015* op. cit).

Whereas Table 5 (*HR Wallingford, July 2015* op. cit) gives us the Annual Significant Load for Mercury (upon which the foregoing calculation of the discharge discrepancy is based), it does not supply an Annual Significant Load of the discharges from Bradwell and the FED process for any of the other metals, except Cadmium. In the case of Cadmium the difference is 0.011 kg year (based on Table 5) as opposed to 0.006 kg year (based on Table 2) a discrepancy of 0.005 kg year, or an understatement by 83%.

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Given that the Mercury discharged is understated by 81%, and Cadmium by 83%, it is reasonable to suppose that the amounts of the other metals discharged are understated to a similar degree, say 80%. As previously outlined, this understatement appears to arise from incomplete statements in the ES and EIA Risk Assessment of metals discharged as a result of the "surplus" NOx scrubber liquor (i.e. not included in the daily FED discharge), the "Active Effluent" and "Treated Site Drainage and Sewage Effluent" waste steams, all of which are required to be included in the calculations to determine compliance of the existing and variation to the existing permit (EPR/DP3127XB) under EIA regulations – discharges must not be regarded only singly but also in combination in order to determine impact.

The Chromium in the FED effluent (Table 2) discharged at an annual volume of 4000 m^3 amounts to 7.4 kg/y, this being 84% of the EQS AA (Table 7). If we then uplift this figure (7.4 kg/y) by 80% (the level of discrepancy which occurred in the case of Mercury and Cadmium) there is an additional load of 5.9 kg/y (80% of 7.4 kg/y), giving a combined load of 13.3 kg year (7.4 kg/y + 5.9 kg/y).

A load of 13.3 kg/y is greater than a load of 7.4 kg/y by 1.79 times. It is therefore demonstrably clear that the Chromium load on the Blackwater estuary will be in excess of the EQS AA (the legal standard) by a significant margin.

Not only will the Chromium load be in excess of the EQS AA by a significant degree, but two further points need to be noted.

Firstly, for environmental evaluation purposes the concentration of Chromium recorded in the figures employed by HR Wallingford in their report (*HR Wallingford EPR/DP3127XB, July 2015* op. cit) are on the assumption that, although Chromium III will be present, the discharge is entirely composed of Chromium VI (ref. Section 5.1, 3rd bullet point). Chromium VI is the most toxic form of this metal.

Secondly, the existing environmental background level for Chromium in the sediment in the Blackwater estuary is exceeding the ERL (effects low range – a level which marks the point at which adverse effects on the biota may be expected), and the concentration of Chromium in these sediments has been rising since 2002. We will consider the levels of metals in the sediments in more detail below.

A further question arises over the EQS MAC (maximum allowable concentration) relating to the FED Mercury discharges.

Table 8 (*HR Wallingford, July 2015* op. cit) records that the FED effluent discharge is attaining, in its predicted environmental concentration (PEC), 45% of the EQS MAC legal standard for Mercury.

Whereas the EQS AA (Annual Average) is a long-term measurement of concentrations in the receiving water body (Blackwater estuary), the EQS MAC is a short-term measurement and focused primarily on specific discharges.

The 45% level of Mercury against the EQS MAC (Table 8) refers to the FED effluent (Table 2) which is discharged on a regular daily basis, and does <u>not</u> incorporate the Mercury component of the "surplus" NOx scrubber liquor (Table 3) which is discharged on an intermittent basis, nor does it include the Mercury component in the "Active Effluent" and "Treated Site Drainage and Sewage Effluent" discharges. The Mercury component in the "surplus" NOx scrubber liquor is known to be almost double the level in the daily FED effluent, whereas the level of Mercury (and other metals) in the "Active Effluent" and "Treated Site Drainage and Sewage Effluent" is unknown because it is nowhere stated in the applicant's ES, the EIA Risk Assessment or supplementary documents accompanying the permit application – an issue which concerns both the permit variation and the existing permit (whose expiry has not been enforced by the licensing authority, the Environment Agency).

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Therefore the question arises, does the Mercury discharge exceed the EQS MAC (bearing in mind that under EIA Regulations all discharges of a specific metal need to be assessed in combination) when these "unrecorded" discharges are made effectively at the same time (same day) ?

Given the almost double concentration of Mercury in the "surplus" NOx scrubber liquor over the FED effluent (with similar elevations in concentration applying to the other metals too), there appears to be a significant possibility that the EQS MAC for Mercury, and other metals licensed under permit EPR/DP3127XB, is exceeded on certain days.

This matter is **not** analysed or reported upon the HR Wallingford Report (ES and EIA Risk Assessment). We regard this, as well as the foregoing details relating to the calculation of the EQS AA levels, as a **significant deficiency.**

Metals in the Sediments of the Estuary.

The extent (geographical) and degree (quantity) of metals in the sediments in the Blackwater estuary, with specific reference to the metals discharged by Bradwell and the FED process is not examined in the applicant's ES or EIA Risk Assessment. This deficiency is only corrected, in part, by the discussion between the Environment Agency (EA) and Natural England (NE) regarding the presence and measurement of metals in the estuary's sediments, and the significance of this in relation to the Habitats Directive and Marine and Coastal Access Act Regulations.

It will therefore be helpful to record this discussion here because salient points do emerge (ref : *Draft Decision Document EPR-DP3127XB, pages 310-313*).

Sediment sampling
(applies to FED, Non RAD and RAD when the new outlets are used)
Environment Agency: The background to this issue is the concern about metals from the discharge adding to the existing levels of metals in the sediments of the receiving waterbodes [sic]. This follows the results of a sub-tidal grab survey by the Agency in 2014 which revealed that several metals in these sediments are above the ' Effects Range Low' threshold which 'often causes adverse effects in marine organisms' as reported in your conservation advice document.
Our view on this risk, as expressed in our consultation documents, is that, if the discharges can not cause a significant increase in the metals concentrations in the water column outside the mixing zone they could not cause significant increases in the deposition of metals into the sediment.
Whilst accepting this principle you subsequently inquired whether sediment sampling in the estuary by the applicant would give extra confidence of no adverse affect.
Your full question and our response is given below.

Your question in an email of the 6 April 2016
Natural England: *Sediment contaminants – Previously I asked whether or not it would be possible to append as a condition to the permit the need to undertake some sediment contaminant sampling. I believe you mentioned that this was not really feasible and I queried whether or not this would be covered by wider WFD monitoring. Am I correct in thinking that for WFD purposes only aqueous sampling is undertaken? If this is the case, do you have information on the general sediment flow within the Blackwater Estuary and could this be used to establish the possible fate of any heavy metals that may settle out?*
If so, would these areas be overlapped by existing aqueous sampling points or would additional points need to be added to the sampling programme?
It would be useful to get a bit more information around this, as both our national specialists shared the concern over possible accumulation of heavy metals. We do acknowledge that the levels of heavy metals

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are relatively low and that the FED discharge is limited, however owing to existing elevated levels of heavy metals in the wider estuary it would be good to rule out a cumulative impact here and monitoring would enable this to be done.

Our responses

Environment Agency: With regard to our sampling, the bottom line is that we have been taking sediment samples and analysing them for metals for many years in various parts of the Blackwater estuary under various legal and environmental drivers. Most recently our contaminant monitoring is driven by the requirements of the EQS and WFD Directives.

The EQS Directive defines EQS's for metals in the water column and some in biota (e.g. mercury), with a requirement to monitor trend substances in biota or sediment. There are no EQSs defined for the sediment.

In this case (because the main FED discharge and the Treated Radioactive Site Drainage discharge are both made only on ebbing tides around high water) our most relevant sampling point (which is now the only routine point for sediments) is in the outer Blackwater Estuary at National Grid Reference TM 06400 11500. It is relevant because the two discharges from the site that have the most significant metals traces are only made on the high waters of the ebbing tide and the sample point is downstream for ebb tide purposes.

As previously explained we don't believe the Magnox discharges will change the existing background water quality beyond the 100 mixing zone, so we are sure they not have any effect on the inner estuary from returning tides.

From 1999 to 2009 our site in the Outer Blackwater (OBW) was sampled annually, taking five replicate samples on each occasion, for the Clean Seas Environmental Monitoring Programme (CSEMP) for metals as defined by OSPAR requirements.

From 2009 the sampling frequency changed to every 3 years and the replicate samples further 'spread out' across the water body. The last samples were taken in April 2015. Alongside the CSEMP sediment monitoring, blue mussels, *Mytilus*, are sampled annually for contaminant analysis at a single site (three replicate samples) in the Outer Blackwater.

The data from these sampling programs are put onto our internal data archive for periodic review for long-term trends but they are also reported to other organisations for various purposes including reporting for OSPAR requirements. These data are available to view freely on the British Oceanographic Data Centre website http://www.bodc.ac.uk/projects/uk/merman/assessments_and_data_access/csemp/

The MERMAN data assessment viewer displays trends for metals in sediments and in blue mussels at the OBW site.

Please note that the latest data may not yet be available through this website but our joint NE/EA marine monitoring officer, should be able to directly access these data for you and provide detail on the sampling strategy and data.

Periodically our whole sampling strategy is reviewed to make sure it is fit for purpose Currently the sampling for 'metals in sediments' has been paused whilst consideration is given to whether the focus of future sampling should be concentrated on 'biota' alone. Potentially, the biota trend monitoring and assessment is providing a clearer picture of recent exposure.

With regard to the question you asked about our sampling of suspended solids (SS) to get a feel for the pattern of sediment deposition in the estuary, the answer is that we have got records of SS's but we can't measure the complex flow patterns within the estuary, so there is no means of predicting deposition patterns.

To conclude on this aspect of your responses to our consultation documents, I can say that, (I) we do have historical data for metals in the sediments in the outer Blackwater Estuary, (ii) we also have data for metals in biota, (iii) this information is available to you via the liaison officer and the above website, (iv) there will be an ongoing programme of monitoring in the outer Blackwater but it may well be focused on metals in biota rather than in sediments (v) if we restrict sampling to biota it will be because our estuarine and hazardous substance experts believe this is more meaningful and (vi) this data will be capable of showing trends.

With regard to the possibility of requiring the applicant to take sediment samples and have them analysed for metals we have considered this and do not think it is a good idea for the following reasons:-

1. The first obvious one is that we think that our ongoing sampling program is sufficient.

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2. If the concentrations of the relevant metals in the sediments did increase during the time the discharge took place it would not be possible to be sure this was the result of the Magnox discharges. The metals could have come (via the water column) from another source anywhere within the catchment, or from the wider coastal waters or the open sea. Or they could have come from a shift in sediments from another part of the estuary which have higher concentrations of metals.
Trend analysis is needed for assessing whether there is a general problem in the wider catchment that needs addressing but it is not possible, in an estuary, to relate trends at any location to any individual point sources. If a strong increasing trend indicated a threat to the estuary we would do our best to pinpoint all the known sources and we would then have to target any actions at the significant, major contributors of metals. As outlined in our consultation documents we do not believe the treated FED discharge and the other discharges from the site have the potential to be significant contributors.
3. Without any means of knowing what had caused an upward trend in metals in the sediments we would not be able to justify taking any mitigating action against Magnox if such a trend was detected from their sampling.
4. When setting permit conditions we have to be certain that they are logical, meaningful, justifiable and legally enforceable. Given the above we don't think that this would be the case for a sediment sampling requirement.
To conclude overall, we believe that our sampling programme will be sufficient to detect any trends of increased deposition of metals within sediments within the sphere of influence of the discharge and that it is not possible to justify a permit condition for extra monitoring by the applicant.

As can be see, there is a great deal of evidence here for assessment in order to determine whether the sediments will be affected by the discharges from Bradwell and the FED process, and whether these discharges are likely to have an adverse impact on the protected conservation features under the Habitats Directive and Marine and Coastal Access Act (MCCA) Regulations.

To keep matters as simple as possible, we identify these issues as follows:

• The ERL (effects low range – a level which marks a boundary beyond which there are likely to be adverse effects on the biota) is currently being exceeded in the case of Chromium, and the level of Chromium in the estuary sediment has been rising consistently since 2002 (ref. Clean Seas Environment Monitoring Programme, NERC http://www.bodc.ac.uk/projects/uk/merman/assessments_and_data_access/csemp/)

• The BAC (background assessment concentration) is a level developed by the Oslo and Paris Commission [OSPAR] for testing whether concentrations are near background levels. Mean concentrations significantly below the BAC level are said to be near background. The BAC level is currently being exceeded i.e. suggesting above natural background levels, in estuary biota for zinc and copper. (ref. Clean Seas Environment Monitoring Programme, NERC http://www.bodc.ac.uk/projects/uk/merman/assessments_and_data_access/csemp/).

• There is reason for concern over, in particular, the Chromium discharge from Bradwell and the FED process. As we have seen, this discharge is certainly 7.4 kg/y, and possibly 13.3 kg/y. Sediment is a key habitat in terms of protected species under the Habitat Directive and Marine and Coastal Access Act (MCCA) Regulations, and any elevation in the Chromium level (which has been rising consistently since 2002) is grounds for concern. The exceedance of BAC levels for Zinc and Copper are also matters requiring very close examination given the amounts to be discharged from Bradwell under permit EPR/DP3127XB.

• Neither the applicant's ES or EIA Risk Assessment has addressed these matters. Natural England has enquired about the levels of metals in the estuary's sediments, and a reference to the Clean Seas programme (op. cit) has revealed an elevation in the ERL level for Chromium. However, the EA advice to NE states: "*The background to this issue is the concern about metals from the discharge adding to the*

existing levels of metals in the sediments of the receiving waterbodes [sic]. *This follows the results of a sub-tidal grab survey by the Agency in 2014 which revealed that several metals in these sediments are above the ' Effects Range Low' threshold which 'often causes adverse effects in marine organisms' as reported in your conservation advice document.*(ref. see above, opening paragraph of EA/NE correspondence).

The question must therefore be : given that the EA holds substantial data about the levels of metals in the estuary's sediment due to its own sampling, and that this is showing **exceedance of ERL levels for <u>several metals</u>**, why has this evidence not been properly presented in this ES, in the EIA Risk Assessment, and indeed to NE and its Habitats Directive/MCCA Assessment by the Environment Agency, and also to this public consultation ?

Without this evidence, in the possession of the EA and yet not presented to the Habitats Directive/ MCCA Appropriate Assessment, one must observe that this failure is procedure is a **serious deficiency.**

• NE has asked for monitoring of the estuary's sediments during the discharge period, but the EA has advised that this is impractical and unnecessary for a number of reasons. These reasons need to be examined:

To be able to do so, we firstly need to consider additional evidence recorded in the discussion between EA and NE in the draft Decision Document (ref : *Draft Decision Document EPR-DP3127XB, page 303*). The following is recorded in connection with heavy metals and their ERL levels in the estuary:

<u>Natural England</u>:
Restrict surface sediment contaminant levels to concentrations that are not adversely impacting on the infauna of the feature. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which mercury was above the effective range low (ERL) levels.

<u>Environment Agency</u>: Extending the time period and using the existing outlet.
The processes by which the metals within the water column of the receiving waters are deposited onto sediments on the estuary bed are too many and complex to calculate what amounts would accumulate within them over time.
But it is common sense that, (whatever the processes are) if the existing background concentration of metals in the water column does not change significantly, then the amounts deposited in the sediments could not change significantly either.
As stated in the above section, we are satisfied that the modelling provided in the original application demonstrated that there would be no significant change in the background concentrations of metals within the receiving estuary outside the mixing zone as a result of a discharge from the existing outlet with the benefit of a minimum of 50:1 pre-dilution in sea-water.
Because of this we are confident that allowing the discharge to continue from the existing outlet and extending the time limit (or removing it completely) would not significantly change the existing levels of metals within the sediment on the estuary bed.

The EA makes the assertion that the processes by which metals in the water column are deposited on the sediments are too many and complex for this to feature in the present evaluation, and the EA then relies on the assertion – deemed to be common sense – that if the EQS AA and MAC are being complied with then the amounts being deposited also cannot be of any significant concern.

There are a series of flaws in this argument. These are:

• The discharges are partially retained in the estuary following each discharge due to a proportion returning on the flood tide, and so concentrations build and are, to a degree, retained in the water column.

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Further, modelling of the effect of the metals in the FED effluent in the Blackwater Estuary concluded that approximately 6% of the total material discharged during the FED dissolution process would remain in the estuary at the end of the FED programme. After 6 months, 90% of this would be lost from the estuary. Therefore, for every kilogramme of particular metal released, 60 grammes is predicated to remain at the end of the FED process, it will be wide spread over the estuary, reducing to about 6 grammes after 6.5 months. These figures are based on the retention calculations given in report 'BRAD/EN-REP/032/FED – FED Discharge Dispersion EX6399'.

(Ref. Section *5.4.4. HR Wallingford Environmental Risk Assessment, July 2015*).

Thus it is clear that the daily discharge level – however that is quantified, see earlier evidence on the understatement of this matter – is available for deposition over a period longer than a day. Processes of deposition are therefore of importance.

• To dismiss these processes as too complex, and then to say that because the EQS AA and MAC are not being exceeded it is therefore logical to hold no concern about the deposition process is not, actually, logical. For example, although deposition processes are complex, a feature of certain metals is that they are deposited on sediment at the point where saline water meets freshwater because the interaction between saline and freshwater causes their precipitation. Thus inter-tidal sediments are prone to deposition of some metals. If this phenomenon is in operation in this instance, the levels being discharged are clearly significant regardless of whether the EQS AA and MAC are being complied with.

• A further flaw in the logic rests on the fact that the discharges may actually be exceeded by the EQS AA and MAC levels – see foregoing evidence. Thus the levels available for deposition, plus their retention in the water column due to the flushing character of the estuary, means that significant levels may be available for deposition.

Secondly, to dismiss the NE requests for monitoring of the sediments during the licence period on the grounds that the EA already does sampling would have a degree of merit if the EA had informed the NE and the EIA Risk Assessment of the result of this monitoring. This has not occurred. Further, in the discussion between EA and NE – see above - the EA advises that whereas sampling for metals in sediment was undertaken annually from 1999 to 2009, in 2009 the frequency changed to once every 3 years with the samples obtained being "spread out" across the water body, and currently (2015) sampling for metals has been "paused" pending a review on whether sampling should be focused on biota alone. Thus the contention from the EA that NE can rely on the Environment Agency's sampling of metals in sediments is simply not sustained by the facts.

Thirdly, EA maintains that without any means of knowing what may have caused an uplift in metal concentrations in sediments (should this occur) the EA believes that it would not be reasonable to impose a 'metals in sediment' monitoring condition on the permit. However, to be logical, such an uplift during the permit period would be *a priori* evidence, especially given the knowledge that such discharges were being licensed. Further, given the already elevated ERL levels in the sediments and the importance of these sediments for 'protected features' under the Habitats Directive and the Marine and Coastal Access Act, it would seem a wise and necessary course to follow. Should levels of metals record an uplift during the licence period, then further investigations could and should follow. This is the precautionary principle at work.

Fourthly, the EA has informed NE that monitoring conditions need to be logical, meaningful, justifiable and legally enforceable. It has to be observed, given the foregoing evidence, that these 'necessary conditions' can be amply met.

Metals in the Biota.

The serious deficiencies evident in the assessment of metals in the sediments of the estuary, and how they may be impacted by Bradwell's discharges, are also evident in the assessment of the impact on the biota in the estuary.

As noted in the case of sediments, the applicant's ES and EIA Risk Assessment give no consideration to this issue.

Consideration in the document relation to the decision-making process are confined to a discussion between the Environment Agency and Natural England (ref. *draft Decision Document, EPR-DP3127XB pages 310-313*) and even here discussion is very limited, with actual examples confined to the Clean Seas Environment Monitoring Programme http://www.bodc.ac.uk/projects/uk/merman/assessments_and_data_access/csemp/

The Clean Seas Programme reveals that Copper and Zinc in the estuary are currently exceeding the BAC (background assessment concentration) level in the blue mussel (*Mytilus edulis)*.

This slender offering of knowledge, and indeed slender assessment, is of concern for two specific reasons. These are:

Firstly the EA has advised NE that it monitors sediments and biota in the estuary on a continuous basis and that it is contemplating focusing its future monitoring on the biota because the EA feel that biota are a more valuable indicator of environmental conditions than the monitoring of sediments. However despite these assertions the EA has provided NE, or so it appears from the recorded conversations in the draft Decision Document, with **no details** of this monitoring of biota and thus the means by which to assess Bradwell's discharges on biota. As the regulator, should the Environment Agency have not provided this information ?

Secondly, the Blackwater estuary Marine Conservation Zone (MCZ) has the native oyster (*Ostrea edulis*) as one of its protected features. Yet the dialogue between EA and NE has revealed no exchange of information or assessment of impact on this particular species due to metals from Bradwell. The native oyster is a filter feeder, so is particularly susceptible to metals in the water column.

The native oyster has been assessed by NE for the impact of nitrates – although, as we have recorded here, the reported level of nitrates emanating from Bradwell in the applicant's ES appears to be understated. However we can find no evidence in the ES or supporting documents to demonstrate that the native oyster has been assessed for metals present in its body tissue, nor for the impact that the discharges of metals from Bradwell will incur. Should this assessment have not taken place under the MCCA Regulations, and is such failure not a contravention of these Regulations ?

Conclusion:

The applicant's assessment, and the assessment by the EA and NE too, of the Blackwater estuary and its protected conservation features for the impact of metals from Bradwell has been very poor indeed.

Some of the key features of these **serious deficiencies** are:

● The applicant's ES and EIA Risk Assessment appear to have **significantly understated** the quantities of individual metals discharged from Bradwell under the permits being sought (which includes the existing permit), with the result that the EQS AA for Chromium is significantly in breach of the legal standard. All other metals need to be re-assessed for EQS AA compliance in the light of these facts. Also,

there is insufficient data for EQS MAC compliance to be determined, and a re-assessment for all metals needs to be undertaken in this regard.

● There is *a priori* evidence, consequently, that the permit application (and existing permit) are **in breach** of the Water Framework Directive Regulations governing EQS AA and MAC legal standards and, this being so, would likely lead to a conclusion under the Habitats Directive and MCCA Regulations that **adverse impact** would occur to the protected features which, if the discharges occur (and this includes the existing permit), would result in a breach of these Regulations.

● There is existing evidence, accompanied by *a priori* evidence, that the levels of metal in the sediments of the Blackwater estuary are in excess of ERL (effects low range) environmental protection levels which, if the discharges occur (and this includes the existing permit) would cause an **adverse impact** on the protected features under the Habitats Directive and MCCA Regulations, and so be in contravention of those Regulations.

● There has been **a failure** in the ES, EIA Risk Assessment and "appropriate assessment" under the Habitats Directive and MCCA Regulations to determine the existing levels of metals in the estuary's biota, particularly with regard to the native oyster (*Ostrea edulis*), and similarly to determine the likelihood of adverse impact from Bradwell metal discharges on the full range of biota, thus constituting **a breach** of the Habitats Directive and MCCA Regulations.

Note: In the discussion between EA and NE on metal levels in the Blackwater estuary (*Draft Decision Document EPR-DP3127XB, page 303*) the Environment Agency states that it is considering not placing a time limit on the discharge permit. Given the foregoing evidence presented by us regarding the apparent deficiencies in the calculation and recording of the metal levels being discharged from Bradwell, accompanied by the serious documented deficiencies in the assessment of levels of metals in the sediment and biota of the estuary, and the incomplete factual record of likely impact on the protected conservation features of the estuary, we would **strongly recommend** that no such removal of a time limit on the permit be considered or granted.

<u>Radioactivity in Blackwater Oysters</u>.

The issue is whether radioactivity in the native oysters (*Ostrea edulis*) in the Blackwater estuary resulting from Bradwell and the FED process, permit EPR/ZP3493SQ, has been properly assessed under the Marine and Coastal Access Act (MCCA) Regulations and in accordance with the requirements of the Environment Agency's *Radiological Monitoring Technical Guidance Note 2, December 2010, Version 1.0*

It needs to be noted that the applicant has submitted no Environmental Statement or EIA Risk Assessment which addresses the question of impact from FED discharges and other Bradwell radioactive discharges upon this protected feature (*Ostrea edulis*), nor has the regulator and licensing authority (Environment Agency) supplied any such Risk Assessment in connection with the Decision Document for permit EPR/ZP3493SQ issued 1st January 2016. The Environment Agency may assert that it evaluated environmental conditions in its Decision Document, that it has established 16 new locations (providing a total of 22) from which sediment samples will be taken, and is monitoring biota in the form of grass and seaweed, all on a biannual basis (ref. *Environment Agency Decision Document, EPR/ZP3493SQ 1st January 2016, pages 8 and 9)* but there is **no monitoring programme for the native oyster** (*Ostrea edulis*) in the permit or Decision Document.

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EA Monitoring Guidance (*Technical Guidance Note 2, op cit*), sets Objectives and Principles. Given that the EA is aware of public concern, both locally and wider afield, concerning radioactive discharges from Bradwell, it seems that Principle 7, Section 4, is particularly appropriate and should be acted upon in relation to monitoring and assessment of whether to uphold the permit (EPR/ZP3493SQ) , both in relation to the well-being of the oyster itself, the harvesters and commercial sellers of the native oyster, and the consumers of the oysters. Principle 7 reads:

- **Principle 7 Satisfy stakeholder concerns** – Programmes should consider legitimate stakeholder concerns and expectations, as far as reasonably achievable.

There is legitimate concern – as we detail below – that the well-being of the oyster is at risk from Bradwell's radioactive discharges, that the health and financial viability of harvesters and commercial suppliers may be at risk due to these discharges, and that the health of consumers may be at risk. In addition, sampling and testing of oysters and their harvesting is reasonably achievable.

Given this reality, it is appropriate that monitoring and assessment of the conditions affecting the native oyster should take account of the following Objectives in Section 3, Technical Guidance Note 2:

- Objective A – Assess total representative person dose.
- Objective C – Assess total impact on wildlife (e.g. dose).
- Objective D – Assess impact on wildlife as an operator's performance measure (e.g. dose).
- Objective E – Provide public and stakeholder reassurance.

The basis for concern is the known presence of radioactivity in oysters in the Blackwater estuary, and the awareness and knowledge of the radioactive discharges from Bradwell. We consider each of these points in turn.

Known presence of radioactivity in Blackwater oysters and habitat (sediment).

Published evidence of the levels of radioactivity in Blackwater estuary oysters is available from the Environment Agency's annual publication, *Radioactivity in Food and the Environment, 2015, RIFE 21*. This states, *extract from Table 4.3(a) and 4.3(b)* as follows:

No. of Samples	**Mean radioactivity concentration (fresh), Bq kg^{-1}**						
	^{137}Cs	**^{238}Pu**	**^{239}Pu + ^{240}Pu**	**^{241}Am**	**^{247}Cm**	**^{243}Cm + ^{244}Cm**	
1	<0.11	0.00034	0.0019	0.0012	*	0.000027	

Note: * Not detected by the method used.

In respect of the sediment on which the oysters are living and harvested from, *RIFE21* figures are:

No. of Samples	**Mean radioactivity concentration (fresh), Bq kg^{-1}**						
	^{137}Cs	**^{238}Pu**	**^{239}Pu + ^{240}Pu**	**^{241}Am**	**^{247}Cm and ^{243}Cm + ^{244}Cm**	**Gross alpha**	**Gross beta**
2	13	*	*	<1.6	*	370	910

Note: * Not sampled.

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The following data on radioactivity in the tissue of the Blackwater oyster comes from *Environmental Monitoring Returns 2016 Q2, Magnox Limited, Sample date 03/05/2016.*

Radioactivity concentration (wet), Bq kg^{-1} , sampled in accordance with UKAS standards.										
Co-144	**Co-60**	**Cs-134**	**Cs-137**	**Eu-154**	**Eu-155**	**K-40**	**Nb-95**	**Ru-106**	**Sb-125**	**Zr-95**
<0.62	<0.22	<0.12	<0.26	<0.21	<0.33	77.6 +/- 6.6	<0.34	<1.1	<0.29	<0.32

The range and quantity of radionuclides discharged from Bradwell as a whole in 2015 (ref. *Annual Extended Analysis, Magnox Limited, EA Public consultation document)* is recorded as:

Radionuclide	Discharge for the Year, GBq
Tritium	36.4
Calcium-45	< 0.021
Manganese-54	< 0.007
Iron-55	< 0.013
Cobalt-58*	< 0.014
Iron-59	< 0.033
Cobalt-60	0.045
Zinc-65	< 0.021
Strontium-90	2.6
Yttrium-90	2.6
Niobium-95*	< 0.025
Zirconium-95*	< 0.023
Ruthenium-106	< 0.159
Rhodium-106	< 0.159
Silver-110m	< 0.010
Antimony-124*	< 0.013
Antimony-125	< 0.013
Tellurium-125m	< 0.012
Caesium-134	< 0.005
Caesium-137	0.41
Cerium-144	< 0.034
Praseodymium-144	< 0.034
Europium-154	< 0.005
Europium-155	< 0.008
Plutonium-238	0.00017
Plutonium-239/40	0.00063
Plutonium-241	0.0061
Americium-241	0.00059
Curium-242	< 0.000042
Curium-243/44	< 0.0000024

Note: 1 GigaBecquerel (GBq) = 1,000,000,000 Becquerels / 1 Becquerel = 1 radioactive disintegration per second.

In order to be able to assess the impact of aqueous FED discharges on the native oyster – an issue which we have recorded here as not having been undertaken by the applicant in its ES and EIA Risk Assessment, nor required by the regulator and licensing authority (Environment Agency) in its Decision Document for permit EPR/ZA3993SQ – we make the following observations:

● The range of radionuclides currently discharged from Bradwell is extensive, both in terms of the number of individual radionuclides and in terms of their quantity. There is a demonstrable and significant man-made input of radionuclides into the estuary over and above naturally occurring radionuclides, and the burden of man-made radionuclides available in the estuary for absorption by the native oyster (a filter feeder from the water column) relative to the burden of naturally occurring radionuclides has not been examined by the applicant or the regulator. One suspects that the man-made burden of radionuclides available for absorption by the oyster on an annual basis is considerably greater than the naturally occurring burden of radionuclides.

● No analysis has been provided by the applicant, nor required by the regulator in the existing permit EPR/ZA3993SQV004, which specifies the exact quantities of individual radionuclides licensed to be discharged as a result of the FED process, other than for Tritium and Caesium-137 (ref. *Existing Discharge Permit ZP3493SQV004, issued 23/03/2012)*.

Therefore the full nature of the radioactive burden from the FED process, it terms of specific radionuclides, available for absorption by the Blackwater oyster is unknown.

● The monitoring profile of the individual radionuclides present in the Blackwater estuary, provided by RIFE21 and Magnox Limited and cited above, is very limited when viewed against the range of radionuclides known to be discharged routinely (ref. *Annual Extended Analysis 2015, Magnox Limited, EA Public consultation document)*.

Therefore there is an absence of thorough background monitoring for the presence of man-made and naturally occurring radionucildes in the tissue of the estuary oyster at the present time. This makes the ability to determine whether the estuary oyster will be impacted by the FED discharges almost impossible, both in terms of man-made radionuclides being absorbed, and the level being absorbed.

● Due to the deficiencies in monitoring of the presence of radionuclides present in the estuary oyster the significance of the presence of these radionuclides in their tissue is difficult to assess, particularly when viewed in terms of the contaminating radionuclides working in combination, both radiologically and chemically, both on the oyster itself and on the harvester and human consumer.

Biological (health) impact on biota and humans from radionuclides is complex. It is not just a matter of measuring the presence and quantity of individual radionuclides. There is the question of the total burden of radionuclides cumulatively on the oyster and human consumer as a result of the discharges. There is the question of the sensitivity of the biology of the oyster and humans to specific radionuclides entering their biological system. There is the question of the chemical toxicity, as opposed to radiological toxicity of this wide range of elements and isotopes acting both individually and in combination upon the biological system of the oyster and human consumers. None of these issues have been assessed by the applicant in its ES and EIA Risk Assessment or addressed by the regulator in its Decision Document and its related monitoring programme.

Conclusion:

As is evident, the data in the ES and EIA Risk Assessment and supplementary documents provided

by the regulator in connection with this permit application has serious gaps. The foremost of these is that the permit application has not authoritatively assessed the impact upon the Blackwater oyster due to radionuclides discharged from Bradwell historically (prior to the permit), thus giving no baseline to a study of potential impact by the FED discharges. An authoritative assessment records not just the full presence of radioactivity, but also records the expert evaluation of the significance of that presence. This has not taken place.

This has been equally matched by a serious deficiency in the appropriate assessment under the MCCA Regulations and related monitoring which has, almost completely, failed to undertake any serious assessment of the impact of historic and proposed (FED) discharges of aqueous radioactivity from Bradwell on the Blackwater native oyster and its habitat – the primary protected feature of the Blackwater Marine Conservation Zone.

What is not the primary issue in this case – albeit in so saying, this is in no way downgrading the importance of this issue – is whether one is of the opinion that the radiological impact on the native oyster is insignificant or seriously adverse, and this includes onward impact on the harvesters and human consumers of the oyster,

What is the primary issue is that the assessment of impact in connection with both this permit application and the permit currently in existence - ZP3493SQV004, has not been properly conducted. Therefore the existing permit and the permit application are **in breach** of the Marine and Coastal Access Act Regulations. Accordingly, it is **our recommendation** that the discharge permit with respect to the current FED radioactive discharges be **revoked**, and that the present application be **refused.**

Summary.

● Marinet Limited does not believe that the existing permit or the permit variation application are able to comply with the FONSE declaration under BPEO Regulations, as evidenced. Therefore the permits are **in breach of the BPEO Regulations**.

● Marinet does not believe that the full nitrate load, arising both from the FED process and other site sources, has been fully recorded and incorporated by the applicants into its statements of the nitrate load on the Blackwater estuary.. This is **in breach of BPEO and EIA Decommissioning Regulations.**

● Marinet has demonstrated that evidence in the applicant's ES and EIA Risk Assessment's modelling shows that the nitrate burden on the estuary resulting from the recorded FED process figures exceeds the 10% deterioration threshold on a widespread basis in the mid and outer estuary after 50 and 57 days of discharge. This would be exacerbated further if Marinet's belief is verified that the nitrate burden arising from Bradwell and the FED process is under recorded. As a result, the nitrate burden on the mid and outer Blackwater estuary from the FED process results **in a breach** of the **BPEO Regulations**, the **WFD Regulations** and, consequentially, in the **Habitats and Marine and Coastal Access Act Regulations**.

● Marinet believes that the procedure for the calculation of the Environmental Quality Standard Annual Average level for metals on the Blackwater estuary arising from Bradwell and the FED process has not been accurately undertaken, and that when these discrepancies are taken into account the discharge of Chromium exceeds the EQS AA level of the Water Framework Directive Regulations. Also if these discrepancies are factored in, the WFD MAC concentrations for all discharged need to be re-assessed for compliance. As a result, there is clear *a priori* evidence that the Chromium discharge is **in breach of the**

WFD Regulations and, consequentially, the discharges of this metal and possibly others are also **in breach of the Habitats Directive and MCCA Regulations**.

● Marinet believes that the regulator (Environment Agency) should be concerned about the levels of metals being released from Bradwell and the FED process in connection with the levels for some of these metals in the sediments of the estuary. Monitoring by the Clean Seas Programme and the EA itself has revealed the ERL (effects low range) levels are currently being exceed for a number of these metals, and the processes by which these metals are deposited on the estuary's sediments are more acute than the EA is currently giving credence to. The foregoing being so, this suggests that discharges of metals from Bradwell and the FED may impact on already elevated levels of metals in the estuary's sediments, leading to **a breach of the Habitats Directive and MCCA Regulations.**

● Marinet believes that the applicant's assessment of the impact of metals on the estuary native oyster (*Ostrea edulis)* is wholly deficient, and that the assessment undertaken by the EA and NE in respect of the native oyster, and indeed other species essential to biota of the estuary upon which SPA protected species are dependent, also displays very serious deficiencies. This catalogue of deficiencies constitutes *a priori* evidence that the metal discharges from Bradwell and the FED process are **in breach of the Marine and Coastal Access Act (MCCA) Regulations** and, very possibly, the **Habitats Directive Regulations.**

● Marinet believes that the assessment of radionuclides, both discharged historically to the estuary (i.e. from the opening of the plant to the present day) and under the FED process, has not been properly evaluated in terms of the impact on the estuary's native oyster (a protected feature of the Blackwater Marine Conservation Zone), nor upon the harvesters and human consumers of the oyster. Accordingly, this is **a breach of the Marine and Coastal Access Act Regulations** and is contrary to the requirements of the Environment Agency's **Radiological Monitoring Technical Guidance Note 2, December 2010, Version 1.0** and may, consequentially, also be **in breach under the Habitats Directive Regulations**.

● Marinet believes that the various breaches listed here under the BPEO and EIA Decommissioning Regulations, the Water Framework Directive Regulations, and the Habitats Directive and Marine and Coastal Access Act Regulations means that that the existing permit in respect of the FED process and its aqueous discharges needs to be **revoked** (in effect, its expiry enforced) and that the new permit variation application should be **refused.**

Marinet asks that you advise us of your response to the matters which we have raised here before arriving at a decision.

Yours sincerely

S. D. Eades
Marinet Limited.

Marinet Limited Registered No: 9241919
Registered Office: c/o Fullard and Duffill Limited, 106 Birmingham Road, Bromsgrove, Worcestershire B61 0DF, UK