

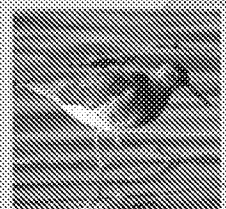
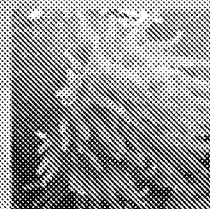
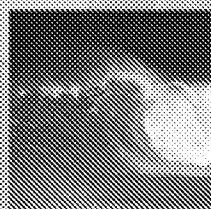
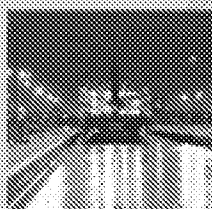
Managed Breach of Shingle Spit at Pagham: Environmental Statement

Update to (Volume 2) Appendix H:
Water Framework Directive Compliance Assessment

Pagham Parish Council

February 2017

Creating sustainable solutions for the marine environment



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D J Honey	E San Martin	C R Scott

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ABP Marine Environmental Research Ltd
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ
T: +44 (0) 2380 711844 W: <http://www.abpmer.co.uk/>

Contents

H.1	Introduction	1
H.2	Water Body Information	3
H.2.1	Overview	3
H.2.2	Potentially Affected Water Bodies.....	4
H.3	Water Quality and Protected Areas.....	7
H.3.1	Bathing Water Directive	7
H.3.2	Shellfish Waters Directive	7
H.3.3	Urban Waste Water Treatment Directive.....	8
H.3.4	Nitrates Directive.....	8
H.3.5	Protected Areas	8
H.4	Water Framework Directive Assessment.....	10
H.4.1	Assessment Methodology.....	10
H.4.2	Contributing to Improvements in WFD Status/ Potential.....	16
H.5	Conclusion	18
H.6	References	19
H.7	Abbreviations/Acronyms	20

Tables

Table H1.	Water Framework Directive Parameters for Potentially Affected Water Bodies Based on 2009 RBMP Classifications and 2013/2014 Interim Results	6
Table H2.	Summary of Proposed Works	10
Table H3.	WFD Compliance Assessment.....	11

Figures

Figure H1.	Water/Sediment Quality Designations and Monitoring Sites (Original Figure 7.1 of R.2446 Main Report).....	22
Figure H2.	Location and Design of Proposed Breach and Channel Infill (Original Figure 2.2 of R.2446 Main Report).....	23

H.1 Introduction

This report is a Water Framework Directive Compliance Assessment that has been prepared by ABPmer to accompany a proposal from Pagham Parish Council (PPC) for a managed breach of the shingle spit fronting Pagham Harbour. This assessment was originally produced to accompany the Environmental Statement (ES) (ABPmer, 2015) for this proposal and was included as Appendix H of that report. During the subsequent period when this planning application was evaluated by Arun District Council¹, the Environment Agency asked that Bathing Water issues also be reviewed. This request is expected to be a planning condition and, to address that condition in advance, this updated version of the original Appendix H WFD assessment has been prepared.

The Pagham Parish Council (PPC) and its working group, the Pagham Flood Defence Steering Group (PFDSG), are proposing to undertake a controlled breach of the shingle spit feature at the mouth of Pagham Harbour on behalf of the local community at Pagham, West Sussex. The primary aim of this proposed shoreline adjustment is to move the coastline towards a more sustainable morphology and help address the severe coastal erosion problems that are being experienced on Pagham Beach as well as achieving other benefits for nature and the community.

The issues of erosion at Pagham Beach are largely being caused by the 'Church Norton Spit' in front of Pagham Harbour which has grown substantially over the last decade. In recent years, the northern end of this spit has migrated closer towards Pagham Beach and, in this position, it has caused a tidal channel to cut into the beach leading to rapid localised shoreline retreat. The formation of the spit and the tidal channel are also 'locking up' shingle and not allowing it to reach adjacent, and more slowly eroding, sections of the Pagham foreshore via the usual long-shore sediment transport pathways. The proposed controlled breach of the Church Norton Spit is designed to alleviate these erosion problems in a manner that works with natural coastal processes rather than alternatives which seek to 'battle' against such processes in a reactive manner.

On behalf of the PPC and PFDSG, ABPmer (with input from other relevant specialists as required) has undertaken a sequence of evidence-based studies to progressively verify, develop and inform this proposal. These studies have included reviewing the proposal against available alternatives, identifying a preferred approach and design for such a measure, confirming the construction methods and undertaking the required impact assessment work. An Environmental Statement (ES) has been prepared to review the environmental impacts of this proposal to inform the process of securing planning permission and other relevant consents.

In addition to the ES, there is a requirement to assess the effects of the proposed works under the requirements of the Water Framework Directive (WFD) (2000/60/EC). There is currently no specific guidance about the application of the WFD to marine/estuarine construction projects². Therefore, this WFD compliance assessment includes consideration of the guidance set-out in the existing

¹: ADC Planning Reference P/97/15/PL - Pagham Harbour managed breach

² This was relevant in 2015 when the original Planning Application was submitted and the WFD assessment was produced based on the Environment Agency (2012) 'Clearing the Waters' guidance. Updated guidance has since been published by the Environment Agency (2016), referred to as 'Clearing the Waters for All' (<https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters>), to consider the potential impact(s) from any activity or development on WFD parameters of nearby coastal and estuarine water bodies. However, following a review by ABPmer, it is considered that use of the original guidance here has not resulted in a material difference in terms of determination whether the proposed development at Pagham complies with the objectives of the WFD.

Environment Agency (2012) 'Clearing the waters' user guide for marine dredging activities. Where appropriate, the assessment will provide reference to relevant sections of the ES.

It should be noted that a WFD compliance assessment was originally included as Appendix H to the ES which was submitted in September 2015 (ABPmer, 2015). This document is now being submitted (September 2016) as an update to that original Appendix H. This update specifically addresses considerations relating to the potential impacts of the proposed works at Pagham on Protected Areas (e.g. Bathing Waters). This issue has been scoped into the assessment following consultation with the Environment Agency during the post-submission period. One main reason for scoping this in now is that there was no opportunity to complete the project during November/December 2015 as originally intended. Instead, the intention is now to progress the work after September 2016 (for nature conservation reasons the aim is to minimise activities during the bird overwintering period) and that is likely to bring the working window into the May to September bathing water period.

While the bathing water details have specifically been updated for this assessment other aspects of the report, such as the water body classifications and the background policy context, have not been altered from the original submission. Therefore, the text must be read in this context.

In addition to reviewing the bathing water details, this update to the WFD compliance assessment also considers the findings from a separate 'Further Information Report' that was issued in May 2016 (ABPmer, 2016) as part of the planning application process. That further information report provided extra information on the nature conservation effects of the proposal and on the associated mitigation and compensation measures. It also reviewed the implications of a natural breach of the spit at Pagham that occurred in early 2016 (i.e. after the original ES submission).

H.2 Water Body Information

H.2.1 Overview

Under the WFD, coastal waters, estuaries, rivers, man-made docks and canals are divided up into a series of discrete water bodies. The WFD sets ecological as well as chemical targets (objectives) for each water body. However, as other factors can affect the ability of a water body to meet its ecological targets, objectives are also set under the WFD in respect of:

- Changes in 'hydromorphological' parameters such as hydrology (tidal flows) and geomorphology (bed forms); and
- Changes in 'physico-chemical' parameters such as dissolved oxygen, salinity and nutrients.

Each surface water body has a hydromorphological designation that describes how modified a water body is from its natural state. Water bodies are either undesignated or designated as a heavily modified water body (HMWB) or artificial water body (AWB). HMWBs are defined as bodies of water which, as a result of physical alteration by human activities (such as flood protection, port/harbour use, commercial fin-fish and shellfisheries and resource extraction), are substantially changed in character and cannot therefore meet good ecological status (GES), whereas AWBs are artificially created.

The default target for HMWBs and AWBs under the WFD is to achieve 'good ecological potential' (GEP), a status which recognises the importance of their human use whilst making sure ecology is protected as far as possible, and good surface water chemical status by 2015 or 2027. Ecological potential and status are measured on a scale of high, good, moderate, poor and bad, while chemical status is measured as either good or fail.

Compliance with chemical status objectives is assessed in relation to environmental quality standards (EQSs) for a specified list of 'priority' and 'priority hazardous' substances. These priority (hazardous) substances were first established by the Priority Substances Directive (2008/105/EC) which entered into force in early 2009. The Priority Substances Directive set objectives, amongst other things, for the reduction of these substances through the cessation of discharges or emissions. As required by the WFD and Priority Substances Directive, a proposal to revise the list of priority (hazardous) substances was submitted in 2012. Subsequently, an updated Priority Substances Directive (2013/39/EU) was published in 2013, identifying new priority substances, setting EQSs for those newly identified substances, revising the EQS for some existing substances in line with scientific progress and setting biota EQS for some existing and newly identified priority substances.

It is intended that the 'new' Priority Substances Directive will be transposed into UK legislation in September 2015, ahead of the publication of the second cycle RBMPs, along with revised directions for the Environment Agency. Therefore, at the time of writing (the original submission), the original Priority Substances Directive (2008/105/EC) remains in force without the forthcoming amendments associated with the updated Priority Substances Directive (2013/39/EU); however, it is considered appropriate to report against revised EQS values where relevant data is available.

River Basin Management Plans (RBMPs) are a requirement of the WFD, setting out measures for each river basin district to improve water quality in rivers, lakes, estuaries, coasts and in groundwater. In 2009, the Environment Agency published the first cycle (2009 to 2015) of RBMPs for England and

Wales, reporting the status and objectives of each individual water body. The managed breach at Pagham is located within the catchment of the South East RBMP (Environment Agency, 2009a).

The Environment Agency is currently updating RBMPs in preparation of the second cycle (2015 to 2021). Draft versions were made available for consultation in late 2014, including draft South East RBMP (Environment Agency, 2014). The draft RBMPs present interim results from 2013 and, therefore, provide an indication of water body status that will be reported in the updated RBMPs in 2015.

In addition, interim results from 2014 are now available via the Environment Agency Catchment Data Explorer³. As the draft RBMPs have not been formally adopted and remain under consultation, it is considered prudent to continue to refer to the existing RBMPs in this assessment and exercise caution in the use of interim results.

H.2.2 Potentially Affected Water Bodies

Water bodies to be considered have been selected on the basis of the following criteria:

- ✧ All surface water bodies that could potentially be directly impacted by the proposal (i.e. those within the direct footprint of the proposed works); and
- ✧ Any surface water bodies that have direct connectivity and could potentially be indirectly affected by the proposed works.

The proposed works (breach and infill) are to be located wholly within the Sussex water body, although very close (<100 m) to the boundary of the adjacent Pagham Harbour water body, see Figure H1 (ABPmer, 2015 Figure 7.1). Therefore, these two water bodies could be affected by the proposed works and are discussed in the following sections (Table H1 provides a summary, including water body status for each parameter assessed).

The Pagham Lagoon water body (ID: GB560704117300) is a small transitional AWB within 2 km of the proposed works (to the north-east), currently achieving an overall moderate potential (Environment Agency, 2009a). However, due to the discrete nature of the water body (i.e. separate from Pagham Harbour water body), Pagham Lagoon has therefore been scoped out of this assessment.

Three riverine water bodies are located upstream of the Pagham Harbour water body, namely Pagham Rife (ID: GB107041012880), Bremere Rife (ID: GB107041006610) and Broad Rife (ID: GB107041006580). These more distant surface water bodies are not considered to be affected by the proposed works at Pagham as the project will only alter the hydrodynamics of the environment in the locality of the works. There will be no physical or environmental effects to riverine environments beyond the Pagham Harbour water body, especially at a water body scale. Equally, these upstream water bodies will not be benefited by the project. However, sections of the Arun and Western Streams management catchment, within which the project site is located, could be altered (through erosion or accretion) in the event of an unmanaged breach at Pagham. It is this adverse effect that is aimed to be avoided by implementing the project. Therefore, these three upstream water bodies have been scoped out of the assessment.

³ Environment Agency - Catchment Data Explorer: <http://environment.data.gov.uk/catchment-planning/>.

H.2.2.1 Sussex

The Sussex water body (ID: GB640704540003) is a coastal water body, designated a HMWB for coastal protection and fin fisheries. The water body currently has an overall moderate status, based on moderate ecological potential and good chemical status (Environment Agency, 2009a). Moderate ecological potential is due to the mitigation measures assessment identifying numerous measures which are 'not in place' (disproportionately expensive). The current classification is reflected in the latest interim results (2014) whereby the Sussex water body is considered to have overall moderate potential, with moderate ecological potential and good chemical status.

H.2.2.2 Pagham Harbour

The Pagham Harbour water body (ID: GB570704700000) was described as coastal in the first cycle South East RBMP (Environment Agency, 2009a); however, the second cycle South East draft RBMP (Environment Agency, 2014) and recent interim classifications have amended the designation to a transitional (i.e. estuarine) water body. Similarly, the water body was classified as an AWB in the 2009 classification, while the recent draft RBMP and interim results refer to the water body as a HMWB (reasons for designation unknown). For the purposes of this assessment, and to reflect the anticipated changes, the Pagham Harbour water body will be considered a transitional HMWB.

The overall status of the Pagham Harbour water body is currently moderate, based on moderate ecological potential and good chemical status ('does not require assessment'), and is therefore failing to meet its WFD objectives (Environment Agency, 2009a). Moderate ecological potential is due to the biological element macroalgae and supporting element dissolved inorganic nitrogen (DIN) both being assessed as moderate (uncertain). This is reflected in the latest interim results from 2014, whereby overall status is considered moderate. However, while these latest results also report ecological potential as moderate, chemical status is assessed as failing to achieve good. In terms of ecological potential, macroalgae is still assessed as moderate, while DIN has been upgraded to good (2013) and high (2014) status in the latest interim results. The biological element angiosperms is also assessed as moderate in the interim results (2014), while the priority substance fluoranthene is failing to achieve good with regards to chemical status.

Table H1. Water Framework Directive Parameters for Potentially Affected Water Bodies Based on 2009 RBMP Classifications and 2013/2014 Interim Results

Parameter	Sussex		Pagham Harbour	
	2009	2013/2014	2009	2013/2014
Water Body ID	GB640704540003		GB570704700000	
Water Body Area	190.60 km ²		2.57 km ²	
Water Body Type	Coastal	Coastal	Coastal	Transitional
Hydromorphological Designation	HMWB	HMWB	AWB	HMWB
Parameter	Classification			
Overall Potential	Moderate	Moderate	Moderate	Moderate
Ecological Potential	Moderate	Moderate	Moderate	Moderate
Chemical Status	Good	Good	N/A	Fail
Invertebrates	Good	Good	Good	Good
Macroalgae	-	-	Moderate	Moderate
Phytoplankton	-	Good	High	High
Angiosperms	-	-	-	Moderate
Dissolved Inorganic Nitrogen	-	Good	Moderate	High
Dissolved Oxygen	-	High	High	High
Un-ionised Ammonia	-	-	High	High
Mitigation Measures Assessment	Moderate	Moderate	Good	-
Hydrological Regime	-	-	-	Good
1-1-1-trichloroethane	-	-	-	Good
Arsenic	High	High	-	High
Copper	High	High	-	High
Dimethoate	High	High	-	-
Iron	High	High	-	High
Zinc	High	High	-	High
1,2-Dichloroethane	High	Good	-	-
Cadmium and Its Compounds	High	Good	-	Good
Hexachlorobenzene	High	Good	-	-
Hexachlorobutadiene	High	Good	-	-
Hexachlorocyclohexane	High	Good	-	-
Nonylphenol	-	-	-	Good
Fluoranthene	-	-	-	Fail
Lead and Its Compounds	High	Good	-	Good
Mercury and Its Compounds	High	Good	-	-
Nickel and Its Compounds	High	Good	-	Good
Pentachlorophenol	High	Good	-	-
Trichlorobenzenes	High	Good	-	-
Trichloromethane	High	Good	-	Good
Aldrin, Dieldrin, Endrin and Isodrin	High	Good	-	-
Carbon Tetrachloride	High	Good	-	-
Para - para DDT	High	Good	-	-
Tetrachloroethylene	High	Good	-	-
Trichloroethylene	High	Good	-	-
Tributyltin Compounds	-	Good	-	-

H.3 Water Quality and Protected Areas

This section outlines the relevant water quality information that is pertinent to other water quality directives and protected areas, specifically within 2 km of the proposed works. These areas are covered by the Bathing Water Directive, the Shellfish Waters Directive, the Urban Waste Water Treatment Directive (UWWTD), other water quality directives (e.g. Nitrates Directive) and international protected areas (e.g. Natura 2000 designations under the Birds and Habitats Directives).

H.3.1 Bathing Water Directive

The revised Bathing Water Directive (rBWD) (2006/7/EC) was adopted in 2006, updating the microbiological and physico-chemical standards set by the original Bathing Waters Directive (BWD) (76/160/EEC) and the process used to measure/monitor water quality at identified bathing waters. The rBWD focuses on fewer microbiological indicators, whilst setting higher standards, compared to those of the BWD. Bathing waters under the rBWD are classified as excellent, good, sufficient or poor according to the levels of certain types of bacteria (intestinal *enterococci* and *Escherichia coli*) in samples obtained during the bathing season (May to September).

The BWD was repealed at the end of 2014 and monitoring of bathing water quality will be reported against rBWD indicators from 2015. The new classification system considers all samples obtained during the previous four years and, therefore, data has been collected for rBWD indicators since 2012.

However, this means rBWD classifications between 2012 and 2014 are 'projected' due to changes to the monitoring regime and the first official classification under this regime will be published towards the end of 2015, when there is a full four-year dataset. The UK Government's target under the rBWD is to achieve 'sufficient' for all bathing waters by 2015, as described under the Bathing Water Regulations 2013 which transposes the rBWD into UK law.

There is one bathing water (Pagham) situated within 2 km of the proposed works. Bathing water quality at Pagham, located approximately 1.5 km (sample point) to the east, has routinely been projected as excellent over the last three years (2012–2014) based on the rBWD.

H.3.2 Shellfish Waters Directive

The Shellfish Waters Directive was originally adopted on 30 October 1979 (79/923/EEC) and replaced on 12 December 2006 (2006/113/EC). It was developed in order to protect designated shellfish waters, thereby maintaining the high water quality necessary for producing edible shellfish (bivalve and gastropod molluscs, including oysters, mussels, cockles and clams). It set physical, chemical and microbiological water quality requirements that designated shellfish waters must either comply with ('mandatory' standards) or endeavour to meet ('guideline' standards), including:

- * Dissolved oxygen – Measured as percentage saturation, should exceed 70% (as a mean), and individual measurements may not be less than 60% unless there are no harmful consequences on the development of shellfish colonies; and
- * Suspended solids – A discharge affecting shellfish waters must not cause the suspended solid content of the water to exceed by more than 30% the content of waters not so affected.

The Shellfish Waters Directive was subsumed (repealed) by the WFD at the end of 2013, which must provide an equivalent level of protection for shellfish waters.

There are no shellfish waters situated within 2 km of the proposed works, with Chichester Harbour (Chichester Channel, Thornham Channel and Emsworth Channel) being the closest at a distance of >15 km to the west. Consequently, the footprint of effect from the proposed works will not overlap with any shellfish waters and this receptor is scoped out of further assessment.

H.3.3 Urban Waste Water Treatment Directive

The Urban Waste Water Treatment Directive (UWWTD) (91/271/EEC) aims to protect the environment from the adverse effects of the collection, treatment and discharge of urban waste water. It sets treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges. In general, the UWWTD requires that collected waste water is treated to at least secondary treatment standards for significant discharges. Secondary treatment is a biological treatment process where bacteria are used to break down the biodegradable matter (already much reduced by primary treatment) in waste water. Under the UWWTD, the UK is required to review environmental waters at four-yearly intervals to determine whether they are sensitive to the effects of sewage discharges.

Sensitive areas under the UWWTD are water bodies affected by eutrophication due to elevated nitrate concentrations and act as an indication that action is required to prevent further pollution caused by nutrients. Nutrients are a particular problem for Pagham Harbour and it has been designated as a "Sensitive Area (Eutrophic)" under the UWWTD (Defra, 2012), located within 2 km of the proposed works.

H.3.4 Nitrates Directive

The Nitrates Directive (91/676/EEC) aims to reduce water pollution from agricultural sources and to prevent such pollution occurring in the future (nitrogen is one of the nutrients that can affect plant growth). Surface waters have to be identified if too much nitrogen has caused a change in plant growth which affects existing plants and animals and the use of the water body.

The Pagham Harbour and Sussex water bodies are both designated under the Nitrates Directive (Environment Agency, 2009a). In addition, areas to the south-west and north of Pagham Harbour and the entirety of Church Norton Spit are designated as Nitrate Vulnerable Zones (NVZs)⁴.

H.3.5 Protected Areas

Article 3 of the Habitats Directive (92/43/EEC, as amended) requires the establishment of a European network of important high-quality conservation sites known as Special Areas of Conservation (SACs) that will contribute to conserving habitat and species identified in Annexes I and II of the Directive. The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds). In accordance with Article 4 of the EC Birds Directive (2009/147/EC), Special Protection Areas (SPAs) are strictly protected sites classified for rare and vulnerable birds (Annex I of the Directive), and for regularly occurring migratory species. Ramsar sites are wetlands of international importance designated under the Ramsar Convention (adopted in 1971 and came into force in 1975), providing a framework for the conservation and wise use of wetlands and their resources.

⁴ Environment Agency - What's In Your Backyard: http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683&y=355134&scale=1&layerGroups=default&sep=map&textonly=cff&lang=_e&topic=nvz#x=488213&y=96944&lg=1,&scale=7.

The following international nature conservation designations are located within 2 km of the proposed works:

- ✧ Pagham Harbour SPA; and
- ✧ Pagham Harbour Ramsar.

The proposed works at Pagham directly overlap with both the Pagham Harbour SPA and Pagham Harbour Ramsar site. Where a Natura 2000 protected area forms part of a water body or where a water body lies within a Natura 2000 protected area, the WFD status objectives apply in addition to the requirement to maintain favourable conservation status or restore it to that status under the Habitats Regulations. Both water bodies potentially affected by the works at Pagham (i.e. Sussex and Pagham Harbour) are designated as Natura 2000 protected areas.

A European Marine Site (EMS) is the collective term used to refer to SACs and SPAs that are covered by tidal water and protect some of the most special marine and coastal habitats and species of European importance. They are defined by the Conservation of Habitats and Species Regulations 2010 (SI 2010/490), which transpose the EC Birds Directive (2009/147/EC) and EC Habitats Directive (92/43/EEC) into national law. The proposed works at Pagham directly overlaps with the Pagham Harbour EMS (English Nature, 2001), which comprises the Pagham Harbour SPA and refers to the Pagham Harbour Ramsar site.

H.4 Water Framework Directive Assessment

H.4.1 Assessment Methodology

Adjustment of the shoreline morphology within transitional (estuarine) and coastal (marine) environments has the potential to either cause deterioration in the ecological or chemical status/potential of a water body, or to compromise improvements which might otherwise lead to a water body meeting its WFD objectives. Potential impacts associated with the proposed works at Pagham could, for example, include:

- ✧ Changes to morphology, water depth and bed substrate;
- ✧ Changes in current speeds and consequent changes to erosion or deposition patterns;
- ✧ Temporary increases in suspended sediment levels;
- ✧ Remobilisation of contaminated sediments from the seabed sediments; and
- ✧ Disturbance of fish and ecology.

Information relating to the scale of the proposed works is summarised in Table H2.

Table H2. Summary of Proposed Works

Parameter	Detail
Location of breach and existing channel to be infilled	See Figure H2 (ABPmer, 2015 Figure 2.2). Proposed works to be located wholly within Sussex water body.
Area of spit to be breached (including side slopes)	19,580 m ² (1.96 ha)
Area of existing channel to be infilled	7,125 m ² (0.71 ha)
Volume of material to be excavated	An excavated volume of around 42,000 m ³ (below 3.0 mODN) with an expected additional 10,500 m ³ needing to be excavated above the +3.0 mODN elevation.
Breach methodology	Heavy plant machinery will be used to breach the spit and excavate material. See Section 3.2.2 of main report.
Infill methodology	Heavy plant machinery will be used to transport the excavated material from the breach to the infill site in the existing channel and/or to stockpile it adjacent to the infill channel until a final push of material is coordinated with the breach of the spit. See Section 3.2.3 of main report.
When the works are planned to be undertaken	Works planned to commence in September 2016 for around 8 to 11 weeks in total (weather depending).

The WFD compliance assessment must determine whether the proposed works at Pagham could cause a change to the status of WFD water bodies or change the ability of a water body to meet its future objectives. The outcome of this assessment process is provided in Table H3 which includes consideration of the construction works (breach and infill) and the subsequent 'operational' phase (i.e. water body conditions post-construction).

Table H3. WFD Compliance Assessment

WFD Parameter	Water Body Assessment	
	Sussex	Pagham Harbour
Invertebrates	During construction, inter-tidal (and sub-tidal) habitat within the Sussex water body will be disturbed where Church Norton Spit is breached and the existing channel is infilled. Coarse sediment (shingle) shores tend to support very low macrofaunal abundance in their mobile and freely draining substratum. The few individuals that may be found are those washed into the habitat by the ebbing tide (e.g. from within Pagham Harbour), including the occasional amphipod or small polychaete. DeFolin's Lagoon Snail (<i>Caecum armoricum</i>), a nationally rare gastropod protected under Schedule 5 of the (1981) Wildlife and Countryside Act in 1992, has been occasionally found along Church Norton Spit. Sheltered saline water bodies are thought to provide the optimal habitat for this species, and to a lesser extent the landward edge of the spit (i.e. within Pagham Harbour as opposed to the exposed, seaward side). Overall, the direct loss of invertebrates and supporting habitat is considered insignificant. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as good in 2009 and 2014).	The mudflats of Pagham Harbour are rich in invertebrates, particularly polychaetes such as the lugworm <i>Arenicola marina</i> and the ragworm <i>Nereis diversicolor</i>. DeFolin's Lagoon Snail (<i>Caecum armoricum</i>), a nationally rare gastropod protected under Schedule 5 of the (1981) Wildlife and Countryside Act in 1992, has been occasionally found along Church Norton Spit. Sheltered saline water bodies are thought to provide the optimal habitat for this species, and to a lesser extent the landward edge of the spit (i.e. within Pagham Harbour water body). The proposed works (breach and infill) are not located within the Pagham Harbour water body and, therefore, there will be no direct loss/disturbance of habitat. Post-construction, Pagham Harbour is expected to fill and drain in much the same manner as present due to the carefully calculated breach dimensions. Therefore, as the scheme will only result in very small changes to water levels and tidal flows, minimal impact is anticipated for the benthic invertebrate community and supporting habitats. Sediment contamination levels are typically low in Pagham Harbour (see Section 7.1.4 of main report). Therefore, disturbance of coarse sediments within Church Norton Spit (downstream of Pagham Harbour) would be expected to result in minimal release of contaminants. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as good in 2009 and 2014).
Macroalgae	Not assessed.	Any macroalgae (seaweed) within the direct footprint of the scheme will be lost during the breach and infill activities. However, the proposed works are not located within the Pagham Harbour water body and, therefore, there will not be direct loss/disturbance of such habitat. Macroalgae within Pagham Harbour could be affected by changes in current velocities; however, Pagham Harbour is expected to fill and drain in much the same manner as present due to the carefully calculated breach dimensions. Pagham Harbour is designated a "Sensitive Area (Eutrophic)" under the UWWTD (Defra, 2012) and, therefore, the critical consideration relates to excessive nutrient availability and large scale macroalgae production. The proposed works are unlikely to significantly increase the nutrient concentration in the water column due to the low organic content anticipated in the sediment comprising Church Norton Spit. In other words, the proposed works will not introduce or result in the redistribution of nutrients in the marine environment and, therefore, would not be expected to result in excessive macroalgal growth.

WFD Parameter	Water Body Assessment	
	Sussex	Pagham Harbour
		The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as moderate in 2009 and 2014), nor prevent the potential achievement of good status/potential.
Phytoplankton	There is no obvious mechanism by which dredging (breach) and disposal (infill) activities could affect phytoplankton at water body level (Environment Agency, 2012). The dominant controls on phytoplankton are light availability, nutrients and salinity (Environment Agency, 2009b). Changes in salinity and light availability are not expected to have a material effect at a water body level compared to existing conditions, while excessive nutrient concentrations are not an issue for this large coastal water body. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as good in 2014).	There is no obvious mechanism by which dredging (breach) and disposal (infill) activities could affect phytoplankton at water body level (Environment Agency, 2012). The dominant controls on phytoplankton are light availability, nutrients and salinity (Environment Agency, 2009b). Changes in salinity and light availability are not expected to have a material effect at a water body level compared to existing conditions. Pagham Harbour is designated a "Sensitive Area (Eutrophic)" under the UWWTD (Defra, 2012) and, therefore, the critical consideration relates to excessive nutrient availability and potential eutrophication. The proposed works are unlikely to significantly increase the nutrient concentration in the water column due to the low organic content anticipated in the sediment comprising Church Norton Spit. In other words, the proposed works will not introduce or result in the redistribution of nutrients in the marine environment and, therefore, would not be expected to result in excessive phytoplankton growth. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as high in 2009 and 2014).
Angiosperms	Not assessed.	Angiosperm is a general term applied to flowering plants. For the purposes of this assessment, it is defined as a type of seagrass habitat (<i>Zostera</i> species). In 2014, the extent of seagrass beds in Pagham Harbour measured approximately 3.4 ha (Environment Agency spatial data). There is no seagrass habitat located within the direct footprint of the scheme and therefore this habitat will not be lost during the breach and infill activities. Furthermore, the proposed works are not located within the Pagham Harbour water body and, therefore, there will be no direct loss/disturbance to such habitat. Despite their small extent, seagrass beds are important habitats in Pagham Harbour in ecological terms, providing supporting habitats for the bird interest features of the Pagham Harbour SPA, and are susceptible to the inundation of sediment. However, the proposed works are not anticipated to significantly increase sedimentation rates, and Pagham Harbour is expected to fill and drain in much the same manner as present due to the carefully calculated breach dimensions. In addition, the proposed works are designed to prevent a potentially unmanaged breach of the spit which could result in significant changes to sediment re-suspension and deposition rates in Pagham Harbour.

WFD Parameter	Water Body Assessment	
	Sussex	Pagham Harbour
		The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as moderate in 2014), nor prevent the potential achievement of good status/potential.
Dissolved Inorganic Nitrogen	Sussex water body is a large coastal water body, for which nutrient enrichment is not considered an issue (e.g. HMWB morphological designation is not related to the Nitrates Directive), and the proposed works will not introduce or result in the redistribution of nutrients in the marine environment. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as good in 2014).	Pagham Harbour is designated a "Sensitive Area (Eutrophic)" under the UWWTD (Defra, 2012) and, therefore, the critical consideration relates to excessive nutrient availability and potential eutrophication. The proposed works (breach and infill) are not located within the Pagham Harbour water body and will not introduce or result in the redistribution of nutrients in the marine environment. While the Pagham Harbour water body is designated a sensitive area, the sediment to be disturbed as part of the proposed works is coarser (e.g. shingle, sand and gravel) and likely to contain much lower nutrient loads. In addition, the proposed works are designed to prevent a potentially unmanaged breach of Church Norton Spit which could result in a large scale disturbance of nutrient-rich sediments due to significant changes in the hydrological regime/flushing rate of Pagham Harbour. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as moderate in 2009 and high in 2014), nor prevent the potential achievement of good status/ potential.
Dissolved Oxygen	The potential increase in suspended sediment concentrations associated with the breach could theoretically lead to subtle changes in oxygen concentration (demand). No dissolved oxygen or oxygen saturation data is available for the Pagham Beach area (i.e. outside Pagham Harbour), but values would be anticipated to be relatively high due to the open nature of the coast and the lack of organic material and industrialisation (Royal Haskoning, 2013). The anticipated effects of the proposed works are short-term and small scale; thus, dissolved oxygen concentrations and saturation are unlikely to be an issue at the water body level. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as high in 2014).	The proposed works are not located within the Pagham Harbour water body; however, the potential increase in suspended sediment concentrations associated with the breach and channel infill could theoretically lead to subtle changes in oxygen concentration (demand) for this water body. Based on available information (Environment Agency monitoring data; see Section 7.1.3.2 of main report), both annual mean dissolved oxygen concentration (8.7 mg/L) and oxygen saturation (99.5%) within the Pagham Harbour water body are high. The anticipated effects of the proposed works are short-term and small scale; thus, dissolved oxygen concentrations and saturation are unlikely to be an issue at the water body level. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as high in 2009 and 2014).
Mitigation Measures Assessment	The South East RBMP (Environment Agency, 2009a) highlights a number of mitigations measures currently 'not in place'. The anticipated effects of the proposed works are largely within the scale of existing natural variability, and are not considered to contradict these mitigation measures should they be introduced. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as moderate in 2009 and 2014), nor prevent the potential achievement of good status/potential.	Not assessed.

WFD Parameter	Water Body Assessment	
	Sussex	Pagham Harbour
Hydrological Regime	Not assessed.	Changes in the locality of water flow will occur as a result of the proposed works (i.e. closure of existing channel and new flow through the breach); however, Pagham Harbour is expected to fill and drain in much the same manner as present due to the carefully calculated breach dimensions. In addition, the proposed works are designed to reduce the uncertainties that currently exist with respect to how the recent unmanaged breach of Church Norton Spit might evolve. That current breach is dynamic and in a state of flux and it could result in significant alterations to the hydrological regime. The proposed works are not anticipated to cause deterioration in status for this parameter (assessed as good in 2014).
Specific Pollutants	Church Norton Spit is characterised by steep upper beaches and shallower mid-beaches mostly composed of a flint shingle, which grades to coarse sand and granules on the extensive low gradient foreshore. Due to the coarse nature of these sediments, the potential for contaminant accumulation is low. Therefore, based on the low contaminant concentrations within Pagham Harbour (higher silt fraction and thus likely higher contaminant concentrations; see Section 7.1.4 of the main report), sediment quality is considered to be good at the location of the breach. The proposed works are not anticipated to cause deterioration in status for these parameters.	Water quality is good within Pagham Harbour, with contaminant concentrations typically well below the annual average EQS (Environment Agency monitoring data; see Section 7.1.3.5 of main report). One sample for chromium and one sample for zinc exceeded the annual average EQS; however, the chromium concentration was less than the maximum allowable concentration EQS and, given the mean concentration for both metals was below the annual average EQS, these elevated values are not considered a major concern. Based on available information (Environment Agency sediment data; see Section 7.1.4 of main report), mean sediment contaminant concentrations were below Cefas Action Level 1 for the majority of samples obtained, with exceptions for arsenic, chromium and copper. There is a small potential for sediment-bound contaminants to be mobilised as the tide flows across after breaching. However, the proposed works are not located within the Pagham Harbour water body. Instead, Church Norton Spit is characterised by steep upper beaches and shallower mid-beaches mostly composed of a flint shingle. Due to the coarse nature of these sediments, the potential for contaminant accumulation is low. Therefore, it is unlikely that contaminants will be mobilised into Pagham Harbour as a result of the breach. The Pagham Harbour water body is assessed as failing to achieve good chemical
Priority Substances		
Priority Hazardous Substances		

WFD Parameter	Water Body Assessment	
	Sussex	Pagham Harbour
Other Pollutants		status in the 2014 interim results due to fluoranthene. However, fluoranthene concentration in sediments collected from within Pagham Harbour is less than the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life threshold effect level (TEL) and the proposed works will not introduce or result in the redistribution of this chemical in the marine environment. The proposed works are not anticipated to cause deterioration in status for these parameters.
Protected Areas	Pagham Bathing Water is located within 2 km of the proposed works and has therefore been scoped into the assessment. The material to be excavated is predominantly coarse and, therefore, any sediment mobilisation will be highly localised; it is considered unlikely that sediment will be dispersed to the Pagham Bathing Water. As described above, the coarse nature of the sediment (and the related strong tidal flows and high wave exposure conditions that characterise the environment) indicates that contaminant concentrations will be low and it is unlikely that significant levels of microbial material will be present (also see Section 7 of the original ES). Therefore, water quality at the bathing water (around 700 m distance from the excavation/infill area) is unlikely to be deteriorated by the proposed works and the bathing water classification will not be affected. Furthermore, it should be noted that the direction in which any small-amounts of pollutants or microbial material that are present will be carried will be largely away from the bathing water given the change in position of the channel. In the longer term, the entire project will help to re-direct the water draining from Pagham Harbour away from the bathing water area so there will be manifest longer-term benefits to the bathing water areas from the works. The proposed works are located within the boundary of the Pagham Harbour SPA and Ramsar sites. Separate studies (the original ES and ABPmer, 2016) have concluded that the proposed works at Pagham will not result in significant adverse effects to these internationally designated sites. Some disturbance to nesting birds during the operational phase is possible as the sites may be more accessible and prone to disturbance by humans. Such disturbance effects will be mitigated (including through adherence to good working practices). There are uncertainties also in respect of the effects on Little Tern nesting habitats but these uncertainties are being dealt with through the application of mitigation and compensation measures. Pagham Harbour is designated a "Sensitive Area (Eutrophic)" under the UWWTD (Defra, 2012) and areas surrounding Pagham Harbour are designated NVZs; therefore, the critical consideration relates to excessive nutrient availability and potential eutrophication. The proposed works (breach and infill) are not located within the Pagham Harbour water body and will not introduce or result in the redistribution of nutrients in the marine environment. While the Pagham Harbour water body is designated a sensitive area, the sediment to be disturbed as part of the proposed works is coarse (e.g. shingle, sand and gravel) and likely to contain low nutrient loads. In addition, the proposed works are designed to manage the risks of ongoing change from the recent unmanaged breach of Church Norton Spit and there will be ongoing management and oversight of the breach once it has been excavated (ABPmer, 2016) Therefore, the proposed works are not anticipated to cause deterioration of the protected areas, nor prevent the Sussex coastal water body or Pagham Harbour transitional water body from meeting their WFD objectives with respect to these parameters.	

In the original planning submission it was anticipated that a temporary causeway would need to be created (supported by sheet-steel piling) to provide low water access during the construction phase (Section 3.2.1). Under such a scenario, a vibratory hammer would be used to drive the sheet piles for this causeway to minimise noise disturbance to marine fauna. This temporary structure, if needed, would be removed once construction work has been completed and any impacts, at water body level, will be similar to those associated with the infilling of the existing channel.

During recent procurement reviews, however, a second opinion on the methods for the work (in addition to that obtained for the ES) was provided by a specialist with a high level of local knowledge and was informed by the natural breaching processes that have been witnessed on site. This natural breach has illustrated how the managed breach could potentially be more sensitively implemented without the need for sheet-steel piling but instead by more closely replicating the natural process of: opening one channel at the preferred location; allowing two channels to operate for a period before then closing the old channel. Adopting this approach would probably take less time than that proposed in the ES (estimated as 8 weeks) and would reduce any impacts during the construction phase.

The assessment terminology used in Table H3 refers to the objectives set under the WFD for all water bodies, whereby developments/schemes must:

- ✧ Not cause deterioration in status/potential;
- ✧ Not prevent the achievement of good status/potential;
- ✧ Not infringe or be in breach of other legislation; and
- ✧ Where possible, attempt to enhance the environment.

The proposed works are not considered to contradict other legislation and the potential environmental benefits of the project are discussed in Section 2 of the main ES report.

Based on the suite of WFD parameters reported for the Sussex and Pagham Harbour water bodies in Table H1, the following parameters (those currently failing to achieve good status/potential) are assessed against the first two objectives listed above:

- ✧ Sussex water body:
 - Mitigation Measures Assessment.
- ✧ Pagham Harbour water body:
 - Macroalgae;
 - Angiosperms;
 - Dissolved Inorganic Nitrogen (although classified as good in 2013 and high in 2014); and
 - Fluoranthene.

The remaining parameters are assessed against the objective of not causing deterioration in status/potential from their current classification of good or high. In some instances, WFD parameters were not assessed as part of the ES (see main report) and, therefore, the potential impact(s) of the project have been considered separately.

H.4.2 Contributing to Improvements in WFD Status/ Potential

The proposed works are primarily driven by the need to move the coastline towards a more sustainable morphology and to help address the coastal erosion problems being experienced on

Pagham Beach as well as achieving other benefits for nature and the community. It is overly optimistic to conclude that the proposed works will lead to a direct improvement in status/potential of one or more WFD parameters. However, the works are expected to marginally improve the tidal flushing of Pagham Harbour, thus potentially improving water quality by reducing the risk of excessive nutrient build-up which can lead to eutrophic events. Furthermore, compared to the existing condition, the proposed works provide greater certainty of benefit and enhanced stability of the physical environment and will direct out-flowing waters offshore rather than along the coast and towards the Bathing Waters. Therefore, it is concluded that the proposed project will support the status and future objectives of nearby water bodies.

The recent unmanaged breach of Church Norton Spit is likely to be highly mobile and unstable. Increased suspended sediment concentrations may arise as it continues to change. This may impact WFD parameters such as invertebrates, phytoplankton, angiosperms, macroalgae and dissolved oxygen. In addition, the ecological potential for dissolved inorganic nitrogen could deteriorate (assessed as high in 2014) due to changes in the hydrological regime/flushing rate of Pagham Harbour; a particular concern given that Pagham Harbour is designated a "Sensitive Area (Eutrophic)" under the UWWTD (Defra, 2012).

H.5 Conclusion

This WFD compliance assessment considers the anticipated effects of the proposed works on the Sussex and Pagham Harbour water bodies, determining whether they will be significantly affected in terms of specific quality elements and their overall objectives. While the project is expected to lead to some small adverse impacts on the marine environment during the construction phase (breach and infill), these are short-term, small scale and localised. In addition, the project could arguably provide a relative improvement in WFD status/potential compared to the uncertain consequences of the recent unmanaged breach of Church Norton Spit. Therefore, it is concluded that the proposed works at Pagham will support nearby water body status and their future objectives.

H.6 References

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H.7 Abbreviations/Acronyms

AWB	Artificial Water Body
BWD	Bathing Water Directive
CD	Chart Datum
Cefas	Centre for Environment, Fisheries and Aquaculture Science
Defra	Department for Environment, Food and Rural Affairs
DIN	Dissolved Inorganic Nitrogen
EA	Environment Agency
EC	European Commission
EEC	European Economic Community
EMS	European Marine Site
EQS	Environmental Quality Standards
ES	Environmental Statement
EU	European Union
GES	Good Ecological Status
GEP	Good Ecological Potential
HMWB	Heavily Modified Water Body
ID	Identity
NVZ	Nitrate Vulnerable Zones
ODN	Ordnance Datum Newlyn
PFD SG	Pagham Flood Defence Steering Group
PPC	Pagham Parish Council
Ramsar	Wetlands of international importance, designated under the Convention on Wetlands (Ramsar, Iran, 1971)
RBMP	River Basin Management Plan
rBWD	Revised Bathing Water Directive
SAC	Special Area of Conservation
SI	Statutory Instruments
SPA	Special Protection Area
TEL	Threshold Effect Level
UK	United Kingdom
UWWTD	Urban Waste Water Treatment Directive
WFD	Water Framework Directive

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Figures





Figure H1. Water/Sediment Quality Designations and Monitoring Sites (Original Figure 7.1 of R.2446 Main Report)

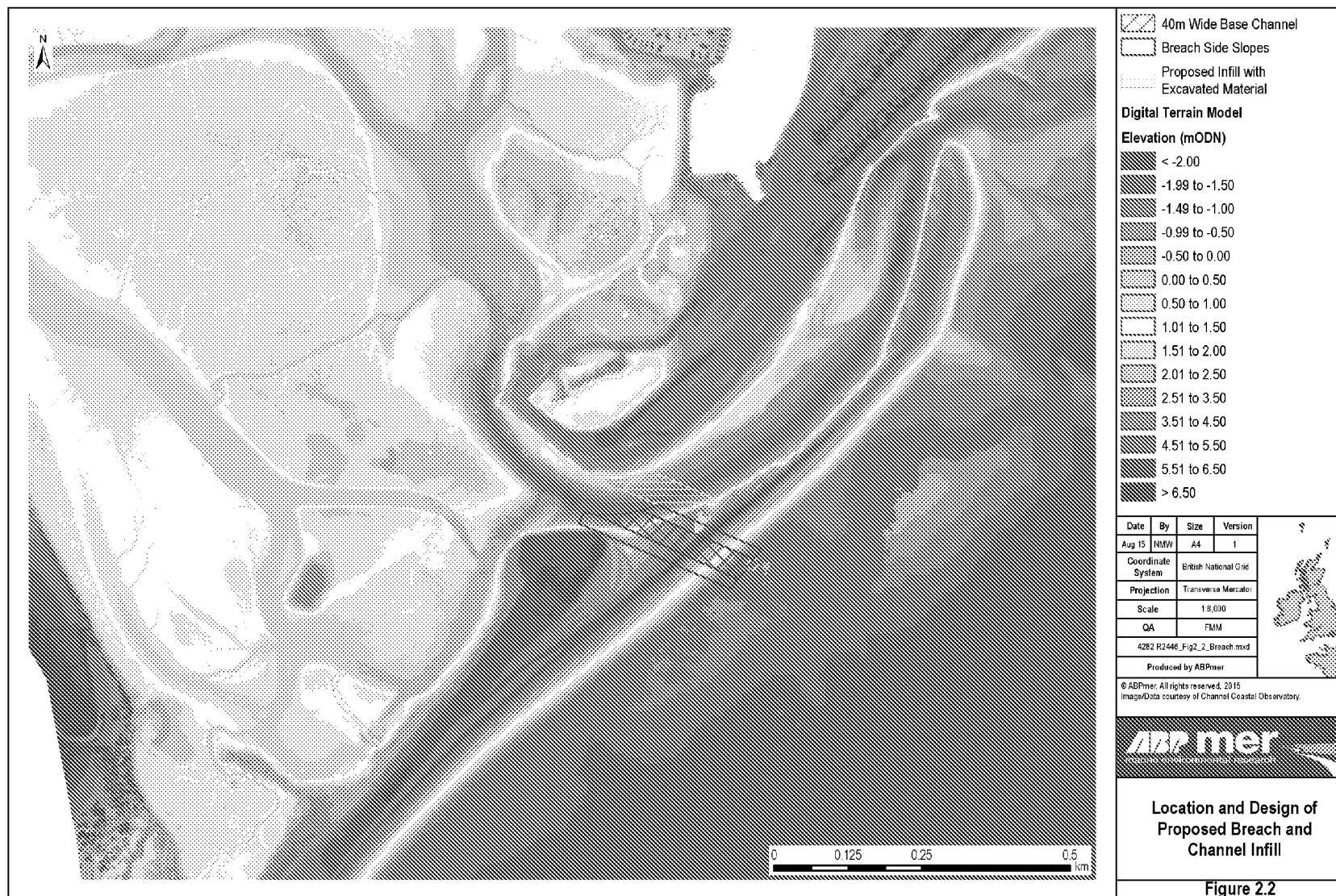


Figure H2. Location and Design of Proposed Breach and Channel Infill (Original Figure 2.2 of R.2446 Main Report)



ABP Marine Environmental Research Ltd (ABPmer)
Quayside Suite, Medina Chambers, Town Quay, Southampton SO14 2AQ



Creating sustainable solutions for the marine environment