Determination of an Application for an Environmental Permit under the Environmental Permitting (England & Wales) Regulations 2010

Consultation on our decision document recording our decision-making process

The Permit Number is:	EPR/DP3127XB
The Applicant / Operator is:	Magnox Limited
The Installation is located at:	Former power station site, Bradwell-on-Sea Essex
Consultation commences on:	20 October 2016
Consultation ends on:	17 November 2016

What this document is about

This is a draft decision document, which accompanies a draft permit.

It explains how we have considered the Applicant's Application, and why we have included the specific conditions in the draft permit we are proposing to issue to the Applicant. It is our record of our decision-making process, to show how we have taken into account all relevant factors in reaching our position. Unless this document explains otherwise, we have accepted the Applicant's proposals.

This document is in draft at this stage, because we have yet to make a final decision. Before we make this decision we want to explain our thinking to the public and other interested parties, to give them a chance to understand that thinking and, if they wish, to make relevant representations to us. We will make our final decision only after carefully taking into account any relevant matter raised in the responses we receive. Our mind remains open at this stage: although we believe we have covered all the relevant issues and reached a reasonable conclusion, our ultimate decision could yet be affected by any information that is relevant to the issues we have to consider. However, unless we receive information that leads us to alter the conditions in the draft Permit, or to reject the Application altogether, we will issue the Permit in its current form.

In this document we frequently say "we have decided". That gives the impression that our mind is already made up; but as we have explained above, we have not yet done so. The language we use enables this document to become the final decision document in due course with no more re-drafting than is absolutely necessary.

We try to explain our decision as accurately, comprehensively and plainly as possible. Achieving all three objectives is not always easy, and we would welcome any feedback as to how we might improve our decision documents in future. A lot of technical terms and acronyms are inevitable in a document of this nature: we provide a glossary of acronyms near the front of the document, for ease of reference.

Preliminary information and use of terms

We gave the application the reference number EPR/DP3127XBV001. We refer to the application as “the **Application**” in this document in order to be consistent.

The number we propose to give the permit is EPR/DP3127XB. We refer to the proposed permit as “the **Permit**” in this document.

The Application was duly made on 24/7/2015.

The Applicant is Magnox Ltd. We refer to Magnox Ltd as “the **Applicant**” in this document. Where we are talking about what would happen after the Permit is granted (if that is our final decision), we call Magnox Ltd “the **Operator**”.

Magnox Ltd’s proposed **discharge** is located at National Grid Reference TL 93580 09640. We refer to this as “**the water discharge activity**” in this document.

Please note that there are two other applications which were made at the same time for variations to two other permits that Magnox Ltd hold for discharges from the Bradwell site. One of these is an application to vary permit PR2TS/E10760 which is for a mixture of effluents including various types of site drainage and a small volume of secondary treated sewage effluent and the other is an application to vary permit EPR/ZP3493SQ which allows Magnox Ltd to receive and dispose of radioactive waste in carrying out specific radioactive substances activities on the site. EPR/ZP3493SQ has conditions that control the release of the radioactive elements of the discharge of treated FED effluent and those of one of the site drainage effluents permitted by PR2TS/E10760. There are separate decision documents (DD’s) explaining how we have determined the applications for variations to EPR/ZP3493SQ and PR2TS/E10760. This document and the DD for PR2TS/E10760 only address the non-radioactive potentially polluting components of the discharges from the site. Although there are links between the three permits and we have determined the applications at the same time we have produced 3 DDs for the sake of clarity and because there are two different regulatory regimes involved.

How this document is structured

This document is split into the following sections:

- Glossary of acronyms
- Our proposed decision
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    - Consultation of Application
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- The legal framework
- The discharge
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- Key issues of the determination
    - Protection of the sensitive receptors of the receiving environment
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    - Habitats
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    - H1 Guidance for impact assessments
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    - Conclusions and implications for permit limits and conditions
- Proposed Permit
    - Emissions limits
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- Other legal requirements
    - The EPR and related Directives

- National primary legislation
- National secondary legislation
- Other relevant EU legislation
- Other relevant legal requirements

- Annexes
  - Consultation Reponses
  - Habitats consultation documents

Glossary of acronyms used in this document

AA		Annual Average
DD		Decision document
DIN		Dissolved Inorganic Nitrogen
DO		Dissolved Oxygen
FED*		Fuel Element Debris
EMS		Environmental Management System
EPR		Environmental Permitting (England and Wales) Regulations 2010 (SI 2010 No. 675) as amended
EQS(s)		Environmental Quality Standard(s)
m^3/day		Cubic metres per day
MAC(s)		Maximum Allowable Concentration(s)
MCZ(s)		Marine Conservation Zone(s)
NOX		
SAC(s)		Special Area(s) of Conservation
SPA(s)		Special Protection Area(s)
SSSI(s)		Site(s) of Special Scientific Interest
WFD		Water Framework Directive (Directive 2000/60/EC)

* Please note this is different from the treated FED effluent which refers to the effluent from the abatement plant.

1 Our proposed decision

We are minded to grant the variation of the Permit to the Applicant. This will allow them to discharge, subject to the conditions in the Permit.

We consider that, in reaching that decision, we have taken into account all relevant considerations and legal requirements and that the Permit will ensure that a high level of protection is provided for the environment and human health.

The draft Permit contains standard conditions common to the existing permit and some bespoke conditions relating to the changes applied for. This document includes an explanation of the bespoke conditions.

2 How we reached our draft decision

2.1 Receipt of Application

The Application was duly made on 24 July 2015. This means we considered it was in the correct form and contained sufficient information for us to begin our determination but not that it necessarily contained all the information we would need to complete that determination.

The Applicant made no claim for commercial confidentiality. We have not received any information in relation to the Application that appears to be confidential in relation to any party.

2.2 Consultation on the Application

Our initial consultation followed our internal guidelines for variations to an existing permit. We advertised the application on the Gov.Uk website on the 5 of August 2015 and invited people to make representations by 18 September 2015. The full application documents were made available to view on the Environment Agency Public Register at our offices in Ipswich (Iceni House, Cobham Road, Ipswich, 1P3 9JD). We also notified the statutory bodies indicated by our internal guidance. That is Maldon District Council and the Kent and Essex branch of the Association of Inshore Fisheries and Conservation Authorities (IFCA).

In recognition of the public interest in the Bradwell site, we exceeded our guidelines by directly notifying some individuals and organisations in the area who, we were aware, had an interest in the FED operation. We contacted them by email on the 6 August 2015. Our email gave notification of this application and another application (Ref - PR2TSE106760) to vary another permit for other discharges from the site. The email also explained that the applications and supporting documents could be downloaded from a web link (https://ea.sharefile.com/d-s9822215ebc94f5a9) and that there were 28 days for them to make any representations to us about the applications. This period was later extended by a further 15 days.

Due to the level of interest in the applications, and the large number of representations we subsequently received, we decided to have another public consultation when we had reached our draft decision, also referred to as a 'minded to' decision. This draft decision document, the accompanying draft permits and the decision document for the application PR2TSE106760 are part of that process.

This process is in accordance with the EPR, our statutory Public Participation Statement and our own Regulatory Guidance Series Note 6 for Determinations involving Sites of High Public Interest. We consider that this process satisfies, and frequently goes beyond the requirements of the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters.

We have also taken into account our obligations under the Local Democracy, Economic Development and Construction Act 2009 (particularly Section 23). This requires us, where we consider it appropriate, to take such steps as we consider appropriate to secure the involvement of representatives of interested persons in the exercise of our functions, by providing them with information, consulting them or involving them in any other way. In this case, our consultation already satisfies the Act's requirements.

In addition to the above, in order to satisfy the requirements of the Habitats Directive, we also sent letters to certain bodies to ascertain if they were aware of any existing, or new, plans, permissions or projects that might have the potential for any 'in combination' affects on the receiving environment with the treated FED effluent discharge and the other discharges from the site which are controlled by the permit PR2TSE10760.

Letters to the following bodies were sent on the 21 October 2015; Maldon DC, Essex County Council, Brightlingsea Harbour Office, the Marine Management Organisation, Kent and Essex IFCA and Anglian Water. The only reply we received was from Anglian Water. They reported that there were no plans or projects to take into account and made no other comment.

2.3 <u>Requests for further information</u>

Although we were able to consider the Application duly made, we did in fact need more information in order to determine it, and made several requests for further information and clarification. A copy of all these have been placed on the sharefile mentioned above

Having carefully considered the Application and all other relevant information, we are now putting our draft decision before the public and other interested parties in the form of a draft Permit, together with this explanatory document. As a result, at this stage in the process, the public has been provided with all the information that is relevant to our determination, including the original Application and additional information obtained subsequently, and we have given the public two separate opportunities (including this one) to comment on the Application and its determination. Once again, we will consider all relevant representations we receive in response to this final consultation and will amend this explanatory document as appropriate to explain how we have done this, when we publish our final decision.

3 The legal framework

The Permit will be varied under regulation 20 of the EPR. The environmental permitting regime is a legal vehicle which delivers most of the relevant legal requirements for activities falling within its scope. In particular the regulated facility is a water discharge activity within the meaning of the EPR.

We address some of the major legal requirements directly where relevant in the body of this document. Other requirements are covered in a section towards the end of this document.

We consider that, if we vary the Permit, it will ensure that the proposed discharge will comply with all relevant legal requirements and that a high level of protection will be delivered for the environment and human health.

We explain how we have addressed specific statutory requirements more fully in the rest of this document.

4 The Discharge

4.1 The permitted activity

The discharge is subject to the EPR because it falls within section 3(a)(iii) of Schedule 21 to the EPR (as ‘trade effluent or sewage effluent’) so is within the definition of a ‘water discharge activity’.

4.2 Description of the discharge and the historical background to the Application

The Application is to vary some of the conditions of an existing permit EPR/DP3127/XBD which was granted on 1 December 2011. The existing permit allows a discharge of up to 30 cubic metres (m^3) a day of a trade effluent from the site of the former nuclear power station at Bradwell on Sea in Essex to the adjacent Blackwater estuary at National Grid Reference TL 99650 09150.

On the permit the trade effluent discharge (the ‘activity’) is described as ‘treated dilute nitric acid’ and in Table S1.1 (of schedule 1) some limits to this activity are outlined. One part of these is that it shall be, “for a 12 month period” and another is that, “a carrier flow of seawater in the siphon tank will dilute the effluent by a factor of 50:1 before discharge to the estuary and ensure complete effluent displacement from within the outlet pipe.”

The main variations that the Applicant requested in the Application are:

(i) to extend the 12 month period for the activity for a further 24 months; and

(ii) to be able to discharge the effluent out of a newly constructed outlet at some date in the future without any dilution/carrier flow of seawater.

(iii) to reduce the maximum daily volume of the discharge to 20 m^3 per day

The background to these requests is that the trade effluent discharge is generated by a waste disposal operation which is part of the decommissioning of the power station and which is taking longer than the Applicant originally envisaged in 2011. Due to technical problems the start of the operation was delayed until the summer of 2014 and it was not completed within 12 months. In the meantime the Applicant's existing outlet to the estuary has been found to be becoming blocked with silt and this has necessitated the construction of a new outlet structure for this effluent and for the site to continue to drain properly. Constructing a new outlet with similar dimensions to the old one would have created too much disturbance of the estuary bed so the new one is much smaller. Its size does not allow the minimum 50:1 pre-dilution required by the permit although this would no longer be needed as a carrier flow because the discharge would be pumped.

The changes to the outlet have implications for the way the effluent would be dispersed and diluted within the receiving estuary and therefore on the way it may impact on the receiving environment. However, extending the time limit for the activity to take place out of the existing outlet does not have the potential for any significant adverse environmental consequences. This view is based on the following factors:

(i) an environmental impact assessment provided by the Applicant for its original application in 2011 established to our satisfaction that the discharge would not have any significant adverse affects on the receiving environment beyond a very limited mixing zone of 100 metres;

(ii) the discharge is limited to a finite polluting load because the operation which generates the effluent is the processing of a finite amount of waste material; and

(iii) the potential polluting effects of the discharge can only be realised by the increases in the existing background average concentrations of pollutants in the receiving waters it could cause.

The result of these factors is that spreading the same finite polluting load over a greater time period would only reduce its polluting potential (proportional to the time taken) because it would reduce the increase in the average concentrations of the pollutants in the receiving waters.

For these reasons since the expiry of the 12 month time limit for the activity we have been allowing the Applicant to continue the discharge from the existing outlet under an enforcement position expressed in a letter of 12 June 2015. This has been our position whilst we have been determining all the permitting issues, including whether there are alternative, and more effective conditions that could replace a time limit for the activity and still provide protection for the environment. In the meantime all the conditions of the existing permit have been in force and will be until the permit is varied. Our enforcement position applies only to the use of the existing outlet.

4.3 Volume and contents of the discharge

The maximum daily volume of the discharge will be reduced from the previously permitted 30 m^3 to 20 m^3. This is considered beneficial and not contentious. The application states that the predicted volume discharged per day will be $12m^3$, however they have applied for this larger volume to cover instances where higher volumes of water are required in the process, or there has been a delay to the previous day's discharge procedure. The impact on the estuary has been assessed assuming a discharge volume of $20m^3$.

A cubic metre is 1,000 litres so the maximum discharge is 20,000 litres. To put this into perspective it may help to picture the discharge as a unit of space of 5 metres by 4 metres by a metre high and then picture this discharging into the Blackwater. At the point of discharge the estuary is approximately 2 kilometres wide and overall is roughly 14 kilometres long. It is estimated to have an average volume of 106,300,000 cubic metres. Therefore in relation to the estuary the discharge is considered to be very small.

As stated above the discharge is an effluent that results from a waste disposal process. The waste in question is usually referred to as FED which stands for Fuel Element Debris. The debris is in the form of fragments of used nuclear fuel casings made from a magnesium alloy. The casings are an intermediate level radioactive waste which are stored in designated vaults on the Bradwell site awaiting disposal. One of the options the Applicant chose for disposal is to dissolve the casing fragments in diluted nitric acid and then to treat the resulting acidic magnesium nitrate liquid in an 'abatement plant' to make it fit for discharge into the adjacent estuary. This process is sometimes referred to as Fuel Element Dissolution and confusingly this is also abbreviated to FED. In this document we will refer to 'treated FED effluent' to mean the effluent from the abatement plant. The treatment in the abatement plant incorporates pH adjustment with sodium hydroxide (caustic soda) to neutralise the acid and precipitate heavy metals (aided by a flocculent) followed by microfiltration and ion exchange for final polishing.

Since applying for the permit in 2011 the Applicant has made one change to the treatment of the debris which is to intermittently add NOx scrubber liquors to the acid it is dissolved in. The NOx liquors are an acidic waste from the scrubbing (i.e cleaning) of the gaseous emissions from the dissolution process. Adding them back into the acid bath is a form of recycling which prevents wasting fresh nitric acid. The NOX liquors contain traces of heavy metals which have been leached from stainless steel components of the scrubbers. When notified of this minor change we decided that the conditions in the existing permit were still appropriate to protect the receiving environment and the consequences of adding them to the influent have been taken account of in this determination.

The potential polluting contents of the maximum 20m 3 a day of treated FED effluent are as follows:

Temperature

The treatment of the debris with acid is an exothermic reaction and the maximum temperature of the influent into the abatement plant is 50 degrees Centigrade. The treatment does not involve any designed cooling processes but some natural cooling will occur during treatment and in the tank as the effluent will be retained in prior to discharge. The Applicant's consultants have calculated the range of temperatures the discharge will be made at depending on the different seasonal ambient air temperatures. The lowest in winter is 21.12 degrees C and the highest in summer is 41.67.

pH

After adjustment with sodium hydroxide in the abatement plant the pH range of the discharge is 6 to 9.

Nitrates

The discharge will contain average concentration of 22,000 milligrams per litre (mg/l) (or 22 grams) of nitrates. The source of the nitrates is the nitric acid used to dissolve the debris. One milligram per litre is the equivalent of one part per million.

Heavy metals

The Application includes details of what hazardous substances have been detected in the treated FED effluent (including NOX liquors) and the maximum concentrations of each of these substances. During the course of the determination it became clear that the data set in the application was not adequate to properly characterise the effluent and we requested more analysis results. For some substances the maximum concentrations detected in the effluent in the extra data set were higher than the results quoted in the application. We used the highest results in our assessment.

Not all the substances needed to be considered in our determination. Only the ones that are known to be potentially toxic in certain concentrations in estuarial waters were included in our assessment. They are all metals and all have environmental quality standards (EQS) to be complied with in estuarial waters. An explanation of EQS's and their importance in environmental impact assessments in given in section 6.4 below.

Table 1 below is a summary of the relevant metals detected in the effluent and their maximum concentrations (from the whole data set provided during the determination period) in micrograms per litre (µg/l). One microgram is one thousandth of a milligram and therefore equivalent to one part per billion.

The sources of the metals in the effluent are, (i) trace metals within the magnesium alloy which are released by the action of the acid (ii) residual metal contaminants from the caustic soda used in the abatement (treatment) plant and (iii) residual traces of metal from the NOx liquors.

Table 1 Maximum concentrations of metals detected in the discharge

Substance	Maximum Concentrations. in combined abated FED and NOx (µg/l)
Cadmium	22.6
Chromium	186.1
Copper	1239
Iron	745
Lead	67
Mercury	5.2
Nickel	226.8
Zinc	1043

4.4 Discharge timing and outlet design

The design of the new outlet structure is based on the results of dilution and dispersion modelling undertaken by HR Wallingford Ltd, the Applicant's consultants, to achieve optimum dilution and dispersion for the discharge. It is has been constructed above the old outlet (approximately 400 metres from the shore) 5.5 metres above the bed of the estuary. It is just below the level of the lowest tide and so is always underwater. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be via manually controlled pumps and is to be made over 30 minutes, on one ebb tide a day between 1 and 2 hours after high water. The Application states that this will be 1 to 2.5 hours after high water but we will restrict it to 1 to 2 for the reasons explained later in this report. The outlet has been placed as high as possible in the water column because treated FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the outer Backwater estuary and open coastal waters being diluted along the way.

4.5 Administration

The Applicant submitted a plan which we consider is satisfactory, showing the site of the Installation and its extent. A plan is included in Schedule 7 to the

Permit, and the Operator is required to carry on the permitted activities within the site boundary.

We are satisfied that the Applicant is the person who will have control over the operation of the regulated facility after the variation of the Permit; and that the Applicant will be able to operate the regulated facility so as to comply with the conditions included in the Permit.

5. Key issues in the determination

The key issues arising during this determination are outlined below together with a brief explanation of how we approached the task of taking them into account to reach our final decision.

- **Protection of all the sensitive receptors of the receiving environment**

The primary issue in this determination is common to all determinations, that is, whether we can grant a permit with conditions that will ensure that the discharge will not result in the risk of any significant adverse affects being caused to any of the sensitive receptors of the receiving environment.

By receptors in this case we mean, (i) all aquatic flora and fauna, (ii) the specific species and features of the sites designated in UK and European habitats legislation i.e. SSSIs, SACs SPAs, Ramsar sites and MCZs and their supporting habitats, (iii) commercial uses of the receiving waters i.e. fisheries, shell fisheries etc and (iv) human health risks from the direct or indirect exposure to the receiving waters via work or recreational activities i.e. fishing, sailing, swimming, beach activities etc.

- **Newly designated Marine Conservation Zones – Blackwater, Crouch, Roach and Colne Estuaries MCZ**

The above MCZ was designated on 21 November 2013, nearly two years after the current permit was issued in December 2011. Since it was designated Natural England have been formulating very detailed advice for the protection of its designated features which include some water quality standards which are drawn from the Water Framework Directive (Directive 2000/60/EC) (WFD). In this determination we have addressed the conservation objectives and water quality standards outlined in the advice documents that Natural England have provided to date, and consulted them to seek their views as the Statutory Nature Conservation Body for the site.

Natural England have also produced similar, revised, conservation advice for the protection of the Essex Estuaries SAC and the situation is the same for this.

- **Uncertain timetable for completion of FED treatment operation and for use of new outlet**

During the determination it has become apparent that the Applicant is not certain that the operation will be completed within the 24 months it requested. We have, therefore, considered not just whether we should allow more than a 24 month extension for the activity but whether there are alternative conditions we could put on a permit that would protect the environment without the need for repeated applications that place a burden on the resources of all parties. There is also uncertainty about when the new outlet will be needed because the siltation process that is blocking the existing outlet is a natural one with too many variables for accurate predictions. We have, therefore, had to be sure that our assessments and determination decisions are correct for all combinations of time period and outlet characteristics.

6. How we addressed key issues and made our decision

6.1 Environmental impact assessments

Because our focus is on environmental protection the primary basis for our determination has been our critique of the Applicant's environmental impact assessment for the changes it is proposing. The main elements of this have been:-

(i) How does the impact assessment compare with the Agency's guidelines for undertaking them?

(ii) Has the assessment incorporated the correct water quality standards to be met in the receiving waters?

(iii) Is the hydrodynamic modelling on which the Applicant's impact assessment relies fit for purpose and are its results correct?

The use of our guidelines in the determination process is important because these guidelines incorporate criteria and methodologies that have been developed over many years to ensure that receiving environments are protected from the contents of discharges. As well as providing technical assistance for applicants, therefore, they also provide a framework for the fair and proportionate judgment of supporting information for applications. The guidance that is relevant in this case and the way in which we have used it is outlined further in the sections below. However there are two key concepts which underpin the impact assessment and our critique of it which it is necessary to bear in mind. These are, 'mixing zones' and 'water quality standards'.

6.2 Acceptable mixing zones and water quality standards

Assessing whether the discharge (through either outlet and over extended time periods) has the potential to harm any of the receptors in the receiving environment would seem to be a very complex task. The receptors are of different types with different sensitivities to different pollutants within the discharge and they are in many different, widespread locations and some are obviously mobile. However the task is simplified by the following factors:-

- The discharge (through either outlet) is very small in relation to the receiving estuary and it will be rapidly diluted on the high waters of the ebbing tides. So its potential zone for adverse effects on receptors is very limited.

  The maximum volume of the discharge is 20 m^3 and the average volume of the Blackwater Estuary alone is estimated to be 106,300,000 m^3.

- There are a range of water quality standards established by European and UK legislation for the protection of aquatic organisms and their habitats and if these are met outside the limited zone of influence we can be sure no receptors will be harmed beyond it.

  A more readily understood water quality standard is that of maintaining the existing background quality of the waters. If the background quality does not significantly change we can be confident that no receptors will be harmed.

The formal term for the ‘limited zone of adverse influence’ mentioned above is a ‘mixing zone’. Mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels of the appropriate water quality standards for the receiving waters. Hence mixing zones, within which dilution can reduce contaminants to below target levels before they spread any further, are allowed. So long as there is no breach of any water quality standard in the rest of the waterbody (see below). Mixing zones were first formally introduced into regulatory practice by the EQS (Environmental Quality Standard) Directive 2008/105/EC (EQSD) which allowed member states to permit such zones of water quality standard exceedance within receiving waters. Subsequently some criteria for the setting of such zones was formulated by representatives from some member states. The criteria are aimed at spatially minimising mixing zones as far a possible within the receiving waters. The Agency is deemed to be the competent authority to determine what size of zone is acceptable in each case but, when the discharge is in the vicinity of a designated conservation site we have to have Natural England’s agreement. In designating mixing zones the Agency ensures that they are restricted to the proximity of the point of discharge and proportionate, having regard to the concentrations of pollutants at the point of discharge and to permit conditions and any other relevant legal obligations.

In this case when the application for the existing permit was made in 2011 the size of the acceptable mixing zone was agreed to be 100 metres from the outlet downstream on the ebbing tide and this was the basis on which we issued the permit with Natural England’s agreement. This Application to vary the permit is based on the same premise.

The following sections will outline:

- what water quality standards are appropriate to protect the receptors of the receiving environment;
- how the Applicant’s impact assessment seeks to establish that they will be met and how it compares with the Agency’s guidelines;
- our evaluation of the assessment together with some additional work of our own;
- the Agency’s guiding principle for setting permit limits of limiting any deterioration in the background water quality to 10% for each water quality standard; and
- our conclusions as to what permit conditions will protect the receptors of the receiving environment from discharges of treated FED effluent through either outlet and over any extended time period.

6.3 Water quality standards and limiting deterioration

There are many water quality standards applicable in estuarine and coastal waters but we have focused on those that are relevant to the treated FED effluent discharge. That is, the standards relating to the pollutants that the discharge contains in amounts that could have significant effects on the receiving waters.

The standards are mainly in the form of specific concentrations of pollutants which have been calculated from long term scientific research to protect aquatic organisms. By being sure that they are not exceeded outside the mixing zone we can be confident of no adverse effects being caused to any receptors. However the Agency has a general duty to ‘minimise’ pollution of the environment and the WFD requires us to prevent significant levels of deterioration occurring in the existing background water quality within waterbodies. So we try not to allow individual discharges to take up all the environmental tolerance between the existing background concentration of a pollutant and the water quality standard for it in each case.

As a general working principle our default aim is to only allow individual discharges to cause up to a 10% deterioration in the existing background water quality for each pollutant they contain so long as even this small deterioration does not cross the threshold of a specific standard or cause the breach of any legal duties.

It was this principle that underpinned our decision to grant the existing permit in 2011 (after obtaining Natural England’s agreement) on the premise that a 10% deterioration in background concentrations of nitrates and metals within the receiving waterbodies would have no significant adverse effects within them and cause no breach of any standard or legal duty. This Application is based on meeting the same criteria.

The water quality standards that need to be met in the receiving waters, and which we applied the limited 10 % deterioration principle to in this case, are outlined in the following sections.

6.4 EQSs (environmental quality standards)

EQSs are the key water quality standard for assessing whether the concentrations of the various heavy metals that the treated FED effluent contains could have any adverse effect on the receptors of the receiving waterbodies. They are based on research into the toxicity of substances to all aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) are set to prevent short term acute toxic effects. Both are calculated by applying safety factors of at least 10 (but sometimes up to 1000) to the lowest known toxicity concentration of substances to make sure that marginal breaches do not cause any harm. Not all hazardous substances have both types of EQS.

EQSs are subject to change on the basis of new research with regulations updating them when necessary. The EQSs we have used in our determination are the most up to date. They are taken from EQSD as amended by Directive 2013/39/EU and Annexe 8 of the WFD which are implemented in England through the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters outside the 100 metre mixing zone no harm would be caused to any aquatic organisms or their habitat. The EQSs for each metal the discharge contains in significant concentrations are shown in Table 2 in section 6.2.5 below. How these standards are to be met upon issuing the Permit is also considered below.

All the EQSs, whatever their source, form part of the WFD water quality standards for the protection of all surface waters which are explained below.

(Note - There are no EQSs for magnesium nitrate or nitrate in surface waters. Any significant polluting effect of the magnesium nitrates concentrations in the treated FED effluent can only be manifested as a plant nutrient which could cause, or exacerbate, the eutrophication of the receiving waterbodies. The standards relating to nitrates are part of WFD requirements as explained below)

6.5 Water Framework Directive (WFD) standards

The WFD integrates previously fragmented European legislation for the protection of the water environment into one comprehensive framework. This framework includes a set of standards for water quality in rivers, lakes, estuaries and coastal waters which are devised from the best available scientific knowledge for the protection of aquatic organism and their habitats. We are required to comply with its requirements in our permitting decisions, and by making sure that we do so we can be confident that we are protecting all the receptors in the receiving waterbodies.

WFD regime

Under the WFD regime all surface waters within the UK have been divided into river basin catchments and subdivided into individual waterbodies for the purposes of classifying and monitoring their water quality and overall ecological health and to enable long term planning and regulatory action to maintain or improve this.

Classification is assessed based on a set of standards made up of chemical and ecological components. These standards include chemical parameters such as EQSs for metals, physiochemical parameters such as dissolved inorganic nitrogen (DIN) and biological standards such as the presence and extent of unwanted growths of phytoplankton or macroalgae (seaweed) which would indicate eutrophication effects from excessive nutrients.

Based on whether all the standards are met, waterbodies are classified into five categories of status: High, Good, Moderate, Poor or Bad. The overall status of the waterbody corresponds to the level of the lowest category for any individual parameter. The main environmental objectives of the WFD that are relevant to the determination of the Application are the prevention of deterioration in the status of waterbodies and the achievement of Good ecological and chemical status in them by 2027. However under the WFD exemptions for not achieving overall Good status are allowed in some circumstances.

In this case the WFD standards that are relevant to our permitting decision are;-

- the chemical standards for the individual metals that the discharge contains. To achieve Good standard the concentration of individual metals in the waterbodies must meet, or be below, their respective EQSs;
- the physiochemical standards for DIN and dissolved oxygen (DO) because the effluent contains dissolved nitrates and these can have an effect on DO concentrations in the waterbodies via eutrophication effects; and
- the biological standards for macroalgae and phytoplankton in the waterbodies because of the potential for the nitrates in the discharge to have eutrophication affects on them.

Waterbodies were first designated in 2009 within the larger units of River Basins that they form the integral parts of. Their individual classifications were based on the Agency's historical water quality monitoring data for them. At this time River Basin Management Plans (RBMPs) were devised so that any actions to improve waterbodies would be in the context of whole river basins and not isolated and piecemeal. Every six years there are major assessments of the quality and status of waterbodies and decisions are made about the feasibility of including actions to achieve the long term objectives for the RBMP in the next six year cycle. Cycle 1 began in 2009 and ended in 2015. Currently we are in Cycle 2 which will end in 2021. So the next date for RBMP objectives to be met is 2021.

WFD classification and objectives for the Blackwater area waterbodies

The WFD classification situation for the waterbodies in the vicinity of the discharge from the Bradwell site is not straightforward. In the transition between the cycles (and since the permit was issued for the treated FED effluent in 2011) the Blackwater area waterbodies have been re-configured and re-classified within the RBMP. Figure 1 below illustrates the changes. It shows (by underlying horizontal shading) that in Cycle 1 the inner section of the Blackwater estuary and the Colne estuary where classified as one waterbody named the 'Blackwater and Colne' but that in Cycle 2 they were separated into two distinct waterbodies as indicated by the different colours on top of the horizontal shading. These waterbodies are labelled as 'transitional' because they are between rivers and the open sea. The adjacent 'Blackwater Outer' and 'Essex' waterbodies are known as 'coastal' waterbodies. These have not been changed within the RBMP. It can be seen from the map that the permitted discharge is into what used to be the 'Blackwater and Colne' and is now the 'Blackwater'. All waterbodies have an identification number within the RBMP. The 'Blackwater and Colne' was GB520503713900. The 'Blackwater' is now GB520503714000 and the 'Colne' is GB520503713800. The 'Blackwater Outer' is GB650503200000 and the 'Essex' is GB65050352001.

At the beginning of Cycle 1 and when the treated FED permit was issued in 2011 the Blackwater and Colne waterbody was classified as overall 'Moderate' status and the Blackwater Outer and Essex waterbodies as overall 'Good'. But in Cycle 2 all the waterbodies in the Blackwater area were re-classified as overall 'Moderate' status. They are all prevented from attaining overall 'Good' status because they do not meet the AA DIN concentration standard which forms part of the physiochemical component.

The Blackwater is also 'Moderate' for macroalgae and phytoplankton standards but the Colne is 'High' for these. Although they fail the DIN standard, the Blackwater Outer and Essex achieve 'Good' or better for the macroalgae, phytoplankton and DO standards. All the waterbodies in the Blackwater area achieve 'Good' standard for metals. There are no failures of the relevant EQSs for metals within any of them.

The achievement of 'Good' status for DO and the biological standards within the Blackwater Outer and Essex waterbodies, despite failures of the DIN standard is significant. It indicates that although the concentrations of nitrogen in them are higher than optimum they are not causing any adverse biological responses. Investigations by the Agency into the possible sources of the excess nitrogen in these waterbodies has been inconclusive. It is not certain if the dominant nitrogen inputs into them are from wider coastal waters and the open sea or from diffuse agricultural inputs and/or point source discharges from the upstream River Blackwater catchment. Because the causes are not certain, and because there is no conclusive evidence of adverse biological consequences, the Agency cannot justify the imposition of costly measures on the potential upstream sources to reduce nitrogen.

For this reason the new long term objective in the RBMP for these waterbodies at the end of Cycle 2 in 2021 (and also for Cycle 3 to 2027) is now ‘Moderate’ overall based on maintaining the ‘Moderate’ status for DIN and ‘Good’ for all the other standards including metals, DO, macroalgae and phytoplankton. The WFD allows such exemptions to achieving ‘Good’ status overall where costs are disproportionate and there is uncertainty over the effectiveness of any possible remedial actions.

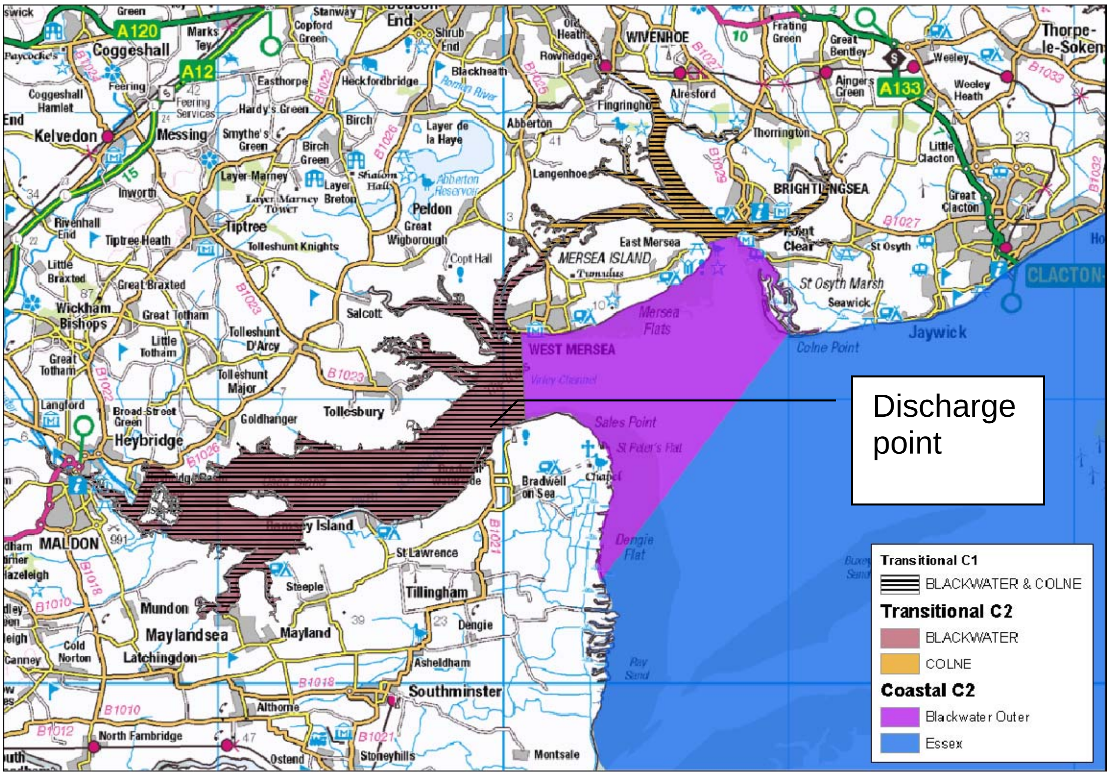


Figure 1 – Map of WFD waterbodies in the Blackwater area showing changes between Cycle 1 and Cycle 2

Targets derived from WFD standards

When determining permit applications we accept that there will be some level of deterioration in the existing background water quality as a result of allowing any discharge. The WFD allows deterioration within the existing class boundaries (other than ‘Bad’) for each standard but (unless there are exceptional circumstances) it does not allow deterioration levels that will breach a classification barrier and cause a waterbody to be downgraded.

We aim to limit the ‘in class’ deterioration as far as it is practical to do so. In some cases (where there is a great deal of leeway between the current quality and the required WFD quality) allowing up to a WFD standard could allow substantial levels of deterioration. Unless more stringent measures are required, the Agency therefore applies the default 10 % deterioration principle.

In this case, therefore, the water quality targets relating to our duties under the WFD and our guidance are:-

- no breach of the EQS concentrations of these metals in the receiving waterbodies so that the ‘Good’ standard for metals is maintained;
- allowing up to a 10% deterioration in the existing annual average background concentrations in the receiving waterbodies of any of the metals contained in the discharge so long as this limited deterioration does not risk causing a failure of an EQS;
- no breach of the WFD ‘Moderate’ DIN standard in the receiving waterbodies;
- allowing up to a 10% deterioration in the existing annual average background concentrations of DIN in the receiving waterbodies so long as this limited deterioration does not risk causing an exceedance of the Moderate standard for DIN;
- no exceedance of the existing WFD status for DO in the receiving waterbodies;
- no exceedance of the WFD ‘Moderate’ biological standards for phytoplankton and opportunistic macroalgae in the Blackwater waterbody or the existing standard for these in the other receiving waterbodies.

There are no specific standards for the physiochemical parameters of temperature and pH in estuarial waters, which the discharge could influence, but there are some guidelines for them which we have taken into account.

If all these targets are achieved outside the mixing zone we can be confident that we will have fulfilled our duty under the WFD. It will also ensure that the existing water quality of the receiving waterbodies will be maintained and all the receptors protected.

6.6 Habitats

There are a large number of designated conservation sites in the vicinity of the discharge which have various levels of statutory protection in UK and European law. They are:

- Blackwater Estuary SSSI
- Colne Estuary SSSI
- Crouch and Roach Estuaries SSSI
- Dengie SSSI
- Foulness SSSI
- Blackwater Estuary (Mid Essex Coast Phase 4) SPA and Ramsar site
- Colne Estuary (MID Essex Coast Phase 2) SPA and Ramsar site
- Crouch and Roach Estuaries (MID Essex Coast Phase 3) SPA and Ramsar site
- Dengie (Mid Essex Coast Phase 1) SPA and Ramsar site
- Foulness (Mid Essex Coast Phase 5) SPA and Ramsar site
- Outer Thames SPA, Essex Estuaries SAC and
- Blackwater, Colne, Crouch and Roach Estuaries MCZ.

There are no specific water quality targets for the protection of the designated features and habitats for the majority of these sites. However, we are confident that if the discharge does not cause a breach of the WFD water quality standards described above (which we conclude would be the case) there would be no significant adverse affects upon them if we granted a permit. In fact Natural England have incorporated some WFD standards in its draft conservation advice for the protection of the Blackwater, Colne, Crouch and Roach Estuaries MCZ and the Essex Estuaries SAC. These are the only sites that have specific water quality targets. However, because these sites are amalgams of their associated SSSIs, the same water quality standards apply within areas of most of the above sites by default.

Examples of the WFD influenced water quality targets that are present in Natural England's conservation advice for the MCZ and Essex Estuaries SAC are:-

(1) Water Quality i.e Dissolved Oxygen

Maintain the DO to levels equating to Good Ecological Status. Excessive nutrients and/or high turbidity can lead to a drop in DO.

(2) Water quality i.e nutrients

Recover the natural water quality and specifically winter dissolved inorganic nitrogen to Good Ecological Status concentrations avoiding deterioration from existing levels.

(3) Opportunistic macroalgae

Reduce opportunistic macroalgae cover where it is encouraged from human activity to a level where epifauna and infauna are adversely impacted in line with Good Ecological Status levels required by Water Framework Directive (WFD)

(4) Water quality contaminants

Reduce aqueous contaminants to levels equating to Food Ecological Status according to WFD. Specifically mercury and its compounds and avoiding deterioration from existing levels.

The full details of how we have assessed the potential impact of the treated FED effluent discharge on the receptors of all the above habitats sites is outlined in the consultation documents we submitted to Natural England which are given in Annexe 2 to this document, but the basis principles are the same as expressed here.

They are the same because they apply to the protection of all receptors. The large number of sites means that there are a large number documents and because the same principles apply there is repetition of information across them. The documents for the Habitats sites of the Blackwater Estuary contain all the key information.

6.7 Protection of shellfish

Before the advent of the WFD, shellfish waters were protected under the Shellfish Waters Directive (Directive 79/923/EEC as amended). It set physical, chemical and microbiological water quality requirements that designated shellfish waters had to comply with. This directive was repealed in 2013 and for most purposes its requirements were subsumed into WFD, which provides the same level of protection to shellfish waters.

Under WFD, shellfish waters can be classified as ‘protected areas’. The Blackwater estuary is such a protected shellfish area. With respect to such protected areas, and since March 2016, measures are to be included in RBMPs to achieve water quality objectives necessary or desirable to improve or protect those protected areas in order to support shellfish life and growth and to contribute to the high quality of shellfish products suitable for human consumption.

The only specific water quality standard for shellfish comes from the Shellfish Water Protected Areas (England and Wales) Directions 2016. This requires that the Agency must endeavour to observe a standard such that discharges will not contain bacteria above a set limit. This standard is mainly applicable to discharges from sewage treatment works serving large settlements. It is not relevant for the discharge under the Permit because the treated FED effluent does not contain any bacteria.

With respect to other substances that may affect the above shellfish objective and which are relevant to the discharge (eg metals and nitrates) we are confident that if the discharge complies with the relevant WFD standards there will be no adverse affect on any shellfish (including native and non-native oysters) outside the mixing zone such that the Blackwater shellfish protected area will be protected in order to support shellfish life and growth and to contribute to the high quality of shellfish products suitable for human consumption.

6.8 Protection of fish

As with shellfish, before the advent of WFD certain fisheries were protected by the Freshwater Fish Directive (Directive 78/659/EEC) which had some specific water quality targets for designated fisheries. This directive was also repealed in 2013 by WFD, which now contains the appropriate standards to ensure protection of species of fish and their habitats. We are therefore confident that if the discharge does not risk a breach of any of the relevant WFD standards in the receiving waterbodies there will be no adverse effect on fish outside of the 100 metre mixing zone.

6.9 Protection of bathing waters

The only specific water quality standard for the protection of public health and the environment in waterbodies in the UK is a bacteriological standard which comes from the Bathing Water Regulations 2013. These implement the revised Bathing Waters Directive (2006/7/EC). These regulations only consider faecal indicator organisms in the classification standards. There are no chemical standards. Under the requirements of the WFD designated bathing waters can be classified as ‘protected areas’ and the only such area in the vicinity of the treated FED effluent from the Bradwell site is at West Mersea which is over three kilometres across the Blackwater estuary from the discharge point.

Because the FED effluent does not contain any faecal matter it does not pose any threat from bacteriological contaminants to the West Mersea bathing site or to bathers, swimmers, or anyone involved in immersion sports or recreational pursuits that involve any contact with water, anywhere in the receiving waterbodies.

6.10 Protection of human health

The Agency has a statutory role to protect the environment and human health from all processes and activities it regulates but (except for the bacteriological standards mentioned above which are not relevant) there are no specific water quality targets to consider for this purpose.

However, in our view, a common sense water quality standard for the protection of human health is that the existing background water quality be maintained. If the work and recreational uses of the waterbodies that currently occur involving a range of exposure levels to the water (from the full immersion of swimmers to the spraying of people walking on the shore from surf or wind) takes place without any adverse human health impacts being caused, we can be confident that limiting any deterioration to within 10% (outside the mixing zone) will not have any human health implications. It should be noted that dilution does not stop at the edge of the mixing zone and that the risks are lower in the wider estuary proportionate to the distance from the discharge point.

The risks of people being exposed to the undiluted treated FED effluent within the mixing zone are extremely low. The mixing zone is limited in scope to approximately 4,000 m^3 within an estuary that has an average volume of 106,300,000 m^3. In addition, discharges into this zone will only occur for 30 minutes on any day that a discharge takes place and it will always be submerged.

6.11 H1 Guidance for impact assessments

At the time of the Application there was published guidance for applicants wishing to understand the framework for assessing environmental impact assessments and setting permit limits for sites regulated by the Agency. In this case the relevant documents were H1 Annexe D1 ‘Assessment of Hazardous Pollutants within Surface Waters’, and Annexe D2 ‘Assessment of sanitary and other pollutants within Surface Water Discharges’. The H1 guidance and H1 Annexe D1 (though not H1 Annexe D2) were withdrawn on 1 February 2016 as part of a wider government initiative to streamline regulatory guidance. However, this guidance still accurately reflects the Agency's approach which is now outlined on the Gov.uk website.

Annexe D1 is relevant for the heavy metals in the discharge and D2 is relevant for assessing the nitrates within it.

Annexe D1 – Heavy Metals

This Annexe outlines a sequence of screening tools to assess the significance of the concentrations of the individual hazardous pollutants within discharges. In this context 'hazardous' means that a substance has known toxicities to aquatic organisms and specific EQSs. If the effluent characteristics meet certain criteria and the concentration of a substance within the discharge screens out at any stage in the sequence it is deemed 'insignificant'. No further assessment is then required and no numeric emission standards are set within permits for substances that are insignificant in H1 terms.

In this case the treated FED effluent failed the initial screening criteria because of its density. One of the screening criteria is that discharge be buoyant. The treated FED effluent is denser than the surrounding seawater and will therefore sink when it is discharged. For discharges that fail any of the screening tests Annexe D1 requires that more complex hydrodynamic modelling be undertaken to establish whether the mixing zone for the effluent, and individual pollutants within it, are acceptable and to facilitate the calculation of appropriate emission standards.

Once the mixing zone has been deemed to be acceptable the criteria for setting emission limits for existing discharges of trade effluent to estuarine waters that are relevant in this case are:-

- the emission standards should not cause a failure of any EQS or any other water quality standard or classification beyond the mixing zone; and

- emission standards for existing discharges of trade effluent can be set at twice the 95% of the effluent quality data results, or higher (if the operator would have difficulty complying with this) so long as this does not risk a failure of any of the above targets.

Annexe D2 – Nitrates

This Annexe relates to the nitrates within the discharge because it addresses WFD standards which include DIN concentrations. Nitrates are one form of DIN.

The implications of Annexe D2 requirements in relation to the nitrates within the discharge can be summarised as:-

- there must be no exceedance of the existing WFD DIN classification of the receiving waterbodies;

- no deterioration at all is the ideal but an increase of up to 10% on the existing background concentrations of DIN is allowable so long as this does not cause failure of the existing class limit and

- there are no definite requirement for the setting of emission standards for nitrates or nitrogen.

6.12 The Applicant's environmental impact assessment

In this case the H1 assessments were undertaken by HR Wallingford, the Applicant's consultant, and because it failed one of the screening tests for hazardous substances HR Wallingford undertook a detailed dilution and dispersion modelling exercise. This built on the previous modelling exercise they undertook for the original application for the treated FED effluent discharge in 2011.

Because the discharge is an existing one, and the acceptability of the 100 metre mixing zone had already been established, HR Wallingford's modelling had slightly different aims to one that we would expect for a brand new discharge. Rather than to calculate the individual mixing zones for each pollutant in the effluent for us to make a decision on their acceptability its main aims were to:

- inform the design of the new outlet structure to achieve the maximum dispersion and dilution characteristics for the effluent;

- confirm that the dilution factors the effluent will be subject to by the time it reaches the edge of the 100 metre mixing zone are sufficient to meet all the relevant water quality standards; and

- predict the increase in background concentration of pollutants outside of the mixing zone in the Blackwater Estuary from the new outlet. This includes assessment of the residual concentration of metals and nitrates from previous discharges returning on the incoming tide.

The models that HR Wallingford used are standard industry types and are populated with real bathymetric dimensions and measured flows from surveys of the estuary, (in all tidal states and seasons). The modelling results include the calculation of the dilution factors that are specific to discharge duration periods around the times of high water on ebbing tides.

The key conclusions of HR Wallingford's modelling that are relevant to assessing the potential impact of the treated FED effluent being discharged through the new outlet on the receptors in the receiving environment are as follows;-

- The minimum dilution for the discharge at the edge of the 100 metre mixing zone over the 30 minutes it discharges is 240:1. This is the dilution factor the discharge would be subject on the lowest ebb tide of any one year at the slowest current over 30 minutes.

- For assessing the potential effects of the discharge on MAC EQSs this is the relevant dilution factor to use because MACs are based on the possible toxic effects of substances occurring over a few hours. If 240:1 dilution is sufficient to render the metals in the discharge to below their MAC EQS concentrations over the 30 minute duration of the discharge we can be sure there will be no toxic affect on any aquatic organism outside the mixing zone.

- The average dilution for the discharge at the edge of the mixing zone over the full range of tides and currents is 1000:1. So the average over the 24 hours of any particularly discharge day would be 48,000:1 (because there are 48 periods of 30 minutes).

  For assessing the potential effects of the discharge on AA EQSs this is the relevant dilution factor to use because AA EQSs are based on the potential for long-term chronic affects. If 48,000:1 is sufficient to reduce the metals in the discharge to below their AA EQS then we can be sure there will be no chronic toxic affects on any aquatic organism outside the mixing zone. Using 48,000:1 is conservative because the discharge is very unlikely to occur every day.

- These dilution factors are more than sufficient to ensure that all the EQSs for the metals within the effluent would not be breached outside the 100 metre mixing zone.

- Beyond the 100 metre mixing zone the plume will spread out further and because the outlet is over 400 metres from the shore and the discharge will be made on ebb tides the dispersed plume will travel in the central area of the estuary out to open waters.

- Beyond the 100 metre mixing zone the existing background AA concentrations of nitrates (and DIN) in the Blackwater estuary, and beyond, will not be increased above 10% over the period of the FED treatment operation, (the model assumes one year of operation). This estimate includes the return of residual nitrates concentrations from waters outside of the estuary on the incoming tides.

- The treated FED discharge will not cause a failure of the existing WFD DIN classification for the Blackwater estuary waterbodies outside the mixing zone.

- The treated FED discharge will not cause a failure of the existing WFD classification for any of the metals in the effluent or an increase of more than 10% in existing AA background concentrations of any of the metals in the Blackwater estuary waterbodies or beyond.

6.13 <u>Our -evaluation of the impact assessment and supplementary work</u>

As previously explained our determination has focused on the impact assessment provided by the Applicant to support its Application for changes to the permit. We have analysed this by (i) comparing it the Agency's guidance for impacts assessment, (ii) checking whether it incorporates the correct water quality targets and (iii) checking whether the modelling on which the assessment is based is fit for purpose.

With regard to the comparison with Agency guidance, the impact assessment provided by the Applicant does, for the most part, follow its key principles even if there are some differences in approach. The calculation of 'dilution factors' that the effluent will be subject to within a fixed mixing zone is not a standard approach but, in this case, we accept that it is a valid one. This is because the Application is for a variation to the permit for an existing discharge which was granted on the basis of there being a 100 metre mixing zone for the effluent. The primary purpose is therefore to establish that the same water quality standards will be met at the same point rather than to specify exactly where within this zone they will be met.

With regard to the water quality targets used the Applicant's consultants quoted a few out-of-date EQSs for the metals in the discharge in the Application and they were not aware of the changes to the waterbody classifications that have just taken place in Cycle 2. They were also unaware of the new conservation targets that Natural England have produced for the protection of the Blackwater, Colne, Crouch and Roach Estuaries MCZ and Essex Estuaries SAC which are partly based on specific WFD standards.

Their lack of awareness of the EQS and WFD changes made no material difference to their overall conclusions because there is sufficient dilution within the mixing zone to meet the new EQSs and the WFD targets they used are more stringent than are now applicable. Their analysis shows that the changes to the discharge would not cause a breach of the overall 'Good' standard for WFD in the Blackwater Outer waterbody which is a more stringent target than the current one of achieving 'Moderate' status. This indicates that the treated FED effluent would not jeopardise the attainment of 'Good' status in the receiving waterbody, especially as it is a temporary discharge.

With regard to the modelling for the impact assessment Agency specialists have scrutinised HR Wallingford's modelling reports. After some questioning for clarification they have confirmed that the modelling tools are appropriate, the inputs were correct and we can have confidence that its main conclusions regarding compliance with EQSs and WFD standards and limiting deterioration to within 10% are valid.

However in order to be sure that the new MCZ standards will be met in the receiving waterbodies the Agency undertook further assessment of its own. This is because although HR Wallingford's modelling established that the input of nitrates from the treated FED effluent will not cause a deterioration beyond 10 % in the annual average background concentrations of nitrates (or

DIN) within the receiving waterbodies, it did not address whether even this limited increase could lead to any adverse short term eutrophic affects such as the blooms of opportunistic macroalgae or phytoplankton, which would be a failure of the MCZ and Essex Estuaries SAC conservation objectives. Our own modelling experts undertook this work, rather than requiring the Applicant to do it, because they have developed bespoke methods and modelling tools for this purpose which are not available to outside bodies.

6.14 Conclusions and the implications for permit limits and conditions

Nitrates

The conclusion of the Agency's modelling work is that an increase of 10% in background nitrates and DIN concentrations would not lead to a significant change in macroalgae or phytoplankton growth and would not cause the breach of any WFD target or threaten any of the MCZ or Essex SAC conservation objectives. However, two recommendations came out of this exercise to limit the potential effects of the nitrates within the discharge even further. The first it to restrict the timing of the 30 minute discharge to within 1 to 2 hours of the high water period, as opposed to 1 to 2.5 hours which the Applicant has stipulated, and the second is to limit (when it is possible to do so), the discharges to daytime ebbing tides on any one day that will ensure the next returning tide occurs in darkness. The return of residual concentrations of nitrates on the incoming tides in darkness will further restrict their uptake by plants which absorb nutrients more readily during photosynthesis in daylight.

The above conclusion regarding the impacts of a 10% increase in background nitrates is valid for the discharge being made through either outlet because it is only the wider dispersion of nitrates within the receiving waterbodies that matters, not the initial dilution and dispersion characteristics near the outlet. The conclusion is also valid for the discharge occurring over any extended time period (i.e. taking place over more than the 24 months applied for), because it is based on the whole nitrate load (from the nitric acid required to treat the remaining FED on site) being discharged within one year. If the same load was discharged over any longer time period the increase in background concentrations of nitrates and DIN within the estuary would be proportionately lower and the potential for any adverse eutrophic affects would be even less.

The implications for the permitting conditions for the nitrates within the discharge are that a time limit for the activity is not necessary if we limit the overall load of nitrates being discharged to that generated by the treatment of the remaining tonnage of FED on site. Controlling the nitrates within the discharge this way has the following advantages over a 'time limited activity' permit;-

- there are numeric nitrate limits to be complied with;
- the limits are tailored to protect the receptors of the receiving waterbodies;

- nitrate load limits will ensure that the FED disposal operation on site is not open ended; and

- no further applications will be necessary to vary the time limit for the activity if the operation timetable slips again.

Details of how these requirements are expressed in the Permit are given in section 7.1.1 below.

Metals

For the original application in 2011 for this discharge the Applicant provided an impact assessment showing that the metals concentrations in the treated FED effluent discharge would not cause a breach of any EQS or WFD target outside a mixing zone 100 metres from the outlet and not cause a deterioration greater than 10% in the existing background concentration of any metal beyond this point. These conclusions were based on the effluent receiving a minimum of 50:1 pre-dilution in abstracted sea-water before discharge and then further dilution within the 100 metre mixing zone, as calculated from dispersion and dilution modelling by HR Wallingford. The effluent is mixed with large volumes of abstracted seawater prior to discharge to give it sufficient head pressure to force it by gravity through the large outlet pipe out into the estuary. Without this the small volume of effluent would accumulate in the outlet pipe held back by estuary waters coming the other way. This would prevent efficient dilution and dispersion and lead to higher concentrations of metals across a greater mixing zone. The primary purpose of the carrier flow of seawater is not therefore to provide dilution to meet environmental targets but to facilitate the discharge. It does, however, provide beneficial dilution and gives additional confidence that the targets are met when discharges are made.

For this Application the Applicant has had to provide evidence that sufficient levels of dilution will be achieved within the same 100 metre mixing when the new outlet is used and to meet the same environmental targets. As stated above, our specialists have analysed the modelling reports from HR Wallingford and are confident that the dilution factors HR Wallingford have calculated are correct. That is, that the absolute minimum dilution for the 30 minute discharge period of the effluent across the full range of possible currents and ebb tide heights is 240:1 and that the average dilution of any discharge is 48,000:1. Table 2 below shows how these dilution factors are sufficient to ensure that all the MAC and AA EQSs for each substance would be met outside the mixing zone. It also shows the dilution factors needed for the effluent to be diluted to the background concentrations in the receiving estuary.

It should be noted that, with regard to EQSs, HR Wallingford made some errors in this regard but that we have used the correct ones in our determination. The dilution factors available for the effluent in the mixing zone are high enough for these errors to make no difference to the conclusion. The correct EQSs are displayed in Table 2 below.

The maximum concentration of each substance so far detected in the effluent is given in the second column on the left in Table 2 next to its MAC and AA EQSs. The next column shows the AA background concentrations for each substance from our monitoring data at the nearest sample point from the outlet over the last three years. The following columns show how much dilution the effluent would require, to meet AA EQSs and background concentrations, and for comparison with the 48.000:1 dilution available within the defined 100m mixing zone. It can be seen that the highest dilution required to meet an AA EQS is 113.6 for copper and that the highest to reduce a substance to its background concentration is 2,791 for lead. So the 48,000:1 dilution available within the mixing zone is more than adequate. This means that for each substance the actual mixing zone required to meet the AA EQS is smaller that the 100m defined mixing zone used in modelling. This is a simple analysis which does not take account of the existing background concentrations in the estuary but, because these are very small, and the dilution factor is huge, they would not make a significant difference to the conclusion.

Because we are confident that the individual metals within the treated FED effluent discharge (from the new outlet) would receive enough dilution to reduce them virtually to existing background concentrations, Since background concentration meet WFD good status we can also be confident that there would be no threat to any WFD targets for metals in the waterbodies. It should be noted that dilution does not stop at the edge of the defined mixing zone and that the dilution factors beyond it will be even greater. This means the effects of the discharge on background concentrations in the wider estuary will be even less, even taking into account the return of residual traces of metals on the incoming tides which the HR Wallingford modelling allows for.

With regard to the meeting of the MAC EQS targets, it can be seen that the highest dilution factor needed is 74:1 for mercury so that the 240:1 available is more than adequate to ensure that its EQS will be met outside the mixing zone. However, because the dilution for MACs is much lower than for AA EQSs the existing background concentrations for substances with MAC; EQSs are more significant. HR Wallingford’s impact assessment report addresses this. HR Wallingford’s impact assessment report addresses this. Taking account of background concentrations, it compares the concentration of metals at the edge of the mixing zone with the MAC EQS, and reports this as a percentage. Mercury is the substance that has the highest concentration in relation to its MAC EQS, at 45 percent. This means that there is still 55% ‘headroom’ available at the edge of the mixing zone before the MAC EQS would be exceeded.

Table 2 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQSs

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQSs	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQSs	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	132	869	48,000	n/a	240

The impact assessments provided by the Applicant for the 2011 application (including calculated dilution factors within a 100 mixing zone and the minimum of 50:1 pre-dilution/carrier-flow) are still valid and we are, therefore, confident that allowing the continuation of the discharge through the existing outlet will not pose a risk to any of the receptors in the receiving waterbodies.

We are also confident that, if we limit the discharge to just being the effluent from the treatment of the finite load of FED generated and stored on site, a time limit is not required to protect the environment. This is because discharging the treated FED effluent over longer periods than one year would reduce its polluting potential. Because it's polluting potential lies in its effects on the annual average background concentrations of each metal in the receiving waterbodies. Extending the discharge period will only lower the resulting increases in annual average concentrations. There is sufficient dilution to achieve MAC EQSs on any one day regardless of the overall discharge period. By controlling the daily and overall load of nitrogen in the discharge (as outlined below), we can make sure the discharge load of metals will be finite also.

The same rationale applies to discharges from the new outlet. We have concluded that there is enough dilution at the edge of the mixing zone to prevent a breach of any MAC EQSs on any one day of discharge, and more than enough to prevent a breach of any AA water quality targets if the FED operation is completed within one year. If it is completed over any longer period (from the same finite load) the AA water quality targets will be met more easily and the MAC EQSs still met.

Our overall conclusion with regard to protecting the receptors of the receiving waterbodies from metals within the effluent is, therefore, that we can allow a continuation of the discharge from either outlet without a time limit for the activity if we limit the overall load of treated FED effluent that is discharged.

Numeric emission limits for metals are required by our hazardous pollutants guidance. The way in which we have set metal limits is outlined below in the Emission Limits section, as is our method of limiting the overall treated FED effluent load.

Temperature

As previously explained, HR Wallingford have calculated that the treated FED effluent, after some ambient cooling in the retaining chamber before discharge, will have a temperature ranging from 21.12 º C in winter to 41.67 º C in summer. Their modelling exercise for the first application in 2011 included an assessment of temperature effects and it concluded that after pre-dilution in the carrier flow and further dilution within the 100 metre mixing zone the temperature of the estuary waters outside it would not be increased by more than 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any receptors of the receiving waterbodies.

The new outlet was designed by HR Wallingford on behalf of the Applicant to achieve the same water quality targets at the edge of the mixing zone and we know that the effluent will be subject to a minimum dilution factor of 240:1 at this point. HR Wallingford have assessed the risk of using the new outlet by taking the worst case temperature differential between discharge and receiving waters (highest temp of effluent in summer and lowest temp of estuary in winter), and dividing this by the minimum dilution factor to estimate that the most the temperature could be increased by beyond the mixing zone is 0.3 º C. The extreme temperature differential used could not occur in practice so this estimate is extremely conservative. But it does show that any discharges through the new outlet would not risk any adverse affects being caused to any receptors outside the mixing zone.

It is clear from the above that the discharge of treated FED effluent through either outlet does not pose a risk to any receptors of the receiving waterbodies from temperature effects. There is no reason to time limit the activity because temperature effects at this level can not accumulate in any way within the receiving waterbodies. The discharge could be made from either outlet and for any time period without having adverse affects from temperature effects.

<u>pH</u>

The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency’s standard pH range for controlling discharges of 6 to 9 in order to prevent harm to aquatic life. However there is a guideline standard for pH in marine waters of 7 to 9 under WFD.

The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and there is additional buffering capacity within the 100 mixing zone.

Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute minimum dilution factors calculated by HR Wallingford of 240:1 at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone.

It is clear from the above that the discharge of treated FED effluent through either outlet would pose no risk to any receptors in the receiving waterbodies outside the 100 metre mixing zone. Because pH is not accumulative there is also no need to time limit the activity to protect receiving environment. The discharge could be made from either outlet and for any period of time without a risk of any adverse affects being caused to any receptors outside the mixing zone from pH effects.

7. Proposed permit

7.1 Emission limits

7.1.1 Nitrates

As previously explained, if we limit the overall nitrate load from the treated FED effluent discharge (through either outlet) to that which can be produced from treating the remaining tonnage of FED waste stored on site we can be confident that there would be no adverse impact on any receptors within the receiving waterbodies over any period of time which is longer than the 49 weeks used in the HR Wallingford modelling exercise.

To ensure this is the case the key input parameters for the nitrate load used in the HR Wallingford modelling exercise have to be represented in the Permit, because it is the modelling exercise that provides the evidence that there will be no adverse affects. The modelling inputs were 20 m^3 a day of treated FED effluent being discharged continuously for 49 weeks with an average nitrate concentration of 22,000 mg/l (as N). This concentration of nitrate in 20 m^3 gives a total daily load of 440 Kg (as N). We have therefore put this figure in the permit as a maximum amount to be discharged on any one day.

We have put a section in the permit for limiting the total load of the overall operation but can not put a definite figure in it at the moment because it will depend on the amount of FED waste remaining on site at the point that the permit is issued. We will set a limit based on the overall load that could be generated by treating all the FED waste generated on site subtracted by that which has been discharged at the time that the permit is issued.

There will be other conditions in the Permit to enable us to keep a check on the daily and overall loads being discharged.

7.1.2 Metals

Our current guidance for the setting of permit limits for hazardous substances requires that we set a numeric emission limit for them if the effluent fails any of the H1 screening criteria. In this case the treated FED effluent failed the criteria because it is not buoyant, so numeric emission limits are required.

For existing discharges of trade effluent into estuarine waters our guidance allows us some leeway in the setting of emission limits, but the overall principle is to minimise (as far as it is practical to do so), the release of hazardous substance into the environment. In this case we have decided to set emission limits at higher concentrations for each substance than has been detected in the effluent so far.

The proposed emission limits allow some leeway for marginal exceedances of previously detected maximum concentrations in recognition of the fact that effluent quality may fluctuate in any treatment process. Where there is a lot of tolerance within the environment we are able to allow a little for these possible fluctuations. We have also taken into account the fact that the operator will only make a discharge if their on-site testing confirms that the effluent meets the emission standards.

Table 3 below illustrates the proposed emission limits for the Permit and compares the dilution factors needed to meet AA and MAC EQSs outside the mixing zone with the dilution factors the effluent will receive at that point. It can be seen that the highest dilution needed to reduce the proposed emission limit concentration to its AA EQS is just over 227:1 for copper and that 48,000:1 is what it will receive. The tolerances are less for MAC EQSs with mercury standing out as needing the highest dilution for the proposed limit of 143:1 with 240:1 being available. The other substances with MAC EQSs need dilutions less than 15:1 however so there is a good amount of environmental tolerance for these.

Table 3 Proposed emission limits for metals and dilution factors

Substance	Proposed permit emission limits (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQSs	Absolute minimum dilution within 100 m mixing zone
Cadmium	45.2	n/a	0.2	0.018	22.6	2,532	48,000	n/a	240
Chromium	372	32	0.6	0.250	620	1,488	48,000	11.6	240
Copper	2478	n/a	10.9	1	227.3	2,478	48,000	n/a	240
Iron	3000	n/a	1000	50	3	60	48,000	n/a	240
Lead	134	14	1.3	0.024	103	5,582	48,000	9.4	240
Mercury	10.4	0.07	n/a	0.008	n/a	1,300	48,000	148	240
Nickel	454	34	8.6	0.94	52.7	482	48,000	13.34	240
Zinc	2086	n/a	7.9	1.2	264	1,738	48,000	n/a	240

It should be noted that mercury is unique within the table because it is not part of the dissolved FED. It is present in the effluent because it is a trace contaminant in the caustic soda used to adjust the pH in the FED effluent treatment plant. The Applicant is aware of this and has been making efforts to source low-mercury caustic soda products to reduce its concentrations in its effluent. The Applicant is also intending to test the mercury levels within the caustic soda before using it in the treatment plant and not to use any batch if it fails the above limit. Doing these two things means that the Applicant can minimise the chance of failures of the above limit and minimise the mercury releases within the limit as far as possible

At face value it may appear that our new emission limits for metals are less stringent than the controls on the existing permit. However the existing permit controls the metals emissions in a different way, which was the standard approach under the legislation and guidance in force when it was issued in 2011.

In the existing Permit (in contrast to the proposed Permit) there are no bespoke emission limits for metals calculated to protect the environment and to be actively monitored for compliance. Instead there are, default, numeric limits for just four of the metals set in a General Standards (GS) table at the rear of the existing permit, as shown below.

List 1 General Standards	
Substance	Limit Total concentration (µg/l) Surface Waters
Cadmium depending on (Water hardness classes) List 1	0.4
Lead and its compounds	14.4
Mercury and its compounds List 1	0.1
Nickel and its compounds	40

GS limits were a part of our permitting regime in force in 2011 because of the requirements of the Dangerous Substance Directive (DSD) (Directive 76/464/EEC) which applied at that time. One of the main principles of the DSD was to control certain substances (the most persistent in the environment) that effluents were ‘liable to contain’. It required that these substances be given emission limits on permits regardless of their potential to cause pollution or not. To comply with this our permitting regime included the use of default limits for some substances to be applied to permits via the ‘back stop’ of a GS table. The GS default standards are extremely precautionary because they have to apply universally regardless of available dilution and the specific sensitivities of the environment

The DSD was repealed in 2013 by WFD and certain of its purposes are now covered by the EQSD. Instead of the DSD requirement to assess whether substances are ‘liable to be contained’ in discharges the EQSD, in combination with WFD, requires us to ensure that discharges do not jeopardise attainment of the EQSs associated with ‘Good’ chemical status. In other words, rather than having default emission standards that apply to any discharge that is liable to contain certain substances, the approach has changed to one of assessing the potential for significant pollution to be caused by these substances and to only set bespoke emission standards if they are needed to meet water quality standards to protect the environment.

It should be noted that the maximum concentrations of substance detected in the effluent (as shown in Table 1 above) are from the raw effluent from the treatment plant before it has been pre-diluted. The Applicant has been able to meet the lower concentrations of the GS table before discharge because of the pre-dilution in seawater.

On our varied Permit the bespoke limits in the table 3 above will apply to the discharge out of both outlets. As outlined below the varied Permit requires the monitoring of the metals within the effluent and the reporting of the results to us for compliance purposes. Operating techniques to minimise mercury releases are also incorporated.

7.1.3 pH

As outlined above, the pH range of the effluent does not have the potential to cause harm outside of the 100 metre mixing zone whichever outlet is used. However pH adjustment is a significant element of the treatment system and limiting and monitoring the pH is, therefore, another means of ensuring that proper treatment has taken place. A pH range of 6 to 9 has therefore been imposed on the Permit for discharges out of both outlets.

7.1.4 Temperature

As previously explained, the effects of the discharge through either outlet on the existing background temperatures outside the mixing zone will be minimal. There is sufficient environmental tolerance to make temperature limits unnecessary.

7.2 Limits of specified activity

This section of a standard EPR permit (Table S1.1a of Schedule 1) allows us to put a brief descriptive condition into the permit to control some aspect of the discharge in a way that is difficult to incorporate in any other section of the permit.

7.2.1 Timing of the discharge

In order to ensure that the effluent is subject to the maximum dilution and dispersion within the receiving estuary, (and to minimise the potential for eutrophic effects of the nitrates within it) the wording of the ‘limits of the specified activity’ require the discharge to be made over 30 minutes within 1 and 2 hours after high water on an ebbing tide. This applies to the discharge through either outlet. The discharge through the existing outlet is represented in the Permit as activity A1 (Schedule 1 - Operations, Table S1.1a Activities) and the discharge through the new outlet as activity A2 (Table S1.1b). The wording to control the timing of the discharge is therefore the same for A1 and A2.

7.2.2 Use of low mercury caustic soda product

As previously explained, the source of mercury in the discharge is residual contaminants within the caustic soda product used for pH adjustment in the treatment system for the FED effluent. So although we have set a limit for mercury in the discharge to minimise its release into the environment there is scope for further minimisation within this limit if the Operator sources caustic soda that is low in mercury. Suitable wording to require this is therefore included in the 'Limits of specified activity' section of the permit in Table S1.1a of Schedule 1 for both the discharges through both outlets (activities A1 and A2)

7.2.3 Criteria for termination of the activities

In table S1.1a of the Permit for activity A1 there is wording that requires the cessation of the discharge through the existing outlet when it becomes inoperable. This ensures that there is no ambiguity within the Permit about which conditions apply to which activity.

In both of the tables S1.1a and S1.1b there is wording requiring the discharge to cease when the nitrate load of the overall FED operation referenced in Table S3.1 is reached. This is to ensure that the overall nitrate load discharged to the estuary is limited to that which is produced only by the treatment of the FED generated on the site. It ensures that the discharge is not open ended.

7.3 Operating techniques

Operating techniques are used within EPR permits when it is necessary to make sure that the operator will use certain techniques, methodologies, systems or procedures etc that are essential for the discharge to meet all the other conditions of the permit and protect the receiving environment but which are too complex to fit into the tables of the schedules in full. By referencing these external documents in Table S1.2 of Schedule 1 of the Permit we can enforce the use of whatever techniques and systems they outline.

7.3.1 Outlet structure

In order to be sure that the dilution and dispersion characteristics that will protect the environment are achieved when the new outlet has to be utilised we have included a reference to an operating technique in Table S1.2 of Schedule 1 of the Permit which requires the Operator to use an outlet that conforms to the design specification they have outlined in the Application. This technique only applies to activity A2 which is the discharge through the new outlet.

7.3.2 Analytical techniques and methodology

The Permit will have conditions requiring the Operator to take representative audit samples of the discharge, and analyse them for all the substances that have numeric emission limits in the Permit. Ordinarily for trade effluent discharges Agency staff would visit the site to take audit samples and they would be analysed by our national laboratory service. But this is not possible for the Bradwell site because the treated FED effluent has low levels of radioactivity which our laboratory service is not set up to deal with.

However, for its own purposes, the Applicant has set up a laboratory on site to test the metals concentrations in the effluent. This is because the Applicant wants to be sure that every release of treated FED effluent complies with the General Standards metals limits in Schedule 3 B of the existing permit (after pre-dilution) before release into the estuary and therefore does not cause any environmental harm. The treated effluent is retained in a holding chamber before being transferred into the main chamber where it mixes with abstracted seawater before release into the estuary. The Applicant's staff sample and analyse the effluent and only transfer it to the main chamber for pre-dilution and release if it will meet the required standards.

Their primary testing method for metals is, 'Inductively Coupled Plasma Mass Spectrometry' (ICPMS). The Applicant has installed an ICPMS machine at large expense under the guidance of an independent specialist scientist with appropriate qualifications and industry accreditation. They are also instituting annual audits of the Applicant's analytical methods and procedures to make sure that they are continuing to conform to the specified regime.

Members of our laboratory service who are specialists in metals analysis and ICPMS techniques have investigated the Applicant's analytical systems and procedures, and the details of the auditing they are subject to. They have concluded that the Applicant's analytical operation is fit for purpose.

A detailed 'operating technique' documents that outline the Applicant's analytical methods and procedures, and the auditing of them, is referenced in Table S1.2 of Schedule 1 of the Permit and applies to both activities and so is applicable for the use of both outlets. This will ensure that we can have confidence in the sample results.

7.3.3 Control release system

The Applicant has a dual key release system for activating the pumps which transfer the treated FED effluent to the main release chamber for discharge into the estuary. The pumps are only activated if two employees use their keys simultaneously. They only activate the pumps if the analytical results produced by the on site lab show that the appropriate emission limits for metals will be met.

In order to make sure that this system continues an operating technique outlining this procedure is included in Table S1.2 of Schedule 1 of the Permit. For activity A1 which is the discharge from the existing outlet the technique will apply to the pumps which release the effluent to the main chamber for pre-dilution mixing. For activity A2 the technique will apply to the pumps that send the discharge direct to the estuary out of the new outlet.

7.3.4 Flow monitoring

We require the monitoring of flow on permits because the polluting potential of a discharge lies within its polluting load which is a factor of flow volume multiplied by the pollutant concentration. In this case we particularly want to track and limit the load of nitrates that are discharged. Our default standards for flow measurement for EPR permits is ‘MCERTS’ which is a certification scheme with a set of criteria to be met that ensures the accuracy of results. The Applicant has confirmed that their flow measurement for the treated FED effluent meets the MCERTS criteria and has produced an operating technique to confirm this which is referenced in table S1.2 in Schedule 1 of the permit.

7.3.5 Discharge timing in relation to daylight

The recommendation of the Agency’s specialists is that it would be beneficial for the discharge of treated FED effluent to be made on the ebbing tide of the day that ensures that the next incoming tide will be in hours of darkness. This is not necessary to achieve the appropriate water quality standards but would help to minimise the effect that the nitrates in the discharge can have within the available environmental tolerance. However, in practice it will not always be possible for the Applicant to adhere to this principle for operational reasons or because, for some periods in summer, both tides return in daylight. We will therefore have an operating technique referenced within the permit that requires the applicant to discharge on the appropriate tide when it is practical to do so.

7.4 Monitoring, recording and reporting

7.4.1 Monitoring and recording

Table S3.1 in Schedule 3 of the Permit lists every parameter of the discharge that requires a numeric emission standard to protect the receiving environment and those which we require the Operator to monitor. We have included a monitoring requirement for, flow rate and volume, pH, nitrate and the metals: cadmium, chromium, copper, iron, lead, mercury, nickel, and zinc. The Operator has to record the results for these parameters for every single discharge made. This applies to discharges made through either outlet.

7.4.2 Reporting

Schedule 4 of the Permit outlines the reporting requirements the Operator has to comply with. Table S.4.1 applies to discharges through either outlet. It requires the Operator to give us all the results they have recorded for all the parameters outlined in Table S3.1 for the previous 3 months. The quarterly results will enable us to keep a track of the overall nitrate that is being discharged from the site and keep an awareness of when the overall permitted nitrate load is likely to be reached. But there is a specific requirement within Table S4.1 for the Operator to notify us when this occurs.

8 Other legal requirements

In this section we explain how we have addressed other relevant legal requirements, to the extent that we have not addressed them elsewhere in this document.

8.1 **The EPR and related Directives**

8.1.1 Regulation 59 of the EPR

Regulation 59 of the EPR requires the Agency to prepare and publish a statement of its policies for complying with its public participation duties. We have published our public participation statement.

This Application is being consulted upon in line with this statement, as well as with our guidance RGS6 on Sites of High Public Interest, which addresses specifically extended consultation arrangements for determinations where public interest is particularly high. This satisfies the requirements of the Public Participation Directive.

Our draft decision in this case has been reached following a programme of public consultation. The way in which this has been done is set out in Section 2.2. A summary of the responses received to our consultations and our consideration of them is set out in Annexe 1.

8.2 **National primary legislation**

8.2.1 Environment Act 1995

(i) Section 4 (Pursuit of Sustainable Development)

We are required to contribute towards achieving sustainable development, as considered appropriate by Ministers and set out in guidance issued to us. The Secretary of State for Environment, Food and Rural Affairs has issued *The Environment Agency's Objectives and Contribution to Sustainable Development: Statutory Guidance (December 2002)*. This document:

> "*provides guidance to the Agency on such matters as the formulation of approaches that the Agency should take to its work, decisions about priorities for the Agency and the allocation of resources. It is not directly applicable to individual regulatory decisions of the Agency*".

It requires the Agency:

'*To protect, enhance and restore the environmental quality of inland and coastal surface water and groundwater, and in particular:*

- *to address both point source and diffuse pollution;*
- *to implement the EC Water Framework Directive; and*
- *to ensure that all relevant quality standards are met.'*

The Agency considers that it has pursued the objectives set out in the Government's guidance, where relevant, and that there are no additional conditions that should be included in this Permit to take account of the Section 4 duty.

(ii) Section 5 (Pollution of the Environment)

The Agency has exercised its powers, when determining this application, for the purpose of preventing or minimising, remedying or mitigation the effects of pollution of the environment.

As explained above, in assessing the Application and setting permit limits and conditions we have used our guiding principle of limiting the potential effects of the treated FED effluent discharge (through either outlet) to causing only up to a 10% deterioration in the existing, background water quality of the receiving waterbody for each pollutant it contains. In this case there was more tolerance within the receiving waterbodies for greater levels of deterioration. We could therefore have set numeric emission limits in the Permit that allowed more than 10% deterioration without threatening a breach of appropriate water quality standards. The Permit therefore fulfils our duty of minimising and mitigating the potentially polluting effects the discharge, (through either outlet) could have on the receiving environment.

(iii) Section 6(1) (Conservation Duties)

Consideration has been given to the Agency's duty to promote the conservation and enhancement of the natural beauty and amenity of inland and coastal waters and the land associated with such waters, and the conservation of flora and fauna which are dependent on an aquatic environment. It is felt that the conditions of the Permit as a whole will be sufficient in this regard and no other appropriate requirements have been identified.

(iv) Section 6(6) (Fisheries Duties)

It is the duty of the Agency to maintain, improve and develop salmon fisheries, trout fisheries, freshwater fisheries, lamprey, smelt and eel fisheries.

As previously explained, we are confident that the discharge of treated FED effluent through either outlet will not significantly change the background water quality in the receiving waterbodies outside the mixing zone and that the appropriate water quality standards required by the WFD will be met within them. Because WFD standards for estuarine waters have been devised to protect all aquatic flora and fauna, including fish and their habitats we are also confident that by setting permit limits and conditions that ensure these standards are met there will be no risk to any fisheries in the receiving waterbodies and not be a barrier, with regard to water quality, to the development, or improvement, of fisheries within them. The Permit will therefore fulfil our duties under the above section.

(v) Section 7 (Pursuit of Conservation Objectives)

We considered whether we should impose any additional or different requirements in terms of our duty to have regard to the various conservation objectives set out in Section 7 (namely to have regard to any effect which the proposals would have on sites of archaeological, architectural, or historic interest; the economic and social well-being of local communities in rural areas; and to take into account any effect which the proposals would have on the beauty or amenity of any rural area) , but concluded that we should not.

(vi) Section 39 (Duty to Have Regard to Costs and Benefits)

The Agency has a duty under section 39 of the Environment Act 1995 to take into account the likely costs and benefits of granting the Application ('costs' being defined as including costs to the environment as well as any person).

As explained above, we are confident that the conditions of the Permit will ensure that switching the treated effluent discharge to the new outlet when it becomes necessary and removing the time limit for the activity will not pose any additional risk to any receptors in the receiving waterbodies outside the 100 mixing zone. This means that the varied Permit will provide exactly the same protection to the receiving environment as the existing permit, which was based on the same premise of protecting all receptors outside the same mixing zone. We are therefore confident that granting the Permit will not increase costs to the environment. We are also confident that the conditions of the Permit are necessary to ensure that the environment is protected so do not impose any unnecessary costs on the Applicant or costs not justified by the associated benefits.

8.2.2 Human Rights Act 1998

We have considered potential interference with rights addressed by the European Convention on Human Rights in reaching our decision and consider that our decision is compatible with our duties under the Human Rights Act 1998. In particular, we have considered the right to life (Article 2), the right to a fair trial (Article 6), the right to respect for private and family life (Article 8) and the right to protection of property (Article 1, First Protocol). We do not believe that Convention rights are engaged in relation to this determination.

8.2.3 Countryside and Rights of Way Act 2000

Section 85 of this Act imposes a duty on the Agency to have regard to the purpose of conserving and enhancing the natural beauty of the area of outstanding natural beauty (AONB). There is no AONB which could be affected by the discharges of treated FED effluent from the Bradwell site.

8.2.4 Wildlife and Countryside Act 1981

Under section 28G of the Wildlife and Countryside Act 1981 the Agency has a duty to take reasonable steps to further the conservation and enhancement of the flora, fauna or geological or physiographical features by reason of which a site is of special scientific interest. Under section 28I the Agency has a duty to consult Natural England in relation to any permit that is likely to damage SSSIs.

We assessed the Application and concluded that the discharge will not damage the special features of any SSSI. This was recorded on a CROW Appendix 4 form, which we used to consult Natural England who agreed with our conclusion.

Our CROW assessments in the form of the Appendix 4 consultation documents submitted to Natural England are given in Annexe 2 of this document.

8.2.5 Natural Environment and Rural Communities Act 2006

Section 40 of this Act requires us to have regard, so far as is consistent with the proper exercise of our functions, to the purpose of conserving biodiversity. We have done so and consider that no different or additional conditions in the Permit are required.

8.2.6 Marine and Coastal Access Act 2009

Amongst other things this Act brought into being the framework for the establishment and protection of Marine Conservation Zones. It appointed Natural England as the body to set criteria for their creation and to designate the features to be protected and the conservation objectives to achieve this. The Blackwater, Colne, Roach and Crouch Estuaries MCZ was designated as a result of the Act. The Agency's role with regard to permitting is to ensure: (a) that our decision accords with the relevant marine policy documents; (b) any discharges we licence in the vicinity of an MCZ will not have any adverse affects on any of the designated features and will further the conservation objectives, or at least hinder them in the least way possible; and (c) that granting the Application poses no significant risk of hindering the achievement of the objectives. We work with Natural England to achieve this and ultimately have to obtain their formal agreement if we decided to grant or vary a permit.

The Blackwater estuary and other waterbodies in the vicinity of the discharge are within the South East Marine Plan area as designated by the Marine Management Organisation (MMO) under the above Act. This area covers approximately 1,400 kilometres of coastline between Felixtowe and Dover. However, at the moment the South East Marine Plan is in development no draft or completed document is available for us to take account of in our determination. We understand that this is because the MMO have recently completed a public consultation process and are about to launch a 'Call of Issues with Supporting Evidence' to identify what should be in it.

In the absence of a draft or completed plan we have considered the generic information in the published marine policy documents and the advice produced by Natural England for meeting the conservation objectives of the Blackwater, Colne, Roach and Crouch Estuaries MCZ. As described in the sections above, we have assessed the potential impact of the discharge of treated FED effluent (through both outlets) upon the receiving MCZ and established to our, and Natural England's, satisfaction that there will be no adverse affects on any designated features, and that all the conservation objectives will be met. We have therefore met the requirements of the above Act.

8.3 **National secondary legislation**

8.3.1 The Conservation of Natural Habitats and Species Regulations 2010

We have assessed the Application in accordance with guidance agreed jointly with Natural England and concluded that there will be no likely significant effect on any European Site (a SAC or SPA) or any Ramsar site.

We consulted Natural England by means of an Appendix 11 assessment, and they agreed with our conclusion, that the discharge would not be likely to have a significant effect on the interest features of protected sites, either alone or in-combination with other plans or projects.

Our habitats assessments in the form of the Appendix 11 consultation documents we submitted to Natural England are given in Annexe 2 to this document.

8.3.2 The Water Environment (Water Framework Directive) Regulations 2003

As required by regulations 3 and 17 of these Regulations, in reaching these determinations the Agency has exercised its water resources functions so as to secure compliance with the Water Framework Directive and has had regard to the RBMP for this river basin district which has been approved under regulation 14 of these Regulations.

For the reasons given in this report the Agency is satisfied that granting this Application on the conditions proposed will not cause the current status of the receiving waterbody to deteriorate for any WFD parameter and will therefore not jeopardise the current target of overall Moderate status for that waterbody by 2021.

In addition to the requirement to achieve Moderate status by 2021, the WFD also requires the implementation of necessary measures with the aim of progressively reducing pollution from priority substances (including nickel, lead and mercury) and ceasing or phasing out emissions, discharges and losses of priority hazardous substances (including cadmium). These requirements are implemented in England at the strategic catchment level through the RBMPs.

For individual permits, if the treatment system proposed by the operator reduces substances in its discharges to concentrations that will maintain the existing waterbody status and will not prevent the WFD targets being achieved, the Agency considers that these additional requirements are met. This is the case with respect to the Permit.

ANNEXE 1: Consultation Reponses

A) <u>Advertising and Consultation on the Application</u>

The Application has been advertised and consulted upon in accordance with the Agency's Public Participation Statement as outlined in section 2.2 above.

Following the advertising of the Application on the Gov.Uk website on the 5 August 2015 (and our subsequent notification of interested parties) we received 44 responses which have been placed on the public register and have been taken into account in our decision. This Annexe summarises how we have done so.

The majority of the responses were aimed at the potential impact of the radioactive components of the discharge on the receiving environment and various aspects of the FED operation. These have been addressed in the equivalent Annexe in the accompanying decision document for the RSR permit EPR/ZP3493SQ. However some of the issues raised could also apply to this Application. For the sake of clarity we have addressed the issues that apply to the non-radioactive components of the discharge in this Annexe and to be comprehensive, we have also included the Annexe from the other decision document.

The following statutory and non-statutory bodies were consulted:-

1) <u>Consultation Responses from Statutory and Non-Statutory Bodies</u>

Maldon District Council	
Summary of issues raised:	**Our consideration of the issues**
N/A – No response received	

Kent and Essex Branch of Maldon District Council	
Summary of issues raised:	**Our consideration of the issues**
N/A – No response received	

West Mersea Town Council - Councillor Sylvia Wargent (PR 6)	
Summary of issues raised:	**Our consideration of the issues**
Why can't the FED effluent be pre-diluted when the new outlet is used?	As explained in the main body of the document the new outlet is too small to allow effective pre-dilution volumes but it has been designed to achieve

	the dilution factors for the effluent that will ensure that the same water quality targets are met (at the edge of the same mixing zone) as occurs for the current pre-diluted discharge
Is the discharge still made only once per day?	The permit allows a maximum of one discharge per day but in practice there may be days when no discharge is made.
Could the discharge be made more frequently than currently, i.e more than 2 or 3 times a week?	Yes it could, but our impact assessment concluded that a continuous daily discharge would have no adverse affects on the receiving environment for the limited duration of the FED operation.
Will the extension lead to a greater volume of effluent being discharged?	No. The overall total volume that can be discharged is finite, because we have limited it in the permit by limiting the overall nitrogen load that it can contain.
Concern for the possible effects of the discharge on bathing waters and recreational uses of the estuary at West Mersea and the knock on effects on tourism industry. Also possible effects on fishermen and oystermen	As explained in the main body of this document we have taken the potential effects of the discharge on all these receptors into account and are satisfied that there is no significant risk to them anywhere in the estuary outside of the limited 100 mixing zone around the outlet and no change to the existing situation.

2) Consultation Responses from Members of the Public and Community Organisations

Topic : The Agency's consultation method	
Summary of issues raised	**Our consideration of the issues**
A number of respondents said that the web advertising and targeting of individuals was	We advertised the application in accordance with our Public

not suitable consultation and that a advertisements of the application should have been made in local newspapers Respondents included ; PR 7, PR 20, PR 25, PR 29, PR 30, PR 44	Participation Statement and Regulatory Guidance Series Note 6 for Determinations involving Sites of High Public Interest. As set out in section 2.2, we also went beyond what would normally be required by this guidance. We are therefore confident that the consultation method was satisfactory and complied with our duties, including under the Aarhus Convention and Local Democracy, Economic Development and Construction Act 2009.
Topic : Possible long term use of the FED facility	
Some respondents have stated their opposition to any proposals for the future importation of FED from other nuclear sites to be treated at the Bradwell facility. Respondents included PR 9, PR10,PR13,PR15,PR16,PR19,PR25, PR26,PR30,PR34,PR35,PR36,PR38, PR39	The equivalent Annexe in the accompanying decision document for the RSR permit explains that we are not currently aware of any such proposals by the Applicant but that the RSR Permit does not preclude it. With regard to this Permit, as explained above, we have set a limit for the overall total nitrogen load that can be discharged from the effluent treatment plant. This limit is based on the amount of nitrogen that will be released by treating only the remaining volume of waste material that has been generated on site. If the Applicant wants to treat any extra FED waste it will have to apply for a new permit and provide further evidence to justify it.
Topic : Lack of pre-dilution	
A number of respondents were concerned about the future lack of pre-dilution of the effluent if the new outlet is used. One questioned why it was included in the existing permit if it is not essential	The addition of large volumes of abstracted seawater to the effluent prior to discharge was instituted to provide a carrier flow that would ensure it

Respondents included PR1,PR2.PR3,PR6.PR7,PR10,PR15, PR16,PR17,PR21,PR25,PR26PR29, PR30,PR34,PR35,PR36,PR38PR39, PR43,PR44	dispersed properly into the estuary. It was necessary because the discharge is by gravity and a small volume wouldn't have sufficient head pressure to disperse easily. However the carrier flow provides useful dilution also and the permit included it to take advantage of this. As explained in the main body of the document above the Applicant has demonstrated to our satisfaction that the same water quality standards can be met at the edge of the same mixing zone when the new outlet has to be used. The new outlet was designed to achieve the maximum dispersion characteristics so that this can be achieved.
Topic : Use of old modelling exercise in support of the Application	
Some respondents questioned the use of an old modelling exercise undertaken by the Applicant's consultants in support of the their request to use the new outlet Respondents included: PR7,PR9,PR10,PR13,PR15,PR16 PR17,PR18,PR22,PR24,PR25, PR29,PR30,PR34,PR36,PR39, PR44	The modelling exercise that supports the Application is based on the one used for the original application for the existing permit but it has been updated. The update included the changed dispersion characteristics of the new outlet. An Agency modelling expert has checked the report and met with the consultants who provided the modelling work to discuss it in more detail. We are satisfied that the updated modelling is fit for purpose.
Topic : No account taken in the application of later timing of discharge	
Some respondents stated that the environmental impact of the proposed later timing of the discharge was not considered	The proposal by the Applicant to change the timing of the discharge from the high water

in the Application and that this timing would increase the chances of the accumulation of pollutants within the estuary. Respondents included: PR9,PR10 PR15,PR16,PR17,PR18,PR25 PR29,PR30,PR40,PR44	point of an ebbing tide to one hour after the high water point is one result of the updated modelling exercise referred to above. The modelling indicates that the change will enhance dispersion of the effluent by allowing the build up of ebbing currents to have taken place before discharge. An Agency expert vetted the report and concurred.
Topic : Effects of temperature changes	
Some respondents stated that insufficient account had been taken in the impact assessment of the possibility of temperature changes affecting the mixing of the effluent within the estuary. Respondents included: PR10,PR15,PR16,PR17,PR18, PR21,PR25,PR29,PR30,PR40 PR44	Although it is not explicitly stated in the Application documents, the temperature characteristics of the effluent were taken into account in the modelling exercise undertaken by the Applicant's consultant. The Agency's modelling expert has verified that this was done correctly and that the results of the modelling exercise are valid.
Topic : Effluent will sink to the estuary bottom with insufficient dilution	
Some respondents have concluded from the Application that the treated FED effluent will sink to the bottom of the estuary within 800 metres having only received 50:1 dilution. Respondents include: PR21,PR44	Our interpretation of the Applicant's supporting information is that 50:1 is the absolute minimum dilution the effluent could receive before it reaches the estuary bed but that this would occur within the 100 metre mixing zone and not beyond it. However, the further dilution available within the mixing zone (after the effluent has reached the estuary bed) means that the absolute minimum dilution it will be subject to at the edge of the mixing zone is 240:1.

Topic : Low refresh rate of the Estuary	
Some respondents expressed concerns that the fact that the receiving waters are an estuary and therefore a “three sided lake” and that it has “a refresh rate of ten days” means that the discharge will not disperse properly and the pollutants within it will accumulate. Respondents include: PR7,PR9 PR10,PR15,PR16,PR17,PR18, PR22.PR24.PR25,PR29,PR30 PR34,PR36,PR38,PR39,PR44	The modelling exercise that the Applicant’s consultant HR Wallingford Ltd undertook (and which we have verified) included the inputs of surveys into the tides and flows within the estuary and so takes account of how the water within it moves in and out. This enables the prediction of what effect the discharge will have on pollutant concentrations within the estuary through time, including the return of residual concentrations of them on returning tides. The fact that the outlet is towards the outer estuary, and that discharges will always be made around the high waters of the ebbing tide, mitigates against accumulation of pollutants within it. The modelling predicts that at the end of the discharge period only 6% of the nitrate and metals load that has been discharged will remain within the estuary and that within a further six months 90% of this 6% will have flushed out. It also predicts that one year afterwards there will be virtually none left. In the meantime, because the discharge can not change the existing background concentrations of pollutants in the water column of the estuary to any significant degree (as outlined in the main document above) there is no risk of this temporary discharge causing any adverse affects on any receptors by accumulating in sediments or

	biota. The modelling was based on the FED operation taking place over one year. If the operation is spread over a longer period the effects on the existing concentrations of pollutants within the estuary will be lower and any risks of accumulation will be lower also.
Topic : No account taken of weather events in modelling	
Some respondents commented that there was no evidence that weather events such as storms and high winds were taken account of in the modelling exercise reported in the Application Respondents include:PR9,PR10, PR15,PR16.PR17,PR18,PR25, PR29,PR30,PR40,PR44	We agree with the comments, but we do not think that the omission makes any difference to the modelling results, Our modelling expert has confirmed that the effects of storms on the dilution and dispersion of the treated FED effluent within the estuary could not be significant and also that their effects could only be positive. Wind can only aid the mixing of the effluent and any increased rainfall would only serve to increase dilution of the effluent and its flushing from the estuary.
Topic : Challenge to "dynamic waterbody" characterisation	
Some respondents challenged the use of this phrase in the Application on the grounds that an estuary being a three sided waterbody can not be dynamic Respondents include:PR21,PR44	This phrase is used in section 5.3.2 on page 11 of the Applicant's Environmental Risk Assessment (BRAD/EN/REP/130FED) in their supporting documents. It is used in the context of explaining whether the discharge fits into certain criteria for the use of screening exercises outlined in the H1 (Annexe D1) guidance document. The H1 document explains that if any of the

	screening criteria are failed the applicant need to undertake hydrodynamic modelling to support their proposals. Although the discharge passes the screening test for which the ‘dynamic waterbody’ phrase is mentioned, it subsequently failed another test and the Applicant did commission the appropriate modelling. As such the use of the phrase was not relevant to our decision but the hydrodynamic modelling exercise that the Applicant’s consultants undertook was.
Topic : Threat to wildlife, native oysters and MCZ	
Many respondents expressed concerns about the possible adverse affects of the discharge on wildlife in the estuary in general and native oysters in particular. They also pointed out that the impact assessment provided by the Applicant did not take account of the designation of the Blackwater, Colne, Crouch and Roach Estuaries as a Marine Conservation Zone. Respondents include:PR3,PR7,PR9 PR10,PR12,PR13,PR15,PR16,PR17 PR18,PR22,PR24,PR25,PR29,PR34 PR36,PR38,PR39,PR41,PR44	As explained in the main body of this document above we have assessed the risk that the discharge poses to all wildlife in the receiving waterbodies (including oysters)and concluded that proposed changes to the permit will have no adverse affects on any. With regard to the MCZ it is correct that the Applicant has not included an assessment for this within their application documents. However, we have undertaking our own habitats assessment and have concluded that the proposed changes to the discharge do not pose a threat to the designated features of the MCZ. Natural England have confirmed they agree with our conclusion.
Topic: Threat to human health	
Some respondents expressed concern about the potential health threats to people who might be exposed to pollutants from the	As explained in the main body of the document the water quality standards that directly

discharge in the estuary as a result of recreational or commercial activity. Respondents include:PR6,PR7,PR8,PR9,PR10, PR13,PR27,PR32	pertain to human health are bacteriological standards and because the treated FED effluent discharge does not contain any pathogens it poses no threat from these. In addition there is sufficient dilution within the mixing zone (100 metres downstream on the ebbing tide from the outlet) to maintain the existing background concentration of metals outside it and to make no significant difference to the background concentration of nitrates. We are confident that the maintenance of the existing background water quality (outside the extremely limited mixing zone) ensures there will be no direct or indirect threat to human health from the requested changes to the discharge. This applies to any degree of exposure to the estuary waters from any recreational or commercial activity, ie. sailing, rowing, swimming, fishing or beach activities.
Topic: Wrong type of application	
A number of respondents stated that the Application should have been for a brand new permit and not for a variation to an existing one Respondents include:PR15,PR16,PR17,PR25,PR30,PR43 PR44	The Agency is required to respond to any valid application that it receives within the legal framework of EPR. In this instance there is no legal reason not to accept the Application as a variation to an existing permit.
Topic: Application should be rejected outright	
A number of respondents stated that the Application should not be given any consideration but should be rejected outright. Respondents include:PR22,PR27,PR31	The Agency does not have the power to reject duly made applications without giving them any consideration. The Application met the

	appropriate criteria and we are obliged to consider it before determining whether it should be granted or rejected. We could only reject the Application if we did not believe that we could issue a permit that would protect all the receptors of the receiving environment. In this case we believe we can issue such a permit.

EXTRACT FROM:

Environment Agency Permitting Draft Decision: RSR Permits

Reference Number EPR/ZP349SQ/V005

Annexe 1: Summary of representations received

When we advertised the applications for the Water Discharge permits variation applications (references: EPR/DP3127XB/V002 and PR2TSE10760/V003), we took the opportunity to notify interested parties that we had received an application for variation of the RSR permit at Bradwell.

We received a significant number of representations for the Water Discharge permits variation applications. a small number of the comments we received related to matters also relevant to radioactive waste discharges and the impact of these discharges on the environment. Due to the high level of public interest in the permit applications we decided to consult the public on our draft decision and draft permit for the RSR permit variation application.

We have summarised in this Annexe how we have taken the responses into account in reaching our decision. Copies of all consultation responses have been placed on the Environment Agency public register, except where the person making the response asked for these not to be made public.

We received 44 responses. These are summarised below, together with our consideration of them.

Topic: Optimisation in the management and disposal of radioactive waste	
Summary of issues raised	**Our consideration of the issues**
A number of respondents have	In 2006 Magnox identified that its preferred

expressed the view that the operational performance of the FED treatment plant at Bradwell has been sub-optimal and/or that the treatment of FED at Bradwell does not represent BAT. **Raised by:** PR7, PR9, PR10, PR15, PR16, PR17, PR19, PR21, PR22, PR25, PR26, PR29, PR30, PR34, PR35, PR36, PR38 PR39, PR40, PR41, PR42, PR44	approach for the management of FED at Bradwell was to treat it on-site by a process of dissolution and abatement to remove radioactivity from the discharge. In 2011 Magnox applied to us for changes to their permit to allow them to carry out the FED treatment process. As part of our determination we considered the technical justification provided by the operator and accepted that Magnox's decision for the treatment of FED could be pursued provided Magnox applied BAT to minimise the levels of radioactivity in the discharges and ensure that the radiological impact to members of the public was kept ALARA. The application included a request to increase the limits for gaseous discharges for H-3 and C-14. Therefore, in accordance with Article 37 of the Euratom Treaty, on 12 March 2012 the UK Government submitted a modified plan for the disposal of radioactive waste arising from the decommissioning of the Bradwell site, including general data on the radiological impact to members of the public in other European member states from discharges associated with the FED treatment. We only granted the permit, in June 2012, after the European Commission had provided its opinion that the planned modification would not give rise to doses to the population in another Member State that would be significant from the point of view of health. The current changes requested by Magnox do not include any requests to change the nature of their discharges (i.e limits in the permit). It took Magnox longer than originally anticipated to bring the FED treatment plant on line and the treatment of FED at site did not start until June 2014. Magnox has had operational difficulties with the FED treatment plant and has not been able to achieve the desired level of throughput. However, the environmental performance of the FED treatment process (abatement to reduce the levels of radioactivity in the discharge) has remained consistent with our regulatory expectations. We are satisfied that the treatment of FED is compatible with the requirement to apply BAT to ensure that radioactivity in the discharges is kept ALARA. The levels of radioactivity in the discharges remain well within the limits set in the environmental permit (less

	than 1% of the annual limits). This does not mean an alternative approach could not equally be demonstrated to be compatible with the requirement to apply BAT. We recognise that a number of other possible approaches to the management of the FED waste could be equally acceptable from an environmental perspective.
Some respondents have stated their opposition to any proposals that might be made for the future importation of FED from other nuclear sites for dissolution at Bradwell. **Raised by:** PR9, PR10, PR13, PR15, PR16, PR17, PR19, PR25, PR26, PR30, PR34, PR35, PR36, PR38, PR39	It is a requirement of the environmental permit that transfers of radioactive waste between sites can only be made via an optimised disposal route. In addition, the possible future importation of FED to Bradwell from other nuclear sites might require planning approval. The conditions of the RSR environmental permit do not preclude the Magnox from disposing of FED that has come from other nuclear sites at Bradwell. We are not aware of any such proposals from Magnox and do not see this as a likely priority for Magnox in the future, as this would further extend the Bradwell decommissioning programme and delay the site's entry to care and maintenance. However, if Magnox's plans were to change we would consider such proposals on the basis of the evidence that would be needed in order to demonstrate that this disposal route is optimised.
Some respondents suggested that Magnox should consider alternative ways of dealing with the discharges from the FED treatment process, such as the use of settlement tanks prior to discharge, or the transport, by boat, and subsequent discharge of the treated FED effluent in the open sea. **Raised by**: PR3, PR9, PR10, PR13, PR15, PR16, PR17, PR21 PR25, PR26, PR30, PR34, PR35, PR36, PR38, PR39, PR44	**Use of settlement tanks:** The FED dissolution process, including treatment of the effluent in the ADAP, involves the use of fine and micro-filtration to remove un-dissolved particles, as well as ion-exchange to remove specific dissolved radionuclides from the liquid waste. Magnox checks the turbidity of the effluent against specified operational environmental performance criteria. Turbidity levels are measured pre and post discharge from the Final Monitoring and Delay Tank to confirm compliance with the RSR environmental permit condition to use BAT to exclude entrained solids. Turbidity results for discharges from the Bradwell Final Monitoring and Delay Tank, covering the period 12 April to 21 October 2015, were provided to us by Magnox (Reference 13). The results showed that the turbidity levels are typically below 1 NTU, with the highest value being 3 NTU. The

	Bradwell Site environmental performance criterion for turbidity in routine discharges from the Final Monitoring and Delay Tank is <10 NTU. For comparison: UK Drinking Water standards prescribe a maximum value for turbidity of 4 NTU. Turbidity levels of discharges from the Final Monitoring and Delay Tank at Bradwell are therefore comparable to drinking water. The operation of settlement tanks prior to discharge would serve to allow heavier particles to settle to the bottom of the tank. However, such particles would have already been removed via the filtration process at ADAP. We do not think any additional measures to further remove suspended solids from the liquid discharges are required, at this stage, to exclude entrained solids from the discharge as the current process demonstrates that BAT is achieved. **Transport of FED effluent by boat for subsequent discharge to the open sea:** The transfer of radioactive liquid waste for disposal at sea is not likely to be consistent with UK Government's radioactive waste discharge strategy and is likely to be in contravention of international agreements – e.g. OSPAR. From an environmental impact perspective it is also unlikely that any reduction to localised radiological impact would be offset by the wider environmental impacts associated with transportation. In addition, such an approach is likely to be unreasonable, in terms of the associated implications for worker health and safety; highly resource intensive; expensive; and impractical. We have not considered this suggestion further.
A number of representations have been made concerning the fact that the new discharge system proposed for use at the site for the disposal of radioactive aqueous waste will not provide the comparable level of initial dilution of the waste that is afforded by the existing aqueous waste discharge system. **Raised by**: PR1, PR2, PR3, PR6, PR7,	We have considered the proposals to utilise the new discharge route for radioactive liquid waste, specifically noting that this route will provide a reduced level of initial dilution to the liquid waste in comparison to the existing discharge system. In particular, the BAT report from Magnox (Reference 6) highlighted several issues with maintaining the existing discharge route, including: risks from de-silting operations on

PR9, PR10, PR15, PR16, PR17, PR21, PR25, PR26, PR29, PR30, PR34, PR35, PR36, PR38, PR39, PR43, PR44	Native Oyster populations; operational restrictions on de-silting operations; costs and hazards arising from de-silting operations; and the likelihood of their success. Even though the proposed discharge system does not provide the same level of dispersion, the environmental impact of these changes will be localised, and for a short time immediately following the discharge. We do not consider these changes to be environmentally significant and also that there are additional environmental benefits to using the new discharge system. We are satisfied that the proposed changes to the aqueous waste discharge management arrangements continue to represent BAT with respect to the radioactivity in the discharges. We are equally satisfied that either the current or the proposed arrangements for the management and control of radioactive liquid effluent discharge could each be considered compatible with the requirement to apply BAT.

Topic: Radiological Assessment: Comparison with constraints and limits	
Summary of issues raised	**Our consideration of the issues**

Some respondents raised concerns that the ongoing discharges of radioactive waste from the site pose a risk of harm to people. **Raised by:** PR14, PR20, PR23, PR28 PR41, PR44	We have carried out detailed assessments of the potential radiological impact of discharges made from Bradwell Site, including the potential impact to public health. The most recent assessment of the potential impact to members of the public was published in the Radioactivity in Food and the Environment (RIFE) report 2014 (Reference 14). This indicates the radiological impact was less than 5 microsieverts, which corresponds to less than 0.5% of the relevant dose limit for members of the public (or less than 0.2% of the average dose to members of the UK population from all sources of radiation). In practice, discharges from Bradwell are significantly below the limits set in the permit. Even if discharges were made at the maximum level allowed by the permit, our assessments indicate the potential radiological impact would be well below the relevant dose limit for members of the public.

Topic: Radiological Assessment: Impact on non-human species and our conservation duties	
Summary of issues raised	**Our consideration of the issues**
Some respondents raised concerns that the application fails to adequately consider the impact of the liquid radioactive waste discharges on the Blackwater Estuary Marine Conservation Zone. **Raised by:** PR9, PR10, PR14, PR15, PR16, PR17, PR19, PR20, PR23 PR21, PR22, PR25, PR26, PR28 PR29, PR30, PR34, PR35, PR36, PR38 , PR39, PR41, PR43, PR44	We have undertaken detailed radiological assessments, which include looking at the potential impact of discharges from Bradwell Site on plant and animal life in the Blackwater Estuary. The Blackwater Estuary holds a number of designations due to its important ecological value. These include designations as a SPA, a SAC, a SSSI and a Ramsar site, as well as a more recent designation as a Marine Conservation Zone (MCZ). We have assessed the potential radiological impact to the environment on the basis of radioactive discharges being made at the levels of the limits in the permit. On this basis, the predicted that dose rates to marine and terrestrial plant and animal life were still below the value where we are satisfied there will be no adverse effect on non-human species. The limits in the

	permit are not being changed so the assessments remain valid for the proposed changes to the liquid discharge system. We have taken account of the recent designation of the area as an MCZ. We remain satisfied that the radioactive discharges made in accordance with the requirements of the environmental permit will not compromise the identified conservation objectives.
Some respondents thought that a new radiological assessment should be done for this application due to the fact that the proposed system of discharging radioactive liquid waste from the site no longer involves the pre-dilution of the waste prior to it being discharged to the Blackwater Estuary. **Raised by:** PR9, PR10, PR15, PR16, PR17, PR21, PR25, PR26, PR29, PR30, PR34, PR35, PR36, PR38, PR39, PR44	Our radiological assessment did not take into account the pre-dilution of the discharge when screening the potential impact on the environment. The screening assessment provides reassurance that even if discharges were made at the level of the limits in the permit they will not cause unacceptable environmental consequences. Our assessment therefore remains valid for the proposed changes to the liquid discharge system. The modelling studies provided by Magnox show that the effect of the reduced dilution provided by the new discharge system for radioactive aqueous waste compared with the existing discharge system is only likely to cause a short term localised increase to the levels of radioactivity in the environment.

Topic: Environmental Monitoring	
Summary of issues raised	**Our consideration of the issues**
We received queries concerning the regulatory programme of environmental monitoring that is undertaken around Bradwell Site, including the scope and coverage of the programme and the availability of the data. **Raised by**: PR6, PR9	Environmental monitoring around Bradwell Site is undertaken separately by Magnox and the relevant regulatory authorities (i.e. the Environment Agency and the FSA). The results of Magnox's environmental monitoring programme are required to be submitted to us under the Bradwell Site's RSR environmental permit. This information is used by the operator to assess the annual retrospective dose received by members of the public It is also a requirement under the site's environmental permit to provide this information to us.

	This information is available to the public. A separate independent programme of environmental monitoring around Bradwell Site is also carried out for the Environment Agency and the FSA. The results of this independent monitoring programme are included in the Radiation in Food and the Environment (RIFE) report, which is published annually. The 2014 RIFE report was published on 28 October 2015 (Reference 14). The 2014 report covers the January to December 2014 period. The FED treatment programme began in June 2014 and so around half of the monitoring in 2014 covers this period. The report found that concentrations of artificial radionuclides in aquatic materials, including seaweed and locally caught fish and shellfish were low. The report found also that the total dose to members of the public, from all sources and pathways, was less than 0.5% of the legal dose limit of exposures of members of the public to ionising radiation. Our environmental monitoring programme continues to show that the levels of radioactivity in the environment are not significant from a radiological perspective. We have already enhanced the coverage of our environmental monitoring programme to take into account public concern over the FED treatment programme. The results obtained from our recent monitoring continue to show that levels of radioactivity in the environment during the FED treatment campaign are similar to the levels of radioactivity found in the environment previously.

Topic: Consultation on the RSR environmental permit application	
Summary of issues raised	**Our consideration of the issues**

We received several representations that our consultation on the RSR environmental permit application was inadequate. **Raised by**: PR20, PR23, PR28, PR29, PR41	We have decided to consult key partner organisations; the public; and interested parties on our draft decision and draft RSR environmental permit for this application. We did not consult on the application. This application is considered to be a small administrative change, as there is no change being sought to the limits in the permit. Our procedures and guidance covering how we deal with environmental permit applications for nuclear sites do not require us to consult on such applications. Nevertheless, we did inform interested parties that we received the RSR permit variation application from Magnox. We did not receive any requests for the RSR application, although we note that a small number of the representations received on the non-RSR variation applications related to the radioactive aspects of the Bradwell site's discharges. We therefore decided to respond to these comments, as set out in this Annexe, and to make our draft RSR-permit and draft decision publically available for comment along with those covering the non-RSR aspects of the discharge.

Topic: Provision of information/transparency	
Summary of issues raised	**Our consideration of the issues**
Included in many of the responses were comments attributed to Magnox and others related to information made available to the public, including via the LCLC. **Raised by**: PR6, PR7, PR9, PR10, PR15, PR16, PR17, PR18, PR19, PR21, PR25, PR26, PR28 PR29, PR30, PR34, PR35, PR36, PR38, PR39, PR43, PR44	These comments do not have a bearing on our decision in relation to this environmental permit variation application. It is our view that these are matters for Magnox Limited to respond to. We recommend that any specific queries or information requests of this nature are directed to the owner of the relevant information. We are committed to operating openly and transparently and have been consistent in our reporting about the environmental significance of permitted discharges.

Topic: Matters outside the Environment Agency's permitting remit

Summary of issues raised	Our consideration of the issues
Information has been requested on the planning requirements in relation to the outfall structure **Raised by**: PR11	The planning requirements in relation to the outfall structure are a matter for the relevant planning authority. We recommend that this information request is directed to the owner of the relevant information.
We note a number of representations included subjective personal statements or preferences about reducing or stopping discharges from FED treatment at Bradwell Site, without providing relevant supporting information or evidence. **Raised by**: PR8, PR9, PR10, PR15, PR16, PR17, PR18, PR19, PR21, PR22, PR25, PR26, PR28, PR29, PR30, PR34, PR35, PR36, PR37 PR38, PR39, PR40, PR42, PR43, PR44	Our permitting decisions take account of broad aspects of detriments, including social and other impacts, as well as the environmental impacts. We have extensive powers to stop discharges where there is evidence of potentially significant environmental harm. We are only likely to use these powers in an enforcement scenario, where the environmental impact is significantly greater than would arise from routine discharges that are controlled under an environmental permit. Potential significant harm to the environment is only likely to arise where discharges are substantially above the thresholds set out in the permit. Our decisions must also be fair and reasonable, and must take account of an operator's business needs, in order for us to continue to meet our requirement to support sustainable growth.

Annexe 1a – References

1. Cover letter to accompany Magnox application (Magnox, EA52453, dated 14 July 2015
2. Details of Proposed Variation to EPR permit EPR/ZP3493SQ to Modify Aqueous Discharge Line Outfall (Magnox, BRAD/EN/REP/099, dated 15 June 2015)
3. Variation to Permit EPR/ZP3493SQ for Gaseous and Particulate Discharges at Bradwell Site (Magnox, BRAD/EN/REP/141, dated 16 June 2015)
4. Introduction to the Safety and Environment Management Prospectus (Magnox, M-023, Issue 3, dated 19 March 2015)
5. Notice for further information and accompanying cover letter (Environment Agency, EPR/ZP3493SQ/V005, dated 29 September 2015)
6. An Assessment Report Demonstrating How the Proposed System for the Disposal of Radioactive Aqueous Waste and for the Discharge of Treated Sewage Effluent and Storm Water to the Blackwater Estuary Represents Best Available Techniques (Magnox, BRAD/EN/REP/169, dated 20 October 2015)
7. Letter requesting more time to determine permit application (Environment Agency, EPR/ZP3493SQ, dated 18 September 2015)
8. Letter accepting proposal to extend period of determination for permit application to 1 February 2016 (Magnox, EA52515, dated 22 September 2015
9. Magnox Bradwell Site Environmental Permit EPR/ZP3493SQ (Environment Agency, dated 26 February 2013)
10. Letter requesting more time to determine permit application (Environment Agency, dated 29 January 2016)
11. Signed copy of Environment Agency letter accepting proposal to extend period of determination for permit application to 1 June 2016 (Magnox, EPR/ZP3493SQ, dated 2 February 2016
12. Magnox correspondence following request for further information in relation to turbidity of discharges from Final Monitoring and Delay Tanks (Magnox, dated 26 October 2015)
13. FDT Turbidity A and B Sample – (Magnox, dated 22 October 2015)
14. Radioactivity in Food and the Environment report 2014 (RIFE-20, dated October 2015)
15. Environmental Permitting: Handling and Determining Environmental Permit Applications for Radioactive Substances Activities on Nuclear Sites (Environment Agency, Operational Instruction 247_10, dated 11 July 2013)
16. Bradwell Immersion Assessment – supplementary radiological assessment to support determination of Magnox application EPR/ZP3493SQ/V005 (Environment Agency, dated March 2016)
17. Radiological Monitoring Technical Guidance Note 2 – Environmental Radiological Monitoring (Environment Agency, Scottish Environment Protection Agency and Food Standards Agency, 764_11/GEHO0811BTVY-E-E, Version 1, dated December 2010)

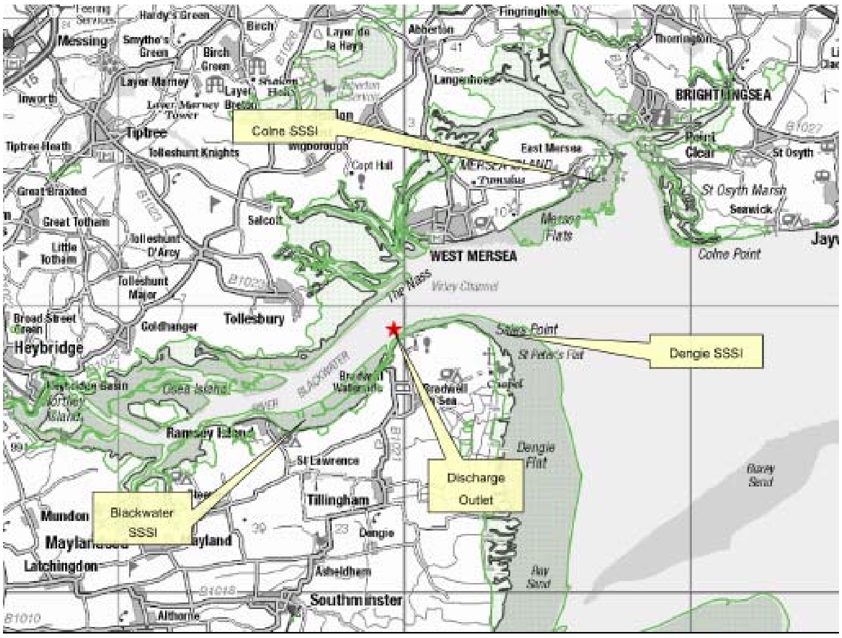
18. Blackwater, Crouch, Roach and Colne Estuaries Marine Conservation Zone (MCZ) – Supplementary Advice on Conserving and Restoring Site Features (Natural England, undated)
19. Decision Document for environmental permit variation application from Magnox for Bradwell Site - EPR/ZP3493SQ/V002 - (Environment Agency, dated 2 April 2012)

Annexe 2 – Habitats consultation documents

The following documents comprise a record of the Agency's formal consultation of Natural England regarding the proposed variations to the Permit and their potential to impact upon the Habitats sites listed in section 6.6. above.

(1) Blackwater Estuary SSSI

CRoW Appendix 4 (140_10_SD02) **CRoW Act 2000: Environment Agency application for permission - Formal Notice**	Environment Agency
Environment Agency Formal Notice to Statutory Nature Conservation Body (SNCB). Requirements of Section 28I of the Wildlife & Countryside Act 1981 as amended by the Countryside and Rights of Way Act (CRoW) 2000. Duty in relation to granting any consent, licence or permit for activities likely to damage Sites of Special Scientific Interest (SSSI).	
1. Environment Agency area/NPS hub:	Essex,Norfolk and Suffolk area of Anglian Region Nottingham hub of National Permitting Service
2. Name of SSSI:	Blackwater Estuary
3. Type of permission:	Environmental Permit – Water Discharge Activity
4. Date for Environment Agency permit determination:	**31/3/2016**

5.	**Predicted 28 day date for SNCB response (under S28 I(4)):**	**28/3/20162016**
6.	**Environment Agency reference no:**	EPR/DP3127XB
7.	**National grid reference:**	**TL 99650 09150** 
8.	**Description of proposal:**	**Brief Description of Proposal** **Site – Former Nuclear Power Station, Bradwell On Sea, Essex** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (1) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This

	leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. Since the beginning of the operation the applicant has made a small change to it by adding acidic ‘NOX’ scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won’t always be included At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge ‘activity’ to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the ‘activity’ has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the ‘activity’ we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent if they comply with all the conditions of the existing permit. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the SSSI. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet

	close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
9. Is the proposed activity within (wholly or partially) the SSSI boundary?	YES
10. Has there been any pre-application discussion or correspondence with SNCB?	NO
11. What aspect(s) of the proposed permission may damage the features which are of special interest for the SSSI?	

The following ‘Operations Requiring Consent’ (or other activities associated with the permission) that may cause damage) are relevant to the proposed permission:

Dumping or spreading or discharge of any material

Features which are of special interest and may be affected by this activity:
List of features:

Broad Feature Description	Common Feature Description
Aggregations of breeding birds	Bearded Tit
Aggregations of breeding birds	Pochard
Aggregations of non-breeding birds	Bar-tailed Godwit
Aggregations of non-breeding birds	Black-tailed Godwit
Aggregations of non-breeding birds	Brent Goose (Dark-bellied)
Aggregations of non-breeding birds	Curlew
Aggregations of non-breeding birds	Dunlin
Aggregations of non-breeding birds	Gadwall
Aggregations of non-breeding birds	Goldeneye
Aggregations of non-breeding birds	Grey Plover
Aggregations of non-breeding birds	Redshank
Aggregations of non-breeding birds	Ringed Plover
Aggregations of non-breeding birds	Shelduck
Aggregations of non-breeding birds	Spotted Redshank
Aggregations of non-breeding birds	Teal
Coastal	Mesozoic - Tertiary Fish/Amphibia - A geological feature.
Coastal vegetated shingle	Coastal vegetated shingle
Ditches	Ditches
Invertebrate assemblage	Saltmarsh, estuary and mudflat
Invertebrate Assemblage	Saltmarsh, Estuary And Mudflat: Saltmarsh And Transitional Brackish Marsh
Nationally scarce plant	Borrer's Saltmarsh-grass
Nationally scarce plant	Dwarf Eelgrass
Nationally scarce plant	One-flowered Glasswort
Nationally scarce plant	Slender Hare's-ear
Population of RDB plant	Saltmarsh Goosefoot
Saltmarsh	Saltmarsh
Vascular Plant Assemblage	Vascular Plant Assemblage
Broad SAC	Atlantic Salt Meadows (Glauco-Puccinellietalia Maritimae)
Broad SAC	Cordgrass Swards
Broad SAC	Estuaries

Broad SAC	Intertidal Mudflats And Sandflats
Broad SAC	Mediterranean Saltmarsh Scrubs
Broad SAC	Salicornia And Other Annuals Colonising Mud And Sand

The invertebrates inhabiting the mud flats and salt marshes of the estuary which provide a food source for the internationally important populations of overwintering wildfowl and the various plant species which form and enrich the salt marsh habitats are the features of the SSSI which are susceptible to the pollutants within the discharge. It is clear from the citation that the Blackwater Estuary SSSI is of regional and national importance as a complex mosaic of estuarial habitats that support a large range of aquatic invertebrates and plant species (including many rare ones) which in turn provide a habitat for internationally important numbers of wildfowl species that are able to overwinter on site.

In assessing the potential impact of the discharge we have sought to be certain that if we allow the discharge (as applied for) it will not pose a risk to <u>any</u> aquatic flora or fauna, so that none of the designated species or habitats will be threatened by it. Our assessment has included the vetting of the impact assessment and extensive dilution and dispersion modelling provided by the applicant supplemented by a Water Framework Directive (WFD) assessment by members of our Estuarine and Coastal Monitoring and Assessment Service (ECMAS) team.

<u>Key factors and concepts in the assessment :-</u>

Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure hat marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1, Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well.

The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.

In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.

The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water.   It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.

The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.

Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide.

Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone.

12. Decision

The permission is **not likely to damage** any of the flora, fauna or geological or physiological features which are of special interest because of **conditions**.

Because there are two aspects to the variation which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge

Temperature

(1) Extending or removing the time limit

The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on aquatic flora or fauna. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds.

(2) Changing to a new outlet

The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the interest feature of the SSSI than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way.

pH

The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to SSSI's habitats but is worth some consideration.

(1) Extending the time period

The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects.

(2) Change of outlet

Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The minimum dilution factors calculated by HR Wallingford of 240:1 at 100 metres from the discharge point means that the pH will be buffered to 7 well before this point.

For this reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would have any significant adverse affect on the interest features of the SSSI from changes to the pH regime.

Metals

(1) Extending the time period or removing it completely

Table 1 below shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge.

This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within its control whilst we re-examine all the issues and consider the request for the outlet change.

Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that the increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance the increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment.

For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(2) Change of outlet

As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of 50. To make sure that there is no risk to the interest features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's

AA EQS's

As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

MAC EQS's

The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 75:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's

Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their BRAD/EN/REP/130/FED (issue 3) illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of 30 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours.

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it.

For reasons given above we do not believe that the requested change of outlet would have any adverse effect on the interest features of the Blackwater Estuary SSSI outside the 100 metre mixing zone from hazardous substances in the effluent. Because the change of outlet would make no difference to the overall load of metals being discharged but has the potential to reduce any of the residual increases in average background concentrations each year we also do not believe there is a need to limit the time period for the activity in any way.

Nutrients

(1) Extending the time period

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the main benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the SSSI. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a WFD target. Increases of 7 to 9% did not pose such a threat.

At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011.

The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue whilst we consider the overall changes to the permit the applicant has requested.

(2) Change of outlet

Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical.

Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates (including the residual concentrations of nitrates returning on the incoming tide) in relation to the location of the SSSI receptors. Their assessment includes using a tool that predicts possible biological responses to nitrate increases such as blooms of macroalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

Their analysis did however produce a recommendation to change to discharge timings. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5. that the applicant is proposing. A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would be at night. We therefore minded to incorporate this restriction in the permit.

To summarise with regards to nutrients, we believe that the variation requests to extend the time period and to switch the discharge to the new outlet (if it becomes necessary) would have no significant adverse effects on the interest features of the receiving Blackwater Estuary SSSI. If we granted a permit it would allow the same (finite) potential load of nitrates that the previous permit allowed to be discharged and the same mixing zone to be achieved. The only difference is that discharging it over a longer period would lessen the environmental impacts, proportional to the length of that period.

Turbidity

The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to turbidity in the receiving estuary waters.

Salinity

The treated FED effluent is not saline but it is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to the existing background salinity regime.

Physical Damage

The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the interest features of the SSSI..

CONCLUSION

The cornerstones to our conclusion that the requested variations will not pose a risk to the interest features of the SSSI are :-

- The discharge is a very small one and beyond an acceptable mixing zone its pollutant load will be diluted to a level that can not be harmful
- All appropriate EQS's will be met outside the mixing zone.
- Because of the timing of the discharge on the ebb tide most of its polluting load will be carried out of the estuary away from most receptors and will be vastly diluted.
- The modelling shows that residual concentrations of pollutants returning on the incoming tide will not have a significant effect on background concentrations.
- The discharge will not significantly change the existing background water quality for individual pollutants, in the estuary. It will meet the Agency's 'no deterioration' guideline of limiting any increases to within 10%
- The discharge will not breach any WFD targets within the estuary
- The discharge is temporary and the overall polluting load is limited

These factors apply to the existing discharge through the existing outlet and would still apply if the discharge has to utilise the new outlet.

The Environment Agency is minded to:

Issue the permission with conditions to ensure no damage to SSSI

Conditions of the permit

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

Allowing the change to the new outlet

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

Nitrates limits and the removal of the time limit for the activity

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the SSSI. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

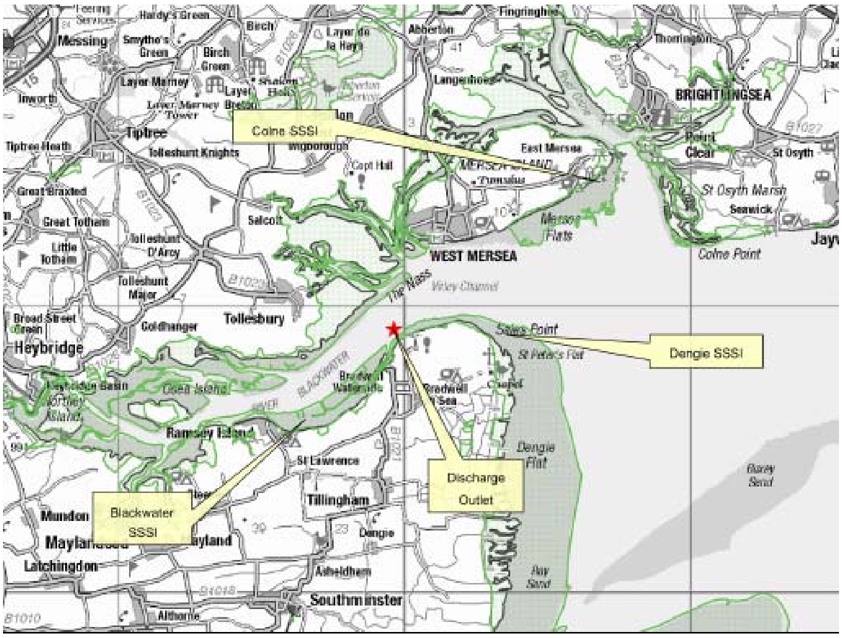
Your agreement to the granting of the permit is sought on this basis

13. Name and job title of Environment Agency officer:	**Bill Greenwood** Permitting Officer
14. Date form sent to SNCB:	**28/2/2016**
For Environment Agency use only, once SNCB response received	
15. SNCB comment on assessment:	i) SNCB advise the operation can go ahead ii) SNCB advise the operation can go ahead with conditions iii) SNCB advise against permitting the operation Please ensure that SNCB response is attached to this Formal Notice.
16. Name and job title of SNCB officer:	
17. Date of receipt of SNCB response:	

(2) Colne Estuary SSSI

CRoW Appendix 4 (140_10_SD02) **CRoW Act 2000: Environment Agency application for permission - Formal Notice**	Environment Agency
Environment Agency Formal Notice to Statutory Nature Conservation Body (SNCB). Requirements of Section 28I of the Wildlife & Countryside Act 1981 as amended by the Countryside and Rights of Way Act (CRoW) 2000. Duty in relation to granting any consent, licence or permit for activities likely to damage Sites of Special Scientific Interest (SSSI).	

18. Environment Agency area/NPS hub:	Essex,Norfolk and Suffolk area of Anglian Region Nottingham hub of National Permitting Service
19. Name of SSSI:	Colne Estuary
20. Type of permission:	Environmental Permit – Water Discharge Activity
21. Date for Environment Agency permit determination:	**31/3/2016**
22. Predicted 28 day date for SNCB response (under S28 I(4)):	**28/3/2016**
23. Environment Agency reference no:	EPR/DP3127XB
24. National grid reference:	**TL 99650 09150**



25. Description of proposal:	**Brief Description of Proposal** **Site – Former Nuclear Power Station, Bradwell On Sea, Essex** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting

	up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (2) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit</u>. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the SSSI. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational

	difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.

26. Is the proposed activity within (wholly or partially) the SSSI boundary?	YES
27. Has there been any pre-application discussion or correspondence with SNCB?	NO

28. What aspect(s) of the proposed permission may damage the features which are of special interest for the SSSI?

The following 'Operations Requiring Consent' (or other activities associated with the permission) that may cause damage) are relevant to the proposed permission:

Dumping or spreading or discharge of any material

Features which are of special interest and may be affected by this activity:

List of features:

Broad Feature Description	Common Feature Description
Active Geomorphological	Saltmarsh Morphology - A geological feature.
Aggregations of breeding birds	Little Tern
Aggregations of breeding birds	Ringed Plover
Aggregations of non-breeding birds	Black-tailed Godwit
Aggregations of non-breeding birds	Brent Goose (Dark-bellied)
Aggregations of non-breeding birds	Dunlin
Aggregations of non-breeding birds	Grey Plover
Aggregations of non-breeding birds	Redshank
Aggregations of non-breeding birds	Ringed Plover
Aggregations of non-breeding birds	Sanderling
Coastal	Quaternary Of The Thames - A geological feature.
Coastal vegetated shingle	Coastal vegetated shingle
Invertebrate Assemblage	Saltmarsh, Estuary And Mudflat: Saltmarsh And Transitional Brackish Marsh
Outstanding Dragonfly Assemblage	Outstanding Dragonfly Assemblage
Saltmarsh	Saltmarsh
Vascular Plant Assemblage	Vascular Plant Assemblage
Broad SAC	Atlantic Salt Meadows (Glauco-Puccinellietalia Maritimae)
Broad SAC	Cordgrass Swards
Broad SAC	Estuaries
Broad SAC	Intertidal Mudflats And Sandflats
Broad SAC	Mediterranean Saltmarsh Scrubs
Broad SAC	Salicornia And Other Annuals Colonising Mud And Sand
Broad SAC	Sandbanks Which Are Slightly Covered By Sea All The Time

The mudflats, salt marshes and grazing marshes of the Colne estuary which form part of the internationally important wetland that supports and allows the overwintering of birds Brent Geese and Black Tailed Godwit and are important for breeding several species of waders and wildfowl. The invertebrates in these habitats which provide the food source for the birds. The salt marshes and intertidal muds of Mersea Flats and Colne point are the main areas that are theoretically susceptible to the influence of the discharge because they are closest to it

In assessing the potential impact of the discharge we have sought to be certain that if we allow the discharge (as applied for) it will not pose a risk to <u>any</u> aquatic flora or fauna, so that none of the designated species or habitats will be threatened by it. Our assessment has included the vetting of the impact assessment and extensive dilution and dispersion modelling provided by the applicant supplemented by a Water Framework Directive (WFD) assessment by members of our Estuarine and Coastal Monitoring and Assessment Service (ECMAS) team.

<u>Key factors and concepts in the assessment :-</u>

Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure hat marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1, Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well.

The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.

In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.

The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.

The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.

Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide.

Receptors in the intertidal zones and out of the main estuary could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone.

29. Decision

The permission is **not likely to damage** any of the flora, fauna or geological or physiological features which are of special interest because of **conditions**.

Because there are two aspects to the variation which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge

Temperature

(3) Extending or removing the time limit

The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the Blackwater Estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on aquatic flora or fauna in the receiving Blackwater Estuary an definitely none on those of the Colne Estuary over 4 kilometres across it. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds.

(4) Changing to a new outlet

The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the interest feature of the Blackwater or Colne Estuaries SSSI's than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way.

pH

The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to SSSI's habitats but is worth some consideration.

(3) Extending the time period

The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects.

(4) Change of outlet

Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The minimum dilution factors calculated by HR Wallingford of 240:1 at 100 metres from the discharge point means that the pH will be buffered to 7 well before this point.

For this reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would have any significant adverse affect on the interest features of the Blackwater or Colne Estuaries SSSI's from changes to the pH regime.

Metals

(3) Extending the time period or removing it completely

Table 1 below shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge.

This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within its control whilst we re-examine all the issues and consider the request for the outlet change.

Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that the increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance the increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment.

For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the Blackwater or Colne Estuaries SSSI's if the existing outlet is used.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(4) Change of outlet

As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of 50. To make sure that there is no risk to the interest features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's

AA EQS's

As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

MAC EQS's

The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 75:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's

Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their BRAD/EN/REP/130/FED (issue 3) illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of 30 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours.

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it.

For reasons given above we do not believe that the requested change of outlet would have any adverse effect on the interest features of the Blackwater Estuary SSSI and certainly none on the Colne Estuary SSSI over 4 kilometres across it from hazardous substances in the effluent. Because the change of outlet would make no difference to the overall load of metals being discharged but has the potential to reduce any of the residual increases in average background concentrations each year we also do not believe there is a need to limit the time period for the activity in any way.

<u>Nutrients</u>

(5) Extending the time period

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the main benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the SSSI. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a WFD target. Increases of 7 to 9% did not pose such a threat.

At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011.

The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue whilst we consider the overall changes to the permit the applicant has requested.

(6) Change of outlet

Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical.

Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates (including the residual concentrations of nitrates returning on the incoming tide) in relation to the location of the SSSI receptors. Their assessment includes using a tool that predicts possible biological responses to nitrate increases such as blooms of macroalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5. that the applicant is proposing. A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would be at night. We therefore minded to incorporate this restriction in the permit.

To summarise with regards to nutrients, we believe that the variation requests to extend the time period and to switch the discharge to the new outlet (if it becomes necessary) would have no significant adverse effects on the interest features of the receiving Blackwater Estuary SSSI or on those of the Colne Estuary over 4 kilometres across it. The main pathway for the dispersed effluent after discharge is in the central channel away from the mouth of the Colne and when the residual concentrations of nitrates return they will be in insufficient concentrations to have any residual effect. If we granted a permit it would allow the same (finite) potential load of nitrates that the previous permit allowed to be discharged and the same mixing zone to be achieved. The only difference is that discharging it over a longer period would lessen the environmental impacts, proportional to the length of that period.

Turbidity

The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to turbidity in the receiving estuary waters.

Salinity

The treated FED effluent is not saline but it is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to the existing background salinity regime.

Physical Damage

The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the interest features of the Colne Estuary SSSI over 4 kilometres from the discharge point and across the main channel flow of the Blackwater.

CONCLUSION

The principle factors to our conclusion that the requested variations will not pose a risk to the interest features of the SSSI are :-

- The discharge is a very small one and beyond an acceptable mixing zone its pollutant load will be diluted to a level that can not be harmful
- All appropriate EQS's will be met outside the mixing zone.
- Because of the timing of the discharge on the ebb tide most of its polluting load will be carried out of the estuary in the central channel of the Blackwater away from the receptors of the Colne SSSI
- The modelling shows that residual concentrations of pollutants returning on the incoming tide will not have a significant effect on background concentrations.
- The discharge will not significantly change the existing background water quality for individual pollutants, in the Blackwater Estuary. It will meet the Agency's 'no deterioration' guideline of limiting any increases to within 10%. The effects on the Colne Estuary 4 kilometres across it will be further diminished.
- The discharge will not breach any WFD targets within the estuary
- The discharge is temporary and the overall polluting load is limited

These factors apply to the existing discharge through the existing outlet and would still apply if the discharge has to utilise the new outlet.

The Environment Agency is minded to:

Issue the permission with conditions to ensure no damage to SSSI

Conditions of the permit

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

<u>Allowing the change to the new outlet</u>

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

<u>Nitrates limits and the removal of the time limit for the activity</u>

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the SSSI. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

<u>Metals limits and safeguards</u>

The FED effluent failed the initial screening test because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

<u>New outlet structure and discharge timing</u>

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement to the granting of the permit is sought on this basis

30. Name and job title of Environment Agency officer:	**Bill Greenwood** Permitting Officer
31. Date form sent to SNCB:	**29/2/2016**
For Environment Agency use only, once SNCB response received	
32. SNCB comment on assessment:	*Please delete as appropriate:* i) SNCB advise the operation can go ahead ii) SNCB advise the operation can go ahead with conditions iii) SNCB advise against permitting the operation Please ensure that SNCB response is attached to this Formal Notice.
33. Name and job title of SNCB officer:	
34. Date of receipt of SNCB response:	

(3) Crouch and Roach Estuaries SSSI

CRoW Appendix 4 (140_10_SD02)

CRoW Act 2000: Environment Agency application for permission - Formal Notice

Environment Agency

Environment Agency Formal Notice to Statutory Nature Conservation Body (SNCB).

Requirements of Section 28I of the Wildlife & Countryside Act 1981 as amended by the Countryside and Rights of Way Act (CRoW) 2000.

Duty in relation to granting any consent, licence or permit for activities likely to damage Sites of Special Scientific Interest (SSSI).

35.	**Environment Agency area/NPS hub:**	Essex,Norfolk and Suffolk area of Anglian Region Nottingham hub of National Permitting Service
36.	**Name of SSSI:**	Crouch and Roach Estuaries
37.	**Type of permission:**	Environmental Permit – Water Discharge Activity
38.	**Date for Environment Agency permit determination:**	**31/3/2016**
39.	**Predicted 28 day date for SNCB response (under S28 I(4)):**	**28/3/2016**
40.	**Environment Agency reference no:**	EPR/DP3127XB
41.	**National grid reference:**	**TL 99650 09150**

42.	**Description of proposal:**	**Brief Description of Proposal** **Site – Former Nuclear Power Station, Bradwell On Sea, Essex** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your

	agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (4) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit.</u> Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary

	concession can have no adverse impact on the SSSI. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential

	receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
43. Is the proposed activity within (wholly or partially) the SSSI boundary?	YES
44. Has there been any pre-application discussion or correspondence with SNCB?	NO

45. What aspect(s) of the proposed permission may damage the features which are of special interest for the SSSI?

The following 'Operations Requiring Consent' (or other activities associated with the permission) that may cause damage) are relevant to the proposed permission:

Dumping or spreading or discharge of any material

Features which are of special interest and may be affected by this activity:
List of features:

Broad Feature Description	Common Feature Description
Aggregations of non-breeding birds	Bar-tailed Godwit
Aggregations of non-breeding birds	Black-tailed Godwit
Aggregations of non-breeding birds	Brent Goose (Dark-bellied)
Aggregations of non-breeding birds	Dunlin
Aggregations of non-breeding birds	Golden Plover
Aggregations of non-breeding birds	Lapwing
Aggregations of non-breeding birds	Redshank
Aggregations of non-breeding birds	Shelduck
Aggregations of non-breeding birds	Shoveler
Ditches	Ditches
Invertebrate Assemblage	Mineral marsh and Open Water: Open Water On Disturbed Sediments
Invertebrate Assemblage	Permanent Wet Mire: Rich Fen
Invertebrate Assemblage	Saltmarsh, Estuary And Mudflat: Saltmarsh And Transitional Brackish Marsh
Saltmarsh	Saltmarsh
Vascular Plant Assemblage	Vascular Plant Assemblage
Broad SAC	Atlantic Salt Meadows (Glauco-Puccinellietalia Maritimae)
Broad SAC	Cordgrass Swards
Broad SAC	Estuaries
Broad SAC	Intertidal Mudflats And Sandflats

Broad SAC	Mediterranean Saltmarsh Scrubs
Broad SAC	Salicornia And Other Annuals Colonising Mud And Sand

The salt marsh and intertidal muds in the outer fringes of the estuaries that provide a contiguous wetland habitat with the Dengie and Foulness SSSI's that support a large range of waders and waterfowl which can overwinter there.

In assessing the potential impact of the discharge we have sought to be certain that if we allow the discharge (as applied for) it will not pose a risk to <u>any</u> aquatic flora or fauna, so that none of the designated species or habitats will be threatened by it. Our assessment has included the vetting of the impact assessment and extensive dilution and dispersion modelling provided by the applicant supplemented by a Water Framework Directive (WFD) style assessment by members of our Estuarine and Coastal Monitoring and Assessment Service (ECMAS) team.

<u>Key factors and concepts in the assessment :-</u>

Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure hat marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1, Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well.

The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.

In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.

The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.

The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.

Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the Blackwater estuary and downstream of the ebbing tide.

Receptors in the intertidal zones or outside the Blackwater, such as those of the Crouch and Roach estuaries which are over 17 kilometres distant could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone.

46. Decision

The permission is **not likely to damage** any of the flora, fauna or geological or physiological features which are of special interest because of **conditions**.

Because there are two aspects to the variation which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge

Temperature

(5) Extending or removing the time limit

The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on aquatic flora or fauna in the Blackwater Estuary or other adjacent or more remote SSSI's. There is no possible impact on the features of the Crouch and Roach estuaries SSSI over 17 kilometres distant. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds.

(6) Changing to a new outlet

The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the interest feature of the receiving, adjacent or remote SSSI's than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way.

<u>pH</u>

The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to SSSI's habitats but is worth some consideration.

(5) Extending the time period

The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects.

(6) Change of outlet

Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The minimum dilution factors calculated by HR Wallingford of 240:1 at 100 metres from the discharge point means that the pH will be buffered to 7 well before this point.

For this reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would have any significant adverse affect on the interest features of the receiving, adjacent or remote SSSI from changes to the pH regime.

<u>Metals</u>

(7) Extending the time period or removing it completely

Table 1 below shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals.

Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge.

This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within its control whilst we re-examine all the issues and consider the request for the outlet change.

Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that the increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance the increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment.

For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the receiving Blackwater SSSI if the existing outlet is used and definitely none on the Crouch and Roach Estuaries SSSI over 17 kilometres distant given the further dilution on route.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(8) Change of outlet

As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of 50. To make sure that there is no risk to the interest features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's

AA EQS's

As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

MAC EQS's

The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 75:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's

Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their BRAD/EN/REP/130/FED (issue 3) illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of 30 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours.

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it.

For the reasons given above we do not believe that the requested change of outlet would have any adverse effect on the interest features of the receiving Blackwater Estuary SSSI outside the 100 metre mixing zone from hazardous substances in the effluent and definitely not on those of the Crouch and Roach Estuaries SSSI over 17 kilometres distant. Because the change of outlet would make no difference to the overall load of metals being discharged but has the potential to reduce any of the residual increases in average background concentrations each year we also do not believe there is a need to limit the time period for the activity in any way.

Nutrients

(9) Extending the time period

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the main benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the SSSI. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a WFD target. Increases of 7 to 9% did not pose such a threat.

At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent or more remote and this was the basis on which we obtained your assent to issuing the original permit in December 2011.

The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue whilst we consider the overall changes to the permit the applicant has requested.

(10) Change of outlet

Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical.

Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates (including the residual concentrations of nitrates returning on the incoming tide) in relation to the location of the SSSI receptors. Their assessment includes using a tool that predicts possible biological responses to nitrate increases such as blooms of macroalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5. that the applicant is proposing. A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would be at night. We therefore minded to incorporate this restriction in the permit.

To summarise with regards to nutrients, we believe that the variation requests to extend the time period and to switch the discharge to the new outlet (if it becomes necessary) would have no significant adverse effects on the interest features of the receiving Blackwater Estuary SSSI or of the other SSSI's adjacent or more remote. The further dilution that the effluent would receive on route to the Crouch and Roach Estuaries SSSI gives even greater comfort that no significant effects would be felt there.. If we granted a permit it would allow the same (finite) potential load of nitrates that the previous permit allowed to be discharged and the same mixing zone to be achieved. The only difference is that discharging it over a longer period would lessen the environmental impacts, proportional to the length of that period.

Turbidity

The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the interest features of the Blackwater Estuary SSSI or of the other adjacent or more remote SSSI's from any changes to turbidity in the receiving estuary waters.

Salinity

The treated FED effluent is not saline but it is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the interest features of any of the SSSI's in the vicinity or more remote from any changes to the existing background salinity regime.

Physical Damage

The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the interest features of the Blackwater SSSI or any of the adjacent or more remote SSSI's

CONCLUSION

The cornerstones to our conclusion that the requested variations will not pose a risk to the interest features of the SSSI are :-

- The discharge is a very small one and beyond an acceptable mixing zone its pollutant load will be diluted to a level that can not be harmful
- All appropriate EQS's will be met outside the mixing zone.
- Because of the timing of the discharge on the ebb tide most of its polluting load will be carried out of the estuary and into coastal waters. The Crouch and Roach estuaries SSSI is over 17 kilometres from the discharge point and the dilution on route to these would further reduce the polluting load of the discharge.
- The discharge will not significantly change the existing background water quality for individual pollutants, in the Blackwater estuary. It will meet the Agency's 'no deterioration' guideline of limiting any increases to within 10% even with this. It could not have a significant affect on the existing background water quality regime on the Crouch and Roach estuaries over 17 kilometres distant.
- The discharge will not breach any WFD targets within or beyond the Blackwater Estuary
- The discharge is temporary and the overall polluting load is limited

These factors apply to the existing discharge through the existing outlet and would still apply if the discharge has to utilise the new outlet.

The Environment Agency is minded to:

Issue the permission with conditions to ensure no damage to SSSI

Conditions of the permit

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

Allowing the change to the new outlet

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

Nitrates limits and the removal of the time limit for the activity

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the SSSI. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

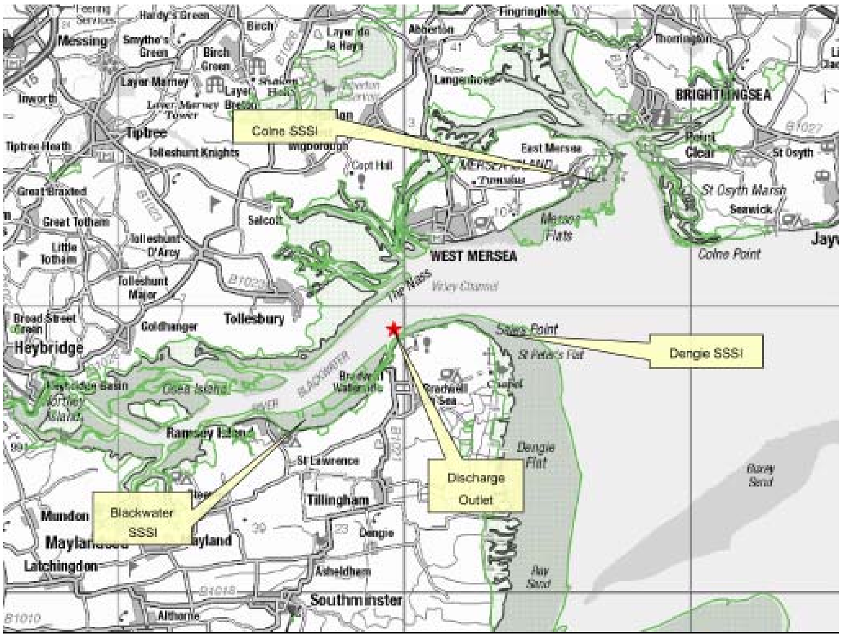
The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement to the granting of the permit is sought on this basis

47. Name and job title of Environment Agency officer:	**Bill Greenwood** Permitting Officer
48. Date form sent to SNCB:	**29/2/2016**
For Environment Agency use only, once SNCB response received	
49. SNCB comment on assessment:	i) SNCB advise the operation can go ahead ii) SNCB advise the operation can go ahead with conditions iii) SNCB advise against permitting the operation Please ensure that SNCB response is attached to this Formal Notice.
50. Name and job title of SNCB officer:	
51. Date of receipt of SNCB response:	

(4)The Dengie SSSI

CRoW Appendix 4 (140_10_SD02) **CRoW Act 2000: Environment Agency application for permission - Formal Notice**	Environment Agency
Environment Agency Formal Notice to Statutory Nature Conservation Body (SNCB). Requirements of Section 28I of the Wildlife & Countryside Act 1981 as amended by the Countryside and Rights of Way Act (CRoW) 2000. Duty in relation to granting any consent, licence or permit for activities likely to damage Sites of Special Scientific Interest (SSSI).	

52. Environment Agency area/NPS hub:	Essex,Norfolk and Suffolk area of Anglian Region Nottingham hub of National Permitting Service
53. Name of SSSI:	Dengie
54. Type of permission:	Environmental Permit – Water Discharge Activity
55. Date for Environment Agency permit determination:	**31/3/2016**
56. Predicted 28 day date for SNCB response (under S28 I(4)):	**28/3/2016**
57. Environment Agency reference no:	EPR/DP3127XB
58. National grid reference:	**TL 99650 09150** 
59. Description of proposal:	**Brief Description of Proposal** **Site – Former Nuclear Power Station, Bradwell On Sea, Essex** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting

	up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to ‘pre-dilute’ the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (5) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence ‘dissolution’. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The assessment is based on the effluent strength including NOX liquors which is conservative because they won’t always be included Since the beginning of the operation the applicant has made a small change to it by adding acidic ‘NOX’ scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. Their effect on metals and nitrates concentrations in the effluent has been accounted for in the impact assessment the applicant has provided and in ours. The frequency of NOX liquor additions to the influent has been overestimated to make the impact assessment results conservative. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge ‘activity’ to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the ‘activity’ has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the ‘activity’ we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit</u>. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the SSSI. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet.

	Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are

	high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
60. Is the proposed activity within (wholly or partially) the SSSI boundary?	YES
61. Has there been any pre-application discussion or correspondence with SNCB?	NO

62. What aspect(s) of the proposed permission may damage the features which are of special interest for the SSSI?

The following 'Operations Requiring Consent' (or other activities associated with the permission) that may cause damage) are relevant to the proposed permission:

Dumping or spreading or discharge of any material

Features which are of special interest and may be affected by this activity:
List of features:

Broad Feature Description	Common Feature Description
Active Geomorphological	Saltmarsh Morphology - A geological feature.
Aggregations of breeding birds	Bearded Tit
Aggregations of breeding birds	Ringed Plover
Aggregations of non-breeding birds	Brent Goose (Dark-bellied)
Aggregations of non-breeding birds	Dunlin
Aggregations of non-breeding birds	Grey Plover
Aggregations of non-breeding birds	Knot
Aggregations of non-breeding birds	Ringed Plover
Aggregations of non-breeding birds	Turnstone
Coastal vegetated shingle	Coastal vegetated shingle
Nationally scarce plant	Lax-flowered Sea-lavender
Saltmarsh	Saltmarsh
Vascular Plant Assemblage	Vascular Plant Assemblage
Broad SPA	Hen Harrier
Broad SAC	Atlantic Salt Meadows (Glauco-Puccinellietalia Maritimae)
Broad SAC	Intertidal Mudflats And Sandflats
Broad SAC	Mediterranean Saltmarsh Scrubs
Broad SAC	Salicornia And Other Annuals Colonising Mud And Sand

The tidal mudflats and salt marshes with their abundant flora and fauna which support national and internationally important population of wildfowl and waders in winter and in summer support a range of breeding coastal birds some of which are rare. The invertebrates of the foreshore mudflats including molluscs, marine worms and crutacea and vegetation including algal species and eel grasses. The areas of the SSSI adjacent to the Blackwater Estuary SSSI around the tip of the Dengie peninsula are theoretically most susceptible to any potential polluting affects of *the discharge because they are the closest to it.*

In assessing the potential impact of the discharge we have sought to be certain that if we allow the discharge (as applied for) it will not pose a risk to <u>any</u> aquatic flora or fauna, so that none of the designated species or habitats will be threatened by it. Our assessment has included the vetting of the impact assessment and extensive dilution and dispersion modelling provided by the applicant supplemented by a Water Framework Directive (WFD) assessment by members of our Estuarine and Coastal Monitoring and Assessment Service (ECMAS) team.

<u>Key factors and concepts in the assessment :-</u>

Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure hat marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1, Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well.

The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.

In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical

Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.

The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.

The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.

Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide.

Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone.

63. Decision

The permission is **not likely to damage** any of the flora, fauna or geological or physiological features which are of special interest because of **conditions**.

Because there are two aspects to the variation which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge

<u>Temperature</u>

(7) Extending or removing the time limit

The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on aquatic flora or fauna. As long as the existing outlet is used we therefore believe that there is any risk to the interest features of the Dengie SSSI the nearest of which are 400 metres from the discharge point. We see no reason to deny an extension of the time period or remove it altogether on temperature grounds.

(8) Changing to a new outlet

The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the interest feature of the Dengie SSSI than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way.

pH

The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to SSSI's habitats but is worth some consideration.

(7) Extending the time period

The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects on the Dengie SSSI.

(8) Change of outlet

Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The minimum dilution factors calculated by HR Wallingford of 240:1 at 100 metres from the discharge point means that the pH will be buffered to 7 well before this point. There is therefore not risk to the interest features of the Dengie SSSI the nearest point of which is 400 metres from the discharge point. For this reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would have any significant adverse affect on the interest features of the SSSI from changes to the pH regime.

Metals

(3) Extending the time period or removing it completely

Table 1 below shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features of the Blackwater Estuary or Dengie SSSI's especially as it was a temporary discharge.

This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within its control whilst we re-examine all the issues and consider the request for the outlet change.

Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that the increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance the increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment.

For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the Blackwater or Dengie SSSI's if the existing outlet is used.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(4) Change of outlet

As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of 50. To make sure that there is no risk to the interest features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's

AA EQS's

As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

MAC EQS's

The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 75:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's

Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their BRAD/EN/REP/130/FED (issue 3) illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of 30 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours.

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it.

For reasons given above we do not believe that the requested change of outlet would have any adverse effect on the interest features of the Dengie SSSI the nearest of which are over 300 metres from the edge of the zone. from hazardous substances in the effluent. Because the change of outlet would make no difference to the overall load of metals being discharged but has the potential to reduce any of the residual increases in average background concentrations each year we also do not believe there is a need to limit the time period for the activity in any way.

Nutrients

(11) Extending the time period

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the main benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the SSSI. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a WFD target. Increases of 7 to 9% did not pose such a threat.

At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011.

The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue whilst we consider the overall changes to the permit the applicant has requested.

(12) Change of outlet

Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical.

Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates (including the residual concentrations of nitrates returning on the incoming tide) in relation to the location of the SSSI receptors. Their assessment includes using a tool that predicts possible biological responses to nitrate increases such as blooms of macroalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5. that the applicant is proposing. A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would be at night. We therefore minded to incorporate this restriction in the permit.

To summarise with regards to nutrients, we believe that the variation requests to extend the time period and to switch the discharge to the new outlet (if it becomes necessary) would have no significant adverse effects on the interest features of the receiving Blackwater Estuary SSSI or on the those of the adjacent Dengie SSSI. If we granted a permit it would allow the same (finite) potential load of nitrates that the previous permit allowed to be discharged and the same mixing zone to be achieved. The only difference is that discharging it over a longer period would lessen the environmental impacts, proportional to the length of that period.

Turbidity

The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to turbidity in the receiving estuary waters.

Salinity

The treated FED effluent is not saline but it is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to the existing background salinity regime.

Physical Damage

The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the interest features of the SSSI..

CONCLUSION

The cornerstones to our conclusion that the requested variations will not pose a risk to the interest features of the SSSI are :-

- The discharge is a very small one and beyond an acceptable mixing zone of 100 metres its pollutant load will be diluted to a level that can not be harmful
- All appropriate EQS's will be met outside the mixing zone.
- Because of the timing of the discharge on the ebb tide most of its polluting load will be carried out of the Blackwater Estuary in its central channel away from the receptors of the Dengie SSSI.
- The modelling shows that residual concentrations of pollutants returning on the incoming tide will not have a significant effect on background concentrations within the Blackwater adjacent to the Dengie
- The discharge will not significantly change the existing background water quality for individual pollutants, in the Blackwater Estuary adjacent to the Dengie SSSI. It will meet the Agency's 'no deterioration' guideline of limiting any increases to within 10%
- The discharge will not breach any WFD targets within the Blackwater Estuary adjacent to the Dengie SSSI
- The discharge is temporary and the overall polluting load is limited

These factors apply to the existing discharge through the existing outlet and would still apply if the discharge has to utilise the new outlet.

The Environment Agency is minded to:

Issue the permission with conditions to ensure no damage to SSSI

Conditions of the permit

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

Allowing the change to the new outlet

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

Nitrates limits and the removal of the time limit for the activity

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the SSSI. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement to the granting of the permit is sought on this basis

64. Name and job title of Environment Agency officer:	**Bill Greenwood** Permitting Officer
65. Date form sent to SNCB:	**29/2/2016**
For Environment Agency use only, once SNCB response received	
66. SNCB comment on assessment:	*Please delete as appropriate:* i) SNCB advise the operation can go ahead ii) SNCB advise the operation can go ahead with conditions iii) SNCB advise against permitting the operation Please ensure that SNCB response is attached to this Formal Notice.
67. Name and job title of SNCB officer:	
68. Date of receipt of SNCB response:	

(5) Foulness SSSI

CRoW Appendix 4 (140_10_SD02) **CRoW Act 2000: Environment Agency application for permission - Formal Notice**	Environment Agency
Environment Agency Formal Notice to Statutory Nature Conservation Body (SNCB). Requirements of Section 28I of the Wildlife & Countryside Act 1981 as amended by the Countryside and Rights of Way Act (CRoW) 2000. Duty in relation to granting any consent, licence or permit for activities likely to damage Sites of Special Scientific Interest (SSSI).	
69. Environment Agency area/NPS hub:	Essex,Norfolk and Suffolk area of Anglian Region Nottingham hub of National Permitting Service
70. Name of SSSI:	Foulness

71. Type of permission:	Environmental Permit – Water Discharge Activity
72. Date for Environment Agency permit determination:	**31/3/2016**
73. Predicted 28 day date for SNCB response (under S28 I(4)):	**28/3/2106**
74. Environment Agency reference no:	EPR/DP3127XB
75. National grid reference:	**TL 99650 09150** 
76. Description of proposal:	**Brief Description of Proposal** **Site – Former Nuclear Power Station, Bradwell On Sea, Essex** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge.

	(6) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence ‘dissolution’. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. Since the beginning of the operation the applicant has made a small change to it by adding acidic ‘NOX’ scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won’t always be included At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge ‘activity’ to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the ‘activity’ has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the ‘activity’ we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit</u>. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the SSSI. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore

	included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
77. Is the proposed activity within (wholly or partially) the SSSI boundary?	YES

78. Has there been any pre-application discussion or correspondence with SNCB?	NO

79. What aspect(s) of the proposed permission may damage the features which are of special interest for the SSSI?

The following 'Operations Requiring Consent' (or other activities associated with the permission) that may cause damage) are relevant to the proposed permission:

Dumping or spreading or discharge of any material

Features which are of special interest and may be affected by this activity:

List of features:

Broad Feature Description	Common Feature Description
Aggregations of breeding birds	Avocet
Aggregations of breeding birds	Common Tern
Aggregations of breeding birds	Little Tern
Aggregations of breeding birds	Ringed Plover
Aggregations of breeding birds	Sandwich Tern
Aggregations of non-breeding birds	Avocet
Aggregations of non-breeding birds	Bar-tailed Godwit
Aggregations of non-breeding birds	Brent Goose (Dark-bellied)
Aggregations of non-breeding birds	Curlew
Aggregations of non-breeding birds	Dunlin
Aggregations of non-breeding birds	Grey Plover
Aggregations of non-breeding birds	Knot
Aggregations of non-breeding birds	Oystercatcher
Aggregations of non-breeding birds	Redshank
Aggregations of non-breeding birds	Shelduck
Coastal vegetated shingle	Coastal vegetated shingle
Invertebrate Assemblage	Saltmarsh, Estuary And Mudflat: Saltmarsh And Transitional Brackish Marsh
Population of Schedule 8 plant	Pedunculate Sea-purslane
Saltmarsh	Saltmarsh
Vascular Plant Assemblage	Vascular Plant Assemblage
Broad SAC	Atlantic Salt Meadows (Glauco-Puccinellietalia Maritimae)
Broad SAC	Cordgrass Swards
Broad SAC	Estuaries
Broad SAC	Intertidal Mudflats And Sandflats
Broad SAC	Mediterranean Saltmarsh Scrubs
Broad SAC	Salicornia And Other Annuals Colonising Mud And Sand
Broad SAC	Sandbanks Which Are Slightly Covered By Sea All The Time

The intertidal sand-silt flats and saltmarshes of the northern section of Foulness which forms a contiguous wetland habitat with the Dengie and Crouch and Roach SSSIsl and are of international importance as winter feeding grounds for nine species of wildfowl and waders.

In assessing the potential impact of the discharge we have sought to be certain that if we allow the discharge (as applied for) it will not pose a risk to <u>any</u> aquatic flora or fauna, so that none of the designated species or habitats will be threatened by it. Our assessment has included the vetting of the impact assessment and extensive dilution and dispersion modelling provided by the applicant supplemented by a Water Framework Directive (WFD) style assessment by members of our Estuarine and Coastal Monitoring and Assessment Service (ECMAS) team.

<u>Key factors and concepts in the assessment :-</u>

Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure hat marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1, Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well.

The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.

In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.

The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.

The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.

Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the Blackwater estuary 4 kilometres before the southern part opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the Blackwater estuary and downstream of the ebbing tide.

Receptors in the intertidal zones and beyond the estuary could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone.

80. Decision

The permission is **not likely to damage** any of the flora, fauna or geological or physiological features which are of special interest because of **conditions**.

Because there are two aspects to the variation which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge

<u>Temperature</u>

(9) Extending or removing the time limit

The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on aquatic flora or fauna even in the Blackwater estuary. It could definitely not affect the temperature regime of the coastal waters of the Foulness SSSI. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds.

(10) Changing to a new outlet

The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the interest feature of the Foulness SSSI than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way.

<u>pH</u>

The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to SSSI's habitats but is worth some consideration.

(9) Extending the time period

The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects.

(10)Change of outlet

Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The minimum dilution factors calculated by HR Wallingford of 240:1 at 100 metres from the discharge point means that the pH will be buffered to 7 well before this point.

For this reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would have any significant adverse affect on the interest features of the Foulness SSSI, which is over 14 kilometres from the discharge point, from changes to the pH regime.

<u>Metals</u>

(13)Extending the time period or removing it completely

Table 1 below shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge.

This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within its control whilst we re-examine all the issues and consider the request for the outlet change.

Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that the increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance the increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment.

For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the receiving Blackwater SSSI if the existing outlet is used and definitely none on the remote Foulness SSSI over 14 kilometres away.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(14)Change of outlet

As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of 50. To make sure that there is no risk to the interest features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's

AA EQS's

As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

MAC EQS's

The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 75:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's

Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their BRAD/EN/REP/130/FED (issue 3) illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of 30 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours.

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it.

For reasons given above we do not believe that the requested change of outlet would have any adverse effect on the interest features of the Blackwater Estuary SSSI outside the 100 metre mixing zone from hazardous substances in the effluent and definitely none on those of the Foulness SSSI over 14 kilometres from the discharge point. Because the change of outlet would make no difference to the overall load of metals being discharged but has the potential to reduce any of the residual increases in average background concentrations each year we also do not believe there is a need to limit the time period for the activity in any way.

<u>Nutrients</u>

(15)Extending the time period

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the main benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the SSSI. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a WFD target. Increases of 7 to 9% did not pose such a threat.

At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or one those of the more remote SSSI's such as the Foulness. This was the basis on which we obtained your assent to issuing the original permit in December 2011.

The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue whilst we consider the overall changes to the permit the applicant has requested.

(16)Change of outlet

Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical.

Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates (including the residual concentrations of nitrates returning on the incoming tide) in relation to the location of the SSSI receptors. Their assessment includes using a tool that predicts possible biological responses to nitrate increases such as blooms of macroalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets in the Blackwater Estuary or beyond, or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5. that the applicant is proposing. A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would be at night. We therefore minded to incorporate this restriction in the permit.

To summarise with regards to nutrients, we believe that the variation requests to extend the time period and to switch the discharge to the new outlet (if it becomes necessary) would have no significant adverse effects on the interest features of the receiving Blackwater Estuary SSSI or on those of the more remote Foulness SSSI If we granted a permit it would allow the same (finite) potential load of nitrates that the previous permit allowed to be discharged and the same mixing zone to be achieved. The only difference is that discharging it over a longer period would lessen the environmental impacts, proportional to the length of that period.

Turbidity

The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to turbidity in the receiving estuary waters.

Salinity

The treated FED effluent is not saline but it is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the interest features of the SSSI from any changes to the existing background salinity regime.

Physical Damage

The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries and could definitely have none on the features of the remote Foulness SSSI over 14 kilometres away. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the interest features of the Foulness SSSI.

CONCLUSION

The cornerstones to our conclusion that the requested variations will not pose a risk to the interest features of the SSSI are :-

- The discharge is a very small one and beyond an acceptable mixing zone its pollutant load will be diluted to a level that can not be harmful
- All appropriate EQS's will be met outside the mixing zone.
- Because of the timing of the discharge on the ebb tide most of its polluting load will be carried out of the Blackwater estuary and achieve very great dilution before it can reach the Foulness SSSI over 14 kilometres distant. .
- The discharge will not significantly change the existing background water quality for individual pollutants even within the receiving in the estuary. It could have no effect on the waters of the Foulness SSSI after further dilution on route.
- The discharge will not breach any WFD targets
- The discharge is temporary and the overall polluting load is limited

These factors apply to the existing discharge through the existing outlet and would still apply if the discharge has to utilise the new outlet.

The Environment Agency is minded to:

Issue the permission with conditions to ensure no damage to SSSI

Conditions of the permit

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

Allowing the change to the new outlet

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

Nitrates limits and the removal of the time limit for the activity

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the SSSI. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two yearswhilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring,recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed (by an independent laboratory) for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement to the granting of the permit is sought on this basis

81. Name and job title of Environment Agency officer:	**Bill Greenwood** Permitting Officer
82. Date form sent to SNCB:	**29/2/2016**
For Environment Agency use only, once SNCB response received	
83. SNCB comment on assessment:	*Please delete as appropriate:* i) SNCB advise the operation can go ahead ii) SNCB advise the operation can go ahead with conditions iii) SNCB advise against permitting the operation Please ensure that SNCB response is attached to this Formal Notice.
84. Name and job title of SNCB officer:	
85. Date of receipt of SNCB response:	

(6) Blackwater Estuary (Mid Essex Coast Phase 4) SPA and Ramsar site

Habitats Directive: Form for recording likely significant effect (Stage 2)	Environment Agency
For consultation	
Part A **Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)**	
Type of permission/activity:	Environmental Permit (Discharge consent)
Environment Agency reference no:	EPR/DP3127XB/V002
National grid reference:	TL 99650 09150
Site description:	**Trade Effluent Discharge from Bradwell Site, Magnox Ltd, Bradwell-on-Sea, Southminster, Essex CM0 7HP**
Brief description of proposal:	**A MAP OF THE SITE IS PROVIDED AT THE END OF THE DOCUMENT.** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below)

	The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (7) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. There is a separate permit controlling the release of radionuclides. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical

	delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit.</u> Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the designated features of any European sites. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting the appropriate EQS's for substances in the effluent within the estuary 100 metres from the discharge point was the

	criteria agreed when the existing permit was granted. The new outlet design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. It is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
European site names and status:	**Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar** **Blackwater Estuary (Mid-Essex Coast Phase 4) SPA (or proposed SPA)**
List of interest features (relevant to this type of permission):	Blackwater Estuary (Mid-Essex Coast Phase 4) Ramsar 1.10 Coastal Habitats (Wetland Plants and Invertebrates) 3.4 Birds of lowland wet grasslands (Black-tailed godwit (3.4), Brent goose (3.4), Dunlin (3.4), Grey plover (3.4) 3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Black-tailed godwit (3.8), Brent goose (3.8), Dunlin (3.8), Grey plover (3.8), Waterfowl(>20, 000) (3.8) 3.9 Birds of estuarine habitats (Black-tailed godwit (3.9), Brent goose (3.9), Dunlin (3.9), Grey plover (3.9), Waterfowl(>20, 000) (3.9)) Blackwater Estuary (Mid-Essex Coast Phase 4) SPA 3.10 Birds of open sea and offshore rocks (Little tern (3.10) 3.4 Birds of lowland wet grasslands (Brent goose (3.4) 3.6 Birds of lowland freshwaters and their margins (Pochard (3.6), Waterfowl(>20, 000) (3.6)). 3.8 Birds of coastal habitats (Pochard (3.8), Waterfowl(>20, 000) (3.8)). 3.9 Birds of estuarine habitats (Black-tailed godwit (3.9), Dunlin (3.9), Grey plover (3.9), Hen harrier (3.9), Pochard (3.9), Ringed plover (3.9), Waterfowl(>20, 000) (3.9))

Is this application necessary to manage the site for nature conservation?	No

What potential hazards are likely to affect the interest features (relevant to this type of permission?

Sensitive interest feature:	**Potential hazard:**	**Potential exposure to hazard and mechanism of effect/impact if known:**

1.10 Coastal Habitats (Wetland Plants and Invertebrates)	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	pH	See detailed assessment below
3.4 Birds of lowland wet grasslands (Black-tailed godwit (3.4), Brent goose (3.4), Dunlin (3.4), Grey plover (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Black-tailed godwit (3.8), Brent goose (3.8), Dunlin (3.8), Grey plover (3.8), Waterfowl(>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Black-tailed godwit (3.9), Brent goose (3.9), Dunlin (3.9), Grey plover (3.9), Waterfowl(>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.10 Birds of open sea and offshore rocks (Little tern (3.10))	Toxic contamination	See detailed assessment below
3.4 Birds of lowland wet grasslands (Brent goose (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Pochard (3.6), Waterfowl(>20, 000)).	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below

	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Pochard (3.8), Waterfowl(>20, 000)).	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Black-tailed godwit (3.9), Dunlin (3.9), Grey plover (3.9), Hen harrier (3.9), Pochard (3.9), Ringed plover (3.9), Waterfowl(>20, 000)).	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below

Is the potential scale or magnitude of any effect likely to be significant?	
Alone?	**No** We do not believe that the proposed changes to the discharge will have any significant adverse affect on the designated species of the European site. The principles of our assessment are outlined below and then each potentially polluting component of the discharge is addressed in turn to explain how we have reached our conclusion. **Key Principles of the assessment** • Environmental Quality Standards (EQS's) EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism to make sure that marginal breaches do not cause any harm. Not

	all hazardous substances have both types of EQS. We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.** • H1 assessments and modelling in support of the application. The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution. • Acceptable mixing zones and dilution factors Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's

	before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised. In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral. The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone. The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 20 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment. Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible. • Pathways and receptors The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for

	only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide. Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone. In this case we are using the term 'receptors' to mean all the aquatic organisms that form parts of the overall ecosystem that supports the designated birds species of the European sites as well as the actual birds listed in the citations. The potential for a direct adverse affect on the birds is virtually impossible because they are very unlikely to come into contact with the effluent or its dispersion plume and the concentrations of the pollutants even in the undiluted effluent would not be harmful to them. The potential for a harmful affect on the birds is really only 'indirect' via possible harmful affects on the organisms that make up their food source, or part of the food chain, or the wider habitat. By basing our assessments on compliance of EQS's and maintaining the background water quality regime we are confident that the potential impact on all receptors will be taken into account. **Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge** <u>Toxic contamination</u> The only toxic components in significant concentrations within the treated FED effluent discharge are the heavy metals listed in table 1 below. (17) Extending the time period or removing it completely Table 1 (End of Document) shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary

	outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge. This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within the limits of the existing permit whilst we re-examine all the issues and consider the request for the outlet change. Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that any potential increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance any increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment. For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used. (18)Change of outlet As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-

	diluted by. To make sure that there is no risk to the designated features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone. MAC EQS's The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 74:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their report 'BRAD/EN/REP/130/FED (issue 3)' which we supplied to you illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of the 20 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours.

	With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. • Conclusion – Toxic effects The potential for any of the designated bird species of the European site to be harmed by the toxic components in the treated FED effluent (from the existing outlet, or the new one) is limited to the 100 metre mixing zone. (within the receiving Blackwater Estuary) Outside this there will be no measurable change to the background water quality regime with regard to heavy metals. This means that there would be no threat to any of the aquatic organisms that form part of the ecosystem for the designated birds including the shellfish and invertebrates that are their food source. The metals from the discharges will not be toxic in the short or long term to these and, if the changes in background concentrations of each metal in the water column outside the mixing zone is insignificant, there can be no significant change to the rates of accumulation of the metals in sediments or bio-accumulation in shellfish etc. In other words the discharge could not cause a significant increase in the existing metal loads in the sediments on the bed of the estuary outside the 100 metre mixing zone. Even within the mixing zone the risks of harm to the designated bird species from the discharge through either the old or new outlets are extremely low. This is because both outlets are below the lowest tides and discharges through both would be made at high water periods. Together with the fact that the FED effluent is denser than seawater and will sink this means that the mixing zones for both are always sub-tidal and deep in the water column. The plume of mixing effluent and water within which EQS's are exceeded will, therefore, always be deep below the surface and the only way in which a bird could come into contact with it would be if it was diving for some reason. Such limited exposure would not be sufficient to cause them harm and given that the discharge is intermittent and last only 20 minutes a day repeated exposure to individual birds is unlikely. Any food consumed from the water column of the mixing zone would also have had limited exposure and so bio-accumulation of metals from the FED effluent within individual birds is also extremely unlikely. Nutrient Enrichment (19)Extending the time period

	The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the Blackwater Estuary conservation sites. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat. At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers. The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011. The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to

	increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue under the control of the existing permit whilst we consider the overall changes to the permit the applicant has requested. (20)Change of outlet Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone. In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in WFD classification bands in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical. Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates including the residual concentrations of nitrates returning on the incoming tides. They utilised a tool that predicts possible biological responses to nitrate increases such as blooms of microalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

	Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We therefore minded to incorporate this restriction in the permit. • Conclusion – Nutrient Enrichment The only potential for the nitrate load of the discharge (through the new or old outlet) to have any significant affect on the designated birds species is for it to cause significant enough increases in the existing background concentrations of nitrates within the Blackwater Estuary to cause blooms of macro algae that would hinder some of the designated birds feeding regime. Theoretically macro algae ‘ mats’ in the estuary could physically prevent some birds accessing food underneath or even prevent the species that constitute suitable food from growing at all in parts of the estuary. Our Site Plan report of 2009 disputed this theory but for this assessment we are relying more on the additional modelling undertaken by our ECMAS team of the potential impacts of the nitrates load of the discharges. Their conclusion was that the FED effluent does not have the potential to cause significant increases in macro-algae blooms within the European site. This is largely because of other physical background conditions in the estuary such as high turbidity which are limiting. Another factor is that the outlet is in the outer part of the estuary in the central channel and that the timing of the discharges on the ebbing tide means that the discharge plume will always be towards the open sea. Even allowing for the return of residual nitrates concentrations on the next incoming tides this means the potential effects would be limited to the outer estuary. The inner estuary where there is currently some evidence of overwintering macro algae mats would not be affected at all Our overall conclusion is that there would be no significant adverse effect on the designated bird species of the European site from the discharge of treated FED effluent through the old or new outlet if we granted a permit for them. Because the overall load of nitrates discharged is from a finite source we also see no reason to time limit the discharge from either outlets in the future. If the discharge is made over a longer period that has been requested the potential increases in annual average background concentrations of nitrates in the Blackwater Estuary, and beyond, will be lower each year proportionate to the extra time taken to complete the operation. <u>Changes in the thermal regime</u>

	(11) Extending or removing the time limit The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the receiving estuary. There can be no direct effect on the designated bird species of the European site from these changes in temperature and if there is no affect on the supporting flora and fauna of the supporting ecosystem there can be no indirect affect either. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds. (12) Changing to a new outlet The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the designated features of the conservation area than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way. <u>pH</u> The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to conservation sites but is worth some consideration. (11)Extending the time period The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any

	discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects. (12)Change of outlet Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute minimum dilution factors calculated by HR Wallingford of 240:1 for the first few minutes of the discharge at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone. For these reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would significantly change the existing background pH regime beyond the mixing zone and that there could be no significant affect on shellfish which could be a food source of the designated birds of the European site. <u>Turbidity</u> The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to turbidity in the receiving estuary waters. <u>Salinity</u> The treated FED effluent is not saline and is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to the existing background salinity regime. <u>Physical Damage</u> The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the designated features of the European site.

In combination with other Environment Agency permissions, plans or projects?	No – As discussed in conclusion
In combination with permissions, plans or projects with competent authorities?	As a result of this risk assessment, the Environment Agency can conclude that: (Select one of the following): i) **No Likely Significant Effect** - this application could act in combination with permissions and/or plans/projects of other competent authorities, consultation has been undertaken and our conclusion is as follows This is discussed in the conclusion

Conclusion: **Is there likely to be a significant effect 'alone and/or in combination' on a European site?**	**No** On the 21st of October we wrote to all the other authorities responsible for assessing and licencing plans, projects and operations in the catchment of the Blackwater and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries. The only other planned discharges we know of to be taken into account are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration. The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc The fundamental reason we believe the three effluents will not have any significant adverse affects on the European sites 'in combination' is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. As stated above 'insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three 'insignificant' discharges can combine to become significant. It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharge every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary. Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to have any significant adverse affect on the designated bird species of the European site or on any organisms that form part of their habitats or on which they feed.

	The Environment Agency is minded to: **Issue the permission with conditions to ensure no significant adverse affect on the designated species of the European site.** <u>Conditions of the permit</u> The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below. <u>Allowing the change to the new outlet</u> The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application. <u>Nitrates limits and the removal of the time limit for the activity</u> The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the European site. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one year or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it. This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the

	resources of both our organisations. <u>Metals limits and safeguards</u> The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone. Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained. With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards. <u>New outlet structure and discharge timing</u> In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above. <u>Self monitoring, recording and reporting</u> The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

	Your agreement is sought on this basis	
EA Officer:	Bill Greenwood	**Date: 29/2/16**
Natural England/CCW comment on assessment:	.	
Natural England/CCW Officer:		**Date:**
If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).		
Part B Suggested scope of the EA appropriate assessment:		

Add details to following framework

- Other competent authorities involved
- Characterise the site in relation to the qualifying features and their conservation objectives;
    - existing information
    - additional surveys
    - management/unauthorised impacts
- Detailed description of plan/project
- Assess each likely impact on the interest features;
    - compare with historical data
    - predict impacts
    - compare with impact from management/unauthorised activities
- Determine the extent to which each possible impact can be avoided.

Natural England/CCW comment on scope of EA appropriate assessment:		
Natural England/CCW Officer:		**Date:**

Site map – Outlet and Blackwater Estuary SPA/ Ramsar highlighted.

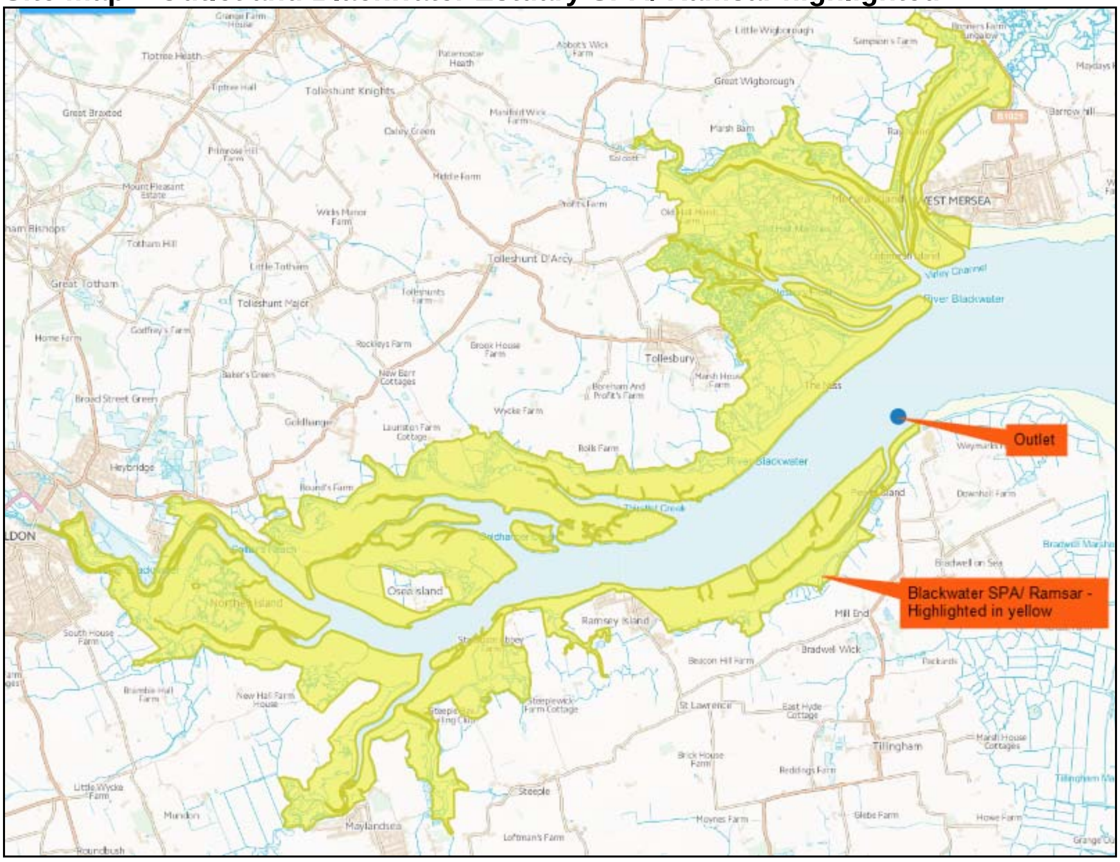


Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone

Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(7)Colne Estuary (Mid Essex Coast Phase 2) SPA and Ramsar

Habitats Directive: Form for recording likely significant effect (Stage 2)

Environment Agency

For consultation

Part A

Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)

Type of permission/activity:	Environmental Permit (Discharge consent)
Environment Agency reference no:	EPR/DP3127XB/V002
National grid reference:	TL 99650 09150
Site description:	**Trade Effluent Discharge from Bradwell Site, Magnox Ltd, Bradwell-on-Sea, Southminster, Essex CM0 7HP**
Brief description of proposal:	**A MAP OF THE SITE IS PROVIDED AT THE END OF THE DOCUMENT.** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (8) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy.

	The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. There is a separate permit controlling the release of radionuclides. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit.</u> Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the designated features of any European sites. The enforcement letter applies to the use of the existing outlet

	only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting the appropriate EQS's for substances in the effluent within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The new outlet design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. It is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted

	along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
European site names and status:	**Colne Estuary (Mid-Essex Coast Phase 2) Ramsar** **Colne Estuary (Mid Essex Coast Phase 3) SPA (or proposed SPA)**
List of interest features (relevant to this type of permission):	Colne Estuary (Mid Essex Coast Phase 3) SPA 3.8 Birds of coastal habitats (Brent goose (3.8), Hen harrier (3.8), Little tern (3.8), Pochard (3.8), Redshank (3.8), Ringed plover (3.8), Seabirds (>20, 000) (3.8) 3.9 Birds of estuarine habitats (Brent goose (3.9), Hen harrier (3.9), Little tern (3.9), Pochard (3.9), Redshank (3.9), Ringed plover (3.9), Seabirds (>20, 000) (3.9)) Colne Estuary (Mid-Essex Coast Phase 2) Ramsar 1.10 Coastal Habitats (Wetland Plants and Invertebrates) 3.4 Birds of lowland wet grasslands (Brent goose (3.4), Redshank (3.4) 3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Brent goose (3.8), Redshank (3.8), Waterfowl(>20, 000) (3.8) 3.9 Birds of estuarine habitats (Brent goose (3.9), Redshank (3.9), Waterfowl(>20, 000) (3.9))
Is this application necessary to manage the site for nature conservation?	No

What potential hazards are likely to affect the interest features (relevant to this type of permission?

Sensitive interest feature:	Potential hazard:	Potential exposure to hazard and mechanism of effect/impact if known:

3.8 Birds of coastal habitats (Brent goose (3.8), Hen harrier (3.8), Little tern (3.8), Pochard (3.8), Redshank (3.8), Ringed plover (3.8), Seabirds (>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Brent goose (3.9), Hen harrier (3.9), Little tern (3.9), Pochard (3.9), Redshank (3.9), Ringed plover (3.9), Seabirds (>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
1.10 Coastal Habitats (Wetland Plants and Invertebrates)	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	pH	See detailed assessment below
3.4 Birds of lowland wet grasslands (Brent goose (3.4), Redshank (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Brent goose (3.8), Redshank (3.8), Waterfowl(>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below

3.9 Birds of estuarine habitats (Brent goose (3.9), Redshank (3.9), Waterfowl(>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below

Is the potential scale or magnitude of any effect likely to be significant?

Alone?

No

We do not believe that the proposed changes to the discharge will have any significant adverse affect on the designated species of the European site. The principles of our assessment are outlined below and then each potentially polluting component of the discharge is addressed in turn to explain how we have reached our conclusion.

Key Principles of the assessment

- Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to 1000 or more) to the lowest known toxicity concentration of each substance to any organism to be sure that marginal breaches do not cause any harm. Not all hazardous substances have both types of EQS..

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

- H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants

	HR Wallingford was based on our published H1 guidance document. (‘*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges’*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are ‘significant’ and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution. • Acceptable mixing zones and dilution factors Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS’s can be achieved within the discharge. EQS’s are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS’s before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised. In this case for the first application we accepted that meeting EQS’s for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ‘ initial dilution’ as the dense FED effluent sinks before mixing

	renders its buoyancy neutral. The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone. The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 20 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment. Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible. • Pathways and receptors The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide. Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone. In this case we are using the term 'receptors' to mean all the aquatic organisms that form parts of the overall ecosystem that supports the designated birds species of the European sites as well as the actual birds listed in the

citations. The potential for a direct adverse affect on the birds is virtually impossible because they are very unlikely to come into contact with the effluent or its dispersion plume and the concentrations of the pollutants even in the undiluted effluent would not be harmful to them. The potential for a harmful affect on the birds is really only 'indirect' via possible harmful affects on the organisms that make up their food source, or part of the food chain, or the wider habitat. By basing our assessments on compliance of EQS's and maintaining the background water quality regime we are confident that the potential impact on all receptors will be taken into account.

Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge

Toxic contamination

The only toxic components in significant concentrations within the treated FED effluent discharge are the heavy metals listed in table 1.

(21) Extending the time period or removing it completely

Table 1 (End of Document) shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge.

This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within the limits of the existing permit whilst we re-examine all the issues and consider

	the request for the outlet change. Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that any potential increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance any increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment. For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used. (22)Change of outlet As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the designated features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background

	concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone. MAC EQS's The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 74:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their report 'BRAD/EN/REP/130/FED (issue 3)' which we supplied to you illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of the 20 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours. With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. • Conclusion – Toxic effects The potential for any of the designated bird species of the European site to be harmed by the toxic components in the treated FED effluent (from the existing outlet, or the

	new one) is limited to the 100 metre mixing zone within the receiving Blackwater Estuary. Outside this there will be no measurable change to the background water quality regime with regard to heavy metals. The Colne Estuary SPA/ Ramsar is over 5km from the point of discharge across the Blackwater and away from the dispersion plume which is in the central Blackwater channel and out to the open sea on the ebbing tides. This means that there would be no threat to any of the aquatic organisms that form part of the ecosystem for the designated birds including the shellfish and invertebrates that are their food source. The metals from the discharges will not be toxic in the short or long term to these and, if the changes in background concentrations of each metal in the water column outside the mixing zone is insignificant, there can be no significant change to the rates of accumulation of the metals in sediments or bio-accumulation in shellfish etc. In other words the discharge could not cause a significant increase in the existing metal loads in the sediments on the bed of the estuary outside the 100 metre mixing zone. Even within the mixing zone the risks of harm to the designated bird species from the discharge through either the old or new outlets are extremely low. This is because both outlets are below the lowest tides and discharges through both would be made at high water periods. Together with the fact that the FED effluent is denser than sweater and will sink this means that the mixing zones for both are always sub-tidal and deep in the water column. The plume of mixing effluent and water within which EQS's are exceeded will, therefore, always be deep below the surface and the only way in which a bird could come into contact with it would be if it was diving for some reason. Such limited exposure would not be sufficient to cause them harm and given that the discharge is intermittent and last only 20 minutes a day repeated exposure to individual birds is unlikely. Any food consumed from the water column of the mixing zone would also have had limited exposure and so bio-accumulation of metals from the FED effluent within individual birds is also extremely unlikely. <u>Nutrient Enrichment</u> (23)Extending the time period The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in

	12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the Blackwater Estuary conservation sites or any site more remote such as the Colne.. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat. At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers. The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011. The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue under the control of the existing permit whilst we consider the overall changes to the permit the applicant has requested. (24)Change of outlet

	Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone. In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in WFD classification bands in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical. Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates including the residual concentrations of nitrates returning on the incoming tides. They utilised a tool that predicts possible biological responses to nitrate increases such as blooms of macro algae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations. Their analysis did however produce a recommendation to change to discharge timings. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We

	therefore minded to incorporate this restriction in the permit. • Conclusion – Nutrient Enrichment The only potential for the nitrate load of the discharge (through the new or old outlet) to have any significant affect on the designated birds species is for it to cause significant enough increases in the existing background concentrations of nitrates within the Colne Estuary to cause blooms of macro algae that would hinder some of the designated birds feeding regime. Theoretically macro algae ' mats' in the estuary could physically prevent some birds accessing food underneath or even prevent the species that constitute suitable food from growing at all in parts of the estuary. Our Site Plan report of 2009 disputed this theory but for this assessment we are relying more on the additional modelling undertaken by our ECMAS team of the potential impacts of the nitrates load of the discharges. Their conclusion was that the FED effluent does not have the potential to cause significant increases in macro-algae blooms within the Blackwater Estuary SPA/ Ramsar or the and therefore the Colne Estuary SPA/ Ramsar which is more remote from the discharge. This is largely because of other physical background conditions in the estuary such as high turbidity which are limiting. Another factor is that the outlet is in the outer part of the Blackwater estuary in the central channel and that the timing of the discharges on the ebbing tide means that the discharge plume will always be towards the open sea. Even allowing for the return of residual nitrates concentrations on the next incoming tides this means the potential effects would be limited to the outer Blackwater estuary. Our overall conclusion is that there would be no significant adverse effect on the designated bird species of the European site from the discharge of treated FED effluent through the old or new outlet if we granted a permit for them. Because the overall load of nitrates discharged is from a finite source we also see no reason to time limit the discharge from either outlets in the future. If the discharge is made over a longer period that has been requested the potential increases in annual average background concentrations of nitrates in the Colne Estuary will be lower each year proportionate to the extra time taken to complete the operation. <u>Changes in the thermal regime</u> (13) Extending or removing the time limit The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR

	Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the receiving Blackwater estuary and definitely not on the Colne estuary. There can be no direct effect on the designated bird species of the European site from these changes in temperature and if there is no affect on the supporting flora and fauna of the supporting ecosystem there can be no indirect affect either. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds. (14) Changing to a new outlet The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the designated features of the conservation area than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way. <u>pH</u> The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to conservation sites but is worth some consideration. (13)Extending the time period The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects. (14)Change of outlet Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute

	minimum dilution factors calculated by HR Wallingford of 240:1 for the first few minutes of the discharge at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone. For these reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would significantly change the existing background pH regime beyond the mixing zone and that there could be no significant affect on shellfish which could be a food source of the designated birds of the European site. <u>Turbidity</u> The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to turbidity in the receiving estuary waters. <u>Salinity</u> The treated FED effluent is not saline and is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to the existing background salinity regime. <u>Physical Damage</u> The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason and the fact the Colne estuary is over 5km from the outlet, an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the designated features of the European site.
In combination with other Environment Agency permissions, plans or projects?	**No – As discussed in conclusion**

In combination with permissions, plans or projects with competent authorities? .	As a result of this risk assessment, the Environment Agency can conclude that: (Select one of the following): ii) **No Likely Significant Effect** - this application could act in combination with permissions and/or plans/projects of other competent authorities, consultation has been undertaken and our conclusion is as follows This is discussed in the conclusion

Conclusion: **Is there likely to be a significant effect 'alone and/or in combination' on a European site?**	**No** On the 21st of October we wrote to all the other authorities responsible for assessing and licencing plans, projects and operations in the catchment of the Colne and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries. The only other planned discharges we know of to be taken into account are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration. The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc The fundamental reason we believe the three effluents will not have any significant adverse affects on the European sites 'in combination' is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. As stated above 'insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three 'insignificant' discharges can combine to become significant. It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharge every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary. Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to have any significant adverse affect on the designated bird species of the European site or on any organisms that form part of their habitats or on which they feed.

	The Environment Agency is minded to: **Issue the permission with conditions to ensure no significant adverse affect on the designated species of the European site.** Conditions of the permit The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below. Allowing the change to the new outlet The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application. Nitrates limits and the removal of the time limit for the activity The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the European. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it. This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

<table>
<tr><td></td><td colspan="2"><u>Metals limits and safeguards</u>

The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too.   We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

<u>New outlet structure and discharge timing</u>

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

<u>Self monitoring, recording and reporting</u>

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement is sought on this basis</td></tr>
<tr><td>EA Officer:</td><td>Bill Greenwood</td><td>Date:29/2/2016</td></tr>
</table>

Natural England/CCW comment on assessment:	.	
Natural England/CCW Officer:		**Date:**
If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).		

Part B Suggested scope of the EA appropriate assessment:
Add details to following framework • Other competent authorities involved • Characterise the site in relation to the qualifying features and their conservation objectives; - existing information - additional surveys - management/unauthorised impacts • Detailed description of plan/project • Assess each likely impact on the interest features; - compare with historical data - predict impacts - compare with impact from management/unauthorised activities • Determine the extent to which each possible impact can be avoided.
Natural England/CCW comment on scope of EA appropriate assessment:

Natural England/CCW Officer:		**Date:**

Site map – Outlet and Colne Estuary SPA/ Ramsar highlighted.

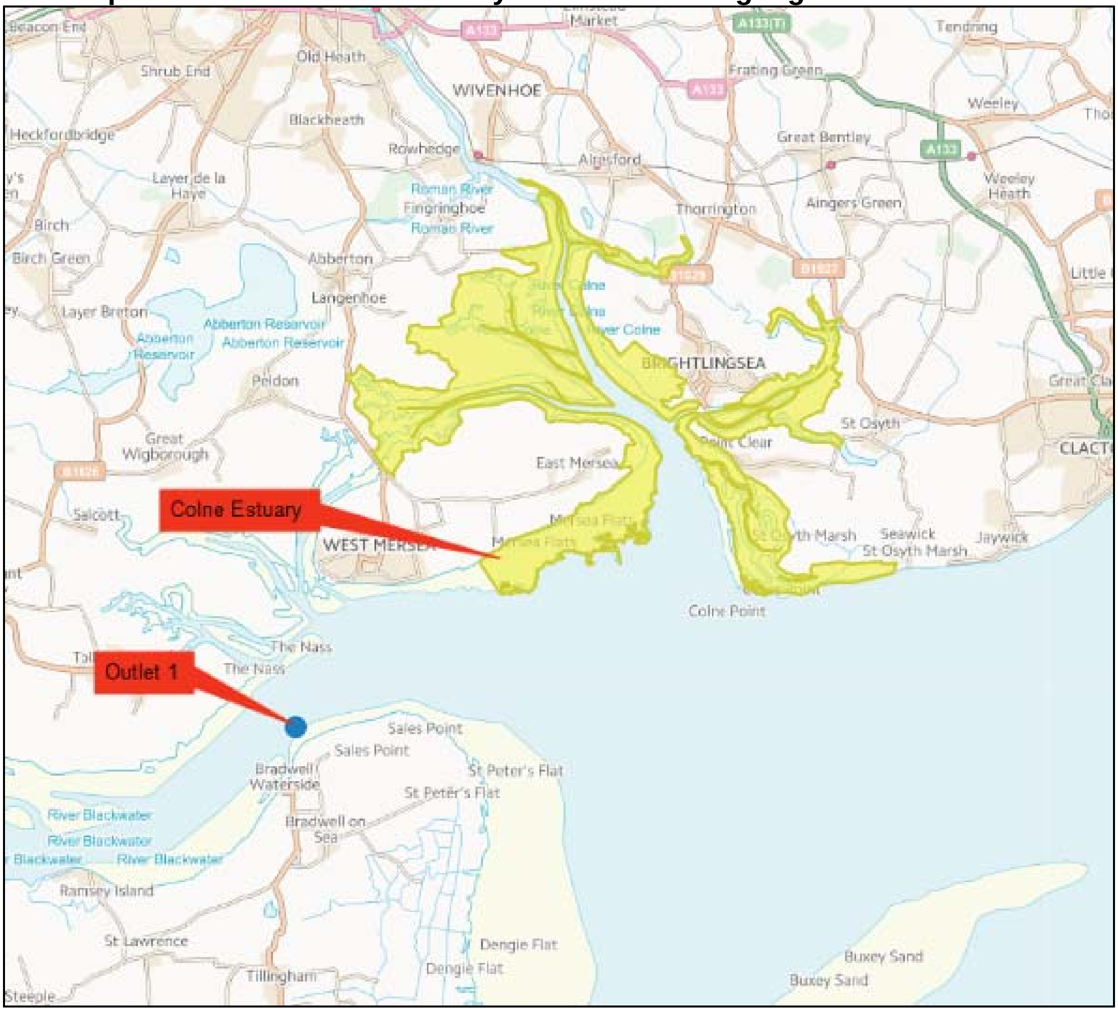


Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(8)Crouch and Roach Estuaries (Mid Essex Coast Phase 3) SPA and Ramsar site.

Habitats Directive: Form for recording likely significant effect (Stage 2)	Environment Agency
For consultation	
Part A **Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)**	
Type of permission/activity:	Environmental Permit (Discharge consent)
Environment Agency reference no:	EPR/DP3127XB/V002
National grid reference:	TL 99650 09150
Site description:	**Trade Effluent Discharge from Bradwell Site, Magnox Ltd, Bradwell-on-Sea, Southminster, Essex CM0 7HP**
Brief description of proposal:	**A MAP OF THE SITE IS PROVIDED AT THE END OF THE DOCUMENT.** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet.

	Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (9) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. There is a separate permit controlling the release of radiocuclides. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim

	before we make a decision on the application we will not take any legal action against them for discharging the FED effluent if they comply with all the conditions of the existing permit. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the designated features of any European sites. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting the appropriate EQS's for substances in the effluent within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The new outlet design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. It is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually

	controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
European site names and status:	**Crouch and Roach Estuaries (Mid Essex Coast Phase 3) SPA (or proposed SPA)** **Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar**
List of interest features (relevant to this type of permission):	Crouch and Roach Estuaries (Mid Essex Coast Phase 3) SPA 3.4 Birds of lowland wet grasslands (Brent goose (3.4), Hen Harrier (3.4) 3.6 Birds of lowland freshwaters and their margins (Hen Harrier (3.6), Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Brent goose (3.8), Hen harrier (3.8) 3.9 Birds of estuarine habitats (Brent goose (3.9)) Crouch and Roach Estuaries (Mid-Essex Coast Phase 3) Ramsar 1.10 Coastal Habitats (Wetland Plants and Invertebrates) 3.4 Birds of lowland wet grasslands (Brent goose (3.4) 3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Brent goose (3.8), Waterfowl(>20, 000) (3.8) 3.9 Birds of estuarine habitats (Brent goose (3.9), Waterfowl(>20, 000) (3.9))
Is this application necessary to manage the site for nature conservation?	No

What potential hazards are likely to affect the interest features (relevant to this type of permission?

Sensitive interest feature:	Potential hazard:	Potential exposure to hazard and mechanism of effect/impact if known:

3.4 Birds of lowland wet grasslands (Brent goose (3.4), Hen Harrier (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Hen Harrier (3.6), Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Brent goose (3.8), Hen harrier (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Brent goose (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
1.10 Coastal Habitats (Wetland Plants and Invertebrates)	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	pH	See detailed assessment below
3.4 Birds of lowland wet grasslands (Brent goose (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below

	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Brent goose (3.8), Waterfowl(>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Brent goose (3.9), Waterfowl(>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below

Is the potential scale or magnitude of any effect likely to be significant?

Alone?	**No** We do not believe that the proposed changes to the discharge will have any significant adverse affect on the designated species of the European site. The principles of our assessment are outlined below and then each potentially polluting component of the discharge is addressed in turn to explain how we have reached our conclusion. **Key Principles of the assessment** • Environmental Quality Standards (EQS's) EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to 1000 or more) to the lowest known toxicity concentration of each substance to any organism to be sure that marginal breaches do not cause any harm. Not all hazardous substances have both types of EQS.. We can be confident that if the relevant EQS

	concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.** • H1 assessments and modelling in support of the application. The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution. • Acceptable mixing zones and dilution factors Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be

	minimised. In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral. The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone. The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 20 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment. Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible. • Pathways and receptors The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the

	initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide. Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone. In this case we are using the term 'receptors' to mean all the aquatic organisms that form parts of the overall ecosystem that supports the designated birds species of the European sites as well as the actual birds listed in the citations. The potential for a direct adverse affect on the birds is virtually impossible because they are very unlikely to come into contact with the effluent or its dispersion plume and the concentrations of the pollutants even in the undiluted effluent would not be harmful to them. The potential for a harmful affect on the birds is really only 'indirect' via possible harmful affects on the organisms that make up their food source, or part of the food chain, or the wider habitat. By basing our assessments on compliance of EQS's and maintaining the background water quality regime we are confident that the potential impact on all receptors will be taken into account. **Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge** <u>Toxic contamination</u> The only toxic components in significant concentrations within the treated FED effluent discharge are the heavy metals listed in table 1 below. (25) Extending the time period or removing it completely Table 1 (End of Document) shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework

	Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge. This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within the limits of the existing permit whilst we re-examine all the issues and consider the request for the outlet change. Because the FED operation is limited to treating a <u>finite</u> amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that any potential increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance any increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment. For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used. (26)Change of outlet As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the designated features of the conservation areas we have to

	be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone. MAC EQS's The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 74:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their report 'BRAD/EN/REP/130/FED (issue 3)' which we supplied to you illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of the 20 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours. With regard to the effect of the discharge on the existing

	background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. • Conclusion – Toxic effects The potential for any of the designated bird species of the European site to be harmed by the toxic components in the treated FED effluent (from the existing outlet, or the new one) is limited to the 100 metre mixing zone within the receiving Blackwater Estuary. Outside this there will be no measurable change to the background water quality regime with regard to heavy metals. The Crouch and Roach Estuaries SPA/ Ramsar is 17km from the point of discharge and there is not possibility of the discharge affecting the metals levels within it. This means that there would be no threat to any of the aquatic organisms that form part of the ecosystem for the designated birds including the shellfish and invertebrates that are their food source. The metals from the discharges will not be toxic in the short or long term to these and, if the changes in background concentrations of each metal in the water column outside the mixing zone is insignificant, there can be no significant change to the rates of accumulation of the metals in sediments or bio-accumulation in shellfish etc. In other words the discharge could not cause a significant increase in the existing metal loads in the sediments on the bed of the even the receiving estuary outside the 100 metre mixing zone. Even within the mixing zone the risks of harm to the designated bird species from the discharge through either the old or new outlets are extremely low. This is because both outlets are below the lowest tides and discharges through both would be made at high water periods. Together with the fact that the FED effluent is denser than sweater and will sink this means that the mixing zones for both are always sub-tidal and deep in the water column. The plume of mixing effluent and water within which EQS's are exceeded will, therefore, always be deep below the surface and the only way in which a bird could come into contact with it would be if it was diving for some reason. Such limited exposure would not be sufficient to cause them harm and given that the discharge is intermittent and last only 20 minutes a day repeated exposure to individual birds is unlikely. Any food consumed from the water column of the mixing zone would also have had limited exposure and so bio-accumulation of metals from the FED effluent within individual birds is also extremely unlikely. <u>Nutrient Enrichment</u> (27)Extending the time period

	The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the Blackwater Estuary conservation sites and therefore not within he Crouch and Roach Estuaries either which are over 14 kilometres from the outlet. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat. At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers. The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011. The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are

	limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue under the control of the existing permit whilst we consider the overall changes to the permit the applicant has requested. (28)Change of outlet Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone. In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in WFD classification bands in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical. Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates including the residual concentrations of nitrates returning on the incoming tides. They utilised a tool that predicts possible biological responses to nitrate increases such as blooms of macroalgae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from

	the effects of the limited increases in background nitrate concentrations. Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We therefore minded to incorporate this restriction in the permit. • Conclusion – Nutrient Enrichment The only potential for the nitrate load of the discharge (through the new or old outlet) to have any significant affect on the designated birds species is for it to cause significant enough increases in the existing background concentrations of nitrates within the Crouch and Roach Estuaries to cause blooms of macroalgae that would hinder some of the designated birds feeding regime. Theoretically macroalgae ' mats' in the estuary could physically prevent some birds accessing food underneath or even prevent the species that constitute suitable food from growing at all in parts of the estuary. Our Site Plan report of 2009 disputed this theory but for this assessment we are relying more on the additional modelling undertaken by our ECMAS team of the potential impacts of the nitrates load of the discharges. Their conclusion was that the FED effluent does not have the potential to cause significant increases in macro-algae blooms within the Blackwater Estuary SPA/ Ramsar or the Colne SPA/RAMSAR. The Crouch and Roach Estuaries SPA/ Ramsar are too remote from the discharge and its dispersion plume (out into the open sea) to be affected by it at all. Our overall conclusion is that there would be no significant adverse effect on the designated bird species of the European site from the discharge of treated FED effluent through the old or new outlet if we granted a permit for them. Because the overall load of nitrates discharged is from a finite source we also see no reason to time limit the discharge from either outlets in the future. If the discharge is made over a longer period that has been requested the potential increases in annual average background concentrations of nitrates in the receiving waters will be lower each year proportionate to the extra time taken to complete the operation. <u>Changes in the thermal regime</u> (15) Extending or removing the time limit

	The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the Blackwater estuary and definitely none on other more remote conservation areas such as the Crouch and Roach estuaries. There can be no direct effect on the designated bird species of the European site from these changes in temperature and if there is no affect on the supporting flora and fauna of the supporting ecosystem there can be no indirect affect either. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds. (16) Changing to a new outlet The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the designated features of the conservation area than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way. <u>pH</u> The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to conservation sites but is worth some consideration. (15)Extending the time period The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any

	discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects. (16)Change of outlet Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute minimum dilution factors calculated by HR Wallingford of 240:1 for the first few minutes of the discharge at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone. For these reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would significantly change the existing background pH regime beyond the mixing zone and that there could be no significant affect on shellfish which could be a food source of the designated birds of any of the European sites in the vicinity or more remote. <u>Turbidity</u> The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the designated features of any of the European sites from any changes to turbidity in the receiving estuary waters. <u>Salinity</u> The treated FED effluent is not saline and is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the designated features of any of the European sites in the vicinity or more remote from any changes to the existing background salinity regime. <u>Physical Damage</u> The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason and the fact the Crouch and Roach Estuaries SPA/ Ramsar is 17km from the outlet, an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the designated

	features of the European site.
In combination with other Environment Agency permissions, plans or projects?	**No – As discussed in conclusion**
In combination with permissions, plans or projects with competent authorities?	As a result of this risk assessment, the Environment Agency can conclude that: (Select one of the following): iii) **No Likely Significant Effect -** this application could act in combination with permissions and/or plans/projects of other competent authorities, consultation has been undertaken and our conclusion is as follows This is discussed in the conclusion

Conclusion: **Is there likely to be a significant effect 'alone and/or in combination' on a European site?**	**No** On the 21st of October we wrote to all the other authorities responsible for assessing and licencing plans, projects and operations in the catchment of the Crouch and Roach Estuaries and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries. The only other planned discharges we know of to be taken into account are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration. The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc The fundamental reason we believe the three effluents will not have any significant adverse affects on the European sites 'in combination' is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. As stated above 'insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three 'insignificant' discharges can combine to become significant. It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharge every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary. Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to have any significant adverse affect on the designated bird species of the European site or on any organisms that form part of their habitats or on which they

	feed. **The Environment Agency is minded to:** **Issue the permission with conditions to ensure no significant adverse affect on the designated species of the European siteI** <u>Conditions of the permit</u> The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below. <u>Allowing the change to the new outlet</u> The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application. <u>Nitrates limits and the removal of the time limit for the activity</u> The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the European site. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it. This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the

	resources of both our organisations. <u>Metals limits and safeguards</u> The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone. Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained. With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards. <u>New outlet structure and discharge timing</u> In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above. <u>Self monitoring, recording and reporting</u> The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

<table>
<tr><td></td><td colspan="2">Your agreement is sought on this basis</td></tr>
<tr><td>EA Officer:</td><td>Bill Greenwood</td><td>Date: 29/2/2016</td></tr>
<tr><td>Natural England/CCW comment on assessment:</td><td colspan="2">.</td></tr>
<tr><td>Natural England/CCW Officer:</td><td></td><td>Date:</td></tr>
<tr><td colspan="3">If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).</td></tr>
<tr><td colspan="3">Part B Suggested scope of the EA appropriate assessment:</td></tr>
<tr><td colspan="3">Add details to following framework
• Other competent authorities involved
• Characterise the site in relation to the qualifying features and their conservation objectives;
- existing information
- additional surveys
- management/unauthorised impacts
• Detailed description of plan/project
• Assess each likely impact on the interest features;
- compare with historical data
- predict impacts
- compare with impact from management/unauthorised activities
• Determine the extent to which each possible impact can be avoided.</td></tr>
<tr><td colspan="3">Natural England/CCW comment on scope of EA appropriate assessment:</td></tr>
<tr><td>Natural England/CCW Officer:</td><td></td><td>Date:</td></tr>
</table>

Site map – Outlet and Crouch & Roach Estuaries SPA/ Ramsar highlighted.

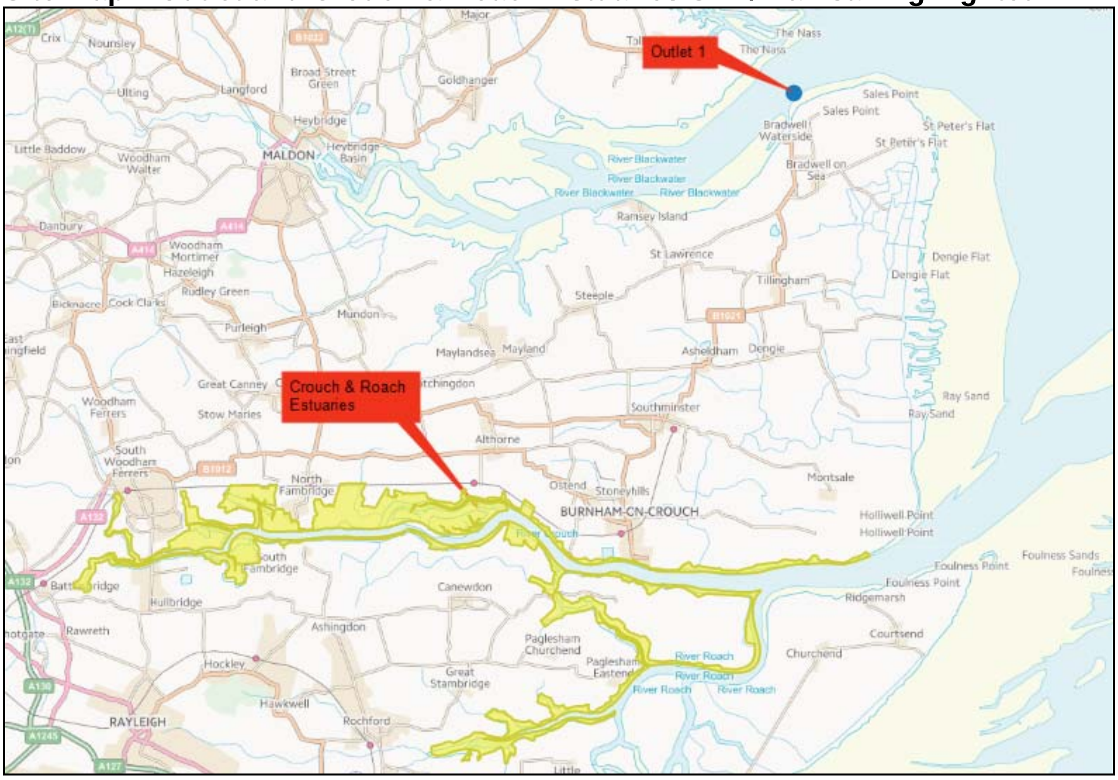


Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone

Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(9)Dengie (Mid Essex Coast Phase 1) SPA and Ramsar

Habitats Directive: Form for recording likely significant effect (Stage 2)	Environment Agency
For consultation	
Part A **Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)**	
Type of permission/activity:	Environmental Permit (Discharge consent)
Environment Agency reference no:	EPR/DP3127XB/V002
National grid reference:	TL 99650 09150
Site description:	**Trade Effluent Discharge from Bradwell Site, Magnox Ltd, Bradwell-on-Sea, Southminster, Essex CM0 7HP**
Brief description of proposal:	**A MAP OF THE SITE IS PROVIDED AT THE END OF THE DOCUMENT.** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (7) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric

	acid hence ‘dissolution’. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. There is a separate permit controlling the release of radionuclides. Since the beginning of the operation the applicant has made a small change to it by adding acidic ‘NOX’ scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won’t always be included. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge ‘activity’ to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the ‘activity’ has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the ‘activity’ we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit.</u> Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the designated features of any European sites. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally

	they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting the appropriate EQS's for substances in the effluent within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The new outlet design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. It is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth

	of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
European site names and status:	**Dengie (Mid-Essex Coast Phase 1) Ramsar** **Dengie (Mid-Essex Coast Phase 3) SPA (or proposed SPA)**
List of interest features (relevant to this type of permission):	Dengie (Mid-Essex Coast Phase 1) Ramsar 1.10 Coastal Habitats (Wetland Plants and Invertebrates) 3.4 Birds of lowland wet grasslands (Brent goose (3.4), Grey plover (3.4), Knot (3.4) 3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Brent goose (3.8), Grey plover (3.8), Knot (3.8), Waterfowl(>20, 000) (3.8) 3.9 Birds of estuarine habitats (Brent goose (3.9), Grey plover (3.9), Knot (3.9), Waterfowl(>20, 000) (3.9)) Dengie (Mid-Essex Coast Phase 3) SPA 3.4 Birds of lowland wet grasslands (Brent goose (3.4), Grey plover (3.4), Hen Harrier (3.4), Knot (3.4) 3.6 Birds of lowland freshwaters and their margins (Hen Harrier (3.6), Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Brent goose (3.8), Hen harrier (3.8), Knot (3.8) 3.9 Birds of estuarine habitats (Brent goose (3.9), Hen harrier (3.9), Knot (3.9))
Is this application necessary to manage the site for nature conservation?	No

What potential hazards are likely to affect the interest features (relevant to this type of permission?

Sensitive interest feature:	**Potential hazard:**	**Potential exposure to hazard and mechanism of effect/impact if known:**

1.10 Coastal Habitats (Wetland Plants and Invertebrates)	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	pH	See detailed assessment below
3.4 Birds of lowland wet grasslands (Brent goose (3.4), Grey plover (3.4), Knot (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Brent goose (3.8), Grey plover (3.8), Knot (3.8), Waterfowl(>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Brent goose (3.9), Grey plover (3.9), Knot (3.9), Waterfowl(>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.4 Birds of lowland wet grasslands (Brent goose (3.4), Grey plover (3.4), Hen Harrier (3.4), Knot (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Hen Harrier (3.6), Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below

	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Brent goose (3.8), Hen harrier (3.8), Knot (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Brent goose (3.9), Hen harrier (3.9), Knot (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below

Is the potential scale or magnitude of any effect likely to be significant?

Alone?	**No** We do not believe that the proposed changes to the discharge will have any significant adverse affect on the designated species of the European site. The principles of our assessment are outlined below and then each potentially polluting component of the discharge is addressed in turn to explain how we have reached our conclusion. **Key Principles of the assessment** • Environmental Quality Standards (EQS's) EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to 1000 or more) to the lowest known toxicity concentration of each substance to any organism to be sure that marginal breaches do not cause any harm. Not all hazardous substances have both types of EQS..

	We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.** • H1 assessments and modelling in support of the application. The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution. • Acceptable mixing zones and dilution factors Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's

	before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised. In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral. The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone. The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 20 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment. Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible. • Pathways and receptors The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for

	only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide. Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone. In this case we are using the term 'receptors' to mean all the aquatic organisms that form parts of the overall ecosystem that supports the designated birds species of the European sites as well as the actual birds listed in the citations. The potential for a direct adverse affect on the birds is virtually impossible because they are very unlikely to come into contact with the effluent or its dispersion plume and the concentrations of the pollutants even in the undiluted effluent would not be harmful to them. The potential for a harmful affect on the birds is really only 'indirect' via possible harmful affects on the organisms that make up their food source, or part of the food chain, or the wider habitat. By basing our assessments on compliance of EQS's and maintaining the background water quality regime we are confident that the potential impact on all receptors will be taken into account. **Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge** <u>Toxic contamination</u> The only toxic components in significant concentrations within the treated FED effluent discharge are the heavy metals listed in table 1 below. (10) Extending the time period or removing it completely Table 1 (End of Document) shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary

	outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge. This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within the limits of the existing permit whilst we re-examine all the issues and consider the request for the outlet change. Because the FED operation is limited to treating a finite amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that any potential increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance any increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment. For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used. (11) Change of outlet As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum

	factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the designated features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone. MAC EQS's The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 74:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their report 'BRAD/EN/REP/130/FED (issue 3)' which we supplied to you illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of the 20 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed

	to it over several hours. With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. • Conclusion – Toxic effects The potential for any of the designated bird species of the European site to be harmed by the toxic components in the treated FED effluent (from the existing outlet, or the new one) is limited to the 100 metre mixing zone within the receiving Blackwater Estuary. Outside this there will be no measurable change to the background water quality regime with regard to heavy metals. This means that there would be no threat to any of the Dengie SSSI ecosystem for the designated birds including the shellfish and invertebrates that are their food source. The metals from the discharges will not be toxic in the short or long term to these and, if the changes in background concentrations of each metal in the water column outside the mixing zone is insignificant, there can be no significant change to the rates of accumulation of the metals in sediments or bio-accumulation in shellfish etc. In other words the discharge could not cause a significant increase in the existing metal loads in the sediments on the bed of the estuary outside the 100 metre mixing zone. Even within the mixing zone the risks of harm to the designated bird species from the discharge through either the old or new outlets are extremely low. This is because both outlets are below the lowest tides and discharges through both would be made at high water periods. Together with the fact that the FED effluent is denser than sweater and will sink this means that the mixing zones for both are always sub-tidal and deep in the water column. The plume of mixing effluent and water within which EQS's are exceeded will, therefore, always be deep below the surface and the only way in which a bird could come into contact with it would be if it was diving for some reason. Such limited exposure would not be sufficient to cause them harm and given that the discharge is intermittent and last only 20 minutes a day repeated exposure to individual birds is unlikely. Any food consumed from the water column of the mixing zone would also have had limited exposure and so bio-accumulation of metals from the FED effluent within individual birds is also extremely unlikely. <u>Nutrient Enrichment</u> (29)Extending the time period

	The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the Blackwater Estuary conservation sites including the Dengie SPA/ Ramsar. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat. At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers. The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011. The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge

	over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue under the control of the existing permit whilst we consider the overall changes to the permit the applicant has requested. (30)Change of outlet Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone. In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in WFD classification bands in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical. Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates including the residual concentrations of nitrates returning on the incoming tides. They utilised a tool that predicts possible biological responses to nitrate increases such as blooms of macro algae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations.

	Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We therefore minded to incorporate this restriction in the permit. • Conclusion – Nutrient Enrichment The only potential for the nitrate load of the discharge (through the new or old outlet) to have any significant affect on the designated birds species is for it to cause significant enough increases in the existing background concentrations of nitrates within the Blackwater Estuary to cause blooms of macro algae that would hinder some of the designated birds feeding regime. Theoretically macro algae ‘ mats' in the estuary could physically prevent some birds accessing food underneath or even prevent the species that constitute suitable food from growing at all in parts of the estuary. Our Site Plan report of 2009 disputed this theory but for this assessment we are relying more on the additional modelling undertaken by our ECMAS team of the potential impacts of the nitrates load of the discharges. Their conclusion was that the FED effluent does not have the potential to cause significant increases in macro-algae blooms within the European site. This is largely because of other physical background conditions in the estuary such as high turbidity which are limiting. Another factor is that the outlet is in the outer part of the estuary in the central channel and that the timing of the discharges on the ebbing tide means that the discharge plume will always be towards the open sea. Even allowing for the return of residual nitrates concentrations on the next incoming tides this means the potential effects would be limited to the outer estuary. The inner estuary where there is currently some evidence of overwintering macro algae mats would not be affected at all Our overall conclusion is that there would be no significant adverse effect on the designated bird species of the European site from the discharge of treated FED effluent through the old or new outlet if we granted a permit for them. Because the overall load of nitrates discharged is from a finite source we also see no reason to time limit the discharge from either outlets in the future. If the discharge is made over a longer period that has been requested the potential increases in annual average background concentrations of nitrates in the Blackwater Estuary, and beyond, will be lower each year proportionate to the extra time taken to complete the operation. <u>Changes in the thermal regime</u>

	(17) Extending or removing the time limit The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna anywhere within the receiving estuary. There can be no direct effect on the designated bird species of the European site from these changes in temperature and if there is no affect on the supporting flora and fauna of the supporting ecosystem there can be no indirect affect either. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds. (18) Changing to a new outlet The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the designated features of the conservation area than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way. <u>pH</u> The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to conservation sites but is worth some consideration. (17)Extending the time period

	The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects. (18)Change of outlet Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute minimum dilution factors calculated by HR Wallingford of 240:1 for the first few minutes of the discharge at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone. For these reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would significantly change the existing background pH regime beyond the mixing zone and that there could be no significant affect on shellfish which could be a food source of the designated birds of the European site. <u>Turbidity</u> The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to turbidity in the receiving estuary waters. <u>Salinity</u> The treated FED effluent is not saline and is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to the existing background salinity regime. <u>Physical Damage</u> The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects

	on the designated features of the European site.
In combination with other Environment Agency permissions, plans or projects?	No – As discussed in conclusion
In combination with permissions, plans or projects with competent authorities?	As a result of this risk assessment, the Environment Agency can conclude that: (Select one of the following): iv) **No Likely Significant Effect -** this application could act in combination with permissions and/or plans/projects of other competent authorities, consultation has been undertaken and our conclusion is as follows This is discussed in the conclusion

Conclusion: **Is there likely to be a significant effect 'alone and/or in combination' on a European site?**	**No** On the 21st of October we wrote to all the other authorities responsible for assessing and licencing plans, projects and operations in the catchment of the Blackwater and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries. The only other planned discharges we know of to be taken into account are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration. The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc The fundamental reason we believe the three effluents will not have any significant adverse affects on the European sites 'in combination' is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. As stated above 'insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three 'insignificant' discharges can combine to become significant. It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharge every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary. Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to have any significant adverse affect on the designated bird species of the European site or on any organisms that form part of their habitats or on which they feed.

	The Environment Agency is minded to: **Issue the permission with conditions to ensure no significant adverse affect on the designated species of the European sitel** <u>Conditions of the permit</u> The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below. <u>Allowing the change to the new outlet</u> The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application. <u>Nitrates limits and the removal of the time limit for the activity</u> The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the European site. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it. This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the

resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too.   We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

	Your agreement is sought on this basis	
EA Officer:	Bill Greenwood	**Date: 29/2/2016**
Natural England/CCW comment on assessment:	.	
Natural England/CCW Officer:		**Date:**
If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).		
Part B Suggested scope of the EA appropriate assessment:		

Add details to following framework

- Other competent authorities involved
- Characterise the site in relation to the qualifying features and their conservation objectives;
  - existing information
  - additional surveys
  - management/unauthorised impacts
- Detailed description of plan/project
- Assess each likely impact on the interest features;
  - compare with historical data
  - predict impacts
  - compare with impact from management/unauthorised activities
- Determine the extent to which each possible impact can be avoided.

Natural England/CCW comment on scope of EA appropriate assessment:		
Natural England/CCW Officer:		**Date:**

Site map – Outlet and Dengie SPA/ Ramsar highlighted.

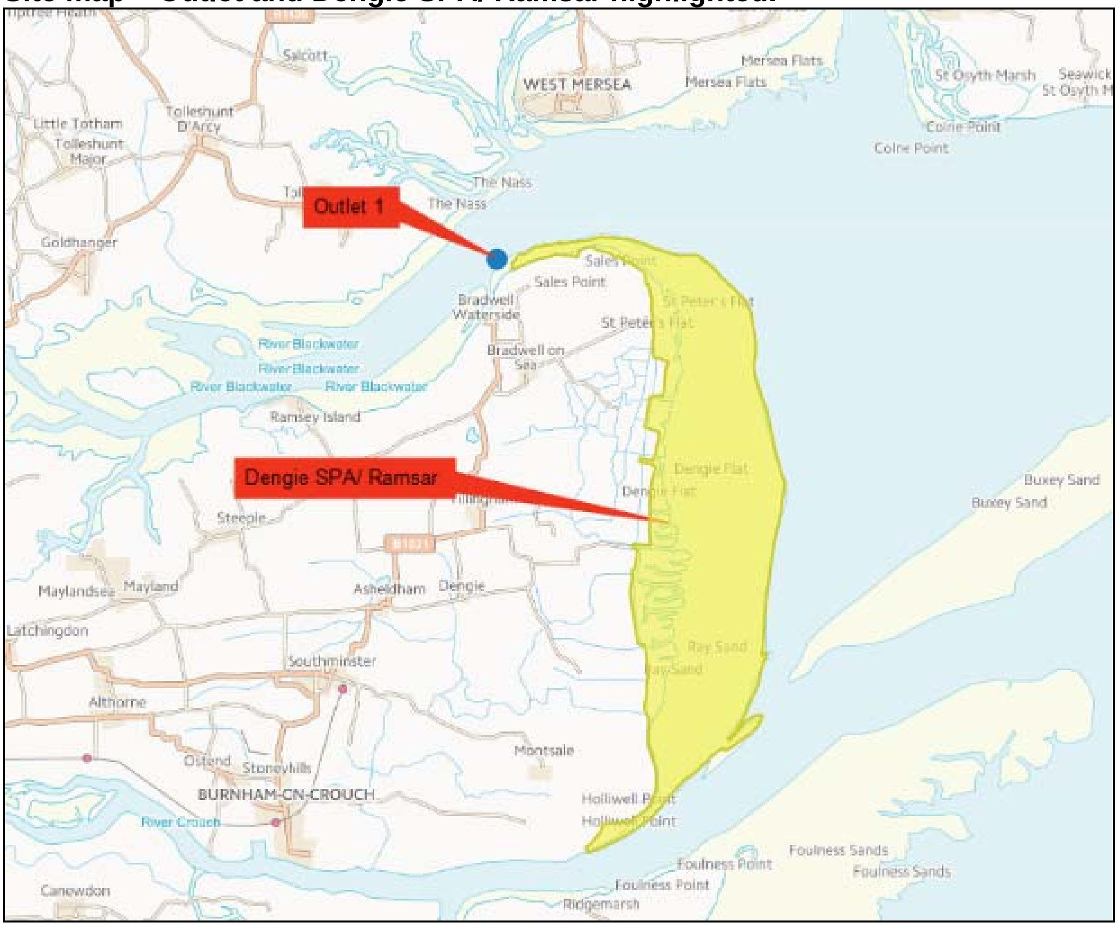


Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(10) Foulness (Mid Essex Coast Phase 5) SPA and Ramsar

Habitats Directive: Form for recording likely significant effect (Stage 2)	Environment Agency

For consultation

Part A
Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)

Type of permission/activity:	Environmental Permit (Discharge consent)
Environment Agency reference no:	EPR/DP3127XB/V002
National grid reference:	TL 99650 09150
Site description:	**Trade Effluent Discharge from Bradwell Site, Magnox Ltd, Bradwell-on-Sea, Southminster, Essex CM0 7HP**
Brief description of proposal:	**A MAP OF THE SITE IS PROVIDED AT THE END OF THE DOCUMENT.** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the

	discharge characteristics because it would no longer be possible to ‘pre-dilute’ the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (12) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence ‘dissolution’. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. Since the beginning of the operation the applicant has made a small change to it by adding acidic ‘NOX’ scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won’t always be included. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge ‘activity’ to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the ‘activity’ has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the ‘activity’ we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit</u>. Because these conditions were set to

	protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the designated features of any European sites. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting the appropriate EQS's for substances in the effluent within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The new outlet design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. It is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will

	initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
European site names and status:	**Foulness (Mid-Essex Coast Phase 5) SPA (or proposed SPA)** **Foulness (Mid-Essex Coast Phase 5) Ramsar**

List of interest features (relevant to this type of permission):	Foulness (Mid-Essex Coast Phase 5) Ramsar 1.10 Coastal Habitats (Wetland Plants and Invertebrates) 3.4 Birds of lowland wet grasslands (Bar-tailed godwit (3.4), Brent goose (3.4), Grey plover (3.4), Knot (3.4), Oystercatcher (3.4), Redshank (3.4) 3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6) 3.8 Birds of coastal habitats (Bar-tailed Godwit (3.8), Brent goose (3.8), Grey plover (3.8), Knot (3.8), Oystercatcher (3.8), Redshank (3.8), Waterfowl(>20, 000) (3.8) 3.9 Birds of estuarine habitats (Bar-tailed Godwit (3.9), Brent goose (3.9), Grey plover (3.9), Knot (3.9), Oystercatcher (3.9), Redshank (3.9), Waterfowl(>20, 000) (3.9)) Foulness (Mid-Essex Coast Phase 5) SPA 3.1 Birds of uplands (Common Redshank (3.1), Hen harrier (3.1) 3.10 Birds of open sea and offshore rocks (Common Tern (3.10), Little tern (3.10), Sandwich tern (3.10) 3.4 Birds of lowland wet grasslands (Bar-tailed godwit (3.4), Brent goose (3.4), Common Redshank (3.4), Grey plover (3.4), Hen Harrier (3.4), Knot (3.4), Oystercatcher (3.4) 3.6 Birds of lowland freshwaters and their margins (Avocet (3.6), Common Redshank (3.6), Common Tern (3.6), Hen Harrier (3.6), Ringed plover (3.6), (Waterfowl(>20, 000) (3.6)) 3.8 Birds of coastal habitats (Avocet (3.8), Bar-tailed Godwit (3.8), Brent goose (3.8), Common Redshank (3.8), Common Tern (3.8), Grey plover (3.8), Hen harrier (3.8), Knot (3.8), Little tern (3.8), Oystercatcher (3.8), Ringed plover (3.8), Sandwich tern (3.8), Waterfowl(>20, 000) (3.8)) 3.9 Birds of estuarine habitats (Avocet (3.9), Bar-tailed Godwit (3.9), Brent goose (3.9), Common Redshank (3.9), Common Tern (3.9), Grey plover (3.9), Hen harrier (3.9), Knot (3.9), Little tern (3.9), Oystercatcher (3.9), Ringed plover (3.9), Sandwich tern (3.9), Waterfowl(>20, 000) (3.9))
Is this application necessary to manage the site for nature conservation?	No

What potential hazards are likely to affect the interest features (relevant to this type of permission?

Sensitive interest feature:	Potential hazard:	Potential exposure to hazard and mechanism of effect/impact if known:

1.10 Coastal Habitats (Wetland Plants and Invertebrates)	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	pH	See detailed assessment below
3.4 Birds of lowland wet grasslands (Bar-tailed godwit (3.4), Brent goose (3.4), Grey plover (3.4), Knot (3.4), Oystercatcher (3.4), Redshank (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Bar-tailed Godwit (3.8), Brent goose (3.8), Grey plover (3.8), Knot (3.8), Oystercatcher (3.8), Redshank (3.8), Waterfowl(>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Bar-tailed Godwit (3.9), Brent goose (3.9), Grey plover (3.9), Knot (3.9), Oystercatcher (3.9), Redshank (3.9), Waterfowl(>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.1 Birds of uplands (Common Redshank (3.1), Hen harrier (3.1))	Toxic contamination	See detailed assessment below
3.10 Birds of open sea and offshore rocks (Common Tern (3.10), Little tern (3.10), Sandwich tern (3.10))	Toxic contamination	See detailed assessment below

3.4 Birds of lowland wet grasslands (Bar-tailed godwit (3.4), Brent goose (3.4), Common Redshank (3.4), Grey plover (3.4), Hen Harrier (3.4), Knot (3.4), Oystercatcher (3.4))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Avocet (3.6), Common Redshank (3.6), Common Tern (3.6), Hen Harrier (3.6), Ringed plover (3.6), Waterfowl(>20, 000) (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below
3.8 Birds of coastal habitats (Avocet (3.8), Bar-tailed Godwit (3.8), Brent goose (3.8), Common Redshank (3.8), Common Tern (3.8), Grey plover (3.8), Hen harrier (3.8), Knot (3.8), Little tern (3.8), Oystercatcher (3.8), Ringed plover (3.8), Sandwich tern (3.8), Waterfowl(>20, 000) (3.8))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
3.9 Birds of estuarine habitats (Avocet (3.9), Bar-tailed Godwit (3.9), Brent goose (3.9), Common Redshank (3.9), Common Tern (3.9), Grey plover (3.9), Hen harrier (3.9), Knot (3.9), Little tern (3.9), Oystercatcher (3.9), Ringed plover (3.9), Sandwich tern (3.9), Waterfowl(>20, 000) (3.9))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Physical Damage	See detailed assessment below
	Salinity	See detailed assessment below
	Siltation	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below

Is the potential scale or magnitude of any effect likely to be significant?	
Alone?	**No** We do not believe that the proposed changes to the discharge will have any significant adverse affect on the designated species of the European site. The principles of our assessment are outlined below and then each potentially polluting component of the discharge is addressed in turn to explain how we have reached our conclusion. **Key Principles of the assessment** • Environmental Quality Standards (EQS's) EQS's are based on research into the toxicity of

	substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to 1000 or more) to the lowest known toxicity concentration of each substance to any organism to be sure that marginal breaches do not cause any harm. Not all hazardous substances have both types of EQS.. We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.** • H1 assessments and modelling in support of the application. The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

	• Acceptable mixing zones and dilution factors Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised. In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral. The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone. The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 20 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment. Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

	• Pathways and receptors The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide. Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone. In this case we are using the term 'receptors' to mean all the aquatic organisms that form parts of the overall ecosystem that supports the designated birds species of the European sites as well as the actual birds listed in the citations. The potential for a direct adverse affect on the birds is virtually impossible because they are very unlikely to come into contact with the effluent or its dispersion plume and the concentrations of the pollutants even in the undiluted effluent would not be harmful to them. The potential for a harmful affect on the birds is really only 'indirect' via possible harmful affects on the organisms that make up their food source, or part of the food chain, or the wider habitat. By basing our assessments on compliance of EQS's and maintaining the background water quality regime we are confident that the potential impact on all receptors will be taken into account. **Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge** <u>Toxic contamination</u> The only toxic components in significant concentrations within the treated FED effluent discharge are the heavy metals listed in table 1 below. (31) Extending the time period or removing it completely Table 1 (End of Document) shows the maximum concentration of metals in the effluent from the FED

	treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge. This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within the limits of the existing permit whilst we re-examine all the issues and consider the request for the outlet change. Because the FED operation is limited to treating a <u>finite</u> amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that any potential increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance any increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment. For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used. (32)Change of outlet As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent

	would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the designated features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone. MAC EQS's The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 74:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their report 'BRAD/EN/REP/130/FED (issue 3)' which we supplied to you illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin

	of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of the 20 minute discharge window and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours. With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. • Conclusion – Toxic effects The potential for any of the designated bird species of the European site to be harmed by the toxic components in the treated FED effluent (from the existing outlet, or the new one) is limited to the 100 metre mixing zone within the receiving Blackwater Estuary. Outside this there will be no measurable change to the background water quality regime with regard to heavy metals. The Foulness SPA/ Ramsar is over 16km from the point of discharge. This means that there would be no threat to any of the aquatic organisms that form part of the ecosystem for the designated birds including the shellfish and invertebrates that are their food source. The metals from the discharges will not be toxic in the short or long term to these and, if the changes in background concentrations of each metal in the water column outside the mixing zone is insignificant, there can be no significant change to the rates of accumulation of the metals in sediments or bio-accumulation in shellfish etc. In other words the discharge could not cause a significant increase in the existing metal loads in the sediments on the bed of the estuary outside the 100 metre mixing zone. Even within the mixing zone the risks of harm to the designated bird species from the discharge through either the old or new outlets are extremely low. This is because both outlets are below the lowest tides and discharges through both would be made at high water periods. Together with the fact that the FED effluent is denser than sweater and will sink this means that the mixing zones for both are always sub-tidal and deep in the water column. The plume of mixing effluent and water within which EQS's are exceeded will, therefore, always be deep below the surface and the only way in which a bird could come into contact with it would be if it was diving for some reason. Such limited exposure would not be sufficient to cause them harm and given that the discharge is

	intermittent and last only 20 minutes a day repeated exposure to individual birds is unlikely. Any food consumed from the water column of the mixing zone would also have had limited exposure and so bio-accumulation of metals from the FED effluent within individual birds is also extremely unlikely. <u>Nutrient Enrichment</u> (33)Extending the time period The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the Blackwater Estuary conservation sites and therefore not within the Foulness SPA/ Ramsar, which is 16km away from the outlet. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat. At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers. The above factors led us to believe that the nitrates in the

	FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011. The same principles still apply but the changes of time period requested in the variation may lower any potential risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue under the control of the existing permit whilst we consider the overall changes to the permit the applicant has requested. (34)Change of outlet Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone. In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in WFD classification bands in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical.

	Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates including the residual concentrations of nitrates returning on the incoming tides. They utilised a tool that predicts possible biological responses to nitrate increases such as blooms of macro algae and phytoplankton which could be harmful to some of the designated species or their habitat. They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations. Their analysis did however produce a recommendation to change to discharge timings.. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We therefore minded to incorporate this restriction in the permit. • Conclusion – Nutrient Enrichment The only potential for the nitrate load of the discharge (through the new or old outlet) to have any significant affect on the designated birds species is for it to cause significant enough increases in the existing background concentrations of nitrates within the Foulness SPA/ Ramsar to cause blooms of macro algae that would hinder some of the designated birds feeding regime. Theoretically macro algae ' mats' in the estuary could physically prevent some birds accessing food underneath or even prevent the species that constitute suitable food from growing at all in parts of the estuary. Our Site Plan report of 2009 disputed this theory but for this assessment we are relying more on the additional modelling undertaken by our ECMAS team of the potential impacts of the nitrates load of the discharges. Their conclusion was that the FED effluent does not have the potential to cause significant increases in macro-algae blooms within the Blackwater Estuary SPA/ Ramsar and definitely not within the Foulness SPA/ Ramsar which is more remote from the discharge. This is largely because of other physical background conditions in the estuary such as high turbidity which are limiting. Another factor is that the outlet is in the outer part of the Blackwater estuary in the central channel and that the timing of the discharges on the ebbing tide means that the discharge plume will always be towards the open sea. Even allowing for the return of residual nitrates concentrations on the next incoming tides this means the potential effects would be limited to the outer Blackwater estuary

	Our overall conclusion is that there would be no significant adverse effect on the designated bird species of the European site from the discharge of treated FED effluent through the old or new outlet if we granted a permit for them. Because the overall load of nitrates discharged is from a finite source we also see no reason to time limit the discharge from either outlets in the future. If the discharge is made over a longer period that has been requested the potential increases in annual average background concentrations of nitrates in the Foulness SPA/ Ramsar will be lower each year proportionate to the extra time taken to complete the operation. <u>Changes in the thermal regime</u> (19) Extending or removing the time limit The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the Foulness SPA/ Ramsar. There can be no direct effect on the designated bird species of the European site from these changes in temperature and if there is no affect on the supporting flora and fauna of the supporting ecosystem there can be no indirect affect either. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds. (20) Changing to a new outlet The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the designated features of the conservation area than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way. <u>pH</u>

	The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to conservation sites but is worth some consideration. (19)Extending the time period The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects. (20)Change of outlet Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute minimum dilution factors calculated by HR Wallingford of 240:1 for the first few minutes of the discharge at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone. For these reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would significantly change the existing background pH regime beyond the mixing zone and that there could be no significant affect on shellfish which could be a food source of the designated birds of the European site. <u>Turbidity</u> The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to turbidity in the receiving estuary waters. <u>Salinity</u> The treated FED effluent is not saline and is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to the existing background salinity regime.

	<u>Physical Damage</u> The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason and the fact the Foulness SPA/ Ramsar is over 16km from the outlet, an extension (or removal of) the allowable time period for the discharge and/or a change of outlet could have no physical adverse effects on the designated features of the European site.
In combination with other Environment Agency permissions, plans or projects?	No – As discussed in conclusion
In combination with permissions, plans or projects with competent authorities?	As a result of this risk assessment, the Environment Agency can conclude that: (Select one of the following): v) **No Likely Significant Effect** - this application could act in combination with permissions and/or plans/projects of other competent authorities, consultation has been undertaken and our conclusion is as follows This is discussed in the conclusion

Conclusion: **Is there likely to be a significant effect 'alone and/or in combination' on a European site?**	**No** On the 21st of October we wrote to all the other authorities responsible for assessing and licencing plans, projects and operations in the catchment of the Blackwater and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries. The only other planned discharges we know of to be taken into account are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration. The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc The fundamental reason we believe the three effluents will not have any significant adverse affects on the European sites 'in combination' is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. As stated above 'insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three 'insignificant' discharges can combine to become significant. It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharge every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary. Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to have any significant adverse affect on the designated bird species of the European site or on any organisms that form part of their habitats or on which they feed.

	The Environment Agency is minded to: **Issue the permission with conditions to ensure no significant adverse affect on the designated species of the European sitel** <u>Conditions of the permit</u> The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below. <u>Allowing the change to the new outlet</u> The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application. <u>Nitrates limits and the removal of the time limit for the activity</u> The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the European site. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it. This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation

	processes in two years time would be a waste of the resources of both our organisations. Metals limits and safeguards The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone. Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained. With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards. New outlet structure and discharge timing In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above. Self monitoring, recording and reporting The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

	Your agreement is sought on this basis	
EA Officer:	Bill Greenwood	**Date: 29/2/2016**
Natural England/CCW comment on assessment:	.	
Natural England/CCW Officer:		**Date:**
If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).		

Part B **Suggested scope of the EA appropriate assessment**:		
Add details to following framework • Other competent authorities involved • Characterise the site in relation to the qualifying features and their conservation objectives; - existing information - additional surveys - management/unauthorised impacts • Detailed description of plan/project • Assess each likely impact on the interest features; - compare with historical data - predict impacts - compare with impact from management/unauthorised activities • Determine the extent to which each possible impact can be avoided.		
Natural England/CCW comment on scope of EA appropriate assessment:		
Natural England/CCW Officer:		**Date:**

Site map – Outlet and Foulness SPA/ Ramsar highlighted.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(11) Outer Thames SPA

Habitats Directive: Form for recording likely significant effect (Stage 2)	Environment Agency
For consultation	
Part A Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)	
Type of permission/activity:	Environmental Permit (Discharge consent)
Environment Agency reference no:	EPR/DP3127XB/V002
National grid reference:	TL 99650 09150
Site description:	**Trade Effluent Discharge from Bradwell Site, Magnox Ltd, Bradwell-on-Sea, Southminster, Essex CM0 7HP**
Brief description of proposal:	**A MAP OF THE SITE IS PROVIDED AT THE END OF THE DOCUMENT.** The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below) The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge. (13) FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. These processes are designed to remove the radio nuclides within the liquid but they also reduce the concentration of metals. The permit we are consulting on here is for the non-radioactive

	components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. There is a separate permit controlling the release of radionuclides. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included. At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems. Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent <u>if they comply with all the conditions of the existing permit.</u> Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the designated features of any European sites. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet. Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be

	discharged is finite. We have therefore included this issue in our assessment as outlined below. (2) The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded. In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting the appropriate EQS's for substances in the effluent within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted. The new outlet design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants. It is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column. Because the discharge will be only be made on the high waters of the ebbing tide the effluent will be carried outwards and dispersed to the wider outer estuary and sea being diluted along the way. Only residual concentrations will return on the incoming tide. The location of the discharge 400 metres into the central channel where there is always a significant flow and depth of water and being on the ebb tide means that the potential receptors for toxic effect from the metals can only be sub-tidal and downstream. The potential receptors for the harmful effects of eutrophication from nitrates in the discharge are also mainly sub-tidal and

	downstream but there is the possibility of wider effects because the nitrates concentrations are high and have the potential to raise the annual average background concentrations in the fringes of the outer estuary.
European site name and status:	**Outer Thames Estuary SPA (or proposed SPA)**
List of interest features (relevant to this type of permission):	Outer Thames Estuary SPA 3.10 Birds of open sea and offshore rocks (Red-throated diver (3.10) 3.6 Birds of lowland freshwaters and their margins (Red-throated diver (3.6))
Is this application necessary to manage the site for nature conservation?	No

What potential hazards are likely to affect the interest features (relevant to this type of permission?

Sensitive interest feature:	Potential hazard:	Potential exposure to hazard and mechanism of effect/impact if known:
3.10 Birds of open sea and offshore rocks (Red-throated diver (3.10))	Toxic contamination	See detailed assessment below
3.6 Birds of lowland freshwaters and their margins (Red-throated diver (3.6))	Changes in thermal regime	See detailed assessment below
	Nutrient Enrichment	See detailed assessment below
	Salinity	See detailed assessment below
	Toxic contamination	See detailed assessment below
	Turbidity	See detailed assessment below
	pH	See detailed assessment below

Is the potential scale or magnitude of any effect likely to be significant?

Alone?	**No** We do not believe that the proposed changes to the discharge will have any significant adverse affect on the designated species of the European site. The principles of our assessment are outlined below and then each potentially polluting component of the discharge is addressed in turn to explain how we have reached our conclusion. **Key Principles of the assessment** . EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to 1000 or more) to the lowest known toxicity concentration of each substance to any organism to be sure that marginal breaches do not cause any harm. Not

	all hazardous substances have both types of EQS.. We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat or the wildfowl that depend on them. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.** • H1 assessments and modelling in support of the application. The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution. • Acceptable mixing zones and dilution factors Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving

	waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised. In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral. The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone. The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 20 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment. Modellers from our Estuarine and Coastal Monitoring and Assessment Service have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible. • Pathways and receptors The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense

	effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only twenty minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The receptors which could be susceptible to the initial effects of the discharge will therefore only be those that are sub-tidal, in the centre channel of the estuary and downstream of the ebbing tide. Receptors in the intertidal zones and could only be affected by pollutants within the discharge that are in sufficient concentrations to have an adverse effect beyond the initial dilution of the mixing zone. In effect it is only the nitrates within the discharge that are in sufficient concentrations to consider the potential for wider diffuse affects beyond the 100 metre mixing zone. In this case we are using the term 'receptors' to mean all the aquatic organisms that form parts of the overall ecosystem that supports the designated birds species of the European sites as well as the actual birds listed in the citations. The potential for a direct adverse affect on the birds is virtually impossible because they are very unlikely to come into contact with the effluent or its dispersion plume and the concentrations of the pollutants even in the undiluted effluent would not be harmful to them. The potential for a harmful affect on the birds is really only 'indirect' via possible harmful affects on the organisms that make up their food source, or part of the food chain, or the wider habitat. By basing our assessments on compliance of EQS's and maintaining the background water quality regime we are confident that the potential impact on all receptors will be taken into account. **Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will outline them separately for most of the potential polluting component of the discharge** <u>Toxic contamination</u> The only toxic components in significant concentrations within the treated FED effluent discharge are the heavy metals listed in table 1 below. (35) Extending the time period or removing it completely Table 1 (End of Document) shows the maximum concentration of metals in the effluent from the FED treatment plant including periods when the NOX scrubber liquor form part of the influent. The table also shows the relevant EQS concentrations which apply in estuarial waters as annual average (AA) figures and maximum allowable concentrations (MAC's). In the original application for the existing permit HR Wallingford's modelling report demonstrated to our satisfaction that all the EQS's for metals would be met within 100 metres of the discharge point and that there would be no

	deterioration above 10 % in the existing background concentrations of individual metals within the estuary outside this mixing zone. It also showed that these low levels of deterioration did not pose a threat to the existing Blackwater and Colne Estuaries Water Framework Directive (WFD) classification for metals. Keeping within 10% deterioration and WFD targets conforms to the Agency's 'no deterioration' guidelines for deciding if individual discharges are allowable. We considered that such small increase on the background levels of pollutants could not have any significant adverse affects on interest features, especially as it was a temporary discharge. This metals assessment was part of the overall impact assessment which led us to recommend to you the granting of the existing permit. We believe that the assessment is still valid which is why we have allowed the discharge to continue within the limits of the existing permit whilst we re-examine all the issues and consider the request for the outlet change. Because the FED operation is limited to treating a <u>finite</u> amount of waste material, and because it is was only 10% complete at the time of this application, extending the allowable time period for a further 24 months does not pose any additional risk to the interest features of the conservation areas. Spreading the finite load of metals over a longer period means that any potential increases in background concentration of metals within the receiving waters over that period will be proportionately lower. If the discharge was evenly spread over 24 months for instance any increases in background concentrations would obviously be halved. Extending or removing the time limit for the activity would make no difference to meeting the MAC EQS's on any one day of discharge but it will help to meet the EQS targets that are annual averages. Preventing the breach of MAC EQS's will be achieved by pre-dilution as demonstrated in the original impact assessment. For these reasons we do not believe that allowing an extension to the time period or removing it completely will have any affect on the interest features of the SSSI if the existing outlet is used. (36)Change of outlet As stated above in the first application HR Wallingford's modelling demonstrated to our satisfaction that beyond 100 metres of the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached and (2) any increase in the existing background concentrations of each metal in the estuary above 10%. Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect average deterioration

	levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the designated features of the conservation areas we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's As sated above, HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and that this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone. MAC EQS's The table above shows that the highest dilution needed to reduce the concentrations of any of the substances in the discharge to below their respective MAC EQS's is 74:1 for mercury and that there is 240:1 dilution available within the mixing zone. But this does not take account of the existing background concentrations which are more significant for assessing MAC EQS's because the dilution available for them is very much lower than for AA EQS's Because of this the applicant calculated what increases the effluent would cause in the existing background concentrations in the estuary on the edge of the mixing zone and what proportion of the EQS would be taken up at that point as a result of a discharge from the new outlet. The last column of Table 8 on page 15 of their report 'BRAD/EN/REP/130/FED (issue 3)' which we supplied to you illustrates that the highest percentage of a MAC EQS taken up is 45% for mercury. The highest figure for any other substance is 5% for iron. There is therefore a margin of 55% to be exceeded before the MAC EQS most at risk would be breached outside the mixing zone. Given that there are safety factors built into EQS's we are confident that a discharge from the outlet would not have a toxic effect on any organism outside the mixing zone. The potential for a toxic effect even within the mixing zone is still low because the 240:1 dilution factor applies only to the first few minutes of the 20 minute discharge window

	and because MAC EQS's are based on the toxic effects of substances on organisms that are continuously exposed to it over several hours. With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. • Conclusion – Toxic effects The potential for any of the designated bird species of the European site to be harmed by the toxic components in the treated FED effluent (from the existing outlet, or the new one) is limited to the 100 metre mixing zone within the receiving Blackwater Estuary. Outside this there will be no measurable change to the background water quality regime with regard to heavy metals. The Outer Thames Estuary SPA is over 4.5km from the point of discharge. This means that there would be no threat to any of the aquatic organisms that form part of the ecosystem for the designated birds including the shellfish and invertebrates that are their food source. The metals from the discharges will not be toxic in the short or long term to these and, if the changes in background concentrations of each metal in the water column outside the mixing zone is insignificant, there can be no significant change to the rates of accumulation of the metals in sediments or bio-accumulation in shellfish etc. In other words the discharge could not cause a significant increase in the existing metal loads in the sediments on the bed of the estuary outside the 100 metre mixing zone. Even within the mixing zone the risks of harm to the designated bird species from the discharge through either the old or new outlets are extremely low. This is because both outlets are below the lowest tides and discharges through both would be made at high water periods. Together with the fact that the FED effluent is denser than sweater and will sink this means that the mixing zones for both are always sub-tidal and deep in the water column. The plume of mixing effluent and water within which EQS's are exceeded will, therefore, always be deep below the surface and the only way in which a bird could come into contact with it would be if it was diving for some reason. Such limited exposure would not be sufficient to cause them harm and given that the discharge is intermittent and last only 20 minutes a day repeated exposure to individual birds is unlikely. Any food consumed from the water column of the mixing zone would also have had limited exposure and so bio-accumulation of metals from the FED effluent within individual birds is also extremely unlikely.

	<u>Nutrient Enrichment</u> (37)Extending the time period The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it has the potential to have an effect on the receiving estuary. This was outlined in the original permit application which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The model showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two. The annual average nitrates concentration is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be significant enough to risk causing any adverse biological response within the Blackwater Estuary conservation sites and therefore definitely not the Outer Thames Estuary SPA which is further away from the outlet. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat. At the time we were also aware of information in the Agency's 'review of consents' and appropriate assessment for the Habitats Directive requirements which fed into the Blackwater Estuary Site Plan in 2009. This report outlines that the only potential for an adverse effect on the designated species of the European sites was the possibility that increased nitrates could increase the growth of algal mats in the estuary which could theoretically, (a) physically prevent the birds feeding on invertebrates or (b) would interfere with the habitat of the invertebrates, causing a reduction in their numbers and therefore a reduction in the bird's food source. However the site plan report concluded that there was no evidence that algal mats do interfere with birds feeding or cause a reduction in invertebrate numbers. The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of the Blackwater SSSI or the other SSSI's adjacent and this was the basis on which we obtained your assent to issuing the original permit in December 2011. The same principles still apply but the changes of time period requested in the variation may lower any potential

	risks to the conservation areas if the discharge is spread over a longer time. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating a 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved. This is the reason we issued the enforcement letter allowing the discharge to continue under the control of the existing permit whilst we consider the overall changes to the permit the applicant has requested. (38)Change of outlet Changing to the new outlet could change the way it initially disperses in the estuary but would not change the overall increase in the background AA nitrates concentrations within it. The load of nitrates to be discharge remains the same so the potential increase in background nitrates concentrations would still not exceed 10 %. This is basic way of assessing the risk but the new (updated) modelling exercise undertaken by HR Wallingford provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points within the estuary discharging from the new outlet would cause. It showed that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone. In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because, (i) they have information and tools for WFD assessments not available to the applicant or their consultant, (ii) the discharge potentially threatens WFD targets within the estuary which the Agency is responsible for (iii) some of our WFD targets are incorporated in Natural England guidelines for MCZ's which we need to address as well as SSSI's and (iv) the outer Blackwater Estuary has been downgraded in WFD classification bands in the last four years from Good to Moderate because of failures of the dissolved inorganic nitrogen (DIN) standard and we want to be sure that allowing the discharge would not threaten a restoration to Good status in the future if this is practical. Our ECMAS team's assessment included a consideration of the dispersion pattern of the effluent and the resulting increases in background concentrations of nitrates including the residual concentrations of nitrates returning on the incoming tides. They utilised a tool that predicts possible biological responses to nitrate increases such as blooms of macro algae and phytoplankton which could be harmful to some of the designated species or their habitat.

	They concluded that the continuation of the discharge and the change to the new outlet would not threaten existing WFD targets or cause harmful biological responses from the effects of the limited increases in background nitrate concentrations. Their analysis did however produce a recommendation to change to discharge timings. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We therefore minded to incorporate this restriction in the permit. • Conclusion – Nutrient Enrichment The only potential for the nitrate load of the discharge (through the new or old outlet) to have any significant affect on the designated birds species is for it to cause significant enough increases in the existing background concentrations of nitrates within the Outer Thames Estuary SPA to cause blooms of macro algae that would hinder some of the designated birds feeding regime. Theoretically macro algae ‘ mats’ in the estuary could physically prevent some birds accessing food underneath or even prevent the species that constitute suitable food from growing at all in parts of the estuary. Our Site Plan report of 2009 disputed this theory but for this assessment we are relying more on the additional modelling undertaken by our ECMAS team of the potential impacts of the nitrates load of the discharges. Their conclusion was that the FED effluent does not have the potential to cause significant increases in macro-algae blooms within the Blackwater Estuary SPA/ Ramsar or in any areas outside it including the areas of the Outer Thames Estuary SPA which is more remote from the discharge. This is largely because of other physical background conditions in the estuary such as high turbidity which are limiting.. Our overall conclusion is that there would be no significant adverse effect on the designated bird species of the European site from the discharge of treated FED effluent through the old or new outlet if we granted a permit for them. Because the overall load of nitrates discharged is from a finite source we also see no reason to time limit the discharge from either outlets in the future. If the discharge is made over a longer period that has been requested the potential increases in annual average background concentrations of nitrates in the Outer Thames Estuary SPA, and beyond, will be lower each year proportionate to the extra time taken to complete the operation. <u>Changes in the thermal regime</u>

	(21) Extending or removing the time limit The FED process is exothermic so a treated FED discharge is always likely to be above the ambient temperature of the receiving waters. However the minimum pre-dilution of 50:1 in abstracted seawater and the massive dilution available in the estuary means that the discharge could not have any effect beyond a limited mixing zone. The average volume of water in the Blackwater estuary is estimated to be 106,300,000 m3. For the original application the applicant's consultants HR Wallingford modelled the impact of the discharge on temperatures in the estuary and concluded that it had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 ^{o} C in summer and 0.3 ^{o} C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 ^{o} C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the Outer Thames Estuary SPA. There can be no direct effect on the designated bird species of the European site from these changes in temperature and if there is no affect on the supporting flora and fauna of the supporting ecosystem there can be no indirect affect either. As long as the existing outlet is used we therefore believe that there is no reason to deny an extension of the time period or remove it altogether on temperature grounds. (22) Changing to a new outlet The new outlet was designed by the applicant's consultant to achieve dispersion characteristics that would achieve the same levels of dilution within the same sized mixing zone based on updated modelling they undertook for the first application. Our ECMAS team have verified the modelling inputs and outputs and on this basis we are confident that using the new outlet will not pose any greater risk to the designated features of the conservation area than the old one with regard to temperature effects and that there is no reason to limit the time for the activity in any way. <u>pH</u> The FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. This falls within the Agency's standard pH range for controlling discharges to prevent harm to aquatic life of 6 to 9. There is no WFD target for pH in marine waters. The only pH target in marine waters is 7 to 9 under the EC directive for the protection of shellfish for human consumption. This does not strictly apply to conservation sites but is worth some consideration. (21)Extending the time period

	The minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge and so there is therefore no reason not to allow an extension to the time period or to remove it entirely on the grounds of potential pH effects. (22)Change of outlet Changing to the new outlet will remove the pre-dilution but any discharge at pH 6 would have a very limited zone of influence around the discharge point. The absolute minimum dilution factors calculated by HR Wallingford of 240:1 for the first few minutes of the discharge at 100 metres from the discharge point means that the pH will be buffered to 7 very quickly within the mixing zone. For these reason we do not believe that allowing the new outlet to be used or extending (or removing) the time limit for the activity would significantly change the existing background pH regime beyond the mixing zone and that there could be no significant affect on shellfish which could be a food source of the designated birds of the European site. Turbidity The filtration and absorption processes within the abatement plant mean that the FED discharge will virtually eliminate suspended solids. For this reason an extension or removal of, the allowable time period for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to turbidity in the receiving estuary waters. Salinity The treated FED effluent is not saline and is too small a volume to have any effect on the background salinity regime within the receiving estuary. For this reason an extension to the allowable time period (or removal of it) for the discharge and/or a change of outlet can have no adverse effect on the designated features of the European site from any changes to the existing background salinity regime. Physical Damage The treated FED effluent is too small in volume to have any physical effect on the features of the receiving estuaries. It has a maximum daily volume of 20 m3 and the average volume of water in the Blackwater Estuary alone is 106,300,000 m3. The new outlet is a small nozzle 5.5 metres above the estuary bed and the discharge will rapidly mix with the background currents without influencing them. For this reason and the fact the Outer Thames Estuary SPA is over 4.5km from the outlet, an extension (or removal of) the allowable time period for the

	discharge and/or a change of outlet could have no physical adverse effects on the designated features of the European site.
In combination with other Environment Agency permissions, plans or projects?	No – As discussed in conclusion
In combination with permissions, plans or projects with competent authorities?	As a result of this risk assessment, the Environment Agency can conclude that: (Select one of the following): vi) **No Likely Significant Effect** - this application could act in combination with permissions and/or plans/projects of other competent authorities, consultation has been undertaken and our conclusion is as follows This is discussed in the conclusion

Conclusion: **Is there likely to be a significant effect 'alone and/or in combination' on a European site?**	**No** On the 21st of October we wrote to all the other authorities responsible for assessing and licencing plans, projects and operations in the catchment of the Outer Thames Estuary SPA and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries. The only other planned discharges we know of to be taken into account are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration. The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc The fundamental reason we believe the three effluents will not have any significant adverse affects on the European sites 'in combination' is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. As stated above 'insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three 'insignificant' discharges can combine to become significant. It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharge every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary. Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to have any significant adverse affect on the designated bird species of the European site or on any organisms that form part of their habitats or on which they

	feed. **The Environment Agency is minded to:** **Issue the permission with conditions to ensure no significant adverse affect on the designated species of the European siteI** <u>Conditions of the permit</u> The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below. <u>Allowing the change to the new outlet</u> The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application. <u>Nitrates limits and the removal of the time limit for the activity</u> The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the European siteI. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it. This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the

	resources of both our organisations. <u>Metals limits and safeguards</u> The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone. Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained. With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards. <u>New outlet structure and discharge timing</u> In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above. <u>Self monitoring, recording and reporting</u> The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

<table>
<tr><td></td><td colspan="2">Your agreement is sought on this basis</td></tr>
<tr><td>EA Officer:</td><td>Bill Greenwood</td><td>Date: 29/02/2016</td></tr>
<tr><td>Natural England/CCW comment on assessment:</td><td colspan="2">.</td></tr>
<tr><td>Natural England/CCW Officer:</td><td></td><td>Date:</td></tr>
<tr><td colspan="3">If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).</td></tr>
<tr><td colspan="3">Part B Suggested scope of the EA appropriate assessment:</td></tr>
<tr><td colspan="3">Add details to following framework
• Other competent authorities involved
• Characterise the site in relation to the qualifying features and their conservation objectives;
- existing information
- additional surveys
- management/unauthorised impacts
• Detailed description of plan/project
• Assess each likely impact on the interest features;
- compare with historical data
- predict impacts
- compare with impact from management/unauthorised activities
• Determine the extent to which each possible impact can be avoided.</td></tr>
<tr><td colspan="3">Natural England/CCW comment on scope of EA appropriate assessment:</td></tr>
<tr><td>Natural England/CCW Officer:</td><td></td><td>Date:</td></tr>
</table>

Site map – Outlet and SPA highlighted.

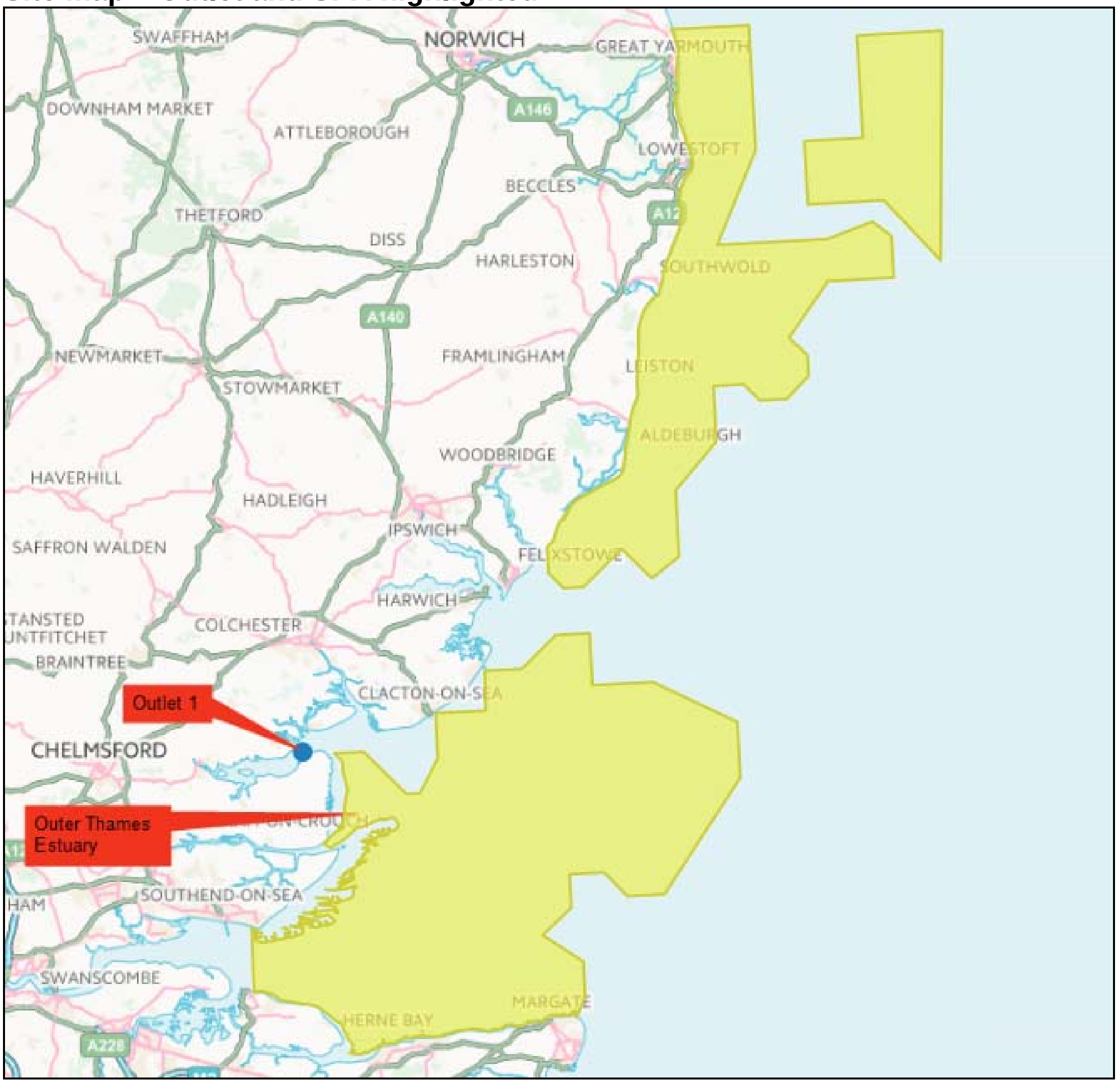


Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

(12) Essex Estuaries SAC

Habitats Directive: Form for recording likely significant effect (Stage 2)

Environment Agency

For consultation

Part A

Permitting officer to complete this section in consultation with Conservation/Ecology section and Natural England/Countryside Council for Wales (CCW)

Type of permission/activity:	Discharge Consents
Environment Agency reference no:	EPR/DP3127XB
National grid reference:	TL 99650 09150

Habitats Assessment for an application to vary an EPR 'water discharge activity' permit EPR/DP3127XB.

Essex Estuaries SAC
(Based on the N.E. documents Conservation advice for Marine Conservation Zone: Essex Estuaries a draft copy of the 'Supplementary advice on conserving and restoring site features' for this SAC)

Name of EA Permitting Officer Bill Greenwood, National Permitting Service, Nottingham Permitting Centre

Date for Environment Agency permit determination 31/3/2016

Predicted 28 day date for NE response 28/3/2016

Date of submission of assessment 29/2/2016

Operator - Magnox Ltd, former nuclear power station site, Bradwell on Sea, Essex.
Discharge – Max 130 m3 a day (in dry weather) of mixed effluents (see below) (NGR - TL 99650 09150

Format of the Assessment Report
A condensed specification of the Conservation Objectives (CO's) is given below followed by a brief

background to the proposed discharge and details of its volume and contents. Below this is an explanation of how we have assessed the potential for the polluting elements of the discharge to have an adverse affect on the designated features of the site and whether it would interfere with the relevant CO's. Finally there is a conclusion section explaining our 'minded to' permitting position.

Discharge – Max 20 m3 a day of treated 'FED' effluent

Component SSSI sites – Colne Estuary SSSI, Blackwater Estuary SSSI, Dengie SSSI, Foulness SSSI, Crouch and Roach Estuaries SSSI, The Cliff, Burnham On Crouch SSSI, Blackwater Estuary SSSI
Overlapping SPA/Ramsar sites – Colne Estuary(Mid-Essex Coast Phase-2), Blackwater Estuary (Mid-Essex Coast Phase-4), Dengie (Mid-Essex Coast Phase-1) Foulness (Mid-Essex Coast Phase-5), Crouch and Roach Estuaries (Mid-Essex Phase-3)

Overlapping MCZ's – Blackwater, Crouch, Roach and Colne Estuaries MCZ

Qualifying features and subfeatures
(1) Estuaries
This feature is the major estuaries of the Blackwater, Colne, Crouch and Roach as well as extensive open coast tidal flats at Foulness, Maplin and the Dengie
(1a) Intertidal rock
This subfeature has been indentified at a series of locations throughout the estuaries.
(1b) Sub-tidal mixed sediment
This subfeature has been identified in the upper reaches of the Blackwater estuary and from its midpoint to the estuary mouth. Also at the east side of the Colne estuary.
(1c) Subtidal mud
This subfeature is widely distributed throughout the site
(2) Mediterranean and thermo – Atlantic halophilus scrubs
This feature comprises 1.36 % of the saltmarshes of the Essex Estuaries site.
(3) Mudflats and sandflats not covered by sweater at low tide
This feature occurs throughout the site including in the Colne, Blackwater, Crouch and Roach estuaries and in the Maplin Sands, Foulness and Dengie.
(3a) Intertidal coarse sediment
This subfeature has been identified in the Blackwater estuary near West Mersea, in the Haybridge Basin, and west of Ramsey Island
(3b) Intertidal mixed sediments
This subfeature has been identified in the upper reaches of the Blackwater and also the east of Osea and on the north back of the Crouch upstream of Burnham.
(3d) Intertidal mud
This subfeature is abundant in all four estuaries of the site. It is present in the intertidal areas of the south and north banks of the Crouch, the Dengie Flats near Bradwell and west of Brightlingsea.
(3e) Intertidal sand and muddy sand
This subfeature is present at the northern and southern ends of the Maplin Sands the south bank of the outer Crouch and the upper reaches of the Blackwater estuary. Also in the Dengie Flats near Tillingham Marshes and near Bradwell
(3f) Intertidal seagrass beds
Recent records show this subfeature occurring both on the Maplin Sands and inside the MOD range at Shoeburyness
(4) Salicornia and other annuals colonising muds and sands
This feature can be found at most saltmarsh sites within the Essex Estuaries SAC.
(5) Spartina swards
This feature was identified in the following locations on the southern bank of the Blackwater estuary, from Maldon around to Maryland Creek near to Steeple, at Mundon Stone Point, Osea Island, in the bay north of Decoy point between Foulness Point down to Eastwick Head.
(6) Non –qualifying feature present: Sandbanks which are slightly covered by sea water all the time.
(6a) Subtidal coarse sediment
This subfeature is present in the mouth of the River Crouch

(6b) Subtidal sands

This subfeature is present in the mouth of the Colne and upper parts and mouth of the Crouch estuary. Also on the southern tip of Buxey Sand between the Ray Sands and Foulness Sands

(6c) Subtidal seagrass beds

This subfeature has been identified on sheltered muddy sands on Maplin Sands

Conservation Objectives

The site's conservation objectives apply to the Special Area of Conservation and the natural habitat and/or species for which the site had been designated ("Qualifying features)

The objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored, as appropriate, and that the site contributes to achieving the 'Favourable Condition Status, of its qualifying features by maintaining or restoring:

- the extent and distribution of qualifying natural habitats and habitats of the qualifying species
- the structure and function (including typical features) of qualifying natural habitats
- the structure and function of the habitats of qualifying species
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely
- the distribution of qualifying species within the site

Definition of favourable condition

For each protected broad-scale habitat:

(1) The extent is stable or increasing and

(2) Its structure and functions its quality, and the composition of its characteristic biological communities (including diversity and abundance of species forming part or inhabiting the habitat) are sufficient to ensure that its condition remains healthy and does not deteriorate.

Any temporary deterioration in condition to be disregarded if the habitat is sufficiently resilient to enable recovery

For each species of marine fauna:

That the population within a zone is supported in numbers which enable it to thrive by maintaining :

(1) The quality and quantity of its habitat and

(2) The number, age and sex ratio of its population

Relevant Attributes and Targets

The relevant ecological characteristics (**attributes**) of the designated species and habitats and the appropriate water quality conditions (**targets**) that are necessary to safeguard them to meet the Conservation Objectives (CO's) for the SAC are listed in groups below By 'relevant' we mean that these are the attributes that could potentially be threatened by the contents of the proposed discharge. An example of non-relevant target for this discharge is, "Reduce the introduction and spread of non native species and pathogens and their impacts". This isn't relevant because the permit is to allow a discharge of trade effluent not to allow some form of shell fishery operation. Another example is, "Maintain the total organic carbon (TOC) content in the sediment at existing levels." This isn't relevant because the discharge does not contain any TOC.

Listing the appropriate targets to safeguard the CO's of the SAC's and grouping them into common types helps to condense this report, avoid too much repetition and focus on the essential issues.

The common attributes (supporting processes and structures) and targets for the above qualifying features and subfeatures are :

(1) Physio-chemical properties

Maintain the natural physio chemical properties of the water - Temperature, pH and salinity.
(2) Water quality i.e turbidity

Maintain natural levels of turbidity (eg concentrations of suspended solid particulates .plankton and other material across the habitat. Turbidity levels can rise and fall rapidly as a result of biological (e.g. plankton blooms) physical (e.g. storms) or human (e.g. coastal development) factors.
(3) Water quality contaminants

Reduce aqueous contaminants to levels equating to Good Ecological Status according to WFD. Specifically mercury and its compounds and avoiding deterioration from its existing levels. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which several heavy metals were recorded as being above Effects Range Low (ERL) threshold. The only heavy metal which may adversely impact aqueous contaminants recorded above the ERL was Mercury in the upper reaches of the River Crouch.
(4) Sediment contaminants

Reduce surface sediment contaminant levels to concentrations that are not adversely impacting on the infauna of the feature
Restrict surface sediment contaminants levels to concentrations where they are not adversely impacting on the infauna of the feature. Various heavy metals are known to affect the species that live in or on the surface of the sediments. These include Hg, As, Zn, Ni, Ch, Cd, etc. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which several heavy metals were recorded as being above Effects Range Low (ERL) threshold.
Reduce surface sediment contaminants (<1cm from the surface) to below the OSPA Environmental Assessment Criteria (EAC) or ERL threshold. Various heavy metals are known to affect the species that live in or on the surface of the sediments. These include Hg, As, Zn, Ni, Ch, Cd, etc. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which several heavy metals were recorded as being above (ERL) thresholds.

Background to the application
The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below)
The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge.

(14)
FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. These processes are designed to remove the radionuclides within the liquid but they also reduce the concentration of metals. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH. Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The

NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres. The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included
At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems.
Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent if they comply with all the conditions of the existing permit. As such all of the permit conditions still apply and are enforceable. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the conservation areas. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet.
Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below.

(2)
The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded.
In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted.
The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants.
The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column.

Key aim and principles of the assessment
The key aim of our assessment has been to determine whether the proposed discharge would cause any direct harm to any of the designated features within the SAC or whether it would prevent them being in 'favourable condition' as defined above. We have therefore tried to asses whether the

proposed discharge would prevent the features spreading and colonising new areas as well as whether it would harm them in their current locations. To assess the potential impact on the designated features in known locations we have used the standard ''pollutant – pathway- receptor ' approach. To assess whether the discharge could prevent the spread of features into new areas we have considered what the spatial zone of adverse affect the discharge could have within the receiving Blackwater Estuary and beyond.

The polluting elements of the discharge that are in sufficient strength in the effluent to potentially cause harm within the SAC are , nitrates, several heavy metals, pH, and temperature and by 'receptor' we mean any aquatic flora or fauna or physical feature that is designated or forms part of the overall habitat of a designated feature.

The criteria we have used for determining ''polluting strength' and the potential for causing harm are the relevant environmental quality standards (EQS's), WFD targets and existing background water quality in the receiving waters. The evidence for the predicted pathways the discharge will take within the receiving waters, and the dilutions it will be subject to, come from modelling exercises undertaken by the applicant's consultants HR Wallingford. These have been vetted by members of our Estuarine Coastal Monitoring and Assessment Service (ECMAS) team and after some clarification the main results accepted. The modelling results also provide evidence of the spatial zone of potential adverse affect the discharge could create within the receiving estuary and beyond.

Fundamentally Magnox's application is based on the contention that outside an 'acceptable' limited mixing zone the effluent will always be sufficiently diluted to meet the relevant EQS's for metals and prevent more than a 10% deterioration in the existing, background levels of nitrates or a breach of any WFD targets. We have analysed their evidence and done some further work of our own to see if their conclusions are correct and whether meeting these criteria would protect the SAC. A more detailed explanation of the key principles are given below followed by sections on how they apply to the relevant attributes and targets that safeguard the conservation objectives.

- Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure hat marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat. The EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

- H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the initial screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well. The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

- Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.
In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.
The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.
The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.
Modellers from our ECMAS team have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

- Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only 30 minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. The features of the inner Blackwater, and the Colne estuary and those of the flats of the Dengie and Foulness SSSI's would not be affected by the discharge because the pathway of the dispersed effluent would not reach them. The features of the Crouch and Roach estuaries are too distant from the discharge to be affected.

A conservative estimate of the size of the initial mixing zone (as calculated in HR Wallingford's modelling) is that it would be 100 metres long, 20 metres wide and 2 metres deep and that it would sink to make contact with the estuary bed after approximately 40 metres. The receptors that would be susceptible to the initial affects of the effluent before it is diluted are therefore only those that are sub-tidal and within this zone of 4,000 m3 extending 100 metres from the discharge point. The only qualifying feature within this zone is ' sub-tidal mud '. Natural England report that there is 7758.65 hectares of sub-tidal mud within the SAC.

We consider that a 100 metre long mixing zone of 4,000 cubic metre volume that would only allow an impact on a very small portion of the overall SAC habitat and features is ‘acceptable’ in this case.

Assessment of possible impacts on attributes and targets

Incorporating the principles and information given above our assessment of the potential for the discharge to impact on the relevant attributes and targets (listed above) which safeguard the CO’s of the SAC are addressed below in turn. Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will explain the ramifications for both.

(1) *Physio-chemical properties*

Maintain the natural physio chemical properties of the water - Temperature, pH and salinity.

Extending the time period and using the existing outlet

The potential of the discharge to have any affect on the natural, background physio-chemical properties of the overall area of the SAC are extremely limited because it is a very small volume in relation to the volumes of water that flow within the receiving Blackwater Estuary. The discharge is a maximum of 20 m3 a day and the estuary has an average volume of 106,300,000 m3. Whilst the existing outlet is used there is also the additional buffer of the minimum pre-dilution of the effluent of a minimum 50:1 in abstracted seawater.

With regards to temperature in the original application HR Wallingford’s modelling estimated that the discharge (which has a raised temperature because the FED process is exothermic) had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the receiving estuary including the native oysters.

With regard to pH the FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. There is no WFD target for pH in marine waters but there is a pH target in the EC Directive for the protection of shellfish for human consumption of 7 to 9. This does not strictly apply to conservation sites but the minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge. So there would be no risk to any aquatic flora or fauna including native oysters from the discharge continuing from the existing outlet.

With regard to salinity the discharge is non-saline and too small to make any change the existing background salinity in the receiving estuary even if it was not pre-diluted in seawater.

For these reasons we can be confident that the discharge from the existing outlets would have a very limited zone of potential adverse affect. It would be confined to 100 metre from the discharge point downstream on the ebbing tide. Outside this the existing background physiochemical conditions would be maintained. There would be no adverse affect on any designated features outside the mixing zone and no hindrance to colonisation by designated features outside it.

Changing to the new outlet

As stated above in the ‘acceptable mixing zones and dilution factors’ section the modelling provided by the applicant’s consultants predicted that there was an absolute minimum dilution available for the effluent of 240:1 within the mixing zone. This is the dilution available over the first few minutes of the 30 minute discharge at high water on the lowest tide with the slowest current. The minimum average dilution for the full range of tides and currents is 1000:1 over the 30 minutes of the discharge and it is therefore 48,000 :1 over 24 hours.

These levels of dilution are more than enough to reduce the temperature and pH of the discharge to the background levels in the receiving waters outside the mixing zone and prevent any affect on any aquatic life, including native oysters. Because the discharge is very small and non-saline it also could not change the background salinity regime even within the mixing zone.

For these reasons we do not believe that allowing the discharge to take place from the new outlet (without pre-dilution) and allowing an extension to the time limit, or removing it completely, would change the existing background physio-chemical properties of the discharge outside the mixing zone. The targets and attributes would be maintained and the CO’s safeguarded.

(2) *Water Quality i.e Dissolved Oxygen*

Maintain the DO to levels equating to Good Ecological Status. Excessive nutrients and/or high turbidity can lead to a drop in DO.

Extending the time limit and using the existing outlet

The treated FED effluent is virtually devoid of suspended solids because ultra-filtration is part of the treatment processes so it can not have any effect on turbidity levels within the receiving waters. So the only way it could have an effect on DO levels in the estuary would be by significantly raising background nutrient levels in the estuary waters which could lead to excessive plant growth within it. Extra plant growth could lead to extra DO being stripped from the water at night by respiratory processes of the plants, or by the respiratory processes of bacteria breaking down organic matter. Sometimes after phytoplankton blooms have reached there peak and died back there are localised DO sags from the increased activity of bacteria breaking down the dead phytoplankton cells.

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it does have the potential to have an effect on the receiving estuary. This was outlined in the original permit application in 2011 which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The modelling showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two.

The annual average nitrates concentration in rivers and transitional waters is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses such as excessive plant growth within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be a significant to risk causing such an adverse response in the 'Blackwater and Colne' estuaries in 2011. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of any of the conservation areas within the vicinity of the discharge in 2011 and this was the basis on which we obtained your assent to issuing the original permit in December 2011. At that time the SAC's had not been designated and the conservation advice not formulated.

Since 2011 the 'Blackwater', 'Blackwater Outer' and 'Colne' estuary have met the necessary DO concentrations to achieve the SAC CO's. In the last three years the 'Blackwater' has been 'Good', 'High' and 'High' for DO the 'Blackwater Outer' has been constantly 'High' and the Colne constantly 'Good. The Crouch estuary has also been Good although it is too remote to be affected by this discharge.

In the overarching WFD classification criteria none of the classified water bodies within the SAC have achieved Good Ecological Status. All of them are currently classified as 'Moderate'. But this has been due to dissolved inorganic nitrogen (DIN) concentrations failing 'Good' standard. A failure of any of the key standards that make up the overall classification causes a failure of Good Ecological Status even if all the other standards achieve it easily.

For this new application (to justify the ongoing discharge and the use of the new outlet) Magnox have provided an updated modelling exercise undertaken by HR Wallingford which provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points. It confirms that there would be no breach of the Agency's 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant's impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because they have information and tools for WFD assessments that are not available to the applicant or their consultant. Their modelling tools can predict the effects on DIN concentrations and the potential for adverse biological responses such as blooms of macroalgae or phytoplankton and how these will impact WFD targets. Using these tools they concluded that the increases in nitrates concentrations caused by the FED effluent discharge would not lead to harmful increases in plant growth and that the current WFD classifications would be maintained everywhere within the range of influence of the dispersed FED plume.

The updated modelling and the extra analysis undertaken by our ECMAs team has give us extra confidence that the nitrates in the FED estuary will not have an adverse affect on the designated features of the SAC outside the 100 metre mixing zone. This is the case if the FED operation was undertaken over just one year and if the operation is delayed and takes longer the risks would be lessened. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved.
On this basis we believe that the zone of potential adverse affect the discharge would cause from its nitrates load would still be limited to the 100 metre mixing zone. Outside this the increases in background nitrates concentrations in the receiving estuary would be restricted to within 10% and this would not create harmful biological responses in the form of excessive plant growth. We are confident that outside the mixing zone there would be no harm to any designated features in their current locations and that the discharge would no prevent the spread or colonisation of features into new areas.
On this basis we see no reason to deny the application to extend the time limit for the activity or to remove the time limit completely. If the discharge takes place over a longer period any increases in the background annual average nitrates concentrations will be lower proportionate to the time taken.

Changing to the new outlet

Changing to the new outlet will change the way it initially disperses in the estuary because there will no longer be any pre-dilution and the effluent will be made from a much smaller outlet higher in the water column. But the higher outlet will allow better mixing in the water column as the dense effluent sinks and the change will not make any difference to the load of nitrates being discharged. So the potential increase in background nitrates concentrations outside the mixing zone would still not exceed 10 %. The updated modelling exercise undertaken by HR Wallingford demonstrates that this is the case and that the supplementary modelling undertaken by our ECMAS team gives us further confidence that the change to the new outlet would not cause excessive plant growth that would threaten existing D.O. concentrations in the inner, or outer, sections of the Blackwater Estuary or beyond them.

The ECMAS analysis did however produce a recommendation to change the discharge timings. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. .A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We are therefore minded to incorporate this restriction in the permit.
On this basis we are confident that allowing the discharge to be made from the new outlet and extending the time limit , or removing it completely, would not threaten the targets or attributes of the SAC's and that the CO's would be maintained.

(3) Water quality i.e nutrients

Recover the natural water quality and specifically winter dissolved inorganic nitrogen (DIN) to Good Ecological Status concentrations avoiding deterioration from existing levels.

Extending the time limit and using the existing outlet

The existing DIN concentrations in the Blackwater estuary and beyond could obviously be affected by the nitrates concentrations within the treated FED effluent because nitrates contain inorganic nitrogen. As part of the modelling exercise undertaken by our ECMAS team, mentioned above, they therefore included an analysis of the potential impacts upon DIN concentrations in the estuary. This was crucial because it is the DIN concentrations that are the cause of the current reporting of the Blackwater, Blackwater Outer and Colne WFD water bodies as 'Moderate' and failing Good Ecological Status even though they are Good or High for other WFD parameters. Currently the Colne, Blackwater and Blackwater Outer are reported as Moderate. The Crouch and Roach estuaries are too remote to be affected by this discharge.

The conclusions of our ECMAS team from their modelling work were;

- the effects of the discharge would be limited to the Blackwater estuary there would be no affect on the Colne estuary because of the dispersion pathway
- the discharge would not cause significant deterioration in existing DIN concentrations in the Blackwater or Blackwater Outer
- these sections would maintain their current classifications
- limiting the discharge to a daytime ebbing tide and to two hours after the high water point would be advantageous.

Based on the above we are confident that allowing the discharge to continue from the existing outlet and extending, or completely removing, the time limit for the activity would not cause a significant difference to the existing background concentrations of DIN in either of the WFD classified sections of the Blackwater estuary or in the Colne estuary. The Crouch and Roach estuaries which are over 14 kilometres away are too remote to be affected. Our analysis is based on the worst case scenario of discharging over one year and if it takes any longer the increases in annual background concentrations of DIN will obviously be proportionately lower.
If we granted the permit it would not help to meet a ‘Recover’ target because allowing any extra input at all can not achieve this. But it would ‘Maintain’ the existing DIN concentrations to levels that would not cause a significant adverse affect on any designated features in their current locations or prevent the colonisation or spread of them into new areas. Although it would not help to achieve a ‘Recover’ target it would not prevent future possibilities of achieving this if it is practical. The current assessment of our ECMAS team is that the dominant factor in failures of the nutrient targets within the SAC is diffuse inputs from the sea outside it which contribute the majority of the nutrient loads within the estuaries.

Changing to the new outlet

Changing the discharge to the new outlet would change the way the effluent initially disperses within the 100 metre mixing zone but it would not change its impact as described above. The zone of potential adverse affect would still be limited to the 100 metre mixing zone and beyond this it would not have the potential to harm a designated feature in SAC or prevent the spread of one into new areas. A change of outlet would not help to meet the ‘Recovery’ target but it would not hinder ‘Maintaining’ current levels of DIN or prevent a ‘Recover’ at a later time if this is possible. The longer the FED operation takes the lower the proportional increases in background concentrations in DIN will be in the receiving waters. In addition because the discharge is ultimately temporary, it can not have a permanent affect on any target or attribute of the SAC’s.

(4) Water quality i.e turbidity

Water turbidity as a result of material suspended in the water including sediment, plankton, pollution or material washed into the estuary from the land.

Extending the time limit and using the existing outlet

Because the treatment of the FED effluent involves ultra filtration processes it will be virtually devoid of suspended solids. The only way it could affect turbidity therefore is if the nutrients in the discharge caused blooms of phytoplankton.

As stated above our ECMAS team undertook a modelling exercise which included an assessment of whether the nitrates within the FED discharge would cause extra growth of plants within the receiving waters. This analysis included the potential for causing extra blooms of phytoplankton. The ECMAS team concluded that there was no risk of extra phytoplankton growth in the Blackwater or Blackwater Outer WFD sections of the estuary, or beyond, as a result of the FED discharge.
We are therefore confident that the above target can be met and the CO’s safeguarded if we allow the discharge from the existing outlet to continue and extend, or remove, the time limit for the activity.

Change of outlet

Allowing a change of outlet will make no difference to any increases in the background concentrations of nitrates in the Blackwater estuary (and beyond) outside the 100 metre mixing zone that the discharge of treated FED effluent could cause. The modelling that our ECMAS team undertook gives us confidence that allowing a change of outlet and extending or removing the time limit for the activity would not threaten the above target or cause a risk of adversely affecting the designated features of the SAC in their current locations or prevent the spreading or colonisation of them to new areas.

(5) Opportunistic macroalgae

Reduce opportunistic macroalgae (OM) cover where it is encouraged from human activity to a level where epifauna and infauna are adversely impacted in line with Good Ecological Status levels required by Water Framework Directive (WFD)

Extending the time limit and using the existing outlet

Currently the Colne the Blackwater and the Blackwater Outer are classified as Moderate under WFD and therefore do not achieve Good Ecological Status overall for all parameters but the Blackwater is reported as Good and the Blackwater Outer as High for the last three years for OM.

The modelling that our ECMAS team undertook also included an analysis of the likely affects of the discharge on OM. They report that opportunistic macroalgae has been recorded in sections of the inner Blackwater estuary which could mean that this is where overall conditions are conducive to its growth. However the HR Wallingford modelling shows that the effluent plume would not penetrate to these areas so there is no risks of exacerbating the current situation there. The modelling did predict some increases in OM in the Blackwater Outer but not enough to downgrade it.

On this basis we are confident that allowing the FED discharge to continue from the existing outlet and extending the time limit, or removing it completely, would not cause a significant affect on the designated features by increasing OM growth or spread. Strictly speaking this would not meet the 'Reduce' target because any additional input can not do this. However we believe that existing levels of OM would be maintained and a 'Restriction' target is feasible. Allowing the discharge would also not prevent the achievement of a 'Reduction' target in future if this is practical. Especially considering that the discharge is temporary and the load of nitrates to be discharge is finite.

Changing to the new outlet

Allowing a change to the new outlet would not change the potential impact of the nitrates as described above because the nitrates load generated by the discharge would be the same. Outside the 100 metre mixing zone the increases in background nitrates concentrations would still be limited to 10% and the potential affects on OM would be the same. That is there would be some increased growth but not enough to cause a downgrading of the WFD classification.

We therefore see no reason not to extend the time limit for the activity or remove it completely. Because the discharge comes from a finite source we also see no reason to time limit the activity. The modelling in support of the application (and the supplementary modelling undertaken by our ECMAS team) is based on the worst case scenario of the discharge occurring over one year. If the operation generating the discharge takes longer the increases in annual average background concentrations of nitrates within the receiving waters of the SAC will be proportionately lower and the effects on OM lower also.

Although the discharge could have an effect on OM growth outside the initial mixing zone it would not exacerbate the growth of OM in the known locations of the inner estuary and not cause a downgrading of WFD status anywhere else. On this basis we believe that the discharge would not cause any harm to any designated feature in their current locations or prevent the spread or colonisation of the features into new areas. Strictly speaking the target of 'Reduce' OM would not be met by allowing the discharge because any addition of nitrates could not cause a reduction. But allowing the discharge would not cause any significant increase in OM and within the SAC or prevent a reduction in future, if this is practical, especially as the discharge is a temporary one and limited to finite load of nitrates overall.

(6) Water quality contaminants

Reduce aqueous contaminants to levels equating to Good Ecological Status according to WFD. Specifically mercury and its compounds and avoiding deterioration from its existing levels. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which several heavy metals were recorded as being above Effects Range Low (ERL) threshold. The only heavy metal which may adversely impact aqueous contaminants recorded above the ERL was Mercury in the upper reaches of the River Crouch.

Extending the time limit and using the existing outlet

The table below shows the maximum concentrations of individual metals within the treated FED effluent and the relevant EQSs for each in estuarine and coastal waters. It also shows what dilution factors are needed in the receiving waters for the effluent to meet the EQS's and reduce the concentrations to existing background concentrations.

In the first application modelling supplied by the applicant's consultants, HR Wallingford demonstrated to our satisfaction that beyond 100 metres from the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached (2) any increase in the existing background concentrations of each metal in the estuary above 10% and (3) any breach of any WFD classification target for any metal. Although the classification of the Blackwater, Blackwater Outer and Colne estuaries is currently Moderate overall (because of failures of the DIN standard,) the situation for metals is different. For all the metals we report on for WFD (which the effluent contains) in these three water bodies the current status is Good or higher. The same is true for the Crouch estuary although there is no possibility of any affect on this because it is so remote from the discharge point. The zone of influence for the discharge from metals within it is very limited because the concentrations are only parts per billion. The modelling supplied for the first application is still valid for the discharge from the existing outlet and we are confident that allowing it to continue and extending the time limit for the activity (or removing it completely) would not make a difference to achieving the above target and safeguarding the CO's of the SAC outside the 100 metre mixing zone. Allowing the activity to take longer than the one year originally allowed in the first permit, or two years now applied for, would only reduce its potential affects because it would spread a finite load of metals over a greater period.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

Change of outlet

Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect annual average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the CO's of the SAC we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's AA EQS's.

HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

Background concentrations of metals within the SAC

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. Mercury only needs 650:1 dilution to meet background concentrations so we are very confident that mercury levels will not be increased outside the mixing zone.
For these reasons we believe that allowing the change of outlet or extending, or completely removing the time limit for the activity would not threaten the above target. The metals in the estuary outside the mixing zone in all areas of the SAC would be maintained to the equivalent of Good Ecological Status. If the discharge takes longer than planned the finite load of meals would just be spread over a longer period and any residual increases in their respective concentrations would be lower in proportion to the time taken.

(7) Sediment contaminants

Reduce surface sediment contaminant levels to concentrations that are not adversely impacting on the infauna of the feature
Restrict surface sediment contaminants levels to concentrations where they are not adversely impacting on the infauna of the feature. Various heavy metals are known to affect the species that live in or on the surface of the of sediments. These include Hg, As, Zn, Ni, Ch, Cd, etc. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which several heavy metals were recorded as being above Effects Range Low (ERL) threshold.
Reduce surface sediment contaminants (<1cm from the surface) to below the OSPA Environmental Assessment Criteria (EAC) or ERL threshold. Various heavy metals are known to affect the species that live in or on the surface of the sediments. These include Hg, As, Zn, Ni, Ch, Cd, etc. This target relates to samples taken from sediments in an EA sub-tidal grab survey of 2014 in which several heavy metals were recorded as being above (ERL) thresholds.

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. Strictly speaking this situation would meet the requirement to 'Restrict' contaminants but not 'Reduce' them. Achieving a 'Reduce' target is not feasible for the permitting of anything containing metals in the effluent. However we are confident that there would be no significant additions to the surface sediments if we allowed the discharge to continue and this would not prevent the future achievement of a 'Reduction' target if this is practical in the future. Especially considering that the discharge is a temporary one and from a source that is finite.

Change to the new outlet
The same principle expressed above applies to the new outlet and the modelling provided by the applicant gives further confidence that the target could be met. It can be seen from the table above that the highest dilution factor needed to reduce any metal in the effluent to its existing annual average background concentration outside the mixing zone is 2,791 for lead and that there is an average dilution available for the effluent within the 100 metre mixing zone of 48,000:1. This dilution factor is still a conservative one because it does not take account of the days on which discharges will not be made. Only 650 :1 is needed for Mercury which is the metal of special concern.

For this reason we believe that allowing the discharge to be made from the new outlet would not threatened the above target of restricting surface sediment contaminants anywhere with the SAC outside the very limited mixing zone. We also see no reason to restrict the time limit for the activity because spreading the finite load of FED effluent over a greater time period would just reduce any residual increases in annual average concentrations in the water column which would proportionately reduce any surface sediment depositions.

With regard to the 'Reduce' target the same situation applies to the use of the new outlet as is described above. That is, allowing the discharge would not achieve a reduction but it will not prevent a reduction target being achieved in the future if this is practical.

Potential 'In combination' affects

On the 21st of October we wrote to all the other authorities responsible for assessing and licensing plans, projects and operations in the catchment of the Blackwater and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries.

The only other planned discharges we know of to be taken into account for this assessment are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration.

The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc.

The fundamental reason we believe the three effluents will not have any significant adverse affects on the above targets and attributes of the SAC is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. Insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three insignificant' discharges can combine to make a significant difference to the existing background water quality regime in the receiving Blackwater estuary or the other water bodies of the SAC beyond it.

It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharged every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary.

Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to threaten any of the targets for attributes that safeguard the CO's of the SAC.

CONCLUSION

Our aim has been to assess whether the discharge from the existing outlet or from the new outlet has the potential to adversely affect any designated feature of the SAC or their supporting habitats in their current location, or whether they would prevent the spread or colonisation of them to new areas. We have done this by considering what the zone of potential adverse affect the polluting load from discharge creates within the receiving estuary.

This zone varies depending on the pollutant in question. For the temperature affects, pH, and metals the zone the discharge can influence is limited to the initial mixing zone stretching 100 metres from discharge point downstream on the ebbing tide. Outside this we are confident there could be no adverse affects on SAC features because all EQSs and WFD targets would be met and the increases in existing background concentrations for each pollutant would be negligible. If the background water quality conditions do not change we can be confident that no harm would be caused to any

designated feature in their current locations and that there would be no hindrance to the spread of features into new areas. This conclusion is not surprising considering the fact that the discharge is extremely small in relation to the flows of water in the Blackwater Estuary and that the metals concentrations, in the discharge,(for instance) are extremely low, i.e parts per billion.
For nitrates in the discharge the situation is more complex because they are much higher concentrations, i.e. parts per million as opposed to parts per billion for the metals. Although the increases in background concentrations outside the initial mixing zone are limited to 10% there was still a need to consider what affects this could have. The modelling provided by the applicant and the supplementary work undertaken by our ECMAS team were the key to understanding these potential affects. They establish that the potential adverse affects outside the mixing zone with particular reference to excess growth of macroalgae or phytoplankton would not be significant.

One key point to note about the proposed discharge is that it is temporary and the overall polluting load to be discharged is finite. Any affects it could have on the SAC are therefore temporary and it could not threaten any ‘Recovery’ or ‘Reduce’ targets in the long term. In the short term we do not believe it would hinder achieving them either because we believe the overriding influences on the current failures of nitrogen standards in the estuaries of the SAC are from marine sources outside it.

On this basis the Agency is minded to:

Issue the permission with conditions to ensure no significant adverse affect on the designated features of the Blackwater, Crouch, Roach and Colne Estuaries Marine Conservation Zone

Conditions of the permit

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

Allowing the change to the new outlet

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

Nitrates limits and the removal of the time limit for the activity

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the SAC. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one year whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement to the granting of the permit is sought on this basis

EA Officer:	Bill Greenwood	**Date: 29/2/2016**
Natural England/CCW comment on assessment:	.	
Natural England/CCW Officer:		**Date:**

If there is a likely significant effect, an appropriate assessment will be required (see part B for suggested scope).

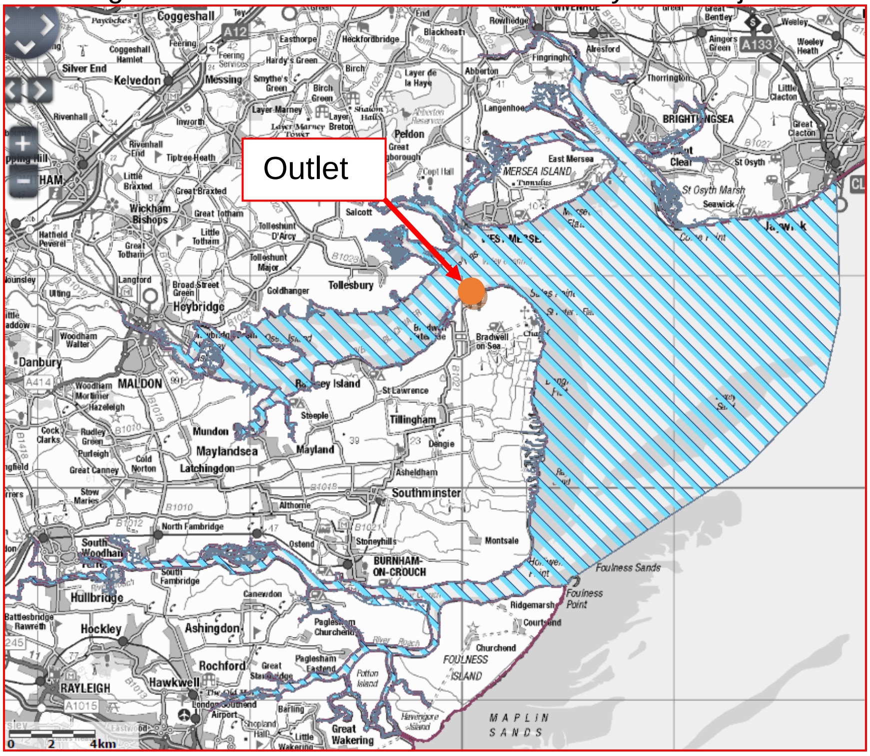
Part B Suggested scope of the EA appropriate assessment:		
Add details to following framework • Other competent authorities involved • Characterise the site in relation to the qualifying features and their conservation objectives; - existing information - additional surveys - management/unauthorised impacts • Detailed description of plan/project • Assess each likely impact on the interest features; - compare with historical data - predict impacts - compare with impact from management/unauthorised activities • Determine the extent to which each possible impact can be avoided.		
Natural England/CCW comment on scope of EA appropriate assessment:		
Natural England/CCW Officer:		**Date:**

(13) Blackwater, Colne, Crouch and Roach Estuaries MCZ

Habitats Assessment for an application to vary an EPR 'water discharge activity' permit EPR/DP3127XB.
Blackwater, Crouch, Roach and Colne Estuaries Marine Conservation Zone
(Based on the N.E. documents Conservation advice for Marine Conservation Zone: Blackwater, Crouch, Roach and Colne Estuaries (BS 03) and a draft copy of the 'Supplementary advice on conserving and restoring site features' for this MCZ)
Name of EA Permitting Officer Bill Greenwood, National Permitting Service, Nottingham Permitting Centre
Date for Environment Agency permit determination 31/3/2016
Predicted 28 day date for NE response 28/3/2016
Date of submission of assessment 29/2/2016
Operator - Magnox Ltd, former nuclear power station site, Bradwell on Sea, Essex.
Discharge – Maximum daily volume of 20 m3 of treated 'FED' effluent (NGR - TL 99650 09150
Format of the assessment report - A condensed specification of the Conservation Objectives (CO's) is given below followed by a brief background to the proposed discharge and details of its volume and contents. Below this is an explanation of how

we have assessed the potential for the polluting elements of the discharge to hinder, or not, the conservation objectives of the site. Finally there is a conclusion section explaining our ‘minded to’ permitting position.

Designation Area - The MCZ is located on the Essex Coast extending from the mean high water mark to where the four estuary mouths join the North Sea



Component SSSI sites – Colne Estuary SSSI, Blackwater Estuary SSSI, Dengie SSSI, Foulness SSSI, Crouch and Roach Estuaries SSSI, The Cliff, Burnham On Sea SSSI, Clacton Cliffs and Foreshore SSSI

Overlapping SPA/Ramsar sites – Colne Estuary(Mid-Essex Coast Phase-2), Blackwater Estuary (Mid-Essex Coast Phase-4), Dengie (Mid-Essex Coast Phase-1) Foulness (Mid-Essex Coast Phase-5), Crouch and Roach Estuaries (Mid-Essex Phase-3)

Overlapping MCZ’s – Essex Estuaries MCZ

Designation Features – (i) intertidal mixed sediment (ii) Native oyster beds, (iii) Native oysters (Ostrea edulis)

(iv) Clifton Cliffs and Foreshore – ***Note*** – *Because this feature is purely geological the only affects the discharge could have on it would be physical damage if it changed the flow regime in the vicinity. But the discharge is too small (20 m3) and too far (16 km) from the feature to have any physical affect upon it. This feature is therefore excluded from the any further assessment.*

Location of the designated features

Native Oysters are known to occur throughout the four component rivers with distributions of wild populations predominantly clustered around the sublitoral parts of the outer Blackwater and Colne estuaries the Ray Sound Channel and the outer Crouch estuary.

Native Oyster beds

Established beds have been recorded in the the sublitoral parts of the Ray Sand Channel and the outer Blackwater area near Mersea Island.

Intertidal Mixed Sediment has been identified in the Blackwater to the east of Osea Island and the upper reaches of the Blackwater. It was also identified on the north bank of the Crouch upstream of Burnham.

Conservation Objectives for each of the designated features

(1) The features are maintained in favourable condition if they are already in favourable condition

(2) Be brought into favourable condition if they are not already in favourable condition

Definition of favourable condition
For each protected broad-scale habitat:

(3) The extent is stable or increasing and
(4) Its structure and functions its quality, and the composition of its characteristic biological communities (including diversity and abundance of species forming part or inhabiting the habitat) are sufficient to ensure that its condition remains healthy and does not deteriorate.

Any temporary deterioration in condition to be disregarded if the habitat is sufficiently resilient to enable recovery

For each species of marine fauna:
That the population within a zone is supported in numbers which enable it to thrive by maintaining:

(3) The quality and quantity of its habitat and
(4) The number, age and sex ratio of its population

Any temporary reduction in numbers of a species is to be disregarded if the population is sufficiently thriving and resilient to enable its recovery

Relevant Attributes and Targets
The relevant ecological characteristics (**attributes**) of the designated species and habitats and the appropriate water quality conditions (**targets**) that are necessary to safeguard them to meet the Conservation Objectives (CO's) for the MCZ are listed in groups below By 'relevant' we mean that these are the attributes that could potentially be threatened by the contents of the proposed discharge. An example of non-relevant target for this discharge is, "Reduce the introduction and spread of non native species and pathogens and their impacts". This isn't relevant because the permit is to allow a discharge of trade effluent not to allow some form of shell fishery operation. Another example is, " Maintain the total organic carbon (TOC) content in the sediment at existing levels." This isn't relevant because the discharge does not contain any TOC.
Listing the appropriate targets to safeguard the CO's of the MCZ's and grouping them into common types helps to condense this report, avoid too much repetition and focus on the essential issues.
The common attributes (supporting processes and structures) and targets for Native Oysters, Native Oyster Beds and Intertidal mixed sediments are:

(5) Physio-chemical properties

Maintain the natural physio chemical properties of the water - Temperature, pH and salinity.

(6) Hydrodynamic and physical conditions

Maintain the hydrodynamic and physical conditions

(7) Water Quality i.e Dissolved Oxygen

Maintain the DO to levels equating to Good Ecological Status. Excessive nutrients and/or high turbidity can lead to a drop in DO.

(8) Water quality i.e nutrients

Recover the natural water quality and specifically winter dissolved inorganic nitrogen to Good Ecological Status concentrations avoiding deterioration from existing levels.

(9) Water quality i.e turbidity

Water turbidity as a result of material suspended in the water including sediment, plankton, pollution or material washed into the estuary from the land.

(10) Opportunistic macroalgae

Reduce opportunistic macroalgae cover where it is encouraged from human activity to a level where epifauna and infauna are adversely impacted in line with Good Ecological Status levels required by Water Framework Directive (WFD)

(11) Water quality contaminants

Reduce aqueous contaminants to levels equating to Food Ecological Status according to WFD. Specifically mercury and its compounds and avoiding deterioration from existing levels. 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

(12) Sediment contaminants

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.

Background to the application

The applicant has requested to vary their existing permit (EPR/DP3127XB) to discharge 30 cubic metres (m3) of treated 'FED' effluent from the Bardwell site into the Backwater Estuary (see map below)

The permit was issued on the 1st December 2011 after obtaining your agreement. The applicant is reducing the maximum daily volume of the effluent to 20 m3 and wishes to make two other more significant changes to the permit, (1) to extend the time period for the FED activity to take place over a further 24 months and (2) to be able to switch the discharge to a newly constructed outlet (at the same location) at some future date if it becomes necessary due to the silting up of the existing outlet. Using the new outlet structure would change the discharge characteristics because it would no longer be possible to 'pre-dilute' the effluent by a minimum factor of 50:1 with a carrier flow of seawater prior to discharge.

(15)

FED stands for Fuel Element Dissolution. It is a process intended to reduce the amount of intermediate radioactive material stored on site. Part of this is in the form of fragments of old fuel casings made of a magnesium alloy. The process involves dissolving the alloy pieces in nitric acid hence 'dissolution'. The resulting acidic, magnesium nitrate liquid is treated so that it is fit to be discharged into the estuary. This leaves a much smaller volume of radioactive sludge to be stored on site. The sludge is stored under the control of a different permit. It will not form part of any discharge. The treatment of the FED effluent includes neutralisation, precipitation, filtration, adsorption and ion exchange. The permit we are consulting on here is for the non-radioactive components in the effluent which are nitrates, residual concentrations of metals, temperature and pH.

Since the beginning of the operation the applicant has made a small change to it by adding acidic 'NOX' scrubber liquors to the FED dissolution batches. The NOX liquors are a by-product of treating the air emissions from the FED process. Because they are acidic the applicant decided to use them in the FED process as a form of recycling to avoid the waste of using additional fresh nitric acid. The NOX liquors contain a small load of the same metals generated by the FED process because they have the same source. The NOX liquors represent a small proportion of the overall volume of FED influent. In a maximum daily volume of 20m3 (20,000 litres) a day of FED the maximum amount of NOX liquors added to the process could be 300 litres.

The assessment is based on the effluent strength including NOX liquors which is conservative because they won't always be included

At the time of issue of the permit in 2011 it was thought that the FED treatment operation that gives rise to the effluent would only last for 12 months. So the permit had a clause limiting the discharge 'activity' to taking place over this period. Due to technical problems the FED treatment operation did not run according to plan and the start was delayed. The Agency was notified of it starting in the summer of 2014 so the allowed period for the 'activity' has now expired although the permit itself is still live. In the application it states that, due to further technical delays, only around 10% of the FED material has been treated and discharged and they would like a further 24 months to complete the process in case there are further problems.

Since the expiry of the limiting date for the 'activity' we have been allowing the operator to make the FED discharge (when they are able to) under the terms of an enforcement letter. This basically means that in the interim before we make a decision on the application we will not take any legal action against them for discharging the FED effluent if they comply with all the conditions of the existing permit. As such all the permit conditions still apply and are enforceable. Because these conditions were set to protect the receiving environment from a discharge source which has a finite load we believe this temporary concession can have no adverse impact on the conservation areas. The enforcement letter applies to the use of the existing outlet only. It does not apply to the use of the new outlet.

Whilst this enforcement position has been in force Magnox have made FED discharges but they have been limited due to further operational difficulties and informally they have intimated that 24 months may not be enough time to treat the remaining tonnage of waste material they need to dispose of. This has focused our attention on the whether there is a need to impose a time limit for the activity within the permit if the overall polluting load to be discharged is finite. We have therefore included this issue in our assessment as outlined below.

(2)

The second part of the application is a request to allow the treated FED effluent to be discharged out of a different outlet when it becomes necessary at some stage. The existing discharge pipe is a large outlet close to the bed of the estuary. A large pipe was necessary to emit the large volumes of cooling water when the power station was active. Since the power station ceased active service and a protective sea wall was removed this outlet has gradually been silting up. A survey undertaken on behalf of the applicant has revealed that silting may prevent the outlet being used within the near future. Because of this and because there will be an ongoing need for a site drainage outlet Magnox have constructed a new outfall structure at the same location with a much smaller pipe for the FED higher above the estuary bed. De-silting the existing pipe or constructing similar sized one would cause too much harmful disturbance of the estuary bed. Active pumping of the FED effluent through a smaller pipe removes the need for large volume of seawater to carry it out into the estuary but it also removes the pre-dilution this afforded.

In order to prevent any deterioration in receiving water quality from this change the new outlet for the FED effluent was designed to ensure that the same dilution factors would be achieved within 100 metres. Meeting appropriate EQS's within the estuary 100 metres from the discharge point was the criteria agreed when the existing permit was granted.

The design is based on the results of extensive dilution and dispersion modelling undertaken by HR Wallingford the applicant's consultants.

The new outlet pipe for the FED effluent is 5.5 metres above the bed of the estuary just below the level of the lowest tide. It is 180 mm in diameter with a 65 mm nozzle to create a jet effect and is at right angles to the currents to enhance mixing. The discharge will be manually controlled and be made in twenty minutes on one ebb tide a day between 1 and 2 hours after high water. The outlet has been placed as high as possible in the water column because FED effluent is denser than seawater and will initially sink before mixing restores its buoyancy to neutral. Initial dilution will occur within the water column.

Key aim and principles of the assessment

The key aim of our assessment has been to determine whether the proposed discharge would cause any direct harm to any of the designated features within the MCZ or whether it would prevent them being in 'favourable condition' as defined above. We have therefore tried to asses whether the proposed discharge would prevent the features spreading and colonising new areas as well as whether it would harm them in their current locations. To assess the potential impact on the designated features in known locations we have used the standard ''pollutant – pathway- receptor ' approach. To assess whether the discharge could prevent the spread of features into new areas we have considered what the spatial zone of adverse affect the discharge could have within the receiving Blackwater Estuary and beyond.

The polluting elements of the discharge that are in sufficient strength in the effluent to potentially cause harm within the MCZ are, nitrates, several heavy metals, pH, and temperature and by 'receptor' we mean any aquatic flora or fauna or physical feature that is designated or forms part of the overall habitat of a designated feature.

The criteria we have used for determining ''polluting strength' and the potential for causing harm are the relevant environmental quality standards (EQS's), WFD targets and existing background water quality in the receiving waters. The evidence for the predicted pathways the discharge will take within the receiving waters, and the dilutions it will be subject to, come from modelling exercises undertaken by the applicant's consultants HR Wallingford. These have been vetted by members of our Estuarine Coastal Monitoring and Assessment Service (ECMAS) team and after some clarification the main results accepted. The modelling results also provide evidence of the spatial zone of potential adverse affect the discharge could create within the receiving estuary and beyond.

Fundamentally Magnox's application is based on the contention that outside an 'acceptable' limited mixing zone the effluent will always be sufficiently diluted to meet the relevant EQS's for metals and prevent more than a 10% deterioration in the existing, background levels of nitrates or a breach of any WFD targets. We have analysed their evidence and done some further work of our own to see if their conclusions are correct and whether meeting these criteria would protect the MCZ. A more detailed explanation of the key principles are given below followed by sections on how they apply to the relevant attributes and targets that safeguard the conservation objectives.

- Environmental Quality Standards (EQS's)

EQS's are based on research into the toxicity of substances to aquatic flora and fauna. Annual average (AA) EQS concentrations for each substance are fixed at preventing long term chronic effects and maximum allowable concentrations (MAC) concentrations are set to prevent short term acute toxic effects. Both are calculated by applying a safety factor of at least 10 (but sometimes up to a 1,000 or more) to the lowest known toxicity concentration of each substance to any organism, to make sure that marginal breaches do not cause any harm. Not all substances have EQS's of both types.

We can be confident that if the relevant EQS concentrations of a specific substance are met in the estuary waters (after the discharge has mixed within an acceptable mixing zone) no harm would be caused to any aquatic organisms or their habitat. The

EQS's we have used in the assessment are those relevant to estuarine waters taken from the EC EQS Directive of 2008 with additions from The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) England and Wales) Directions 2010**.**

- H1 assessments and modelling in support of the application.

The assessments provided by the applicant's consultants HR Wallingford was based on our published H1 guidance document. ('*H1, Annexe D1 Assessment of hazardous pollutants within surface water discharges'*,) This provides screening tools to decide if the concentrations of hazardous substances in the discharge are 'significant' and have the potential to cause harm. If the screening phases are not passed it requires detailed modelling assessments. In this case the FED effluent failed the initial screening tests primarily because it is denser than seawater and not buoyant. The applicant therefore provided the results of a complex modelling exercise undertaken by their consultants HR Wallingford. The modelling addressed nitrates concentrations as well as metals because the discharge could threaten Water Framework Directive nitrates for these targets as well.
The models are standard industry types and are populated with real bathymetric dimensions and measured flows (in all tidal states and seasons) from actual surveys of the estuary. They predict the dispersion of the effluent as it mixes within the estuarial waters and the dilution factors at various points. This enables (i) the calculation of the initial dilution factors the discharge will receive at various distances from the outlet (ii) the dilution factors further afield from the outlet at various points so that the resulting concentration of pollutants can be predicted. This includes the residual concentrations of pollutants returning on the incoming tides (iii) the pathways of the dispersed effluent within the estuary on different tides and flows and (iv) the calculation of the optimum time to discharge and optimum outlet design to achieve the best dispersion and dilution.

- Acceptable mixing zones and dilution factors

Allowable mixing zones are a concept used in environmental regulation in recognition of the fact that it is not always possible for effluents to be treated to the levels where EQS's can be achieved within the discharge. EQS's are in any case meant to apply within the receiving waters not within discharges. Hence mixing zones (within which dilution can reduce contaminants to below EQS's before they spread any further) are allowed. But there are criteria for judging what size of zone is acceptable for each pollutant so that any potential harm can be minimised.
In this case for the first application we accepted that meeting EQS's for the metals within the effluent within 100 metres of the outlet was acceptable based on the information and modelling the applicant provided at that time. When it became clear that a new outlet structure was needed and that pre-dilution would not be practical Wallingford used their models to design a FED outlet that would match the performance of meeting water quality targets within 100 metres. This is to be achieved by using a small outlet nozzle to create a faster more turbulent discharge at the right point on the ebbing tide and at a higher level within the water column to get greater ' initial dilution' as the dense FED effluent sinks before mixing renders its buoyancy neutral.
The Wallingford models show that an absolute minimum dilution factor of 240:1 would be achieved by the time the effluent has mixed with estuary waters 100 metres from the discharge point. It is the dilution that the effluent would receive for the first few minutes of the 30 minute discharge window on the lowest of the range of tides and slowest currents that occurs within the estuary 1 to 2.5 hours after high water. It is therefore the relevant dilution factor to use together with the MAC EQS to assess the possibility of any substance having an instantaneous toxic effect on any organism outside the mixing zone.

The most appropriate dilution factor to use to assess compliance with annual average (AA) EQS's outside the mixing zone is 48,000:1. This is because the model shows that the 'average' dilution factor at 100 metres over the 30 minute window of the discharge (and the full range of tides and current speeds) is 1000:1. Since there are 48 half hours in a day the daily average dilution will be 48,000. In practice there will not be a discharge every day of the year so 48,000:1 is actually a conservative figure to use for an annual average concentration assessment.

Modellers from our ECMAS team have vetted the modelling reports submitted in support of the application and after some clarification questions were answered they have verified that its findings with regard to dilution factors are credible.

- Pathways and receptors

The FED outlet is situated 5.5 metres above the sea bed 400 metres out into central channel in an outer section of the estuary 4 kilometres before the southern part of the estuary opens out at Sales Point. At this height it is below water even at the lowest level of the lowest tide and provides the maximum initial dilution for the dense effluent. Because of this and because it will only be discharged just after high water on the ebbing tide (for only 30 minutes) the effluent pathway as it disperses and is diluted will always be towards the outer estuary and sea. A conservative estimate of the size of the mixing zone (as calculated in HR Wallingford's modelling) is that it would be 100 metres long, 20 metres wide and 2 metres deep and that it would sink to make contact with the estuary bed after approximately 40 metres. The receptors that would be susceptible to the initial affects of the effluent before it is diluted are therefore only those that are within this zone of 4,000 m3 extending 100 metres from the discharge point. The intertidal mixed sediments are obviously not within this zone. The only designated features that could be present are native oysters and native oyster beds and only those beyond approximately 40 metres from the discharge point would be exposed because the effluent would not reach the bed before this distance.

We consider that a 100 metre long mixing zone of 4,000 cubic metre volume that would only allow an impact on this very small portion of the overall MCZ habitat and features to be 'acceptable' in this case.

Assessment of possible impacts on attributes and targets

Incorporating the principles and information given above our assessment of the potential for the discharge to impact on the relevant attributes and targets (listed above) which safeguard the CO's of the MCZ are addressed below in turn. Because there are two aspects to the variation (extending the time limit for the activity and changing the outlet type) which incorporate different risks we will explain the ramifications for both.

(6) Physio-chemical properties

Maintain the natural physio chemical properties of the water - Temperature, pH and salinity.

Extending the time period and using the existing outlet

The potential of the discharge to have any affect on the natural, background physio-chemical properties of the overall area of the MCZ are extremely limited because it is a very small volume in relation to the volumes of water that flow within the receiving Blackwater Estuary. The discharge is a maximum of 20 m3 a day and the estuary has an average volume of 106,300,000 m3. Whilst the existing outlet is used there is also the additional buffer of the minimum pre-dilution of the effluent of a minimum 50:1 in abstracted seawater.

With regards to temperature in the original application HR Wallingford's modelling estimated that the discharge (which has a raised temperature because the FED process is exothermic) had the potential to raise the estuary waters outside the 100 metre mixing zone by 0.2 º C in summer and 0.3 º C in winter. This is well within the WFD guideline threshold of keeping the temperature differentials within 2 º C and we considered that such a negligible change could not have any adverse effect on any aquatic flora or fauna within the receiving estuary including the native oysters.

With regard to pH the FED process involves the use of nitric acid but the treatment in the abatement plant includes neutralising the acidic effluent to a pH range of 6 to 8. There is no WFD target for pH in marine waters but there is a pH target in the EC directive for the protection of shellfish for human consumption of 7 to 9. This does not strictly apply to conservation sites but the minimum 50:1 pre-dilution that takes place whilst the existing outlet is available for use means that any discharge at pH 6 will be buffered to pH 7 before discharge. So there would be no risk to any aquatic flora or fauna including native oysters from the discharge continuing from the existing outlet.

With regard to salinity the discharge is non-saline and too small to make any change the existing background salinity in the receiving estuary even if it was not pre-diluted in seawater.

For these reasons we can be confident that the discharge from the existing outlets would have a very limited zone of potential adverse affect. It would be confined to 100 metre from the discharge point downstream on the ebbing tide. Outside this the existing background physiochemical conditions would be maintained. There would be no adverse affect on any designated features outside the mixing zone and no hindrance to colonisation by designated features outside it.

Changing to the new outlet

As stated above in the 'acceptable mixing zones and dilution factors' section the modelling provided by the applicant's consultants predicted that there was an absolute minimum dilution available for the effluent of 240:1 within the mixing zone. This is the dilution available over the first few minutes of the 30 minute discharge at high water on the lowest tide with the slowest current. The minimum average dilution for the full range of tides and currents is 1000:1 over the 30 minutes of the discharge and it is therefore 48,000 :1 over 24 hours.

These levels of dilution are more than enough to reduce the temperature and pH of the discharge to the background levels in the receiving waters outside the mixing zone and prevent any affect on any aquatic life, including native oysters. Because the discharge is very small and non-saline it also could not change the background salinity regime even within the mixing zone.

For these reasons we do not believe that allowing the discharge to take place from the new outlet (without pre-dilution) and allowing an extension to the time limit, or removing it completely, would change the existing background physio-chemical properties of the discharge outside the mixing zone. The targets and attributes would be maintained and the CO's safeguarded.

(7) Hydrodynamic and physical conditions

Maintain the hydrodynamic and physical conditions

Extending the time limit and using the existing outlet

Even though the (20 m3) effluent is mixed with a minimum of 50 times its volume in abstracted seawater before it is discharged, it is too small to have any affect on the background hydrodynamic conditions within the estuary. The estuary has an average volume of 106,300,000 m3 so the > 1,000 m3 of pre-diluted effluent is too insignificant to influence its currents or tidal levels.

We are therefore confident that extending the time limit for the discharge (or removing it completely) will not threaten any CO's of the MCZ.

Changing to the new outlet

If we allowed the discharge to be made from the new outlet it would no longer be pre-diluted in abstracted seawater and its maximum volume would be reduced to 20 m3. It would therefore pose an even lower risk to the existing hydrodynamic and physical conditions within the MCZ than the current discharge.

We are therefore confident that allowing the discharge to be made from the new outlet and extending the existing time limit (or removing it completely) would not pose a risk to the designated features of the MCZ. The attributes and the targets would be maintained.

(8) Water Quality i.e Dissolved Oxygen

Maintain the DO to levels equating to Good Ecological Status. Excessive nutrients and/or high turbidity can lead to a drop in DO.

Extending the time limit and using the existing outlet

The treated FED effluent is virtually devoid of suspended solids because ultra-filtration is part of the treatment processes so it can not have any effect on turbidity levels within the receiving waters. So the only way it could have an effect on DO levels in the estuary would be by significantly raising background nutrient levels in the estuary waters which could lead to excessive plant growth within it. Extra plant growth could lead to extra DO being stripped from the water at night by respiratory processes of the plants, or by the respiratory processes of bacteria breaking down organic matter. Sometimes after phytoplankton blooms have reached there peak and died back there are localised DO sags from the increased activity of bacteria breaking down the dead phytoplankton cells.

The only nutrient within the FED effluent is nitrogen in the form of nitrates. Although the discharge is very small (20 cubic metres) it contains relatively high concentration of nitrates (average 22,000 mg/l) so it does have the potential to have an effect on the receiving estuary. This was outlined in the original permit application in 2011 which also included the results of a modelling exercise undertaken by the applicant's consultants HR Wallingford. The modelling showed that the discharge had the potential to raise the existing annual average (AA) background concentration of nitrates in the Blackwater and Colne estuaries by up to 7 to 9 % if the whole FED processing was accomplished in 12 months. It further predicted that most of the additional nitrates would be flushed out of the estuary after one year and all of them after two.

The annual average nitrates concentration in rivers and transitional waters is the basic benchmark of eutrophication and is used to assess the likelihood of a discharge causing adverse biological responses such as excessive plant growth within habitats. A temporary increase of only 7 to 9% AA nitrogen was not considered to be a significant to risk causing such an adverse response in the Blackwater and Colne estuaries in 2011. This level of increase also fitted within the Agency' 'no deterioration ' criteria of only allowing individual discharges to cause up to a 10% increase in background concentrations for any one pollutant as long as this does not cause a breach of a Water Framework Directive (WFD) target. Increases of 7 to 9% did not pose such a threat.

The above factors led us to believe that the nitrates in the FED discharge could not have adverse effect on the features of any of the conservation areas within the vicinity of the discharge in 2011 and this was the basis on which we obtained your assent to issuing the original permit in December 2011. At that time the MCZ's had not been designated and the conservation advice not formulated.

Since 2011 the 'Blackwater', 'Blackwater Outer' and 'Colne' estuaries have met the necessary DO concentrations to achieve the MCZ CO's. In the last three years the 'Blackwater' has been 'Good', 'High' and 'High' for D.O the 'Blackwater Outer' has been constantly ‘High’ and the Colne constantly ‘Good’. The Crouch estuary has also been ‘Good’ although it is too remote to be affected by this discharge.

In the overarching WFD classification criteria none of the classified water bodies within the MCZ have achieved Good Ecological Status. All of them are currently classified as ‘Moderate’. But this has been due to dissolved inorganic nitrogen (DIN) concentrations failing ‘Good’ standard. A failure of any of the key standards that make up the overall classification causes a failure of Good Ecological Status even if all the other standards achieve it easily.

For this new application (to justify the ongoing discharge and the use of the new outlet) Magnox have provided an updated modelling exercise undertaken by HR Wallingford which provides a more sophisticated analysis. It predicts the pathways of the dispersion of the effluent and the resulting increase in background nitrates concentrations at various points. It confirms that there would be no breach of the Agency’s 10 % deterioration guideline for the annual average of nitrates anywhere outside the mixing zone.

In addition to the applicant’s impact assessment officers from our ECMAS team have undertaken their own supplementary nitrates assessment. This was done because they have information and tools for WFD assessments that are not available to the applicant or their consultant. Their modelling tools can predict the effects on DIN concentrations and the potential for adverse biological responses such as blooms of macroalgae or phytoplankton and how these will impact WFD targets. Using these tools they concluded that the increases in nitrates concentrations caused by the FED effluent discharge would not lead to harmful increases in plant growth and that the current WFD classifications would be maintained everywhere within the range of influence of the dispersed FED plume.

The updated modelling and the extra analysis undertaken by our ECMAs team has give us extra confidence that the nitrates in the FED estuary will not have an adverse affect on the designated features of the MCZ outside the 100 metre mixing zone. This is the case if the FED operation was undertaken over just one year and if the operation is delayed and takes longer the risks would be lessened. This is a result of the nitrates to be discharged coming from a source that is finite. They are limited to the nitrates that will be released from treating 210 tonnes of FED waste overall. Spreading the discharge over a longer time period can only lower its potential to increase the background annual average concentrations of nitrates in the estuary. For instance, if the discharge was spread evenly over 24 months the increase in the background annual average concentrations would obviously be halved.

On this basis we believe that the zone of potential adverse affect the discharge would cause from its nitrates load would still be limited to the 100 metre mixing zone. Outside this the increases in background nitrates concentrations in the receiving estuary would be restricted to within 10% and this would not create harmful biological responses in the form of excessive plant growth. We are confident that outside the mixing zone there would be no harm to any designated features in their current locations and that the discharge would no prevent the spread or colonisation of features into new areas.

On this basis we see no reason to deny the application to extend the time limit for the activity or to remove the time limit completely. If the discharge takes place over a longer period any increases in the background annual average nitrates concentrations will be lower proportionate to the time taken.

Changing to the new outlet

Changing to the new outlet will change the way it initially disperses in the estuary because there will no longer be any pre-dilution and the effluent will be made from a much smaller outlet higher in the water column. But the higher outlet will allow better mixing in the water column as the dense effluent sinks and the change will not make any difference to the load of nitrates being discharged. So the potential increase in

background nitrates concentrations outside the mixing zone would still not exceed 10 %. The updated modelling exercise undertaken by HR Wallingford demonstrates that this is the case and that the supplementary modelling undertaken by our ECMAS team gives us further confidence that the change to the new outlet would not cause excessive plant growth that would threaten existing DO concentrations in the inner, or outer, sections of the Blackwater Estuary or beyond them.
The ECMAS analysis did however produce a recommendation to change the discharge timings. Their modelling indicated that it would be advantageous to restrict the discharge window to 1 to 2 hours rather than the 1 to 2.5 requested in the application. A further recommendation is that the discharge always be made on the daytime ebbing tide. This would mean that any residual concentrations of nitrates returning on the next incoming tide would be less likely to be taken up by plants because it would happen in darkness. Plants are known to absorb greater amounts of nutrients during the times they are photosynthesising. We are therefore minded to incorporate this restriction in the permit.
On this basis we are confident that allowing the discharge to be made from the new outlet and extending the time limit , or removing it completely, would not threaten the targets or attributes of the MCZ's and that the CO's would be maintained.

(9) Water quality i.e nutrients

Recover the natural water quality and specifically winter dissolved inorganic nitrogen (DIN) to Good Ecological Status concentrations avoiding deterioration from existing levels.

Extending the time limit and using the existing outlet

The existing DIN concentrations in the Blackwater estuary and beyond could obviously be affected by the nitrates concentrations within the treated FED effluent because nitrates contain inorganic nitrogen. As part of the modelling exercise undertaken by our ECMAS team, mentioned above, they therefore included an analysis of the potential impacts upon DIN concentrations in the estuary. This was crucial because it is the DIN concentrations that are the cause of the current reporting of the Blackwater, Blackwater Outer and Colne WFD water bodies as 'Moderate' and failing Good Ecological Status even though they are Good or High for other WFD parameters. Currently the Colne, Blackwater and Blackwater Outer are reported as Moderate. The Crouch and Roach estuaries are too remote to be affected by this discharge.
The conclusions of our ECMAS team from their modelling work were;

- the effects of the discharge would be limited to the Blackwater estuary there would be no affect on the Colne estuary because of the dispersion pathway
- the discharge would not cause significant deterioration in existing DIN concentrations in the Blackwater or Blackwater Outer
- these sections would maintain their current classifications
- limiting the discharge to a daytime ebbing tide and to two hours after the high water point would be advantageous.

Based on the above we are confident that allowing the discharge to continue from the existing outlet and extending, or completely removing, the time limit for the activity would not cause a significant difference to the existing background concentrations of DIN in either of the WFD classified sections of the Blackwater estuary or in the Colne estuary. The Crouch and Roach estuaries which are over 14 kilometres away are too remote to be affected. Our analysis is based on the worst case scenario of discharging over one year and if it takes any longer the increases in annual background concentrations of DIN will obviously be proportionately lower.
If we granted the permit it would not help to meet a 'Recover' target because allowing any extra input at all can not achieve this. But it would 'Maintain' the existing DIN

concentrations to levels that would not cause a significant adverse affect on any designated features in their current locations or prevent the colonisation or spread of them into new areas. Although it would not help to achieve a ‘Recover’ target it would not prevent future possibilities of achieving this if it is practical. The current assessment of our ECMAS team is that the dominant factor in failures of the nutrient targets within the MCZ is diffuse inputs from the sea outside it which contribute the majority of the nutrient loads within the estuaries.

Changing to the new outlet

Changing the discharge to the new outlet would change the way the effluent initially disperses within the 100 metre mixing zone but it would not change its impact as described above. The zone of potential adverse affect would still be limited to the 100 metre mixing zone and beyond this it would not have the potential to harm a designated feature in MCZ or prevent the spread of one into new areas. A change of outlet would not help to meet the ‘Recovery’ target but it would not hinder ‘Maintaining’ current levels of DIN or prevent a ‘Recover’ at a later time if this is possible. The longer the FED operation takes the lower the proportional increases in background concentrations in DIN will be in the receiving waters. In addition because the discharge is ultimately temporary, it can not have a permanent affect on any target or attribute of the MCZ’s.

(10) Water quality i.e turbidity

Water turbidity as a result of material suspended in the water including sediment, plankton, pollution or material washed into the estuary from the land.

Extending the time limit and using the existing outlet

Because the treatment of the FED effluent involves ultra filtration processes it will be virtually devoid of suspended solids. The only way it could affect turbidity therefore is if the nutrients in the discharge caused blooms of phytoplankton.

As stated above our ECMAS team undertook a modelling exercise which included an assessment of whether the nitrates within the FED discharge would cause extra growth of plants within the receiving waters. This analysis included the potential for causing extra blooms of phytoplankton. The ECMAS team concluded that there was no risk of extra phytoplankton growth in the Blackwater or Blackwater Outer WFD sections of the estuary, or beyond, as a result of the FED discharge.

We are therefore confident that the above target can be met and the CO’s safeguarded if we allow the discharge from the existing outlet to continue and extend, or remove, the time limit for the activity.

Change of outlet

Allowing a change of outlet will make no difference to any increases in the background concentrations of nitrates in the Blackwater estuary (and beyond) outside the 100 metre mixing zone that the discharge of treated FED effluent could cause. The modelling that our ECMAS team undertook gives us confidence that allowing a change of outlet and extending or removing the time limit for the activity would not threaten the above target or cause a risk of adversely affecting the designated features of the MCZ in their current locations or prevent the spreading or colonisation of them to new areas.

(11) Opportunistic macroalgae

Reduce opportunistic macroalgae (OM) cover where it is encouraged from human activity to a level where epifauna and infauna are adversely impacted in line with Good Ecological Status levels required by Water Framework Directive (WFD)

Extending the time limit and using the existing outlet

Currently the Colne the Blackwater and the Blackwater Outer are classified as Moderate under WFD and therefore do not achieve Good Ecological Status overall for all parameters but the Blackwater is reported as Good and the Blackwater Outer as High for the last three years for OM.

The modelling that our ECMAS team undertook also included an analysis of the likely affects of the discharge on OM. They report that opportunistic macroalgae has been recorded in sections of the inner Blackwater estuary which could mean that this is where overall conditions are conducive to its growth. However the HR Wallingford modelling shows that the effluent plume would not penetrate to these areas so there is no risks of exacerbating the current situation there. The modelling did predict some increases in OM in the Blackwater Outer but not enough to downgrade it.
On this basis we are confident that allowing the FED discharge to continue from the existing outlet and extending the time limit, or removing it completely, would not cause a significant affect on the designated features by increasing OM growth or spread. Strictly speaking this would not meet the 'Reduce' target because any additional input can not do this. However we believe that existing levels of OM would be maintained and a 'Restriction' target is feasible. Allowing the discharge would also not prevent the achievement of a 'Reduction' target in future if this is practical. Especially considering that the discharge is temporary and the load of nitrates to be discharge is finite..

Changing to the new outlet

Allowing a change to the new outlet would not change the potential impact of the nitrates as described above because the nitrates load generated by the discharge would be the same. Outside the 100 metre mixing zone the increases in background nitrates concentrations would still be limited to 10% and the potential affects on OM would be the same. That is there would be some increased growth but not enough to cause a downgrading of the WFD classification.
We therefore see no reason not to extend the time limit for the activity or remove it completely. Because the discharge comes from a finite source we also see no reason to time limit the activity. The modelling in support of the application (and the supplementary modelling undertaken by our ECMAS team) is based on the worst case scenario of the discharge occurring over one year. If the operation generating the discharge takes longer the increases in annual average background concentrations of nitrates within the receiving waters of the MCZ will be proportionately lower and the effects on OM lower also.
Although the discharge could have an effect on OM growth outside the initial mixing zone it would not exacerbate the growth of OM in the known locations of the inner estuary and not cause a downgrading of WFD status anywhere else. On this basis we believe that the discharge would not cause any harm to any designated feature in their current locations or prevent the spread or colonisation of the features into new areas. Strictly speaking the target of 'Reduce' OM would not be met by allowing the discharge because any addition of nitrates could not cause a reduction. But allowing the discharge would not cause any significant increase in OM and within the MCZ or prevent a reduction in future, if this is practical, especially as the discharge is a temporary one and limited to finite load of nitrates overall.

(12) Water quality contaminants

Reduce aqueous contaminants to levels equating to Good Ecological Status according to WFD. Specifically mercury and its compounds and avoiding deterioration from existing levels. 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

Extending the time limit and using the existing outlet

The table below shows the maximum concentrations of individual metals within the treated FED effluent and the relevant EQSs for each in estuarine and coastal waters. It also shows what dilution factors are needed in the receiving waters for the effluent to meet the EQS's and reduce the concentrations to existing background concentrations.

In the first application modelling supplied by the applicant's consultants, HR Wallingford demonstrated to our satisfaction that beyond 100 metres from the discharge point the (pre-diluted) effluent would have mixed and had sufficient dilution to prevent, (1) any of the individual EQS's for the metals being breached (2) any increase in the existing background concentrations of each metal in the estuary above 10% and (3) any breach of any WFD classification target for any metal. Although the classification of the Blackwater, Blackwater Outer and Colne estuaries is currently Moderate overall (because of failures of the DIN standard) the situation for metals is different. For all the metals we report on for WFD (which the effluent contains) in these three water bodies the current status is Good or higher. The same is true for the Crouch estuary although there is no possibility of any affect on this because it is so remote from the discharge point. The zone of influence for the discharge from metals within it is very limited because the concentrations are only parts per billion.

The modelling supplied for the first application is still valid for the discharge from the existing outlet and we are confident that allowing it to continue and extending the time limit for the activity (or removing it completely) would not make a difference to achieving the above target and safeguarding the CO's of the MCZ outside the 100 metre mixing zone. Allowing the activity to take longer than the one year originally allowed in the first permit, or two years now applied for, would only reduce its potential affects because it would spread a finite load of metals over a greater period.

Table 1 Maximum concentrations of metals in the effluent and minimum dilutions needed to meet EQS's

Substance	Max Conc. of combined abated FED and NOx (µg/l)	EQS MAC (µg/l)	EQS AA (µg/l)	AA Background Conc. Blackwater S.E. of West Mersea	Dilution needed to meet Annual Average EQS 's	Dilution needed to meet Annual Average background concentrations	Average dilution within 100 m mixing zone	Dilution needed to meet MAC EQS's	Absolute minimum dilution within 100 m mixing zone
Cadmium	22.6	n/a	0.2	0.018	113	1,266	48,000	n/a	240
Chromium	186.1	32	0.6	0.250	310	744	48,000	5.8	240
Copper	1239	n/a	10.9	1	113.6	1,239	48,000	n/a	240
Iron	745	n/a	1000	50	0	14.9	48,000	n/a	240
Lead	67	14	1.3	0.024	51.5	2,791	48,000	4.7	240
Mercury	5.2	0.07	n/a	0.008	n/a	650	48,000	74	240
Nickel	226.8	34	8.6	0.94	26.3	241	48,000	6.67	240
Zinc	1043	n/a	7.9	1.2	142	869	48,000	n/a	240

Change of outlet

Changing the outlet to one that does not allow pre-dilution of the effluent can not have any effect on the overall load of metals being discharged to the estuary over the course of the operation so it cannot affect annual average deterioration levels. But it will obviously increase the concentration of metals within the discharge on any one day by a minimum factor of fifty. Fifty was the minimum amount it was pre-diluted by. To make sure that there is no risk to the CO's of the MCZ we have to be sure that there is enough dilution within an allowable mixing zone to meet the relevant EQS's

AA EQS's

HR Wallingford's report in support of the application predicts a minimum annual average dilution factor of 48,000:1 at 100 metres from the discharge point and this is the relevant figure to use to assess potential breaches of AA EQS's. The table above shows the maximum concentrations of each substance in the effluent and the average dilution needed to meet them. It also shows the average dilution needed to reduce the effluent concentrations to annual average background concentration. This type of analysis does not include the background concentrations of the substance in the calculation but when dealing with dilutions of 48,000:1 (which is conservative because the discharge will not take place every day) it can be understood that there is enough dilution to render these insignificant. The table shows that the maximum dilution needed to meet an AA EQS for any substance is 310:1 for chromium. With 48,000:1 dilution we can therefore be certain that no substance in the effluent has the potential to breach an AA EQS outside the mixing zone.

Background concentrations of metals within the MCZ

With regard to the effect of the discharge on the existing background concentrations of each metal in the receiving estuary it can be seen from Table 1 that the highest dilution factor needed to reduce a metal in the effluent to annual average background levels is 2,791:1 for lead. Because there is a daily average dilution available within the mixing zone of 48,000; 1 we are confident that the effect on AA background concentration will be too small to be measurable outside it. Mercury only needs 650:1 dilution to meet background concentrations so we are very confident that mercury levels will not be increased outside the mixing zone.

For these reasons we believe that allowing the change of outlet or extending, or completely removing the time limit for the activity would not threaten the above target. The metals in the estuary outside the mixing zone in all areas of the MCZ would be maintained to the equivalent of Good Ecological Status. If the discharge takes longer than planned the finite load of meals would just be spread over a longer period and any residual increases in their respective concentrations would be lower in proportion to the time taken.

(13) Sediment contaminants

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.

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.

Change to the new outlet

The same principle expressed above applies to the new outlet and the modelling provided by the applicant gives further confidence that the target could be met. It can be seen from the table above that the highest dilution factor needed to reduce any metal in the effluent to its existing annual average background concentration outside the mixing zone is 2,791 for lead and that there is an average dilution available for the effluent within the 100 metre mixing zone of 48,000:1. This dilution factor is still a conservative one because it does not take account of the days on which discharges will not be made. Only 650 :1 is needed for Mercury which is the metal of special concern.

For this reason we believe that allowing the discharge to be made from the new outlet would not threatened the above target of restricting surface sediment contaminants anywhere with the MCZ outside the very limited mixing zone. We also see no reason to restrict the time limit for the activity because spreading the finite load of FED effluent over a greater time period would just reduce any residual increases in annual average concentrations in the water column which would proportionately reduce any surface sediment depositions.

Potential 'In combination' affects

On the 21st of October we wrote to all the other authorities responsible for assessing and licensing plans, projects and operations in the catchment of the Blackwater and wider Essex Estuaries to ascertain if there are any that need to be taken into account in combination with the applications from Magnox Ltd. We have not received any feedback at all to these enquiries.

The only other planned discharges we know of to be taken into account for this assessment are those in the other Magnox applications for the Bradwell site which we are consulting you on. They are (a) the discharge of up to 30 m3 of treated radioactive site drainage and (b) a discharge of up to 130 m3 (in dry weather) of a mixture of, (i) clean surface water runoff, (ii) treated (non-radioactive) contaminated void and surface waters, (iii) secondary treated sewage effluent and (iv) waste water from the treatment of tap water with reverse osmosis filtration.

The only possible potential for a significant 'in combination' affect from the three Magnox effluents on the European site is from the heavy metals that each contain. A few heavy metals are the only pollutants that the three effluents have in common that are present in significant concentrations. Except for iron the metals listed in Table 1 above are also in the discharge (a) and discharge (b) also contains traces of chromium, copper, lead, nickel and zinc.

The fundamental reason we believe the three effluents will not have any significant adverse affects on the above targets and attributes of the MCZ is that the discharges (a) and (b) readily screened out in the initial stages of an 'H1' assessment as insignificant, and that this discharge has been established by more complex modelling to be insignificant also. Insignificant' in the terms of H1 assessments means that there will be no threat of a breach of EQS's or WFD water quality targets and no significant changes to the existing background water quality outside the mixing zone. In other words we do not believe that three insignificant' discharges can combine to make a significant difference to the existing background water quality regime in the receiving Blackwater estuary or the other water bodies of the MCZ beyond it.

It should also be noted that the physical possibilities for the three discharges to combine in the estuary waters are limited because they are not continuous daily discharges. Two of them are rainfall related and although the FED effluent could theoretically be discharged every day it is unlikely to happen in practice, which is why an extension to the time limit has been necessary.

Given both the above factors we do not believe that the changes to the three discharges Magnox have applied for (including the change of outlet and the extension or removal of the time limit for the FED effluent) could combine to threaten any of the targets for attributes that safeguard the CO's of the MCZ.

CONCLUSION

Our aim has been to assess whether the discharge from the existing outlet or from the new outlet has the potential alone or in combination to adversely affect any designated feature of the MCZ or their supporting habitats in their current location, or whether they would prevent the spread or colonisation of them to new areas. We have done this by considering what the zone of potential adverse affect the polluting load from discharge creates within the receiving estuary or beyond.

This zone varies depending on the pollutant in question. For the temperature affects, pH, and metals the zone the discharge can influence is limited to the initial mixing zone stretching 100 metres from discharge point downstream on the ebbing tide. Outside this we are confident there could be no adverse affects on MCZ features because all EQSs and WFD targets would be met and the increases in existing

background concentrations for each pollutant would be negligible. If the background water quality conditions do not change we can be confident that no harm would be caused to any designated feature in their current locations and that there would be no hindrance to the spread of features into new areas. This conclusion is not surprising considering the fact that the discharge is extremely small in relation to the flows of water in the Blackwater Estuary and that the metals concentrations, in the discharge,(for instance) are extremely low, i.e parts per billion.
For nitrates in the discharge the situation is more complex because they are much higher concentrations, i.e. parts per million as opposed to parts per billion for the metals. Although the increases in background concentrations outside the initial mixing zone are limited to 10% there was still a need to consider what affects this could have. The modelling provided by the applicant and the supplementary work undertaken by our ECMAS team were the key to understanding these potential affects. They establish that the potential adverse affects outside the mixing zone with particular reference to excess growth of macroalgae or phytoplankton would not be significant. Very large areas of the MCZ are outside the wider potential zone of influence of the discharge anyway. The wider dispersion plume outside the initial dilution mixing zone is in the main central channel of the Blackwater estuary into the open sea. This takes it away from the inner Blackwater, the Colne estuary and the Dengie and Foulness SSSI's. The Colne and Roach estuaries are too remote to be affected and the only pollutant from the effluent that can still be in significant concentrations as it returns on the incoming tide are nitrates. The residual concentrations of these have been taken into account in HR Wallingford's models and those of our ECMAS team with the results described above.
One key point to note about the proposed discharge is that it is temporary and the overall polluting load to be discharged is finite. Any affects it could have on the MCZ are therefore temporary and it could not threaten any 'Recovery' or 'Reduce' targets in the long term. In the short term we do not believe it would hinder achieving them either because we believe the overriding influences on the current failures of nitrogen standards in the estuaries of the MCZ are from marine sources outside it.
On this basis the Agency is minded to:

Issue the permission with conditions to ensure no significant adverse affect on the designated features of the Blackwater, Crouch, Roach and Colne Estuaries Marine Conservation Zone

<u>Conditions of the permit</u>

The permit will have all the usual standard descriptive conditions but we are minded to have bespoke conditions also. The rationale behind some of the important conditions are outlined below.

<u>Allowing the change to the new outlet</u>

The permit will have conditions that are appropriate for a change to the new outlet if this becomes necessary during the time it takes for Magnox to treat the finite tonnage of waste material quoted in the application.

<u>Nitrates limits and the removal of the time limit for the activity</u>

The threat to the interest features from nitrates in the discharge has been assessed by the HR Wallingford models and (having verified them) we are confident that the results of the modelling demonstrates the impacts will have no significant affect on the MCZ. In order to be sure that there is no impact in reality we therefore have to be sure that the nitrogen loadings used in the modelling inputs are adhered to in practice. We are therefore minded to include in the permit a daily maximum nitrogen load and an overall load for the entire operation. This will accomplish three things, it will, (i) ensure that increases in AA concentrations in the estuary outside the mixing zone will not exceed 10% of existing background levels (ii) allow the possibility of the discharges being made over longer periods than one or two years whilst preventing the exceedance of the overall load of nitrates being discharged so that the increases in AA concentrations may be proportionately lower than 10% and (iii) remove the need for a time limit for the discharge without reducing our control over it.

This last point is important because the time limit Magnox have applied for is already looking impractical and they have indicated informally that the process may now take longer than the two years they have applied for. Having an overall nitrate load limit would keep us in control whilst avoiding the need for a further determination process in two years. For all the reasons given above we believe that having to repeat the determination and consultation processes in two years time would be a waste of the resources of both our organisations.

Metals limits and safeguards

The FED effluent failed the initial screening test primarily because it is denser than seawater and in accordance with our guidance we are therefore minded to set numeric emission limits for the metals that were in significant enough concentrations to require modelling. We will set limits for each that, (i) prevent any breach of MAC or AA EQS's outside the mixing zone. (ii) prevent any significant increase in background concentrations outside the mixing zone and (iii) prevent any breach of WFD targets outside the mixing zone.

Magnox's formal procedure for discharging treated FED effluent includes safeguards to prevent a breach of permit limits. The treated effluent is stored in a holding chamber and tested to make sure it meets all permit limits before the discharge pumps are activated. There is a dual key system to activate the discharge pumps to ensure that two personnel with the appropriate skills and knowledge have to be involved in the decision to pump or not. This elaborate system was designed because of the residual nuclear elements in the discharge but serves to control the nitrates and metals too. We are minded to encapsulate this procedure in an operating technique within the permit so that the system will be maintained.

With numeric limits and this operating technique we would be confident that all the above targets would be met. The same procedure will ensure no breach of nitrates standards.

New outlet structure and discharge timing

In order to be sure that the dilution and dispersion characteristics that produce the necessary mixing within the estuary to protect the interest features are achieved we will include conditions in the permit that stipulate that the outlet structure and timing of the discharge conform to the specifications in the application except for the slight restriction in the discharge window and the limitation to daytime discharges only mentioned above.

Self monitoring, recording and reporting

The permit will have conditions requiring the operator to take representative audit samples of the discharge, and have them analysed for all the substances limited in the permit including the metals and nitrate concentrations. It will also require the dates and volumes of the discharges to be recorded. Other conditions will require the routine reporting of this information to us on a regular basis.

Your agreement to the granting of the permit is sought on this basis

ADDENDUM DOCUMENT

This document was submitted to Natural England to correct clerical errors they had found in the above consultation documents and to respond to the technical queries they had raised during the consultation process. Parts of it refer to the other application we have been determining simultaneously.

Addendum to Habitats consultation documents for applications EPR/DP3127XB and PR2TSE10760 submitted on 29/2/2016

The consultation documents listed below were submitted on the 29 February 2016. This document is an addendum to summarise the changes we have made in the light of your responses and provides extra information to address the concerns you have raised.

Section 1 below outlines what could be termed the clerical corrections and section 2 is a summary of the technical issues.

EPR/DP3127XB (13 documents in total)

This permit is for the discharge of treated FED effluent.

Appendix 4's for, Blackwater Estuary SSSI, Colne Estuary, SSSI, Dengie SSSI, Foulness SSSI, Crouch and Roach Estuaries SSSI

Appendix 11's for, Colne Estuary (Mid-Essex Coast Phase-2) SPA/Ramsar, Blackwater Estuary (Mid-Essex Coast Phase-4) SPA Ramsar, Dengie (Mid-Essex Coast Phase-1) SPA Ramsar, Foulness (Mid-Essex Coast Phase-5) SPA Ramsar, Crouch and Roach Estuaries (Mid-Essex Phase-3) SPA Ramsar, Thames Estuary SPA

Assessments for Blackwater, Colne, Crouch and Roach Estuaries Marine Conservation Zone and for Essex Estuaries SAC

(Note; Essex Estuaries SAC incorrectly treated as an MCZ)

PR2TSE10760 (26 documents in total)

This permit is for two discharges, one of mixed effluent containing treated non radioactive site (Non RAD SD) drainage and one of treated radioactive site drainage (RAD SD). For the sake of clarity we submitted separate consultation documents for each of the habitat sites below for each discharge.

Two Appendix 4's for, Blackwater Estuary SSSI, Colne Estuary, SSSI, Dengie SSSI, Foulness SSSI, Crouch and Roach Estuaries SSSI

Two Appendix 11's for, Colne Estuary (Mid-Essex Coast Phase-2) SPA/Ramsar, Blackwater Estuary (Mid-Essex Coast Phase-4) SPA Ramsar, Dengie (Mid-Essex Coast Phase-1) SPA Ramsar, Foulness (Mid-Essex Coast Phase-5) SPA Ramsar, Crouch and Roach Estuaries (Mid-Essex Phase-3) SPA Ramsar, Thames Estuary SPA

Two assessments for Blackwater, Colne, Crouch and Roach Estuaries Marine Conservation Zone

Two assessments for Essex Estuaries SAC - Essex Estuaries SAC incorrectly treated as an MCZ

(1) Clerical Corrections

Essex Estuaries SAC Appendix 11's

We re-submitted three Appendix11's for the SAC having mistakenly initially submitted them as MCZ assessments. Following your comments on them we now submit them again with your suggested amendments as follows;

(i) Inclusion of the overlapping SPA's/Ramsars

(ii) Conservation objectives amended as suggested

(iii) Inclusion of the information that the only designated feature within the mixing zone is ‘subtidal mud’ and the extent of the area of this feature in the SAC (as you report) is given for comparison

<u>All other Appendix 11 ‘s</u>

Inclusion of > 20,000 waterfowl assemblage feature for the SPAs and addition of the saltmarsh Ramsar feature in the format agreed in your email of 13 May 2016.

<u>All Appendix 4’s</u>

Inclusion of the appropriate interest features to all the Appendix 4’s

<u>All consultation documents</u>

In checking the documents for your responses we noticed that the explanation of safety factors for EQS’ on all the documents was incorrect. This section has been re-worded on every document.

(2) <u>Technical Issues</u>

To avoid having to rewrite, or add to, sections of 39 documents the technical issues you have raised are addressed here with explanations of which discharge they apply to although some of them apply to all the discharges from the Bradwell site.
In addition to addressing your issues there are some others which have arisen since the consultation documents were submitted which we have discussed informally but not yet put into writing. These are also be outlined and explained below.

‘In combination’ effects
(applies to FED, Non RAD and RAD when the new outlets have to be used)
Your main response to our consultation documents was the need for a more robust ‘in combination’ assessment. That is, an assessment of the potential for the metals concentrations in the three discharges from the Bradwell site to combine to have an adverse affect on the features of the designated sites. The three discharges are, treated FED effluent (FED), treated non-radioactive site drainage effluent (NON RAD SD) and treated radioactive site drainage(RAD SD).
In the habitats documents we relied on the fact that the concentrations of metals in the NON RAD SD and RAD SD passed the screening tests in H1 guidance and were deemed to be ‘insignificant’ and that the hydrodynamic modelling for the treated FED effluent discharge established that it was also ‘insignificant’. Our conclusion was that three ‘insignificant’ discharges (two of which are made on different tides and so cannot combine) could not add up to have significant adverse affect.
The main problem in producing a more quantified approach to potential ‘in combination’ affects was that the applicant did not provide modelling dilution factors for the NON RAD SD because it passed the H1 screening exercise. However in the light of your request we asked our modelling experts to see if they could help with this and they subsequently used the information in the application and some standard modelling software to calculate what is called an ‘initial dilution’ (ID) factor for the NON RAD SD.
ID’s are the dilutions factors that effluents are subject to just within the water column as they rise to the surface. They are conservative because they do not take account of any lateral dilution as the current moves and disperses the effluent to the edge of the mixing zone. In this case our modeller calculated what is termed a ‘still water’ ID which is even more conservative because it does not even take account of the water current moving through the effluent column as it rises. The ID dilution factor was also calculated using the depth at the lowest astronomical tide because the NON RAD SD effluent is part of the mixed effluents discharge that is pumped automatically and can occur at any tidal state. The resulting ID factor is therefore an extreme worst case

scenario that could not actually occur in any real event. However it is useful as tool to rule out any possibility of an instantaneous toxic ‘in combination’ event.
Our modeller’s first calculation of ID was a factor of 4.8:1 and this is the figure we gave you in our original ‘in combination’ assessment in our email on the 16 May 2016. The email included a table which added up the contributions of metals concentrations from the three effluents on to the existing background concentrations. Subsequently our modeller needed to revisit the calculation for another purpose and found that a slight error had been made. Having corrected the error the revised ID factor is now calculated to be 9.2:1.
The table below is a revised version of the one we sent you on the 16 May 2016. It is different in two respects. The first is that we have used the 9.2:1 dilution factor to recalculate the contribution of metals from the Non RAD SD. The second is that instead of using the maximum concentration of metals detected in the FED effluent we have used the emission limit for each metal that we are intended to put on the permit we are minded to issue. We didn’t do this in the original table because we had not calculated definitive limits at that stage.
With the exception of Iron the emission limits have been derived by doubling the maximum concentrations detected in the effluent in accordance with our guidance for the setting of limits for existing discharges of trade effluent. In the case of Iron we have quadrupled the maximum concentration for reasons outlined separately in a section below.
The table below illustrates how we have used these figures, and the absolute minimum dilution factors for the FED (250:1) and NON RAD (240:1) from the applicants hydrodynamic modelling of the effluents, to calculate what contribution each would make to the overall concentration of each metal in the estuary at the edge of the mixing zone. It shows that if all three discharges made their contribution of metals into the mixing zone at the same time and this was added to the existing background concentrations, there would be no breach of the MAC EQS at the edge of the zone for any substance.
As illustrated in the table the contribution from each discharge has been calculated by dividing the maximum concentration detected in each effluent by the dilution factor that has been calculated for it. For the metals that do not have MAC EQS’s I have included the AA EQS in the table to give something to make a comparison with. It can be seen that there is only one case where the AA EQS would be slightly breached. The total contributions and the background concentration of Zinc add up to 10.56 and the AA EQS for Zinc of 7.9. However in practice no AA EQS’s would be broken because the dilutions available for AA EQS’s are huge (i.e 48,000 :1).
It should also be noted that the total concentration of all the contributions plus the background concentrations in the bottom of each column is a very large overestimate that could not occur in practice. This is not only because the 9.2:1 factor used for the NON RAD SD does not allow for any movement of current through the vertical mixing zone or any lateral movement over 100 metres, but also because the FED and NON RAD contributions could not be at the edge of the mixing zone at the same time. This is because they will be discharged on different tides even if they were discharged on the same day. There will always, therefore, be several hours between them and each one will have cleared from the edge of the mixing zone before the next one takes place. We have only included the three together to completely rule out any chance of an ‘in combination; effect.
We haven’t produced a similar table for the combination of the effluents compared with annual average EQS’s because the dilution factors for AA EQS’s are much greater than for MAC’s (i.e 48,000 :1 for FED) so the contributions for each effluent can only be very much lower than the one in the table. So the result would be the same it would just be more emphatic.

It is therefore clear that the three discharges can not combine with each other or the existing background levels to create a short term toxic effect, or a long term chronic effect in the receiving waters outside the mixing zone.

Discharge Type	**Cadmium (ug/l)**	**Chromium (ug/l)**	**Copper (ug/l)**	**Iron (ug/l)**	**Lead (ug/l)**	**Mercury (ug/l)**	**Nickel (ug/l)**	**Zinc (ug/l)**
Contribution from the treated **FED** effluent to metal in the mixing zone (Max Conc in effluent divided by minimum dilution of 250 :1)	45.2 ÷ 250 = 0.18	372 ÷ 250 = 1.48	2,478 ÷ 250 = 9.9	3,000 ÷ 250 = 12.0	134 ÷ 250 = 0.53	10.4 ÷ 250 = 0.04	454÷ 250 = 1.8	2,086. ÷ 250 = 8.3
Contribution from the **RAD SD** (Max Conc,in effluent divided by the minimum dilution of 240:1)	2 ÷ 240 = 0.008	23 ÷ 240 = 0.09	30 ÷ 240 = 0.1	485 ÷ 240 = 2.0	5 ÷ 240 = 0.02	2.1 ÷ 240 = 0.008	14 ÷ 240 = 0.05	122 ÷ 240 = 0.50
Contribution of the **NON RAD SD** (Max Conc in effluent divided by the minimum dilution of 4.18 :1)	Nil	11.4 ÷ 9.2 = 1.2	3.23 ÷ 9.2 = 0.35	Nil	1.54 ÷ 9.2 = 0.16	Nil	4.92 ÷ 9.2 = 0.53	5.23 ÷ 9.2 = 0.56
Background Concentration	0.018	0.250	1	57.96	0.024	0.008	0.94	1.2
Total	0.2	3.02	11.35	71.96	0.734	0.056	3.32	10.56
MAC EQS	No MAC EQS (AA EQS 0.2)	32	No MAC (AA EQS 10.9)	No MAC (AA EQS 1000)	14	0.07	34	No MAC (AA EQS 7.9)

Sediment sampling
(applies to FED, Non RAD and RAD when the new outlets are used)
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. 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

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 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

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.

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.

Temperature affecting mixing of the effluent
(mainly applies to FED when the new outlet is used)

Although it is not explicitly stated in the modelling documents provided in support of the application, the effects of the temperature of the FED effluent on its mixing within the receiving waters has been taken into account, Our modelling expert has verified that this has done correctly and that the results of the modelling exercise are valid.

We note your comments that the pumping of the Non RAD SD and RAD SD could raise the temperature of these effluents very slightly. We agree with your conclusions that these rises will be extremely small and not significant,

Plant response confined to the outer estuary
(applies to the FED only)

We note your comment that it is useful to state that the potential for adverse (eutrophic) plant responses occurring from the nitrate load of the FED discharge would be limited to the outer Blackwater estuary. This is the view of our modelling expert based on her vetting of the applicant's hydrodynamic modelling and further work she undertook herself.

Limiting of discharge timing may be restricted
(applies to FED only when the new outlet is used)

In the consultation documents for the treated FED effluent discharge we stated that additional work undertaken by our modelling expert indicated that there would be an advantage (in terms of further limiting the potential effects of nitrates on plants in the estuary) in having a permit condition that would restrict the discharges of FED effluent to only those tides that ensured that the returning incoming tides happened in darkness, and that we intended to have such a condition in the draft. However when we informed the applicant of this they said that this would be impractical in some periods of summer, because of the long hours of daylight.

We have therefore asked the applicant to produce an 'operating technique' (OT) that will outline the criteria for the timing for discharges to be made as often as is practicable (given the hours of daylight and the timing of the tides) on a tide that will ensure a returning tide is in darkness. We will endeavour to ensure that this OT is as robust as possible.

It should be remembered that the purpose of this discharge timing was mitigation within an acceptable parameter for protection of the environment and not an essential requirement to ensure that water quality targets are met and the environment protected.

Change of the volume of sewage effluent
(applies to the mixed effluent discharge only when the new outlet is used)

As part of the determination process we asked the applicant to verify the specification of their package sewage treatment plant (STP) that serves the workforce on site and the effluent from which forms part of the 'mixed effluent' discharge controlled by permit PR2TSE10760.

In their response the applicants stated that the maximum daily volume the STP could discharge is 45 cubic metres (m3) and not 30 m3 as indicated in the application. This volume is the designed maximum daily capacity of the STP and is suitable for the current size of workforce on site. The daily volume is unlikely to reach this level because the per capita water usage on site is probably lower than the maximums used for the design of STP's but (for the purposes of assessing the impact) we have to assume the worst case scenario of this occurring every day.

For the existing discharge of sewage effluent in large volumes of abstracted seawater the possible increase in volume is definitely not significant because of the big pre-dilution.

However when the new outlet has to be used we still do not believe that the 15 m3 increase will be significant. This is because of the way the mixed effluent discharge is made via automatic pumps from a holding chamber. As described in the main consultation document, as well as receiving STP effluent the holding chamber also takes two types of site drainage and a small volume of reverse osmosis waste waters. A float switch in this chamber is set to discharge 130 m3 from it when a certain level is reached and up to a maximum 50,000 m3 on one day, if ingress continues because of continued wet weather.

This means that in a period of prolonged dry weather the only input into the chamber may be treated sewage effluent and, after a few days , this may trigger a discharge of 130 m3 of treated effluent alone.

Prior to being informed of the potential increase of the daily volume of the STP effluent we had already based our impact assessment on this worse case scenario of a 130 m3 discharge made up entirely of sewage effluent. The only difference the increased volume makes is that the number of days it could take the sewage effluent alone to trigger a discharge will be slightly less.

Because the discharge is pumped automatically it could occur on any tidal state and in any current flow. We have therefore considered the absolute worst case scenario of a discharge of 130 m3 of STP effluent at the lowest tidal state. As stated above the lowest possible dilution for the effluent at the lowest astronomical tide has been calculated by our modelling expert to be 9.2:1 but this only takes account of dilution upwards in the water column and not of dilution that it would receive laterally or as current flows through the mixing zone. However even a 9.2:1 dilution is enough to prevent any instant polluting effects from the effluent which is designed to achieve a standard of 20 mg/l BOD (Biochemical Oxygen Demand) 30 mg/l suspended solids and 20 mg/l of ammonia. Because sewage effluent is buoyant it will rise to the surface to mix further and pose no risk to species on the estuary bed. On other tidal states and when there are site drainage waters mixed with it the dilution factors for the sewage effluent will be much greater. For these reasons we do not believe the increase in the possible maximum daily volume of the treated sewage effluent into the holding chamber from 30 m3 to 45 m3 poses any risk to any of the designated features of any of the habitats sites.

Proposed change to emission limit for Iron

In the consultation documents we stated that we would be setting emission limits for substances on the permit for the treated FED effluent that would, prevent a breach of the conservation objectives of the MCZ and protect all the designated interest features of all habitats sites listed above.

When setting emission standards for hazardous substances (such as metals) the Agency does not allow individual discharges to take up all the environmental tolerance available in the receiving waters but seeks to minimise the release of them as far as possible. But this has to be balanced with what it is practical for the permit holder to comply with and the knowledge that all effluents have the potential to fluctuate in quality. Where there is a lot of tolerance within the environment we are able to allow a little for these possible fluctuations. This prevents us having to become engaged in enforcement work for failures of limits that would not actually have any adverse environmental impact because of there being sufficient dilution in the receiving environment. In this case for instance there is 48,000:1 dilution available to prevent a breach of an AA EQS. Theoretically we could set an emission standard close to 48,000 X the AA EQS for the discharge without causing a breach of

the EQS outside the mixing zone. But because we want to minimise the releases of substances we would not set such a limit.
In line with the ‘H1’ guidance (published on the Gov.UK website) we can set emission standards for existing discharges of trade effluent up to twice the maximum concentrations detected in the effluent and higher multiples if it is justified. With the exception of Iron that is what we are proposing in this case and the table above demonstrates that this would not lead to breaches of EQS.
The reason we have made the exception for Iron and quadrupled the maximum concentration to derive an emission standard are;

(1) Iron is less toxic and persistent in the environment than the other metals detected in the effluent.

(2) In contrast to the other metals detected in the effluent, the maximum iron concentration detected is less than its EQS. The maximum detected is 745 micrograms and the EQS is 1000 micrograms.

(3) Iron is also one of the metals that does not have a MAC EQS so there is no threat of a direct toxic affect from a breach of concentrations well in excess of 1000 micrograms

(4) Iron is not one of the metals detected in concerning concentrations in the grab survey of metals in sediments mentioned in the MCZ conservation advice.

(5) Allowing some extra leeway for iron will prevent the applicant missing some discharge opportunities which would be costly for them and would also delay the completion of the FED project.

    The background to this is that Magnox Ltd analyse every batch of treated FED effluent and check the results before deciding to discharge it. If there is any failure of an emission standard they will not make a discharge. Failing to make a discharge on the high waters of a tide means that many hours can be wasted until the effluent is re-tested for greater accuracy or re-treated to meet the effluent standard. Currently, because they are able to allow for large volumes of pre-dilution in abstracted seawater, the metals standards on the existing permit are routinely met. But when the switch is made to the new outlet and the new emission limits have to be met without pre-dilution there is the potential for marginal failures of a limit to cause delays.

    The analytical data that Magnox provided for past discharges indicates that on quite a few occasions they would not have been able to meet the proposed metals limits and make a discharge (without re-testing or re-treating) if they had not had the facility to pre-dilute their effluent. So in future without pre-dilution there is the risk of this happening. They have therefore requested that we relax the indicative metals limits we have given them to prevent costly delays.

    Except for Iron we have declined to do this because the evidence we have at the moment does not support a relaxation. However in case of iron we are minded to double again our original doubling of the maximum concentrations detected in the effluent and our new proposed emissions standard for iron is 3,000 micrograms. The table above shows that this would not threaten a breach of any EQS. Iron only has an AA EQS and there is 48,000:1 dilution for the treated FED effluent at the edge of the mixing zone.

Allowing this relaxation of the proposed iron limit will therefore help to prevent a few delays of the operation without risking a significant adverse affect on the environment.

THE RESPONSE FROM NATURAL ENGLAND TO THE ABOVE CONSULSTATION DOCUMENTS

Date: 08 July 2016
Our ref: 180591
Your ref: PR2TS/E10760, EPR/DP3127XB

NATURAL ENGLAND

Bill Greenwood
Water Quality Permitting Officer
Environment Agency

International House, Ashford, Kent TN23 1HU.

T 07788 574908

BY EMAIL ONLY

Dear Bill

Advice on Bradwell Discharge Permits: PR2TS/E10760 (NON-RAD and RAD), EPR/DP3127XB (FED)

Thank you for your request for formal advice on the above discharge permits, received 28 June 2016. The following constitutes Natural England's formal statutory response.

Please note that the advice below relates to the following documents which formed part of this consultation:

1. 15 Appendix 4 documents
2. 21 Appendix 11 documents
3. 3 MCZ Assessments
4. Habitats Addendum Report

Natural England welcomed the dialogue between the Environment Agency and ourselves during the drafting and finalisation of these documents. Throughout these discussions Natural England worked on the principle that the EA is the competent statutory body to assess such impacts and therefore, to a large extent relied upon your status and public duties to ensure that issues relating to water quality were adequately assessed.

We believe that the Habitats Addendum Report provides a useful overview of the key issues we sought clarification on and further, it sets out clearly the appropriate analysis and mitigation which underpins the decisions relating to these three discharge permits.

Marine and Coastal Access Act 2009

The proposed discharges, as set out in the information provided, occur within a Marine Conservation Zone (MCZ).The Blackwater, Crouch, Roach and Colne Estuaries MCZ has been designated due to the presence of:

- Intertidal mixed sediments
- Clacton Cliffs and Foreshore
- Native oyster *(Ostrea edulis)* beds
- Native oyster *(Ostrea edulis)*

Having reviewed the evidence and mitigation relating to the site we believe that the discharges will not hinder the conservation objectives of this site, so long as they are undertaken in strict accordance with the conditions that the EA are minded to append to the permits.

The Conservation of Habitats and Species Regulations 2010 (as amended) and The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (as amended)

We can confirm that the three discharges are located both within and adjacent to the Crouch and Roach Estuaries Special Protection Area (SPA) and Ramsar, Blackwater Estuary SPA and Ramsar, Colne Estuary SPA and Ramsar, Dengie SPA and Ramsar, Foulness SPA and Ramsar, Outer Thames Estuary pSPA and Essex Estuaries Special Area of Conservation (SAC). Please note that the Outer Thames Estuary pSPA is currently out for consultation regarding an extension to the site to cover the marine foraging areas of two tern species which are features of the exisiting coastal SPAs. We are aware that the original Appendix 11 document drafted for this site was written prior to these proposals and does not include these new features and extents. We can confirm, however, all the information provided in the forms for the coastal SPAs adequately assess any potential impacts to these species (including whilst they are foraging at sea).

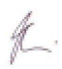
Having reviewed the evidence and mitigation relating to these sites, providing the permits for these discharges are granted with the conditions outlined in the documentation appended, it can be excluded that they will have a significant effect on any SPA, SAC or Ramsar site, either individually or in combination with other plans or projects. Therefore it is our view that an Appropriate Assessment of the implications of these discharges on the site's conservation objectives should not be required.

Wildlife and Countryside Act 1981 (as amended)

We can confirm that the proposed discharges are located either within or adjacent to Blackwater Estuaries SSSI, Colne Estuary SSSI, Dengie SSSI and Foulness SSSI. Natural England advises that the permits, if granted with the conditions outlined in the documentation appended, are not likely to damage the interest features for which the sites have been notified.

Please note, if the EA are minded to grant these permits with different conditions from what has been detailed in these assessments, our advice may not remain fit for purpose and we would need to be re-consulted. For any queries relating to the content of this letter please contact me using the details provided below.

Yours sincerely



Ingrid Chudleigh
Senior Marine Adviser
E-mail: ingrid.chudleigh@naturalengland.org.uk